REPORT

UPON

COTTON INSECTS,

PREPARED

UNDER THE DIRECTION OF THE COMMISSIONER OF AGRICULTURE IN PURSUANCE OF AN ACT OF CONGRESS APPROVED JUNE 19, 1878.

BY

J. HENRY COMSTOCK,
ENTOMOLOGIST TO THE DEPARTMENT OF AGRICULTURE.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1879.

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IN THE SENATE OF THE UNITED STATES,
March 3, 1879.

The following resolution was agreed to by the Senate January 28, 1879, and concurred in by the House of Representatives March 3, 1879:

Resolved by the Senate (the House of Representatives concurring), That there be printed 10,000 copies of the special report from the Department of Agriculture on the insects affecting the cotton plant, with the necessary illustrations, to be made by the Public Printer under the sanction of the Joint Committee on Public Printing, 5,000 of which shall be for the use of the House of Representatives, 3,000 for the use of the Senate, and 2,000 for the use of the Department of Agriculture.

Attest:

GEO. C. GORHAM,
Secretary.

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LETTER TO THE COMMISSIONER.

WASHINGTON, *November* 14, 1879.

SIR: In accordance with the instructions which I received from you when entering upon my duties as Entomologist to the Department of Agriculture, I have the honor to submit a report of the investigation of insects injurious to the cotton plant, which has been carried on by this department. This investigation was begun July 1, 1878, and was continued until the close of the present season.

The following extract from the annual report of this department for 1878 (pp. 210–215), gives the history of that part of the investigation conducted by my predecessor, Prof. C. V. Riley.

Pursuant to an appropriation by the last Congress for the purpose, and in accordance with your instructions, I have carried on a special investigation of the insects injurious to the cotton plant. The commission of inquiry was organized by the appointment of the following gentlemen: As special agents, Prof. J. H. Comstock, of Ithaca, N. Y., whose position as professor of entomology in Cornell University and whose experience with insects injurious to vegetation had well fitted him for such labor; and Prof. A. R. Grote, of Buffalo, N. Y., whom a residence of several years at Demopolis, Ala., and a special study of the cotton-worm, had also well prepared for the inquiry. As local agents and observers: Dr. E. H. Anderson, of Kirkwood, Miss.; William J. Jones, of Virginia Point, Tex.; Prof. J. E. Willet, of Macon, Ga.; and Prof. Eugéne A. Smith, of Tuscaloosa, Ala. Mr. E. A. Schwarz, of Detroit, Mich., has also been engaged during the winter to visit all the Southern States and the West India islands, with a special view of getting at the facts of hibernation. To Prof. Comstock was assigned the cotton region of Arkansas and Tennessee, and of Mississippi and Alabama north of Vicksburg and Meridian and the Alabama Central Railroad; to Mr. Grote that of Florida and Georgia, and of Alabama south of the railroad mentioned; while, with the assistance of the local observers, I have myself given more especial attention to the extremities of the belt, viz, Texas, Louisiana, Southern Mississippi, and the Carolinas.

The following circular-letter was prepared for the use of agents, and distributed, with corresponding blanks, to correspondents in the cotton belt. It will explain the scope of the inquiry:

DEPARTMENT OF AGRICULTURE,
Washington, D. C., July 22, 1878.

SIR: The entomologist of the department having prepared a series of inquiries for the special scientific observers to whom has been assigned the duty of studying the history and depredation of the worm known as *Aletia argillacea*, as well as other insects which injure the cotton plant, I have caused copies of these circulars to be printed and sent you, in hope that you may feel interest enough in the subject to make report thereon.

Should you do so, please observe carefully the following suggestions:

Write only on one side of the paper blanks sent; and, if more room is desired to answer fully, write on another sheet, numbering and lettering to correspond with letter and number of question.

If any special points arise before the termination of the season, please communicate freely, marking your envelope "cotton insects."

Respectfully, &c.,

WM. G. LE DUC, *Commissioner.*

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THE COTTON-WORM.

This insect (*Aletia argillacea*,* Hübn.) will naturally receive most attention, being, as it is, by far the most injurious of the different enemies of the cotton plant. Data are requested on all the following topics:

PAST HISTORY OF THE COTTON-WORM.

1. Give, so far as you can from trustworthy records, the earliest year in which cotton was grown in your State, county, or locality.

1*a*. During what year (exact or approximate) did the worm first make its appearance in your locality, and, as far as you are aware, in the State; in other words, how many years elapsed after cotton first began to be grown before the worm began to work upon it?

1*b*. Specify the years when it has been unusually abundant and destructive.

INFLUENCE OF THE WEATHER ON THE INSECT.

2 State what you know from experience of the effects of weather on the insect, and more particularly—

2*a*. The character of seasons most favorable to its increase.

2*b*. The character of the summer and winter—whether wet or dry, mild or severe—that have preceded years in which the worm has been abundant and destructive.

2*c*. Do wet summers favor its multiplication?

2*d*. Effects of different kinds of weather on the eggs.

2*e*. Effects of different kinds of weather on the moths.

2*f*. Month of year when greatest injury is done.

STATISTICS OF LOSSES.

3. Give, as correctly as you can, estimates of the loss to the crop in your county and State during notable cotton-worm years.

MIGRATIONS OF THE MOTHS.

It is a well-established fact that the parent moth of the cotton-worm is often found in autumn many hundred miles away from the cotton belt, and there is no reason to doubt that it is often carried by favorable winds to northward regions where it cannot perpetuate its species and must therefore perish. Mr. A. R. Grote and others even believe that the species perishes each year with the plant, and that the moth always comes into the cotton States from more Southern countries, where the cotton plant is perennial; in other words, that the moth is habitually migratory and cannot survive the winter in the great cotton regions of the States. While there are many facts that lend weight to this theory, there is, also, much to be said against it; and we desire to collect all facts that in any way bear on the question. While we hope to get much valuable information on this head from the Signal Bureau, we also ask for the experience of correspondents.

4. Please state, therefore, as nearly as you can from the records, the *prevailing* direction and force of the wind in your locality, first,

4*a*. In the month of February; second,

4*b*. In the month of March; third,

4*c*. In the month of April; fourth,

4*d*. In the month of May; fifth,

4*e*. In the month of June; sixth,

4*f*. Whether, in your opinion, there are winds from the south that are sufficiently strong and constant to counteract the prevailing trade-winds which are toward the equator.

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* The *Noctua xylina* of Say.

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4*g*. The prevailing direction of the wind from July till frost.

4*h*. The side of a field on which the worms first begin to work.

4*i*. Do local topographical features influence the extent of the worm's ravages?

4*j*. Does or can the worm feed upon any other plant than cotton, and have you ever known it to do so?

HABITS AND NATURAL HISTORY.

These have already been studied, and are pretty well known; but experience will differ somewhat with local ty, and we call attention to the following topics:

5. State the time when the first moths are noticed in your locality.

5*a*. Date when the first worms have been noticed in past years.

5*b*. Date when the last worms have been seen in past years, or were noticed the present year.

5*c*. Number of broods or generations of the worms generally produced.

5*d*. In what other situations besides the folded cotton leaves have you known the worms to spin?

5*e*. Have you ever known the chrysalis to survive a frost, or to be found in sound and healthy condition in winter?

5*f* Have you ever found the moth hibernating or flying during mild winter weather?

5*g*. How late in the spring has the moth been found alive?

NATURAL ENEMIES.

It is a little singular that no enemies of the cotton-worm have hitherto been reported. That the insect has its enemies, both special and general, there can be little doubt, and we would ask particular attention to the following topics:

6. Are any birds, quadrupeds, or reptiles known to attack the insect in your locality?

6*a*. Are any predaceous insects or parasites known to prey upon it, either in the egg, larva, or chrysalis state?

REMEDIES AND METHODS OF DESTRUCTION.

7. What has been the result of the efforts to allure and destroy the moths, and what methods have proved most satisfactory? Give your estimate of the relative value for this purpose of poisoned sugar, molasses and vinegar, and fires.

7*a*. Are the moths most attracted to sweetened substances when smeared onto trees, boards, etc., or when contained in vessels in or near which lamps may be lighted?

7*b*. Are any flowers known to be attractive to the moth? If so, specify them and their season of blooming.

7*c*. What do you know of your own observation of the influence of jute grown near or with the cotton?

7*d*. Has any effort beeen made to destroy the moth in its winter quarters?

7*e*. Have any systematic and organized attempts been made to gather and destroy the chrysalides, or to facilitate their collection and destruction by furnishing inviting material for the worms to sp n up in?

7*f*. What has been done toward destroying the eggs?

7*g*. Has anything been found more generally useful and applicable or cheaper than the use of the Paris green mixture to destroy the worms.

7*h*. Have you known of any injurious effects following the use of this poison, either to the plant, to man, or to animals?

7*i*. State what you consider the best and most effective method of destroying them in your section.

7*j*. State the cost per acre of protecting a crop by the best means employed.

☞ *We shall be glad to receive figures, either photographs or drawings, of machines or contrivances employed for the wholesale use of the Paris green mixture, either in the fluid state or as a powder; or any other kinds of machines or traps employed for the destruction of the insect. Models of such are still more desirable, and may be sent by express unpaid to the department.*

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OTHER COTTON INSECTS.

There are many other insects that attack and do more or less injury to the cotton plant. Many of these have been figured and referred to by the former entomologist to the department, Mr. Townend Glover, but there is much yet to learn of their habits and natural history and of the best means of subduing them. Specimens of all insects that may be found upon the plant are, therefore, earnestly solicited, with accounts of their work and habits and the amount of injury they do. These specimens are best sent by mail, in tight .in or wood n boxes. If living (and all found feeding on the plant should thus be sent) a supply of food should be inclosed with them; if first killed, they should be carefully packed in a little cotton to prevent shaking and breaking.

☞ *Correspondents who desire to make especial observations with a view of replying to this circular, and who wish furthe information as to the best manner of preserving specimens, will receive assistance and further instructions upon communicating with the department.*

CHAS. V. RILEY,
Entomologist.

Two circumstances have somewhat interfered with the 'nquiry, viz, the yellow fever and the general freedom of the plant from the cotton-worm, the serious injuries of this last having been restricted to the cane-brake regions of Alabama and to the southwest counties of Georgia, especially the country between the forks of the Flint and Chattahoochee Rivers—the more malarious portions of either State. Its appearance n injurious numbers both here and in South Texas was from four to six weeks later than usual, and this was one cause of the small amount of injury done. The weather at the time of their greatest abundance was wet and interfered with the application of remedies.

Professor Comstock's observations were chiefly confined to that fertile cotton-growing region along the line of the Alabama Central Railroad, known as the "cane-brake." He reach d Selma July 20. There he met many prominent planters, and from them collected important statistics respecting the occurrence of the cotton-worm and the results of experiments in the use of remedies for this species. July 23 he began his field observations near Uniontown, Perry County, and from that time on, till the middle of October, he was constantly engaged in studying the habits of cotton insects on plantations in Dallas, Perry, Hale, and Marengo Counties. His only absence from this region was from August 10 to August 15, when I directed him to make a trip through the State northward as far as Madison County, where much cotton is grown. Professor Comstock has prepared a full and valuable report, which will be incorporated in the final report of the investigation.

Professor Grote's operations will appear by the following extract from a brief report submitted.

[Professor Grote's report is given in full in Appendix I of this work. J. H. C.]

Starting south myself the latter part of August, I passed through Tennessee to Mitchell County in Southwest Georgia, and thence, during September, through the cotton sections of the southeastern part of that State and of the Carolinas and Virginia. I was at this time made painfully aware of the hindering effects of the yellow fever. One can scarcely conceive of the panic and excitement that prevailed, even in regions where there was little or no danger. But a few weeks before in the thicker cotton counties of Alabama and Georgia the prevailing topic of conversation, as I learned, was the work of the Cotton-worm. At the time of my visit its injuries were forgotten in the all-absorbing subject of the epidemic. Cotton fields were neglected, and in sight of acres of stripped and spindling stalks one heard but the universal refrain—yellow fever, yellow fever. It seriously interfered with my own plans, and obliged me to avoid the very Mississippi cotton fields which I desired most to visit.

Notwithstanding this serious drawback to the present year's operations, much that is valuable and important has been learned. There is a very general want of knowl-

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edge among the people of the South regarding the real habits of the cotton-worm, and I find that the opinions of the most observant are seldom founded on intelligent observation; and that such opinions are consequently of little value. This state of things is due to three evident causes: First, the general unhealthiness of the region in which the insect does most damage, and the intense heat that prevails during the months when most of the observations must be made; second, the fact that the culture of the crop is turned over to uneducated and unobserving negroes; third, the failure to discriminate between the cotton-worm and the Boll-worm (*Heliothis armigera*) in their later stages, and the natural difficulty that besets the solution of some of the questions, such as the winter habits of the *Aletia*.

It had often been a wonder to me that no true parasite had ever been found infesting this insect since there scarcely exists a plant-feeding species that is not attacked by some parasite. No less than nine distinct species of these parasites have been discovered on the cotton-worm this summer, and this fact has an important bearing on several of the knotty questions that present themselves in our inquiry. Again, I had wondered what plants the moth naturally fed from, since it was known to be fond of sweets, and had, to my knowledge, done considerable injury by boring into various ripe fruits. The cotton plant is peculiar for having a gland on the under side of from one to three ribs of the more mature leaves, and a still larger gland at the outer base of the three lobes of the involucre. As soon as I learned that these glands secreted a sweetened liquid, I inferred that the plant would be found to furnish nourishment to the moth as well as to the larva, and drew attention to this belief in the Atlanta, Ga., Constitution of September 8, 1878. It was with no small degree of pleasure that at Baconton subsequently, in company with Professors Comstock and Willett, I was able to prove my anticipation correct, by studying the normal habits of the moth with a dark-lantern at night. The moth is, therefore, attracted to the plant by the sweets which this last affords, and as these sweets are first produced when the plant begins to flower and fruit, we have here a possible explanation of the well-known fact that the worm is seldom noticed on the young plant till about the time of fruiting. We have so discovered that the moth feeds on the honey copiously secreted from glands occurring at the apex of the peduncle just above the pods of the cow-pea (*Dolychos*), extensively grown through the South as a forage plant; also on the sweet exudation from the flowers of *Paspalum læve*, a tolerably common grass. It is by taking advantage of this love for sweets which the moth possesses that we shall probably arrive at one of the most effectual ways of preventing the ravages of the worm, for if we can allure the first moths of the season to certain death, we nip the evil in the bud.

Upon the 1st of May, 1879, Professor Riley's resignation taking effect at that date, I was placed by you in charge of the Entomological Division. The printing of a report upon the investigation had just been ordered. Two months of the fiscal year yet remained; and my first step was to secure the appointment of Mr. William Trelease, of Brooklyn, N. Y., as a special agent. Mr. Trelease was instructed to proceed to the canebrake region of Alabama, in order to make and report observations upon the first appearance of the worms, and upon several points respecting which there was doubt.

Upon reviewing the material which was at hand for the report it was found to consist chiefly of biological, statistical, and chronological data; but little work had been done as yet upon experiments with remedies, it having been Professor Riley's plan to leave the practical part of the investigation for the season of 1879. It was therefore deemed advisable that Mr. Trelease should be kept in the field until the appearance of the

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so-called "third crop" of the worms, in order that some efficient work might be done in this direction, and in order that the report might not be lacking in so important a particular.

Mr. Trelease, therefore, remained in Dallas County, Alabama, through the summer, confirming the observations of the agents of last year, and conducting an extensive series of experiments. He was recalled to this city September 15.

The report has been prepared as quickly as was consistent with the other labors of the division. Work was begun upon it as soon as I entered upon my duties, and has been progressing during the entire season.

Although a great part of the investigation was conducted under the direction of my distinguished predecessor, it is due to him, as well as to myself, to state that the writer alone is responsible for the opinions expressed and the conclusions drawn in the body of this report.

I take pleasure in acknowledging the valuable aid rendered by the special agents and local observers of the Entomological Division, whose names have already been given. Their special reports appear in Appendix I of this work. An extended correspondence has been carried on with each of these gentlemen, and much valuable data thus obtained which does not appear in their reports.

Other correspondents of the Department have rendered important assistance, especially in the form of replies to the circular already quoted. The information thus obtained has been classified and forms Appendix II of this work. The names of these correspondents are given in Appendix III.

It is not possible to give here full credit for the numerous favors and courtesies received from the people of the South by those connected with this investigation. Wherever we went we were received with the utmost hospitality; and all seemed anxious to facilitate our researches.

I am indebted to Dr. H. A. Hagen and Dr. D. L. Phares for important bibliographical references; to Mr. Edmund Burgess for determinations of *Diptera;* to Rev. H. C. McCook for the descriptions of ants and notes on their habits, given at the close of Chapter VI; to Dr. P. R. Hoy for information respecting the occurrence of *Aletia argillacea* in Wisconsin; to the Charleston Library Society for the loan of books; to Mr. E. T. Cresson for determination of *Hymenoptera;* to Prof. F. H. King and Dr. Elliott Coues for information respecting the English sparrow, to Mr. Robert Ridgway for a list of the insectivorous birds of the South; and to Prof. C. V. Riley for determinations of parasites of *Aletia argillacea.*

The original drawings of insects have been made from nature, chiefly by Mr. G. Marx; a few were drawn by Mr. Th. Pergande, who also rendered valuable assistance in making biological observations on the insects bred in my office. Assistance was rendered by Mr. C. R. Dodge

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in the preparations of the sections referring to statistics of losses and to winds.

I wish to acknowledge, especially, the efficient assistance of Mr. L. O. Howard, who has aided me during the preparation of the entire report.

I am, sir, with much respect, your obedient servant,

J. HENRY COMSTOCK,
Entomologist.

HON. WM. G. LE DUC,
Commissioner of Agriculture.

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Painted from Nature by Geo. Marx.

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THE COTTON WORM.

Aletia argillacea (Huebner)

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[illegible]

1. *Sphingidæ*.—Hawk moths or humming [illegible].
2. *Ægeriadæ*.—Clear winged moths.
3. *Zygænidæ*.—A family to which [illegible]
4. *Bombycidæ*.—Spinners.
5. *Noctuidæ*.—Owlet-moths.

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THE COTTON-WORM.

CHAPTER I.

CLASSIFICATION AND NOMENCLATURE.

In glancing over the literature on the insect under consideration we find that it is known by various popular titles. The "*Chenille*" is a name which still holds in many parts of the South. It was originally introduced by the French planters emigrating from Martinique and other French West Indies to Georgia in 1801–1802, and also by the French settlers of Louisiana. Although literally signifying nothing but *caterpillar*, it has come to be applied to this insect distinctively, as *the* caterpillar *par excellence*. The "Army-worm" is a title which has often been applied to this insect, but is one which should be avoided on account of the danger of confounding it with the Army-worm of the North. In order to avoid this danger many have called it the "cotton army-worm." Mr. Glover has given his sanction to this name in the Department of Agriculture reports. It has also been called by many writers "the cotton-caterpillar," a name sufficiently distinctive. By many it is known by the simple term "the caterpillar" in contradistinction to "the worm" as commonly applied to the boll-worm. By others, and these are by far the majority, it is termed "the cotton-worm." This latter name we shall adopt in this report as being the shortest and simplest and best adapted for a popular name. The moth has generally been called the "cotton-fly" or "cotton-moth" or "cotton-worm moth."

And now, briefly, as to the scientific classification of the cotton-worm moth. Primarily it belongs to the order "LEPIDOPTERA" or scaly-winged insects. All Lepidoptera are characterized by having four membranous wings covered with imbricated scales (appearing to the naked eye as the so-called "dust" of a butterfly's wing) and by having the mouth parts formed for sucking, the maxillae forming a tube of greater or less length. The order of Lepidoptera is divided into two sections—*Rhopalocera* (including all butterflies) and *Heterocera* (including all moths.) The Heteroceres are subdivided into the following families:

1. *Sphingidae.*—Hawk-moths or humming-bird moths.
2. *Ægeriadae.*—Clear-winged moths.
3. *Zygaenidae.*—A family to which no popular name has been given.
4. *Bombycidae.*—Spinners.
5. *Noctuidae.*—Owlet-moths.

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6. *Geometridae.*—Measuring-worm moths.
7. *Pyralidae.*—Snout-moths.
8. *Tortricidae.*—Leaf rollers.
9. *Tineidae.*—Leaf miners.
10. *Pterophoridae.*—Plume moths.

Family 5—the Noctuidae—is characterized by having the body robust, the antennæ almost constantly simple, the thorax stout and often crested, the mouth parts well developed, the spiral tongue being greatly elongated. The wings in repose are ordinarily deflexed at the sides of the body, and the abdomen is of an elongate conical form.

Mr. Grote in his "List of the Noctuidae of North America"* places all North American Noctuids in the three tribes, *Bombyciae*, *Noctuae*, and *Noctuo-Phalænidi*, *Noctuae* containing the bulk of the family, *Bombyciae* and *Noctuo-Phalænidi* simply the forms osculating with the preceeding and succeeding families. To this tribe *Noctuae* belong many very injurious insects in addition to the cotton-worm. All of the cut-worms, so destructive to many crops, the boll-worm, the army-worm of the North, the "grass-worm" and many others of lesser importance, the wheat-head army-worm, the corn and potato stalk borers (*Gortyna*), and others. To the genus *Aletia* of this tribe *Noctuae*, the cotton-worm moth belongs, and it is known by the specific name of *argillacea*.

The history of the synonymy of Aletia is interesting. On January 1, 1827, Dr. C. W. Capers, who had been making a study of the cotton-worm, sent specimens for identification to Thomas Say, then Professor of Natural History in the University of Pennsylvania. Mr. Say answered:

> I have carefully examined the contents of the box which accompanied your letter. It contained several cotton-moths which are much injured, but as far as I am enabled to judge by their remaining characters, they constitute a new species, of which I have made the following description.†

NOCTUA Fabr.

N. XYLINA.—Olivaceous, tinged with vinaceous; superior wings with a black spot.

Description.—Head vinaceous, with a small whitish tuft before; antennæ pale honey-yellow, of moderate length, covered with scales above and short hair beneath; labrum rounded, small; mandibles conic, whitish, with a fascicle of sericeous fulvous hair on the inner base; maxillæ as long as the antennæ, papillaceous towards the tip; palpi densely covered with short equal scales, which are intermixed rufous and white; second joint much longer than the first; third joint very distinct, conic, linear; thorax vinaceous with more or less of olivaceous, particularly on the sides; superior wings vinaceous, towards the posterior margin obsoletely olivaceous; a little above and partly on the second bifurcation of the post costal nervure is an oblique sub-oval, blackish spot, in which are paler scales, forming almost a double pupil; posterior to this spot is an obsolete, much-undulated, interrupted, dull rufous line, reaching the anal margin near the middle and the costal margin at two-thirds the distance from the humerus; behind this line is a distinct one, and in some specimens a still less distinct one toward the base of the wing, accompanied by a small spot; inferior wings

*Bull. Buff. Soc. Nat. Sci. 1875.

† Say's Entomology of N. A. Ed., Le Conte, I. 370.

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on the inferior page, with a slight, slender, rufous band; anterior tibiæ with a spine; posterior tibiæ with spines on the middle and tip; claws distinct, emarginate beneath.

Length to tip of superior wings nine-tenths of an inch.

Larva sixteen-footed, spotted; eyes spotted; beneath immaculate, simple. Pupa simple, dark chestnut or blackish; three of the abdominal segments with dilated rufous, posterior margins.

In the above description, if any errors occur as regards color, you can rectify them from more recent and perfect specimens.

Considering that the specimens received were badly rubbed, this description is a very accurate one.

In 1846, Mr. T. Affleck, of Washington, Adams County, Mississippi, sent Harris, the great New England Entomologist, specimens of the moth for identification. Harris was in doubt, and wrote Doubleday, the English Lepidopterist, on the subject, as follows:*

Probably you have heard of the "army-worm," a caterpillar that invades the cotton fields of the Southern States, and has this year destroyed at least one-third of the crop in Louisiana and Mississippi. Several communications have been made to me respecting it, and a correspondent in Mississippi having, as he states, profited by my book on destructive insects, so far as to be able to trace the transformation of the army-worm has recently sent to me in a letter some specimens of the moth developed from this worm or caterpillar, with a description of the caterpillar. The moth was new to my collection, and, though a good deal injured in transmission, is yet in such a state that the genus might be made out by one familiar with the modern genera. From the habits of the larva it seems to me that the insect must approach near to the genus *Cosmia*. * * * Mr. Say described the moth from very bad specimens under the name of *Noctua xylina*. I have been requested to redescribe it correctly, and wish to give to it the name of the modern genus to which it may belong.

Mr. Doubleday, in his answer (April 2, 1847), said:† "Your cotton-moth is near to *Ophiusa*, but is a new genus. We have nothing exactly the same. I have searched through Abbott's drawings and cannot find it." He also expressed the same opinion in a meeting of the London Entomological Society of nearly the same date.‡

Harris never redescribed the insect, but, after receiving Doubleday's letter, wrote to Mr. Affleck:

The cotton-moth will prove to be the type of a new or undetermined genus. Fabricius describes *an entirely different insect* under the name of *Noctua gossypii*. Say gives a pretty good description of the true cotton-moth, styling it *Noctua xylina;* which was a good and proper name for the insect, as the subject was understood by Mr. Say, who did not pretend to know much about the *Lepidoptera*. *Ophiusa xylina* better accords *with the present state of the science.*§

Mr. B. C. L. Wailes, former State geologist of Mississippi, and corresponding member of the Boston Society of Natural History, has published an account of the cotton-worm,‖ in which he speaks of it by the scientific name of *Depressaria gossypioides*. As this error of Mr. Wailes has misled many, it is worthy of mention here. The principal insect

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* Entomological papers of T. W. Harris, Boston, 1869, p. 169.

† *Ibid.*, p. 173.

‡ Trans. Ent. Soc., London, 1848, Proc. 33.

§ Affleck's Southern Almanac, 1851, p. 49.

‖ Agriculture and Geology of Miss., 1854, pp. 146–148.

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enemy to cotton culture in India has been named by Mr. Saunders *Depressaria gossypiella.** This insect is a Tineid moth, the larva of which bores into the forming cotton seed. Mr. Wailes had evidently either seen the name attached to an insufficient description or had ignored the description entirely, presupposing its identity with our cotton-worm moth from its similar powers of destruction.

In 1864 Mr. A. R. Grote, having carefully compared the descriptions of Guenée's *Anomis bipunctina* † and Say's *Noctua xylina*, came to the conclusion that they were synonymous.‡ Say's specific name having the priority, *bipunctina* fell to the ground, while the more modern genus *Anomis* of Huebner took the place of the Fabrician genus *Noctua*, and the cotton-moth was for some ten years or more known as *Anomis xylina* Say.

In 1874 Mr. Grote discovered that Hübner had in 1822 § described and figured the cotton-moth under the name of *Aletia argillacea;* and, as Mr. Grote had in the mean time made himself familiar with the type of the genus *Anomis* (*A. erosa* Hübn.) and found it to differ "structurally and generically from the cotton-worm moth," he decided that Hübner's combined name should hold in the future, and accordingly introduced it into his "List of the Noctuidæ of North America," 1874. Mr. Grote also announced this conclusion in a paper read before the Hartford meeting of the American Association for the Advancement of Science.‖ We shall in this report follow the highest American authority on the group; but to show the doubt that may still exist as to the identity of *Anomis xylina* and *Aletia argillacea*, and as a matter of curiosity, we quote the original description of the cotton-moth; it will also serve as a specimen of Huebnerian workmanship.

200.——

ALETIA ARGILLACEA.

Aus Bahia. Vom Herrn Sommer abgelassen. Eine *Noctua genuina* and *Heliophila lineata*. Sie ist der *A. Vitellina* ¶ sehr ahnlich, hat aber in nichts eine Gleichheit mit ihr und auf den Schwingen einen weissen Punct. Ihre Abildung, 399, 400 stellt ein *männliches muster vor.***

Figures 399 and 400 are very highly-colored representations of what may, by a stretch of the imagination, be called the cotton-worm moth. The figure of *A. vitellina* represents a moth with reddish-brown primaries, with a reniform spot on each, and uncolored secondaries.

* Trans. Ent. Soc., London, 1843, vi, p. 284.

† Noctuelites, vol. II, p. 401 (1852).

‡ Proc. Ent. Soc. Phil. III (1864), p. 541.

§ Zuträge zur Sammlung Exotischer Schmettlinge 2^es Hund. 200 pl., 399.

‖ Proc. A. A. A. S. vol. 23, part II, p. 13 (1874.)

¶ Hübn. Noc., 379, Vitellina.

** This may be very freely translated: "From Bahia. Left by Mr. Sommer. A true noctuid, and a specimen of *Heliophila lineata*. It is very like *A. Vitellina*, except that it has a white dot on the wings. Figs. 399 and 400 represent the male."

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The synonymy of the cotton-moth then remains as follows:

Aletia argillacea, Hübner, Zutr. zu Sam. Exot. Schmet. 2es Hund., p. 32. n. 200, figs. 399, 400.

Noctua xylina, Say. Correspondence relative to the insect that destroys the Cotton Plant. New Harmony Disseminator, 1830.

Anomis grandipuncta, Guenée, Noctuélites, vol. 2, p. 400 (1852).

Anomis bipunctina, Guenée, Noctuélites, vol. 2, p. 401, id., vol. 3, p. 397 (1852).

Anomis xylina, Grote, Proc. Ent. Soc. Phil., vol. 3, p. 541, 1864.

Aletia argillacea, Hübn., Grote, List Noctuidæ of North America, p. 24, 1874.

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CHAPTER II.

PAST HISTORY OF THE COTTON-WORM.

The materials for the early history of the cotton-worm and its ravages are scanty enough. The literature, as may be seen by reference to the bibliographical list, has been far from extensive, and, from the very nature of the subject, so utilitarian in its character that all points not relating directly to remedy have been looked upon as useless. This, taken in connection with the fact of the recentness of all papers of value, offers but a poor outlook for an exhaustive history of the cotton-worm of long ago. Yet such material has not been entirely wanting. Scraps from this place and scraps from that, when patched together, have made a tissue containing many tangible points of information, and afford a fair running account of the earlier appearances of Aletia. As we near the present date, however, our sources of information become more varied, and the information itself more accurate, until for the last fifteen years the material for a nearly complete chronology is at hand. The main sources of information have been three in number: First, what the literature contains upon this point; second, the answers of correspondents to questions 1, 1*a*, 1*b*, and 3 of the 1878 circular letter (see introduction); third, the regular monthly reports of the statistical correspondents of this department upon the condition of crops, as contained in the "Monthly Reports of the Department of Agriculture," from 1866 to 1876, inclusive, and in the occasional bulletins of the department since 1876.

The first important point to be cleared up in the history of the cotton-worm is, whether it is really indigenous to this country or whether it has been introduced from abroad. On this point Mr. Grote has the following:*

> Now Hübner describes the moth of the cotton-worm at first as from Bahia. Sufficient testimony as to the indentity of our insect with one destructive to the West Indian, Mexican, and Brazilian perennial cotton is at hand, and the fact is established. In a classificatory point of view the affinities of the cotton-worm are with Southern rather than with Northern forms of its family, as I have already pointed out.

So far as the past history goes, it upholds Mr. Grote in the belief that *Aletia* is really an indigene of South America and the West Indies, and creates a probability that its spread in this country was originally the result of an accidental introduction or of immigration on the part of the moth. Were the insect indigenous to this country its history would be coeval with the history of cotton culture within the present limits of the United States, but, upon referring to the records, we find that this is not so. Short staple cotton was grown quite extensively as a garden

*Proc. A. A. A. S. XXIII (1874), Part II, p. 15.

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crop in Maryland, Virginia, the Carolinas, and Georgia for many years previous to the Revolution. In a "History of Virginia, by a Native and Inhabitant of the Place," published in 1722, we find that cotton was grown in that colony at least 130 years before the Revolution. In Carroll's Historical Collections of South Carolina many references are made to the early culture of cotton. The writer of a pamphlet on "A Brief Description of the Province of Carolina and the Coast of Florida," published in 1666, mentions the fact that at the Cape Fear settlements they grew "indico, tobacco, very good, and *cotton-wool.*" In the same collection is found Dr. Hewitt's early account of Georgia and South Carolina, in which he alludes to cotton particularly, and describes the method of planting.

He says that cotton, "though not of importance enough to have occupied the whole attention of the colonists, might, nevertheless, in conjunction with other staples, have been rendered profitable and useful."

"In Wilson's account of the 'Province of Carolina in America,' published in 1682, it is stated that 'cotton of the Cyprus and Malta sort grows well and a good plenty of the seed is sent thither.' In Peter Purry's description of the Province of Carolina, drawn up in Charleston in 1731, 'flax and cotton' are said to 'thrive admirably.'"* Cotton began to be exported toward the middle of the 18th century. In 1748 Charlestown exported 7 bags of cotton-wool, and in 1754 an additional quantity was shipped. Various quantities were exported up to the time of the Revolution, and during the war for Independence much of the country was supplied with home-grown, home-manufactured cotton cloths. Instances could be multiplied without number, but are unnecessary to our purpose. In 1786 the celebrated Sea Island cotton was introduced into Georgia from the Bahamas (Long Island and Exuma), to which place it had been brought in 1785 from Anguilla, an island in the Carib Sea,† and this seems to have been the point from which the first great extension of the cultivation of cotton in America dates.

The first appearance of the cotton-worm in this country now on record was in 1793 in Georgia and South Carolina, after cotton had been grown for 150 years. This certainly would seem to indicate the introduction of the worm at that time or shortly previous.

In Louisiana and Mississippi the evidence on this point seems to be more conclusive; for, if the testimony of the early navigators is to be believed, cotton is indigenous around the mouth of the Mississippi.‡

The plant was probably first cultivated by the early French colonists

* Memoir on the Cotton Plant. W. E. Seabrook. Charleston, 1844.

† Ure's Hist. of Cotton Manufacture, I, 150.

‡ "Even as far north as the Meschacebe, or Mississippi, the early explorers of that river and its tributary streams saw 'cotton growing wild in the codd, and in great plenty.'"—Seabrook's Memoir, p. 5.

Respecting this statement of Seabrook's, however, Dr. Asa Gray writes: "I know of no authority whatever for indigenous *Gossypium* on the Mississippi, nor for its culture there before European settlement. I doubt if there is any."

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from Santo Domingo. "Charlevoix, on his visit to Natchez, in 1722, saw the cotton plant growing in the garden of Sieur Le Noir, the company's clerk."

"Bienville states in one of his dispatches, dated in April, 1735, that the cultivation of cotton proved advantageous." "Governor Vaudreuil, in a dispatch dated 1746, mentions cotton as among the articles received by the boats which came down annually from Illinois to New Orleans."*

Cotton having been cultivated as early as this, it seems strange that we never hear of an appearance of the cotton-worm before 1804 in that section of the country. Yet that is absolutely the first reliable date that we have been able to find, and it certainly would seem to argue a recent introduction of the worm.

The insufficiency and unreliability of the records may be urged against such argument as this, and with some degree of justice; still it would seem as if so formidable an enemy to the plant would be mentioned whenever the culture of cotton was spoken of.

As to the absolute identity of the insect which ravaged the cotton fields of Guiana and the West Indies in the latter part of the eighteenth century with our North American cotton-worm, there can be little doubt. The only point making it at all uncertain is Fabricius' description of a cotton-moth (*Noctua gossypii*) from South America; the habits of which are similar to those of *Aletia*, and yet which is a different insect entirely, according to the description.† Yet, all things considered, we may safely conclude that Fabricius' insect, although alike in habits, is not the *important* southern "Chenille."

In a queer old article published in Brewster's Edinburgh Encyclopedia, Dr. Chisolm, of Clifton, who had studied the chenille in Guiana in 1801 and 1802, gives the following description of the insect in all its stages:

Phalaena geometra seticornis alis omnibus sub-griseis sub-angulatis deflexis.

Larva subpilosa setulis nigris interpositis: 12 poda, 20-annulata, dorso nigro nitido, linea dorsali, lineolis geminis lateralibus flavescentbus albis; abdomine alba flavescente.

Pupa obtecta, subovalis, fusca nigricens, coriacea.

Habitat in Guiana, Gossypii variis, forsan omnibus speciebus, quarum folia, petiolos fructusque etiam immeturos mira diraque voracitate, devorat.

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* Wailes Agric. Geol. of Miss., 1854, p. 141.

† Fabricius' description is as follows:

No. 286. *Noctua gossypii.*

Cristata alis deflexis fusco cinereoque variis: posticis hyalinis immaculatis.

Habitat ,in America meridionalis Parthenis hysterofero, gossypis polyphaga folia caulesque destruent, Dr. Pflug. Devoratur a meleagride Gallapavone, Dr. V. Rohr. Praecedenti (which is *Noctua histrionica* from East Indies) nimis affinis. Antennæ fuscæ. Thorax lobo antico distincto, postice cristatus, cinereo fuscoque variegatus. Abdomen cineream. Alæ anticæ mox magis fuscæ, mox magis cinereæ macula costati, oblonga, fusca versus apicem. Costa albo punctata. Posticae albo hyalinæ immaculatæ. Tibiae fuscæ. Larva gregaria, glabra, fusco grisescens; vitta dorsali, lata, fusca, quæ linea flava, maculis albis intersecta, includitur. (The next species is *N. Brassicaria* from South America, stated to be "nimis praecedentibus affinis.")—J. C. Fabricius, Entomologica Systematica, vol. iii, part 2; Hafniae 1794, pp. 96–97.

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From this description, incomplete and inaccurate as it is, our cotton-worm can be recognized; and this, taken in connection with Huebner's description of *Aletia* as from Brazil, and with Mr. Grote's testimony upon this point, renders the identity of the destructive Northern and Southern insects highly probable, to say the least.

And now to our account of the ravages of the chenille.

The early explorers of the West Indies found cotton growing wild, and the first settlers began its cultivation. We learn from an old account* that early in the last century the cotton-cultivators were accustomed to the injuries of a worm which appeared in great numbers. In Guiana the chenille was certainly known by the earliest cultivators of cotton in that country (1705 to 1752). In the Bahamas the caterpillar was also destructive from the first cultivation of cotton. 1788, however, so far exceeded all previous years, that we always find it particularly alluded to. In this year, between March and September, no less that 280 tons of cotton, at a moderate estimate, were devoured by this worm.†

In 1794 the worms were again very abundant and the crop on several of the islands suffered severely. On Acklin's Island two-thirds of the crop was lost, and this was also the approximate loss on this island in 1788.‡ In 1801, the cotton-crop having failed for a number of years, a committee of the members of the general assembly of the Bahamas was appointed to draw up a series of questions inquiring into the causes of this failure, and to forward them to the most intelligent planters on the islands. Mr. McKinnon says, concerning the result of the investigation: "Amongst the causes assigned for the severe and general disappointment, the most prominent is the destruction committed by those most baneful insects, the red bug and the chenille." §

In 1801 and 1802 there was an emigration of French cotton-planters from Martinique to Southwest Georgia on account of the ravages of the caterpillar in the West Indies,|| and on many islands the cultivation of cotton was entirely stopped.

The first recorded appearance of the cotton worm in the United States was, as we have already stated, in 1793. In that year it swept the cotton fields of Georgia and South Carolina, doing a great deal of damage, more particularly in Georgia. "In that year," says Mr. Spalding, "the destruction was complete. From Major Butler's field of 400 acres only 18 bags were made."¶ In 1800 there was another general appearance of the worms, and in that year the crops in South Carolina suffered equally with those in Georgia. Dr. Phares and Dr. Capers state that this was the first appearance of the worm in South Carolina, but we have the

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* Winterbotham's European Settlements in West Indies, 1795?

† Hist. Civil and Commercial of the West Indies. Bryan Edwards, Phila. 1805. III, 96.

‡ McKinnon's Tour through the West Indies, 1802–1803.

§ Ibid.

|| See Appendix I, report of A. R. Grote.

¶ Seabrook's Memoir, p. 42.

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testimony of Mr. J. W. Grace and the evidence of a strong probability as to its occurrence there in 1793.

We find no evidence of its reappearance again until 1804, although it must have been seen in small numbers. 1804 was the first of the series of three great caterpillar years (1825 and 1846 being the other two), which gave rise to the almost universal theory that the greatest ravages of the chenille were to be expected every twenty-one years. In this year it swept over every portion of the cotton belt, which at that time comprised a fair part of South Carolina, the coast and southernmost counties of Georgia, the country for some distance back of Mobile Bay in Alabama, and counties of Mississippi and Louisiana along the great river. Concerning this year Dr. Phares has the following in his lecture before the Woodville Farmers' Club, May 4, 1869:

In 1804 the cotton-worm made one of its widest and most devastating invasions. It was, I believe, on this occasion that Father St. Pierre was most earnestly entreated by his simple-minded parishioners of Louisiana to furnish holy water with which to repel "les chenilles." In districts further north, where they came later, they were finally exterminated by a snow storm.

Between 1804 and 1825 there were no general incursions. The caterpillar appeared many times, but in limited districts. Perhaps the severest of these limited appearances was in 1814 in portions of Louisiana. Mr. Winfree says:* "In 1814 or thereabouts they ate the cotton down to the ground in Iberville Parish in June." Dr. Phares remarks: "In 1814 perhaps it was they came in June in portions of Louisiana, the plant being very backward in consequence of a very cold late spring, they ate it down to the ground so that not a lock of lint was matured nor a seed saved."

A good idea of the destruction in 1825, the second of the general invasions, is again to be gained from Dr. Phares' paper. He says:

In 1825, the destruction was general in extent, embracing all the cotton States; the late Mr. Affleck in one of his papers asserting that the destruction was "universal and complete." I must here be permitted to say that it was not "complete," as I most distinctly remember and know I saw fields in which many bolls were fully matured and gathered before the chenilles injured the plant, and considerable quantities of very superior cotton were made. This was the first year that I saw the chenilles, and circumstances so impressed me that my recollections of their appearance are more vivid than of any time since.

The insect was again destroyed by a storm, as we have seen happen less extensively several times since; the wind and rain beating them down, and the water sweeping them along and forming immense heaps in some places.

Mr. Affleck's phrase "universal and complete" was certainly used with justice so far as a great part of the cotton belt was concerned in 1825. An old correspondent in Conecuh County, Alabama, places the loss this year at 90 per cent., while Mr. Fuller, of Edisto Island, South Carolina, states that old planters informed him that the entire crop was lost. On the other hand, Dr. Capers dismisses this year with the remark, "In 1825 they were spreading, but perished again by a storm."

* De Bow's Review, 1847, vol. iv, p. 251.

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Dr. Capers* says concerning the succeeding year:

In 1826 they destroyed the crops. The first notice of them this year was at Saint Helena, La., on the 1st of August. Soon after they were found on all the coast, from New Orleans to North Carolina. On August 23 they had destroyed almost all the cotton leaves, but suddenly they left the plants, though not for the purpose of webbing up, as many were young.

The cause of their sudden disappearance is said to have been that they were too much exposed to the powerful effects of the sun, in consequence of the plants being nearly destitute of foliage, and not protecting them from its direct rays.

It is quite possible that Dr. Capers has made a mistake of a year, and that this note really should refer to the year 1825, as a diligent searching of records shows no other account of the prevalence of the caterpillar in 1826. This is the most natural conclusion to arrive at, through it may simply be a case of exaggeration.

We have notes of the appearance of the worm, without, however, much damage resulting, in limited localities in 1828, 1829, 1833, 1834, and 1836. Considerable damage was done in Leon County, Florida, and the surrounding counties in 1830; in Southern Alabama in 1831, and again in Northern Florida in 1832. In 1834 the worms appeared in Texas for the first time. Mr. G. S. Clark, of Hempstead, Waller County, writes: "In 1834 a boat load of cotton seed was brought from New Orleans, and that year the worms made their first appearance and destroyed the crop." In 1836 they are stated to have been very destructive in Greene County, Alabama. According to Mr. Grote, Hon. Robert Toombs sold his plantation in Southwest Georgia on account of the ravages committed by the cotton-worm in Early and Clay Counties in 1835.

In 1838, the injuries were more general. Dr. Phares says: "They spread over a large portion of the cotton States that year, doing much damage in September and October." Colonel Whitner, speaking for Leon County, Florida, says: "The caterpillar appeared early in August. The second brood stripped the plants by the 20th of September, and were so numerous that, after devouring the entire foliage, they barked the limbs and stalks and ate out bolls nearly grown." The year 1839 was noted neither for extended ravages nor for marked devastations in particular localities.

In 1840, the appearance of the caterpillar was very general, extending north into Arkansas and South Carolina. In most cases they were too late to do severe damage, and the only locality which suffered much, appears to have been Northern Florida. Concerning the caterpillars this year in Leon County, Florida, Dr. Capers says: "They came out from the 15th to the 20th of July, and by the 6th of September the plants were stripped of leaves and young bolls, so that the entire crop was less than one-half the average of other years." It is a noticeable fact, upon viewing the past ravages of the caterpillar, that this northwestern tier of Florida counties has never been exempt since 1830 and

*Dep. of Agr. Ann. Rept. 1855, pp. 74, 75.

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that it has suffered more in proportion to its size and the amount of cotton grown than any other section of the country.

The caterpillars were not at all widespread nor were their ravages remarkably severe in 1841, '42, '43, '44, '45. There was about 20 per cent. loss in Madison and Leon Counties, Florida, in 1841; elsewhere the worms came too late to do much damage except by depreciating the quality of the cotton by soiling it with their excrement. Great damage was reported from this source in West Feliciana Parish, Louisiana. In 1842, although the worms were reported from parts of Texas, Alabama, Florida, and Georgia, but little injury seems to have been done. The same can be said for 1843, except that in this year the caterpillars were reported from South Carolina, and that the combined damages from caterpillars and storms is reported at 33 per cent. from Leon County, Florida. In 1844, they appeared early in Florida (being found webbed July 13, in Leon County) and along the coast in Matagorda and Brazoria Counties, Texas. The marked feature of the year 1844 was the abundance of the caterpillars in certain parishes in Louisiana. East and West Feliciana, East Baton Rouge, Saint Mary's, Saint Landry, Avoyelles, Rapides, Concordia, Red River, Jackson, Madison, and Catahoula all lost more or less of the crop. A few short newspaper paragraphs may not come amiss in showing the situation.

The Saint Landry Whig, of August, 1844, says:

> We are truly sorry to announce that the cotton crop in this parish is lamentably cut up. The caterpillar is making sad havoc. We learn that many of the planters on Bayou Bœuf contemplate abandoning cotton altogether and intend planting sugar-cane. The cotton crop this year in most of that section will not yield half the usual quantity, and all around us a third at least will be lost. We are no alarmists, but speak the words of soberness and of truth, and people at distance may rely on this statement.

The Red River Republican, of similar date, has the following:

> In our last we mentioned the appearance of the dreaded caterpillar on our cotton fields. We have since received information from the country that puts to rest all doubts. The real insect, so destructive in other years, can be seen on almost every plantation in the parish. Every effort to arrest the progress of the destroyers has been in vain. They approach the tender plant in myriads and the work of destruction is completed in a short time.

The Baton Rouge Advertiser of September 11, 1844, says:

> The caterpillar is doing immense destruction on the cotton plantations in this parish. Wherever the crop is late, the bolls being tender and new "forms" constantly emerging, the yield will be *more than one-half less* than the anticipated crop. This is the opinion of a highly respectable planter with whom we have had conversation on the subject.

In the Concordia Intelligencer of like date we find the following:

> THE ARMY-WORM.—This destructive insect to the hopes of the planter has just made its appearance in terrible quantities throughout the State. A gentleman just from the Opelousas counties informs us that the caterpillar has made its appearance in that region three weeks since. Within the past six days it has passed over the broad fields of Concordia, leaving them as if a whitening frost had blighted them. One-third of

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the crop at least in this region has been destroyed, how much more time will determine. With the overflow and now the army-worm, the planter has but a slender prospect of being remunerated for his labor.

The Alexandria Republican for August 31, 1844, has the following:

A visit to Bayou Reef has given us ocular proof of the fearful ravages of the dreaded caterpillar. The work of destruction has been complete. Scarcely a green leaf is to be seen in any direction—the plantations resembling rye-fields. In the opinion of the best informed, the yield in the parish will not be more than one-third of the average crop. Bad news, but true.

In other cotton States the destruction was not to be compared to this, in spite of the newspaper exaggeration which marks it. In Mississippi the damage was slight. In Alabama, certain localities report considerable injury. In Monroe County the worms were "bad in sections." In Clarke County they were very destructive. In Greene County the loss amounted to 33 per cent. In Georgia and Florida the loss was very slight.

In 1845, the damage was greater than it had been since 1838. A curious instance is mentioned of this year by Mr. E. Richards,* of Cedar Key, Fla., showing the migratory power of the moth:

The last of July, 1845, these caterpillars made their appearance in a small field of three or four acres of sea-island cotton, planted on Way Key, as an experiment to see if cotton could be advantageously cultivated on the Keys, no other cotton having been previously planted within 80 miles of them; but the whole crop was devoured. The caterpillar was at the same time destroying the cotton in the interior of the country.

Mr. Glover remarked concerning this statement—

It would seem to prove that it (the cotton-moth) is migratory in its habits, as there is no other way of accounting for its sudden presence, except that, having previously existed on some other plant or weed, it had left it for food more congenial to its taste, although it has been asserted that the real caterpillar will eat nothing but cotton.

This being the year preceding the great cotton-worm year of 1846, it is worth our while to look at it more carefully than at others. It is at the head of an ascending scale of years, beginning with 1839. Each year, from 1839 to 1845, the destructions were gradually increased. As more moths hibernated, the more caterpillars there were the ensuing year. Throwing parasitic and climatic checks aside, the tendency would be for the worms to increase in geometrical proportion. As the caterpillar increased, however, so, naturally, will the parasites; and when once, through meteorological reasons, the cotton-worms receive a decided check, the parasites will be in a position to reduce their numbers to a marked degree. This being the case, we would expect to see, in a succession of favorable years, a gradual increase in the ravages of the caterpillars, until, after a year of great injury, there is a sudden falling off—a drop, as it were—to the bottom of another ascending scale of years. This succession will, of course, be modified by many circumstances, but the tendency will always be the same.

The year 1846 was the third of the twenty-one-year irruptions, and

* Dept. of Agr., Rept. 1855, p. 74.

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was one of the worst years we have ever had. The caterpillars appeared very early in Texas, Louisiana, Mississippi, and Florida, earlier than they had ever before been observed. In Texas, they made great havoc in the coast counties, but the inland counties did not suffer so much. Walker, however, and some of the surrounding counties, lost from 50 to 60 per cent. of the crop. In Louisiana and Mississippi, according to Dr. Harris,* the caterpillars destroyed, on the average, one-third of the entire crop. The state of things in Mississippi was well described by Mr. Affleck, writing, September 9, 1846, to the American Agriculturist. Mr. Affleck says:

The caterpillar, cotton-worm, cotton-moth (*Noctua xylina*), or chenille of the French West Indies, Guiana, &c., has utterly blighted the hopes of the cotton-planter for the present year, and produced most anxious fears for the future. I have heard from the greater part of the cotton-growing region—the news is all alike—the worm has destroyed the crop. I have no idea that any considerable portion of any State will escape. * * * The present year the crop is unusually backward, at least four weeks later than usual. We have but just commenced picking; usually beginning about the last week in July or the first week in August. At this moment every field within this region of country, say south of Vicksburg, is stripped of everything but the stems, the larger branches, and a few of the first bolls, already too hard for the the worms' power of mastication. The full-grown bolls not yet become hard are completely eaten out, a circumstance I have never heard of but once before, in 1825. The fields present a most melancholy appearance; looking from the bluff at Natches across the river to those fine plantations back of Vidalia, nothing is to be seen but the brown withered skeleton of the plant.

The devastation in Alabama equalled, if indeed it did not exceed, that in the States just mentioned. From nearly every part of the State it is reported to have been one of the very worst years. Our correspondent in Barbour County states that, when the leaf supply failed, the caterpillars fairly ate the bark off the plant, a thing which has not been done since. The old inhabitants even now gauge all destructive years by the standard of 1846.

In Northern Florida the damage was even greater than usual. I quote from Colonel Whitner:

It was found webbed up on the 7th of July. The second brood began to web up on the 26th of that month, and, by the 20th, the parts of the field in which the worm was first seen were found to be eaten out, and the fly, the worms large and small, and the chrysalides were discovered at the same time, a state of things never before observed. By the 5th of September the damage amounted to a loss of more than one-half of the crop.

It will be seen from this that only nineteen days elapsed between the spinning up of two successive broods, which is certainly indicative of a very quick development. The confusion of broods of which Colonel Whitner speaks has always been noticeable in years when the caterpillars have been at all abundant since that time. As the season advances the confusion becomes more marked until we have them as eggs, caterpillars, chrysalides, and moths at one and the same time.

* Entomological Correspondence, p. 169.

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In Georgia the ravages were as great as elsewhere, the counties along the coast and those of the southern tier suffering the most.

South Carolina was severely afflicted. Mr. Fuller, of Edisto Island, Colleton County, writes as follows:*

In 1846, they appeared on the 20th of July (a very unusually early date), and by the 10th of September I suppose there was scarcely a cotton leaf or any tender portion of the plants remaining, and the worms not fully grown, deserted the ravaged fields in millions in search of food, failing to find which, they died from starvation. The crop in this island was about 40 per cent. of an average one.

Other parts of South Carolina report total loss, but reports of this kind are always to be taken with some degree of allowance. No caterpillars were reported north of the State, nor were any reported from Arkansas.

So severe a year as this would naturally arouse the planters, as indeed it did arouse them, to the necessity of knowing more about the habits of these destructive insects, and of discovering some appropriate remedy for their ravages. Up to this time very little had been written about the chenille. Thomas Say had described the moth scientifically in 1827, but had no opportunities for studying its habits. Dr. C. W. Capers, Hon. W. E. Seabrook, Mr. Thomas Affleck, and one or two other intelligent men had given the insect some attention, and had published more or less about it; but all of their accounts were somewhat fallacious, and even had they been perfect, they were too few and far between to have done much good.†

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* Dept. of Agr., Ann. Rept., 1856, p. 76.

† Mr. Seabrook gives the following interesting account of how an enterprising South Carolina farmer saved his crop in 1843:

"The caterpillar appeared in several parts of the field of John Townsend, of Saint John's, Colleton, early in August last. The plants were luxuriant in growth and tender in weed and leaf, and the weather, being warm and rather moist, was altogether propitious to the spread and multiplying of the worms. By the adoption of prompt and vigorous measures, some of which are new, and a rigid perseverance in their execution, his crop escaped unscathed, while many of his fellow-laborers who lacked faith in any remedy suffered greatly. In the attainment of his purpose the means resorted to by Mr. Townsend were the following:

"1. His people searched for and killed both the worm and the chrysalis of the first brood.

"2. On the appearance of the second brood he scattered corn over the field to invite the notice of the birds, and while they depredated on the worms on the top of the stalks and their upper limbs, the turkeys destroyed the enemy on the lower branches.

"3. When in the aurelia (chrysalis) state the negroes crushed them between their fingers.

"4. Some patches of cotton where the caterpillars were very thick and the birds and turkeys could not get access to them were destroyed.

"5. The tops of the plants and the ends of all the tender and luxuriant branches, where the eggs of the butterfly are usually deposited, were cut off.

"By these means, resolutely pursued, although at one time the prospect of checking the depredators was most cheerless, not the slightest injury to the field was sustained. The experiment cost Mr. Townsend 2½ acres of cotton, about 15 bushels of

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The 1846 invasion called forth a great many newspaper articles, which failed, unfortunately, to advance the sum-total of our knowledge to any great extent. Specimens were sent this year to Harris, but he was unable to do more than mere classificatory work upon them. In the fall of 1846, Mr. Affleck, in the letter already quoted from,* gave the first hint at the migration theory which has recently occupied so prominent a place in all researches on the cotton-worm. Early in 1847 Dr. Gorham,† having arrived independently at the conclusion that we have an influx of the moths every year from more southern countries, published a paper upon the subject. In this paper he gives the first notice of a parasite upon the chenille, and draws up a description of what is undoubtedly *Pimpla conquisitor.* Mr. Affleck observed this parasite two or three years later, and figured it in 1851.‡ Dr. Gorham's article excited a real interest. It was reprinted in several prominent Southern journals, and was answered by several writers. No one seemed, however, to agree with his views on migration until the theory was again independently proposed by Dr. W. I. Burnett in 1854.§ Among all these discursive writings there was, however, so much of a fallacious nature that the good which they accomplished was reduced to the minimum.

The prevalence of parasites towards the close of this year (1846) is a point worthy of note. Dr. Gorham came to the conclusion that *not one* of the last brood of caterpillars escaped parisitism, and to account for their appearance the ensuing year was obliged to originate his migration theory.

In spite of this wonderful abundance of parasites, however, the worms were on hand bright and early in the summer of 1847. Their first appearance was simultaneous in Northern Florida and Southern Louisiana. They appeared early over a large part of the cotton belt, and were found in great numbers as far north as Southern Arkansas; 1847 was, however, in nearly every cotton State, an unfavorable year for cotton, on account of drought with an occasional heavy storm. The same causes which affected the cotton had their effect also upon the caterpillar, and its insect enemies were enabled to get the upper hand. The result was, that, instead of the year being more severe than 1846, as it at first bid fair to be, it was a marked one in but few localities. In Florida, where the worms were first seen in early July, the damage was so slight as to cause a return of "*no injury.*" The principal ravages occurred in Northern Louisiana and Southern Arkansas. Carroll Parish, Louisiana, reports them as "very bad," and Miller County, Arkansas, reports a loss of two-

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corn, and the work of all his people for about five days. This gentleman was aroused to unusual action by the reflection, founded on analogical reasoning, that, of one moth of feeble wing and tender body, which a vigilant eye might discover and destroy, the progeny in six weeks amounted to at least twenty millions of worms." (Figures too high.)

* American Agriculturist, vol. v, p. 342.

† De Bow's Review, III, pp. 535–543.

‡ Southern Rural Almanac, 1851, p. 50.

§ Proc. Bost. Soc. Nat. Hist., 18 4, vol. iv, pp. 316–319.

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thirds of the crop. Local injury seems to have been done in Montgomery County, Alabama, and in Coffee County, Georgia, to a considerable extent.

From 1848 to 1860, inclusive, there was not a single notable worm year. The caterpillars were every year more or less injurious in limited districts, but not a single general invasion took place. The increase in their numbers was comparatively slight, and frequent unfavorable years kept them well subdued. In addition to this, the planters had worked into a clean and thorough system of cultivation; there was no waste and no rubbish, and such a method has always proved the best way to keep all insect pests in check.

The year 1848 seems to have been even much more unfavorable for the caterpillars than was 1847. We have them reported simply from the northwestern part of Florida and from the canebrake region of Alabama.

In 1849, they were found over a wider extent of country. Eastern Texas, Central Alabama, Northern Florida, Southern Georgia, and the southern coast of South Carolina reported their presence with little or no damage. Leon County, Florida, is the only locality in which severe damage was done.

In 1850 no great injury was done. The worms appeared in parts of Texas, Alabama, Florida, South Carolina, and for the first time in Tennessee.

In 1851 they were found in the canebrake region and in Northern Florida. The correspondent from Gadsden County reports "clean devouring" for this year.

In 1852 they were more wide-spread again and heavy local losses were reported from Greene County, Alabama, and Leon County, Florida. Other localities reported no material damage. On the South Carolina coast they appeared rather earlier than usual, but little harm was accomplished.

In 1853 they again appeared in Arkansas, and some localities in Mississippi were more than usually afflicted.

In 1854 they were numerous in the canebrake region; 1855 was a dry year, and, according to Dr. Phares, the caterpillars were destroyed by drought and heat; 1856 was a year of remarkable exemption; 1857, 1858, and 1859 are unworthy of remark as caterpillar years; in 1860 they were more abundant in the canebrake and in parts of Texas and Mississippi than they had been for the few preceding years.

From 1861 to 1865, inclusive, the cotton crop was necessarily greatly curtailed, and the reports of the activity of the caterpillar during that period could hardly be expected to be of sufficient accuracy or completeness to assist in studying the periodical appearances. Still the reports have been comparatively full, and show that the caterpillars were present over all the more southern portions of the cotton belt and were increasing in numbers every year. In 1861 and 1862, although they were widespread, their ravages were reported as slight from every

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locality. In 1863 they did considerable damage in Austin County and the surrounding country in Texas. In the latter part of this season they were found as far north as Wayne and Halifax Counties in North Carolina, although the harm that they did was very slight. In 1864 they were reported as destructive in Jefferson Parish, Louisiana, and in Jefferson County, Mississippi. They reached North Carolina again this year, and were reported from Edgecombe County. Eighteen hundred and sixty-five was a marked year in parts of Texas, in Southern Arkansas, and all through Central Alabama. The worms were again seen in Edgecombe County and Halifax County, North Carolina.

From 1866 to 1877 we are enabled to chronicle the appearances of the caterpillars with much more certainty than in previous years. During this time the Department of Agriculture published regular monthly reports, giving, among other things, the condition of the different crops as sent in by regular correspondents all over the country. Information given at the time of the ravages is, of course, more reliable than that called up from the memory after a term of years. Moreover, the answers to the 1878 circular will naturally be more accurate concerning the more recent years. From 1866 to date, the caterpillars have been widespread every year. In some years the ravages have been more severe and general than in others; but few localities in any of the more southern portions of the belt can boast exemption during any one year. Both the caterpillars and the boll-worm have been infinitely more injurious than in the time before the war. This is thought, as before stated, to proceed almost entirely from the general looseness and carelessness of the present system of cultivation. Of course there are many exceptions, but as long as the careless are in the majority the innocent must suffer with the guilty.

In the spring of 1866 there was a large planting, and many hopes were entertained for the success of the crop. A full crop was needed. The war had impoverished the South, and cotton had risen greatly in value. The hopes, however, of many were destined not to be fulfilled. The caterpillars made their appearance in immense numbers in most of the States, and in many localities destroyed the whole crop. Louisiania lost one-half of her whole crop. Texas lost 40 per cent.; Alabama lost 42 per cent.; and Mississippi lost 30 per cent. These figures are simply general averages, for while in one county everything would be devoured, in another the loss would be small. Texas suffered severely all through her cotton-growing region. Goliad County reported almost total loss. In Austin County the cotton was damaged worse than it ever had been before. In Polk County they "devoured everything." In Lamar County (the northernmost county of the State) they made their first and last appearance. They never had been seen there before; they never have been seen there since. In Tensas Parish, Louisiana, the "entire crop of the county was stripped." They were very destructive in South Arkansas, and across the river in the richest cotton counties of Mississippi.

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In Alabama they were first observed in Lowndes County. They came in force by the middle of August, and, much of the crop being young from replanting, the damage was very great. In Montgomery County they were not found until September 1. In Greene County the crop was nearly ruined, and adjoining counties suffered severely. Florida escaped this year without severe injury, and Georgia was almost unscathed. The caterpillars were reported as far north as Wayne, Edgecombe, and Franklin Counties, in North Carolina, but their numbers were few, and they came late in the season. The damage was consequently insignificant.

As we have before stated, the fact that the years 1804, 1825, and 1846 had been remarkable caterpillar years had given rise to the theory, credited by nearly every one, that the greatest ravages of the chenilles were to be expected at intervals of twenty-one years, and, as a result, many had been dreading the coming of 1867 as the fourth of these terrible years. It proved, however, to be but little worse than 1866 as a year of general destruction, and it certainly was not as bad as the following year, 1868. In Texas, it is true, it was, perhaps, as destructive a year as has been experienced, but in Louisiana it was no worse, and in other States not so bad as the previous year. The crops in Texas suffered greatly. In Colorado and Fayette Counties the ravages were the worst ever experienced. As far west as Comal County the worms appeared in tremendous numbers. In Austin County they were even worse than in 1866, and four-fifths of the crop was destroyed. Northeast, in Polk, Walker, Trinity, and Cherokee, the same state of affairs was to be seen. Polk reports total loss. Our correspondent from Walker County says: "They swept the fields like a besom of destruction," and in Cherokee great damage was done. Although it has been an unusual thing for the northern tier of Texas counties to suffer, Red River County this time reported almost a complete failure. In Louisiana they were more or less destructive over the whole State, East and West Feliciana and Jackson Parishes suffering perhaps the most. The crops of counties along the river in Arkansas and Mississippi were partially destroyed, the interior counties of the latter State suffering comparatively little. Their first appearance was in June in Pike County, and before the season was over this county had suffered severely. In Wilkinson they were very destructive, as also in Covington, and later in the season as far north as De Soto. In Alabama the losses were comparatively slight. Greene County lost one-fifth of the crop, and Pickens perhaps more, but in other parts no great injury was reported. Florida was also comparatively exempt. There were few reports of losses from Georgia, Charleston County sending in the only heavy loss—5 per cent. In South and North Carolina the caterpillars were abundant toward the end of the season, but their injuries were slight in the latter State, and not great in the former.

The believers in the twenty-one-year theory breathed more freely at

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the close of this season; but their feelings of relief were premature, as 1868 proved to be one of the worst years yet on record. The ravages in Texas and Louisiana were, perhaps, on the whole, not equal to those of 1867, but the other States suffered greatly. In Alabama and Georgia the injuries have only been equalled by those of 1873. The first noted appearance of the caterpillars in 1868 was in Austin County, Texas, in the latter part of May. This was the earliest appearance up to this time on record, and grave fears were at once expressed of the failure of the crop. These fears were abundantly fulfilled so far as Austin County was concerned, for the crop was nearly destroyed as early as July by the third brood proper. In Fort Bend County they were very numerous by July 20, but not nearly as destructive as in Austin. They were again present in great numbers in Comal County. Hardin reported the unusual loss of one-half, and in Polk County the crop was partially destroyed. Further north, in Upshur, the loss was not serious; in Titus they made no appearance till August 30, when it was too late to do much damage. In Grayson County the crop was injured to some extent, and Fannin reported a loss of 25 per cent. Louisiana as a general thing reported "not so bad as 1867," and Arkansas likewise. In Mississippi the losses were considerable, in some localities more and in others less than in the preceding years. Wilkinson County was badly afflicted, while in the neighboring county of Pike the worms were not as bad as in 1867. In Hinds the damage from insects was great, but our correspondent states that *Aletia* ravages were inferior to those of the boll-worm. Attala County lost one-half, and Washington three-tenths, which are perhaps but little above the average for that part of the State. The northern part did not suffer very greatly, and our correspondent from Panola states that in his county the injuries were less than in any other part of the State. In Alabama the loss was great. Strange to say, the more northern regions suffered more than did the southern and central counties. There were a few exceptions to this, for in Conecuh nearly one-half was lost, in Crenshaw one-fourth, in Barbour one-fifth, and in Montgomery three-tenths. Lowndes, Wilcox, Dallas, Autauga, Perry, Hale, Sumter, Pickens, and Lee escaped without great injury, while in Clay, Saint Clair, Marshall, and Lawrence the losses amounted to one-half the crop. Great damage was done in Northern Florida. The crops of Georgia, however, suffered more than those of any other State. Decatur County lost from one-half to two-thirds, and in other southern counties the damage was great. The most unprecedented injury was done through the center of the State. Stewart, Chattahoochee, Marion, Macon, Taylor, Crawford, Emanuel, Baldwin, Troup, Heard, Butts, Columbia, Wilkes, Hall, all suffered severely. The damage in these counties will foot up nearly to one-half the crop, which is very remarkable for Central Georgia, where the injury is rarely excessive. In the more northern counties it was reported as coming too late to do much harm. In South Carolina the injury was greater than it had been before. Newberry district returned

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a loss of one-third, a remarkable loss for this State. Considerable damage was also done in Abbeville and Spartansburg districts. In North Carolina the caterpillars appeared September 1, earlier than ever before. They ate many leaves, but little damage was accomplished. One of our correspondents states that they came just at the right time to clear the leaves away from the ripening bolls.*

Thus we see that 1868 is the culminating point of a long series of years in which the ravages of the caterpillars have been gradually growing more severe, and now, in 1869, comes the sudden fall; 1869 proved to be a remarkably dry year, and cotton suffered more from drought than from any other cause. This at once brought *Aletia* under the power of its insect enemies, and when the statistician of this department glanced over the field in his monthly report for December, 1869, he stated: "The caterpillar and boll-worm committed depredations in some sections, destroying here and there the crop of a county, but their ravages were by no means general." The points of injury this year were very scattered, and were due, for the most part, to local causes. Two of the counties in the southern part of the Texas cotton-growing region, Matagorda and Goliad, suffered very severely; but farther north, the crops were by no means greatly injured. Off to the west, the caterpillars made their appearance in one field in Blanco County for the first time in its cotton-growing history. In Polk County the crop was partially destroyed, but in surrounding counties the damage was slight. In Louisiana the worms were to be found all over the State, but not a single parish reports any loss worthy of note. In Mississippi, also, the loss was comparatively insignificant. In Alabama more damage was done. A few counties, which reported small losses the year before, were more severely afflicted this year. In Wilcox the worms were very bad; Macon reported great damage; in Dallas 20 per cent. of the crop was lost, and in Greene 30 per cent. With these few exceptions, the injury was slight. From a comparatively limited region in Northern Florida extremely varied accounts are given of the ravages this year. In Leon County the worms appeared early, one-fourth of the crop was destroyed and much greater loss anticipated, when they suddenly and unaccountably disappeared. Bradford County reported the damage as severe, and Putnam lost 50 per cent. of the crop. Santa-Rosa, Jackson, and Duval, on the other hand, report the caterpillars as not very injurious. Southern Georgia and the coast counties of that State were badly invaded, while the remainder of the State reported slight injuries. In Brooks County the caterpillars did considerable damage; Glynn lost three-tenths of the crop, and Liberty from one-third to one-half. The crop in South Carolina does not seem to have been at all damaged this year. In Wayne County, North Carolina, the third brood of caterpillars came in August, the earliest date on record for that State, and did some little damage.

We should naturally expect an increase in the ravages of the worms again in 1870, but the same causes which reduced their numbers so

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greatly in 1869 again operated in 1870, the growing season being remarkable for long-continued drought. In the statistical summing up for the year, we find the following remark: "A general exemption from losses by insects is noted with occasional exceptions, mostly in Louisiana and Texas (the counties of Matagorda, Henderson, and Red River, in Texas, and Rutherford, in Tennessee, have been infested with bollworms)." In Texas, Goliad and Matagorda Counties again report considerable injuries, and Galveston County lost one-half the crop. In Montgomery County they were seen webbing up before July 1. Polk County lost part of the crop, but elsewhere they were not bad. In Louisiana the worms were abundant and destructive in East Feliciana, Rapides, Avoyelles, Tensas, and Jackson Parishes. In Rapides the crop was damaged 20 per cent. in August, and there were some injuries later. Avoyelles lost 50 per cent. of the crop from storms and caterpillars. Mississippi was almost entirely exempt from severe ravages by the worms. They were present, but in small numbers. Nearly all of the richest cotton counties of Alabama reported the presence of the caterpillars in the early part of the year, but the final reports show an entire exemption from severe injuries. None of the correspondents in Florida and Georgia consider 1870 worthy of note as a worm year, though many of them speak of the unusual freedom from insect pests. The caterpillars appeared in South Carolina, and were also reported from Cumberland County, North Carolina, but no damage resulted.

In 1871 there was a general increase in the ravages of the worms, the especial point of destruction being Louisiana. The caterpillars were present in force over all the Southern cotton States, but in all but Louisiana the last brood was just too late to destroy the crop. In Texas they were reported from all over the cotton-growing region, from Bexar to Red River. The greatest damage was done in Bexar, Matagorda, Liberty, Rusk, and Cherokee, but in these counties it was nothing more than the top crop that was taken. Louisiana, as we have before said, was the point of greatest injury this year. The loss was, however, very unequally and strangely distributed throughout the State. In Saint Landry there was general destruction. Iberia lost 45 per cent. of the crop. Washington lost one-third. Avoyelles reported total loss, and Caddo serious injury. On the other hand, although considerable injury was done in East and West Feliciana, Rapides, and Richland, the parishes of Tangipahoa, Tensas, Madison, Red River, Claiborne, Ouachita, and Morehouse report but few worms. In La Fayette County, Arkansas, the caterpillars appeared rather late, but did some little damage. Mississippi cotton suffered more from drought in 1871 than from any other cause. The caterpillar did considerable damage in Wilkinson and Jefferson Counties, but, although they were present all over the State, their injuries in other portions were limited. In Alabama the worms were reported from many localities, but, as before, losses were not great. The northern part of the State was not touched. The only counties reporting

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loss that is at all severe were the widely-separated ones of Crenshaw and Bibb, in each of which the loss amounted to one-half of the crop. The correspondent in Crenshaw remarked upon the regular northeast course which the worms seemed to take. In Florida the correspondents forgot to say anything about the caterpillars, in their dismay at the havoc created by the violent storms which visited that section of the country the latter part of the season. In Gadsden County alone does the caterpillar seem to have done much damage. In Georgia the caterpillar was an element not to be taken into account in summing up the damage this year. Early in the season, drought, with rust, and later, violent storms completely overshadowed the insects. They were barely mentioned from some half dozen localities, Clay County alone reporting considerable damage from their ravages. They do not seem to have appeared this year in South and North Carolina.

In 1872 there was a great increase in the loss occasioned by the caterpillar ravages. Texas did not suffer to any great extent, and the damage was no more severe than in the previous year in Louisiana. Mississippi lost considerably, but the greatest injury was done in Alabama and Florida. In Georgia the loss was much greater than usual, as it was also in South Carolina, and the caterpillars were very abundant in North Carolina. The presence of the worms early in June was reported from Texas, Louisiana, and Florida. In Texas, Matagorda and Victoria were the first counties to report caterpillars; in the latter county they were seen as early as June 6, and in the former about the same time. Some damage was done in these counties, as well as in De Witt, Gonzales, Austin, Waller, Liberty, Walker, Polk, Upshur, and Kaufman. In Fayette they were very troublesome, and in Liberty they were present in large numbers as early as July. The State as a whole did not, however, suffer at all severely. In Louisiana the caterpillars were reported in June and appeared in force in August. They nearly "finished" the crop in Tangipahoa, and reduced that of Marion to a half average. In Concordia many fields were entirely stripped of foliage. In Rapides two-thirds of the crop was destroyed, and the caterpillars were reported in injurious numbers in Saint Landry, Washington, Red River, and Jackson. Arkansas reported them this year from one locality alone, Columbia County. In Mississippi the ravages were general. Marion, Clarke, Rankin, Hinds, and Noxubee Counties suffered the most, perhaps, the loss in all amounting to nearly one-half the crop. In other localities the losses varied from almost nothing up to 25 per cent.

The state of things this year in Alabama was well set forth in the September report of this department, as follows:

Our August returns from Alabama foreshadowed an extensive visitation of the cotton caterpillar, which, as our September reports show, was fully and painfully realized. In some places the boll-worm vied with the cotton-worm in its destructive influence. Reports of either or both of these pests come from Macon, Pike, Marengo, Conecuh, Perry, Montgomery, Crenshaw, Russell, Fisk, Calhoun, Chambers, Butler, Autauga, Dallas, Wilcox, and Tuscaloosa Counties. In Crenshaw the fields were denuded of

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foliage. In Calhoun the crop prospect was reduced 25 per cent. in five days. In Autauga the roads, woods, and wells were full of army and boll-worms. In Wilcox the caterpillars, after stripping the cotton plant of its leaves, attacked the bolls, eating the smaller ones and killing the larger ones by gnawing around them. In Perry the crop was cut down to half an average after August 20. In Conecuh the destruction was almost complete, as it also was in Russell. All through the cane-brake region the loss was very severe. Butler, Clark, Wilcox, Dallas, Perry, and Tuscaloosa report a loss of one-half; Pike, Bibb, Hale, Calhoun, and Limestone a loss of one-fourth or over. With the exception of 1873, this was, perhaps, as bad a worm year as Alabama ever had. In Florida also the damage was very great. In Suwannee County the caterpillars appeared July 15, and within a month many fields were entirely stripped. In Leon they made their appearance August 18, and within a week the last cotton leaf had disappeared.

The same report comes from Taylor County. Columbia County suffered a loss of 75 per cent. from rust and caterpillars combined. Leon County lost two-thirds of the crop; Orange, Jackson, Jefferson, Suwannee lost one-half, and Clay one-third. The Madison County correspondent, on the other hand, reported "not much loss." The caterpillars were destructive in almost every part of Georgia, although their ravages were far less than in the neighboring States of Alabama and Florida. Calhoun and Heard lost half the crop; Lee, Marion, and Columbia one-third; Decatur, Baldwin, and Coweta from one-fifth to one-third; Berrien, Worth, Clay, Dooly, Sumter, Schley, Chattahoochee, Muscogee, Upson, Wilkinson, Putnam, Glascock, Greene, Spalding, Floyd, and Chattooga, all were afflicted in a lesser degree. In South Carolina the caterpillars were very destructive in Richland County. In Orangeburgh they appeared in great numbers, but were rather late. In North Carolina they were widespread, and were reported from six of the cotton-growing counties of that State. So ends 1872, which we think can fairly be placed among the six great cotton-worm years, 1804, 1825, 1846, 1868, 1872, 1873.

From the time of the first appearance of the chenille down to the present date, it is doubtful if 1873 was ever equaled as a year of general caterpillar ravages. From Atascosa and Medina Counties in Texas, to Prince George and Princess Anne in Virginia, through every portion of the cotton-growing region, these pests were to be found in destructive numbers, and few localities escaped serious injury. As was to be expected from their prevalence in 1872 the hibernation was extensive and caterpillars were reported remarkably early in the spring of 1873. They were seen on May 30 along the Flint River in Decatur County, Georgia. Just over the State line, in Jackson and Gadsden Counties, Florida, they were observed about the same time. They had also made their appearance in Marion County, Mississippi, and also in Barbour County, Alabama.

Early in June they were reported from Atascosa County, Texas, as sweeping the third planting of cotton, the first two having already been destroyed by grasshoppers. They had also made their appearance in Victoria County, Texas. Before July 12 they had been reported from

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the following localities: Atascosa, Austin, and Galveston Counties, Texas; Tangipahoa, West Feliciana, Concordia, Rapides, and Carroll Parishes, Louisiana; Wilkinson, Marion, and Jasper Counties, Mississippi; Clarke, Wilcox, Dallas, Tuscaloosa, Barbour, and Saint Clair Counties, Alabama; Liberty, Leon, Jackson, Gadsden, Suwannee, and Columbia Counties, Florida; and Decatur County, Georgia. These localities are of extreme interest and should be borne in mind as showing probable localities of hibernation.

In Texas the distribution of the worms was much more general than it ever had been before, many counties reporting them for the first time. The points of heaviest damage seemed to be irregularly distributed throughout the cotton-growing part of the State. They seemed to follow no law, nor were they massed together as one would expect. The greater or lesser destructiveness seems to depend so entirely upon various local causes that this result is brought about. The worms were more universally present in the southwest cotton counties than before, but few of them suffered severely, the exceptions being Medina, Brazoria, Fort Bend, and Lavaca. The following counties were the worst afflicted of any in the State: Burnet, Austin, Waller, Washington, Grimes, Hardin, Nacogdoches, Shelby, Marion, Rusk, Henderson. The loss in these counties amounted to from 25 per cent. to 75 per cent. of the crop. The correspondent from Liberty says that total destruction was anticipated, but that the caterpillars unaccountably stopped short of the whole crop. A curious fact was noted by the correspondent from Smith County to the effect that while the cotton on "red lands" was seriously damaged, that on "gray lands" was scarcely touched.

In Louisiana the damage was very great. The more southern parts of the State were seriously injured by the earlier broods of the caterpillars, while the more northern counties were, some of them, entirely untouched until late in September. Even as late as this the crop was in many instances almost entirely destroyed. In Iberia, Tangipahoa, West Feliciana, Avoyelles, Rapides, Tensas, Franklin, Caddo, Boissier, and Claiborne the worms did great damage, inflicting losses varying from one-third to nearly the whole crop. Madison, however, and one or two other more northern parishes, reported them as coming too late to do much harm. The caterpillars were this year more abundant in Arkansas than they ever had been before. Great damage was done in Hempstead County; the top crop was taken in Little River, and considerable damage was done in Columbia, Union, Ashley, Drew, Dorsey, Clark, Polk, and Garland Counties. Mississippi was badly afflicted all over the State. Appearing in Marion in May, they rapidly spread and increased with each successive brood. Some of the upper counties they did not reach until after the 1st of September. Loss amounting to 20 per cent. of the crop and over was inflicted on the following counties: Wilkinson, Jefferson, Claiborne, Clark, Warren, Rankin, Madison, Washington, Lowndes, Le Flore, Grenada, Lee, and several others. The cat-

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erpillars made their appearance this year in Tennessee in considerable numbers, but their ravages were inferior to those of the boll-worm. Shelby County reported 50 per cent. loss from the combined ravages of the two insects. In Dickinson County the crops were also damaged by *Aletia*. In Alabama the caterpillars were this year reported from thirty-eight counties. Many who, up to this time, had considered the loss unworthy of mention now sent in exaggerated reports of the ravages. Some, however, report them as not so destructive as in the previous year, which, it will be remembered, was one of the worst years Alabama ever experienced. The caterpillars made their first appearance along the Chattahoochee River, in Barbour County, and in that county before the end of the season they had damaged the crop to the extent of one-half In Henry County, just south, they were not seen until much later, but then came in immense numbers and stripped the fields. In Coffee and other counties farther to the west only the late cotton suffered seriously Throughout the canebrake the damage was very great. Dallas County suffered a loss of more than one-half. Lowndes reported a loss of 70 per cent. Montgomery reported "weed late, and worms early; damage very great." Autauga lost from two-thirds to three-fourths of the crop. In Hale the crop was the poorest for thirty-five years. Greene lost one-third. On the other hand Bullock County, surrounded by Barbour, Russell, Pike, Macon, and Montgomery, in which the damage was so great, reported "not many worms." Of the more northern counties, Bibb reported one-third loss; Chambers reported the top crop ruined and other damage; in Randolph, Talladega, and Calhoun they were very bad; in Saint Clair and Jefferson they were also destructive. The correspondent from Blount County said: "Caterpillars took the leaves, but this only hastened the ripening of the bolls; best crop ever produced here."

In Florida, in 1873, the principal damage was done, not as usual in the northwest but in the northeast. In Jackson, Liberty, Gadsden, and Leon, our old standby's for the caterpillars, they were present in force, but the loss they occasioned was so insignificant compared with that made by the September and October storms that they were lost sight of by the correspondents; then, too, the storms destroyed the caterpillars even more effectually than the cotton. In Jefferson, Taylor, Madison, Suwannee, Hamilton, and Columbia Counties, however, the damage from caterpillars was enormous. The correspondent from Taylor County parenthesizes, "the caterpillars have nearly stopped cotton culture in this county."

One of the very worst affected States in 1873 was Georgia. The caterpillars were reported earliest from this State, and later in the season were to be found in almost every cotton field within her limits, from Decatur to Whitfield. The counties in which the most injury was done, were as follows: Clinch, Sumter, Stewart, Taylor, Wilkinson. These counties lost one half or more. Calhoun, Lee, Worth, Dooly, Marion,

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Schley, Muscogee, Twiggs, Richmond, McDuffie, Heard, Coweta, Baldwin, Wilkes, Lincoln, Jackson, Carroll all report losses varying from 25 to 50 per cent. Even as far north as Floyd, Franklin, and Whitfield, the top crop was swept, and the sum total considerably shortened. Many counties reported it the worst year ever experienced, the crop being nearly ruined. It is a curious fact that the coast counties did not suffer this year as greatly as did the counties in the interior, whereas usually the reverse is the case.

In South Carolina the invasion was quite general. In many districts which had simply known it as a late fall comer, it appeared early enough to do some little damage, but few seem to have suffered at all severely. In Lexington they were bad, and in Marion all cotton on improved lands was stripped. In Edgefield the growth of the plants was stopped by the leaf-eating of the caterpillars, but the bolls opened finely. This was also the case in Orangeburgh, but the quality of the cotton was injured by the excrement of the worms. They were reported, in addition to these districts, from Williamsburgh, Richland, Fairfield, Newberry, Laurens, Chesterfield, and Marlborough.

In North Carolina, the prevalence of the caterpillars was utterly beyond all precedent, and in some counties great damage was done. In Bladen, rust and caterpillars combined to make a loss of 50 per cent. In Carteret, they were worse than ever before; late plantings were cut down one-half. In Lenoir, the crop suffered a loss from caterpillars alone of 25 per cent. In Stanley, they were observed in parts of the county where they were never known before, but were too late to do much damage. In Greene, the leaves were stripped. In Pitt, they appeared for the first time and did considerable damage. The correspondent from Beaufort says: "The caterpillars saved the top crop from frost." In Chowan, the caterpillars made their first appearance, and in Perquimons they damaged the crop to the extent of 50 per cent. Currituck suffered a loss of one-third of the crop, and in Martin, where they appeared for the first time, the late crop was taken entire. Many other counties chronicled their appearance without further comment.

In the latter part of September and the early part of October, the chenilles did the unheard of thing of appearing in the cotton fields of Virginia in sufficient numbers to do a little damage. The correspondent from Sussex County says: "A worm heretofore unknown stripped the leaves just before the cool nights of October." In Southampton, the leaves were also stripped. In Prince George, all the cotton was late planted and was more or less injured by the caterpillars. In Princess Anne, their presence was also noted.

The comparison between the damage done by the cotton-worm and that produced by other causes this year, is well treated in the Department of Agriculture Monthly Report for February, 1874, as follows:

The causes of injury are various, the more prominent being the ravages of worms in stopping the development of the bolls and staining fiber; the destruction of the plant or beating out the fiber, or reducing its grade with dirt and "trash," by heavy

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storms of rain or wind; premature decay arising from imperfect cultivation, superabundant moisture in the soil in the spring, drought in summer, and the train of diseases which accompany the low vitality of the plant from whatever cause, and, finally, the effect of frost in arresting the development of half-mature fiber and in discoloring it. The relative influence of each cause in damaging the crop of 1873, as indicated by our correspondents, may be stated in the following order in the different States:

North Carolina.—Rains, frost, worms.

South Carolina.—Rains, frost, worms.

Georgia.—Worms, more than all other causes combined; rains, frost, drought, high winds.

Florida.—Storms of rain, worms.

Alabama.—Worms, rains, frost.

Mississippi.—Worms, spring rains, drought, frost.

Louisiana.—Worms, rains, high winds.

Texas.—Worms, rains, drought, frost, bad gins and inexperienced ginners.

Arkansas.—Rains, worms, drought, frost.

Tennessee.—Drought, frost, rains, plant-lice, a cold and wet spring.

In the Gulf States the greatest injury thus appears to have been wrought by worms, excepting only Florida, where the devastating storms in September and October, particularly that of September 19, proved more destructive than the caterpillar, which was abundant and sufficiently injurious. Though the main damage by insects was done by the caterpillar (*Anonilina*) there was much loss occasioned by the boll-worm (*Heliothis Armigera*) and some injury in localities by the cotton-louse or *Aphis*.

All through the South the efforts of the planters against the cotton-worm were this year marked by the first extensive use of Paris green. The fact that experiments with the "green" as a cotton-worm destroyer had been made during the season of 1872, was incidentally mentioned by Prof. J. Parish Stelle in an article in the Mobile Register in the fall of that year;* and in a recent letter from Professor Stelle, he claims the credit of being the first to publicly recommend its use, through the columns of that paper. Mr. J. Donovan, of Kushla, Ala., experimented with the poison in 1872, and claims (according to Mr. Schwarz) to be the first who ever applied it for the destruction of *Aletia*. Professor Stelle remarks in his letter that Mr. Donovan first applied it in obedience to a recommendation of his in the Register. Rev. W. A. Stickney, of Faunsdale, Ala., informs me by letter that early in 1873 a Mr. Clark was selling Paris green in Alabama for the destruction of the cotton-worm, and claimed that it had been fully tried the previous year in Texas. Mr. Stickney says: "I could not ascertain whether the experiment had been applied to crops preceding 1872. But from *that year* (1872), if not still further back, Clark's formula derived warranty."

In May, 1873, Prof. C. V. Riley publicly recommended Paris green as a cotton-worm destroyer before the Indianapolis meeting of the American Agricultural Congress, and in his Sixth Missouri Entomological Report mentions the fact that he had suggested it the *previous year* in the following words:

In June, 1872, at the organization in Saint Louis of the National Agricultural Congress, there were present many delegates from the South. It was my privilege on that

* Reimpr. Southern Farm and House, October 1872, p. 457.

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occasion to lecture before the congress on economic entomology, and to suggest, in answer to inquiries from Gen. William H. Jackson, of Nashville, Tenn., and Dr. J. O. Wharton, of Ferry, Miss., that the Paris green mixture which was doing such good work in preserving our potato fields against the ravages of the Colorado potato-beetle might prove equally efficient against the ravages of the insect which takes the place of this potato enemy in the cotton fields of the South.'

At the Indianapolis meeting of the congress, according to Professor Stelle, after the reading of Professor Riley's paper, Mr. Donovan rose and made the statement that he had used the poison the previous year, 1872, at the recommendation of the Mobile Register. The whole question indeed, as to whom the credit is due, is involved in doubt; it is, however, not a question of paramount importance.

In early fall, 1873, the following circular was issued by Commissioner Watts, with a view of ascertaining the practical workings of Paris green:

PROTECTION AGAINST COTTON INSECTS.

To Correspondents:

The annual losses of cotton from ravages of cotton insects amount possibly to half a million bales in years of insect prevalence, One-fourth of a million bales would be deemed a light infliction, and yet, at $100 per bale, such a loss would be equivalent to $25,000,000. The methods to be employed for lessening their ravages have been heretofore canvassed by the entomologist of this department. The remedy can only be applied by the planters themselves, and their own experience can best render practicable and efficient the means employed.

Numerous correspondents have of late been experimenting with a mixture of Paris green and flour or plaster, dusted on the plants when wet with dew—a remedy which has proved very efficient against the Colorado potato-beetle and other insects. Some report this remedy effectual against the cotton-caterpillar, while others declare it of no value whatever; others, still, hesitate to try it for fear of poisoning. It is of the utmost importance that the facts in the experience of planters the present season should be carefully reported, showing the quality and proportions of material used, the method and frequency of its application, and the observed results, that a thorough test may be made of its value or worthlessness. The answer of the following questions is therefore requested:

I. What is the result of your experience or observations as to the efficacy of Paris green, or other arsenical compounds mixed with flour or plaster, for the destruction of the cotton-caterpillar?

II. In what proportions, and in what mode, time, and frequency of application have experiments been made?

III. Have any injurious effects of the poison been observed, either upon the plants or the soil, or in human poisoning in its application, or in the destruction of beneficial insects, as bees, &c?

IV. Have you used any other remedies, or means of extirpation, such as fires or torches in the fields to destroy the perfect moths on their first appearance, and with what success?

Yours, respectfully,

FRED' K. WATTS,
Commissioner.

The report on the answers to this circular as published in the department report for 1873 show the results of most experiments with Paris green to be highly favorable to its use as a remedy, and it has since been extensively used throughout the South. There are still many who

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earnestly protest against the use of this poison; but a discussion as to its merits does not belong here, and will be found in Chapter VII, under the head of "Remedies."

After 1873—the climax—came 1874 which may be called an anti-climax. 1874 was a remarkably dry year over nearly the whole of the cotton belt, Texas alone suffering more perhaps from worms than from drought. The result was, as it has been in so many cases, that the injuries of the caterpillars underwent a most wonderful diminution from those of the previous year, and very few localities report 1874 as a severe worm year. The caterpillars made their appearance in June in Southern Texas, but increased remarkably slowly with successive broods. Toward the latter part of the season, however, they were present in destructive numbers in many counties. Paris green was used to a considerable extent this year and with success in some localities. The correspondent from Lavaca County reports "caterpillars would have been destructive but for the use of Paris green." From Harris County the report was, "Paris green keeps them in check." The greatest losses were reported from the widely-separated counties of Burnet and Hardin, Burnet reporting 40 per cent. loss and Hardin 33 per cent. The top crop was destroyed in Austin and Bandera. Considerable damage was done in Colorado, Waller, Fayette, Polk and Cherokee. The worms were on hand, but little injury was done in San Jacinto, Walker, Upshur and in most of the more northern counties. In Mississippi the crop suffered severely from drought, and in most localities the case was, as the correspondent from Kemper County expressed it, "the drought killed the cotton and the worms too." The leaves were stripped, however, in Lowndes, Wilkinson and several other counties, which served to make the plants still more susceptible to the drought. In Hancock County, down on the Gulf coast, the crop suffered severely from the caterpillars. The correspondent from that county said: "Heretofore it was thought that worms would not injure cotton on the seashore, but this hope has proved fallacious."

In Louisiana, the chenille made its appearance in early June, Rapides being the first parish to report its presence. The damage done in the State was not at all great, as from the slow increase occasioned by drought and parasites, they did not attain injurious numbers until it was too late to do much harm.

In Alabama the crop was a poor one, but this was due more to drought than to insect ravages. Several counties, it is true, reported "ruined by drought and caterpillars"; but the caterpillars were invariably subordinated to the drought. The correspondent from Coffee County reported "some worms, but the drought was too much for them." Barbour and surrounding counties reported them as "not bad," and estimated the loss at perhaps one sixth of the crop. In Florida the state of affairs was much the same; the damage from insects was comparatively insignificant. Nearly all localities reported that the hot weather killed the caterpillars.

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In Georgia the worms were widespread—a natural result from the great invasion of the previous year. In Early they were seen July 1, and had done some little damage before picking season. In Schley they appeared too late to do harm, and in Muscogee were seen upon bottom lands only. Some damage was done in Dodge, Wilkes, Jackson, and several other counties, and Murray suffered a loss of 40 per cent. In South Carolina they were seen in a few localities, some crops being damaged in Beaufort and Richland Counties. Pamlico County, North Carolina, reported "the worm," but it is difficult to say whether the cotton-worm or the boll-worm is meant.

In the latter part of this year Mr. A. R. Grote read a paper before the Hartford meeting of the American Association for the Advancement of Science, in which he announced that, after long study and personal observation, he had come to the conclusion that "the cotton worm may be considered not a denizen, but a visitant brought by various causes to breed in a strange region, and that it naturally dies out with us in the cotton belt, unable to suit itself *as yet* to the altered economy of its food plant and to contend with the changes of our seasons."

This is, of course, nothing more than a repetition of the *migration theory*, as we may call it, which Thomas Affleck, Dr. Gorham, and Dr. Burnett had successively and independently put forth as the result of their study into the natural history of this insect, and it is a very interesting fact, that a man of Mr. Grote's scientific ability should have arrived at the same result through independent observation and reasoning. It is also a curious and interesting fact that one of the arguments by which Dr. Gorham reached this theory, and one of the main arguments by which Mr. Grote arrived at the same point, started from bases as diametrically opposed to each other as two bases could well be; namely, the existence and the non-existence of parasites. Dr. Gorham visits the cotton fields after the last brood of worms has spun up, and, finding every chrysalis that he tries to breed parasitized, jumps to the conclusion that all of the last brood are parasitized. The natural question now is, where will they come from next year? and the natural conclusion, from some exterior country where the cotton plant is perennial and parasites do not exist. Mr. Grote's observations, on the other hand, failed to show him any parasite, although he acknowledged that such might exist; and the absence of such peculiar parasites argued that the worm was not a regular denizen, and could be accounted for only by the spreading of the insect as a moth. Since Mr. Grote again put the old theory into shape, it has been much discussed by those interested, its principal opponent being Professor Riley. Yet that the latter plainly acklowledged the strength of Mr. Grote's arguments is seen in the cotton-worm circular of 1878. (See introduction.) A special chapter will be devoted to this subject.

In March, 1854, some six months before Mr. Grote read his Hartford

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paper, Mr. Townend Glover was casually placed on record * as favoring what may be called a *partial immigration theory*, in the following words:

The theory of our entomologist, which he deems to be sufficiently verified by some years of study in the field as to the movement and spread of the caterpillar, is that in the more northern portion of the cotton belt the frosts of winter destroy the insect in all its stages, unless in situations of unusual protection, but that in the more southern portion, where severe frosts rarely occur, they survive the risks of winter, and as they increase, by their repeated generations during the summer, they migrate northward in the fly-state (the perfect insect) to "fresh fields and pastures new." This would account for the general prevalence of the insecton the gulf coast and its comparative scarcity and late appearance in the more northern regions, which facts are by no means singular in the records of the past year, but in accordance with the history of former visitations.

All credit should be given to Mr. Glover for this phase of the theory, which the extended investigations of the past year show to have been more nearly correct than any suggestion heretofore made. Indeed, the work of Mr. Glover on cotton insects, the results of which are scattered all through the Department of Agriculture reports from 1854 to 1874, is by far the most valuable that has been done by any one person. This tribute is due to Mr. Glover, and we can only regret that a painful disease debars him from prolonged scientific work.

In 1875, instead of an increase over the preceding year, we see a still further decrease in the prevalence of the cotton caterpillars, owing to nearly the same causes which produced the decrease in 1874. Eighteen hundred and seventy-five was another very dry year, and in August and September there was an occasional severe storm, causing great damage. From these causes the caterpillars were so held in check that in the monthly report for September, 1875, we find the following statement: "Losses from prevalence of insects will scarcely be a factor in calculating the product of the present year." In fact, the only State in which much damage was done was Florida. In Texas they were first seen in July, but in very small numbers. In Austin County alone do they appear to have done any material damage, unless we except Polk County, where the crop is said to have been "partially destroyed." Slight injuries were reported from Matagorda, Fayette, Waller, Hardin, Walker, Limestone, Bosque, and Upshur. From Louisiana there were no reports of insect prevalence in 1875. The cotton-worm was there, but in such small numbers that it would have been a waste of ink on the part of correspondents to mention it. From Arkansas the caterpillars were reported from Woodruff and Pope Counties. In Mississippi the damage was very slight. In Alabama the worms were more abundant than in the last-named States, but still did but little injury to the crop. In Lowndes they were reported to have eaten things clear, but in other localities they were not worthy of extended notice. In Florida the damage was greater. The caterpillars do not seem to have been noticed early in

* Department of Agriculture, monthly Report, February and March, 1874, p. 125.

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the season, and their coming in force later seemed all the more disastrous from being unexpected. The correspondent from Jackson County said: "After the appearance of a fine top crop, the caterpillars made their appearance in force and cut off all our hopes." There were injuries in many localities, notably in Columbia and Leon Counties. In Georgia they were noticed in several localities, but their damage was very slight In South and North Carolina they appear not to have been noticed.

In 1876 there was a general increase in the numbers of the caterpillars and in the extent of their ravages. The following brief extracts from the monthly reports will serve to give a general idea of their prevalence and importance:

The caterpillar is confined to the southerly portion of the Gulf States; its depredations are most severe in Alabama. In most of the infested districts its reproduction was too late to destroy the top crops. * * * Caterpillars appeared about the middle of July in Liberty County, Georgia, and stripped the plants of leaves, but not so early as to materially injure the yield. Some damage by the caterpillars is reported in Early County, and in Muscogee. * * * Caterpillars have reduced the yield in Florida, notably in Columbia County. * * * The caterpillar has been somewhat destructive to the top crop in portions of Alabama. The loss is estimated at 50 per cent. in Conecuh; at 40 per cent. in Hale (50 in the southern portion), where the fields were swept as early as the 1st of September. * * * The causes of injury in Mississippi are worms, drought, wet weather, and frosts. * * * The causes for injury for 1876 may be summed up: drought on the Atlantic coast, the caterpillars in the Gulf States, in Alabama especially, and the boll-worm in Arkansas.

In Texas the caterpillars appeared in force much later than the previous year, but yet were sufficiently early to do considerable damage. The localities of their earliest appearance in Texas have nearly always been in the Colorado and Brazos bottoms, and these have also been almost universally the worst affected localities. This year, up the line of those rivers, Matagorda, Waller, Austin, Fayette, Bastrop, and Burnet report the worst injuries that are reported from the State, while in counties both south and north the worms were almost invariably too late. In Victoria the worms appeared later than last year, but stripped the leaves. In Lavaca only the late plantings were taken. In Matagorda they were "bad," and in Austin made a "clean sweep." Burnet lost 40 per cent. of the crop, but in Cherokee, Rusk, Upshur, and neighboring counties, the damage was slight. In Louisiana and Arkansas the damage this year was slight, and occurred principally in Rapides and Caddo Parishes, Louisiana, and in Nevada County, Arkansas. In Mississippi, considerable injury was done, principally on the Alabama side of the State, in the counties of Jasper, Clarke, Kemper, and Lowndes. The Jasper County crop was greatly injured; in Clarke the whole top crop was taken; in Kemper, the plants were stripped; and in Lowndes, a loss of from 35 to 50 per cent. was suffered. In other parts of the State the worms appeared, doing the most harm in Covington, Wilkinson, Adams, Jefferson, and Rankin. Of these, Jefferson suffered the most—25 per cent. In Alabama the worms were present in all parts of the State, from Baldwin to Lauderdale. Few localities outside of the

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fertile "cane-brake region" were badly damaged, however, the most notable exception being Conecuh County, where 50 per cent. of the crop was lost. In Marengo, the plants were completely stripped. From Dallas, 40 per cent. loss was reported. The worms were injurious in Lowndes, Montgomery, and Bullock. The Autauga correspondent reported "caterpillars by the million." In Perry, two-thirds of the county was swept. Bibb lost one-half and Hall one-fourth of the crop. Further north, although the worms were numerous, as a general thing they came too late. In Florida, the crop of a few counties was damaged this year, but the injury was far from being general. In Jackson County they appeared July 1, and were destructive later. In Jefferson, the crop was badly injured, as also in Madison. In Columbia, the worms just barely put in an appearance in September. The caterpillars were prevalent in quite a number of localities in Georgia, and did "some considerable damage" both in Muscogee and in Harris. In Early, they riddled the cotton in spots, but were not general. Twiggs reported them as being present in force. In South Carolina no damage was done, the worms being seen in September, but in small numbers.

With 1876 the monthly reports of the Department of Agriculture close, and since then there has been issued an occasional bulletin on the condition of crops. Much of our previous matter on the prevalence during each year since 1866 was based upon data from these monthly reports, in addition to that furnished by the 1878 correspondence and by the miscellaneous articles published upon cotton insects. As a result of the discontinuance of these reports, the data for 1877 and 1878 are not as complete as those for previous years, and hardly as accurate.

As a general cotton-worm year 1877 appears to have been somewhat worse than 1876. The marked feature this year was the immense amount of damage done in Texas, more particularly in the southern portions of the cotton-growing region. In a bulletin in July, 1877,* we find that the following Texan counties were already infested: Uvalde, Atascosa, Victoria, Brazoria, Hardin, and Jasper. The following is from an August bulletin:

The prospect in *Texas* is marked by the appearance of the caterpillar. More than one-half of the counties reported are infested, not seriously as yet, except in a few cases. In *Lavaca* the bulk of the crop is destroyed; in *Gonzales*, 75 per cent., a complete wreck where preventives were not used. Poison is successfully applied by prudent planters. * * * The caterpillar has appeared in the parishes of *Saint Landry*, *Richland*, and *Claiborne*, in Louisiana; in *Perry*, *Wilcox*, and *Conecuh*, in Alabama; in *Columbia*, Florida; and in *Brooks*, Georgia.

In addition to the localities already mentioned, we glean the following from the answers of the general circular: In Fayette, Colorado, Austin, Waller, Hardin, Walker, and Polk, the caterpillars were very numerous; in Austin, inflicting a loss of 50 per cent.; in Hardin, 75 per

* In these bulletins the reports are all sent in before the 12th of the month for which they are published.

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cent.; and in Polk, "total destruction." These reports seem to make 1877 as bad a worm year as Texas has experienced.

In Louisiana the damage was comparatively slight. In addition to the parishes already mentioned, some injury was reported from East Feliciana and Jackson. In Mississippi the worms were abundant only in the southern part of the State—in Wilkinson, Jefferson, Covington, and neighboring counties. In Alabama the caterpillars were general but not very destructive compared with preceding years. In Northern Florida they were abundant but not remarkably destructive, while Georgia was very slightly touched.

In the winter of 1877–'78, the bill creating the cotton-insect investigation passed Congress, and in early summer work was begun. In June the following Texas reports came in:

Uvalde: Cotton-worms appearing in small shoals. *Atascosa:* Cotton-worms making their appearance here. *Matagorda:* The caterpillar has appeared in due course of time; will get his share of the crop. *Brazoria:* The cotton-worm has made its appearance in some parts of our county; as yet it has done no damage to the catton. *Victoria:* The worms are playing havoc with the cotton. *Lavaca:* Cotton-worm reported in several localities. *Fort Bend:* Worms have made their appearance in some localities, but as yet have done no damage. *Austin:* The first brood of worms has appeared in several places. *Hardin:* The green-worm that always comes before the cotton-worm is here on the cotton; also, the fly that lays the egg that produces the cotton-worm is here. *Polk:* Cotton-worms in abundance; farmers are using Preston & Roberia's Texas worm-destroyer with great success. *Jasper:* Worms are making their appearance in many places, and if they come in great abundance the cotton crop will be a total failure.

It is difficult to make any comparative estimate of the destruction from caterpillars in 1878, since in most parts of the South all thought of other calamities was lost in the fear of the great epidemic. From such data as we have been able to gather, however, it seems to have been the worst year since 1873, in all the Southern cotton States excepting Texas, where it was exceeded by 1877. In spite of the general early appearance of the caterpillars in the latter State, little serious damage was done. The greatest injury seems to have been in Matagorda, Colorado, Washington, Polk, and Cherokee counties, but the loss probably did not exceed 20 per cent. in any of these. In Louisiana caterpillars were prevalent. They were destructive in East Feliciana, Concordia, Madison, Jackson, Bienville, Bossier, and Caddo Parishes; more particularly so in the last three named. Pope County, Arkansas, suffered a loss of 25 per cent., and in Crawford they were nearly as bad. In Mississippi they were abundant in nearly all of the cotton-growing counties as far north as Chickasaw, but, from the fact that in this State were the headquarters of the fever, we have been able to get few particulars as to the abundance of the worms. In Alabama the damage was considerable. Many counties report the presence of the worms with greater or less loss. The greatest damage was done in Monroe, Conecuh, Dale, Wilcox, Barbour, Lowndes, Dallas, Montgomery, Macon, Autauga, Perry, Hale, Green, Sumter, and Pickens. The average loss was about

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from 15 to 20 per cent. The correspondent from Pickens county says that the loss was one-third on low lands with late planting, and one-tenth on high lands with early planting. In Florida the damage to northern counties was not great, but south, in Hillsborough, the caterpillars were very destructive. More or less damage was done in Marion, La Fayette, Columbia, Jackson, Jefferson, Leon, Gadsden, and Santa Rosa, but in none was it excessive. In Georgia the worms were all over the State towards the end of the season, but in no locality was great damage done. They were perhaps more abundant in the southern counties of Thomas, Brooks, Baker, Mitchell, and Dougherty than elsewhere. In South Carolina they were not reported, but were found by Professor Riley, in a short stop at Columbia, September 16.

This brings the *past history* of the cotton-worm down to the present year.

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The following is a table showing approximately the amount of damage done by the cotton-worm by years and by counties. *a* represents a loss of 50 % of the crop or more; *b*, from 25 to 50 %; *c*, from 10 to 25 %; and *d*, under 10 %. When a letter is marked with an asterisk it indicates that the statement is based upon the 1878 correspondence. When not so marked, the statement is taken from printed contemporaneous records.

Counties.	1804.	1814.	1825.	1826.	1830.	1831.	1832.	1834.	1835.	1836.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
TEXAS.																												
Uvalde																												
Medina																												
Atascosa																												
Goliad																												
Victoria																												
Matagorda																	d*	c*	b*									
Brazoria																	d*	c*	b*									
Wharton																												
Lavaca																												
Dewitt																												
Gonzales																												
Guadaloupe																												
Bexar																												
Bandera																												
Comal																												
Caldwell																												
Fayette																												
Colorado																												
Austin																							d*					
Fort Bend																												
Galveston																		d*	b*									
Blanco																												
Burnet																												
Williamson																												
Bastrop																												
Washington															d*													
Waller								b*																				
Harris																												
Liberty																												
Hardin																												
Jasper																												
Polk																			b*				c*					
San Jacinto																												
Montgomery																												
Walker																									c*			
Grimes																												
Brazos																												
Leon																												
Trinity																												

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Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1804.	1814.	1825.	1826.	1830.	1831.	1832.	1834.	1835.	1836.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
TEXAS—Continued.																												
Shelby																												
Nacogdoches																												
Cherokee																												
Anderson																												
Limestone																												
Bosque																												
Henderson																												
Smith																												
Rusk																			b*	b*		c*						
Marion																												
Upshur																												
Wood																												
Kaufman																												
Hunt																												
Titus																												
Red River																												
Lamar																												
Fannin																												
Grayson																												
Bowie																				c*								
LOUISIANA.																												
Cameron																												
Saint Mary's																	c*											
Iberia																												
Assumption																												
Jefferson																												
East Baton Rouge																	c*											
Iberville	a*	a*																b*										
Tangipahoa																												
Washington																												
West Feliciana														c*			c*	c*	a*									
East Feliciana																	c*	c*										
Saint Landry																	b*	c*	b*									
Avoyelles																	c*		b*									
Rapides																	c		b*									
Natchitoches																	c											
Concordia																	c	c*	b*									
Catahoula																	c											
Tensas																												
Franklin																												
Jackson																	d	c*										

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Bienville																												
Richland																												
Red River																												
Madison																	d	b*										
Caddo																												
Bossier																												
Claiborne																												
Ouachita																												
Union																												
Morehouse																												
Carroll																			a*	b*								
ARKANSAS.																												
Miller													d*															
La Fayette																												
Columbia																										d*		
Union																												
Ashley																												
Nevada																												
Drew																												
Hempstead																												
Little River																												
Dorsey																												
Clark																												
Polk																												
Garland																												
Woodruff																												
Pope																												
Crawford																												
MISSISSIPPI.																												
Hancock																												
Wilkinson	a*		b*								b*							b*	a*									
Amite												d*							a*							c*		
Pike																												
Marion																												
Adams			a*														c	b*	b*									
Franklin																		c*	b*									
Jefferson																		c*										
Covington																			a*									
Wayne																												
Claiborne																												
Jasper																												
Clarke																			b*									
Warren																												
Hinds																												
Rankin																												
Newton																												
Lauderdale																												
Leake																												

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Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1804.	1814.	1825.	1826.	1830.	1831.	1832.	1834.	1835.	1836.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
MISSISSIPPI—Contin'd.																												
Neshoba																												
Kemper																												
Madison																												
Issaquena																												
Washington																												
Holmes																												
Attala																												
Winston																												
Noxubee																												
Choctaw																												
Lowndes																			b*		a*							
Le Flore																												
Grenada																												
Yalabusha																												
Chickasaw																												
Monroe																												
Lee																												
Bolivar																												
Coahoma																												
Panola																												
De Soto																												
TENNESSEE.																												
Shelby																												
Perry																							c*					
Dickson																												
ALABAMA.																												
Baldwin										c*					c*		c*	c*	b*	c*	d*	d*	d*	d*	c*	d*	c*	d*
Conecuh			a*			b*																						
Geneva																												
Coffee																												
Dale												c*	c*	c*	c*													
Henry																												
Barbour																		b*	a*									
Crenshaw																	c*											
Pike																												
Butler																												
Monroe			a*										c*				c*		c*	c*							c*	
Clarke																	b*											
Choctaw																												

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Marengo																												
Wilcox																						c*						
Dallas																												
Lowndes																	c*		c*									
Montgomery																			b*	b*								
Bullock																			a*									
Russell																												
Lee																												
Macon																				b*								
Autauga					b*																d*	c*					c*	d*
Perry																			b*									
Hale																c*	c*								c*			
Greene										b*							b*	c*	b*	c*	d*	c*	d*	c*	c*	c*	c*	d*
Sumter																			b*			c*	d*	c*	c*	c*	c*	d*
Pickens																												
Tuscaloosa																												
Bibb					b*																							
Chambers																												
Randolph																												
Clay																												
Talladega																												
Calhoun																												
Saint Clair																												
Jefferson																												
Blount																												
Marshall																												
Lawrence																												
Colbert																												
Lauderdale																												
Limestone																												
Madison																												
Jackson																												
FLORIDA.																												
Hillsborough																												
Orange																												
Marion																												
Levy																		b*										
Putnam																												
Alachua																												
Lafayette																												
Santa Rosa													c*	d*	d*	d*	d*	c*	a*	d*	d*	c*	d*	d*	c*	d*	d*	c*
Jackson																												
Liberty																												
Gadsden																								a*				b*
Wakulla																												
Leon					b						a	d	a	c		b*	c*	b*	a*	d*	d*	b*			b*			
Jefferson																												
Taylor							c*																					
Madison										d*		c*		c*														
Suwannee																												

Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1804.	1814.	1825.	1826.	1830.	1831.	1832.	1834.	1835.	1836.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
FLORIDA—Continued.																												
Hamilton																												
Columbia																												
Bradford																												
Clay																												
Duval																												
GEORGIA.																												
Decatur																												
Thomas																												
Brooks																												
Clinch																												
Charlton																												
Berrien																												
Early									b*																			
Mitchell																												
Calhoun																												
Baker																												
Clay									b*																			
Dougherty																												
Lee																												
Worth																												
Coffee																				b*								
Glynn																												
McIntosh																												
Liberty	a*		a*										b*			c*		c*	a*	b*					c*			
Tatnall																												
Dodge																												
Dooly																c*						c*			c*			
Sumter													c*															
Stewart																												
Chattahoochee																												
Marion										d*																		
Schley																	c*											
Macon															c*													
Muscogee																												
Harris																												
Taylor																												
Talbot										c*																		
Crawford																												
Bibb																												
Twiggs																												
Laurens																												

Emanuel																												
Effingham											b*																	
Wilkinson																												
Johnson																												
Jefferson																												
Glascock																												
Burke																		b*										c*
Richmond																												
Columbia																												
McDuffie																												
Upson																												
Troup																												
Heard																												
Coweta																												
Spalding																												
Butts																												
Baldwin																												
Putnam																												
Warren																												
Greene																												
Morgan																												
Walton																												
Oglethorpe																												
Wilkes																											c*	
Lincoln																												
Clarke	a*		a*										c*			d*			a*	b*					c*			
Madison																												
Jackson																												
Gwinnett																												
Carroll																												
Floyd																												
Franklin																												
Hall																												
Chattooga																												
Whitfield																												
Murray																												
SOUTH CAROLINA.																												
Beaufort																												
Colleton	a*		a*										c*			c*			a*			d*	d*		d*			
Orangeburg																												
Williamsburg																												
Lexington																												
Edgefield																												
Abbeville																												
Richland																												
Fairfield																												
Newberry																												
Laurens																												
Chesterfield																												
Marlborough																												

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Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1804.	1814.	1825.	1826.	1830.	1831.	1832.	1834.	1835.	1836.	1838.	1839.	1840.	1841.	1842.	1843.	1844.	1845.	1846.	1847.	1848.	1849.	1850.	1851.	1852.	1853.	1854.	1855.
SOUTH CAROLINA—Continued.																												
Marion																												
Union																												
Spartanburg																												
NORTH CAROLINA.																												
Bladen																												
Carteret																												
Pamlico																												
Craven																												
Jones																												
Lenoir																												
Duplin																												
Sampson																												
Cumberland																												
Union																												
Wayne																												
Montgomery																												
Stanly																												
Lincoln																												
Rowan																												
Greene																												
Pitt																												
Beaufort																												
Tyrrell																												
Martin																												
Edgecombe																												
Wake																												
Franklin																												
Halifax																												
Bertie																												
Chowan																												
Perquimans																												
Currituck																												
VIRGINIA.																												
Southampton																												
Sussex																												
Prince George																												
Princess Anne																												

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Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
TEXAS.																							
Uvalde																						d	c
Medina																		c					
Atascosa																		c				d	c
Goliad											a			b	b								
Victoria															b		c	c			c	c	
Matagorda														b		d	c	c		d	c		c
Brazoria																		b				c	c
Wharton																		c					
Lavaca											b							b	c		d	a	c
Dewitt											c						d						
Gonzales																	c					a	
Guadaloupe																		c					
Bexar																d							
Bandera																			c				
Comal												c*	b*										
Caldwell																		c					
Fayette				c*	c*	c*	d*	c*	c*	c*	b*	a*	c*	c*	c	d*	c	c*	d	d*	c	c*	c*
Colorado												b							c			c*	c*
Austin								b*			b*	a	b*		c	d	d	b	c	c*	b	a*	c
Fort Bend													c					b					
Galveston															a			c					
Blanco														d*		d		c					
Burnet																c*		b*	b		b*		
Williamson																			d				
Bastrop																					d		
Washington											c		c					b			d		c
Waller													c*	c*	c*	d*	d*	b	d*	d	c	c*	c*
Harris																			d				
Liberty																d	c	c					c
Hardin				c*							b		a*			d		a*	b*	c*		a*	c
Jasper																						c	c
Polk										c*	a*	a*	c*	c*	c*	d*	c*	c	c*	d*	d*	a*	c*
San Jacinto																			d				
Montgomery															c			c					
Walker							d*			c*	c*	b*	c*	c*	c*	d*	d*	c*	d*	d*	c*	c*	c*
Grimes																		b					
Brazos													d										
Leon															c			c					
Trinity											d												
Shelby																		a					
Nacogdoches																		a					
Cherokee												b				b*		c	b*		c*		c*
Anderson																		c					

Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
TEXAS—Continued.																							
Limestone																				d			
Bosque																				d			
Henderson												c*		c				b					
Smith																		c					
Rusk						c*			c*				d			d		c			d		
Marion																		c					
Upshur						c*	d*	c	c*	c*	b*	b*	d*	d*	d*	d*	d*	c	d*	d*	d*	c*	d*
Wood																		c					
Kaufman																	d						
Hunt												d				d							
Titus												c*	d*										
Red River												b				d		c					
Lamar											c*												
Fannin													b										
Grayson													c										
Bowie																							
LOUISIANA.																							
Cameron																		b					
Saint Mary's																							
Iberia																b		b	d				
Assumption																		c					
Jefferson									b*														
East Baton Rouge																		c	c				
Iberville																							
Tangipahoa																c	a	a					
Washington																c	c						
West Feliciana									c*	c*	b*	b*				b	b	a					
East Feliciana												c*		c	b*	c	b	b*	c			c*	c*
Saint Landry																a	c					c	
Avoyelles															b	a		b					
Rapides															b	b	a	a	c		c		
Natchitoches																							
Concordia																	c	c					c*
Catahoula																							
Tensas											a	c			c	c		c					
Franklin																		c					
Jackson												a	b		b		c		c			c*	c*
Bienville																							b*
Richland																b		c				d	
Red River																c	c						
Madison											c					d		d					c*

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Caddo															b		a			d		b*
Bossier																	b					b
Claiborne															c		b					
Ouachita															d						d	
Union												c	d				c					
Morehouse															d		c					
Carroll														c			c					
ARKANSAS.																						
Miller										b*	b*	b*										
La Fayette															c							
Columbia																c	c					
Union												c*					c					
Ashley																	c					
Nevada																				d		
Drew													d				c					
Hempstead																	b					
Little River																	c					
Dorsey																	c					
Clark																	c					
Polk																	c					
Garland																	d					
Woodruff																		d	d			
Pope																		d*	d*			b*
Crawford																						c
MISSISSIPPI.																						
Hancock																		b				
Wilkinson												b*	b*			b	c	a	c	d*	c	c*	c*
Amite					c*						b*						b						c*
Pike												c	c				b	b					
Marion												c					b	b					
Adams																		c			c		
Franklin																							
Jefferson									b*			c	c*	c	c	b		b			b	c*	b*
Covington											b*	b*	b*								c	c*	c*
Wayne																	c						
Claiborne												c						b					
Jasper																c	c	c	c		b		
Clarke											c*		c*			c	b	c	c		c		c*
Warren																	c	c					
Hinds													c			c	b						
Rankin																	a	c			d		c*
Newton																c		c					
Lauderdale																c							
Leake													c										
Neshoba																	c						
Kemper																		c	d		c		
Madison										d*		c*	c*					b					c*
Issaquena																c							

Table showing approximately the amount of damage done by the cotton worm by years and counties, &c.—Continued.

Counties.	1856.	1857.	1858.	1850.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
MISSISSIPPI—Continued.																							
Washington											c*		b					b					
Holmes																		c					
Attala													a				c						
Winston													b				c	c		c			
Noxubee																	a	c					
Choctaw																							c
Lowndes												c*						b	c		b		c*
Le Flore																		c					
Grenada																	c	c					
Yalabusha											b	c				d	d						
Chickasaw			c*										c*				b		d				c
Monroe																							c
Lee																		c					
Bolivar																c							
Coahoma																d							
Panola													d										
De Soto												c											
TENNESSEE.																							
Shelby																		b					
Perry																							
Dickson																		c					
ALABAMA.																							
Baldwin	d*	d*			c*	c*	c*	d*	d*	c*	c*	c*	c*	c*	d*	d*	c*	c*	c*	d*	c*	d*	c
Conecuh												b*	b*			d	a	c	c*	d*	a	c	c*
Geneva																		c					
Coffee																		c	d		c		
Dale										c*	c*	b*	c*	c*	d*	c*	c*	c*	d*	d*	c*	c*	c*
Henry																		b					
Barbour													c*					a	c*				c*
Crenshaw													b*			a	c	b			c		c
Pike																	b	c			b		
Butler																	a	c					
Monroe											b*	c*	c*	c*		c*		b*	c*		d	c*	c*
Clarke															c*			c	b		c		
Choctaw																		c					
Marengo																c		c			b		c
Wilcox					c*	c*	c*	c*	c*	c*	c*	c*	c*	b*	d*	c*	b	b	c*	c*	d	c	c*
Dallas								c*	c*	b*	b*	c*	c*	c	d*	c*	a	a	c		b	c*	c
Lowndes							c*	c*			b*	c*	c*	c*	d*		c	a*		c*	c	c*	c*

Montgomery					c*	c*	c*	c*	c*	c*	b*	c*	b*	c*	d*	c*	b	b	c*		c*		c*
Bullock								c*					c*	c*	d*	c	b*	c*	c*	c*	c*	c*	d
Russell																	a	c	c		c		
Lee													c*				c	b					
Macon													b*	b	d*		c	b	c*	c*	c*	c*	d*
Autauga													c*	c*		c*	c	a			b	c*	c*
Perry											c*		c*	c*	d*	c*	a	b	c*		a	c	c*
Hale								c*	c*		c*		c*	c*	d*	c	b	a	b		b		c*
Greene	d*	d*	c*	d*	c*	c*	d*	c*	c*	c*	a*	c*	b*	c*	d*	d*	b*	b	c*	c*	c	c*	c*
Sumter	d*	d*	d*	d*	c*	c*	d*	d*	c*	c*	b*	c*	c*	c*	d*	d*	b*	b*	d*	c*	c*	c*	c*
Pickens											b*	c*	c*	c*	d*	d*	c	b*	d*	d*	c*	c*	c*
Tuscaloosa																	b	c					
Bibb											b*					a*	b*	b			a*		
Chambers																	c	c					
Randolph													c*					b					
Clay													a*				c						
Talladega																		c					
Calhoun																	b	b					
Saint Clair													b*				c	c					
Jefferson																		c					d
Blount																	c	d					
Marshall													b*										
Lawrence													a*										
Colbert																	c						
Lauderdale																					c		
Limestone																	b						
Madison																		c					
Jackson																	c	c					
FLORIDA.																							
Hillsborough																							b
Orange																	a						
Marion																							c
Levy												b*					b						
Putnam														a									
Alachua																	a						
La Fayette																							c
Santa Rosa	d*	d*	d*	c*	c*	d*	d*	d*	c*	d*	c*	c*	b*	c*	d*	d*	b*	b*		c*	d*	d*	c*
Jackson											a*	c*		c			b	c		a	b		c
Liberty																		c					
Gadsden																c	a	c					c
Wakulla																		b	c				
Leon													b	b			a	b	c	c	c		c
Jefferson																	a	b			b		c
Taylor											b*						c	a					
Madison																	c	a					
Suwannee																	a	a					
Hamilton																		a					
Columbia																	a	a	d		d	c	c
Bradford														b						c			
Clay																	b						
Duval														c									

Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
GEORGIA.																							
Decatur													a	c			b	c					
Thomas																							d
Brooks														b				c				c	c*
Clinch																		a					
Charlton												c*											
Berrien			c*				c*						b*				c*						
Early																		c	c	c	c		d*
Mitchell																							d*
Calhoun																	a	b					d*
Baker																							d*
Clay																c	c						d*
Dougherty																							d*
Lee																c	b	c					c
Worth																	c	b					c
Coffee											b*		b*	c*		c*		b*	c*	c*			
Glynn														b				c					
McIntosh													c										
Liberty														b				c	c				
Tatnall													c										
Dodge																			c				d
Dooly																	c	b					c
Sumter																	c*	b	c				
Stewart													b					b					
Chattahoochee													c*			c*	c	b*					
Marion													c*	c*	c*	c*	b	b	c*				
Schley														c			c	b	d				
Macon													c*					b					d
Muscogee																	c	b	c*		c		
Harris																			c		c		
Taylor													c					a					
Talbot																							
Crawford													b										
Bibb																		d	d				d
Twiggs																	c	b			d		
Laurens																							d
Emanuel													b										d
Effingham																							
Wilkinson																	c	c					
Johnson																		c					
Jefferson																		c					
Glascock																	c						
Burke										c*													
Richmond																		c					

Columbia													a		e*		b						
McDuffie																		c					
Upson																	c	e					
Troup													a										
Heard													b				a	b					
Coweta																	c	b					
Spalding																	c	c					
Butts													b					c					
Baldwin													b				c	b					
Putnam													d				c*	c	c*				
Warren													c*										
Greene													b*				c*						
Morgan													c										
Walton													c*			c*							
Oglethorpe													c*										
Wilkes													b*					c	c*				
Lincoln																		b					
Clarke																							
Madison												c*						c					
Jackson												c*		c*				b	d*				
Gwinnett																		c					
Carroll																		c					
Floyd																	c	c					
Franklin																		c					
Hall													c										
Chattooga																	c						
Whitefield																		c					
Murray																			b				
SOUTH CAROLINA.																							
Beaufort																			d		d		
Colleton						d*			d*			d*			d*								
Orangeburg																	c*	d					
Williamsburg																		d					
Lexington																		c					
Edgefield																		d					
Abbeville													c										
Richland																	c	c	d		d		
Fairfield																		d					
Newberry													b					d					
Laurens																		d					
Chesterfield																		d					
Marlborough																		d					
Marion																		d					
Union												d*											
Spartanburgh													d										

Table showing approximately the amount of damage done by the cotton-worm by years and counties, &c.—Continued.

Counties.	1856.	1857.	1858.	1859.	1860.	1861.	1862.	1863.	1864.	1865.	1866.	1867.	1868.	1869.	1870.	1871.	1872.	1873.	1874.	1875.	1876.	1877.	1878.
NORTH CAROLINA.																							
Bladen																		*c*					
Carteret																		*c*					
Pamlico																			*d*				
Craven																	*d*						
Jones																		*c*					
Lenoir																		*b*					
Duplin													*d*										
Sampson													*d*				*d*	*d*					
Cumberland												*d*			*d**			*d**					
Union																	*d**						
Wayne								*d**			*d**	*d**	*d*	*d*									
Montgomery																		*d**					
Stanley																		*d*					
Lincoln																		*d**					
Rowan																		*d*					
Greene																		*d*					
Pitt																		*c*					
Beaufort																		*d*					
Tyrrell																	*d*	*d*					
Martin																		*c*					
Edgecombe									*d**	*d**	*d**	*d**					*d*						
Wake																	*d*						
Franklin											*d**							*d*					
Halifax								*d**		*d**	*d**												
Bertie													*d*										
Chowan																		*d*					
Perquimons																		*b*					
Currituck																		*b*					
VIRGINIA.																							
Southampton																		*d*					
Sussex																		*d*					
Prince George																		*d*					
Princess Anne																		*d*					

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STATISTICS OF LOSSES.

In estimating the amount of injury to the cotton crop of the entire cotton-growing section, or a single State, for a given year or a series of years, it is exceedingly difficult to obtain anything more than an approximate result. In the first place, the area under cultivation is so large, and the localities of severest injury so scattered, even in the same county, that the record of a single observer, or even two or three, will hardly suffice to give the true average for the whole county, and the same remarks will apply as well in an attempt to make up the State average. There are many minor considerations entering into the calculation, which, if not carefully weighed, will tend to perceptibly change the final figures.

In numbers of instances we have reported, for a given year, the loss of the entire crop, which, perhaps, for the whole county may only represent a loss of 60 to 70 per cent. As will be shown hereafter, the more forward the crop the less liablility there is to its being overtaken by disaster. If, however, the crop is grown upon low, wet land, or has been subject to an undue amount of rainfall, or worse, has had only careless or imperfect cultivation, the percentage of loss will be much higher than in more favorable localities, or under more favorable conditions, and an estimate based on returns from such localities would be far from the correct one. This is shown by reports from different parts of the same county, one planter placing the loss at one-third, while another states that the damage will hardly reach a twentieth, which may be called a "slight injury."

In some years the cotton is affected by rust to a greater or less extent.

In Lowndes County, Alabama, in 1866 there was a loss of 30 per cent., owing to the lateness of the cotton over a considerable area, caused by old seed having been planted; and in the same county, in 1873, wet weather and the worms together caused almost a complete failure; the wet weather was responsible, in this case, for 22 per cent. of the loss.

In portions of Louisiana, in 1841, the greatest losses resulted from injury to quality rather than quantity—from litter and excrement dropped by worms upon the open bolls. Frequently other insects are responsible for a portion of the damage—the aphis, the cut-worm or the boll-worm; and while their injuries are, comparatively speaking, small, still they should be taken into account as far as possible. In consideration of all these causes of loss, as they are more than likely to be charged to the account of the cotton-worm by the local observers, after getting as correct an estimate as possible from data furnished, it is necessary to place the percentage somewhat lower to be within bounds.

YEARS OF LOSSES.

Many of the "oldest inhabitants" remember the year 1825 as one of severe injury, the reports varying from 33 per cent. to almost total de-

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struction. As an example, a record of 10 bales to 500 acres is given as an average for Conecuh County, Alabama. In 1846 and 1847 the figures again run high, and are given from 33.3 to 66.6 per cent. The returns for the years that follow, up to the period of the war, are quite meager, but still sufficient to show that the worms were at work in places, some years doing considerable damage. For the years since the war the reports point to severe losses, the figures probably ranging highest in 1873, when 50 per cent. of injury is common, and even 66 to 90 per cent. quoted. Mr. P. D. Bowles, of Evergreen, Ala., gives as the general average for all years since 1868, 50 per cent., which may be correct for southern sections of the State, though very high for the State as a whole.

In tabulating the returns for years since the war, reports of "complete failure" or "almost total loss" are frequently found from nearly all the Gulf States, and representing almost every year. Statements of 50 to 75 per cent. occur more frequently, the greater losses having been suffered in Texas and Florida, although in the lower central counties of Alabama, particularly upon what is known as the black lands or "black belt," the destructiveness has been severe in all years of insect prevalence. A loss of one-third is of common occurrence; indeed a majority of the returns indicate for bad years, in localities of heaviest production, a general average of 25 to 33 per cent. Of course the percentage for the more northern portions of the State, or those portions where cotton is less generally grown, are so very much lower that it must make considerable difference with the general average for the whole area of cotton production.

The following extracts of replies to a circular sent out by the department will give some idea of the worst years of injury from the cotton-worm, and amount of loss in particular localities:

Woodville, Wilkinson County, Mississippi.—In 1825 and 1846 fully 50 per cent.; in 1867, 1868, and 1873, probably 25 per cent. Many other years, and for several successive years, *in certain localities*, I have known the crop wholly destroyed in July, so that not enough seed was matured to plant the next crop.

Alleyton, Colorado County, Texas.—One bale to 100 acres in 1867.

Moscow, Polk County, Texas.—In 1867 and 1873, the loss was total; in 1877, about 75 per cent.

Texarkana, Miller County, Arkansas.—During the years 1865, 1866, and 1867, the worms destroyed at least 25 per cent. of the crop each year; and in some portions of the Red River lands the entire crop on many plantations.

Evergreen, Conecuh County, Alabama.—In 1825 the oldest farmers now living estimate the loss at 98 per cent.; loss in 1867, at least 66.6 per cent.; in 1868, 25 per cent.; in 1873, about 40 per cent., some placing it at 75 and some 90 per cent.; in 1874, about the same as 1873. In 1874 Mr. C. Drumond gathered 900 pounds of seed-cotton from 14 acres, which would have produced 1,000 pounds per acre.

Waterboro, Colleton County, South Carolina.—About three-fourths of a crop in most years, when worms have been general, and in some neighborhoods seven-eighths.

Burkville, Lowndes County, Alabama.—In 1873 the loss was 70 per cent. This year, [1878] on the bottom and lime lands, a loss of 20 per cent. is claimed.

Columbia, Brazoria County, Texas.—During many years three-fourths of the crop is destroyed.

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Ashwood Station, Wilkinson County, Mississippi.—In 1873, 40 to 50 per cent.

Station Creek, Covington County, Mississippi.—In 1847 and 1848, probably 50 per cent.

Denison's Landing, Perry County, Tennessee.—It is quite difficult to give even an approximation of the loss sustained in the State or county during years of the severest visitation; for while old, large farms have lost maybe 50 to 75 per cent., new, small farms, inclosed by dense forests, have suffered very frequently none at all.

Isabella, Worth County, Georgia.—In a bad worm year, wet and cool, they destroy all the top cotton, and necessarily it is cut off one-half.

Faunsdale, Marengo County, Alabama.—In 1872 and 1873 the cotton crop was cut short one-half.

Tionus, Bibb County, Alabama.—In 1866, about one-third; in 1871, about one-half; in 1872, one-fourth; in 1873, one-eighth; and in 1876, one-half.

Hawkinsville, Barbour County, Alabama.—In 1873, I am satisfied I lost one-half of my crop; in 1868 and 1874, one-sixth; and in 1878, one-fifth.

Gilmer, Upshur County, Texas.—Two-thirds during the years of greatest damage, though all fields are not attacked alike; it depends upon the locality of the field and maturity of the crop.

Millheim, Austin County, Texas.—In the year 1863, the worm having been very destructive, destroyed about 25 to 30 per cent. of the crop. In 1868, the first appearance of the worm having been the earliest on record, the crop was nearly destroyed the first part of July, and injured more than 50 per cent.

Morrison's Mills, Alachua County, Florida.—In some fields I have seen four-fifths destroyed; in others, not exceeding one-fifth, though both were *entirely eaten over* by the worm. But I think it safe to say the destruction generally amounted to one-third in bad years.

Milton, Florida.—In the black lands of Montgomery and Lowndes Counties, Alabama, the worm rarely if ever destroyed less than one-half, and often three-fourths of the crop.

Saint Francisville, West Feliciana Parish, Louisiana.—In 1846 the cotton crops here were cut short from 50 to 60 per cent. In the last fourteen years the destructive years were particularly 1867, 1871, 1872, and 1873.

Waverly, Walker County, Texas.—I cannot make any attempt at estimates of losses, as I have never kept any data; but millions of dollars have been lost, and many farmers brought to ruin and poverty.

Turning from the gloomy side of the question there are returns of "slight injury" from many localities. In North Carolina the worms are so late in making their appearance, the planters generally consider them a benefit, as they eat off the top leaves, and allowing the sun and air to come to the lower bolls, ripen, and cause them to open better. This is likewise the case in some locations, as far south as Louisiana and Texas; a correspondent in Waller County, in the latter State, attributing the damage to a too favorable growth of the plant, in which case the worms, by stripping the leaves, benefited rather than injured the crop. It is not unusual to find reports of slight loss in counties adjoining those where the injury has been considerable. We give a few returns as examples of slight injury:

Fayetteville, Cumberland County, North Carolina.—So late in making their appearance in this latitude, it is doubtful if they ever do any injury.

Buena Vista, Marion County, Georgia.—The losses from worms in this county have been very small, not one bale out of 1,000.

Atauquaville, Autauqua County, Alabama.—My general impression is that in the aggregate the losses have not been considerable.

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Greenville, Hunt County, Texas.—The loss in our county was very slight; * * * few fields were visited, and those in isolated spots, where the plant grew more luxuriantly; and only the upper branches, which were tender, were attacked.

Other examples could be given, but these will suffice.

GENERAL ESTIMATES OF LOSS.

In the report of the statistician of the Department of Agriculture for 1877, the loss by the cotton-worm was estimated for that year at $15,000,000, much the larger portion in Texas, though the injury was considerable as far east as the cotton belt of Alabama.* Notwithstanding this great loss, the year was one of unusual harvest, and with this consideration in view, the figures offer a suggestion as to the fearful amount of damage that must follow in a year of general visitation.

In the Entomologist's Report, in the annual report of the Department of Agriculture for 1873 (p. 164), there appears a general estimate, also furnished by the statistician, which placed the amount of damage at possibly half a million bales, in years of insect prevalence. One-fourth of a million bales he considers a slight infliction, and yet at $100 per bale, the loss would be equal in round numbers to $25,000,000.

A number of general estimates have been given by local observers in reply to a cotton-worm circular recently sent out by this department, which in the main are not far out of the way. Mr. J. F. Culver, Union Springs, Ala., estimates the loss in Bullock County, at about 5,000 bales, which amounts to $250,000 at the rate of $50 per bale. Mr. H. Hawkins, of Hawkinsville, Ala., who lost one-half of his crop in 1873 and one-fifth in 1878, makes a rough estimate for Barbour County, in most years of $50,000. For the year 1878, the losses to Pope County, Arkansas, from cotton-worms are given in round numbers by Mr. T. S. Edwards, of Gum Log, at $100,000; and a glance at figures in the Ninth Census Report, keeping in view the enormous increase in cotton productions in Texas and Arkansas since 1869, would seem to bear out the statement.

RATIO OF LOSS BETWEEN EARLY AND LATE CROPS.

While the date of appearance of the worm has much to do with the amount of damage to a crop—an appearance in July, August, or September, in parts of Texas, amounting to 75, 50, and 25 per cent. of loss, respectively—still upon plantations where the cotton is late in coming to maturity, the greatest losses may be expected, generally speaking; and any causes that tend to retard the growth of the plants, only serve to increase the percentages of injury. In former years, in the eastern part of Mississippi, there was a certainty of most of the blossoms "making" that came by the 10th of September; now they cannot be counted upon after August 1. In the center of the cotton belt in Alabama, as a rule, when a good stand has been secured early

* Annual Report for 1877, p. 156.

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in the season, the bulk of cotton generally forms and matures before the appearance of the worm in great numbers, and the loss is small, while in late fields, as high as 66 per cent. has been lost.

Mr. J. H. Calloway, of Montgomery County, Alabama, gives the following as his opinion upon the subject:

When the crop is well advanced, the land being well prepared, and planted just as early as the season will permit, cultivated well and rapidly, and, as the saying is, pushed from the word "go," the loss is much less than when planted late and poorly cultivated.

Mr. David Lee, of Mount Willing, Lowndes County, Ala., says:

If the season is favorable, the cotton planted early, and well cultivated, much is gained, and the loss would be light, as there would be less for the worms to destroy. But if the spring is cool and wet, and the summer wet, the crop will, of necessity, be badly cultivated, and consequently will be late; under such disadvantages the crop would be cut off one-third.

ESTIMATES OF LOSS BY STATES.

In estimating the total amount of losses from the ravages of cotton-worms in the United States, the data extends over such a long period—from 1825 to 1878—we are only able to form a general average for a series of years. In calculating the quantity destroyed, an average crop of the past fourteen years, which is only a little larger than an average crop of fourteen years prior to 1861, is taken as the basis. Such average is an increase of about 25 per cent. upon the crop of 1869, a little in excess of three and a quarter millions of bales.

In estimating for the States, especially where the data is incomplete, as it necessarily must be, the localities of heaviest production must be considered and due allowance made for counties producing only a tenth, or perhaps, a twentieth as much, on account of greater isolation of the plantations. A loss of 25 per cent. in Dallas County, Alabama, as an example, would represent in round numbers a decrease in value of the crop to the extent of $360,000, while the same percentage of injury for the same year in Marion County, would represent a loss of but $7,000. It is therefore necessary, after a percentage of injury has been calculated from the data in hand, to study location and the amount of cotton there produced in favorable years, and allowing a small deduction for other causes of loss that may not have been noted, to strike a general average for the whole State, which will be found from 5 to 10 per cent. lower.

Although the losses in recent years have been more severely felt in Texas than in any other State, we select Alabama to illustrate the method of obtaining an estimate, partly from the fact that it represents the average of injury, but more particularly because the fullest returns have been received from this section of the cotton-growing region. These returns have been received from the cotton belt of heaviest producing counties, thirteen in number, as follows: Hall, Sumpter, Marengo, Perry,

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Wilcox, Monroe, Lowndes, Montgomery, Bullock, Pickens, Greene, Crenshaw, and Conecuh, the last four lying just outside the lines of heaviest production, as indicated in the Annual Report of the Department of Agriculture for 1876.*

Montgomery County produced in 1869, according to the Ninth Census, 25,000 bales in round numbers; add 25 per cent. to bring this production up to an average of 14 years, and the figures are 31,500 bales. From the reports of local observers, we find a fair estimate for a destructive year would be 30 per cent. for the county, or 9,450 bales. Taking the percentages of loss in the other 12 counties, in the same manner, and finding the number of bales they represent, the sum total of loss in the counties named above is found to be 56,790; dividing this decimally by the total crop of the 13 counties for an average year (or 224,700 bales), we find the average percentage of loss to be 25.2. But this percentage cannot be taken as correct in regard to the State as a whole, as these 13 counties produce two-fifths of the cotton grown in Alabama, the other three-fifths representing 51 counties, the larger number of which lie above the center of the State. Here the plantations are not so liable to attack, owing to their greater isolation, or from their higher latitude cannot suffer as much when attacked, as the worms are sure to appear later, and for this portion of the State a fair estimate of loss would be 12.5, or in round numbers 39,000 bales. This added to the loss in the cotton belt gives a total of 95,790 bales, upon a crop of 536,000.

The average of 14 years for Alabama, at the rate of $50 per bale, which is low for a series of years, gives us the startling amount of $4,987,000, or nearly five millions, as the destruction in Alabama for a single year, when the worms are numerous. Startling as the figures may seem to those unacquainted with cotton-worm visitations, they doubtless would be found below the real amount of loss could we by any means ascertain it with certainty.

In Georgia, the percentage of injury for the whole State is a little lower, or 16.5 per cent. Sixteen cotton-growing counties, representing about one-fifth of the productions for the whole number, give a loss of 17,972 bales out of 71,600, or 25.1 per cent. of injury. For the remaining four-fifths, or 403,000 bales, 15 per cent. is a high average. Making 60,450, or a total for the State of 78,422 bales out of 474,600, and a loss in value equal to $3,921,000.

For Mississippi the percentage of loss for the whole State is 17, or 123,000 bales, out of an average crop of 760,000. Here the figures show 24 per cent. as the loss for a little over a third of the State, in counties of heaviest production, with 15 per cent. for the remaining two-thirds. Total loss, $6,150,000.

In making the calculations for Louisiana, where there has been a greater increase in cotton production for a number of years past, the figures of the Ninth Census must be raised about two-fifths, instead of

*Report of the Statistician, p. 120. See, also, map facing title page.

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one-fourth, to get a proper average. This gives 438,700 bales as the entire crop of the State, and the total average loss for all counties is placed at 20 per cent., a noticeable increase over those States lying to the eastward, or 89,740 bales, worth $4,487,000.

The height of cotton-worm devastation culminates in Texas, 28 per cent. representing the loss for the whole State. In 18 counties, growing about two-fifths of the cotton produced, the percentage of loss is 35 per cent., or more than a third, with 20 per cent. for the remaining two-thirds. Cotton production has increased to a still greater extent here than in other States since 1869, and one-half must be added to the census figures which gives, in round numbers, 525,000 bales as a fair average for 14 years, and 28 per cent. places the loss for the State at 198,125 bales. Texas then suffers in a fear of greatest injury, a loss of at least 25,000 bales more than any other single State; and the sum total foots up $7,406,000.

Florida must take the lowest rank in the amount of cotton produced, yet her percentage of destruction by worms must be rated between that of Louisiana and Texas, or at 24 per cent. Out of an annual production (average) of 49,739 bales, the devastation amounts to 12,000 bales, reducing the money value of the crop $600,000.

In the northern tier of cotton States the losses are small. In North Carolina it is a question if the injury is not more than compensated in the benefit derived from the stripping of the leaves where the vegetation is rank and the plants are unable to mature the bolls. As all the evidence is on the side of benefit we shall leave the State out of the calculation, as the injury can be but a trifle at the most.

In South Carolina, Tennessee, and Arkansas the losses are small from the attacks of cotton-worms, although there are other causes that sometimes operate unfavorably against the crops. After a careful consideration of the damage in these States, the percentages are set down as follows: South Carolina, 5 per cent., or 11,225 bales out of a crop of 224,500 bales; loss, $560,000. Tennessee, 5 per cent., or 8,365 bales out of a crop of 147,300; loss, $418,000. Arkansas, 8 per cent., or 27,760 bales out of a crop of 347,000; loss, $1,380,000.

SUMMARY.

Any causes tending to retard the growth of the cotton plants only make the destruction of a larger percentage of the crop more certain in unfavorable cotton-worm years. On the contrary, upon those plantations where an early stand is secured, and everything is pushed from the start, with exemption from other causes of injury, only a small proportion of the crop is destroyed.

Locality, too, has much to do with increasing the percentages of loss. In localities of heaviest production, where the plantations are large and are near together, should the season be a little earlier, the losses are almost double those in more isolated regions, and even in the same counties location has much to do with raising or lowering the percentages.

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From the few extracts given it is shown that in years of severe injury 33, 50, 75, or even 98 per cent. of the entire crop may be destroyed upon some plantations, while others escape with trifling injury. In the States lying to the extreme southward, as Florida and Texas, we find the highest percentages of loss; and only a little lower rate for the cotton belt, where the ratio of loss increases from east to west, commencing with Georgia at 16 per cent., and ending with Texas at 28 per cent. In the northern tier of States the percentages are shown to be very low, North Carolina planters generally believing the worm to be a blessing rather than a curse, by removing superabundant foliage.

The method of estimating the amounts of loss for each State has been fully explained, and the figures presented both for number of bales and money value; it now only remains to present these figures in tabular form, and the whole subject is before the reader in the most available shape tor study or perusal.

States.	Percentages of loss for worst years.			Total crop.—Average for 14 years, in bales.	Losses.—Average for worst years, in bales.	Value at $50 per bale.
	Highest.	Lowest.	Average			
South Carolina	....	....	5	224, 500	11, 225	$560, 000
Georgia	25. 1	15	16. 5	474, 000	78, 422	3, 912, 000
Florida	....	....	24	49, 700	12, 000	600, 000
Alabama	25. 2	12. 5	17. 8	536, 700	95, 790	4, 789, 000
Mississippi	24	15	17	706, 000	123, 070	6, 150, 000
Louisiana	....	....	20	438, 700	89, 740	4, 487, 000
Texas	35	20	28	525, 000	148, 125	7, 406, 000
Arkansas	....	....	8	347, 000	27, 760	1, 380, 000
Tennessee	....	....	5	147, 000	8, 365	418, 000
Total	....	....	17. 2	3, 449, 200	594, 497	29, 711, 000

The terms "highest" and "lowest," in the columns devoted to percentage of loss, do not refer to the greatest amount of injury, or the reverse, inflicted in individual localities, but to a general average for the principal counties of heaviest production on the one hand, on the average for the remainder of the State on the other. The average for the State as a whole appears in the third column.

The result shows a possible loss of $30,000,000 in years of general prevalence of the worm, and, as these visitations are becoming more frequent, it is probable that the real losses from the cotton caterpillar are equivalent to an average of $15,000,000 to $20,000,000 annually for the entire period since the war. There is much evidence also to show that the losses were equally disastrous prior to 1861.

It should be stated that Virginia, the Indian Territory, and some other States, produce a small amount of cotton, which, with the productions of North Carolina, are not included in the above figures. It should also be borne in mind that while the quantities are assumed as State averages for the period since the war, they are approximately correct, sufficiently so for the purposes of this exposition.

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Fifty dollars has been assumed as the price of a bale of cotton, though an average of fourteen years would raise these figures considerably. The plantation prices, from 1865 to 1870, ranged from 40 cents per pound down to 12 cents; or, per bale, from $180 to $60; and cotton is now sold upon the plantation at $40. Our estimate, therefore, of $50 per bale, is only an average for the last eight years.

Of course the percentage of loss, as given in the preceding pages, cannot be demonstrated beyond possibility of cavil; the aim has been to make them too low, rather than a possible exaggeration.

THE COTTON-WORM IN OTHER COUNTRIES.

As would be inferred from the discussion at the beginning of this chapter, the larva of *Aletia argillacea* attacks cotton only in the cotton-growing regions of North and South America and in the intervening islands. There was, indeed, a rumor that went the rounds of the press some years ago to the effect that the cotton-worm had made its appearance in Egypt shortly after an importation of American seed, but investigation proved it to be false. India, America's greatest competitor in cotton culture, has a destructive cotton enemy in the shape of a boll-worm, differing greatly, however, from our boll-worm, but equally destructive.*

The cotton crop in Australia is injured by the cotton-bug (allied to the "red bug" of the Bahamas and Florida); in Greece, the cut-worms injure the young crop; in Italy and in Sicily larvæ of several species injure the growing plant, and in other cotton-growing countries local insect enemies are found; but all of these countries are blessed with immunity from the ravages of the American cotton-worm.

Of the extent of its injuries in the West Indies, in the latter part of the last century, some idea has already been given. In the Bahamas the cotton-worm was injurious every year, from the time where we left it up to 1834, when the emancipation of the slaves took place and put an end to cotton culture. The insects were to be seen the whole year round, but were less numerous after the stormy season, which is in September and October, and most numerous just before the beginning of the gales. In general, *Aletia* was not considered by the natives as a *serious* enemy to the cotton plant, as the damage done by it was always small compared to that done by the "cotton-bug" (*Dysdercus suturellus*, H. Schf). Upon the breaking out of the civil war in the United States, cotton culture recommenced in the Bahamas with great activity, and upon the close of the war again decreased, Long Island and Exuma being the only islands pursuing its cultivation at present. All inhabitants unite in saying that Aletia has not been seen since a great hurricane which took place in

* The larva of *Depressaria gossypiella* Saunders, incidentally mentioned in chapter I. The moth, which is a small Tineid, lays the egg in the blossom, and the young larva mines in the forming seed, preventing the maturing of the boll. One-fourth of the crop is frequently lost from the ravages of this insect.

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1866, and Mr. Schwarz was unable to find a trace of the insect in any of its stages.*

In Cuba, no cotton has been grown for fifty years or more, except a very small quantity at the southeast end of the island, and an occasional plant for medicinal purposes. Many of the present inhabitants do not know the reason for this, and many Americans traveling in Cuba have expressed their surprise that cotton is not cultivated with such evident advantages in the way of soil and climate. J. P. Guarché, United States consul at Matanzas, writing to the Department of Agriculture in 1855, explains this as follows:

Thirty-five or forty years ago attempts were made by emigrants from the United States, but with little or no success; and since that time the gradual rise in the cost of labor here and the gradual depression in its value in our own country have deterred the most sanguine from the prosecution of this branch of industry. Labor and capital always seek their highest reward, which no doubt will continue to be found in the cultivation of sugar-cane and tobacco, for which this island is so admirably adapted. Another obstacle also exists in the fact that the *soil generates a worm* which attacks the cotton plant and destroys the greater part of the crop almost every year. This worm is said to infest the plantations of our Southern States, *but its ravages there are represented to be trifling in comparison with what they are here.*

In the neighboring island of San Domingo the state of things is not nearly so bad. Cotton has there been grown almost since the first settlement of the island, and is now an important article of export. The cotton-worm has always been known as one of the drawbacks to the crop, but never as a remarkably serious one, and in the other islands which export cotton at present (Porto Rico, Trinidad, Barbuda, Martinique, and Guadaloupe) the same can be said. As stated in the beginning of this chapter, however, on more than one island the culture of cotton has been entirely abandoned from the attacks of this insect.

In Mexico the principal cotton-growing regions are the vicinities of Vera Cruz, Matamoros, Monclova, Santiago, Colima, and Acapulco. It is entirely for domestic purposes, however. We have heard of the cotton-worm from Matamoros and Monclova, close to the Texan border, in times gone by, and also along the Gulf coast of Vera Cruz. As to its occurrence on the western coast of Mexico we have no data whatsoever.

In British Guiana cotton culture was begun in 1752 and continued until 1838, when it had dwindled to a very small industry, partly owing to the ravages of the chenille. Dr. Chisholm's observations† in 1801 and 1802, of which we have already spoken, are the fullest which we have found upon the cotton-worm in South America, and from them we quote the following:

One of the most singular circumstances respecting this species of the Phalena is the uncommonly fragrant smell which issues from the plant on which it feeds, although neither the animal itself nor the plant is possessed of the fragrance separately. * * * So powerful is the odor produced by the ravages of this caterpillar that it may be perceived more than a hundred yards from the plant. A whole year may sometimes

* See Appendix I, Report of E. A. Schwarz (preliminary).

† Brewster's Edinburgh Encylopedia, article Cotton.

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occur without any appearance of the chenille; and, notwithstanding this, the year immediately following may be marked by the most extensive proofs of its voracity. * * * A curious observation relative to the history of the cotton-moth and caterpillar is the rapidity with which it carries its ravages to distinct and even distant fields of the plantation. We should be inclined to imagine that the wind has much agency in spreading its destructive progeny; for in the course of a single night whole fields, consisting of from four to ten acres, hitherto unmolested, have been devoured by them. Or does this proceed from the flight of myriads of the insect in its perfect state to distant fields and then depositing their eggs, whose fecundation is quickened by the fostering heat of a favorable season, and thus giving rise to those sudden and astounding colonizations. That the leaves of cotton are the nidi as well as the food of the chenille is evident from the operations of the caterpillar when preparing for its change to the pupa state. By means of a thready substance, resembling a spider's web, of a white color, the leaf which the larva intended for the scene of its transformations is drawn together so as to form a funnel-shaped fold, close at the edges, and shut up at the broadest part or base. The pupa is inclosed in a covering of the thready substance, and acquires its perfect form or image at the expiration of nine days. * * *

Immediately after dusk, in those seasons which are unfavorable to their propagation, myriads approach the candles and are very troublesome, but soon terminate their existence in its flame. The period of their existence, when not destroyed by such causes, is about nine days; and the whole life of the insect, including all its transformations from the ovum to the death of the moth, is about twenty-seven days. In the pupa state this insect is subjected to the rapacity of several other insects. Those I have more particularly observed are a small species of apterous bug, I believe the *Cimex grylloides*, and the common red ant. These are often found in the hollow folded leaf, having the means of disengaging themselves from it by a cylindrical passage penetrating to the helpless pupa, of which, when these insects infest it, nothing remains but the shell or coriaceous coat. * * * The evolutions of the larvæ and the transformations and the death of the insect, or the appearance and disappearance of the chenille, are certainly regulated by particular states of the atmosphere and by the phases or changes of the moon. The chenille or larva of the cotton-moth generally appears in years favoring the fecundation of its ova, in July or August, a few days before the new moon; increases during the increase of the moon, and nearly about the full moon begins to disappear, and soon after ceases altogether. Happily for the planter, however, this happens only every second or third year. But in years uncommonly favorable, the chenille appears and disappears *every month from July to October*, and afterwards from the *middle of January to the beginning of March*. * * *

Although the planters anathematize this destructive insect with all the virulence of Ernulphus, it does not seem that anything effectual has been attempted to prevent or destroy the evil. * * * A prudent, economical planter will increase the brood of every species of domestic poultry, particularly turkeys; for this has a tendency to diminish the brood of the chenille in a very great degree, while profit arises from the augmentation of useful stock. Turkeys are observed to have a remarkable appetite for the larvæ of the cotton-moth, and devour prodigious quantities of them. But the most useful and natural enemy of the chenille is the bird called in the colony Chenille bird (the black and yellow Manakyn of Edwards, or the *Pipea aureola* of Linnæus), and the *Certhia familiaris*, or house wren, and the *Parus nigrus* of Linn., mentioned by Dr. Bancroft (Nat. Hist. of Guiana, p. 182). The former of these appears on the coast with the chenille, and the flocks are numerous in proportion to the insect," &c.

We also learn from Dr. Ure,* in 1835, that the chenille was the most prominent enemy to the cotton plant in British Guiana.

In Dutch Guiana cotton culture began in 1706, and considerable

* Cotton Manufacture, I, 174.

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cotton is still exported. The chenille has always been very destructive, and is ranked as the most injurious foe to the crop. Mr. F. W. Cragin, United States consul at Paramaribo, in writing to the Department of Agriculture, in 1856, speaks of the chenille as *Noctua xylina*, Say.

Brazil has grown cotton for many years. Concerning the appearance of the cotton-worm in the more northern cotton-growing provinces there can be little doubt, from their contiguity to Guiana. Farther south, the original *Aletia argillacea* came from Bahia. We find an interesting letter on the occurrence of the insect in the more southern province of Sao Paulo in Professor Willet's report.* Professor Willet says:

Dr. E. L. McIntyre, of Thomasville, Ga., writes: "I settled in the province of Sao Paulo, Brazil, in the year 1866, and remained there eight years and a half. The cultivation of cotton was of recent date then, and they were planting their fourth crop when I arrived. Prior to the year 1863 there had been some cotton planted in the country, perhaps of an indigenous variety, but no one had ever observed a cotton-worm, and I believe they had never existed there.† In 1862 the price of cotton offering great inducements to Brazilian farmers they sought to procure seeds, but none could be had, and I am informed the seed then being used was brought from New Orleans. The first year no caterpillars were seen, but after the second they commenced to eat the leaves, and had increased to such an extent that when I moved from there the cultivation of cotton was nearly abandoned.

Concerning the appearance of Aletia in the other South American countries which export cotton—Venezuela and Peru, and in those countries in which it is cultivated simply for domestic purposes, United States of Colombia, Ecuador, Bolivia, and Argentine Republic—we regret having no data whatsoever.

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* Appendix I, Report of J. E. Willet.

† Undoubtedly an incorrect inference.

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CHAPTER III.

HABITS AND NATURAL HISTORY.

Much has been written respecting the habits and natural history of the cotton-worm, but the greater part of these writings have appeared in agricultural journals of limited circulation. In many instances this can hardly be deemed a misfortune, for the germs of truth contained in the accounts of this insect are, in most cases, accompanied by a great amount of error. It is very strange that so few writers should have made and recorded careful observations on a pest whose ravages have been so great and long continued.

A few observers, however, have carefully studied the insect and published accounts which, in the main, are accurate. The most important of these writings are those of Professor Glover, Mr. Affleck, and Doctor Phares. A complete list of the writings consulted in the preparation of this report is given elsewhere.*

Although the published accounts have been carefully studied preparatory to writing this chapter, the facts herein recorded are, unless otherwise stated, the result of observations made during the seasons of 1878 and 1879. Care has been taken to verify even those facts which have already been generally received. To the general reader some of the points which are discussed in detail will doubtless seem trivial; but in deciding what is the best mode of combating this pest these very points are often among those which become most important.

THE EGG.

In this stage of its existence the cotton-worm is known to but few people, both its color and size shielding it from the observation of untrained eyes. Every cotton planter should, however, not only become familiar with the appearance of the egg but know just where to look for it. With this knowledge time may be gained, the loss of which in the application of remedies may result disastrously. As it is now, the worms are rarely observed until nearly full grown, and then but little time remains for the protection of the crop.

The egg is circular, much flattened, and ribbed; its greatest diameter is a little more than one fortieth of an inch (.685^{mm}); its form is shown in Fig. 1. When first laid the egg is of a beautiful bluish-green color; this changes to a dirty white before it hatches.

Owing to the fact that the tender foliage at the top of the plant is

* See chapter IX—Bibliography.

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first destroyed by the cotton-worm, it is generally believed by planters that the greater number, if not all, the eggs are laid upon that part of the plant. This belief gave rise to the practice which has been carried on in some localities, of cutting off and destroying the terminal shoots of the plant; the planters thinking that in this way the eggs would be destroyed and the crop saved. This idea I found to be an erroneous one. Rarely eggs may be found on any part of the plant above ground, but almost invariably they are deposited on the lower surface of the larger leaves, and by far the greater number of them are to be found on the middle third of the plant.*

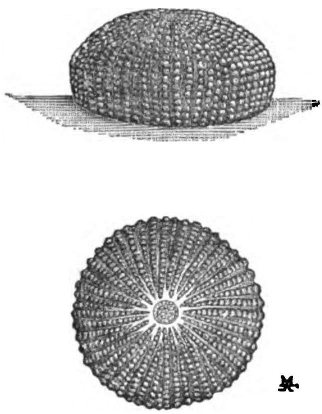

Fig. 1.

The eggs are deposited singly, and I rarely found more than four or five upon a single leaf, even when the moths were most abundant; still they sometimes occur in greater numbers. The duration of the insect in this state varies greatly, depending upon the season. During the warmer part of the summer months the eggs hatch in little more than two days after they are deposited, but in the autumn they may remain nearly a week before the larvae issue.

THE LARVA.

Some time before the larva issues, it can be seen through the trans parent shell of the egg, the eyes, mandibles, and V-shaped suture separating the epicranium from the clypeus being especially prominent. A few hours later, after repeated efforts, which are plainly visible with a microscope, the larva succeeds in breaking a hole through one side of the shell, and it soon eats its way out. Occasionally the larva, as soon as it emerges, eats a portion of the egg-shell; usually, however, the shell is left undisturbed.

The newly hatched larva is of a very pale green color, or white with a faint tinge of green; the head is pale yellow, with no trace of the black piliferous spots which are so conspicuous in the later stages; the ocelli are black; the piliferous spots of the body are at first quite indistinct, but soon become more prominent; the thoracic legs and the third and fourth pairs of abdominal legs are very long; the first and second pairs of abdominal legs are mere tubercles.

The young larva usually remains on the lower surface of the leaf upon which the egg was deposited, feeding upon the more tender portions and leaving the upper cuticle unbroken. Sometimes, however, small larvae which evidently have been hatched recently are found on leaves where no signs of egg-shells can be detected, while shells but no larvae are

* For a detailed discussion of this point and of the number of eggs upon each leaf, see Appendix I, report of W. Trelease.

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found on larger leaves just below these. Yet I believe that the larvae always feed a little before leaving the leaf on which they were born. The young larva does not eat entirely through the leaf until it is nearly two days old, and often not until the fourth day after it leaves the egg. Thus the earliest indication of the presence of the worms is numerous, small, semi-transparent spots upon the larger leaves. The smallest larvae which I found eating through a leaf in the field measured from five-sixteenths to three-eighths inch in length (8^{mm} to 9.5^{mm}). In confinement the newly-hatched larvae eat the upper surface or lower surface of the leaf according as they happen to be on one side or the other but do not perforate the leaf till two to four days old. The injury done to the cotton during this early part of the life of the larvae is inconsiderable.

The young larvae are extremely active. Their first and second pairs of abdominal legs being functionless, they resemble in their mode of locomotion the true measuring-worms (*Geometridae*) even more than do the full-grown larvae. When disturbed they drop from their resting place by means of a silken thread; frequently they climb back again in the way commonly employed by spinning caterpillars, which is to bend the head down to one side, and catch hold of the thread with the anterior pair of legs, then, supporting the body by these legs, seize the thread again with the jaws at as high a point as possible; this act is repeated until the larva regains its place. It sometimes happens that a larva in moving about encounters one of these silken threads extending from one point of support to another; in such a case the larva is able to walk along this thread with its ordinary looping motion, as if walking along the lower surface of a twig. The abdominal legs are obviously fitted for clasping any small object; but it is not until we examine the thoracic legs with a microscope that we can see how well adapted they, too, are for this purpose.

In Fig. 2, *a* represents the terminal portion of the leg of a young larva, and *b* and *c* represent the claws of a full-grown larva. It will be seen that in each case there is a piece shaped something like the hoof of a horse, which, acting with the true claw, forms a very efficient clasping organ. In the young larva there is a curious fan-shaped appendage (Fig. 2, *a a*) attached near the base of the claw, the function of which we failed to discover. This appendage is present in the fullgrown larva; but here it loses its peculiar form, becoming long and narrow.

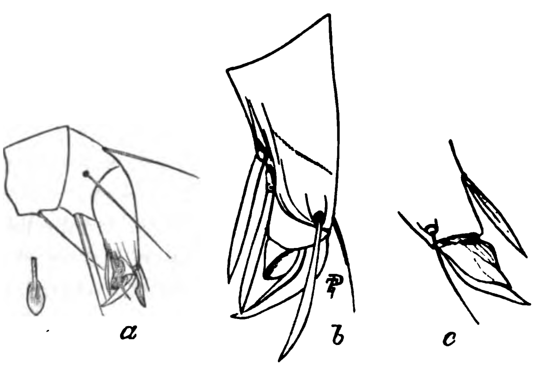

FIG. 2.

Observations made in the field during the month of August indicate

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that, as a rule, this insect lives at that season thirteen days as a larva, before webbing up, and remains as a larva one day after this, before changing to a pupa. Occasionally, two days elapse between the webbing up and the change to pupa. Specimens which were kept in breeding-cages in my office remained eighteen days in the larval state. This unusually long time was probably due to the fact that the temperature of the room in which they were kept was much lower than that in the cotton-fields. Specimens bred by Professor Glover under similar circumstances passed twenty days before webbing up.*

The larva sheds its skin five times during the period of its growth. The individuals which I bred moulted at regular intervals of three days, the first moult being made when the larvae were three days old. At this moult nearly all the larvae ate their shed skins. During the first stage the head of the larva is marked only by the six black eyes on either side. After the first moult the conspicuous black spots on the head appear. When six days old the larvæ moulted the second time, and when nine days old the third moult occurred. At this moult the larvae began to vary in color; some becoming striped with black, and others remaining green. On the twelfth day the fourth moult occurred, and the fifth moult on the fifteenth day. Three days later the larvae webbed up. When full grown the larva measures 1⅝ inches in length. A detailed description of the full-grown larva is appended to this section.

The variation in color referred to above is quite interesting; no explanation of it has been discovered. I found by experiment that the distinction is not a sexual one, as moths of each sex were bred from each kind of larvae. General observations, that is, those made without absolutely counting the individuals of each color, show that there are no dark larvæ in either the first or second broods. About one-fourth, or less, of the third brood are striped with black. About one-half, or slightly more, of the fourth brood are dark, many of them being almost entirely black; while nearly all of the fifth brood, "third crop" of the planters, are black or very darkly striped.

After the larvae become large enough to eat through the leaves, or, in the language of the planter, "to rag the cotton," they move to the top of the plant and destroy the tender terminal foliage; thus the earliest indication usually observed of the presence of the worms is the "ragging" of the tops of the plants. As already stated, this has led to the practice of "topping" the cotton.

In feeding, the worms rest upon either the upper or lower surface of the leaf, but more frequently upon the latter. They eat most early in the morning and late in the evening. As we have frequently observed with other caterpillars, the cotton worm may often be seen resting upon some portion of the plant, supporting itself by its prolegs and swinging the anterior part of its body from side to side as if fanning itself. The larva has another interesting habit. When touched or otherwise fright-

* Agricultural Report, 1855, p 75.

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ened, or sometimes when it wishes to move to another part of the plant, it suddenly throws itself by a jerking motion into the air. I have carefully studied this mode of jumping. It is as follows: The larva clings to its support by its three posterior pairs of prolegs; it swings the anterior part of its body to one side, and then, rapidly moving it to the other, lets go at the proper moment; the momentum of the anterior part of the body is sufficient to carry the whole body some distance. In this way a larva can jump two feet in a horizontal direction. They will often spring from the highest part of the cotton plant and fall to the ground. On one occasion (August 26) I was in a field where the plants were nearly stripped of their leaves at the top; the larvae were moving to the lower leaves. I saw none crawling down the stalks. All, so far as observed, performed the journey by jumping. They rarely fail to alight upon their feet and cling to the object touched. Not one in fifty strikes one leaf and falls to another before getting hold with the hooks with which the prolegs are furnished. Many, springing too far from the plant, would touch no leaf and thus fall to the ground. This larva does not seem able to cling by its true legs, and, by swinging the posterior part of the body, jump. When I press upon the head of the insect with a stick or pencil, it seems unable to jump unless it can first withdraw its head. But if the pencil be put on the posterior part of the larva, it will jerk the anterior portion of the body so violently as to pull itself from beneath the pencil. I have been unable to find any silk connecting the larva with the object from which it springs; and I am of the opinion that in jumping it does not spin a thread.

I did not observe a single instance of *systematic* marching, as is indicated by the popular name army-worm, which has been so generally applied to this species. I saw on several occasions immense numbers of the larvae on the ground, crawling in *all directions* in search of food or places in which to transform. And on one occasion (August 26) I saw myriads of the worms of different sizes crawling in all directions over the ground, when there was plenty of food and places in which to transform on the plants, as not more than one-third of the foliage had been eaten. This was the time when I observed so many larvae springing from the stripped upper portions of the plant to the leaves below; perhaps most of the worms on the ground were those which, in jumping, had failed to alight on the lower leaves. I visited the field at night to ascertain if the marching was kept up at that time. I found none crawling over the ground, and nearly all those on the plants were perfectly at rest.

When the larvae are feeding on the cotton in great numbers there arises a peculiar sweetish odor, which, although not easy to describe, is very characteristic. This odor, I supposed, proceeded from the excrement of the larvæ; but Mr. Trelease is of the opinion that it is "due partially to the crushing of the leaves by so many mandibles." In any case this odor is perceptible only when the larvae are present in great numbers. The fact that many planters say that they can smell the

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worms sooner than they can find them otherwise is very strong evidence of the lack of proper knowledge of the habits of this species.

Many planters believe that the cotton-worm will only eat the cotton after it has reached a certain stage of maturity. They have been led to this conclusion chiefly owing to the fact that the early broods of the worm consist of so few individuals that they usually escape observation. Other facts which have led to this belief are not so easily explained. It is sometimes observed that certain cotton-plants are left untouched while other and older cotton growing near is entirely destroyed. An instance of this came under my personal observation. In a field where the cotton-worms were very abundant and had destroyed two-thirds of the foliage, I observed that along a ditch through this field the cotton was green and very little eaten. On inquiry, I learned that this cotton had been planted a month later than that in the remainder of the field, as the cotton first planted along the sides of the ditch had been washed away. It may be that the nectar glands, which will be discussed later, were not so active on the younger plants as on the older ones; and hence the moths, not being attracted to these plants, did not oviposit on them. It should be noted, however, that when this observation was made (August 20) the younger plants were as large as those planted earlier in the season; and I can see no reason why the nectar glands on these should not have been as active as those on the older plants. Had facts which were discovered later in the season been known at that time, this point would probably have been cleared up.

It has been often remarked that the worms will not eat cotton which is affected with rust. The reason usually assigned is that the leaves are not suitable food. Although, doubtless, larvae would not thrive so so well on such plants, is it not probable that less eggs are laid upon them owing to the small amount of nectar secreted by them?

Although, as a rule, the cotton-worm feeds only on the leaves of the cotton plant, it is occasionally found lying within the open flowers feeding upon the stamens. It also frequently destroys the buds and small bolls. This is the case when the plant is stripped of its foliage. I have also seen many buds and bolls destroyed when the foliage on the lower third of the plants was eaten but little. When a cotton-worm destroys a boll, it does not, like the boll-worm, merely eat out its contents, but often eats the greater part of the pod also.

From what has been learned respecting the time required for the full development of the larva, and the small amount of injury done during its early stages, it can be seen that the accounts which are often heard respecting the short time which elapses from the first appearance of the worms to the complete destruction of the crop are founded on an error. We have heard many accounts of instances where fields had been attacked by cotton-worms and destroyed within three days! If by "first appearance" one understands the earliest time at which a brood of cotton-worms has been developed of sufficient size, both as to indi-

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viduals and numbers, to be easily seen, these accounts will not convey a wrong impression. For example, a planter informed the writer, in reply to questions respecting a certain field, that the worms first appeared in it three days previous. It was a field adjoining his residence, through which he passed every day, and was one to which, as he informed me, he had paid special attention. On visiting the field I found it very badly infested with cotton-worms which were then *two-thirds grown*, and hence must have been more than three days old.*

Although observers may fall into error respecting the time required for the devastation of a field of cotton by this pest, exaggeration is hardly possible respecting the completeness of the destruction which sometimes occurs. We have repeatedly seen places in which the plants were so completely stripped of their foliage that there were not left as many uneaten leaves as there were stalks, a few dried and brown leaves on the lower part of the plants being the only semblance of foliage left on what, ten days previous, was a beautiful green field. In cases of this kind, not only are all the green leaves eaten, but the young bolls are also destroyed, and often the bark is gnawed from the small branches.

The stopping of the growth of the plant is not the only loss which the destruction of the foliage entails. Open cotton is frequently injured by the dropping of the excrement of the larvae upon it. Much injury also results from the premature opening of the bolls, caused by the destruction of the foliage. Not only is such cotton of inferior quality, but when, in addition to the fully-developed bolls, many immature ones are made to open, it is often impossible for the planters to pick the cotton before much of it falls out upon the ground and is thus seriously damaged. Immense losses sometimes occur in this way, when wind and rain closely follow the destruction of the foliage by the worms.

On the other hand, in some parts of the cotton belt—notably the more northern sections—the advent of the cotton-worm is not dreaded. It rarely reaches these regions till late in the season, and then the planters consider the destruction of the foliage a benefit rather than otherwise, as in this way the maturity of young bolls, which would otherwise be destroyed by frost, is hastened. Sometimes, even in southern portions of the cotton belt, in localities where the plant grows very rank if the worms do not appear early, the destruction of the leaves late in the season is regarded as a source of profit.

No well authenticated instance is recorded of the cotton-worm feeding upon any plant except cotton.† Many experiments were tried to

*We have seen that the time required for the cotton-worm to attain its growth varies greatly, depending upon temperature. Hence it may be possible that under unusual conditions a brood of worms might be developed so rapidly that they would strip a field in a few days after their first appearance. Still, under ordinary circumstances, this would not be the case.

†P. Winifree, De Bow's Review, iv, 251 (1847), says: "In the West Indies they feed promiscuously on the leaves of a plant there called the salve-bush; this plant grows about the height and its leaves are a good deal like the mullein of this country, having a whitish color and a soft velvety feeling."

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induce them to feed upon other plants, all resulting negatively. Even when the larvae were placed upon plants closely allied to cotton they starved. Still there is reason to believe, as will be shown later, that another food-plant exists in Wisconsin at least.

When full grown, the larva folds one edge of a leaf over its body and fastens it down with yellowish silk. It then spins a delicate cocoon about itself. At times, when the cotton-worms are very numerous, it frequently occurs that the foliage is so badly eaten that is with difficulty that the worms find a leaf in which to web up. Their endeavors to conceal their bodies before pupating are at such times very amusing. The merest fragment of a leaf is called into service; and frequently very vigorous struggles ensue between rivals endeavoring to secure the same place. Often, too, the trouble of the successful competitor does not end with his webbing up. Other larvae not yet fully grown, finding this remnant of a a leaf, devour it, exposing the pupa, which either falls to the ground or hangs suspended by some of the silken fiber which happens to be attached to the uneaten frame-work of the leaf. A detailed description of the larva is appended. This will serve to distinguish the cotton-worm from other larvae which are sometimes mistaken for it.

ALETIA ARGILLACEA, Hübner.

Full-grown larva.

Length, 1⅝ inches (41^{mm}). Color, light-green, striped with white and black, and spotted with black and yellow; in many individuals, especially those of the earlier broods, the black stripes are wanting. Head, ochre-yellow, with thirty black spots, from each of which arises a short, stiff, black hair (13 *a*). Body, light-green, with dorsal line, two subdorsal lines, and lateral line white, and with numerous intensely black piliferous spots. The more conspicuous of these spots are arranged as follows: Eight forming two transverse rows of four each on the dorsal part of the first body segment (prothorax); a simple transverse row of four on each of the two following segments (in these two rows the inner spots are much smaller than the outer ones); on each of the eight following segments (first to eighth abdominal), four spots, forming the angles of a square; a row of spots on the lower subdorsal line, one spot on each segment; below these, three spots, forming a triangle. In the green varieties the piliferous spots are surrounded with white, and are thus rendered more conspicuous; spiracles black. Usually a row of indistinct yellow spots upon and above the upper subdorsal line. All legs pale-green; claws of thoracic legs black; first pair of abdominal legs rudimentary; second pair half as large as third pair. The distribution of black varies greatly in different specimens. In some there are no black stripes, this color being almost entirely absent, except in the piliferous spots described above; in other specimens all that part of the body above the lateral line, excepting the dorsal and subdorsal lines, is black. The following grades between these two extremes may be found:

a. Dorsal line bordered on each side with black; varies in width in different specimens from those in which it is a mere line to those in which the entire space between the dorsal line and the upper subdorsal line is black.

b. Similar to variety *a*, except that the space between the subdorsal lines is also black.

c. Similar to variety *b*, except that the space between the lateral line and the lower subdorsal line is more or less black. Antennæ three jointed, basal joint large, fleshy; second joint about one-third the length of first joint, and often not visible, being with-

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drawn into first joint; third joint equal in length to the first and of a brown color. This joint bears at its outer extremity three conical tubercles, one of which is large, appearing like a subjoint, and bearing a small tubercle; mandibles strong, pale, with their edges and teeth black; teeth, four, rather dull.

PUPA.

After the larva has formed its cocoon within a folded leaf, its body shortens and increases in diameter, assuming a somewhat fusiform shape. Those parts that were light green become bluish or copper color. After one or two days have elapsed the larva sheds its skin and becomes a pupa.

This is at first of a delicate green color, but in a few hours it changes to a chestnut-brown, which sometimes becomes so dark as to be almost black. This change in color is attended by a toughening and hardening of the body walls. Frequently the head, thorax, and wing-sheaths become darker than the remaining portions of the body. The posterior third of the fourth, fifth, and sixth abdominal segments is much lighter in color than the remaining part of the segments. When the pupa is much contracted, the lighter portion of each of these segments is covered by the following segment: The length of the pupa varies from five-eighths to thirteen-sixteenths inches (16^{mm}–20^{mm}). Its form is shown on Plate I. The wing-sheaths nearly reach the fifth abdominal segment. The tip of the abdomen is furnished with four hooks A short distance in front there are four other hooks, each one arising from a small pit. Fig. 3 represents two views of this part of the pupa, *a* the dorsal view, and *b* the ventral view.

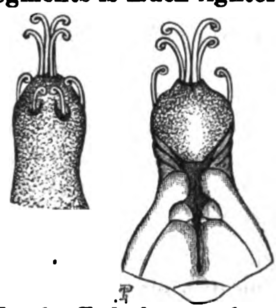

FIG. 3.—End of pupa, above and below.

When a field is badly infested with cotton-worms they frequently eat the folded leaves containing pupæ. Occasionally such pupae remain suspended by their hooks and fragments of the cocoon attached to the remains of the leaf, as shown on Plate I.

The duration of the pupa state varies greatly. During the warmer part of the summer it is only six or seven days, but in the autumn individuals of this species have been known to remain a month in this state.

THE ADULT.

The size and appearance of the adult is represented on Plate I. The general color of the upper surface of the wings and body is light-brown. The anterior wings are tinged with wine-color on the inner and middle parts, shading into a light olive-green on the external portions. These wings are marked by several wavy transverse lines of a reddish color, and by a black or grayish spot near the center of each wing; outer border fringed with white, with six reddish spots. These characters

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will serve to distinguish this insect, but a more detailed description is appended to this section.

Unlike the larva, the adult *Aletia argillacea* is not confined to a single article of food, the moths feeding upon sweets of many kinds. Although nectar forms a considerable part of this food, the moths seldom visit flowers for this substance. A few plants possess nectar glands in addition to those of the flowers, and it is from such plants that these moths obtain nectar. The cotton plant is one of this number, each leaf being furnished with from one to three nectar-secreting glands. Usually there is but one of these, which is situated on the lower surface of the main rib, near the petiole; occasionally leaves can be found in which each of the three larger ribs is furnished with a gland. This gland appears to the naked eye as a swelling of the rib, in the center of which is a depression containing usually a drop of clear, somewhat viscid, sweet fluid. When this fluid is not consumed by moths, ants, or other insects, it will accumulate so as to form a large drop projecting beyond the walls of the gland. Other glands, similar in appearance and function, are situated, one at the base of each of the three bracts forming the involucre or "square," and sometimes also three additional glands at the bottom of the calyx alternating with these bracts.

These glands were first figured by Professor Glover in his manuscript work on cotton. The leaf-gland is represented on Plate IX of that work, accompanied by the statement: "This is frequently filled with a sweet substance which proves very attractive to ants and other insects." The glands of the involucre are represented on at least six different plates; and on Plate XX especial attention is called to them. The explanation of the plate reads as follows: "One of the three glands on the outside of the involucre secreting a sweet, viscid substance much sought after by flies, ants, &c. This gland is sometimes pierced by insects, causing a different kind of rot."

While in the field, during the summer of 1878, I became interested in these facts, which I afterwards learned had been observed long before by Professor Glover. When I informed Professor Riley of certain observations that I had made, he suggested that perhaps the cotton-moth also derived nourishment from these glands. Subsequently, at Baconton, we, in company with Professor Willet, went into the field at night with dark-lanterns to study this subject. Within a half hour from the time we entered the field, I had the pleasure of pointing out to Professor Riley a moth in the act of sipping nectar from a gland at the base of a boll; thus proving the truth of his inference. We also observed moths feeding at the heads of *Paspalum læve*, a common grass growing as a weed in the cotton fields. Although no other moths were observed at that time to feed on the nectar of cotton, during the present season (1879) many observations have been made showing that it is the normal habit of this insect to do so. A few days after the discovery of the moth feeding at the extra-floral nectar glands of the cotton, my host, Captain Bacon, informed me that as he was riding home in the evening from a

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distant part of his plantation he observed a large number of moths flying about some cow-pea vines that were growing in a corn-field. I at once equipped myself with a lantern and proceeded to the corn-field. On arriving there I witnessed a remarkable sight; thousands of the cotton-moths were about the pea-vines feeding on the nectar excreted by a series of glands situated near the end of the peduncle which is produced beyond the last flower or pod. The moths were not at all shy, but would remain engrossed in partaking of their repast even when the lantern was brought within a few inches of them. In no instance were the moths seen to visit the flower of the pea.

It is probable that the cotton-moth feeds about nectar excreted by many other plants. Mr. Trelease observed it feeding at the ovate glands which are situated at the base of the petiole of the larger coffee weed (*Cassia occidentalis*).

The subject of extra floral nectar glands is very interesting; and it is one which has been studied but little. The problems presented by it are quite puzzling. In the case of the nectar glands of flowers we have organs which, serving to attract bees and other insects, and thus insuring cross-fertilization, are very useful to the plant. But the functions which extra floral nectar glands perform are seldom as obvious. In case of the cotton plant these glands serve to attract the moths and thus insure the oviposition of eggs upon it. Thus the plant upon which the glands are the most active will prove most attractive to the moths, and hence will be the one the most likely to be infested by worms. Therefore, instead of being beneficial, as we know the floral nectar-glands to be, the extra floral glands seem at first sight to be injurious to the plant.

It was not until we learned that the small ants, so abundant in cotton fields and which are attracted to the plants by these glands, are the most efficient check upon the increase of cotton-worms that we understood how beneficial these glands really are. For, although the moths, led by instinct to oviposit only upon the food plant of their young, would visit the cotton plants even if the glands were not present, it is not improbable that the ants are first attracted to the plants by the supply of nectar which they find there, and as this nectar is secreted by the very young plants the ants doubtless begin the destruction of cotton-worms as soon as they appear. The statement of Professor Riley that "these sweets are first produced when the plant begins to flower and fruit" (Annual Report Department of Agriculture, 1878, p. 215), was merely a conjecture which subsequent observations failed to confirm. In reality, glands were found on some cotyledons; these, however, did not seem to secrete nectar; but the gland on the first leaf begins to secrete nectar (as indicated by the first visits of ants) about the time that the third or fourth leaf expands.*

* The bearing of this subject of nectar upon the subject of the enemies of the cotton-plant is so important that we have requested Mr. Trelease to prepare a paper upon it, which will be found in Part III.

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The cotton-moth is not confined to a diet of nectar, as many fruit-growers have learned to their cost. Frequently the fig crop is completely destroyed in some sections of the cotton belt, as is also the August crop of peaches. The moths have also been known to feed on apples, grapes, melons, and the jujube. A remarkable instance of their feeding on melons in Wisconsin was communicated to Professor Riley last year; we quote from a letter on file in this department:

RACINE, WIS., *November* 17, 1878.

DEAR SIR: In a communication to the Scientific American you stated that the *Aletia argillacea* bored into peaches in Kansas. In this connection it may not be uninteresting to state the following: Charles Jackson, 4 miles from Racine, raised large quantities of melons for market, mostly of the nutmeg variety. He complained to me that there was a miller that swarmed in his melon patch at night, and did much damage. I visited the locality at night, and discovered that it was the *Aletia argillacea*, and that they did literally swarm; and wherever there was a ripe melon that had a slight crack on its surface, there the moths were sucking and crowding into the fruit; and in that way they did considerable damage. This was on September 10, 1877. Last fall they were not so numerous, and did less damage. I noticed where the melons were perfectly sound they did not work. * * *

P. R. HOY, *M. D.*

C. V. RILEY, *Washington, D. C.*

Recently, at my request, Dr. Hoy sent to this department a specimen of a melon-eating moth, and it proves to be without doubt *Aletia argillacea*. Dr. Hoy's observations are very interesting, not merely as illustrating another mode in which this pernicious pest may be the source of serious annoyance, but also as bearing on the question of the migratory powers of the moth. We shall have occasion to refer to this again in another chapter.

Although it appears from the letter of Dr. Hoy that the moths injured only those melons which were cracked, it is certain that in the case of figs, peaches, and grapes the moths have the power of piercing holes through the unbroken rind of the fruit, and thus of destroying fruit previously uninjured. That a moth should have this power is a remarkable fact. As a rule, butterflies and moths are only able to sip fluid sweets from open reservoirs, as the nectaries of flowers, the organ with which this is done being soft and flexible.

While in the field last year I carefully watched the operation of piercing the skin of a peach. At times the moth used the tip of its maxillæ as if it were trying to prick a hole into the fruit; at other times the tip of the maxillæ was incurved, and the dorsal surface thus presented to the peach used as a rasp. A study of the structure of the maxillæ shows how well adapted they are for piercing and rasping. The tip of the organ is well adapted for piercing, as is

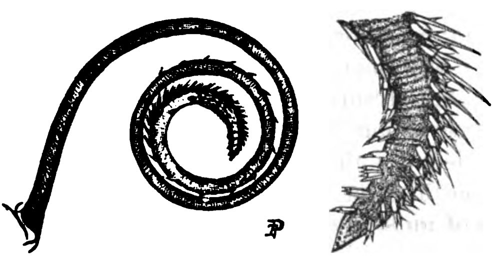

FIG. 4.—Maxillae of cotton-moth.

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shown by Fig. 4; and the portion immediately preceding the tip is equally well adapted for rasping, being furnished with numerous spines on the dorsal surface. The ventral surface of this part of the organ is is also provided with spines. Probably these are of little use in piercing the rind of fruit, but doubtless they aid much in enlarging a hole when it is once made, and also in lacerating the pulp of fruit, thus setting free the juice. Fig. 5 represents a cross section of the maxillæ. The relation of all the parts is well shown, excepting the arrangement of the muscles which are within the walls of each maxilla. These muscles were torn in cutting the section.*

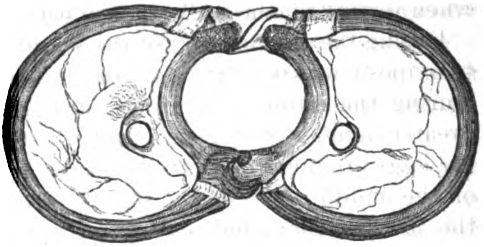

FIG. 5.—Cross-section of maxillae.

Although many Lepidoptera may be found to possess the power of piercing the rinds of fruits when the subject is more carefully studied, as yet but few instances have been observed. The following is the most striking: An Australian moth (*Ophideres fullonica*) is very destructive to oranges. This insect is furnished with maxillae similar to those of *Aletia argillacea*, with which it is able to pierce the thick skin of the orange. Figures and careful descriptions of the structure of the maxillæ of this orange-sucking moth have been published by M. Künckel, Comptes Rendus, August 30, 1875, and Francis Darwin, Quarterly Journal Microscopical Science, 1875, p. 384. Mr. Darwin also states, on the authority of Mr. R. TriméN, Curator of the South African Museum, that at the Cape of Good Hope a great deal of fruit is thus injured by Lepidoptera. Other instances of Lepidoptera piercing vegetable tissues for the purpose of obtaining the juices are given by the elder Darwin in his work on the fertilization of Orchids.

Although there is no doubt respecting the ability of the moths to perforate the rinds of fruit, it is evident that they will seldom do so if it can be avoided. Thus, when one moth has made a hole through the skin of a peach, others crowd around and make use of the same opening. I have observed seven moths making use of a single perforation at one time. In this way the juice of the peach is extracted, only a spongy mass being left. In feeding upon figs, however, the moths frequently, instead of making use of the natural opening of that fruit, pierce the outer rind. Mr. Trelease made careful notes respecting the manner in which the moths feed. These are published in his report. (See Appendix I.)

* As this report is written chiefly for those who have not made a special study of entomology, a few words in explanation of the structure of the maxillæ of moths will not be out of place. In their simplest form, the mouth parts of insects consist of an upper lip, an under lip, and two pairs of jaws acting horizontally between them. In the case of butterflies and moths (*Lepidoptera*) the lower pair of jaws is developed into two long, flexible organs; each of these has on one side a groove, and the two are fastened together so that the grooves form a tube, as shown in the center of Fig. 5.

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There has been some discussion respecting the natural position of the moth while at rest. I found that in the field it almost invariably alights with its head down, but the majority of specimens which I saw in houses, when resting on the walls, did so with the head directed upwards.

During the warmer part of the season the moths in confinement began to oviposit within thirty-six hours after emerging from the pupa state. During the autumn the time varied from four days to a week. The greater number of eggs are laid during the night. As already stated, the eggs are deposited chiefly on the lower surface of the larger leaves on the middle third of the plant. This may be owing to the fact that the moth is attracted to that part of the plant by the nectar glands which are on the leaves. In fact, Mr. Trelease observed moths alternately sipping nectar from these glands and ovipositing. During the operation the moths flew from leaf to leaf and from plant to plant, each moth depositing but a single egg on a leaf. Still, if we accept this as explaining why the moths oviposit on that part of the plant, it is difficult to say why more eggs are not laid near the glands on the involucre, which the moths also frequently visit.

The number of eggs laid by a single moth probably varies from 400 to 600. September 11, I counted the number of eggs in the ovaries of a female taken in the field. There were 400 well developed eggs and 284 immature ones. After that date I dissected many females, but found only immature eggs.

It is difficult to say how long this insect exists in the adult state; doubtless the time varies greatly with the season. Moths of the third and fourth broods die in confinement within five days after their exclusion from the pupa, while, as we shall show later, those of the last brood remain alive several months.

The number of broods of this insect in a single season, is also somewhat difficult to determine. For not only does the earliest brood appear at different times in different sections of the cotton belt, but in the same locality different individuals of the first brood were found to vary in age nearly two weeks. As a result of this variation during the latter part of the season, examples of all stages were found at the same time in the same field. Still a large proportion of the cotton-worms in a given locality undergo their transformations at nearly the same time; so that broods sufficiently well marked for our purpose have been observed. And we conclude that in those sections in which we believe the moth to hibernate, there are each year at least six broods. By the 1st of September of the present year (1879) larvæ of the fifth brood (third crop) were appearing in considerable numbers in Central Alabama. Moths bred from specimens of this brood which were sent to this department began to oviposit October 10, and October 15 larvæ of the sixth brood began to appear. It is probable that the sixth brood appeared at an earlier date in Alabama, the development of the specimens in my breeding-cages being retarded by the low temperature of the room in which they were kept.

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One of the most remarkable things in the natural history of this insect is the powers of flight which the moth possesses. There is no reason to believe that the species can survive the winter north of the cotton belt; still, the moths have been repeatedly taken far north of the limit of cotton culture; we are, therefore, forced to conclude that these moths have flown, aided perhaps by winds, from some portion of the cotton belt to where they were found. Dr. Packard has taken the moth on Coney Island and in Salem Harbor. Mr. Edward Burgess states that it flew aboard his yacht in Boston Bay, September 9, 1873. Mr. Grote informs me that it has occurred at Buffalo in September and October, and that he has heard of it at Chicago, Detroit, London, Ont., Albany, and New York. Professor Riley reports it from Chicago, and the letter of Mr. P. R. Hoy, already quoted, shows that it has occurred at Racine, Wis., in the autumn, repeatedly, in great numbers. It will be noted that, in all the instances in which the date of the occurrence of the moths in these northern localities is given, they were found only in the autumn. This confirms the conclusion that the moths cannot endure a northern winter and that their presence in the Northern States is dependent on migrations from the South.

Dr. Hoy states that he has never found the moths at Racine earlier than the last week of August. But the fact that they occur there in so great numbers as his letter indicates is very remarkable; and what is more wonderful, Dr. Hoy informs me that he has repeatedly found the moth while the wings were yet soft, not quite dry! This indicates without doubt that the moths had just emerged from the pupa state; and that the larva has a food-plant in that locality. The numbers in which they occur there strengthens, if possible, this conclusion. For it is easier to suppose that a few moths have migrated to that locality each year, and that it is the progeny of these moths which swarm upon the melons, than it is to suppose that the insect should migrate to that place year after year in swarms, while it is but rarely observed, and then in small numbers, elsewhere in the Northern States. As yet we have no idea what this food-plant is. The immature moths were taken "in the woods at night while sugaring"; this indicates that it is not a cultivated plant; and we venture to predict that the plant is not common in the Southern States; else the larva would have been observed upon it during the seasons that the cotton fields have been stripped of their foliage.*

* As Dr. Hoy did not know the larva of *Aletia argillacea*, I sent him specimens to compare with the different larvae in his collection in order to ascertain if he had taken it at Racine. Just as this report is going to the press I receive from him a larva which undoubtedly belongs to this species. Respecting it, Dr. Hoy says: "I send to-day the only Wisconsin larva of the Aletia. I only received five, one of which I preserved; the other four died in my breeding-cage as I did not know what they were, and was deceived as to the plant on which they were found. This is my record: "Taken in Pike Woods by Mary Deel, August 10, 1879; food-plant not satisfactorily described; unknown to me.'"

Since the above was written Dr. Packard notes, in the January number of the

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ALETIA ARGILLACEA Hübner.

♂ ♀.—Color above light brown tinged with olive-green and wine color. Expanse of wings one and three-sixteenths inches to one and seven-sixteenths inches (30mm to 36mm). Length of body three-sixteenths to eleven-sixteenths inches (13mm to 17mm). Head varies from light brown to wine color, with a small whitish tuft before. Antennae clothed with dark-wine colored and white scales above, and short yellow hairs below. Mandibles conic, light yellow, furnished at the tip with a brush of spiny hairs. Labial palpi densely clothed with short scales which are white and wine color mixed; second joint twice the length of the first; third joint equaling the first in length but much smaller. Thorax same color as head. Anterior wings tinged with wine color on the inner and middle part, shading into a light olive-green on the external portion. In some specimens the anterior wings are light olive-green throughout; in other specimens the reddish tinge is very pronounced.

External to and in front of the central portion of the anterior wing is a conspicuous black or grayish spot, composed of dark scales interspersed with white ones. Parallel to the anterior margin of the wing is a row of four minute white spots; one is situated at the base of the wing, one between the dark discal spot and the anterior margin of the wing, the other two at equal distances between these; one or more of these spots are frequently wanting, and sometimes each one is surrounded by reddish scales; the anterior wing is also marked by three transverse wavy lines, of a reddish color margined with white; the inner line is one-fourth of the length of the wing from the body, the second line is near the middle of the wing, and the third line is outside the discal spot. Fringe white with six reddish spots; posterior wings with basal portion light, and outer part clouded; lower-surface light brownish gray; anterior wings with disk clouded and a short reddish band on the outer third of costa; posterior wings with a transverse, narrow, wavy, brown band near the middle of the wing. Described from 75 specimens.

THE THREE CROPS OF WORMS.

Notwithstanding that there are probably five or six broods of cotton-worms every year in the southern and central parts of the cotton belt, it is generally believed that there are only three broods. These have been designated by the planters as the first, second, and third crops respectively. It is impossible to state a rule by which it can be determined to what broods the three crops correspond, as this differs in different localities and different seasons. Almost invariably numbers of the first brood of worms, and very often of the second, also, are so small that they escape the notice of observers. After a brood of sufficient size to be easily perceived has been developed, in about two more generations a sufficient number of worms is produced to strip the cotton of its foliage. The result of this, as will be shown later, is the destruction of the greater part of the worms also. The subsequent broods are small; on this account, and because of the cotton crop being destroyed, the planters lose interest in the development of the worms, and the later broods are not noticed. In a word, the idea of there being only three "crops" of worms has arisen from the fact that as a rule there are only three broods of sufficient size to be noticed by the planters before the cotton crop is

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American Naturalist, the fact that specimens of *argillacea* flew into his study window at Providence Sept. 30. He says: "The moth was in a perfectly fresh condition, and bore every appearance of having quite recently emerged from the chrysalis. Its appearance certainly did not bear out the theory that all the northern individuals fly northward from the cotton belt," &c.

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destroyed, or before the cotton has reached a stage of maturity, after which the eating of the foliage by the worms is not considered a calamity. In some instances the first crop of worms is doubtless the second brood of the season; in some instances it is not until the third brood is produced that the worms are of sufficient numbers to be observed, and thus designated as a crop.

The term "crop of worms" has become thoroughly incorporated in the language of those most interested in the cotton-worm; and, moreover, it is a very convenient term. We shall therefore adopt it; employing it, however, in the sense in which it is generally used. Thus, by first crop of worms we shall mean not the first brood, but the earliest brood that is of sufficient size to be easily noticed; and the second and third crops are the two broods immediately following the first crop. The term brood will be used in its usual sense.

DISAPPEARANCE OF THIRD CROP.

While contemplating, in the autumn of 1878, the immense number of worms which constitute the third crop, I was struck with the fact that if even a thousandth part of the worms were to mature and survive the winter the second brood in the spring would be of sufficient numbers to destroy the cotton crop. I was therefore interested in watching the disappearance of this so-called third crop.

The result of these observations shows that when the cotton-worms occur in sufficiently great numbers to strip the cotton of its foliage the greater part of that brood perishes at once.

When the leaves of the cotton are destroyed the worms are forced to migrate in search of more food; or, if they are fully grown, as is often the case, in search of places in which to undergo their transformations. While at Faunsdale, Marengo County, Alabama, August 28, 1878, I was fortunate enough to witness an attempted migration of this kind, which was attended with astonishing results.

As soon as the larvae left the cotton stalks they experienced great difficulty in crawling over the surface of the ground. Clinging hold of the loose particles of earth by its prolegs, a larva would attempt to stretch its body forward in the manner peculiar to "loopers," but no sooner was the anterior part of its body raised from the ground than the insect, unable to balance itself upon the crumbling bits of earth, would fall to one side with the full length of its body upon the ground. Had it been a cloudy day, or had the ground been shaded, this would not have been so serious a matter to the larva; but, as is usually the case at that season of the year, the sun was shining with an intense heat and the surface of the soil was as hot as the sides of an oven. The larvae did not seem to suffer so long as they were resting with their legs upon the ground, but no sooner did one of them fall so as to touch the earth with its body than it began to squirm violently. Sometimes a larva would regain its position upon its legs, but the first attempt at

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looping would result as before, and in a very short time, often not more than one or two minutes, it would succumb. The number of worms destroyed in this way is immense. I am certain that in the field in which I made these observations there were to each square foot of land at least an average of five dead worms that had been killed in the way described within a few hours. Other causes tend to render this destruction more complete. Thousands of larvae are destroyed by ants. Many pupae and larvae which have "webbed up" and partially transformed are deprived of their covering of leaves by their voracious companions and fall to the ground where they perish. And still others, apparently more fortunate in transforming within the folds of the leaves of other plants than cotton, are imprisoned in their retreats by their companions which follow and attempt to use the same leaves for the same purpose.

DISAPPEARANCE OF THE LAST BROOD.

Evidently after the disappearance of the brood of worms known as the third crop, one or more broods are usually developed in some parts of the cotton belt. Wherever the earliest spring brood is of considerable size, there will be developed in the second generation a sufficient number of worms to attract general attention. In this case the fourth brood will constitute the third crop, and there will remain sufficient time for the development of one or two later broods. As already explained these broods are small and attract little attention. Nevertheless, the disappearance of the last brood is one of the most important points in the life-history of the cotton-worm. It is here that we may hope to learn much on the long-disputed point as to whether the species dies out each year in the United States or not. I regret that I have not been able to make personal observations on this point, as my stay in the field extended only to the first of October. Fortunately careful notes bearing on this subject were taken by Prof. E. A. Smith, at Tuscaloosa, Ala., and by Prof. I. E. Willet, at Macon, Ga. The following quotations from letters which Professor Smith addressed to this depart ment at the time will furnish important details respecting the disappearance of the autumn brood in Alabama:

OCTOBER 10.

The worms have eaten most of the leaves and young buds of the plants in my field and are on the move. They may be seen moving through the grass, potato vines, &c., and upon the trunks of pine trees, seldom, however, higher than five or six feet from the ground, as they jump off or fall back after climbing to that height. I do not see that they have begun to eat anything else than the cotton. Most of the worms of the past week or ten days have webbed up in the cotton leaves, and many chrysalides hang from the denuded leaf stalks. They are scarcely at all covered; the leaf blade in which they were once wrapped having been eaten away, and they hang almost free in the air. The present brood of worms I find webbing up in the leaves of various plants; the following I have noticed: sweet potatoes, *Cassia obtusifolia*, and *C. occidentalis*, *Physalis lanceolata*, *Solanum Carolinense*, sassafras, *Pharbitis nil*, *Ipomea tamnifolia*, *Sida spinosa*, *Ambrosia artemisiæfolia*, *Xanthium strumarium*, *Euphorbia maculata*, *Amarantus spinosus*, *Quercus aquatica* (small tree), sweet gum, watermelon, and young mulberries. The latter seems a favorite; nearly all the leaves of half a dozen young mulberry plants are rolled up by the worms. A few worms of the present brood I have found webbed up in the cracks of the bark of old field pines standing in the field. Most that I have seen have been on the east, north, and west sides; have seen none on the south side of the trees. The greater part of the present brood, however, are webbing up in any leaves that they encounter, grass leaves excepted.

The web made by the present brood of worms is simply a leaf rolled once and bound together by the silk. In the case of those worms webbing up in the crevices of pine bark, a thin gauze of silk was all that protected them. Through this web the worm can easily be seen. Thus far, I see no tendency on the part of the worms to make a denser cocoon than those of the preceding brood. I have noticed the moths occasionally fly up from a mass of sweet-potato vines, among which *Cassia obtusifolia* and *C. occidentalis* were growing. Perhaps the glands on the leaf stalks of these two species may have offered some attraction, though I have not seen any moth upon the plants. In some old stumps in my field I have not yet found any chrysalides, nor have I noticed any in the ground.

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OCTOBER 16.

As I wrote you October 10 the caterpillars were then moving about in search of food, the cotton leaves being nearly all eaten up. After about two days only a few worms were to be seen, the greater part having disappeared, or webbed up in all sorts of leaves, in the crevices of bark of pine trees, and, in one instance, in the mosquito-netting in one of the rooms in my house.

After the great majority of the worms had left the plants a few might be seen for several days, eating the cotton boll or stretched at length along the petiole or one of the ribs of a denuded leaf. These stragglers would eat into large bolls (nearly full grown). Since day before yesterday, October 14, I have not noticed any worms in the field. The leaves were about all eaten up by the 10th or 11th, so that the worms were noticed only a few days afterwards, and then only as stragglers from the main army of worms, which had gone in search of food or had webbed up. I saw no worm eating anything except the leaves and bolls and young buds of the cotton plant.

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OCTOBER 21.

On last Friday night we had some frost, and for the past three nights I have not noticed any of the cotton moths at my baited trees; but there is another moth which comes, whether the weather be cold or warm. I have a few chrysalides under a glass shade; several moths have come from them since the cool weather set in, and I expect to see quite a number of the moths yet from the last brood of worms which webbed up after they had eaten up all of the cotton leaves.

* * * * * * *

OCTOBER 26.

Since last writing we have had two or three heavy white frosts, viz, on the nights of the 22d, 23d, and 24th. On these nights I saw no moths, except one or two species of which I wrote last week. I do not know their names, but they are not *Aletia*. On the morning of the 23d three moths came from the chrysalides which I have under a glass shade, on a shelf on my porch exposed to the weather. The moths were benumbed with cold and apparently dead; but they all revived after being brought into a warm room. I turned them loose next day when it was warm and pleasant. Last night the thermometer stood out-doors at 60° F., and on visiting my baited trees I found several of the cotton moths there. They seem to lie up during the cold spells and to come out when the weather moderates. I have in mind always to find out, if possible, whether the chrysalides are formed in the ground. I have found many *on* the ground, but they had evidently dropped from the plants after having webbed up there; other worms having eaten away the leaves which sustained them. There are hundreds and perhaps thousands of chrysalides of the last brood of worms, webbed up in the leaves

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of various kinds of weeds, of which I gave you a partial list some time ago. To this you can add *Passiflora incarnata*. The great majority of these chrysalides have not yet hatched out.

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NOVEMBER 4.

The evening of October 26 was warm (66° at 7 p. m.), and more than 50 cotton-moths were counted at my baited tree. It rained before morning, then cleared off cold, so that on the 27th and 28th no moths were seen. On the 29th it was warmer and cloudy, rained slightly, and I counted 7 or 8 moths. On the 30th, 31st, 1st, and 2d, cold and frosty nights; no moths seen. During this last cold spell ice has formed in thin sheets, and I am anxious to know how it has affected the moths. One has hatched out from the chrysalides, which I have under cover since the cold nights of the last week.

* * * * * * *

NOVEMBER 11.

I judge by the scarcity of the cotton-moths since cold weather that they are not able to stand the cold, and have either been killed or forced to seek secure quarters. I have found none yet in bark of trees or elsewhere. Some of the chrysalides of the last brood are still rolled in the leaves in the cotton field; but a few which I examined some days ago seem to have died. These chrysalides are slightly shriveled up, and some of them are certainly decaying, if I may judge by the smell when they are opened.

The following extracts from letters received by this department from Professor Willet will indicate the details of the disappearance of the last brood of 1878 in Georgia:

OCTOBER 6.

I was in the cotton fields some hours this morning. The condition of things is about this: Very few larvæ; mostly greenish-yellow in color. Few pupae; moths mostly out; all will be out in two or three days. Many moths, probably a majority just out from pupæ. Considerable number of eggs; none some days since. I hear of caterpillars in small numbers in most of the State below this. This brood of caterpillars has webbed up almost entirely on the cotton stalks on which they fed. Where those stalks were entirely divested of leaves, a few went to weeds near by. They seem to have no disposition to ramble, eating the leaves, investing chrysalides, the involucre of bolls, and even young bolls before they would crawl to adjacent stalks which had not been touched.

The moths, as yet, are near the small, isolated patches invaded by them as caterpillars, and on the southwest side of field towards which a strong northeaster has driven them some days. I do not find many in the grass and stubble on borders of the field.

* * * * * * *

OCTOBER 10.

I send box, with about a dozen each, of larvae and pupae, all I found yesterday in walking over 10 to 15 acres. The moths are much scattered, and attractives put out night before last drew only two or three. I do not find that they are leaving the field for shelter. There are no dead trees nor stumps in which they may hide; but I scare up none in the waste patches of grass and weeds on one side of the field. If it was now August, we should have the promise of a large crop of worms soon. It is of interest to know whether they will appear in October.

* * * * * *

OCTOBER 18.

The situation in the field here is as follows: A few moths; most rather ragged; a few, new and bright, just out from late pupae; some eggs, a few green and fresh, others dried up; *no larvae*. I searched diligently with a glass for young larvae, but

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found not one where there were eggs a week to ten days ago. There were plenty of grown larvae when we returned here, September 15, and a few pupae and moths. The caterpillars diminished gradually till about October 1, since which time there have been only occasional stragglers. The pupae increased to about same date, and moths came out very numerously from October 1 to 5; more sparingly afterwards. The abundance of pupae and moths foreshadowed a good brood of caterpillars which will never appear, even if we have no frost to-night. Northeasters have prevailed during the month, though without frost. It has been very dry. The thermometer was 51° on Sunday and 50° this morning—the coldest day. The cotton leaves are old and speckled, except the new young leaves here and there, which are fresh and green.

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OCTOBER 19.

I sent you a few pupae and some moths in chloral solution yesterday, supposing they would be the last. But there was very little frost last night, and I visited another field to-day, where the cotton was planted later and is younger, and, being on well-manured ground, is fresher, greener, and more vigorous. Here the situation is somewhat less advanced than in the field sent from last.

Thermometer at sunrise, 39°. Wind northwest. Slight frost; cotton plant injured. A few moths, flying rather feebly from cold. A few eggs, some fresh; some straggling larvae, mostly nearly full fed—a few half grown, and two only ½ inch long, the only young ones I have seen for some time. The cotton plant still quite green and vigorous and blooming; wasps sucking freely at the glands—our social subterranean wasp, called "yellow-jacket."

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OCTOBER 26.

I visited the field to-day from which I sent you specimens on the 19th. There was a slight frost on that morning (19th) as I wrote; thermometer 39° F. There was a similar one next morning, 20th; thermometer 38°.5 F. At a point not far from the field (Pio Nono College, which reports to the Signal Office), I understand the registering minimum there stood at 33°. Cotton partially killed in places; worst where the worms were. Very dry. I send you two boxes of specimens, one box containing a few *Aletia* moths caught in the field and 30 or 40 pupae, the other a dozen or so living *Aletia argillacea* larvæ.

Situation.—Cotton foliage much reduced by age and cold, but still some young green leaves and some blooms. A few *Aletia* eggs, two or three seen; fewer than a week ago. No young larvae, none less than three-quarters grown; a few pupae, and about as many moths as a week ago, most of them apparently just out.

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NOVEMBER 2.

We had ice and temperature of 31°.5 F. yesterday, and white frost and temperature 33° F. this morning. The cotton plant is dead. Will write you more fully in a day or two.

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NOVEMBER 7.

The moths continued to be found in the fields, most abundantly near the patches most eaten, where they were daily coming out from pupae, certainly till October 26; November 1, when the freeze occurred, not one was scared up. I have seen no difference in the habits of the last brood of worms here in webbing up or seeking quarters.

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DECEMBER 11.

I intended placing some chrysalides and moths of *Aletia argillacea* in boxes and exposing them, with fair protection, through the winter, to see whether they could pass the winter here alive. I soon found, before frost, that it was impracticable then, as the former would come out and the latter die from the warmth. Frost caught me in this quandary. I then gathered, November 4, a lot of chrysalides (the moths had disappeared) and, on examining them, found them in so unsatisfactory condition, that I concluded not to expose them. About two dozen were placed in a box in my sitting

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room, hoping to hatch some moths for exposure. The following is the result: In some two weeks two moths came out; they seemed delicate, and one lived only two days, the other four or five. No other moths have appeared. November 29, I found four Ichneumon flies out in box. December 2 one more, and December 7 another, the sixth, the last, with no ovipositor. In breaking open the dried chrysalides, I destroyed two pupae of parasites. These make eight parasites in some two dozen chrysalides; a large proportion. I had 75 chrysalides in a box in *summer;* about 50 came out moths; most of the others could not escape from and perished in the dried leaves. I saw not a parasite of any kind.

The two following extracts from Professor Grote's letters also bear upon this point:

The cotton plant is now (November 21) stripped of leaves, except here and there at the tops; there is also a little new growth on the main stem. The worm appeared here September 7, increasing in size and more noticeable up to the 15th, when the earliest webbing was noticed. The worm was not very numerous nor of even distribution. The October brood was hardly noticed; nevertheless, it must have existed, as I have been finding chrysalides (not many) for the last few days wherever the leaf still held. This shows that the last brood does not quit the plant, as I have formerly observed in Alabama. Nevertheless, I searched a piece of wood and some fence-corners, as instructed, but found nothing.

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SAINT CATHERINE'S ISLAND, COAST OF GEORGIA,
November 28, 1878.

I think my observations go to show that the worm does not leave the plant for the last or at any time. In Savannah I failed to find any traces away from the field. In my former published observations in Alabama, I found the last chrysalides giving the fly in the face of the frost. When the leaf fails, the worms web up any way possible in the squares, or between the stem and the leaf stalks. They never leave the plant; in a few cases they spin up on weeds in the cotton rows.

From the above-quoted correspondence and from other material, some of which may be found in Appendix II, we feel warranted in stating the following conclusions respecting the disappearance of the last brood of worms: In making preparations to undergo their tranformations, individuals of this brood do not differ in habits from those of the preceding broods, except that, as the foliage of the cotton is frequently destroyed, it becomes necessary for the worms to seek other places in which to web up. Thus we see the worms webbing up, not only in the leaves of cotton, but in the leaves of any plant that they can find, and even in the crevices of bark of trees. No tendency on the part of the worms to make a denser cocoon than those of the preceding broods was observed. A large part of the pupae, which were enveloped in leaves of cotton, became exposed and fell to the ground owing to the consuming of the leaves by other larvae. Many such pupae would naturally fall prey to predaceous insects or be destroyed by other causes. Thus we find, as with the third crop, that a large proportion of this brood is destroyed in a very short time after assuming the pupa state. The length of time which individuals of this brood remained in the pupa state varied greatly; many moths emerged early in October, and a few emerged each day till

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the latter part of the month, when heavy frost occurred. The only instances of moths emerging from the pupa state after a heavy frost, of which we have been able to learn, are those mentioned in Professor Smith's letters of October 26 and November 4, and in Professor Willet's letter of December 11. Professor Smith also wrote December 30: "All the chrysalides which I have examined are dead, so that not many, if any, will survive the winter."

FIRST APPEARANCE.

No point in the life history of the cotton-worm is of higher interest than the first appearance of the insect in the spring. Not only may we expect to learn here important facts bearing upon the question of hibernation of the species in our territory, but other facts which will be of service to us in our efforts to devise some way in which to check the increase of this pest as soon as it appears. The general impression has been that the earliest appearance of the worms in the cotton fields was during the latter part of June or in July. This has been urged as a proof of the theory that the species dies out each season in the United States; and, what is much more serious, this idea has influenced the planters to neglect making any efforts to destroy the worms early in the season.

Although vigorous efforts were made to collect specimens of the moth early in the spring, none were observed. Baits of various sweetened mixtures were exposed; these attracted many moths, but none of them were *Aletia*. Neither did any specimens of the cotton-moth come to light at that season. This, however, only proves the futility of any attempts of this kind to destroy the moth at that season of the year, For we know that moths were present and ovipositing on the cotton very soon after the young plants emerged from the ground. This is shown by the fact that May 21 a full-grown larva was found in Dallas County, Alabama, on some small cotton, which was planted April 30, and was well up about May 8. On May 23 another larva was found in the same field. As this cotton was immediately adjoining some which was planted a month earlier, there is a possibility that the larvae were hatched on the latter, and migrated to the place where found; but in any case it is evident that moths were flying and ovipositing on the cotton while it was yet quite young. Other larvae were observed at this time; one May 23 on the older cotton; and another June 3. These particular instances are cited, as there is no doubt of the identity of the larvae. We believe, however, that they were found even earlier in the season. Colonel Lewis, of Vernon Station, in the Canebrake region, Alabama, found a full-grown larva May 17; and May 24 they were reported from two other plantations in the Canebrake.

The following testimony of our correspondents is important as confirming these observations. It will be seen that in several instances the worms have been observed at even earlier dates than those given above.

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The extracts are from the answers to the question, "Date when the first worms have been noticed in your locality?"

In 1875, they appeared the 8th of May; 1876, 1st June.—[J. H. Krancher, Millheim, Austin County, Texas.]

Worms were seen in 1873 in May.—[H. Hawkins, Hawkinsville, Barbour County, Alabama.]

I have seen a well-developed caterpillar eating the cotton when I was putting it to stand in May, but the appearance then was no sign that they destroyed the crop earlier than usual; did not propogate or do any harm until the season of the year usual, from June on.—[A. Jay, Jaysville, Conecuh County, Alabama.]

Late in May or early in June.—[C. C. Howard, Autaugaville, Autauga County, Alabama.]

In 1873, I saw them as early as 20th of May.—[R. S. Williams, Mount Meigs, Montgomery County, Alabama.]

The first appearance of the worms is difficult to ascertain, from the fact that they are so few at first and scattered over so large an area of cotton fields. The negroes who mostly cultivate these fields say that the first worms appear sooner than we imagine (say some time in May). Our own observation is that the eggs of the moth are deposited when the cotton begins to bloom; and this is later some years than others. The average time is the first week in June on the earliest cotton stalks.—[Dr. John Peurifoy, Mount Meigs, Montgomery County, Alabama.]

Early in May, 1868, I found several worms in different localities.—[P. T. Graves, Burkville, Lowndes County, Alabama.]

On swamp land, May 31, 1877.—[J. H. Smith and J. F. Calhoun, Minter, Dallas County, Alabama.]

May 12.—J. A. Callaway, Snowdown, Montgomery County, Alabama.

The first worms that I have ever known were reported as early as May 1.—[R. W. Russell, Lowndesborough, Lowndes County, Alabama.

I think there is a pretty good brood hatched out in May and early in June that would destroy the crop but for the plowing that shakes them off the stalks and covers them with earth.—[J. W. Burke, Fayette, Jefferson County, Mississippi.

May, June, July, August.—[D. L. Phares, Woodville, Wilkinson County, Mississippi.

I have had my neighbors tell me that they found the genuine army worm on the young cotton plants when working them for the first time—scraping and chopping out, but I cannot say that I have seen any so early myself. These persons were reliable and I have governed myself in planting by what they reported to me.—[Douglass M. Hamilton, Saint Francisville, West Feliciana County, Louisiana.]

Last of May on my place; have heard of them in other localities sooner.—[Wm. A. Harris, Isabella, Worth County, Georgia.

1869; May 12, 1873; May 24, 1877; June 19, 1878; June 15.—[Robert Gamble, Tallahassee, Leon County, Florida.

Sometimes as early as May.—[J. D. Driesbach, Tensaw, Baldwin County, Alabama.

The 17th of May, 1874.—[P. D. Bowles, Evergreen, Conecuh County, Alabama.

Thus we see that there is not as long an interval between the disappearance of the last brood in the fall and the appearance of the first brood in the spring as there has been supposed to be. In fact the interval is as short as possible; for the moths oviposit on the cotton as soon as there is sufficient food for the larvæ. The first larva found by Mr. Trelease this season had consumed several plants.

A topic of scarcely less interest than the date at which the cotton-worms first appear is the localities in which the first brood occurs. Every planter

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with whom we have conversed on the subject informs us that in each locality the worms first appear on a certain plantation, and on a very limited part of that plantation. We examined several of these places carefully, but found no striking local peculiarities. They all agree, however, in being on low land and where the cotton has a thrifty growth. In connection with this testimony of the planters, we must take into account the fact that they seldom observe the worms till the latter part of June or even till July. It is evident, therefore, that it is the first "crop" of worms that appear in the above described localities, and that the testimony has but little bearing on the origin of the first brood. As yet we have but little data upon this point; but that which we have indicates that the first brood of worms is scattered indiscriminately over those sections in which they occur. Specimens of the first brood were found by Mr. Trelease on cotton growing on bottom land, in a swamp, on an elevation rising from this, and on a ridge considerably distant from the swamp. Thus no local peculiarities of the soil seem to influence the distribution of the worms, except that where the cotton is the earliest the moths first find a place to oviposit.

We have therefore a very interesting problem presented to us. Why is it that if individuals of the first brood of worms occur indiscriminately on cotton growing on wet and on dry land, that the greater proportion of the second or third brood (the first crop) is found only on low, wet lands? The only explanation we can offer, so far, is that in the wet lands there is but little to check the natural increase of the species; while in dry lands the predaceous insects, especially ants, destroy a large proportion of the larvae of the earlier broods. This point will be referred to again in the chapter on influence of weather.

It has often been asserted, especially by those who advocate the theory of immigrations of the moth, that the cotton-worm appears first in the western and southern portions of the cotton belt, and progresses regularly toward the east and north. But this does not seem to be the case. As we have already shown, in the spring of the present year (1879) the worms were in Central Alabama as early as there was food for them. And in 1873, when the first brood was so large as to attract general attention, the worms appeared simultaneously (during May) in Jackson County and Gadsden County, Florida, Decatur County, Georgia, Marion County, Mississippi, and Atascosa County and Victoria County, Texas.*

HIBERNATION.

How does the cotton-worm pass the winter? This is a question most often asked respecting this insect, and as yet the answers have been only theories. Many have believed that the pupae of the last brood pass the winter in the ground. This we now know cannot be the case, as the larvae of the last brood web up in leaves in a similar way as do the

* Monthly reports of the Department of Agriculture, 1873, p. 23-9.

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larvae of other broods, and those pupae which fall to the ground on account of the destruction of their leafy covering are soon destroyed by ants. Even if they were not destroyed, they have no power of working their way into the earth, as has been supposed by many. Of the very many pupae which have been found in the ground and sent to this department by persons supposing them to be those of the cotton-worm, not one has proved to be such. Many moths closely related to the cotton-worm—that is, belonging to the same family (the *Noctuidae*)—pass the winter in the ground in the pupa state. It is such pupae, and especially those of the boll-worm, that have been mistaken for those of the cotton-worm.

It has been contended by some that if the cotton-worm survived the winter in the United States, it would exist in such numbers in the spring that it would sweep away the young cotton plants at once. But, from what we have seen of the disappearance of the "third crop" and of the last brood, it is evident that in any case only a few individuals survive the autumn. Numerous instances of pupae which were undoubtedly those of the cotton-worm remaining alive after heavy frosts, and even till midwinter, are on record; but it is a suggestive fact that there are but few well authenticated instances of pupae producing moths after heavy frosts have occurred, those mentioned in the letters of Professors Smith and Willet, quoted above, being the only ones known to us. Is it not probable that observers have been misled by the movements of pupae containing parasites? Every entomologist knows that dead pupae are frequently seen to roll about as if alive, the motions being due to the parasite within. One of the most interesting of the published observations on this point is the following, by William Jones, in the Southern Cultivator, March 1, 1869:

Last fall we watched the caterpillar up to the time when their operations were suspended by a severe frost. We found large numbers killed by the cold—a few, in sheltered spots still alive. Many were caught just beginning to wind up and preparing to pass into the chrysalid state, whilst the chrysalids were in every stage up to the point of being ready to come out as moths. On the edge of the field the chrysalids were attached to briars and weeds, having wound themselves up in their leaves (which winding up in leaves is, so far as we have observed, their invariable habit). We collected a large number of these chrysalids, and, inclosing them in a bag, hung them up in a porch facing northward. The thermometer indicated:

November 2, 30°.
November 20, 28°.
November 22, 25°.
November 23, 24°.
December 2, 27°.
December 12, 12°.
December 13, 16°.

We examined them on the 14th of December, and found them still alive. On examining the bag again, about the last of December, to our very great disappointment, we found that a bird had pierced the bag and eaten them. We shall have to wait, therefore, another opportunity to test the manner in which the insect passes through the winter. About the middle of February we visited the same field again; a majority of

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chrysalid cases (which were still abundant) we found empty, with every indication of the insect having matured and escaped. A limited number we found apparently unchanged, and started back rejoicing that we had been able to replace those destroyed by the bird; but, alas, upon accidentally crushing one, we found within it an ichneumon, and this proved to be the case with all we had collected. Some of the ichneumons had completed their transformation, and were about to come out as perfect insects.

Many planters believe that they have seen the adult during winter and early spring. But in every instance when such moths have been sent to an entomologist they have proved to belong to some other species than *Aletia argillacea.* Many moths were sent to this department during the past winter, by persons supposing them to be cotton-moth; but in every instance, with one possible exception, they proved to belong to other species. The only instance where there is any doubt is in the case of some moths collected by Judge J. F. Baily, of Marion, Ala. Respecting these moths, Judge Baily writes:

They appeared the last days of February in swarms, about dusk, around the roofs of the houses, as if they had come from the shingles as winter quarters. Since their first appearance in February, I have seen them every pleasant evening, in the twilight, sporting first around the plum blooms, and then around the peach, the mock-orange, the Chinese quince, and other blooms.

Specimens of the moths were sent to Prof. E. A. Smith, to whom the letter from which we have just quoted was addressed. Professor Smith forwarded the specimens to the department, but they never reached their destination. At a later date Professor Smith writes:

I am sorry you did not receive the moths which I sent you from Judge Baily. They were very much rubbed, and I could not be sure about them, still they did not appear to me to be the cotton-moth.

At a still later date Professor Smith wrote:

I have just returned from a trip to Marion, where I saw Judge Baily. Judge Baily has never since that time seen any of the moths which were so abundant a month or two ago; he will try his best to collect any moth that resembles *Aletia,* and I think if it visits his neighborhood he will observe it. I am very doubtful if what he sent me and I sent to you was the true cotton-moth; it resembled *Leucania unipuncta.*

During the winter of 1878–'79 the following named local observers for this department were on the look out for living pupae or adults of *A. argillacea:* Professor Willet, at Macon, Ga.; Professor Smith, at Tuscaloosa, Ala.; Dr. Anderson, at Kirkwood, Miss., and Judge Jones, at Virginia Point, Tex. Not one of these gentlemen was successful. Professor Smith, in particular, made great exertions to obtain specimens of the adult. He had sweetened mixtures for attracting moths exposed during the entire winter; but although he constantly obtained other moths, as already stated, not a single Aletia was found. It is important to note that Professor Smith's observations were made at a point which may be farther north than the cotton-moth can hibernate. But in the latter part of December Professor Willet made a trip to Southern Georgia, where a careful search was rewarded only by a few dead pupae and many empty pupa-skins; the latter were found in dead wood and under

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bark of pine trees; many were also taken from ragweed on edge of a cotton field.

In addition to the efforts of the local observers, Mr. Schwarz, who has had a wide and very successful experience as a field entomologist, made an extended tour through the cotton belt, in order to ascertain what he could respecting the winter quarters of this insect.

Mr. Schwarz was no more successful in this particular than were his colaborers. As he did not include the details of this trip in his report, which is published in Appendix I of this work, the following account of his journey will be of interest as bearing on the question of hibernation.

Mr. Schwarz proceeded from Washington to Galveston, Tex., which point he reached December 5. He made a short and unavailing search with Judge Jones, and then proceeded to Columbia, Brazoria County. From that point he writes:

After two days digging in the cotton field, with the assistance of a negro, I have satisfied myself that neither on the cotton plant nor in the ground is to be found a single trace of the hibernation of *Aletia argillacea*, at least in this portion of the cotton belt. It remains to look for the moth in the woods, which, with their countless trunks and logs of live-oak (there are no pine trees here), afford plenty of shelter. I began to look in these old trees and under bark, and by smoking in cracks of logs I captured a few other *Noctuidae*, but no *Aletia*. I tried sugaring some trees last night, but with no success.

I also tried lanterns and caught a few *Noctuidae*, but no *A. argillacea*. I shall continue to look for it in the woods, but I have given up the hope of finding the chrysalis in the ground, and in this last conclusion the farmers of the Brazos bottom agree with me.

Thence he proceeded to San Antonio and from there to Columbus, Colorado County, which he reached December 25. Investigations here resulted in the finding of four parasitized chrysalides. Hearne, Tex., was his next point of destination; and from there he returned to Galveston and went by boat to New Orleans. From this place he writes as follows, giving his explanation of his want of success:

After more than four weeks experience in the South I have come to the conclusion that *Aletia argillacea* hibernates in the United States. The reasons which lead me to believe this are, first, the gradual increase in the number from the very few specimens in the first generation to the myriads of the last generation. Second, that *A. argillacea* has been observed much earlier in the season than is generally believed. One of the best observers I met, Mr. G. Little, has seen the worms on the 10th of May. It seems to me, therefore, an established fact that very few specimens of *A. argillacea* appear very early in the season, and probably those only in the bottom-lands. It appears to me highly improbable that these few specimens should immigrate from the South, year after year, or at least during the past ten years. I think if the moth is migratory in its habits it would appear suddenly in considerable numbers. (I do not know upon what grounds the theory of the "three generations" of the cotton-worm is founded, but I cannot see how this insect which transforms in less than four weeks should pass through only three generations if it appears as soon as the beginning of May). It is certainly much more natural to assume that a few, perhaps only a very few specimens of the moth, probably impregnated females, do hibernate. There is, of course, but little chance to find one of these hibernating specimens owing to the multitude of hiding

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places and the difficulty, or rather impossibility, of making a thorough investigation in this respect. In my opinion the least difficult way of solving this vexed question would be to place an observer at some suitable point in the South, who should from the very first warm day of the year, say the 1st of February, go out every evening with lanterns and try the experiment of sugaring trees. If this course were followed I think he would be able to find *A. argillacea.* To find the moth in the winter time in the cracks of the countless old live-oaks in the bottom-lands is a matter of mere chance.

At Bayou Sara, La., Mr. Schwarz made a thorough search for hibernating moths under the bark of trees surrounding the field, and in similar places, but without success. From a letter dated Vicksburg, Miss., January 28, we extract the following:

Since I wrote you my last letter I have continued my efforts to find hibernating individuals of *Aletia.* Favored by the mild weather, I have hunted every day from morning until evening with this sole object in view, and have certainly made a thorough investigation of the country around Bayou Sara and Francisville. I never saw a country better suited for this purpose than the valleys and bluffs in West Feliciana Parish; but my efforts were all in vain, and I failed completely to discover any trace of the hibernation of the moth. However, my belief in the hibernation of the cotton-insect is not shaken by this failure, but I must confess that I feel very much discouraged after this fortnight of uninterrupted effort, and almost despair of finding the moth. But this failure does not by any means warrant the acceptation of the theory of the annual migration of the moth, as I can prove by the following facts: During the last warm days the country around Bayou Sara has been swarming with *Vanessa Atlanta,* and I have never been able to find a single living specimen of the perfect insect, or a living pupa in winter quarters. I could add similar instances, *e. g.*, *Orchestria vittata* and *Dibolia aerea* among the Coleoptera have during the last warm days been commonly seen flying about or sitting on fence posts, etc., and I have never succeeded in finding these species in their winter quarters. I repeat that the vast majority of hiding places best suited for the hibernation of a Lepidopteron—I mean the cracks in *dry,* solid timber—are inaccessible, and the investigation of the few of these cracks which are accessible is connected with considerable difficulty and loss of time. If we are unable to find even very common insects in their winter quarters, we ought not to be astonished if we are unable to find the cotton-moth, which, if it hibernates here, does so certainly in very small numbers.

A letter from Mobile, Ala., February 17, contains the following:

Since leaving Vicksburg I have traveled through the central portions of the cotton belts of Mississippi and Alabama, stopping at Jackson, Canton, Kirkwood, Meridian, and Tuscaloosa. During all this time the weather has been unfavorable; in fact since I left Bayou Sara there has been nothing but rain and cold. However, it was with great interest that I entered this part of the cotton belt, as I found here for the first time fine lands where a thorough search for *A. argillacea* is much more easily made than in the more southern bottom-lands, which are full of thick forests of live-oak. But after excursions made at the places mentioned, and after the information I received regarding the appearance of the cotton-worm last year, I feel fully convinced that this insect does *not* hibernate in any stage in the upland cotton districts of Mississippi and Alabama.

In the course of the journey mentioned in the above extract Mr. Schwarz spent some time with Dr. Anderson, in Kirkwood, Miss., and with Prof. E. A. Smith, in Tuscaloosa, Ala. Mr. Schwarz says in the last quoted letter:

Dr. Anderson thinks that the following conditions favorable to the hibernation of the pupa may occur: First, the chrysalis might fall to the ground and be accidently

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covered by leaves and other debris. Second, it might be carried into the gin-houses and covered with old seeds or refuse cotton, &c.

The first case is very improbable, in my opinion, as the chrysalid would certainly be killed by the mold, or the decay brought on by moisture. In regard to the second case I must confess that I consider it very possible provided that Dr. Anderson's observation be correct. While in Hearne, I examined the refuse cotton of a gin-house, and subsequently again near Canton, but without success. The possibility, however, that the pupa could hibernate in such places cannot be denied.

It is to be regretted that Professor Smith and Dr. Anderson do not reside in the southern extremities of the cotton belt, as there is no question in my mind but that *A. argillacea* spreads from there to the more northern portions every year; and that the question of the hibernation of this insect can only be solved by patient observations in these southern bottom-lands.

Professor Smith, whose house is well situated for observation, as his own cotton field is close by, will certainly fail in finding the cotton-moth on his sugared trees, although he is "baiting" his trees every warm evening.

As a very good place for observations to be taken early in the spring, I would recommend Columbus, Tex., or one of the other great bottom-lands of the State. In Southern Louisiana the bottom-lands, or rather the low alluvial lands, are exclusively devoted to the cultivation of the sugar-cane. The Mississippi bottom-land in the Louisiana cotton belt is not extensive enough for such observation. In the interior of Louisiana and throughout Mississippi the true bottom-lands are not cultivated generally because they are subject to frequent overflows; this, however, is not the case with those in Texas.

From Mobile, Mr. Schwarz proceeded to Tallahassee, Fla., by way of Eufaula, Ala. In a letter of February 26, from the latter place, he says:

I spent a whole day on Mr. Donovan's plantation in hunting for *Aletia argillacea*, but with no success. Near the cotton field begins a very large thick hummock, where a thorough investigation is altogether impossible. * * * In order to go from Mobile to Florida I had to make a detour by way of Eufaula. At this place I had to wait four days for the steamer. However, I was not sorry to be detained at Eufaula, as cotton is most extensively planted in the vicinity of the place, and as I have found here for the first time a locality where hiding places for hibernation of the moth are comparatively scarce. I had thus an opportunity to make in two days a systematic and *thorough* exploration of the broad valley of a little creek. In fact I looked everywhere except in the roofs of the houses. Moreover, several fields were just plowed, and I had again occasion to convince myself that there are no pupæ of *A. argillacea* in the ground. I repeat here that I feel more than ever convinced that the insect does not hibernate in these more northern portions of the cotton belt.

In his first letter from Tallahassee, February 28, we find the following:

I would like to add that Dr. Anderson's assertion that he saw *A. argillacea* flying during the warm spell in January is quite incorrect. The doctor, like Prof. E. A. Smith and myself, as well as others, saw only other *Noctuids* flying about the houses, and they almost exclusively belonged to a single very common species (I think it is *Boarmia*), which I find everywhere, under bark, in cracks in fences, flying during the warm hours of the day, at night, &c. Very often and in many places I heard the opinion that *Aletia argillacea* hibernates as a moth, because it has been seen flying in warm evenings during the winter; but I have never found a man who actually knows what *Aletia argillacea* is among the flying moths.

In his second letter from Tallahassee, March 5, he writes as follows:

After three months' traveling through cold and rain, I find here in Florida most glorious, warm weather, and during my stay in Tallahassee I did not lose a single day

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by rain. But I am sorry to say that notwithstanding all my efforts I have failed again to find *Aletia*, although the country here looked very promising.

The country in the vicinity of this city is very rolling, almost hilly, and numerous ponds, here called "beautiful lakes," are in the depressions; but there are no large creeks or rivers here. It is not at all a "bottom-land," but cotton is planted under various conditions: on top of the hills in sandy soils, on dry "hummock land," and on the edges of the ponds. The growth of the plant is here better than I have seen since leaving Bayou Sara.

The cotton-worm makes its appearance here every year in large numbers, and very early in the season; several planters are positive of having seen the worm in the latter part of May. In other words, here again is a district where it is more than probable that *A. argillacea* is indigenous. The worms are injurious every year, as nothing is done here for their destruction except some occasional attempts with Paris green. The damage is never uniformly distributed, owing doubtless to the nature of the country. In 1878 the worms injured only the cotton on the lower fields, but from contradictory statements I find it impossible to give the exact amount of damage done. When the owner of a field says that in 1878 the worms destroyed his entire cotton crop, and his neighbor, speaking of the same field, asserts that the worms did but little harm, it is rather difficult to find out the truth. However, it is certain that in 1878 they had here a fair crop, amounting in average from three-fourths of a bale to one bale per acre.

This locality is most promising for the purpose of hunting *A. argillacea;* as, with the exception of a few large hammocks, hiding places for hibernation are not so abundant as in the other southernmost cotton districts which I have visited. Induced by my previous failure to find the imago of *A. argillacea*, and influenced somewhat by Dr. Anderson's assertion that four pupæ had survived the cold weather of December, I spent considerable time in looking for pupæ in places where they might have found accidental shelter. Such places are the gin-houses, and when the cotton fields run on a half-cleared hammock where numerous fallen leaves have accumulated. But all the pupæ found in such places were unfortunately either empty or frozen, and I did not even find parasites, although I found several pupæ from which the parasites had escaped. A number of eggs (I send them with this) which I found during a most careful examination of a gin-house do not appear to be those of *Aletia*. As at this season there is much plowing going on, I had ample opportunity to convince myself that no pupæ are in the ground. I offered a prize of five cents for each pupa brought to me, and received eight. All, however, were killed by the frost, and it is certain that not a single pupa of the number was found in the ground. One negro brought me a large *Attacus* pupa as the "web" of the cotton-worm, and wished ten cents for it on account of its size.

The few hammocks in the vicinity of Tallahassee are quite large, and, of course, are full of very tall, old trees, and a thorough exploration of them is out of the question.

From Tallahassee Mr. Schwarz proceeded to Savannah, Ga., via Gainesville, Fla. In the latter place he found no trace of the cotton-moth. While at Savannah he visited Saint Simon's, one of the Sea Islands. Concerning the results he states:

I am sorry to say that I have failed again to find any trace of *Aletia argillacea*, although these Sea Islands are most favorable for an investigation. The woods, half hammock and half pine woods, peculiar to the islands, are very open, and hollow trees, &c., are comparatively scarce.

From Savannah Mr. Schwarz took steamer to the Bahamas; and as an account of the results of this trip are given in Appendix I, further quotations from letters will be unnecessary.

In considering the results of Mr. Schwarz's observations, it should be

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remembered that during the greater part of the time while he was in the field the weather was unusually cold, so that hibernating insects would not be likely to be out from their places of concealment; and that, as Mr. Schwarz has well said, the failure to find the hiding place of the cotton-moth is not proof that the species does not hibernate, for he also failed to find in their winter quarters other insects which are very common, and respecting the hibernation of which there is no doubt.

Although we firmly believe (both from the *a posteriori* reasons, which will be given at length in the chapter on the theory of migrations, and from positive evidence to be soon brought forward) that the cotton-moth hibernates in some portions of the cotton belt of the United States, we have given these negative results at length, not merely for their purely scientific interest, but as furnishing valuable data to be used in making plans for the destruction of this pest.

The undoubted positive evidence of the hibernation of this insect consists of a very limited number of observations; for although we believe that some at least of the many planters who think they have observed the cotton-moth in midwinter and early spring are right, still the fact that in every instance when specimens of the moths observed have been sent to entomologists it has been found that some other species has been mistaken for *Aletia argillacea* prevents our accepting testimony of this kind.

The following list comprises the names of those moths which have been most frequently sent to this department by persons believing them to be the cotton-moth:

Phoberia atomaris (moth), Georgia.
Hypena scabralis (moth), Georgia.
Leucania unipuncta (moth), Alabama.
Drasteria erechta, moth.
Agrotis (several species).

But we cannot doubt the statements of so accurate an observer as Mr. Thomas Affleck, who says, in his Southern Rural Almanac, 1851, pp. 49, 50:

On the 22d of December last, 1849, I saw great numbers of the *cotton-moth* during the dusk of the evening flitting about the fence corners, dead trees which still retained their bark, and about certain sheds near this village—Washington, Miss. The weather was and had been unseasonably warm. A few cool days followed, during which I could not find a single moth. But again, on the 27th or 28th of the same month, I saw them in equal numbers. I leave it to naturalists to say whether or no this settles the question of hibernation. It is positive evidence, so far as it goes. Whether they continued to exist until the cotton plant was large enough to support their progeny I cannot say; nor could I satisfy myself as to where they found shelter.

Equally interesting are the observations of Mr. John T. Humphreys, late naturalist and entomologist to the State department of agriculture of Georgia, who says in a letter which we recently received from him:

1st. *That it hibernates in the chrysalis state.*—This may be true of other "cut-worms" (which in some cases I doubt, while in others I know), but there is not the slightest

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warrant for any such supposition in the history of *A. argillacea* Hübn. This question I have subjected to the most crucial test, selecting 3,200 larvæ and noting their change into the pupa state. I planted them in detached groups (as chrysalids), under different soils, and at different depths (the latter to do away with cavilings). Some I placed just beyond the frost-line, others at the line, and, again, others just above the line. (Was there ever a chrysalid foolish enough, when forced to bury itself under *terra firma*, to leave its work of protection half-way done?) *In every instance* the pupation under ground was a failure. You well know how bewildered an ant becomes when its antennæ are removed; just so with *A. argillacea* when the chrysalis is entombed. I am giving you general outlines, which, I am sure will appear plausible to you as an insect physiologist. Two of these moths (preserved in my cabinet) did actually burrow upwards from a depth of three inches, in soil that was quite loose and not compacted by the cold and the winds of winter (to say nothing of accidental pressure), and their wings were so much mutilated by their escape as to serve them no longer as instruments of flight. These experiments, repeated over and over, have proven to me the impossibility of anything bordering upon a *general pupation of A. argillacea under ground.*

2d. *That it hibernates as a moth.*—This is overwhelmingly true. Not under the leafless stalks of cotton, nor under the clods of dirt and rocks about them, but beneath the scales of pine trees in neighboring forests, in cotton-gin houses and elsewhere (particularly in the first-named), have I found the *A. argillacea* in numbers from December until May, wings perfect, no scale abrasions, and agility equal to that of any brood. I have found the moth in iron concretions not far from Cuthbert (Randolph County, Georgia), in the vicinity of Burgess Mills. This curious contrast you may note *en passant*, while the first broods (May to June 16) invariably appear first in the hammock-growth bordered plantations, the moths of the last brood are found in midwinter principally amid the pine growths. On this point, however, I have no space to elaborate. Your own reasoning will be as good as any one else.

In another letter Mr. Humphreys states:

I found the moth (*A. argillacea* Hübn) hibernating on Saint Simon's Island, Georgia, February, 1876, and near Brunswick at the same time. I also found it in Randolph County, Georgia, November 8, 1876. The hibernating moth has been seen in barns and cotton-gin sheds from November to May, in the counties along Chattahoochie River, Decatur, Early, Clay, and in Thomas, Brooks, Lowndes, on the Glynn (Atlantic) coast.

And Professor Grote himself, in the paper in which he proposes the theory of migrations, says:

The last brood of worms changed into chrysalids in myriads on the leafless stems, clinging by their few threads as best they might, and disclosed the moth in the face of the frost, many of the chrysalids perishing. Afterwards, on sunny winter days, I have noticed the live moth about gin-houses and fodder-stacks, or the negro quarters.

Professor Grote adds: "Was this a true hibernation, or merely an accidental survival? The locality and the condition seem to me alike artificial." It appears to us that just the conditions described may be found on any plantation in the South, and that a few "accidental survivals" are all that is necessary to perpetuate the species in any locality. It has often been urged, by those who believe that the presence of the cotton-worm in our country is dependent upon the immigration of moths from other countries, that, did the species hibernate in our territory, the moths would be seen early in the spring. We believe that the only reason it has not been observed at that season of the year is that it occurs in small numbers and that very few observers have thoroughly

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searched for it at that time. That moths are present and ovipositing on the cotton very soon after the young plants emerge from the ground has already been shown in the section on the first appearance of the worms.

Our conclusions are that the species does not hibernate as a pupa, but that in certain portions of our cotton belt the species does hibernate as a moth. The number of moths, however, which survive the winter is very small compared with the number of pupae of the last brood of the previous season.

It is probable that of those moths which mature before frosts sufficiently heavy to destroy the pupæ occur, only the more vigorous individuals, and of them especially those which choose unusually-protected situations for their winter quarters, are able to survive the winter.

As to localities in which the species hibernates, we conclude from the data drawn from a study of the past history of the insect that in the following-named places the moth usually survives the winter:

Texas.—Principally in the Colorado and Brazos bottoms, as far north as Grimes County and as far south as Victoria; occasionally as far north as Cherokee, *possibly* to Upshur, though not probable.

Louisiana.—The southeastern parishes along the river—East and West Feliciana, East Baton Rouge, and Iberville; possibly Saint Landry, Avoyelles, Concordia and neighborhood.

Mississippi.—The southwestern counties, near the river—Wilkinson, Adams, Amite, &c.

Alabama.—Principally in the "cane-brake" region; possibly in the southeastern counties, along the Chattahoochee.

Florida.—Principally in those northern counties near the Appalachicola—Gadsden, Jackson, Leon, &c.; possibly in adjoining cotton-growing counties.

Georgia.—Southwestern counties—Decatur, &c., along the Flint and Chattahoochee; in former years probably in the Sea Islands and coast counties.

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CHAPTER IV.

THE THEORY OF MIGRATIONS OF THE MOTH.

Although we have expressed our belief, in Chapter III that the cotton-worm hibernates as a moth in certain portions of the United States, we feel it important to give an account of the theory of migrations, which has played so prominent a part in the discussion repecting this insect. It should be stated that, although this theory is now held by but few people, among the number are those who rank high as entomologists and who have also had considerable experience in the study of this particular species.

In order to give those who have proposed this theory due credit, we will state it in their own words. The earliest hint that we have found of the possibility that the cotton-worm may be brought frequently to this country from regions farther south, is contained in the following extract from a letter by Mr. Thomas Affleck, published in the American Agriculturist for November, 1846 (vol v., p. 342):

The pupa is black or dark brown and shining. From the moment it begins to spin until it issues from the pupa a perfect moth is from eight to nine days of warm seasonable weather, but if unusually cool it extends to a longer period, even to weeks; hence I am inclined to think that it is in the pupa state the insect is preserved over winter. In fact, there is no doubt that many are thus saved—the moths that are seen occasionally on a warm winter's day, having been hatched prematurely by the unseasonable warmth of the weather, and quickly perish from cold and want of food. But whether we at all times receive our supply from this source, or whether (which I think is quite as probable) they are not unfrequently brought on a gale of wind from the West Indies, Mexico, or the coast of Guiana, will be difficult to decide. My observations lead me to the conclusion that after a steady cold winter we have the caterpillar early and in abundance; and after a mild or warm one we have them, if at all, but partially and late in the season. The pupa is frequently found during winter safely sheltered under a scale of bark, between two evergreen leaves, under the splinter of a fence-rail, or in a tuft of pine leaves.

Early in the following year (1847) Dr. D. B. Gorham, having independently arrived at the conclusion that we have an influx of the cotton-worm every year from more southern countries, published a paper on the subject in De Bow's Review (vol. iii, pp. 535–543). We quote those parts of the paper referring to this theory:

Let us now pass to the consideration of the cotton-fly, premising, however, before entering into an examination of this destructive little moth, that my remarks are intended less to enlighten others than to elicit information from some one who is better able to inform the public mind on this interesting subject. As for myself, I must confess that my limited observations do not justify me in coming to any positive conclusions, and have by no means satisfied my curiosity; but my information, such as it is, I give in the following pages, with the hope that however imperfect it may prove in

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the main, yet that some mite of information may be gleaned from it. It is impossible to think for a moment that this species of moth has escaped the observation of entomologists, for the plant upon which it feeds to the absolute exclusion of all others (being the great staple production of many countries) must have brought it into notice at various times and at various places. From its univorous nature (to coin a word) it must have been coeval with and inseparable from the existence of the cotton plant. My principal motive for broaching this subject is on account of the frequent remark made and fears entertained that the army-worm would become an annual plague. But scinc I have investigated their nature, I have come to the conclusion that these fears are groundless, and that the cotton-fly can never become naturalized in our climate.

The first irruption, as I am informed by an old planter, that this insect made on the cotton fields of Louisiana was about the year 1820, when its progress was marked with the same utter destruction of the cotton crop as in the subsequent years of their appearance. It then disappeared until 1840, a period of twenty years. There is something singular and unaccountable in the periods of this insect, something vastly different from the periodicities of others which we find with us, for they appear to be governed by some fixed laws; the most of them are annual, very few biennial. Now, the grasshopper, house-fly, and mosquito may be looked for at the return of summer with as much confidence and certainty as we look for the revolutions of the seasons. The *Cicada septendecem* never fails to make his appearance once in seventeen years. But who can tell whether the cotton-fly will appear next year or fifty years hence? No scourge, whether under the form of a devouring insect or that of a malignant disease, ever became annual in one particular place. Look at the locust of Egypt; suppose that voracious insect to become annual, the prolific valley of the Nile, once the granary of Asia and Europe, would become a howling desert. Look at the plague that devastates sometimes Smyrna and Constantinople; did the cause of that distemper act with the like intensity at each return of the season, those flourishing cities would long since have been numbered with Thebes and Memphis. Let the cholera or yellow-fever prevail in New Orleans every year as it has at times, and that great emporium of the Southwest would become a puny village. Is there not an invisible hand that sways the destinies of the world: a hand that stays the devastations of plague, pestilence, and famine? The cotton-fly belongs to that numerous class of insects known to naturalists under the term of phalena or moth tribe. The following are its specific characters, without the technicalities made use of by the naturalist, so far as they could well be avoided. * * *

During the present year, the time that my observations commenced for the first time, the cotton-fly again made its appearance in the latter part of August, at first making but little progress, but about the middle of September their numbers increased so prodigiously that in many instances they would eat over a field of several hundred acres in four or eight days. The number of eggs deposited by the female is uncertain; they are smaller than a mustard seed, and always deposited on the under surface of the leaf during the night; in a few days their eggs hatch. The worm, at first a minute living point, falls immediately to work to devour the leaf. Its growth is rapid, for its labors cease not night or day until it arrives at maturity; it then winds itself up into a leaf by means of a web resembling a *cobweb*, casts its skin, and changes into a chrysalis, in which state it remains ten days, then it bursts the thin walls of the chrysalis and comes forth a perfect insect. In turn, it begins the work of reproduction, deposits its eggs, and in ten more days it dies.

Thus in every ten days there is an additional generation, and they go on increasing *ad infinitum*. As soon as the leaves were consumed in a field this great *army* took up its march—some in search of comfortable quarters where they might repose from their labors, others on a foraging expedition replenish the means of their subsistence. They first took shelter in the first leaf they met with, but generally they proceeded as far as the fence, a barrier beyond which they never traveled, where they found a plentiful supply of leaves in which they enveloped themselves. The second

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division extended their march much farther, sometimes traveling half a mile from the point whence they started, perishing by cart-loads for the want of food and the many casualties to which their journey subjected them, such as carriage-wheels, heat of the sun, and the rapacity of birds.

Here, then, it would appear was an end of the cotton-worm for a season at least, for those which yet remain in chrysalis in the fence-corners will change to the fly in ten days. But where are now the cotton leaves upon which the pregnant female is to deposit her eggs? There is not one left. If they are placed on any other leaf the eggs may hatch, but the worm must perish, as we have just seen them perishing by myriads while wending their way through a various and luxuriant herbage in search of that food intended for them by nature. In ten days from the time that the worm becomes a chrysalis on the borders of the cotton fields a host of flies are seen issuing therefrom; they go forth in search of food for their forthcoming progeny. Now it is to be found their days are numbered; in ten more, if they meet with no cotton leaves, they themselves must die, and thus put an end to the whole race. But their search is continued, and now when the weary insect is ready to finish its term of days, a tender but sparse foliage crowns the leafless twigs of the cotton plant; on them the eggs are deposited; they hatch, the worm eats, returns again to its chrysalis. The cotton stalk still puts forth new leaves, they grow and expand until the fields again look green; ten days, aye, forty, elapse, yet there is not a worm to be found. One would have thought that this second crop of leaves would scarcely have been sufficient for a single repast for them, yet the food that they so lately devoured with such voraciousness is now left untouched. What is the matter? Why don't they eat; their food is spread before them? Read on, the answer will be found in the sequel. Let us examine the cause. In nearly every fourth leaf we find a chrysalis writhing and contorting itself at the touch. Ah, here is the explanation of the difficulty, this is no ten days' chrysalis, but that in which it is to hibernate, possibly for one winter, perchance for twenty. Let us take a pocketful of these home and place them beneath tumblers, and wait patiently to see what they will produce. If I had found a treasure my delight could not have been greater than that I experienced at the idea of unraveling this mystery. But man is prone to disappointment, as we shall soon see. About the 15th of November the insect appeared, but, *mirabile dictu*, as different from the cotton-fly as it is possible to suppose one insect could differ from another. It belonged altogether to a different family, a description of which I give as follows:

Now, it is evident from its specific character, as well as from its parasitic nature, this insect belongs to that numerous class called *ichneumons*, of which there are upwards of five hundred species. As I am not at present in possession of any practical work on entomology, I cannot determine the species of this ichneumon; but to show that it differs in some respects from the family to which it belongs, I will quote a paragraph from a work before me, in which are set forth some peculiarities belonging to that class of insects as a genus:

"The whole of this singular genus have been denominated parasitical, on account of the very extraordinary manner in which they provide for the future support of their young. The fly feeds on the honey of flowers, and, when about to lay her eggs, perforates the body of some other insect, or its larvæ with its sting or instrument at the end of the abdomen, and then deposits them. The eggs in a few days hatch, and the young larvæ, which resemble minute white maggots, nourish themselves with the juices of the foster parent, which, however, continues to move about and feed until near the time of its changing into a chrysalis, when the larvæ of the ichneumon creep out by perforating the skin in various places, and, each spinning itself up in a small oval silken case, changes into a chrysalis, and after a certain period they emerge in the state of complete ichneumons."

It will be seen that there is a peculiarity attached to this ichneumon not included in the above description: that of appropriating the chrysalis as well as the larvæ of other insects to the use of their young. All ichneumons that I ever read of spin their own chrysalis, but this is the prince of parasites, for not content with eating the

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substance of his neighbor, he seizes also on his house. So far as I have read concerning this curious family of insects, this is a nondescript. As an example of these insects called ichneumons, I may mention the *Ichneumon seductor*, or dirt-dauber, well known to everybody as that wasp-like insect which builds its clay houses on the walls, and particularly in the recesses of windows, to the great annoyance of the tidy housewife.

Thus is answered the question why the cotton-fly did not again eat up the scant foliage which subsequently appeared on the stalks. This little usurper goes forth in search of whom he may devour, and as soon as he finds a house built and well provisioned, he seizes upon it for his posterity, which he does in the following manner: When he finds a cotton-worm, he pierces it with the instrument with which its tail is armed, and deposits an egg; the cotton-worm soon spins itself up into its case, there to await the period of its perfection, which never arrives, for soon the egg of the ichneumon hatches, and falls to devouring his helpless companion. This work of extermination continues until there is not a vestige of the cotton-fly left. I venture to say, while I am now writing (1st of December), there is not an egg, chrysalis, or fly in the confines of the United States.

My speculations on the nature and habits of the fly have led me to adopt the following hypothesis: That it is a native of tropical climates, and never can pass a single winter beyond them, consequently never can become naturalized in the United States, or anywhere else where the cotton plant is not perennial, for nature has made no provision by which they can survive more than ten or twelve days; therefore they must perish wherever the cotton plant perishes during a period of six months. That wherever they have prevailed in our cotton-growing regions, it is when they have become very numerous, and consumed all the cotton in their native climes, and then go in search of their food in more northern climates. It is not to be presumed that this happens often, but the same remark will hold in regard to the cotton-fly as it will to many other insects, that owing to some unknown cause they become exceedingly numerous, but at long and irregular intervals. The locust has already been noticed as an example, and many more might be cited. I, however, will mention another to which I was an eye-witness. About eighteen years ago the *green* or *blow fly* became so numerous that thousands of animals perished by them, also some human beings. The least spot of blood, the moisture of the mouth, eyes, or nose, was sufficient to cause a deposit of eggs. Sick persons, particularly those who had not proper attention, suffered. Several negro children who came under my notice fell a sacrifice to them, and it was with difficulty that many others were saved. In these instances the fly deposited the eggs within the nostrils, where they soon caused death by producing inflammation of the brain. This fly is annual, and scarcely ever deposits its eggs on an animal, except it be the victim of a running sore, but at the period alluded to above it appeared that there was scarcely animal flesh enough to feed the maggots of this numerous host. It is but once within my recollection that I have witnessed this phenomenon, and neither before nor since have I heard of such ravages of the green fly. Why they should have existed in such incredible numbers at the time referred to is a question not to be easily answered

There are three circumstances upon which I found my arguments in support of my hypothesis of the cotton-fly: First. Nature has made no provision by which it could survive the winter season. Second. The irregularity of their appearance. Third. Their progress from south to north and from west to east.

It may be remarked on proposition first, that all insects included within the genus *phalena* hibernate in the state of a chrysalis, therefore it is utterly impossible for the cotton-fly to hibernate in that manner, as they remain but ten days in chrysalis. The fly does not hibernate, for the period of their existence is but ten or twelve days. It cannot be in the state of the egg, for it is a law equally inflexible with regard to this tribe, that the egg must be deposited on the leaf on which the larvæ are to feed, and the reason is very plain, for these larvæ, when first hatched, are minute living

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points of an exceedingly helpless nature, almost devoid of locomotion, or possessing it in too small a degree to enable it to go in search of food. But let us suppose that the egg does not survive the winter; how does it happen that when the worm first makes its appearance it is found on the very summits of the cotton instead of the lower branch? parts that it would reach the soonest if it proceeded from the ground upwards.

The *phalena mori*, or silkworm, is an insect of the same genus as the cotton-fly, and whose habitudes are very much the same as the latter, tropical in its nature, confining itself to a particular vegetable, the different species of mulberry, and being short-lived in the chrysalis, remaining in this state but fifteen days. At the approach of winter, when the mulberry trees cast their leaves and remain leafless for many months, these insects, in our climate, would all perish, were they left to themselves. But art in this respect has triumphed over nature, for the silk-grower at a certain season gathers a parcel of eggs and places them in a cold dark place until the mulberry tree shall again afford them food in the spring, and in this manner they are perpetuated, and this is the only possible way that they could be preserved here; they are like some tender exotic, which flourishes as long as the warmth of the hot-house affords it a congenial atmosphere, but perishes if left to buffet the rigors of winter.

Proposition second: Here I contend that when an insect is a native of or naturalized in any country they are always governed by some invariable laws which determine their appearance. The grasshopper is annual, coming every spring or summer; the locust of our climate septem-decennial, appearing once in seventeen years; but the cotton-fly has no regular periods of return, showing that when it reaches our climate it is by some casualty.

In proposition third, I maintain that if the cotton-fly sojourned here during the winter or winters, when it did appear at all it would do so simultaneously through the whole cotton district, instead of which we see it progressing regularly from south to north and from west to east.

Such are the speculations that I have entertained concerning the cotton-worm, from which I conclude that it originates in South America, and reaches us through Mexico, and never can become a denizen of our soil.

Dr. Gorham's article excited considerable interest. It was republished in several prominent Southern journals, and elicited a number of answers. We have been able to find no evidence, however, that the theory was accepted at that time by any writer on the subject.

Seven years later (March 17, 1853) a communication from Dr. W. I. Burnett, entitled "The Cotton-worm of the Southern States," was read before the Boston Society of Natural History.* In this communication the theory of migrations was again proposed. In this instance the theorist evidently based his conclusions on a small amount of evidence, as is shown by the first paragraph of the following quotation, and the statement in the third paragraph that he had seen the insect only in the larva state. We quote Dr. Burnett's paper entire:

During the past winter I have been collecting materials for the history of that most devastating of American insects, the cotton-worm. In this I have been aided and favored by several intelligent Southern planters, whose severe losses from the ravages of this animal have made them keenly alive to many of its habits and modes of life. Of these gentlemen, I am particularly indebted to Mr. Robert Chisolm, of Palmetto Hall, Beaufort, S. C., an intelligent and extensive cotton planter, who has with much care watched the economy of this insect during several of its later appearances. He has sent me several communications, from which, together with an examination of the

* Published in 1854, Proc. Boston Soc. Nat. Hist., iv, p. 316.

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larval specimens with which they were accompanied, I have been able to prepare the following account:

This insect appears to be but little known in science, although the injury to property which it causes is perhaps greater and more deplorable than that occasioned by any other with which we are acquainted. On the years of its appearance, the entire cotton crop of certain districts is often cut short, and in not a few instances single plantations have suffered to the amount of from ten to fifteen thousand dollars.

It is one of the span-worms or *Geometridae*, belonging to the same family of insects as the canker-worm, which is so much feared by horticulturists of the North.

I have as yet only seen the larva. It is not indigenous to the Southern States, and there is no evidence that it can live naturally north of the shores of Texas. Most probably it is a native of Brazil or some other equatorial climate in that vicinity, for it is so sensitive to the cold as to quickly die in an atmosphere even approaching the freezing point. It appears, then, on the Southern cotton fields always as in migration, coming suddenly like a foreign enemy and always selecting the most thrifty plantations. It is very remarkable, therefore, that it should appear regularly at intervals of every three years in the same districts, striking first the seaboard and progressing gradually inland as circumstances may favor. But equally remarkable in this connection is the fact that its most extensive and deplorable ravages occur always after intervals of twenty-one years, or every seventh time of its advent, as shown in the years 1804, 1825, and 1846 during the last half century. These facts are inexplicable, unless referable to some peculiar conditions of their economy in their native land. Little is known from what southern direction they come, for, like all insects of this family their movements are made at night, and the seaboard planter often rises in the morning to find whole sections of his plantations covered with the adult insects busily engaged in depositing their eggs on the tender leaves of the cotton. There is, however, no regularity in the exact month of their coming, for Mr. Chisolm says that on his plantations they came in 1840 quite early, but in 1843 much later, and remained until frost; in 1846, in June, and in 1849 and 1852 in August.

The cotton-caterpillar is nearly always accompanied directly by another insect, called the boll-worm (probably one of the *Noctuidae*), which confines its attacks to the immature lint and seeds of the green pods of the short-stapled variety of cotton; and, as short cotton is mostly cultivated in sections farther south than those of the long-stapled variety, this boll-worm is generally seen in Texas and Mississippi six weeks or so before the cotton-caterpillar proper appears on the coast of Georgia and South Carolina. Little is known of its habits more than this; for its ravages are comparatively so inconsiderable that it attracts scarcely any attention of the planter. Its concomitancy with the true cotton-worm, however, is not a little remarkable, and there is no doubt that it belongs to a different family of insects.

The cotton-insect having made its appearance, shows considerable sagacity in always seeking first the most luxuriant fields. The eggs, which are of a dull white color, are deposited singly, or at most in twos, on the under surface of the most tender leaves. Their period of incubation is quite short, being six or seven days, and the time of hatching is always after sunset or in the night. They then begin to feed ravenously, and grow in proportion, their attacks being always confined to the long-stapled variety when accessible, though, when hard pushed, they will eat the short variety; but never anything else; and if their numbers are disproportionate in excess to the cotton at hand, they will die of starvation rather than touch any other vegetable.

During their caterpillar state they are almost wholly unaffected by all changes in the weather, excepting cold; for the heaviest rains and the severest gales of wind do not stay their movements or prevent in the least their devastations. Mr. Chisolm says that a very violent hurricane of two or three hours' duration, which swept over his plantations in August last, made no impression whatever on their progress. If, however, there occurs even a slight frost they are killed throughout. These circumstances are worthy of mention, as bearing upon their probable tropical origin. Their

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larval state is of about ten days' duration, and, during this time, they moult two or three times, changing their colors and general appearance in the same singular manner as the canker-worm of the North. The caterpillar, when full-grown and well fed, is sixteen legged, of the size of a common crow-quill, and from an inch and a quarter to an inch and a half in length. It has a reddish head, is whitish below, and brownish black above; on each side are two longitudinal, wavy white lines, and another straight on the middle of the back. When ready to wind up they swing down from the cotton plant, and, without any choice, take up indifferently with the nearest objects, on which they may rest during this process. Their chrysalid state continues about twelve days; the moths then appear and immediately go about depositing their eggs, after which they die. This perfect state lasts only four or five days. Such is the routine of their reproduction. When they appear early in the season, there are usually three broods; but some years they come so late that only a single new generation is seen. In either case the last brood almost invariably perishes throughout, being either killed instantly by the frost or dying from starvation, having eaten all the cotton before their transformations take place. It follows, therefore, that these ravaging insects as they appear in the cotton fields of the South do so at the loss of that portion of their race, for they leave no progeny behind them. At the same time this condition of things makes the matter the more deplorable for the planter, for, as he has to contend with a suddenly invading foe from foreign parts, he is rendered wholly powerless in averting this regularly periodical destruction of property.

Dr. Burnett's statement of the theory, being published in a purely scientific journal of limited circulation in the South, seems to have failed to attract much attention, as we have been unable to find it mentioned in any of the agricultural journals of that time. Neither do we find any reference to a theory of migrations until nearly twenty years later, when Mr. A. R. Grote, in an article in the Rural Carolinian for November, 1871, incidentally made the following statement:

The question with us has been, where does the first brood come from? The November chrysalises all became moths during warmer days, or were finally destroyed by frost or the process of cultivation. On sunny winter days a few of the hibernating moths were seen about fodder stalks. But before the young cotton was large enough to furnish food in the next spring, our cotton-worm had entirely disappeared, nor could we find it in any stage. We always hear of it southwardly from us. We know that the southerly winds bring the moth. Indeed, Professor Packard writes us that he has found the moth as far north as the coast of Massachusetts. Out of sight of land off Charleston we ourselves have seen numbers of cut-worm moths flying about the ship, blown from the shore.

It was not, however, until August, 1874, at the Hartford meeting of the American Association for the Advancement of Science, that Mr. Grote put forth the theory in a definite form. Mr. Grote's conclusions were based upon observations made during a residence of several years in Central Alabama, and were published, like those of his predecessors, without any knowledge of earlier writings on the subject. We see here the strange phenomenon of a scientific theory being independently developed and proposed four times in a little more than a quarter of a century.

We will quote only that part of Mr. Grote's paper which refers to this theory:

It is the object of the present paper to throw, happily, some light on the biography of the cotton-worm as it occurs in the Southern States, and in so doing I think it will

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become apparent that Prof. C. V. Riley has regarded the same subject from an erroneous stand-point, having considered the cotton-worm as belonging to our fauna, and accordingly misunderstood its economy as displayed with us and far from its natural abode. And here, while I am obliged to differ on a scientific question with Professor Riley, I bear willing testimony to the great good achieved by the publication of the Missouri Reports.

The *Aletia argillacea*, or cotton-worm, is an insect belonging to the Noctuæ, a group of nocturnal moths. It is one of a number of intertropical or Southern forms, somewhat nearly allied to our more thickly-scaled and Northern genus *Plusia*. The caterpillar is a "half-looper," to use a common term, and the chrysalis is held within an exceedingly loose web on the plant, the few threads usually binding over the edge of the leaf, and of themselves furnishing no adequate protection to the pupa. (I here exhibit to the association specimens of the larva, pupa, and moth of Aletia.) Technical descriptions of the different stages are already extant, and so may be passed over here. The more immediate question for our solution is the consecutive history of the insect, so that we may be prepared to offer suggestions to the agriculturists for its destruction.

The region over which, during five seasons, I have observed the cotton-worm, embraces the central portion of the cotton belt in the States of Georgia and Alabama, and in particular the counties of Marengo and Greene, lying along the Tombigbee and Black Warrior Rivers. There cotton is planted in March and April, blooms in June and July, and perishes in November or with the frost. The earliest period at which I have noticed the young worm was the last week in June, and its usual appearance was in July, sometimes as late as the latter part of the month. Its date of appearance was irregular, and never accurately coincided in any two seasons. Sometimes it seemed as though we were "*not going to have any worm at all this year*," a remark suggested by hope and the tardiness of its advent. My observations have been mainly directed to the question of the origination of the first brood, and have led me to record the following results: I have observed that the appearance of the worm in the fields was always heralded by flights of the moth, which came to light in houses at least a week before the worm was noticed on the plants. I have observed that the distribution of the first brood was irregular, the worms occurring here and there over miles of country, while infesting some plantations, skipping unaccountably others, which the second brood, however, seldom failed to reach. I have noticed that the worm was always heard of to the southward at first, and never to the northward, of any given locality in the cotton belt. Finally, after diligent search, no traces of the insect in any stage could be found by me during the months *preceding* the appearance of the first brood heralded by the moth, and *after* the cotton was above the ground. The broods themselves were consecutive and without interruption so long as the conditions were favorable. The last brood, in years where the worm was numerous, eat up every portion of the plant that was at all soft, flowers, the persistent calyx, the very young ball, the terminal shoots. The last brood of worms changed into chrysalides in myriads on the leafless stems, clinging by their few threads as best they might, and disclosed the moth in the face of the frost, many of the chrysalides perishing. Afterwards, on sunny winter days, I have noticed the live moth about gin-houses and fodder stacks, or the negro quarters. Was this a true "hibernation," or merely an accidental survival? The locality and the condition seem to me alike artificial.

Now, Hübner describes the moth of the cotton-worm at first as from Bahia. Sufficient testimony to the identity of our insect with one destructive to the West Indian, Mexican, and Brazilian perennial cotton is at hand, and the fact is established. In a classificatory point of view the affinities of the cotton-worm are with Southern rather than Northern forms of its family, as I have already pointed out. The conclusion to which I have come with regard to the cotton-worm is *that it dies out every year (with its food plant), that it occurs in the cotton belt of the Southern States, and that its next appearance is the result of immigration*. Testimony is at hand to show that for many years

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after the cultivation of the cotton plant was introduced into the Southern States, the cotton-worm never appeared. The date at which it first appeared in central Alabama has been differently stated to me, but it evidently but little preceded the late war. That the moth is capable of sustaining long and extended flight is readily proven. Professor Packard observed the moth off the coast of the Eastern States, as also Mr. Burgess. I have observed the moth in October in Buffalo, N. Y., as also Dr. Harvey. According to Mr. Riley the moth has been observed in Chicago, I presume in the fall. It seems that the moth follows the coast-line northward, as also the water-courses that empty into the Gulf of Mexico. It is noteworthy here that the water-shed of the Ohio and Mississippi extends to within fifty miles of Buffalo. As an example of the prolonged flight of moths, I will state that I have observed in the Gulf Stream, off the Carolinas, and out of sight of land, in the month of August, large numbers of a moth, the *Agrotis annexa* of Treitschke.

Again, I have been struck by the absence of parasitic checks to the cotton-worm in the South. I could never discover any, although such may exist. Spreading, as I believe it to do, as a moth, the absence of peculiar parasites to the worm may be reasonably accounted for. I have already and elsewhere pointed out, that in order to make the first brood of the cotton-worm the progeny of the so-called "hibernating" individuals (as Professor Riley would suppose), a period of several months had to be accounted for, since these "hibernating" moths could not wait till midsummer to deposit their eggs; and while the cotton is young, and even before it is up, insect life is active, and the weather is warm and other vegetation fully out in the region of the South where I have lived. There is also no reason to believe that the cotton-worm ever breeds in the North, and this, notwithstanding Professor Riley's suggestions to the contrary in the sixth report before mentioned. The worm never has been noticed on any other plant than the cotton, and in the South perishes by thousands rather than eat any other. The habit of wandering in masses when food fails is a proof of this, as while the worm is supplied with cotton-leaf it never quits the plant, transforming to the chrysalis on the stalk which has furnished it nutriment. The wandering habit is not normal, but accidental, and the worm is not "gregarious" like the "tent caterpillar." Its "hibernation" with us must also be regarded as accidental, or at least as barren of results. For when springs comes the *Aletia argillacea* has vanished, and is not found with the hibernating species of Lepidoptera renewedly active. And if it *were* found in February and March, it would find no cotton plants upon which to deposit its eggs. If oviposition ever takes place in these months in the cotton belt, the young cotton, free from worms, disproves its efficacy.

It is possible that in the southern portions of Texas, or the Floridian peninsula, the Aletia may sustain itself during the entire year; I have no means of information on this point. My observations are made on its occurrence over the central and principal portions of the cotton belt, and into which I believe it to be imported *de novo* every season that it there occurs and from more southern regions. I conclude, therefore, that while the cotton plant is not indigenous to the Southern States (where it becomes an annual), the cotton-worm moth may be considered not a denizen, but a visitant, brought by various causes to breed in a strange region, and that it naturally dies out with us in the cotton belt, unable to suit itself *as yet* to the altered economy of its food-plant and to contend with the changes of our seasons. When this fact is comprehended it will simplify the process of artificial extermination by limiting the period during which we can successfully attack the cotton-worm, and by doing away with a certain class of proposed remedies. From the foregoing it will be evident that, 1, the artificial agent employed to destroy the cotton-worm must be employed against the first brood as it appears in any given locality during the progression of the moth northward; and, 2, that in order to be effectual, a concerted action in the application of the remedial agent in any given locality will be found necessary.

Before entering upon any discussion of the theory of migration let us examine the data upon which the theorists have based their conclusions.

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Respecting Mr. Affleck's statements, there is but little to be said except in praise of the accuracy of his observations. Had there been in the South many observers of insects as careful as he was, the mooted points respecting the life history of the cotton-worm would have been cleared up long ago. His observations are of peculiar interest to us, when we remember that he was not a professional naturalist, but simply a very industrious and observing planter, who did all he could to advance the best methods of agriculture.

Mr. Affleck observed that while this insect remained only eight or nine days in the pupa state during the summer, as the season advanced it underwent its transformations much more slowly, and he very naturally concluded that the species hibernated as a pupa. But after trying experiments upon pupae, and observing the moths flying during the winter, he changed his views, and published in his almanac for 1851 his belief that the species hibernated as a moth. Although Mr. Affleck does not state distinctly the reasons for his belief that the moths "are not unfrequently brought on a gale of wind from the West Indies, Mexico, or the coast of Guiana," a careful study of his paper leads us to infer that he believed that during warm winters the moths emerged prematurely and were all destroyed by the cold; and that following such winters the worms were unusually late in making their appearance, their presence being dependent upon an influx of moths from regions farther south. It is an interesting fact, in this connection, that many planters have a theory just the opposite of this. They believe that as the insect was originally a tropical one it is unable to endure unusually severe winters; and they state that the seasons following such winters are not likely to be marked by extensive ravages of this pest.

In Dr. Gorham's article we find abundant meterial, if it were reliable, for the complete establishment of the theory of migrations. First, as to the "periods of this insect." Although there are many instances of a locality escaping severe ravages of this pest for many years, still we find published accounts of its appearance in destructive numbers in some portion of the cotton belt every year since 1825, and of numerous instances prior to that date, though from insufficiency of records we cannot state positively that it occurred *every year* from the time of its first appearance in our country. Hence, even if it did entirely disappear from some portions of the cotton belt, it is not necessary to suppose that those sections have been restocked by immigrations from foreign countries, at least since 1825. The principal argument, however, upon which Dr. Gorham based his theory, was the supposition that *A. argillacea* never remains more than ten days in either pupa or adult state, and consequently could not survive the winter season. We have shown in Chapter III, that the length of time required for this insect to complete its transformations varies greatly; that it may remain a month in the pupa state; and that it is known to remain several months in the adult state. Dr. Gorham's illusions respecting those points furnish good evidence

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that he had not read Mr. Affleck's statement of the theory. Dr. Gorham had still another reason for his conclusions which was in itself sufficient to prove the theory. He collected pupæ late in the season, and finding that all of them were parasitized he concluded that the entire fall brood had been destroyed by parasites. From the description which Dr. Gorham published of the parasite, it is evident that it was *Pimpla conquisitor*. His account of its operations is very interesting, being, we believe, the first published notice of any parasite infesting the cotton-worm. And the fact that this Ichneumon infests the last brood of *A. argillacea* to a very great extent has been confirmed by the experience of the past year. Still many pupæ of this brood do escape; and we therefore infer that Dr. Gorham made his collections late in the season after the unparasitized individuals had emerged from the pupa state, and before the parasites themselves had completed their development.

The data upon which Dr. Burnett founded his theory were very insufficient. It is surprising that a man of his scientific attainments should have proposed a theory simply upon the statements of an untrained observer. For there is no evidence that Dr. Burnett ever studied the subject in the field; although, as we learn from the notice of his life, written by the late Professor Wyman,* he passed several winters in the South. Each of the three reasons which Dr. Burnett brings forward as proof of the truth of his theory has already been shown to be a mistaken idea. The insect, in the adult state at least, is not "so sensitive to the cold as to quickly die in an atmosphere even approaching the freezing-point." It does not appear only "at intervals of every three years." Neither does the pest appear first upon the seaboard and progress gradually inland.

In the case of Mr. Grote we find the first instance among those who have proposed the theory of migrations, of a writer who is both a trained entomologist of high standing, and one who based his conclusions on extended personal observations in the field. It is also worthy of note that Mr. Grote's researches were made in one of the localities which has suffered most from the ravages of the cotton-worm, and one in which, as we have already indicated, we believe the species to hibernate. For these reasons Mr. Grote's essay in particular should be carefully studied by one treating of the theory of migrations. Such study taken in connection with what is now known respecting the first appearance of the worms in the spring will, we believe, reveal the fact that Mr. Grote's observations were not made, as he supposed, upon the first brood, but upon the brood to which we have referred as the first crop, *i. e.* the second brood, or in some cases the third brood. The statement that "the earliest period at which I have noticed the young worm was the last week in June, and its usual appearance was in July, sometimes as late as the latter part of the month" is sufficient to prove this. For we

* Proc. Bost. Soc. Nat. Hist. V. 65.

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have shown in the chapter on Natural History that the first brood is developed in May, as soon as the cotton plants furnish sufficient food. And there is no doubt in our opinion that the moths, which Mr. Grote observed to be attracted to light in houses in June or July and which he supposed "heralded" the appearance of the first brood of worms, had been developed the same season in neighboring cotton fields. It will be remembered that all efforts to obtain moths in the early part of the past season failed, though the presence of full-grown worms on cotton in the latter part of May indicated that moths had visited the fields several weeks earlier. It is not strange that Mr. Grote failed to observe the larvae of the first brood; for, doubtless, he was led by the universal testimony of the planters to expect them at a much later season than that at which they occur. Moreover, it is not an easy task to find the larvae in May, even when a person is looking for them, they occur in such small numbers. Mr. Grote is also mistaken in supposing that worms are always reported southward of any given locality before they are found north of it; as a study of the past history shows, it has not been an uncommon thing for cotton-worms to be reported in Central Alabama earlier than in the southern part of the State. As to the supposed absence of parasitic checks we will simply refer to our remarks on Dr. Gorham's paper, and to the chapter on Natural Enemies, where the subject is discussed at length.

It seems to us that when we have weighed carefully the data upon which the theorists have based their conclusions, there remains but little reason for a discussion of the theory. All the supposed facts which have been brought forward to support it, with a single exception, have proven to be mistaken ideas. The moths are evidently capable of making long flights, as is shown by their occurrence in the autumn several hundred miles north of the latitude in which they can survive the winter. But this alone is not sufficient to prove the theory. It simply shows that did the moths occur in large numbers within an equal distance south of our territory we would be liable to suffer from incursions of the pest from those regions. But it remains to be proven that the presence of moths in our country is dependent upon such incursions. Mr. Schwarz has shown in his report* that there can have been no invasion of the moth from the Bahamas since 1866. And it can hardly be supposed that moths have come to us from the islands south of the Bahamas since that date, for in that case the latter islands would have been restocked with worms by some of the migrating individuals on the passage to this country. With regard to the possibility of receiving moths from Cuba, we find that, although cotton is indigenous there, very little is grown; and, too, there is no evidence of an excessive multiplication of the cotton-worm on the island. In a collection of insects injurious to cotton made by my friend Mr. B. W. Law, near Havana, not a specimen of Aletia was found. Hence we cannot believe that since the year 1866 our country has suffered to any great extent by immigrations of moths from the West Indies.

*Appendix I. Report of E. A. Schwarz.

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Certainly the presence of cotton-worms in Florida, Georgia, and Alabama cannot be dependent upon the incursion of moths from those islands, neither does it seem probable that swarms of moths come into those States annually from Mexico by way of Texas, Louisiana, and Mississippi. In the first place but little cotton is grown in the northern part of Mexico; secondly, the worms appear as early in Alabama, Georgia, and Florida as they do in Texas, which would not be the case if their presence were dependent upon flights of moths via the latter State.

Briefly, our conclusions are that although the adult Aletia may occasionally come into the Gulf States from regions farther south, the presence of the cotton-worm in those States is not dependent upon such immigrations.

INFLUENCE OF WINDS ON IMMIGRATION OF MOTHS.

In the course of the present investigation considerable attention has been given to a study of the winds of the Southern States as bearing on the theory of migrations of the moths. The results of this study are quite important. For, although there is no doubt that the moths survive the winter in all of the Gulf States, it is of interest to know if we are also subject to immigrations of this pest.

As to the question whether the winds from the south are sufficiently strong and constant to counteract the prevailing trade winds, which are toward the equator, the opinions of correspondents differ widely. In some instances the question has not been fully understood, the replies being found too unintelligible to use as evidence either way. As a brief summary of opinions, however, it may be stated that 60 per cent. of the replies affirm that the south winds are sufficiently strong to counteract the trade winds, 28 per cent. are in the negative, with 5 per cent. of doubtful answers. Some of the statements are made most positively, and seem almost convincing in regard to migration of the moths. Mr. E. M. Thompson, of Jefferson, Ga., mentions that strange birds and fowls, foreign to the climate, are found in his locality, blown and left there by southerly winds, and, from this circumstance, is of the opinion that the south winds are sufficiently constant and heavy to bring the moths from that direction.

The following extracts are given as examples of the replies under this heading:

Orangeburgh, Orangeburgh County, South Carolina.—During June, July, and August we have strong south wind, beginning about eight o'clock in the morning, and lasting until late at night, plenty strong enough to bring moths from a great distance.—[Paul S. Felder.

Crittenden's Mills, Ala.—I think we have [south winds strong enough to counteract the prevailing trade winds], as, during February and March, the winds blow down many trees here. The southern border of this county is within 50 miles of the Gulf of Mexico; hence we have *heavy Gulf winds.*—[J. C. Matthews.

Woodville, Wilkinson County, Mississippi.—Yes; beyond a doubt. Nearly every year—perhaps I should say every year—such winds occur.—[D. L. Phares.

Decaturville, Decatur County, Tennessee.—There are times when our south and southwest winds are strong enough to counteract any other.—[John McMillan.

Larissa Cherokee County, Texas.—There are [strong south winds] caused by the large

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surface of prairie in the State, which turn our northeast trade, or what would be such, to south, southeast, or southwest.—[William Barnes.

Millheim, Austin County, Texas.—In some years, the winds are sufficiently strong to have the effect [of counteracting the trade winds]. I have noticed that the strong winds from the south and southwest generally occur in a dry year.—[J. H. Kraucher.

Union Springs, Autauga, County, Alabama.—Trade winds have but little influence in this part of Alabama.—[J. R. Rodgers.

Jayville, Conecuh County, Alabama.—While I think the wind is often strong enough from the south to drive before it the caterpillar fly, I am not at all inclined to the opinion that they get here in that way, unless it be the fly of the army-worm.—[Andrew Jay.

Lake Saint John, Concordia Parish, Louisiana.—During March and April the prevailing wind is south and west, lasting sometimes a week, strong enough and lasting long enough to bring a moth from South America, I should think. I have no record of the wind, but if the moths are brought here by the wind, which I think they are, it is during the months of March, April, and May.—[H. B. Shaw.

Isabella, Worth County, Georgia.—Not often, only occasionally.—[Wm. A. Harris.

Burkeville, Lowndes County, Alabama.—South winds but seldom prevail for longer than 24 hours, occasionally two days with decided prevalence.—[P. T. Graves.

Enterprise, Clark County, Mississippi.—Rarely ever have strong winds from the south long at a time.—[W. Speillman.

Dennison's Landing, Perry County, Tennessee.—I cannot remember to have observed winds from the south sufficiently strong to have counteracted the prevailing trade winds toward the equator.—[A. W. Hunt, M. D.

Hempstead, Waller County, Texas.—Do not believe our winds are sufficiently strong or continuous to have any effect on the trade winds.—[S. P. Clark.

Mulberry, Autauga County, Alabama.—I can scarcely credit the suggestion that the wind is sufficiently strong and continuous from the south to have much influence on the transportation of the moth.—[C. W. Howard.

From these statements, even where they are given negatively, it will be seen that there are short periods of strong southerly winds in nearly every one of the cotton States. Upon the sea-coast the winds are of course stronger and more constant in their prevailing southerly direction than in the interior. The question then arises as to how many days will be required for the wind to blow—with force—in a given direction, to bring the moths from the nearest point to the southward of the United States at which they may be found.

As early as May, at Indianola, Tex., the winds are almost wholly southerly, and by reference to the weather-bureau records for that month it will be seen that an average velocity of 17 miles per hour is recorded for the five nights from the 15th to the 19th, inclusive; the exact point of the compass indicated being southeast. This is the highest velocity for southerly night winds at Indianola recorded for the month of May, 1873 (the *average* being but 9.5 for the entire 31 days), and probably as high as in any other month. The average for the nine stations in Georgia, Alabama, Mississippi, Louisiana, and Texas, for the three months, April, May, and June, 1873, is found to be but a fraction less than 6 miles per hour. How far then are we able to judge by general averages, when we consider that there are days of almost total calm, the force hardly reaching 1 or 2 miles per hour, and but few days when the velocity reaches 15 to 20 miles per hour? The question of

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migration, therefore, as affected by winds, is narrowed down to these two considerations:

1. Has a south or southerly breeze, with a velocity of 12 to 20 miles an hour, sufficient force to bring the cotton-worm moth from the "perennial cotton-fields?"

2. Would an occasional strong breeze of one, three, or five days' duration, at the rate of velocity given, allow a sufficient length of time for the moth to make its journey?

If these questions can be answered affirmatively, having in mind that the moths *are* moved by the winds within our own borders, we have a very strong argument in favor of the theory that the insects are brought to the cotton States from the southward at the beginning of the season, for the winds are almost constantly from the southward through the season when the moths would most likely take advantage of them. The ordinary low rate of velocity (for night winds) often increases to 12, 15, 18, or 22 miles per hour, and this force, with slight variation, occasionally continues for two or three, or even five days in succession. If, on the contrary, a higher velocity is required than the figures in the tables indicate, and for a longer duration of time than has been stated, the wind records prove that the destruction of 1873 was not occasioned by the progeny of moths that came across the Gulf of Mexico.

In the circular sent out by the Department of Agriculture, the correspondents were requested to furnish data upon the two points named—prevailing direction and velocity—for each month separately from February to June, and collectively from July until frost. Replies were received from over seventy localities in the cotton States, the greater majority from Georgia, Alabama, Mississippi, and Texas. As a whole, these observations bear evidence of reliability, though in some cases the question has been misunderstood, and two or three points of the compass indicated at once as the "prevailing" direction for the month. In view of this error in making up the returns it was found necessary, for the sake of approximate correctness, to tabulate all of the observations, and thus ascertain the prevailing direction by calculating the percentages for each point of the compass. The figures thus obtained cannot, of course, be relied upon as absolutely correct, as the replies are not given from actual records, or for a particular year, but as general observations. The reply of "variable," which occurs occasionally in the returns, necessarily alters the final figures in estimating the percentages of winds from the different points; still the results obtained agree very closely with the official figures, as ascertained from the records of the United States Signal Office.

As has been stated, the replies are principally from four of the Gulf States, though ten States are represented in the returns. The total number of answers for the different months amount to about four hundred. These observations are for day and not night winds. For convenience of tabulation, as well as to save unnecessary labor, but four "directions"

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are indicated in the tables, viz, northerly, to include northeast, north, and northwest; southerly, to include southeast, south, and southwest; and east and west. When south winds are mentioned or the letter S occurs, therefore, either due south, southeast, or southwest are to be understood.

From a study of the northerly and southerly winds, as given in these returns, we find that prevailing southerly winds occur in February in but two States, Alabama and Texas, in the ratios of 7 to 4, and 10 to 7, respectively. In Georgia the northerly winds prevail in the ratio of 7 to 4 in each State, while in the other States they are equal. In March northerly winds prevail only in North Carolina and Florida, while the northerly and southerly winds are equal in South Carolina and Georgia, and southerly winds prevail in the remaining States. For April, May, and June the prevailing direction is almost invariably southerly for all the States, with the exception of Florida and Tennessee, where they are about equal. In the Gulf States the percentages of southerly winds run very high, culminating in June. For the remainder of the year, until frost, the months have been considered as a whole, though a subsequent study of the weather-bureau returns shows that it would have been better to have considered them separately, as a decided change in direction, particularly in the Gulf States, takes place in September, so marked a change indeed that the records of north winds in September and October almost neutralize the high percentage of south winds in July and August.

The following tabulation of returns for the different months for the State of Alabama will illustrate the manner in which the questions are answered:

ALABAMA.

County.	Town.	February.	March.	April.
Autauga	Mulberry	N	E. and N	Variable.
Bullock	Union Springs	W	W. and N. W	
Greene	Forkland	N. and N. E	N. and N. E	N.
Hale	Green Springs	S. W. and S. E	S. E. and S. W	S. E.
Lowndes	Lowndesborough	E. and S	E. and S	E. and S.
Marengo	Faunsdale	S. E	S. E	S. E.
Montgomery	Pike Road	E. and S. E	E. and S. E	E. and S. E.
Do	Mount Meigs	Variable		S. W., variable.
Do	Snowdoun	S. E. to N. W	S. E. to N. W	S. W. to N. E.
Sumter	Gaston	S. & S. W., N. & N. W	S. E. & S., W. & N. W	S. E. and S.
Wilcox	Camden		E. and W	W. to N. E.
Dale	Crittenden's Mills	S., W., and S. W		W. and N. W.

County.	Town.	May.	June.	July till frost.
Autauga	Mulberry	Variable	Variable	Variable.
Bullock	Union Springs	S. and S. W	S. and S. W	W. and N. W.
Greene	Forkland	S	S	S. and S. W.
Hale	Green Springs	S. E. and S. W		
Lowndes	Lowndesborough			E. in fall.
Marengo	Faunsdale	S. E	S. E	S. E.
Montgomery	Pike Road	E. and S. E	E. and S. E	E. and S. E.
Do	Mount Meigs	Southerly		W. and southerly.
Do	Snowdoun	S. W. to N. E	Gentle S	S.
Sumter	Gaston	S. E. and S	S. and S. W	S. and W., variable.
Wilcox	Camden	S. to N. E	S. to N. E	N. W.
Dale	Crittenden's Mills	S. and W	S. and W	W. and N. W.

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The following table gives the prevailing direction in each of the ten States for the months indicated, as compiled from the returns, with the ratio of northerly to southerly winds for each:

States.	February.		March.		April.	
	Direction.	Ratio N. to S. winds.	Direction.	Ratio N. to S. winds.	Direction.	Ratio N. to S. winds.
North Carolina	—*	—	N.	0†	N.	2 to 1
South Carolina	—	—	—	—	—	—
Georgia	N.	5 to 2	—	—	S.	3 to 4
Florida	N.	0	N.	2 to 1	—	—
Alabama	S.	4 to 7	S.	5 to 6	S.	4 to 7
Mississippi	N.	7 to 4	S.	3 to 6	S.	1 to 7
Louisiana	......	......	S.	0	S.	0
Texas	S.	7 to 10	S.	2 to 8	S.	0
Arkansas	—	—	S.	1 to 3	S.	0
Tennessee	S.	1 to 2	......	......	—	—

States.	May.		June.		July till frost.	
	Direction.	Ratio N. to S. winds.	Direction.	Ratio N. to S. winds.	Direction.	Ratio N. to S. winds.
North Carolina	S.	0	S.	0	S.	0
South Carolina	S.	0	S.	0	S.	0
Georgia	S.	2 to 6	S.	1 to 6	S.	5 to 7
Florida	—	—	S.	0	S.	1 to 2
Alabama	S.	2 to 10	S.	0	S.	8 to 11
Mississippi	S.	1 to 7	S.	0	S.	1 to 7
Louisiana	......	......	......	......	......	......
Texas	S.	0	S.	0	S.	1 to 10
Arkansas	S.	0	S.	0	S.	0
Tennessee	—	—	S.	0	S.	1 to 2

*A dash signifies that the northerly and southerly winds for the month are about equal.
† Returns meager, and no southerly or northerly winds recorded, as the case may be.

As a brief summary of the information contained in the department returns, in relation to direction, the following figures are given, showing the prevailing direction of the winds for the cotton States, as a whole, with the percentages of winds in each point of the compass for the months named. The percentages are estimated per hundred observations:

Prevailing direction.	February.	March.	April.	May.	June.	July till frost.
Northerly (N., N. E., and N. W)	40.2	31.7	21.5	12.9	2.2	22.9
East	11.2	14.3	10.7	11.2	6.6	10.8
Southerly (S., S. E., and S. W)	40.2	46.0	56.9	69.8	80.0	50.0
West	8.4	7.9	10.7	6.4	11.0	16.0

After the completion of the work on these returns it was thought advisable to verify the statements by records of actual daily observation, obtained from the Weather Bureau of the War Department, and at the same time to make the report more valuable by taking into account, at the same time, the velocity of the winds, which has hardly been considered in the department returns, or indicated in too vague a manner to be reduced to figures for tabulation.

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The tri-daily records for the year 1873 were decided upon, as this was known to be a year in which the worm was particularly destructive, and thirteen stations were selected, in South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas, and Tennessee, from which to obtain the necessary data. As the moths are nocturnal in habits, the night winds only were considered, and the record of 11 o'clock p. m. for each day of the nine months, from February to October, were tabulated, making, in all, between four and five thousand daily records. From the interesting data thus obtained a number of tables have been prepared, which confirm the previous statement. In studying the tables of velocity, it will be noted that the figures are very low in some cases, and it must be borne in mind that the records are for night winds, which are always lighter than the winds occurring in the day-time, unless when preceding or accompanying storms. The storm winds, generally speaking, are from other points of the compass than south.

The calms have also been considered the records for furnishing interesting data for study in connection with the subject of this chapter. Twenty-five days (nights) of calm in July, and twenty-seven days in August, in Augusta, Ga., would not assist the moths in their migrations in that locality to any alarming degree. It is worthy of remark, however, that Augusta is an exception to the other stations in this matter of calms.

The records for Texas, made at Indianola and Galveston, should be corrected slightly for inland localities, as the winds on the coast, and backward for a few miles, are more invariably southerly, and blow with greater force than higher up in the cotton regions. They are not far out of the way as indicating general direction, as can easily be verified by reference to inland stations in adjacent States. Key West, Fla., was particularly chosen from its maritime situation, and is an exception to all the other stations, the wind prevailing from the eastward for almost the entire nine months, as indicated in the tables, the prevailing direction in February and October being northerly. A study of wind records at various points on the West India Islands would prove interesting, and might throw considerable light upon the question under consideration.

The four following tables show the prevailing direction of winds at the sattions named for the months of February to October (inclusive), 1873, and the fifth contains a summary of the whole.

By reference to the first line of figures in Tables A and B for each station, the total number of northerly, east, southerly, or west winds, and number of days of calm for each month, will be found indicated by the word *direction.* In the second line is given the average velocity in miles per hour, expressed decimally, and in the two remaining lines the highest and lowest records of velocity during the month are stated. In some cases an apparent discrepancy may be noted between the number of days in the calendar month and the total number of days of recorded winds and calms, caused by the absence of observations, in some in-

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stances, in the printed records of the Weather Bureau from which these returns are made up.

Referring to the fifth table, we have an exhibit of the number of days of perceptible winds from all quarters (without considering calms); the prevailing direction for the month, and the percentage of prevailing winds, calculated from the totals of actual days of wind for the month, as above.

A study of these tables reveals the fact that the prevailing direction of the winds in the cotton States, as far as we are able to judge from the thirteen stations, is almost without exception southerly for six months of the year from March to August, ranging from 31 to 93 per cent. Further, that the prevailing direction for the remaining months—February, September, and October—is quite variable. During the month of February, however, southerly winds prevailed in Charleston, Savannah, Lake City, Vicksburg, New Orleans, Indianola, and Galveston. In Mobile the northerly and southerly winds were equal, and of the remaining five stations, three indicate a northerly direction, and one, each, east and west. For the month of September the winds are southerly at Shreveport, Indianola, and Galveston, east at Key West, and northerly at the remaining stations. The October winds at Vicksburg, Indianola, and Galveston are southerly; at New Orleans the southerly and northerly winds are equal, and in the remaining States the latter direction prevails. The highest percentage of northerly winds is 83 per cent. and the lowest 35 per cent.

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TABLE A.

Table showing number of days of northerly, east, southerly, and west winds, with highest, lowest, and average velocity in miles per hour, and calms indicated.*

FEBRUARY TO JUNE (INCLUSIVE), 1873.

Stations.	Direction and velocity in miles per hour.	February.					March.					April.					May.					June.				
		N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.
Charleston, S. C	Direction in days	5	2	9	7	4	8	1	13	4	5	3	2	20	3	2	6	4	18	2	1	3	5	17	4	1
	Average velocity in miles	7	3	8.5	9	0	9.5	8	8.6	7	0	7	14	5.5	5.8	0	8.5	10	6	4	0	11	13	7.3	5.5	0
	Highest velocity	14	4	18	20	—	17	8	16	16	—	9	20	16	6	—	15	18	20	4	—	16	16	12	8	—
	Lowest velocity	4	2	2	2	—	4	—	4	4	—	4	8	2	4	—	4	4	2	—	—	4	8	2	4	—
Augusta, Ga	Direction in days	3	1	3	8	13	2	0	10	4	15	1	0	5	4	20	5	5	8	4	9	5	2	8	2	13
	Average velocity in miles	11	8	4	5	—	6	0	5.8	8	—	4	0	6.5	8	—	9.3	4.2	4.5	8	—	6	4	4.5	4	—
	Highest velocity	16	8	4	12	—	8	—	18	12	—	4	—	12	12	—	8	8	8	12	—	10	4	8	4	—
	Lowest velocity	4	—	—	4	—	4	—	4	4	—	—	—	4	4	—	4	4	4	4	—	4	—	4	—	—
Savannah, Ga	Direction in days	4	2	10	6	6	8	0	13	4	6	4	1	16	5	4	4	3	18	1	5	6	2	14	3	5
	Average velocity in miles	9.5	5	11	7	—	7.5	0	6	4	—	4.5	8	6.7	4	—	7	7	5.5	12	—	8	7	3.1	3.6	—
	Highest velocity	20	8	16	16	—	16	—	12	4	—	6	8	12	5	—	16	12	12	12	—	16	12	6	5	—
	Lowest velocity	4	2	3	4	—	4	—	3	—	—	4	—	4	2	—	4	4	1	—	—	2	2	2	2	—
Key West, Fla	Direction in days	8	11	6	1	2	16	12	2	0	1	12	12	3	1	2	10	15	6	0	0	1	18	8	1	2
	Average velocity in miles	10	10	8.5	10	—	12	10	9	0	—	10	12	9	27	—	7.8	8.2	8	0	—	2	6.1	8	7	—
	Highest velocity	15	16	17	10	—	20	26	10	—	—	26	18	14	27	—	19	19	15	—	—	2	12	13	7	—
	Lowest velocity	5	5	1	—	—	3	4	8	—	—	2	6	6	—	—	2	3	3	—	—	—	2	3	—	—
Lake City, Fla	Direction in days	5	3	11	3	6	7	5	9	0	10	2	1	13	9	5	6	3	11	5	6	1	3	11	10	5
	Average velocity in miles	4.6	4	7	5	—	7	5.5	5	0	—	2.5	4	5.3	4.7	—	5.6	5.3	3.6	3.4	—	6	2.6	4.8	5.2	—
	Highest velocity	8	4	12	8	—	12	8	8	—	—	3	4	14	8	—	12	8	8	4	—	6	4	8	8	—
	Lowest velocity	4	—	2	2	—	4	4	4	—	—	2	—	2	2	—	2	4	2	2	—	—	1	2	4	—
Mobile, Ala	Direction in days	9	1	9	0	8	9	1	16	1	4	7	0	14	1	8	8	0	11	2	10	5	2	12	1	10
	Average velocity in miles	4.6	5	6	6	—	7	1	4	4	—	4	0	5.2	2	—	6	0	5.3	3	—	3.2	2.5	3	1	—
	Highest velocity	6	5	12	6	—	18	1	12	4	—	12	—	8	2	—	16	—	16	4	—	5	4	6	1	—
	Lowest velocity	1	—	1	—	—	1	—	1	—	—	1	—	2	—	—	2	—	1	2	—	1	1	1	—	—
Montgomery, Ala	Direction in days	12	3	9	0	4	9	1	13	1	7	1	0	16	4	9	3	3	18	1	6	3	3	15	0	9
	Average velocity in miles	5	2.6	3.6	0	—	5	2	3.8	2	—	8	0	3.6	2.2	—	3	8.3	3.5	1	—	2.3	4.6	3.3	0	—
	Highest velocity	12	4	14	—	—	12	2	6	2	—	8	—	6	5	—	7	10	8	1	—	4	5	14	—	—
	Lowest velocity	2	2	1	—	—	4	—	1	—	—	—	—	1	1	—	1	5	1	—	—	1	4	1	—	—

* N., N. E., and N. W. are called northerly, and S., S. E., and S. W. southerly.

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TABLE A—Continued.

Table showing number of days of northerly, east, southerly, and west winds, with highest, lowest, and average velocity in miles per hour, and calms indicated.*

FEBRUARY TO JUNE (INCLUSIVE), 1873.

Stations.	Direction and velocity in miles per hour.	February.					March.					April.					May.					June.				
		N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.
Vicksburg, Miss.	Direction in days	8	6	11	0	8	11	4	16	0	0	6	2	14	2	5	6	2	14	0	9	2	1	15	1	11
	Average velocity in miles	5.5	5.3	3.5	0	—	6	3.2	7	0	—	8	7	8.6	8	—	6	6	4.6	0	—	1.5	4	3.5	1	—
	Highest velocity	19	8	16	0	—	24	5	14	—	—	20	8	12	8	—	10	10	9	—	—	2	4	8	1	—
	Lowest velocity	1	3	2	0	—	1	1	2	—	—	2	6	4	—	—	1	2	2	—	—	1	—	1	—	—
New Orleans, La.	Direction in days	7	3	14	2	2	5	6	19	1	0	4	1	22	2	1	4	2	21	2	2	1	4	24	0	1
	Average velocity in miles	9.5	7	7.3	7	—	13	5	5.5	1	—	6	4	6.5	6	—	8.2	8.5	4.5	2	—	3	3	5	0	—
	Highest velocity	16	12	20	16	—	20	8	8	1	—	12	4	10	6	—	14	16	10	2	—	3	4	8	0	—
	Lowest velocity	4	4	3	1	—	4	2	2	—	—	3	—	3	—	—	3	1	1	—	—	—	2	2	0	—
Shreveport, La.	Direction in days	7	5	4	4	7	10	1	16	2	2	7	3	13	3	4	4	6	13	4	4	4	4	18	0	4
	Average velocity in miles	7.3	5	6	10	—	6.7	12	7.5	3	—	8	5.3	8.6	11	—	4	6.5	6.7	5.5	—	3	4.2	6	0	—
	Highest velocity	11	10	12	18	—	18	12	35	5	—	17	10	23	19	—	6	13	17	8	—	5	7	15	—	—
	Lowest velocity	2	2	2	2	—	2	—	1	1	—	2	2	2	4	—	2	4	2	5	—	1	1	2	—	—
Indianola, Tex.	Direction in days	8	4	14	2	0	7	3	20	1	0	8	0	22	0	0	3	5	23	0	0	1	0	28	1	0
	Average velocity in miles	20.5	6.5	10	8	—	20	9	5.6	1	—	21.5	0	9.7	0	—	11	19.5	9.2	0	—	12	0	7.2	4	—
	Highest velocity in miles	48	13	20	16	—	44	11	20	1	—	54	—	16	—	—	25	31	19	0	....	12	0	21	4	....
	Lowest velocity in miles	2	1	2	1	—	1	5	1	—	—	4	—	2	—	—	2	7	2	0	....	—	0	1	—	....
Galveston, Tex.	Direction in days	7	1	17	2	1	4	2	24	0	1	8	0	17	0	5	5	1	25	0	0	1	2	26	0	1
	Average velocity in miles	19.5	10	6.5	16	—	19.7	9	6.2	0	—	8.5	0	8.6	0	—	12.5	13	9.6	0	—	4	13	7.5	0	—
	Highest velocity	66	10	12	20	—	46	11	10	—	—	15	0	16	0	—	26	13	22	—	—	4	24	16	—	—
	Lowest velocity	6	—	1	12	—	6	7	2	—	—	3	0	1	0	—	3	—	4	—	—	—	2	4	—	—
Memphis, Tenn.	Direction in days	11	1	10	6	0	12	1	12	3	3	9	2	15	3	1	7	1	15	3	5	4	3	17	1	5
	Average velocity in miles	5.3	0	4.5	6.5	—	5.6	4	7.5	7.3	—	5	3.5	7	8.6	—	4	6	4.5	6	—	4	3	4.6	2	—
	Highest velocity	16	—	10	10	—	12	4	12	18	—	9	5	16	12	—	8	6	8	10	—	4	4	16	2	....
	Lowest velocity	1	—	2	4	—	1	—	4	2	—	1	2	1	6	—	1	—	1	4	—	—	1	1	—	....

*N., N. E., and N. W. are called northerly, and S., S. E., and S. W. southerly.

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TABLE B.

Table showing number of days of northerly, east, southerly, and west winds, with highest, lowest, and average velocity in miles per hour, and calms indicated.

JULY TO OCTOBER (INCLUSIVE), 1873.

Stations.	Direction and velocity in miles per hour.	July.					August.					September.					October.				
		N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.
Charleston, S. C.	Direction in days	0	6	20	0	5	2	4	19	4	2	15	8	11	0	1	16	1	6	3	5
	Average velocity in miles	0	10	6.3	0	—	6	5	5.5	4.5	—	9.6	3.3	6	0	—	7.6	2	4.6	4	—
	Highest velocity	—	12	16	0	—	8	8	8	6	—	16	4	12	0	—	16	2	10	4	—
	Lowest velocity	—	8	2	0	—	4	4	4	4	—	4	2	4	0	—	2	—	1	—	—
Augusta, Ga	Direction in days	1	1	4	0	25	0	1	2	1	27	9	2	2	3	14	5	0	1	2	23
	Average velocity in miles	4	4	4	0	—	0	8	4	8	—	4.5	4	4	5.3	—	4.5	0	4	8	—
	Highest velocity	4	4	4	0	—	0	8	4	8	—	8	4	4	8	—	8	0	4	8	—
	Lowest velocity	—	—	—	—	—	—	—	—	—	—	4	—	—	4	—	2	0	—	—	—
Savannah, Ga	Direction in days	3	1	17	1	9	3	3	18	0	7	12	2	9	1	6	16	1	8	1	5
	Average velocity in miles	6.6	8	4.5	4	—	3.6	3	5	0	—	9	3.5	5	2	—	5	3	5.5	12	—
	Highest velocity	8	8	16	4	—	4	4	8	—	—	18	4	8	2	—	16	3	8	12	—
	Lowest velocity	4	—	2	—	—	3	2	2	—	—	2	3	4	—	—	2	—	2	—	—
Key West, Fla	Direction in days	9	10	9	2	1	8	17	4	1	0	12	13	1	3	1	20	9	0	2	0
	Average velocity in miles	14.3	11.6	5.7	11	—	12.5	8.4	8	2	—	12.5	9.6	8	7	—	15.5	16.2	0	22	0
	Highest velocity	20	20	9	14	—	16	15	11	2	—	19	18	8	11	—	30	24	—	22	—
	Lowest velocity	6	7	3	8	—	4	4	4	—	—	6	3	—	3	—	2	2	—	—	—
Lake City, Fla	Direction in days	1	8	13	2	7	8	2	18	1	7	7	6	9	2	1	15	8	5	1	7
	Average velocity in miles	1	2.4	4	4	—	3	1	3.8	2	—	5.4	3	3.7	3	—	7.6	3	4	3	—
	Highest velocity	1	4	8	4	—	4	1	6	2	—	8	4	8	4	—	20	4	8	3	—
	Lowest velocity	—	2	3	—	—	2	—	2	—	—	3	1	1	2	—	1	2	2	—	—
Mobile, Ala	Direction in days	6	2	12	2	9	5	4	11	4	7	17	3	4	2	4	14	0	2	2	13
	Average velocity in miles	4	4	3	3.5	0	3.8	6.5	4.5	3.2	—	6.5	2.5	3.4	6	—	7.3	0	1.5	4.5	—
	Highest velocity	6	4	12	5	—	6	12	12	4	—	12	3	8	6	—	26	—	2	6	—
	Lowest velocity	2	—	1	2	—	2	4	2	2	—	2	2	1	—	—	1	—	1	3	—
Montgomery, Ala	Direction in days	1	2	13	0	15	1	3	5	1	21	11	5	5	0	9	9	2	5	2	12
	Average velocity in miles	1	10	3.7	0	—	1	1.6	2	1	—	3	3.6	2	0	—	6	4	5	2.5	0
	Highest velocity	1	10	8	—	—	1	2	4	1	—	8	4	4	—	—	16	4	12	4	—
	Lowest velocity	—	—	1	—	—	—	1	1	—	—	1	2	1	—	—	1	—	2	1	—

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TABLE B—Continued.

Table showing number of days of northerly, east, southerly, and west winds, with highest, lowest, and average velocity in miles per hour, and calms indicated.

JULY TO OCTOBER (INCLUSIVE), 1873.

Stations.	Direction and velocity in miles per hour.	July.					August.					September.					October.				
		N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm.	N.	E.	S.	W.	Calm	N.	E.	S.	W.	Calm.
Vicksburg, Miss.	Direction in days	4	0	12	0	15	2	3	7	0	19	10	6	5	0	9	5	3	8	1	4
	Average velocity in miles.	1.5	2	3.6	0	—	2	6	2.6	0	—	4.3	2.5	5	0	—	4.6	3.3	4.7	2	—
	Highest velocity	6	2	10	0	—	2	8	8	0	—	12	4	10	0	—	14	6	7	2	—
	Lowest velocity	2	—	2	0	—	—	2	1	0	—	1	1	1	0	—	1	2	3	—	—
New Orleans, La.	Direction in days	3	4	18	3	3	6	4	9	5	7	14	4	7	1	4	10	6	10	3	2
	Average velocity in miles	6	5.5	3.6	4	—	4	6.7	3.7	3.8	—	8.5	8.2	3.7	3	—	11	8	4.8	4	—
	Highest velocity	6	6	5	4	—	6	12	8	6	—	16	14	7	3	—	24	8	7	5	—
	Lowest velocity	4	5	1	—	—	1	3	1	2	—	2	4	2	—	—	2	1	1	2	—
Shreveport, La.	Direction in days	4	3	19	0	5	7	1	10	1	12	8	8	11	1	7	13	1	2	0	6
	Average velocity in miles.	4.7	5	6.5	0	—	2.4	5	3.9	2	—	5	5.3	5	5	—	5.5	5	4.3	0	—
	Highest velocity	8	5	18	0	—	7	5	10	2	—	8	6	12	5	—	14	5	8	0	—
	Lowest velocity	2	—	2	0	—	1	—	2	—	—	1	5	2	—	—	1	—	1	0	—
Indianola, Tex.	Direction in days	3	2	2.5	0	0	1	2	28	0	0	6	4	20	0	0	7	6	16	0	2
	Average velocity in miles.	9	17	8.5	0	—	16	9	8.5	0	—	23	14	9	0	—	22	15	8.6	0	—
	Highest velocity	12	22	14	0	—	16	10	12	0	—	28	16	16	0	—	28	18	10	0	—
	Lowest velocity	6	12	2	0	—	—	8	4	0	—	17	9	3	0	—	5	8	4	0	—
Galveston, Tex.	Direction in days	1	2	23	1	4	2	2	22	1	4	6	3	17	1	3	10	2	19	0	0
	Average velocity in miles.	12	9	6.9	2	—	6	3	4.6	4	—	12	8	9	7	—	13	5	7.6	0	—
	Highest velocity	12	11	14	2	—	7	5	10	4	—	16	10	20	7	—	28	8	18	0	—
	Lowest velocity	—	7	2	—	—	5	1	1	—	—	4	5	4	—	—	2	2	1	0	—
Memphis, Tenn.	Direction in days	8	1	18	1	3	15	2	9	0	5	17	0	7	1	5	17	1	9	1	3
	Average velocity in miles.	4	5	4	4	—	3	1.5	3.3	0	—	5	0	4.5	3	—	5.6	3	2.3	18	—
	Highest velocity	10	5	7	4	—	5	2	9	0	—	13	0	5	3	—	18	3	6	18	—
	Lowest velocity	1	—	2	—	......	1	1	1	0	—	2	0	4	—	—	1	—	1	—	—

TABLE C.

Table showing number of days of perceptible winds in each month (calms omitted), with the prevailing direction and percentage of days for the same.

Stations.		February.	March.	April.	May.	June.	July.	August.	September.	October.
Charleston, S. C	Number of days wind blew	23	26	28	30	20	26	29	29	26
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	N.	N.
	Percentage of days	37	50	71	60	58	76	65	51	61
Augusta, Ga	Number of days wind blew	15	16	10	22	17	6	4	16	8
	Prevailing direction	W.	S.	S.	S.	S.	S.	S.	N.	N.
	Percentage of days	53	62	50	81	47	66	50	56	63
Savannah, Ga	Number of days wind blew	22	25	26	26	25	22	24	24	26
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	N.	N.
	Percentage of days	45	56	61	69	56	77	75	52	61
Key West, Fla	Number of days wind blew	26	30	28	31	28	30	30	20	31
	Prevailing direction	E.	N.	N. & E. Equal.	E.	E.	E.	E.	E.	N.
	Percentage of days	42	53		48	64	33	56	47	64
Lake City, Fla	Number of days wind blew	22	21	25	25	25	24	24	24	24
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	S.	N.
	Percentage of days	50	42	52	44	44	54	75	37	62
Mobile, Ala	Number of days wind blew	19	27	22	21	20	22	24	26	18
	Prevailing direction	N. & S. Equal.	S.	S.	S.	S.	S.	S.	N.	N.
	Percentage of days		59	63	47	60	54	41	65	77
Montgomery, Ala	Number of days wind blew	24	24	21	25	21	16	10	21	18
	Prevailing direction	N.	S.	S.	S.	S.	S.	S.	N.	N.
	Percentage of days	50	54	76	72	71	81	50	52	50
Vicksburg, Miss	Number of days wind blew	25	31	24	22	19	16	12	21	17
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	N.	S.
	Percentage of days	44	54	56	63	79	75	58	47	47
New Orleans, La	Number of days wind blew	26	30	29	29	29	28	24	26	29
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	N.	N. & S. Equal.
	Percentage of days	53	61	75	72	82	64	83	53	
Shreveport, La	Number of days wind blew	20	29	26	27	26	26	19	23	16
	Prevailing direction	N.	S.	S.	S.	S.	S.	S.	S.	N.
	Percentage of days	35	55	50	48	75	73	52	47	81
Indianola, Tex	Number of days wind blew	28	31	30	31	30	31	31	30	29
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	S.	S.
	Percentage of days	50	64	73	74	93	83	90	66	55
Galveston, Tex	Number of days wind blew	27	30	25	31	29	27	27	27	31
	Prevailing direction	S.	S.	S.	S.	S.	S.	S.	S.	S.
	Percentage of days	63	80	68	80	89	83	81	63	61
Memphis, Tenn	Number of days wind blew	28	28	29	26	25	28	26	25	28
	Prevailing direction	N.	N. & S. Equal.	S.	S.	S.	S.	N.	N.	N.
	Percentage of days	40		51	57	68	64	57	63	61

CHAPTER V.

INFLUENCE OF WEATHER.

It seems curious that observers should be so divided in opinion as they are concerning so simple a point as whether a mild or a severe winter is the more apt to be followed by a bad worm season. Of the correspondents of the department, some hold one view, others the directly opposite opinion, while still others state that the degree of severity of the winter makes no difference whatever with the extent of the ravages the succeeding season. Those holding the last view base their opinion on the fact that they have actually known disastrous worm seasons to follow cold and warm winters indiscriminately.*

Those holding the opposing views referred to also claim to found their opinions upon actual experience. The advocates of the view that a severe winter will be followed by the worm give as their explanation the fact that during warm winters the moths come forth from their hibernating quarters and die of hunger, whereas while in winter quarters and in the true state of hibernating somnolency not only is no food necessary, but they are less exposed to dangers of all kinds which would assail them if they flew out, attracted by sunshiny weather. The upholders of the theory that warm winters are more apt to be followed by the worm simply urge the idea that the severity of the colder winters kills the hibernating individuals.

The truth of the matter, as it seems to us, is that, other things being equal, a warm winter is more favorable to hibernation than a cold one. It seems to be true that the cotton-moth was originally a tropical or subtropical insect, and that only in favored localities within the limits of the United States can it hibernate at all. As we go northward the winters become too severe for survival from one season to another. Farther south, then, winters approaching to this northern severity must be unfavorable, while winters approaching those of the normal habitat of the moth will prove favorable. This is reasoning in the abstract. Actual experience seems to show that occasionally the greatest worm years follow undoubtedly cold winters. This seems to have been the case with the season of 1873, in some parts of Alabama at least. Such instances we think, however, must be laid to a combination of other causes, working through a series of years; and that, instead of the severity of the preceding winter having been the sole cause, the ravages of the worms would have been even worse had a mild winter come before.

Another and more important point concerning the influence of weather, brought out by the 1878 circular, was,—do the worms flourish most in a

* This fact has been used as an argument for the migration theory.

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wet or dry season? In the answers to this question great unanimity was found. With but few exceptions, the general opinion seems to be that wet years are the most disastrous caterpillar years.

This fact (for such it undoubtedly is) has been always accounted for by the fact that wet weather produces a rank and succulent weed, of superior nourishing power to one dwarfed and dried by continued drought, and by the fact that in hot dry weather many worms are actually killed by the heat of the sun and by the oven-like heat of the earth when marching is attempted.

Another point, intimately connected with this last, is the one that the low, damp parts of a field are the ones where the worms always appear first in spring. This may be accounted for by the probable fact that on damp parts of a plantation the early cotton grows faster than on the drier parts; nectar is earlier secreted from the foliar glands; the hibernating moths are attracted by the nectar to that part of the field, and consequently more eggs are there laid.

Both of these facts have, however, been accounted for by a plausible theory, first publicly put forth by Mr. N. A. Davis, of Cherokee County, Texas, in 1866 or 1867. In a letter of recent date, Mr. Davis states his theory in the following words:

Hon. WM. G. LE DUC,
Commissioner of Agriculture:

DEAR SIR: Much has been said and written, and valuable time and money expended in study and experiments to learn the nature and to destroy that great enemy of the cotton planter of the South—the cotton-worm.

The most generally received opinion is that *wet* seasons *produce* the worm, and *warm dry* seasons kill them. The caterpillar makes its appearance in the warmest climates and at the hottest season of the year, and the warmer the climate and the hotter the season the greater their thrift and multiplication. If they appear in May it will in this latitude require at least 32 days to pass through all their different stages; but from July 1 to September 15 not more that 28 days are necessary.

That wet seasons are favorable to their *protection* and multiplication we will not deny; but it is from other causes.

My observations, beginning in 1866, have fully satisfied me of the fallacy of the above theories and as thoroughly convinced me of the fact that the *Formica* (little red ant) is the great *friend* and *protector* of the cotton planter of the South. They are found by the million in almost every spot of land on which the cotton plant is grown over the regions of country liable to the ravages of the worm. In other portions of the South not infested by the worm I have noticed this ant in but limited numbers, showing the wisdom and goodness of the Divine Distributor for our good. Herewith I forward you specimen ant.

When the weather is favorable all the day long, they, true to their ancient and proverbial reputation, are at work climbing every plant and traversing every leaf, especially the under side where the egg is deposited, and the young worm makes its appearance with the same instinct to find and devour that is found in the miller that deposits them there. They devour the eggs and the worm (until about two days old) and finally make havoc of the chrysalis. The discovery was accidental. I had been watching and experimenting to learn the nature and habits of the worm, to ascertain the periods of their different stages, and to learn the period from one brood to another, and the probable number of worms that might be expected from each miller, and on this occasion I was gathering chrysalides to see what was the probable number then

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on the plant, compared with the number already on the wing. Proposing to myself a certain number, I proceeded, but I had not gathered many until my attention was arrested by the stings of the ants on my hands, revenging themselves on me for disturbing them while at their noble work of protecting me against my great enemy. When I opened the leaves I found a number that contained neither living chrysalis nor the shell from which the miller had made its timely exit, but a shell severed in twain at the middle of the body. The examination was continued until it was found that more than one-half of all I opened had been thus destroyed.

My curiosity was then excited to know if it were the ants and why the middle was made the point of attack. Soon I had the pleasure of witnessing their assault, and discovered the reason they regarded the middle as the vulnerable point. When the chrysalis was bitten or stung it would move or flounder, each end moving back and forth violently, but the middle remained almost motionless. If the ant had taken hold of either end it would have been thrown loose or perhaps wounded; but at the middle it could not be wounded nor its hold broken. And in two to five minutes after the assault was made the prize was captured, and the slain furnished a bountiful repast for all present, say from one to two dozen.

With this first observation we were not content, but from time to time went and watched until every doubt of casualty or uncertainty was removed. And as we had begun to form a new theory on witnessing this first victory, and as we were anxious to know whose side these little soldiers were fighting on, we felt we were more than repaid for our trouble in being able to perfect that theory, which to our mind was fully demonstrated; and for ten years we have not seen any reason, either from the press or our own observation, to change the conclusions at which we then arrived, and which we sent to the Texas Farmer and was published in that journal.

The theory is the following, viz: The ant will protect the cotton plant from the ravages of the caterpillar if no wet lands are planted and if the high lands are not plowed when too wet, either of which may prove fatal.

For the last ten years we have seen the miller in May without a single exception, and once in April. When the seasons have been wet the worm has appeared in force; when dry they have done no harm. As to the condition or state in which it passes through the winter, we are not fully satisfied, for we have seen the miller in midwinter in the rotten places of old timbers.

Suppose in a field of one hundred acres there be one acre of land protected from the ant by being too wet for its habitation, for it can neither live nor work on wet lands, and by the 15th of May one miller makes its deposit of 2,000* eggs, which entomologists are agreed is the reasonable number; now by the same ratio on June 15 we will have 4,000,000; on July 15 we will have 8,000,000,000 worms— enough to consume every leaf on the hundred acres and a whole neighborhood besides; and if we would allow the increase to be one-half the above the result will be the same.

And, again, if there should be half a dozen millers in May to begin the work, how vast the number would be seen in July. Yet, with the hope there will be no worms this year, planters will risk the planting of that wet acre.

In the next place, many planters plow their lands when wet, and thereby destroy the ant by imbedding them in mortar, from which they cannot extricate themselves. If the soil is stirred with a plow while in proper condition it will take it but a few hours to repair its house, and then he is ready for the field again.

When we first presented this theory we were met with the statement that by observation it was known that the worm sometimes defoliated the highlands first; consequently the wet-land theory was incorrect. But our observations were not at fault on this subject; for when the fly made its appearance, if the weather was showery or plants wet until a late hour in the morning and at an early hour in the evening with the dew, it would leave low land for higher ground and drier plants to deposit its eggs. Therefore, the highest and driest portions of the field would be the first destroyed; and

*Figures four times too large.—J. H. C.

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if the fields were all of this character some neighboring fields would suffer from the injudicious example of him who planted low, wet lands.

Let no wet lands be planted on which the ant cannot live, nor let the highlands be plowed while wet to destroy the ant, and I am persuaded that the cotton crop will never be destroyed by the worm again. The observance of these facts will do more than all the poisons discovered and all the poison-distributers combined to protect the planter in his toil and guarantee him the rewards of his hands.

And, in conclusion, I will say to those that are skeptical, you have but to go to the field and see for yourself, and you will no longer be doubtful.

Hoping these suggestions may lead to inquiry, and that some system will be suggested that will secure concert of action, even if by legislation, I am, sir,

Your obedient servant,

N. A. DAVIS,

JACKSONVILLE, TEX., *August* 16, 1879.

Almost simultaneously with the letter from Mr. Davis in one extreme of the cotton belt came a communication from Mr. J. C. Brown, of Willet, Barnwell County, South Carolina, the other extreme, expressing almost precisely the same views. Mr. Brown introduced this in his reply to the 1878 circular, which he had retained until this time to make further observations. He says:

The common ant maintains an equilibrium *when it is not too wet.* The ant will destroy the eggs unless the rainy weather keeps it in its retreat. This is the reason that a dry season is never a caterpillar one.

Upon receiving this we wrote to Mr. Brown for further particulars and received the following reply:

DEAR SIR: In answer to yours of the 29th instant in relation to cotton-worm and whether the common ants were destructive to it, would reply that I have observed the ant on the cotton-plant and apparently searching it for prey. During sunny weather they are numerous, every cotton-plant having several crawling over it, and they do destroy the eggs of the cotton-worm, for I have seen them stop as soon as they came across them and eat and carry them away. In wet weather the ant has retreated to its quarters and few can be found anywhere in the cotton field, and the caterpillars have undisturbed opportunity to multiply and increase.

We have the worm here now in force, and would be greatly damaged, but its first appearance was two weeks too late. And I have noticed that my theory of the ant has had additional substantials for its support, for during four or five sunny days there is a decided increase and activity on the part of the ant and a marked decrease of the same on the part of the worm.

Yours, respectfully,

JAMES C. BROWN.

WILLET, BARNWELL COUNTY, SOUTH CAROLINA.

This same idea is again expressed by Mr. Douglass M. Hamilton, of Saint Francisville, La., in his report, in which he says: "Ants of many kinds are found preying on them *in good weather, but not in bad*, and this is the reason given why the worm increases so much faster in rainy, wet weather than in dry and fair weather."

Mr. Wm. V. Keary, of North Bend, Cheneyville, Parish of Rapides, Louisiana, December 17, 1877, in writing to J. Curtis Waldo, says: "The cotton caterpillar requires a wet season to accumulate, as such weather

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is destructive to its natural enemies, the ant, and also an insect called the ichneumon," &c.

Professor Riley informs me in conversation that the same point has been forced upon his attention during his investigations the past summer, and it will probably be elaborated in the forthcoming bulletin of the United States Entomological Commission.

The following extracts from Mr. Trelease's note-book are of interest in this connection:

September 10, 1879.—On the second place, where 100 acres are eaten out entirely, I find thousands of nearly-grown aletias crawling in every direction. In wet places they are not so much molested by ants, for there are few of these; but on dry, sandy places I find ants killing many larvæ. * * * Can it be that aletia first appears in wet places because the ants are not so numerous there as on high, sandy places? Early I found caterpillars on both bottom and ridge land. Were not most of the latter killed? This theory must be taken in connection with that of the nectar, for certainly there are more eggs laid in wet ground. Can it not be that this is partly due to the fact that more moths are excluded in such places and lay their eggs without leaving them?

The one sentence, "*Early I found caterpillars on both bottom and ridge lands*," forms a strong argument for Mr. Davis's theory.

And now as to our own conclusions: If it can be shown that the number of cotton-worms actually killed by the ants is as great as stated by the upholders of the theory, then there can be no doubt but that it accounts for observed facts. In the next chapter is given what evidence we have collected as to the efficacy of the ants as destroyers of the cotton-worm; but it seems hardly sufficient to warrant us in unqualifiedly supporting so broad a theory. We can safely say, though, that the agency of the ants is *one* of the prominent factors in bringing about the dry-weather scarcity or wet-weather abundance of the cotton-worm. The most important time for the ants to be pursuing their good work is among the early broods of worms—in May and June. Every worm killed at this time saves the cotton from hundreds later. The numbers of individuals in the earlier broods are small, and more appreciable work can then be done. Later in the season the abundance of the worms, if they have been protected by wet weather earlier, is so marked that an ordinary change of the weather has small influence over them.

The law, then, which we should lay down for the influence of weather upon the cotton-worm, taking all evidence into consideration, would be: A mild winter, followed by a rainy May and June, will usually bring a destructive "third crop" of the worms, while an opposite state of the weather will be more likely to bring about comparative exemption.

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CHAPTER VI.

NATURAL ENEMIES OF THE COTTON-WORM.

Prior to any remarks upon remedies, comes, naturally, a chapter upon this subject, for the encouragement of the natural enemies of any injurious insect is the first remedy that suggests itself. In order to pursue this subject to the best advantage it will be necessary to divide it into two heads—vertebrate and invertebrate enemies.

VERTEBRATE ENEMIES.

Of mammals but five have been observed to devour the cotton-worm in any of its stages, although, without doubt, several others have the habit. These are three domestic and two wild—hogs, dogs, and cats, and coons and bats.

Concerning the fondness of hogs for cotton-worms almost every planter can testify. On several occasions, when early broods of the worm have stripped the cotton and migrated to adjoining fields, pigs have been turned into the road and have devoured enormous numbers. Mr. R. F. Henry, of Pickens County, Alabama, states that the hogs become perfectly ravenous for the worms, and if allowed to remain in the cotton-field will almost entirely destroy the plant in their efforts to get at them.

Mr. R. J. Williams, of Mount Meigs, Ala., says: "Hogs will feed and fatten on the worms." Mr. J. S. Hausberger, of Tionus, Ala., says: "When hogs can get to them they destroy them with the greatest avidity." Mr. P. D. Bowles, of Evergreen, Ala., says: "When they leave the field and get out so that the hogs can have access to them, they will feed upon them." Mr. J. W. Gilmore, of Gaston, Ala., says: "Hogs eat them greedily." Mr. C. B. Richardson, of Henderson, Tex., says: "In 1846 and 1847, after stripping the cotton of leaves and small bolls, the worms crawled in millions through the fence into the road, and my hogs promenaded the road eating them." Instances might be multiplied, but it will be unnecessary.

Many instances of *dogs* eating the worms have been observed, although it is doubtful whether any dog would stoop to it unless on the verge of starvation. To the poor dogs of the freedmen, however, the cotton-worms are a boon which they are not slow to appreciate. The domestic *cats*, with their carnivorous tastes, will eat the cotton-worms until they are filled to repletion. We have the testimony of Mr. R. B. Dunlap, of Boligee, Ala., as to *coons* eating the worms. It is probable also that both skunks and opossums do some amount of good by eating the worms.

One of the most effective mammalian enemies of the cotton-worm is the common "leather-winged bat" (*Vespertilio Sp.*). This animal has often been observed to catch the moths on the wing at night, and Mr.

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Trelease observed many bats around the jujube trees on which the moths were collected at night, repeatedly darting under and each time catching a moth. It is hard to estimate the amount of good which is accomplished in this way, as with each female moth is usually destroyed some hundreds of embryo worms.

Our list of birds is a longer one. It is probable that the planters in general do not sufficiently appreciate the amount of good which birds as a class do for them. There are many who at this late date insist that no bird will touch the cotton-worm. One correspondent has the following upon this point:

> I have spent much time in watching this point. I have even thrown them among chickens and they refused to touch them. When a field of cotton is devoured, and the worms start to travel, moving simultaneously across woodland, road, street, and dam, up branches and ravines, I have seen them exposed to birds, flies, hogs, &c., but have never seen anything eat them.

Many hold this opinion, and it is difficult to say what is the cause of it. The use of domestic fowls has always been urged as a remedy for the cotton-worm, and undoubtedly they can be used to a great advantage. It was always the practice of Mr. John Townsend, of Saint John's, S. C., a most successful planter, to scatter corn over the fields to invite the notice of wild birds, and while they destroyed the worms upon the top cotton he drove his flocks of turkeys into the field to feed upon those upon the lower branches.*

Dr. Chisholm mentions the use of fowls for a similar purpose in Guiana as long ago as 1801. Mr. Schwarz, in speaking of Mr. J. Donovan, a successful planter of Kushla, Ala., says:

> Mr. Donovan is always able to keep the worms in check by the following simple and cheap method: He drives his large flock of turkeys into the field, and if the plants are too high a boy brings the worms down by knocking at the plants with a stick. This is repeated every day, and this remedy has so far proved a success. Of course it can only be applied in small fields which are near the house and where the cotton plants are not of large size. According to Mr. Donovan, the chickens are very fond, too, of the cotton-worms, but, of course cannot reach as high as the turkeys.

Dr. John Peurifoy, of Montgomery, Ala., makes the following proposition:

> All the birds feed upon the moths; and the barn-yard fowls, even the geese, eat the worms with great gusto. And in this connection it occurs to us that henneries might be built at proper distances and made a paying institution; for we have noticed that all around the barn-yard the cotton is saved from the worm, and continues to grow and develop a full crop for several acres, or as far out as the hens feed, while the balance is completely riddled, and the loss at times reaches one-half the crop. This proposition would be laughed at if named here, while the planters pay $1.25 per acre for Paris green, and if the season be rainy the poison fails and great loss results.

We will here enumerate a few of the testimonials on the poultry question:

> Domestic fowls eat them voraciously.—[W. W. Hand, Forkland, Greene County, Ala.

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* Seabrook's Memoir, p. 44.

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Turkeys and chickens feed on the worms and chrysalis. Poultry near houses thin them out greatly.—[R. H. Powell, Union Springs, Bullock County, Ala.

Chickens, turkeys, and almost all kinds of fowls are very eager after them in this locality.—[J. L. Hausberger, Tionus, Bibb County, Alabama.

Cotton planted near farm-houses has been greatly protected by the fowls eating them.—[J. D. Johnston, Sumterville, Alabama.

Immediately around the cabin where there is poultry and turkeys, the cotton will not be destroyed.—[H. A. Stollewerck, Uniontown, Perry County, Alabama.

Turkeys eat them eagerly, and a cotton-field near a dwelling has been preserved by the turkeys. Chickens also eat them, but their height prevents them from destroying them as effectually as the turkeys.—A. Jay, Jayville, Conecuh County, Alabama.

Chickens, turkeys, and geese eat them.—[F. M. Meekin, Morrison's Mills, Alachua County, Florida.

Chickens are very destructive to them. The guinea-chicken is of more value, as it travels farther.—[S. P. Odom, Drayton, Dooly County, Georgia.

When the worms are numerous the fowls and birds gather to the cotton-fields and remain there, daily feeding on them.—[D. M. Hamilton, Saint Francisville, West Feliciana Parish, Louisiana.

The common fowls will eat them.—[Jno. A. Maryman, East Feliciana Parish, Louisiana.

Having occasion to move my fowls during the summer to a location near the cotton fields my chickens took to the field and ate so many worms that they did not care for other kind of food, and seemed to do well on them. Turkeys and guinea-fowls are very fond of them.—[C. F. Sheirod, Columbus, Lowndes County, Mississippi.

Ducks, geese, and chickens, most small birds, and especially turkeys, wild and tame.—[C. Welch, Station Creek, Covington, Mississippi.

Chickens and turkeys also feed on them. They both soon learn to find the chrysalis. I have often seen chickens jumping up for them. A few years ago I called to see a friend in an adjoining county who had a large plantation, and found his cotton stripped of its leaves, except a ten acre field near his house. On inquiry, he told me that his turkeys had kept the worms from injuring that field. It was then the third crop of worms.—[W. Spillman, Enterprise, Clark County, Mississippi.

Our domestic turkeys are the greatest enemies of the worm.—[Geo. F. Webb, Amite County, Mississippi.

I saved a small lot of cotton near the residence by feeding the turkeys in it.—[C. B. Richardson, Henderson, Rush County, Texas.

From these multiplied evidences it seems clear, notwithstanding contrary reports, that much can be done toward the extermination of the cotton-worm with the aid of domestic fowls where poisons are not used; this latter contingency, of course, rendering it necessary to carefully isolate the fields from poultry. Concerning the general use of fowls as insect-destroyers, Prof. Samuel Aughey has the following:*

It is also probable that the value of chickens and turkeys for the general destruction of insects is underestimated. Those who have carefully examined the stomachs of chickens and turkeys taken at random from a farm-yard have often been surprised at the number of insects that they had confiscated. One turkey that I purchased in a butcher-shop in Lincoln, Nebr., in October, 1874, had 47 locusts and 23 other insects in its stomach. One that I dissected in October, 1873, had in its stomach 53 of our common insects. When domesticated they retain the eating habits of their wild state and take every insect that crosses their path. I have rarely examined the stomachs of chickens without finding some insects. The exceptions to this rule have been gen-

* First Annual Report, U. S. E. C. on Rocky Mountain Locust, p. 339.

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erally those that have been kept in confinement. The farmer, therefore, who makes provision for a large amount of poultry on his lands, accomplishes a double purpose: His profits are to that extent increased, and a large number of insects that would damage his crops are destroyed.

These are the precise sentiments of Doctor Chisholm when he said:

A prudent economical planter will increase the brood of every species of domestic poultry, particularly turkeys, for this has a tendency to diminish the brood of the chenille in a very great degree, while profit arises from the augmentation of useful stock. Turkeys are observed to have a remarkable appetite for the larvæ of the cotton-moth and devour prodigious quantities of them.

And now let us turn from the consideration of domestic birds to that of wild birds. It has long been noticed that the cotton near the edge of the field where there were trees and bushes was not eaten by the worms, and this we can safely ascribe to the good offices of the birds. In many parts of the South the amount of good performed by these little friends of the planters is not appreciated, and they are shot indiscriminately by the ignorant freedmen and others. The subject as to what particular species destroy the worms has been studied but little in this investigation, and we are obliged to rely upon the random reports of correspondents. From these we have gathered the following partial list:

1. The painted bunting or nonpareil (*Cyanospiza ciris*, Linn). This bird was found nesting on cotton at Macon Station, Ga., and as, according to the best authorities, its food is to a great extent insects, it may safely be put down as a destroyer of the cotton-worm.

2. The indigo bird (*Cyanospiza cyanea*, Baird). Observed by Mr. Trelease to destroy the cotton worm.

3. The mocking-bird (*Mimus polyglottus*, Linn). This bird, whose food consists principally of insects, has been reported from all over the South as being a great cotton-worm eater.

4. The bluebird (*Sialia sialis*, Baird). The food of this bird also consists principally of insects, and it has often been seen to destroy the cotton-worm.

5. The rice-bird, or bobolink, or reed bird (*Dolichonyx oryzivorus*, Swainson), is reported by Professor Willet to feed upon the cotton-worm.

6. The "yellow oriole" (*Icterus baltimore?*) has been seen by Mr. G. W. Smith-Vaniz, of Canton, Miss., in numbers, devouring the cotton-worm.

7. The "yellow-jacket" (*Chrysomitris tristis?* Bonap). This is a popular name which is extremely indefinite and cannot be found among the popular names adopted by modern ornithologists. It may refer to the common yellow-bird or thistle bird or American goldfinch.

8. The bee-martin or king-bird (*Tyrannus carolinensis*, Baird). This bird, which feeds almost exclusively on winged insects, is perhaps the oftenest quoted as a cotton-worm moth destroyer of all birds. It is, according to one correspondent, a common sight to see them darting about a field towards dusk, catching the moths on the wing or searching for them under the leaves.

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9. The barn-swallow (*Hirundo horreorum*, Barton). This bird also has been observed to catch the moth on the wing.

10. The night-hawk or bull-bat (*Chordeiles Virginianus*) has been often seen to catch adult *Aletia* on the wing at dusk.

11. Red-wing blackbird (*Agelaius phœnicus*, Vieillot). These birds destroy immense numbers of the cotton-worms.

12. Cow blackbird (*Molothoris pecoris*, Swainson).

13. Rain crow or yellow-billed cuckoo (*Coccygus Americanus*, Bonap.). "The rain crow feeds voraciously on them," (W. A. Harris, Isabella, Worth County, Georgia). All through Georgia and Alabama this bird is first mentioned in answer to the question, "What birds feed on the cotton-worm?"

14. Loggerhead or Southern shrike (*Colluris ludovicianus*, Baird).

15. The field sparrow (*Spizella fusilla*).

16. The chipping sparrow (*Spizella socialis*).

17. The song sparrow (*Melospiza melodia*).

18. The lesser sap-sucker (*Picus pubescens*, Linn.).

19. The wild turkey (*Meleagris gallopavo*, var. *gallopavo*). Concerning this bird Mr. Trelease says: "Wild turkeys frequent Mr. Melton's plantation in search of the caterpillar, and the plantation is covered with their tracks. They are seen here, and I believe they have been seen catching the worms." Mr. P. D. Bowles says: "The wild turkey has been known to feed upon them in the field near the swamps," and Mr. J. N. Gilmore remarks, "The wild turkey is particularly fond of them."

20. The quail (*Ortyx Virginianus*, Bonap.) feeds upon the cotton-worm, according to Professor Willet.

21. Partridge, ruffed grouse or pheasant (*Bonasa umbellus*, var. *umbellus*, Stephens).

22. Prairie chicken, prairie hen, or pinnated grouse (*Cupidonia cupido*, var. *cupido*, Baird).

The great majority of our correspondents replied that "all birds" or "all insectivorous birds" eat the worms, without specifying the kind, and the list is made up of the commoner species which are incidentally mentioned, and may therefore be accepted as containing the names of those birds which perhaps do the most good.

The good will with which the native sparrows destroy the cotton-worm and the reported efficacy of the English sparrow in ridding the Northern cities of the canker worm have led many Southern planters to believe firmly in the feasibility and advisability of introducing this latter bird upon the Southern plantations. Many letters like the following have been received:

Prof. J. H. Comstock:

Dear Sir: Several planters request me to see what can be done with the European sparrow as an enemy of the cotton-worm; I therefore write to see if you consider it advisable to send me several pairs of the birds to be liberated on the plantation where I now am, and provided with nesting, gourds, &c. Being a social bird and fond of living in cities I do not know how the experiment would succeed, nor do I know how

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the sparrow would use the oat crop in the spring. I shall be thankful for any information as to this, and also on such efforts as may already have been made to introduce the sparrows in the cotton-growing districts.

Very truly yours,

W. T——.

SELMA, ALA., *July* 28, 1879.

Here is another of the same drift:

MR. J. H. COMSTOCK:

DEAR SIR: * * * The first field has an orchard on one side and forest trees on two other sides, and I observe numbers of yellow orioles (?) everywhere among the cotton very busy searching the stalks. This circumstance is, I think, explanatory of the paucity of the caterpillars in that field, although the cotton is older and considerably larger than the other, and the worm first appeared there. I am of the opinion, furthermore, that we have here the key to the method of warfare that is to be waged against the destructive pest—birds! I think it is possible that the English sparrow may be the only thing that can save us from the incalculable losses wrought by the worm, and I hope that the department will distribute a number of them to reliable agents at different points and have results noted and made public, &c.

Very respectfully,

GEORGE W. SMITH VANIZ.

CANTON MISS, *July* 26, 1879.

Before taking the course outlined by these gentlemen, the subject needs to be carefully looked at on all sides. There are, in the first place, arguments against the good to be accomplished by such a course, and, in the next place, strong evidences of probable harm. Prof. F. H. King, of River Falls, Wis., in a letter of recent date has the following on this point:

If you will not deem it presumptuous in me, allow me to suggest that it is barely possible that the English house sparrow will not thrive in the warm cotton districts. This caution is brought to mind by the fact that the sparrow in Europe does not live in Spain or Italy, and, by what appears to be a fact in this country, that they are spreading westward from Boston, New York, and Philadelphia much faster than southward, and further by the fact that in the Northern States and in Europe wherever they take up their abode there they spend the winter.

One other peculiarity in the habits of this bird appears to me to argue seriously against its general usefulness to the cotton-grower. It is peculiarly partial to cities, and the larger the city the better. From these haunts, so far as I am yet able to learn, it only makes occasional flights to the immediately adjacent country when food at home is scanty.

This latter point has been verified by experience. A year or so since the sparrows were introduced in Bibb County, Georgia, with a view of destroying the cotton-worms; but they almost immediately forsook the plantations, and were last year seen nesting about a church in the city of Macon.

For the past few years a spirited discussion has been going on relative to the merits and demerits of the English sparrow in the North, and, in spite of a strong resistance on the part of the friends of the sparrow, the general tide of scientific opinion seems to be setting against them. There can be no better place for collecting the opinions of the leading participants in this discussion than here in answer to the many

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demands for the sparrows from the South. The first item which we shall quote is from The Country, being a report of a discussion on the bird by the Nuttall Ornithological Club, of Cambridge, Mass.

SPARROWS BROUGHT TO JUDGMENT.

[Communicated officially by the Club.]

At a meeting of the Nuttall Ornithological Club, of Cambridge, Mass., held on January 28, 1878, the evening was devoted to a discussion of the English or house sparrow in America. In order to obtain a fair expression of opinion on the subject from the ornithologists of the vicinity, notice of the proposed consideration of the subject was sent to all the resident members of the Club, and several of the corresponding members were invited to contribute. In view of the great practical and economic interest of the subject to the general public, the secretary of the Club was requested to prepare a report of the discussion for publication, which is herewith appended. The result of the canvass, it may be premised, was a decision most decidedly unfavorable to the value and attractiveness of the sparrow in the United States.

The president of the Club, Mr. William Brewster, remarked that when the sparrows were first introduced he was disposed to view them in the light of a blessing. He recollected, when they were still an uncommon sight among us, that he noticed a small colony nesting in a martin-house in Medford. The numerous apartments in the box were occupied by martins and sparrows in about equal numbers, and the birds were sitting peaceably together on the ledge or carrying in food to their young or sitting mates. This, he stated, was the only observation he had ever made tending to show these birds in a favorable light.

Since their permanent establishment in this locality they had certainly driven away many of our native species, though he did not say that this result is as yet so marked in his neighborhood as elsewhere, where the sparrows had become more numerous. In Washington, in 1873, he saw the English sparrow in the city parks and public squares in limited numbers, but none in the Smithsonian grounds, where song sparrows, black snowbirds, bluebirds, and a few other species abounded. During a visit to Washington the present winter not a single native bird was observed in those grounds. The noisy foreigners had taken their places, and nearly every tree and clump of bushes resounded with their querulous, disagreeable chattering. Mr. Chas. M. Carpenter, of Providence, R. I., had informed him that in that city the sparrows were fast banishing the home varieties, especially waging war on such as select boxes for their nesting-sites, and that the new-comer was regarded there as an unmitigated nuisance. As for claims for the bird on the ground of having exterminated or even materially diminished the numbers of the insects that prey upon the shade trees in Boston or vicinity, the speaker thought we should be extremely careful how we credit them with what may have been the result of other and less conspicuous agencies. Insects, as well as many other organic creatures, are well known to pass through periodical cycles of excessive abundance and comparative scarcity. Granting that in Boston the Orgyia pest was much abated through several successive years after the sparrows were introduced in that city, we had no right to give the sparrows credit for that occurrence. Circumstances may have favored the sparrows. Had not this insect just passed through a cycle of comparative scarcity? If the sparrows acted to any great extent as destroying agents, having once fairly obtained the upper hand, why did they not keep these insects down? During the past summer the larvæ of the species in question had again appeared in formidable swarms on Boston Common and vicinity, yet the number of sparrows had probably quadrupled every year.

Mr. H. A. Purdie observed that last summer he published, in the Boston Advertiser of July 30, a short article, speaking of the hordes of caterpillars that had then been infesting the trees of the common, and of Bowdoin street; and later, their cocoons

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were to be seen by thousands on both trees, houses, and fences. These caterpillars were the larvæ of the tussock plumed or vaporer moth, the *Orgyia leuco stigma* of entomologists. The city forester, Mr. Galvin, soon had a force of men removing the cocoons and killing the crawling things, for the sparrow gave both a wide berth. The ravages of these pests among the foliage was so great that in some instances whole trees were "chewed up," although each tree had one or more occupied bird-boxes. In the Advertiser of December 6 there appeared a communication headed "Justice to the Sparrow." It was, in part, a reply to the July article above referred to. This writer claimed, on the authority of Mr. Galvin and two policemen, that the caterpillars had been wholly restricted to a narrow strip north of the path leading from Winter to Spruce street, or to about one-tenth of the common. This Mr. Purdie positively denied. Again, the writer called particular attention to the fact that the November rains, soaking the cocoons, rendered yielding and pliable these envelopes, impervious to any bird, and firmly glued to the trees when dry; the sparrows were thus enabled to devour the clusters of eggs in these "receptacles," which they were seen doing. Mr. Purdie replied that the wingless female imago of Orgyia, crawling from the inside simply to the outside of her cocoon, deposits there her eggs, covering them with a frothy matter, which, on drying, becomes brittle. The eggs are thus easily accessible to a strong-beaked bird like the sparrow. The cocoons everywhere conspicuous are not "impervious," but often so thin and slight that the inclosed insect can be seen through the walls. The larvæ are greatly subject to the attacks of various parasites, and entomologists know that in collecting the cocoons in winter in order to destroy them, none but such as have the egg masses glued upon them need be taken, as all others contain the empty male chrysalis, some friendly parasite, or spiders and their eggs. Therefore, it was these foes of the tussock moth, the beneficial spiders, that the sparrows were so eagerly hunting after, when they attacked the "contents" of the cocoons.

As to our native birds, Mr. Purdie was confident of their diminished numbers since the introduction of the foreign sparrow. Formerly he had observed about fifty species of small birds on and about the public garden and common in Boston at different seasons of the year, and from fifteen to twenty were summer residents, raising their young in the midst of the city. Now, these birds do not visit the city.

Mr. H. D. Minot said the house-sparrows were quarrelsome and noisy. He had seen them drive away and sometimes even kill other birds and eat sound leaf and fruit buds. They often frequented infested trees, especially where they have no boxes, without disturbing the worms. Trees could better be protected by artificial means. Last summer those elms about Harvard College which were properly tarred but not frequented by the sparrows were almost intact, while most of the trees outside, not cared for except by these birds, were largely or wholly stripped of foliage. As shown in Europe, it is the tendency of small wild birds, if not persecuted, to draw nearer to man and civilization. As this country becomes more thickly settled, our native species would have increased (not decreased) in the neighborhood of cities, and have supplied our needs as insect-destroyers, had we not checked them by introducing a foreign sparrow which was now spreading far and wide and driving native birds of much greater value before it. As regards the testimony of Dr. Thomas Brewer, the sparrows' chief advocate, he stated emphatically, and from long personal observation, first, that the indigenous birds on Boston Common had materially decreased within five years, both in numbers and variety, robins alone yet holding their own; second, that Mr. Galvin, the city forester, and the police to whom Dr. Brewer had referred, were not competent witnesses in this case; and third, that, as to the green appearance of the common in September, it should be borne in mind that a tree may be defoliated in June or July and well clothed again in autumn. The dirty habits of the sparrows, Mr. Minot thought, and the unsightliness of their boxes, greatly counteracted the pleasure to be derived from all their supposed virtues.

Mr. Theodore Roosevelt, jr., of New York, said that some years ago sparrows were

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apparently of service in New York City in destroying canker-worms; but last year worms were very abundant in the gardens of that city and not interferred with by the birds. In America he had never observed them molest grain, but in Egypt he had seen them feeding in the fields in flocks of many hundred, and on shooting them their crops were found to çontain only grain. He had often watched them assault snow-birds, song and chipping sparrows, and had known them to kill a yellow-billed woodpecker, actually mobbing it to death. Other birds, as purple martins, he knew they had driven away by occupying their boxes very early in the spring. This immigrant had spread into the surrounding country, and at West Point, on the Hudson, land owners had been obliged to shoot them, as they destroyed the buds of fruit trees and drove away the song birds.*

Mr. Ruthven Deane stated that he had repeatedly seen the sparrows attack and drive off our native species. These instances were witnessed both on Boston Common and in gardens in Cambridge. He referred to one instance where a white-bellied swallow returned to her nest in a martin-house attached to the trunk of an elm; a cockney sparrow (which had not previously been reared in the box, nor had any of his ancestors) was perched upon the ridge-pole, and disputed the swallow's right by attacking and forcing her to the ground, and leaving her only to resume his position on the ridge-pole.

Mr. Deane also read the following letter, which, though addressed to Dr. Brewer, was recently sent (apparently as an "open letter") to Mr. Deane for publication:

"Dr. T. M. Brewer:

"Dear Sir: I want to ask of you a reply to these facts, in regard to the diet of English sparrows habituated to our climate, which I have with the greatest care obtained, and with no prejudice, of course, to the scientific results: Last season I obtained 39 individual sparrows, during the height of the canker-worm pest, in the Jamaica Plain district (near Boston); about an equal number of males and females. These birds had been allowed to gather any food they liked, and their houses were placed in the midst of several elms infested with worms.. On dissection no insect or worm, whole or in part, could be found in their digestive tract even with the glass, but grain, oats, seeds, and gravel, alone gave evidence, distinct in these cases, of a granivorous life. I have never, as yet, met with a like series of experiments on your part, and hence I desire to have a brief reason for your assertions to the contrary in different papers.

"I am, very respectfully,

JOHN DIXWELL, M. D.

Hotel Boylston, *Boston*, *January* 3, 1878."

Messrs. C. F. Batchelder and Walter Woodman both supported Messrs. Minot's and Deane's statements as to the decrease of many singing-birds in Cambridge, and especially that of the house-wren, a most valuable insect-destroyer.

Mr. A. M. Frayer, of Watertown, remarked that he did not think we should look into the city to see what we are to expect from the house-sparrow, but to the suburbs, where it is yet living in a more natural condition. This last summer a flock of about a dozen took up their residence near a small patch of standing rye, and before it was time to harvest the grain the gourmands had eaten every kernel and beaten down the straw. On Long Island, New York, the native birds, for the last five years, had been steadily decreasing as the alien increased.

Mr. J. A. Allen stated that, although he had hitherto purposely kept out of the sparrow controversy, it had not been from any lack of interest in the subject. He had believed the subject to be not so one-sided as many have assumed; that the sparrows

*Plenty of confirmatory evidence is observable in New York City to-day, although here no public provision is made for feeding the sparrows. In City Hall Square, particularly, the cocoons of Orgyia moths are to be seen in large quantities on both elms and maples. In many cases the bird-boxes in these trees at present inhabited by the sparrows are almost completely covered by a crowded thatch of chrysalids.—Ed.

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are not quite such unmitigated pests as they have sometimes been represented to be, nor, on the other hand, quite so unalloyed a benefaction as some have claimed. While they have some good points, they are certainly not lacking in bad ones. Before taking sides on a question of so much importance, he had waited for the accumulation of evidence—in other words, till the sparrows had so increased in numbers that our knowledge of their proclivities would enable us to judge of the results of an experiment that at first seemed praiseworthy. The sparrows, it is true, came to us with a bad name, and many a wise one on the other side of the Atlantic had warned us of the consequences of what they termed an act of folly.

The introduction of the European house-sparrow to the principal cities of the Atlantic seaboard and to many of those of the interior, he continued, has been made mainly within the last ten or twelve years; but in consequence of their remarkable power of reproduction and their pampered lives, protected, as they have been, from all natural checks upon their increase, and at the same time provided with an abundance of food and innumerable resting sites, they have already so multiplied in many places that they have begun to spread into the adjoining rural districts. While to some degree annoying, even in the cities, by their harsh cries and ceaseless clamor, and other not wholly agreeable acts, the report comes to us that they are already rendering themselves obnoxious to the farmer and horticulturist by their attacks upon the crops. An equally serious charge against them is their influence upon our native birds, for the increase of the sparrow is everywhere coincident with a decrease of our far more desirable native species.

Having had his attention called of late rather strongly to the subject, Mr. Allen had been led not only to collect his own observations on this subject, but to seek information from localities beyond his own immediate vicinity; and on weighing the evidence, had been rather surprised at the preponderance of facts unfavorable to the sparrows. As regards the favorable side of the case, he stated that he had no doubt that the sparrows, in no small degree, held in check the canker-worms and other obnoxious caterpillars. During the last three or four years he had had very favorable opportunities for observations. During this period the elms in the vicinity of his house have had no other protection than that afforded by the English sparrows, yet they have retained their foliage in excellent condition, while other trees not many yards distant, unfrequented by the sparrows, and also in no way protected, have been almost wholly stripped of their leaves. The canker-worm moths laid their eggs freely on all the trees here referred to, and the eggs hatched on all in apparently equal abundance; but when the sparrows were in sufficient force, they checked their ravages before they had time to do serious harm. He had observed the sparrows, day after day, during the canker-worm season hunting among the leaves for caterpillars and seizing them. So far as regards this part of the subject, there is neither influence nor guesswork, but visual proof. The destruction of a few caterpillars, however, he regards as almost the sole good that can be adduced in their favor. Their presence in small numbers, and especially in winter, is indeed cheery and pleasant; but when in force their harsh chatter becomes a positive nuisance, and even in summer renders the notes of other birds singing in the neighboring trees almost undistinguishable.

In regard to the unfavorable side of the score the list of charges is a long one, and the greater part are too well attested to admit of reasonable doubt. First in the list is their unfavorable influence upon our native birds. Ordinarily, so far as his observations extend, he believed they were not violently aggressive, but readily became so whenever there was a conflict of interest, and occasionally without provocation. The little chipping sparrows commonly associated with them on terms of intimacy and harmony, and rarely had he seen them pursue or attack other birds when meeting with them at a distance from their own domiciles. But that they do, by their abundance and petulance, tend to crowd out and supplant our native birds seems nearly unquestionable, since the latter disappear whenever the house sparrows become abundant. Upon such species as have a preference for nesting-sites similar to their own, they do exert,

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however, a most positive influence. These are bluebirds, white-bellied swallows, purple martins, and wrens—birds of attractive ways, agreeable notes, and highly insectivorous in their diet. When the sparrows were first introduced in Cambridge, probably at least a dozen bird-houses were put up to each pair of sparrows. The result was that the native species just mentioned found abundant nesting-places, and at once became more abundant than formerly. As the sparrows rapidly increased, they very naturally possessed themselves of the bird-boxes and forced their former occupants elsewhere. He cited the following instances as having fallen under his observation:

Three years ago no less than three pairs of wrens and as many pairs each of bluebirds and white-bellied swallows raised their young in boxes in sight of his windows. The following year one-half disappeared, and last year not one of these nine pairs of native birds had a representative left within this small area. Not that all the boxes were occupied by the sparrows, but they claimed possession of all and by force of numbers retained them. In most cases the former occupants, finding their homes already in the possession of their enemies, appeared to make no struggle to regain them, a reconnaissance of the field apparently satisfying them of the hopelessness of any such attempt; in other cases they were not given up without long and hard-fought battles. On inquiry he found that similar incidents have been observed in neighboring parts of Cambridge. Besides this, instances of uncalled-for aggression had come to his notice, one of which he had himself observed. Last year a colony of sparrows, not content with three times as many boxes as they had use for, to gain possession of which they had dispossessed wrens and swallows, attacked a pair of robins that very unwisely, as it proved, had chosen a nesting-site in an elm close to this pugnacious colony, by which they were so persistently harassed that they had to abandon their completed nest and its, to them, precious contents.

In this connection Mr. Allen read a communication from Mr. Robert Ridgway, of Washington, D. C., in relation to the effect of the sparrows upon the native birds, in which Mr. Ridgway stated that since the appearance of the house sparrow in that city, the native species, including suchbright-colored and musical birds as the Baltimore and orchard oriole and blue-birds, as well as purple martins, cat-birds, song-sparrows, &c., have nearly abandoned the city. Before the sparrows came these and others were abundant in all the public parks and reservations. The sparrows have now spread in strong force throughout the city, and the native birds have either in part or entirely disappeared, the sparrows abounding to the "almost utter exclusion of other birds." These he gives as the facts of the case, without claiming that the increase of the sparrows and the decrease of the indigenous species held the relation of "cause and effect." The native species, he claims, combine all the praiseworthy traits possessed by the sparrows with either beauty of plumage or the gift of song, neither of which qualities belong to the introduced birds. He regards the latter as only exceptionally insectivorous, while the species they supplant are prominently so. He also alludes to the well-known habits of the sparrows as street birds, from which source they derive a large share of their food.

Mr. Allen further stated that every ornithologist of note throughout the country who has expressed himself upon the subject (and nearly all have done so) has, almost without exception, declared against the sparrow. Not a few of them consider their rapid increase an alarming evil, that will soon call for legislative action to hold it in check. Their influence upon the native species is on all sides spoken of as deleterious. They are aggressive and pugnacious by nature, and, if not by actual attacks upon the native birds, will crowd them out by their excessive numbers. The introduced sparrow is to a greater extent a granivorous feeder than most of our own species of the same family, and subsists upon an insect diet only exceptionally, and not as a rule, as is the case with many of the species their unchecked increase will most surely supplant. They were, however, ostensibly introduced for the purpose of keeping in check certain insect pests, and in some cases seem to have been of service in this regard.

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Hitherto by far the worst of these in Eastern Massachusetts has been the canker-worm. The sparrows, under certain conditions, feed freely upon these, both in the imago and larva states, and if numerous enough would doubtless do much to keep them in check. But to do this, several pairs of sparrows are evidently necessary for the protection of each tree subject to the attacks of the canker-worms.

In order to have the sparrows effective, they must have their homes in the trees; hence it will be necessary to provide two or three bird-houses for each individual tree of the millions of elm, apple, and other trees that the canker-worms infest, and to wait for the sparrows to multiply so as to occupy them before we can hope for the protection of the trees by the sparrows.

With the known predilection of sparrows for the buds of fruit-trees and for ripening grain, to say nothing of the other depredations they are known to commit, respecting which we have testimony from the Old World as well as at home, shall we not have burdened ourselves with a tenfold worse pest than the canker-worms prove to be? But every one who has given attention to the subject knows that we do not need the help of the sparrows for the suppression of the canker-worms. There are various effective devices for the prevention of the descent of the female moth, and for her destruction before reaching those portions of the tree she seeks for oviposition. What we need is an enlightened public opinion that shall enforce, by statutory enactments, the protection of our fruit and shade trees by already well-known available means, making it a penal offense for any person to neglect the protection of any trees on his premises subject to the attacks of the canker-worms. The sparrows are hence a needless and deleterious addition to our fauna, which threatens to soon prove a pest it may be no easy task to eradicate. Instead of being pampered and protected, they should be, if not at once expelled, at least left to take their chances in the struggle for existence without the advantage of the shelter and the food they now find so abundantly provided for them by unwise human foresight. They should not only be placed on the same footing as the native species, but all laws for their protection should be repealed, so that every fruit-grower or farmer who finds them detrimental to his interest can protect himself by summary means, if he chooses, from their inroads without the risk of a legal prosecution.

In concluding his remarks, Mr. Allen read, as further contribution to the subject under discussion, a communication from Dr. Charles C. Abbott, of Trenton, N. J., which Dr. Abbott had kindly forwarded to be read before the Nuttall Club. Dr. Abbott wrote:

"The house sparrows have been very abundant within the city limits of Trenton for about ten years; and only within the past two years have they wandered therefrom, except as single stragglers. Even now they are not permanent residents of the rural districts, but come and go in large flocks, apparently on foraging expeditions. My attention has frequently been called to their depredations committed in town gardens; and I have long known that the fruit and leaf buds of peach, plum, cherry, and pear trees were eagerly devoured by them when such trees were growing in the city. Friends of the sparrow claimed that it arose from a scarcity of food, and were the birds fed with crumbs of bread, and similar scraps thrown from kitchen-doors, the trees would not be molested. This, however, is not true, for even after being gorged with bread and rice they have been seen to pick these buds from the trees and drag them to the ground.

"I have several times watched flocks or colonies of these birds on my own farm, three miles from the city, and have also noticed some of their habits as a street-frequenting bird, and have the following serious charges to make against them:

"First. They are carnivorous; eagerly destroying and devouring the eggs and newly-hatched young of other birds. Instances of this I have frequently witnessed.

"Secondly. They are as cruel as butcher-birds, and will harass, maim, and often kill other birds. As an instance, a pair of sparrows have been seen to attack, while in its nest, a bluebird, and so injure it that it could not escape from or defend itself against subsequent attacks as it fluttered from the nesting-place.

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"Thirdly. Their increase, often four broods in a year, is such that, if they do not drive off other and more desirable species, they will soon crowd them out, and force our songsters to quit their ancient habitats from want of food.

"Fourthly. Their decided preference for fruit and leaf buds over animal food (*i. e.*, insect larvæ) renders them decidedly a pest to horticulturists.

"Fifthly. They are already, often in large flocks, beginning to visit our grain-fields and destroy a large amount of wheat and rye. Their habits in the grain-fields are much the same as those of the reed-birds on the reeds. They cling to the stalk with all the agility of that bird and strip the head of grain of nearly every kernel. Just as the reed-birds visit, in untold millions, the rice plantations, and destroy so much of that grain, so, before long will the coming legions of sparrows attack our wheat and rye.

"I might add a dozen objections other than these, but have we not here sufficient to demonstrate that the introduction of this bird was the introduction of a pest?"

At the close of the discussion a vote was taken on the question of whether or not, in the opinion of those present, the further increase of the house sparrows in this country was desirable. The result was a *unanimous negative*.

H. A. PURDIE,
Secretary Nuttall Ornithological Club.

And now for an article on the other side. Dr. H. A. Hagen, professor of entomology in Harvard University, published the following article in the American Agriculturist for May, 1878:

The decisions of the "Nuttall Club," of which a report is given in No. 18 of the "N. Y. Country," are based upon observations contradicting in several points the older ones, which are accepted by science, in the most decided manner. It appears by the report that the Club either had no knowledge of these earlier observations, covering a space of more than a century, and sustained by ornithologists of well-known reputation, or that it did not deem it worth while to compare its own observations with earlier ones, which ought to have been done to fulfill the well-known demands of science. The sparrow literature is large, and opinions during the past century have considerably changed, until the final decision is most decidedly favorable to its value.

I will select only three authors, who are ornithologists, each one an authority for the economic natural history of his time, covering a space of one hundred years, and showing the gradual progress of the opinion as to the value of the sparrow.

Mr. T. F. Bock, in 1784, considered the sparrow simply as a nuisance, so injurious and obnoxious that he demanded that the legislature should be applied to for its destruction; this was carried out several times with such pernicious effect that the sparrow had to be introduced again. It is not necessary to give Mr. Bock's decisions, as they are exactly identical—the carnivorous and murderous habits excepted—with those of the Nuttall Club in 1878.

Mr. F. M. Bechstein, in 1795, says: "The food of the sparrow, insects and grain, indicates him to be beneficial instead of injurious. In spring he visits all fruit-trees, collects caterpillars from the leaves and flowers, and kills an exceedingly large number of May-beetles to feed his young. In summer he lives on the seeds of lettuce and spinach, on young pears, cherries, grapes, and berries. In the fall he goes into the grain-field and eats a large quantity of ripening or ripe grain. The greatest benefit he confers is in the destruction of innumerable noxious insects, May-beetles, pea-grubs, caterpillars, and grasshoppers, to feed his young."

The sparrow is from this not so injurious as he was declared to be in former times, and upon the whole is certainly more beneficial than harmful. I know towns where sparrows were killed as injurious, but the fruit-trees there never had fruit, though other towns in the neighborhood had plenty of it. The cause was that the caterpillars were not killed by the sparrows. Through loss came wisdom; the sparrows were again introduced, and it was found more profitable to protect the fruit-trees and vines against their depredation by simple artificial means.

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Dr. C. W. L. Gloger, in 1858, says: "The formerly much-abused sparrow is often an impudent fellow, but he eats insects as long as they are to be found. With some predilection he collects leaf-lice from the buds of shrubs and trees and feeds his young with caterpillars. Certainly the sparrows merits well the few cherries and grapes which he steals, as he protects so many other fruits which he leaves untouched. In former times people were short-sighted enough to hunt and kill the sparrow; now opinion has changed. All intelligent horticulturists especially will never persecute the sparrow."

Among the large number of books on horticulture, there is not one which even excuses much less commends its destruction. If the sparrows were injurious they would be much more so for horticulturists than for farmers. The stomach of the sparrow in fall or winter is rounded with seeds of weeds, which is certainly more than an equivalent for the grain stolen in summer.

These opinions are based upon observations made through a century and supported by authors of acknowledged reputation, while the decisions of the "Nuttall Club" are given only after the observations of a few years. I would only object to a few observations given in the report, the rest being sufficiently answered by the above extracts.

The report states "the sparrows to be carnivorous birds, eagerly destroying and devouring eggs and newly-hatched young of other birds." It is well known to every naturalist what science understands by the term "carnivorous birds," and it is well known that sparrows do not belong to them. This term as applied to the sparrow is decidedly out of place in the report of an ornithological club. The other part of the quotation reminds me of a quibble a century old. It was said that "the sparrow invades the nests of pigeons, to cut open the crop of the young ones, and to feed upon the grain contained in them *when he needs it*." Of course it was understood that he never needed it. The report says further, "the decided preference for fruits and leaf-buds [the last observation is an original one with the 'Nuttall Club'] renders them decidedly a pest to horticulturists." As this statement, if true, would be alarming for horticulturists, I should be very glad if the above quoted contradictory observations of Bechstein and Gloger would find a place in some prominent paper or magazine devoted to the interests of horticulturists. But I can give them some further consolation. It is, perhaps, not commonly known to what extent the horticulturists here find it profitable to depend upon German horticulturists. In 1867, wishing to send home a set of flower-seeds, I went to the most prominent dealers, stated my purpose, and got the following answer: "We import all our seeds from Germany." In 1874, I was asked by a friend to send the seeds of the American native pine-tree. After going around in Boston without success, I wrote to New York, Philadelphia, and Saint Louis, and had from all the same answer. Now, when American dealers find it profitable to import seed from Germany, and the German dealers find it profitable to export them, it is rather obvious that the sparrows, so exceedingly common in Germany nursery-gardens, cannot be a pest there, and consequently will not be a pest here. A book commending the persecution of sparrows would at this day be considered by intelligent German horticulturists as a curiosity.

The argument suggested in the report of the "Club," that the help of the sparrows is not needed for the suppression of the canker-worm, because various effective devices exist for the protection of the fruit and shade trees, decidedly loses its value, when summer after summer we have seen those devices applied with care, and in spite of these the foliage was destroyed, except where the sparrows were present in sufficient number to check it. Prominence has always been given to the alleged fact that the sparrows drive off indigenous birds. According to my personal observation in Cambridge, and other suburbs of Boston, this is not true. When I arrived here in 1867, I was surprised by the scarcity of birds in such a large number of beautiful gardens and splendid grounds. The following spring I was able to understand why birds were so rare here, as I saw and heard morning and afternoon around and very near to the museum, and elsewhere, the shooting of every kind of bird. I saw boys plundering the nests of

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the most valuable insect-eaters, robins not excepted, and I also saw target-shooting in the open field; the target fastened to large trees upon which were birds' nests. During recent years the protection of sparrows has surely saved the native birds, and I have never seen in Cambridge more native birds, and never heard more beautiful song-birds, than in the summer of 1877.

Concerning the diminished number of native birds in the Smithsonian grounds in Washington, I am assured that one of the foremost American ornithologists denies it to be the fact. After all, it should not be forgotten that by the rapid increase of the cities (Cambridge has now more than twice as many inhabitants as it had in 1867), and with the incessant disappearance of trees and shrubs, some kinds of birds may prefer to go to more secluded places.

The argument that sparrows drive other birds out of the bird-boxes is rather a funny one, when it will be remembered that all those bird-boxes were placed only for the sparrow. I think every bird will fight for its home; nevertheless I observed, in 1877, sparrows driven out of the box which they had used the year before by swallows, which raised their young safely among a dozen of boxes near by used by sparrows. In a box in the garden at the corner of Broadway and Harvard streets, a pair of swallows and a pair of sparrows settled last year together. The box had *only one entrance* through which both had to pass, and as there were two glass windows in the box, both nests could be observed, and the young of both were safely raised. If, as it seems to be the case, that native birds prefer now to breed in bird-boxes, which they did not and could not do here in former years, it would be simply reasonable to place more boxes everywhere, and, as is done in Europe, different sizes for different kinds of birds.

Nobody has ever contended that the sparrow is a beauty or a charming singer. Indeed he is only an indefatigable business man, minding first his own affairs, as is not uncommon among business men. But he is admirably adapted for his business, which is to destroy insects; he is very enduring, staying through the winter, when few other insect-eating birds are here; he begins to breed much earlier and breeds much oftener than other birds, and is, therefore, more able to give an effective help in the destruction of insects and weeds. But it is true that he should be supported, as Mr. Allen remarks judiciously in the report, through enforcing, by statutory enactments, the protection of the fruit and shade trees by all available means.

As no naturalist would pretend that a bird, by importation into a foreign but similar climate, could entirely change its character in a few years, the sparrow question will probably here go through the same, though briefer, stages of opinion as in Europe. I consider the sparrow to be a most valuable addition to the native birds, and most certainly beneficial to both horticulturists and farmers.

And now, to return once more to the other side of the question, we will quote an article by Dr. Elliott Coues, one of our greatest ornithologists, published in the American Naturalist, August, 1878:

"It is very regretable that the 'sparrow question,' which has already become a matter of national moment, should have degenerated into such a miserable personal controversy between the sentimentalists who misrepresent the facts, and the ornithologists who understand them, that a prudent person, whatever his views, might refrain from having anything to do with it. But it is with me a matter of conscientious discharge of my duty to place the facts properly before the people, that they may be informed and warned in time, before the pest shall have become ineradicable. I do not write for ornithologists; for, so far as I am aware, there is not a scientific ornithologist in America, among those who have expressed any decided opinion, who are in favor of the wretched interlopers which we have so thoughtlessly introduced, and played with, and cuddled, like a parcel of hysterical, slate-pencil-eating school-girls. I have held a tight rein on this controversy from the first, and probably know more of its inside history than any other person; and I am in a position to affirm that the sneers, the invectives, the ridicule and abuse, and the wild assertions of the leader

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or leaders of the pro-sparrow faction, result from a frantic despair in the face of the *facts* which ornithologists coolly adduce. The fact that the sparrow is a nuisance in a variety of ways, that it does not do any appreciable good, that it does a very obvious amount of damage, that it harasses, drives off, and sometimes destroys useful native birds, and that it has no place in the natural economy of this country, are patent to every one who will take the trouble to see for himself. These same facts, some or all, are disagreeably obvious to many persons, especially agriculturists whose fields and gardens are assailed. All of these same facts are admitted by competent ornithologists generally. None of them are publicly disputed, so far as I know, by any person or persons whose authority has any weight in a question of this kind.

"The friends of the sparrows in this country fall in the following categories: First, those who know nothing and care nothing particularly about them except that they rather like the pert and brusque familiarity of the birds—a class composed chiefly of children, women, and old fogies. Secondly, those who are or were instrumental in getting the birds here, and who are interested, either in reputation or in pocket, to keep them here. Thirdly, quasi-ornithologists who have been misled into hasty expressions of opinion to which they feel bound to stick. Fourthly, the *claquers* of the last, who play a sort of 'Simon says up' game. Fifthly, a very few intelligent and scientific persons, but not practical nor professional ornithologists, who recognize fully what little good the sparrow undeniably does, and shape a favorable argument mainly from the undisputed advantages which result from a just and proper number of the sparrows in Europe.

"Most of my antagonists in this matter—those that fall in the first four categories above named—are of course not worth serious attention, for they either have no decided opinions of any sort, or else they are not open to instruction. But I have a particular word to say to those who draw an honest argument, not without some show of reason, from *the state of things in Europe*. I grant, if they wish, everything they adduce, from Prévost (who by the way is a great tallyho! for the members of the third category above) to the last investigator of the contents of sparrows' crops; and I simply reply that the argument *does not apply to the case of the sparrow in America*. In Europe these birds are part and parcel of the natural fauna of the country. They are not, as I understand, petted, pampered, and sedulously protected from their natural enemies as they are here. They shift for themselves, find certain sources of food supply, have a fair share of natural enemies, and are kept within due bounds of multiplication by natural causes; so that the "balance of power," to use a political phrase, adjusts itself. In short, they have their useful part to play and they play it; they have their natural checks, and their increase is naturally checked. They are useful birds; and when, after somewhat excessive multiplication, from any cause, they have been injudiciously exterminated in certain districts, it has been found necessary to restore such districts at great trouble and expense. All this, I believe, is admitted on all hands.

"But the principle of *mutatis mutandis* does not apply to the sparrow in America. The things that would have to be changed to make the sparrows fit here cannot be changed. The complement of our air fauna was made up without these birds. There is no room for them; and if there is any work for them, time has shown that they slight it or neglect it altogether. The only way to make the sparrows eat the worms they were imported to destroy, and which they seem to specially dislike, would be to starve them into such unpalatable fare. Instead of that, we sedulously feed them from our tables till they are grown too fat and lazy to think of worms. And if we did not do so, it would be useless to expect them to take to a diet they do not relish, when the streets are full of manure, of which they are especially fond, and the trees of our orchards are full of fruit blossoms, and the gardens are full of small fruit, and the fields are waving with grain, all these things being the *natural* food of birds of the sparrow tribe, to whom an insectivorous diet is only an occasional and temporary variation.

"Again, the matter of the limitless multiplication of these pestilent famine-breeders presents itself very differently in this country. A single female has been known to lay over thirty eggs in a season. They ordinarily raise three or four broods a year, and

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may have half a dozen at a time. They are safely housed from their natural enemies; rather, they have no special enemies in this country, and such enemies as their excessive abundance might raise up against them have, in at least one case, been summarily disposed of, as in the silly action of the Bostonian regarding the *shrikes*. There is thus practically *no* check upon their limitless multiplication, and they are insidiously multiplying at a rate that perhaps few suspect. A short ten years ago a sparrow was something of a sight anywhere; now the millions we have are countless. The sparrows have played mischief enough already, I know, but I say deliberately that this is nothing to what the next decade or two will witness if this desperate sparrow-mania goes on. We may have before long people knocking at the Congressional gates for an appropriation for a sparrow commission, like the Grasshopper Commission now sitting, to consider if there be any available relief from the scourge. When the sparrows overflow into all the country—and they are beginning to do so already—and settle in hordes on the grain-fields, a good many will doubtless be destroyed by the birds and beasts of prey, but it may then be too late. At present, an occasional stone from some idle boy, or an occasional cat on the woodshed, are all the sparrow has to look out for.

"I think it will be evident that the *argumentum ad Europeam* cannot logically apply here. I have dwelt upon it because it is the only show of reason I find in my worthier opponents; yet it is fallacious, thoroughly fallacious. The crude observations of the less worthy, the misrepresentations and tergiversations of interested persons, and all vociferations of the pyrgitomaniacs are wasted in a case like this, or are not wasted only in so far as they serve to dress up a melodramatic spectacle, at seeing which well-informed persons usually smile. The philopasserites may be reminded that sentiment is not science, the present being a question of applied or economic science; that satire, ridicule, and sophistry, however potent in the political or theological arena, are impotent in the field of science.

"For the common good as well as for the benefit of those who may care to defend the sparrows, I make the following specifications of my general charge against these birds.

"1. They neglect entirely, or perform very insufficiently, the business they were imported to do. In spite of some good service at one season of the year in a few particular localities against some particular kinds of insects, the state of our shade-trees remains substantially as it was before their introduction. Some of the decrease of noxious insects at times is due to their periodical decrease, with which the sparrows have nothing to do; and in spite of assertions to the contrary, people are still scraping trees and still employing the usual defenses against insects in precisely those places where it was said that the sparrows had done the business.

"2. They attack, harass, fight against, dispossess, drive away, and sometimes actually kill various of our native birds which are much more insectivorous by nature than themselves, and which might do us better service if they were equally encouraged. This fact is suppressed, explained away, or flatly denied, according to the disingenuousness, the aptitude for quibbling, or the audacity of the third and fourth categories of persons above described. It is attested, however, by numberless competent and veracious eye-witnesses.

"3. They commit great depredations in the kitchen-garden, the orchard, and the grain-field. We are only as yet on the very threshold of this matter, yet how obvious it is. And what may be expected, when, instead of a few hundred million sparrows, we have the millions of millions which will be ours in a few years if we persist in this folly.

"4. They are personally obnoxious and unpleasant to many persons. For myself, 'I rather like them too; they rather amuse and interest me and are not at all disagreeable, as long as I can keep their disastrous results out of mind. I am not a delicate woman nor yet a sqeamish man, to be shocked by their perpetual antics during the spring and summer; being something of an anatomist, I can stand it without embarrassment, but all are not so constituted. Neither am I a nervous invalid, to be fretted and annoyed

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into positive illness by the incessant turmoil at the window; but others are. Nor do I, I regret to say, own a house where the steps and window-sill and trellis-work and lawn are so befilthed that none of my servants will stay if they have to clean up after the birds; others, however, are in such case. I grant that this is all a matter of taste rather than of science, but such as it is, it is largely against the sparrow.

"5. They have, at present, practically no natural enemies nor any check whatever upon limitless increase. This would be undesirable, even in the case of the most desirable birds; as the case stands, *we are repeating the history of the white weed and the Norway rat.**

"I have to make one suggestion and to offer two recommendations.

"It is a fact, that with all this talk and countertalk about the *food* of the sparrow, and to what extent it may feed upon insects injurious to our fruit and shade trees, nobody has yet made the experiments obviously necessary to determine exactly what the birds eat in the country. I would, therefore, suggest the obvious propriety of finding out exactly, in the only proper and scientific way, instead of sawing the air any longer in such a futile way. I suggest that, at the height of the insect season, at the time when the sparrows should be eating the bugs, if they ever do, in some places fairly infested with bugs, a sufficient number of sparrows be killed and examined in respect to the contents of their crops. Let the authorities of any of our large cities—preferably Boston, where the birds *are said* to have done so much good, and where the sparrow combination talks loudest—furnish to proper persons, say, five hundred sparrows, whose stomachs shall be examined by some competent botanist and entomologist together. If noxious insects should be found to form the greatest portion, or even any considerable portion, of the food of these birds, I would yield the case so far as this particular count is concerned. At present I continue to believe that the scraping and other occupation of the city forestering Othellos is not gone.

"As to my recommendation, I am often asked, 'Would you then have sparrows exterminated?' While I am not prepared to advise such an extreme measure as this, I do not hesitate to declare that prompt and stringent measures should be taken, as *a matter of national economy*, to check the increase of the birds. We have enough already. Without unnecessary cruelty the numbers might be kept down, if not diminished, by the following gradually and continually operating means:

"I. *Let the birds shift for themselves.*—Turn them loose, and put them on the same footing as other birds—that is, take down the boxes and all the special contrivances for sheltering and petting the birds; stop feeding them; stop supplying them with building materials; let them take care of themselves.

"II. *Abolish the legal penalties for killing them.*—The birds are now under the arm of the law, which protects them from most of the natural vicissitudes of bird life. Let the boys kill them if they wish, or let them be trapped and used as pigeons or glass balls are now used in shooting-matches among sportsmen. Vast numbers of pigeons are destroyed in this way; there are even 'sparrow clubs' in various cities, which make a business of practicing on various of our small birds, for which the European sparrow would be an admirable substitute, answering all the conditions these marksmen could desire. In this way the birds might even be made a source of some little revenue, instead of a burden and a pest; they are to be had in practically unlimited numbers, and could be sold by the city to such persons as might desire to use them for sporting purposes.

"The present article is to be regarded as a mere outline of the important subject. I have collected a voluminous mass of testimony during the past two or three years, which I intend to digest, in order to bring the whole matter in its true light on permanent record, in treating of the species in the 'Birds of the Colorado Valley,' for the plague has spread even to that remote portion of our much-besparrowed country."

"* A writer in the *London Garden* says: "It may be remembered that in one of the back numbers of the '*Garden*' I mentioned that the introduction of the sparrows would turn out to be a great mistake, and they are now finding this out."

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The firmest upholder of the sparrows, and the man who has written most in their defense, is Dr. Thomas M. Brewer, of Boston. Owing to the fact that nearly all his writings upon this subject are controversial, and that in no one of them which we have seen is there a general summing up of the pro-sparrow arguments, we have had difficulty in selecting from them one to present to our readers. We have finally hit upon his correspondence with Mr. Galvin, city forester of Boston, as in it he summarizes his main points, and as he has always considered Mr. Galvin's evidence as almost conclusive. It is from the Boston Transcript for April:

"BOSTON, *April* 23, 1877.

"DEAR SIR: Having taken a deep interest in the introduction into this country of the house sparrow of Europe, and, while holding my own convictions, based upon careful observations as to the value of this bird, and as to the truth or the falsehood of the accusations made against them, I take this liberty to ask you a few questions. I do this because I well know that your previous knowledge of the habits of this species, and your daily opportunities of a closer study of them than any one else can enjoy since their introduction into Boston, give to your evidence an indisputable importance, and that your conclusions far outweigh the crude, hasty opinions of prejudiced persons who have never had the opportunity as yourself, and whose sweeping assertions have no reliable data for their basis, but are, therefore, untrustworthy and worthless. You have, no doubt, seen those oft-repeated accusations, all of which are contrary to my experience. Desiring to know whether I am right or wrong in my conclusions, I take the liberty of appealing to you, that you may correct me if I am wrong, and confirm me wherever I may be right.

"Was the introduction of the sparrow attended with any marked effect in Boston in the destruction of insects injurious to the foliage of ornamental trees on the Common or elsewhere in the city?

"Have you any reason to believe that the sparrow is still beneficial to our community in the destruction of injurious insects?

"Have you ever known the sparrow to attack any other bird or contend with any species except in defense of its own nest or box?

"Have you noticed any decrease in the number of our native birds that visit our city in the summer season; and, if so, of what species; and do you attribute any decrease to known adverse action of the sparrow?

"The Daily Advertiser recently asserted, as a positive, indisputable fact, that the sparrow shows a particular animosity against the robin and the bluebird. If this be true, it cannot have escaped your notice. Have you witnessed or have any of your men reported to you any instances of such animosity?

"In this matter, with all my own warmly-interested sympathy for and in favor of the sparrow, I desire a full and candid statement of your convictions, drawn from your own observations, whether they are in support of my views or the contrary.

"Yours, very sincerely,

"T. M. BREWER.

"JOHN GALVIN,
"*City Forester.*"

"CITY HALL, *Boston, April* 23, 1877.

"DEAR SIR: I am perfectly willing to answer all your questions frankly and fully. You are right in supposing that I am and have been familiar with the habits of the sparrow even before their introduction. Since their coming to Boston my duties and those of my men have given them constant opportunity to notice what they do. Their introduction into Boston was immediately attended with great benefit, almost beyond calculation. The trees on the Common were infested with a nasty yellow caterpillar, which destroyed the leaves and buds of the elms and other trees, and these insects in-

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creased very rapidly in spite of all my men could do to destroy them. And at the south end the elm trees were eaten every June by swarms of canker-worms. Both of these pests have been pretty nearly exterminated, and the trees, many of which would otherwise have died, have been saved.

"The sparrow is still of great use; but for it, these insects would return, and other pests would attack the trees. Last spring (1876) the buds of many of the larger elms were attacked by a great many of a small kind of lice. The sparrows soon found them out and ate them greedily. Consequently, the foliage, instead of drying up, as it would have done but for the sparrows, was never finer. My men could do nothing. They had no wings like the sparrow, who could cling to the buds and clean them one by one. Yet for all this good the sparrow was doing there were some so prejudiced against it and who can see no good, but only harm, in anything it does, who raised a hue and cry that the sparrows were eating the buds! Instead of that they were eating the bud-eater; but instead of being thanked for the good they were doing, they were only abused. I believe that the wages of all my men would not compensate Boston for the loss of the sparrow.

"In answer to your third question, I say, without hesitation, the sparrow does not molest or interfere with any other bird. It does not trouble the robin or bluebird or manifest any animosity against either. All summer long they are together, and it would be impossible for this to be done without my men or I noticing it, yet I never witnessed anything of the kind.

"I have not noticed any decrease in the number of birds; on the contrary, a very marked increase of various kinds. The robins were more numerous on the Common last summer than ever before. The little chip-sparrow has become very numerous, and seems to be very fond of the sparrow, often feeding on the same bit of bread. The small martins have very greatly increased in numbers on account of the number of boxes. These they have taken possession of whenever they want one, and drive the sparrow away. Before the sparrows came there were no bluebirds at all; now they are becoming quite common, and often treat the sparrows very badly, taking away their boxes and breaking up their nests. The sparrows, of course, show fight, but the bluebirds are always too strong for them. The writer in the Advertiser, in my opinion, is all wrong.

"I am all in favor of the sparrows. I believe that they do no harm, but a great deal of good. Thousands of dollars would not pay the city for their loss, and I would be very sorry to see anything done to prejudice people against them or permit their destruction.

"JOHN GALVIN,
"*Superintendent.*

"Dr. THOMAS M. BREWER."

Prof. Samuel Aughey, of Lincoln, Nebr., from whom we have already quoted, a gentleman who has paid great attention to the subject of insectivorous birds, has decided opinions on the sparrow question. The following is from his report to the United States Entomological Commission:

"Some persons have advocated the introduction of English sparrows in order to mitigate our insect plagues. Such a policy, it appears to me, would be highly objectionable. The moral qualities, or what is near akin to moral qualities, of the English sparrow are bad. Where I have seen this bird in America it has gradually driven off our small native birds. Around Philadelphia, where it has now monopolized the ground, I last year renewed its acquaintance. I again revisited some of my old haunts where in early life I studied our native birds. I could hardly find a bluebird, a robin, or native sparrow where they were abundant in 1858, 1859, 1860, and 1861. The English sparrow, however, greeted me everywhere. It was the opinion of all that I consulted that it had driven off the native birds. Certainly this, to say the least, is

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unfortunate. Many kinds of birds not only give more variety, but they certainly destroy insects of more species than a single one. If we protect our own native birds, and especially if we cultivate groves of timber where they can find shelter, and banish hunting-dogs, guns, and traps, in a comparatively few years the balance of nature must be so restored that insects will rapidly decrease, and again reach the normal number that prevailed at the first settlement of the country. Besides, it is well known that the English sparrow has become partially naturalized in a small section of Nebraska. Some years ago, as I have learned from Hon. J. Sterling Morton, the English sparrows were introduced into Nebraska City, and have multiplied to a considerable extent, but the number of species of insects that they feed on, as has been anticipated, has been found to be small. This, of course, could have been endured if they were not so hostile to other birds, native to the soil, that do much better.

"Another fact concerning these sparrows, not well known, is that they are only partly insectivorous; they are more granivorous than insectivorous, and in their native habitats they are often destroyed because of their destructive raids on wheat and other grain seeds. They have, therefore, far less claim on our protection and care than our own far more beautiful and more highly insectivorous birds. It is another illustration of the fact that sometimes we go abroad for that which we have in greater perfection at home."*

From these representative opinions it will be seen that, to say the very least, much doubt exists as to the real character of the English sparrow. Under existing circumstances, therefore, it will pay the Southern planters to hesitate long before introducing into their midst what may prove to be a curse, and thus taking a step which they may long regret. My own advice is, after careful consideration of the subject, cultivate and protect the native birds, and drop all thought of the English sparrow for the present. Protect the native insectivorous birds, by putting a stop to their destruction by ignorant individuals and by birds of prey. There are two birds in particular which should always be killed on sight. These are the blue-jay and the cow-bird. We quote from Professor Aughey concerning these two bad characters:

Among the birds most hostile to birds are the blue-jays. They rob the nests of other birds of their eggs. Wantonly they often kill even the young and throw them out of the nest. The increase of jays is, therefore, incompatible with the general increase of insectivorous and other small birds, especially of those that nest on trees and shrubs. It is hard for the naturalist to give up such a dandy among birds, but, as he is only a blackleg in fine clothes, the feathered tribes are healthier and safer without his society.

Perhaps no bird causes such wholesale destruction among birds as the cow-bird. Its habit of laying its eggs in the nests of other birds, one only in a nest, and leaving them to be hatched out and nourished by the foster parents, to the destruction of their own kind, merits banishment and death. Even crows and magpies do much less harm to other birds than jays and cow-birds.

In addition to doing away with these active enemies of the insectivorous birds, the latter should be encouraged in every possible way to nest around plantations. For the martins, native sparrows, and others that will make use of artificial nesting places, boxes should be provided, if possible. Children should be taught to protect, not to destroy them,

* Any person desiring to study the subject further will find a complete bibliography of the sparrow controversy in the Bulletin of the Hayden Geological and Geographical Survey of the Territories, vol. v, No. 2, compiled by Dr. Elliott Coues.

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and a general sentiment in favor of birds should be established. Not only would the cotton-worm suffer, but a good step will have been taken towards releasing the planter from the tyranny of his other numerous insect enemies.

Among reptiles, several varieties of lizzards have been reported by correspondents as eating cotton-worms, but none have mentioned names or forwarded specimens, so we shall have to do without specific names. Land turtles are also reported to be fond of the worms, and, as might naturally be expected, the common toad is said to feast upon them.

The following is a list of the insectivorous birds occurring in the cotton belt. Those *nesting* in the Southern States, and which consequently are to be relied upon in time of need, are marked with an asterisk.

For this list the department is indebted to Mr. Robert Ridgeway, ornithologist to the Smithsonian Institution:

* NAUCLERUS FURCATUS, Vigors. *Swallow-tailed Hawk.* Feeds extensively upon grasshoppers.

* ICTINIA MISSISSIPPIENSIS, Gray. *Mississippi Kite.* Feeds extensively upon grasshoppers.

* COCCYGUS AMERICANUS, Bonap. *Yellow-billed Cuckoo, or Rain Crow.*

* COCCYGUS ERYTHROPHTHALMUS, Bonap. *Black-billed Cuckoo.*

* CAMPEPHILUS PRINCIPALIS, Gray. *Ivory-Billed Woodpecker.*

* PICUS VILLOSUS, Linn. *Hairy Woodpecker.*

* PICUS SCALARIS, Wagler. *Texas Sapsucker.*

* PICUS BOREALIS, Vieill. *Red Cockaded Woodpecker.*

* HYLOTOMUS PILEATUS, Baird. *Black Woodpecker.*

* CENTURUS CAROLINUS, Bonap. *Red-bellied Woodpecker.*

* MELANERPES ERYTHROCEPHALUS, Sw. *Red-Headed Woodpecker.*

* COLAPTES AURATUS, Swainson. *Yellow-shafted Flicker.*

* CHAETURA PELASGIA, Steph. *Chimney Swallow.*

* ANTROSTOMUS CAROLINENSIS, Gould. *Chuck-will's-widow.*

* ANTROSTOMUS VOCIFERUS, Bonap. *Whip-poor-will.*

* CHORDEILES POPETUE, Baird. *Night Hawk.*

* MILVULUS FORFICATUS, Sw. *Scissor-tail.* Not found east of Louisiana.

* TYRANNUS CAROLINENSIS, Baird. *King Bird; Bee Bird.* Destructive to bees.

* TYRANNUS DOMINICENSIS, Rich. *Gray King Bird.*

* MYIARCHUS CRINITUS, Cab. *Great Crested Flycatcher.*

* SAYORNIS FUSCUS, Baird. *Pewee.*

* CONTOPUS VIRENS, Cab. *Wood Pewee.*

* EMPIDONAX ACADICUS, Baird. *Green-crested Flycatcher.*

* TURDUS MUSTELINUS, Gm. *Wood Thrush.*

TURDUS PALLASI, Cab. *Hermit Thrush.*

TURDUS FUSCESCENS, Stephens. *Wilson's Thrush.*

TURDUS SWAINSONII, Cab. *Olive-backed Thrush.*

TURDUS ALICIAE, Baird. *Gray-cheeked Thrush.*

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* TURDUS MIGRATORIUS, Linn. *Robin.* Destructive to certain small fruits.

* SIALIA SIALIS, Baird. *Blue Bird.*

REGULUS CALENDULA, Licht. *Ruby-crowned Wren.*

REGULUS SATRAPA, Licht. *Golden-crested Wren.*

ANTHUS LUDOVICIANUS, Licht. *Tit-lark.*

* MNIOTILTA VARIA, Vieill. *Black and white Creeper.*

* PARULA AMERICANA, Bonap. *Blue Yellow-back.*

* PROTONOTARIA CITREA, Baird. *Prothonotary Warbler.*

* GEOTHLYPIS TRICHAS, Cab. *Maryland Yellow-throat.*

GEOTHLYPIS PHILADELPHIA, Baird. *Mourning Warbler.*

OPORORNIS AGILIS, Baird. *Connecticut Warbler.*

* OPORORNIS FORMOSUS, Baird. *Kentucky Warbler.*

* ICTERIA VIRIDIS, Bonap. *Yellow-breasted Chat.*

* HELMITHERUS VERMIVORUS, Bonap. *Worm-eating Warbler.*

* HELMITHERUS SWAINSONII, Bonap. *Swainson's Warbler.*

* HELMINTHOPHAGA PINUS, Baird. *Blue-winged Yellow Warbler.*

HELMINTHOPHAGA CHRYSOPTERA, Baird. *Golden-winged Warbler.*

* HELMINTHOPHAGA BACHMANI, Cab. *Bachman's Warbler.*

HELMINTHOPHAGA RUFICAPILLA, Baird. *Nashville Warbler.*

HELMINTHOPHAGA CELATA, Baird. *Orange-crowned Warbler.*

HELMINTHOPHAGA PEREGRINA, Cab. *Tennessee Warbler.*

* SEIURUS AUROCAPILLUS, Sw. *Golden-crowned Thrush.*

SEIURUS NOVEBORACENSIS, Nutt. *Water Thrush.*

* SEIURUS LUDOVICIANUS, Bonap. *Large-billed Water Thrush.*

DENDROICA VIRENS, Baird. *Black-throated Green Warbler.*

DENDROICA CANADENSIS, Baird. *Black-throated Blue Warbler.*

DENDROICA CORONATA, Gray. *Yellow-rump Warbler.*

DENDROICA BLACKBURNIAE, Baird. *Blackburnian Warbler.*

DENDROICA CASTANEA, Baird. *Bay-breasted Warbler.*

* DENDROICA PINUS, Baird. *Pine-creeping Warbler.*

DENDROICA PENNSYLVANICA, Baird. *Chestnut-sided Warbler.*

* DENDROICA CAERULEA, Baird. *Blue Warbler.*

DENDROICA STRIATA, Baird. *Black Poll Warbler.*

* DENDROICA AESTIVA, Baird. *Yellow Warbler.*

DENDROICA MACULOSA, Baird. *Black and Yellow Warbler.*

DENDROICA KIRTLANDII, Baird. *Kirtland's Warbler.*

DENDROICA TIGRINA, Baird. *Cape May Warbler.*

DENDROICA CARBONATA, Baird. *Carbonated Warbler.*

DENDROICA PALMARUM, Baird. *Yellow Red Poll.*

* DENDROICA SUPERCILIOSA, Baird. *Yellow-throated Warbler.*

* DENDROICA DISCOLOR, Baird. *Prairie Warbler.*

* MYIODIOCTES MITRATUS, Aud. *Hooded Warbler.*

MYIODIOCTES MINUTUS, Baird. *Small-headed Flycatcher.*

MYIODIOCTES PUSILLUS, Bonap. *Green Black-cap Flycatcher.*

MYIODIOCTES CANADENSIS, Aud. *Canada Flycatcher.*

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* SETOPHAGA RUTICILLA, Sw. *Redstart.*
* PYRANGA RUBRA, Vieill. *Scarlet Tanager.*
* PYRANGA AESTIVA, Vieill. *Summer Red Bird.*
* HIRUNDO HORREORUM, Barton. *Barn Swallow.*
* HIRUNDO LUNIFRONS, Say. *Cliff Swallow.*
* HIRUNDO BICOLOR, Vieill. *White-bellied Swallow.*
* COTYLE RIPARIA, Boie. *Bank Swallow.*
* COTYLE SERRIPENNIS, Bonap. *Rough-winged Swallow.*
* PROGNE PURPUREA, Boie. *Purple Martin.*
* AMPELIS CEDRORUM, Baird. *Cedar Bird.* Feeds also on cherries, &c.
* COLLYRIO LUDOVICIANUS, Baird. *Loggerhead Shrike.*
* VIREO OLIVACEUS, Vieill. *Red-eyed Flycatcher.*
VIERO PHILADELPHICUS, Cassin. *Philadelphia Vireo.*
* VIERO GILVUS, Bonap. *Warbling Flycatcher.*
* VIREO NOVEBORACENSIS, Bonap. *White-eyed Vireo.*
* VIREO SOLITARIUS, Vieill. *Blue-headed Flycatcher.*
* VIREO FLAVIFRONS, Vieill. *Yellow-throated Flycatcher.*
* MIMUS POLYGLOTTUS, Boie. *Mocking Bird.* Feeds also upon berries and other small fruit.
* MIMUS CAROLINENSIS, Gray. *Cat Bird.* Feeds also upon berries and other small fruit.
* HARPORHYNCHUS RUFUS, Cab. *Brown Thrush.*
* THRYOTHORUS LUDOVICIANUS, Bonap. *Great Carolina Wren.*
* THRYOTHORUS BEWICKII, Bonap. *Bewick's Wren.*
* CISTOTHORUS PALUSTRIS, Cab. *Long-billed Marsh Wren.*
* CISTOTHORUS STELLARIS, Cab. *Short-billed Marsh Wren.*
* TROGLODYTES AEDON, Vieill. *House Wren.*
TROGLODYTES HYEMALIS, Vieill. *Winter Wren.*
CERTHIA AMERICANA, Bonap. *American Creeper.*
SITTA CAROLINENSIS, Gmelin. *White-Bellied Nuthatch.*
SITTA CANADENSIS, Linn. *Red-Bellied Nuthatch.*
SITTA PUSILLA, Latham. *Brown-headed Nuthatch.*
POLIOPTILA CAERULEA, Sclat. *Blue-gray Gnatcatcher.*
LOPHOPHANES BICOLOR, Bonap. *Tufted Titmouse.*
PARUS CAROLINENSIS, Aud. *Carolina Titmouse.*
†* CHRYSOMITRIS TRISTIS, Bonap. *Yellow Bird.*
* COTURNICULUS PASSERINUS, Bonap. *Yellow-winged Sparrow.*
* COTURNICULUS HENSLOWI, Bonap. *Henslow's Bunting.*
* AMMODROMUS CAUDACUTUS, Sw. *Sharp-tailed Finch.*
* AMMODROMUS MARITIMUS, Sw. *Sea-side Finch.*
* SPIZELLA PUSILLA, Bonap. *Field Sparrow.*
* SPIZELLA SOCIALIS, Bonap. *Chipping Sparrow.*

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† The sparrow tribe (*Fringillidæ*) are chiefly granivorous, but prey upon insects to a greater or less extent during the breeding season. Only those breeding in the cotton States are included in this list.—R. R.

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* MELOSPIZA MELODIA, Baird. *Song Sparrow.*
* PEUCAEA AESTIVALIS, Cab. *Bachman's Finch.*
* EUSPIZA AMERICANA, Bonap. *Black-throated Bunting.*
* GUIRACA CAERULEA, Sw. *Blue Grosbeak.*
* CYANOSPIZA CIRIS, Baird. *Painted Bunting.*
* CYANOSPIZA CYANEA, Baird. *Indigo Bird.*
* SPERMOPHILA MORELETII, Pucheran. *Little Seedeater.*
* PYRRHULOXIA SINUATA, Bonap. *Texas Cardinal.*
* CARDINALIS VIRGINIANUS, Bonap. *Red Bird.*
* PIPILO ERYTHROPHTHALMUS, Vieill. *Ground Robin; Towhee.*
* AGELAIUS PHOENICEUS. Vieill. *Red-winged Blackbird.*
* STURNELLA MAGNA, Sw. *Meadow Lark.*
* ICTERUS SPURIUS, Bonap. *Orchard Oriole.* Extremely beneficial.
* ICTERUS BALTIMORE, Daudin. *Baltimore Oriole.* Extremely beneficial.
* QUISCALUS MACROURA, Sw. *Long-tailed Grakle.*
* QUISCALUS MAJOR, Vieill. *Boat-tailed Grakle.*
* QUISCALUS VERSICOLOR, Vieill. *Crow Blackbird.*
* QUISCALUS BARITUS, Vieill. *Florida Blackbird.*
* CORVUS AMERICANUS, Aud. *Common Crow.* Great difference of opinion as to whether destructive or not, but unquestionably chiefly insectiverous.
* var. CORVUS FLORIDANUS, Baird. *Florida Crow.*
* CORVUS OSSIFRAGUS, Wilson. *Fish Crow.*
* CYANURA CRISTATA, Sw. *Blue Jay.* Omnivorous and scarcely beneficial.
* CYANOCITTA FLORIDANA, Bonap. *Florida Jay.*
* ORTYX VIRGINIANUS, Bonap. *Partridge; Quail.* Very beneficial; few birds, if any, more so.

INVERTEBRATE ENEMIES.

The invertebrate enemies of the cotton-worm are, with the exception of the spiders, all true insects. These enemies may be divided, for the sake of convenience, into those *predaceous* and those *parasitic* upon the cotton-worm in one or another of its stages.*

PREDACEOUS.

SPIDERS (*Araneida*).—That the numerous spiders, always to be found about cotton fields, do a considerable amount of good in capturing the cotton-worms and the cotton-moths cannot be doubted. The jumping

* The use of these two words in contradistinction the one to the other is to be deprecated, under ordinary circumstances, from the fact that they are not sufficiently definitely limited in their meaning, and that there are many insects which it would be difficult to designate by the one word or the other. In the present case, however, no such difficulty occurs, and we adopt the terms *predaceous* and *parasitic* as affording the most convenient division of this head.

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spiders (*Attides*) destroy many young larvae and occasionally are able to capture a moth.

Mr. Trelease says:* "One day in July I saw a small jumping-spider leap upon a half grown larva, which it killed and sucked the juices from." This spider proved to be a specimen of *Attus nubilus* and was only a trifle over one-sixth of an inch in length (4^{mm}). As a characteristic jumping spider we figure it. (See Fig. 6.) In color the thorax is dark brown and the abdomen is very light with markings of brown. These jumpers never lose a chance to catch a moth when they are able, as is evinced by the following extract, also from Mr. Trelease's report:

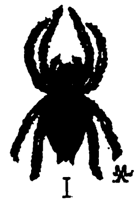

FIG. 6.—Attus nubilus.

About twilight of August 27, while watching numbers of moths engaged in eating rotting peaches on the ground, I heard a rather loud rustling among them, and several took flight from the point where the noise was heard. Going to the spot I found that a large ground-spider had captured one of the moths, which was beating its wings in futile efforts to escape. Owing to the darkness, the spider was allowed to escape, so that I did not determine the species.

The large nesting spiders (*Epeirides*), of which the commonest species through the Southern cotton-fields is *Argiope riparia* (*Epeira riparia* of older authors), catch the moths in their webs.

A common and doubtless a beneficial species which I observed upon the cotton-plant in Alabama is a large pale-green spider, with long spiny legs (*Oxyopes viridans*). (See Fig. 7.)

Clubiona pallens was found nesting in cotton quite abundantly. They fold the cotton leaves in much the same manner as do the cotton-worms, forming thereby a sort of basket, in which they deposit their eggs. They may at once be distinguished from the *Aletia* web by the whiteness of the silk of the former.

FIG. 7.—Oxyopes viridans.

Among the smaller species which have been noticed upon the plant among the young worms may be mentioned *Attus fasciatus*, *Theridium globosum*, *Theridium funebre*, *Epeira stellata*, *Sinyphia communis*, *Tethragnata extensa*, *Metha sp.*, *and Xysticus sp.*†

Of the true insects that prey upon the eggs, larvae, or adult of *Aletia argillacea*, some 35 species have been observed by the correspondents and observers of the department. Of these we shall speak in their regular scientific order, beginning with those belonging to the NEUROPTERA, the lowest order of insects.

*Appendix I, report of William Trelease.

†The determinations of the spiders mentioned in this report were made by Mr. George Marx, of this department.

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APHIS LIONS (*Neur.*, gen. *Chrysopa*). The aphis lions are the larvae of the "golden-eyed lace-wing flies"—insects with slender bodies and extremely delicate, gauze-like wings.

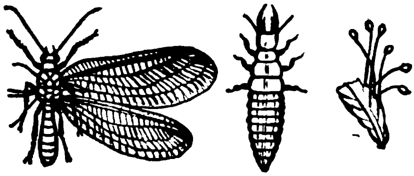

FIG. 8.—Chrysopa perla.

Their color is usually green and their eyes golden (represented in all stages by Figures 8 and 9). Upon being disturbed, they emit a disagreeable, fetid odor. Their eggs are white and are supported by long foot-stalks, as shown in the figure, usually upon plants infested with plant-lice. The larvae are active and extremely voracious. There are

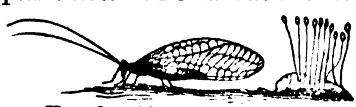

FIG. 9.—Chrysopa oculata.

two or more broods in the course of the summer, and the last brood winters in the chrysalis state, protected by a compact, round, whitish cocoon.

These aphis lions are abundant upon the cotton plant throughout the summer, and in the early part of the season do the planters much good by destroying the cotton-aphides in large numbers. Later in the season, we have the authority of Dr. Phares for stating that they devour the eggs and newly-hatched larvae of the cotton-moth. Mr. Trelease makes the following mention of these insects:

The larvae (aphis-lions) of the lace-winged flies are also very plentiful on cotton, where they prey upon Aphides, and very likely they may also destroy eggs of *Aletia*.

In his notes he says:

Late in July numerous individuals of the larvae of lace-winged flies, or aphis-lions have been found with their jaws over the glands on the under surface of the cotton-leaves, where they were probably feeding on nectar through their hollow mandibles, though they may have been lying in wait for some insect.

Mr. Trelease also states that it is an idea prevalent among many planters that these lace-winged flies are always to be found where there are larvae of *Aletia*.

MOSQUITO-HAWKS, DRAGON-FLIES, or DEVIL'S DARNING-NEEDLES (*Neur.*, Fam. *Libellulidae*).—These insects, in the adult stage, are so well known as not to warrant description. The eggs are laid in the water, either indiscriminately dropped or deposited around the stem of some aquatic plant. The larvae are predacious, living upon other aquatic insects, and are remarkable for two things: 1, the syringe-like apparatus into which the posterior part of the alimentary canal is transformed, and by violently ejecting a stream from which the insect is propelled through the water; and, 2, the arrangement of the jaws at the tip of a long spoon-shaped projection of the lower lip, which can be folded under the head out of sight while the insect approaches its unsuspecting prey. The habits of the perfect insects are also predaceous. (We figure one of the most common species, *Libellula trimaculata*.) They catch and eat numbers of insects upon the wing.

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As to their good offices in destroying cotton-moths, we quote from Mr. F. M. Meekin, of Morrison's Mills, Alachua County, Florida:

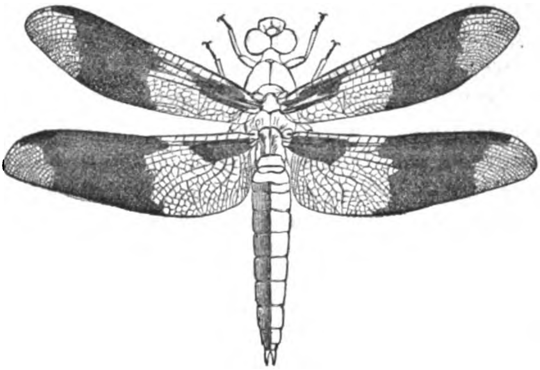

FIG. 10.—Libellula trimaculata.

There is an insect commonly called the mosquito-hawk (I do not know its technical name). It is long-bodied, has two sets of membranous wings, a large head, and a long continuation of the abdominal portion of the body. There are many sizes and colors. They live on insects and on each other, and I have frequently seen them catch the moth of the cotton-caterpillar. This mosquito-hawk is very numerous here, of many varieties, varying in size from an inch to two and a half or three inches in length of body. I think it does more to prevent the development of the cotton-caterpillar than all the rest of its enemies.

Mr. Meekin probably claims too much for these insects. Still, in view of his statements and of the well-known habits of dragon-flies, there can be little doubt but that they can be considered as active enemies of the cotton-moth.

In the next order, ORTHOPTERA, we find but one insect which preys upon *Aletia argillacea;* although in parts of Texas, according to Mr. Schwarz, the planters insist that the grasshoppers eat the cotton-worm!

THE REAR-HORSE, CAMEL-CRICKET, OR DEVIL'S RIDING-HORSE (*Mantis Carolina*). As useful an insect as occurs in the Southern States is known by the above popular names in different localities. Its food consists entirely of other insects, which it approaches stealthily and seizes with its powerful spined forelegs. The amount of good which it does in thus destroying noxious insects is hard to estimate. The capacity of each individual can be seen from the fact that in one night a single female has been known to kill and devour eleven Colorado potato beetles,

FIG. 11.—Eggs of Mantis Carolina.

leaving only the wing-cases and parts of the legs.* The only objection to them seems to be that they are not sufficiently discriminating in choosing their prey, and beneficial as well as noxious insects suffer from their attacks. They seem to be especially fond of one another, and after sexual union the female frequently devours the male.†

*See First Missouri Entomological Report, p. 169 (1869).
†See Packard's Guide to the Study of Insects, p. 575.

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The mantis winters in the egg state and its peculiar egg masses (see Fig. 11) are abundant and conspicuous upon tree twigs throughout the winter.

In spite of the good reputation of these "rear-horses" as insect destroyers, Mr. J. H. Krancher, of Millheim, Austin County, Texas, seems to be the only one of our correspondents who has actually seen them kill the cotton-worms, as he includes them in his list of insect enemies. In addition, Mr. Trelease reports the following:

My friend Mr. John Wilkins, of Selma, Ala., tells me that in the canebrake he has several times seen the common green mantis (*Mantis Carolina*) leap upon these larvae (cotton-worms) on plants near the borders of cotton-fields, but these insects do not venture far from the bushes around the field.

It is probable, however, that these insects are more abundant than it would seem at first glance, and when the cotton is well grown will probably be found in all parts of the field and not confined to the bushes around its border. They should never be thoughtlessly killed.

The next order, HEMIPTERA, contains several hard-working cotton-worm enemies.

THE SPINED SOLDIER-BUG (*Arma* (*Podisus*) *spinosa* Dallas).—This insect (Fig. 12) is a most useful one from its usual cannibalistic habits. Mr. Glover's *résumé* of its habits is as follows:*


FIG. 12.—Arma spinosa.

"Ins. found puncturing the leaves and limbs of apple-trees and sucking out the sap (Fitch). It is, however, also beneficial as destroying the larvæ of the Colorado potato-bug (*Doryphora* 10-*lineatea*) by puncturing them with its beak and sucking out their juices. It also destroys lady-bugs (*Coccinella*) (American Entomologist) Andrena, a wild bee, and the American gooseberry saw-fly (*Pristiphora grossulariæ*, Walsh; also the Cicada (Am. Ent., i., 47). This insect is said to be one of the bitterest enemies to the Colorado potato-bug, and therefore, although it may perhaps do some injury to fruit trees, it ought to be regarded as a public benefactor and not destroyed."

There can be no doubt but that this insect does an excellent work in the cotton-fields of the South. Dr. Phares says, in answer to question 6 *a* of the 1878 circular:

Many are said to do so, of which I cannot testify; but for the following I can: Soldier-bugs pierce the caterpillar, suck their juices, and thus destroy them (see illustrative plate, Rural Carolinian, August, 1870, p. 683). The soldier-bug presents his lance, moves deliberately and steadily along till the caterpillar is impaled.

Specimens were also received from Mr. Trelease, with the remark that he had observed them on several occasions to kill the cotton-worm. In addition to these statements, we have two more which may possibly refer to this insect, although they may just as well refer to any one of the many others in this order. Mr. George F. Webb, of Amite County, Mississippi, says: "There is an insect, the name of which I cannot give, that pierces with its beak into the worm, and the worm expires; but this is of no consequence, the number of worms being billions and the bugs being comparatively few." Dr. J. U. Ball, of Bayou Sara,

*Manuscript Notes from my Journal, Hemiptera. Washington, 1876.

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La., says: "The chinch-bug known to be one of its enemies;" and J. P. Krancher states that "several varieties of field bugs are known to attack it."

THE GREEN SOLDIER-BUG (*Raphigaster* [*Nezara*] *hilaris*, [*Pennsylvanicus*, of Fitch.]).

This insect was figured by Mr. Glover in his report on Cotton Insects (Rept. Dept. of Agri., 1855, Pl. VIII, Fig. 5, p. 93), and in the text spoken of as piercing cotton-bolls and sucking the sap. Mr. Bailey, of Monticello, Fla., is given as authority for the statement. It was said to be very abundant in the cotton fields.

FIG. 13.—Raphigaster hilaris.

Concerning its killing the cotton-worm, Professor Willet in a recent letter to this department has the following:

A word about an enemy to the cotton-worm. At Montezuma, Macon County, Georgia, September 20, when collecting cotton-worms (*Aletia argillacea*) for experiments, I saw one extended in the air horizontally from a cotton leaf, holding on only by his two anal feet and contorting his body about as if in great pain. On examination, I found a plant bug had pierced him about the anus and was quietly sucking his juices. I had no vial nor box, and could only drop them in the basket with other larvæ. The next morning I found the caterpillar dead; but the bug was not to be found. I think from the hurried sight I got it is what Glover calls the green Plant Bug, Plate VIII, Fig. 5. A gentleman living there told me he saw another cotton-worm impaled in its side by a similar bug.

It would, of course, be unsafe to accept the identity of the insects upon such insufficient grounds, but it is probable that, if not the same, Mr. Willet's insect was an allied species of Raphigaster. We have Mr. Glover's authority that either *hilaris* or a closely allied species is predaceous upon the Colorado potato-beetle. It is probable also that the same insect is meant by several of our correspondents, who enumerate "green chinches" as among the enemies of the cotton-worm. A very conscientious correspondent says, "I have seen a green chinch sucking the juices of the cotton-worm; cannot say that the worm was injured by the act"!

THE THICK-THIGHED METAPODIUS (*Acanthocephala* [*Metapodius*] *femorata*, Fab., *Rhinuchus nasulus* of Say).—Concerning the occurrence of this insect in the cotton field, Mr. Glover said in 1855:

These insects, though somewhat numerous, were never observed to suck the sap from the bolls, yet it would be well to investigate their habits more minutely before deciding whether they are injurious or not.

The following short account of the insect is from the department report for 1875, p. 129:

Acanthocephala (*Metapodius femorata*), so called from its swollen, spiny thighs, is a large reddish-brown or blackish insect, quite abundant in the southern cotton fields. It is very slow in its motions, and appears to be fond of basking in the sun. The thighs are strongly developed and spiny, especially on the under side, while the shanks have broad thin plate or leaf-like projections on their sides, which gave these insects a very peculiar appearance. The eggs are smooth, short, oval, and have been found arranged in beads like a necklace on the leaf of white pine. The full-grown

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insect is said to injure cherries in the Western States by puncturing them with its beak and sucking out the juices, thus proving it, at least in one instance, to be a feeder on vegetable substances.

FIG. 14.—Acanthocephala femorata.

Its importance to the cotton planter is shown by the following account by Mr. Trelease:

Several bugs (*Hemiptera*) were seen to kill the cotton-worm. Early in the season great numbers of a large ill-smelling bug with dilated hind legs (*Acanthocephala femorata*) were seen in the weeds and shrubbery about the borders of the cotton-fields, being very noticeable on account of its buzzing flight. After *Aletia* appeared in numbers, fewer of these bugs were seen, but they were several times seen to catch caterpillars and suck the juices of their bodies.

The full-grown insect is shown at Fig. 14. Planters will do well to avoid destroying either these insects or their eggs.

THE DEVIL'S HORSE OR WHEEL-BUG (*Prionotus cristatus*, Lin.; *Reduvius novenarius*, Say).—Mr. Glover, in the 1855 report, mentions this insect as among the few beneficial to the cotton plant. He there mentions that he placed a young

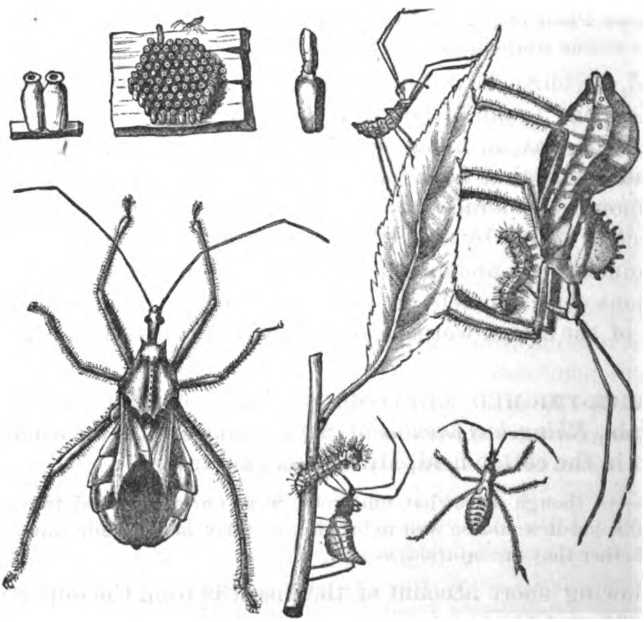

FIG. 15.—Prionotus cristatus.

specimen of *Reduvius* in a box with ten caterpillars, all of which it destroyed in the short space of five hours.

Concerning the general habits of the insect, we quote from the excellent account in the Department of Agriculture Report for 1875, p. 128:

This insect is very common in Washington, and is very destructive to insects; and as agriculturists are very apt to clear their trees in spring of eggs, cocoons, &c., of

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insects, imagining that they are all injurious to vegetation, it will be well to warn them that some species are beneficial, by destroying injurious insects, and their clusters of eggs should be preserved wherever found. Among these, a hexagonal mass of eggs will frequently be met with, cemented together with a species of gum or resin, which is said to be gathered from the tree by the female. These hexagonal masses of eggs are deposited on the bark of trees, on fence-rails, under the eaves of outbuildings, or wherever the female chances to be at the time of oviposition, to the number of seventy or more; each egg, when separated from the mass presenting the appearance of a somewhat square flask standing on its own bottom. The larvae, when young, are blood-red with black marks, and do not resemble the adult insect, excepting somewhat in form and habits. The larvae, pupae, and perfect insects feed upon all other insects they can overcome, not even sparing their own brethren. When very young they destroy great numbers of plant-lice, *Aphides*, and, when older, they prey upon caterpillars, or, indeed, upon any other insect they can overpower. They kill their prey by inserting into it the proboscis, which ejects a most powerful poisonous liquid into the worm. The victim thus pierced dies in a very short time. Then they leisurely suck the juices out and drop the empty skin.

The perfect wheel-bug is a large and very singular-looking insect, of very slow and deliberate motions when undisturbed and stealing up to its prey. It is of a grey color, and has a high semicircular ridge or projection on the crest of its thorax, armed with nine perfectly arranged teeth or cog-like protuberances like very short spokes or cogs of a wheel; hence the vulgar name of wheel-bug. The young shed their skins several times before attaining their full size. As this insect is constantly employed, from the moment it is hatched, in searching for and destroying noxious insects, it may be considered a friend to the horticulturist and farmer.

A dozen or so of these insects, placed near the nest of some of those caterpillars so destructive to our fruit and forest trees will destroy almost every caterpillar in it in a short time, as they are so extremely voracious that each insect will destroy several caterpillars daily. Great care must be taken, however, when handling the adult insects, as they are very apt to sting or rather insert their strong curved beaks into the naked flesh, and the poisonous fluid ejected, when the wound is made, is extremely powerful, and much more painful than the sting of a large wasp or hornet. One of these insects, having stung the writer, the pain lasted for several hours, and was only alleviated by applications of ammonia. Several days afterward the flesh immediately surrounding the puncture was so much poisoned that it sloughed off, leaving a small hole in the injured thumb.

For the activeness of the devil's horse in the cotton fields of the South, many correspondents have vouched, and planters should treat him like the friend that he is.

THE RAPACIOUS SOLDIER-BUG (*Sinea multispinosa*, De Geer, [Say's *Reduvius raptatorius*]).—This insect (see Fig. 16) is found all over the country, North and South, preying upon all kinds of insects. Like the last-named species, when young it devotes itself to plant-lice, but upon attaining its growth it attacks insects of a larger size and of more economic importance. In the North it has done a good work in destroying canker-worms, Colorado potato-beetles, and other pests, and during the past summer they were seen in considerable numbers about the cotton fields, engaged in killing the cotton-worms.

According to the editors of the American Entomologist, Vol. I, p. 207, the eggs of the rapacious soldier-bug are about the size of a common pin's head, are laid in two parallel rows upon the bark of limbs or twigs, and each egg is bordered round its tip-end with a fringe of short prickles.

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When newly hatched, the young soldier-bugs may be frequently found in the curl of the common elm-leaf plant-louse (*Schizoneura Americana*), and also the common apple aphis (*Aphis mali*), busily engaged in devouring the lice; and it is more than probable that in the cotton fields they will be found preying upon the cotton-louse (*Aphis gossypii*). The full-grown insect is shown at Fig. 16. It is brownish in color, with a reddish stripe down the back of the abdomen. The front legs are greatly enlarged and powerfully spined, enabling the insect to hold its struggling prey. From these spines, and those upon the head, it has gained its scientific name, *Multispinosa*.

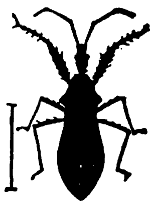

FIG. 16.—Sinea multispinosa.

In addition to these five hemipterous insects, many specimens of a small black and red bug were many times seen about the pupae of Aletia, and were often found within the loose cocoons. Although they were never actually observed to kill the chrysalides, their presence looks suspicious, especially as upon examination their beaks were found to be of the short, broad, predaceous type. All of the specimens forwarded to the department were of immature individuals, from which it was impossible to ascertain the species. They were flat, nearly round, a trifle over one-tenth of an inch (3^{mm}) in length. The head and thorax were black; the abdomen had a broad red band around near the margin, and three narrow transverse white bands.

Although we have several parasites on the cotton-worm belonging to the next order, DIPTERA, the only predaceous insects from this order are the Asilus flies.

ASILUS-FLIES OR ROBBER-FLIES (Dipt. fam. *Asiliidae*.)—The large buzzing fly with long slender abdomen, and thick hairy throat, is a familiar sight in the cotton field to the observing planter. A popular name was never more appropriately applied than that of robber-flies ("*raubfliegen*"), given to these flies by the Germans. They are among the most rapacious of insects; but not only are they as indiscriminating as other predaceous insects, but some species seem actually to *prefer* beneficial insects as a steady diet. There is almost no enemy which the apiarist fears more than these "bee-killers," as some species are termed. Dr. Fitch has written a very interesting account of these insects, from which we take the following*:

These flies are inhuman murderers. They are the savages of the insect world, putting their captives to death with merciless cruelty. Their large eyes, divided into such a multitude of facets, probably give them the most acute and accurate vision for espying and seizing their prey; and their long stout legs, their bearded and bristly head, their whole aspect indicates them to be of a predatory and ferocious character. Like the hawk, they swoop upon their prey, and, grasping it securely between their fore feet, they violently bear it away. They have no teeth and jaws wherewith to bite, gnaw, and masticate their food, but are furnished instead with an apparatus which answers them equally well for nourishing themselves. It is well known what maddening pain the horseflies occasion to horses and cattle in wounding them and sucking their blood. These Asilus-flies possess similar organs, but larger and more

* Fitch's Noxious Insects of New York, IX, 255.

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simple in their structure, more firm, stout, and powerful. In the horse-flies the trunk or proboscis is soft, flexible, and sensitive; here it is hard and destitute of feeling—a large, tapering horn-like tube, inclosing a sharp lance or spear-pointed tongue to dart out from its end and cut a wound for it to enter; this end, moreover, being fringed and bearded around with stiff bristles to bend backward and thus hold it securely in the wound into which it is crowded.

The proboscis of the horse-fly is tormenting, but this of the Asilus-flies is torturing. That presses its soft cushion-like lips to the wound to suck the blood from it; this crowds its hard prickly knob into the wound to pump the juices therefrom. It is said Asilus flies sometimes attack cattle and horses, but other writers disbelieve this. * * * Certain it is that these flies nourish themselves principally upon other insects, attacking all that they are sufficiently large and strong to overpower. Even the hard crustaceous shell with which the beetles are covered, fails to protect them from the butchery of these barbarians. And formidably as the bee is equipped for punishing any intruder which ventures to molest it, it here finds itself overmatched, and its sting powerless against the horny proboscis of its murderer. These flies appear to be particularly prone to attack the bees. Robineau Des Voidy states that he had repeatedly seen the *Asilus diadema*, a European species somewhat smaller than this of Nebraska, flying with a bee in its hold. But it probably does not relish these more than it does other insects. We presume it to be because it finds them in such abundance as enables it to make a meal upon them most readily, and with least exertion, that these flies fall upon the bees and rose-bugs. And so large as they are, a single one will require perhaps a hundred bees per day for its nourishment. If these flies are common, therefore, they will inevitably occasion great losses to the bee-keepers in that part of the country.

Since the foregoing account was written, Mr. Thomson has favored us with another communication giving some most interesting observations upon the habits and destructiveness of this insect, which we here append in his own words. He says:

"After sending you the specimens I watched its proceedings and habits with much care, and found that, in addition to the honey bee and rose bugs, it devours many other kinds of beetles, bugs, and flies, some of which are as large again as itself. It appears to be in the months of June and July that it is abroad upon the wing, destroying the bees. None of them are now (August) to be seen. When in pursuit of its prey it makes quite rapid dashes, always capturing the bee on the wing. When once secured by wrapping its legs about it, pressing it tightly to its own body, it immediately seeks a bush or tall weed upon which it alights and commences devouring its prey by eating (piercing) a hole into the body, and in a short time entirely consuming it (sucking out the fluids and soft internal viscera) and leaving only the hard outer skin or shell of the bee. Upon the ground, beneath some favorable perch for the fly near the apiary, hundreds of these shells of bees are found, accumulated in a single day. Whether the work of one fly or of several I am not able to say. I have just returned from a professional tour through the northern part of our territory, taking nursery orders, and in many things this business and the apiary are closely connected. In no case have I found a hive of bees that has thrown off a swarm this season! The dry weather, bad pasture, and other reasons were assigned as the cause. But many persons, since they have found this fly at his work of destruction, now believe it to be the cause of this non-swarming of the bees; and I am led to the same opinion. I have only to add further that this bee-killer delights in hot dry weather, and it is very invulnerable and tenacious of life. I have observed the honey-bee and also the hornet sting it repeatedly, but with no other effect than to cause it to tighten its hold upon them. Once when I forced the assassin to release his prey, he gave me such a wound in the hand as has taught me ever since to be very cautious how I interfere with him."

Mr. Thompson, in an article in the Rural World for September 12, 1868, stated that he had observed one individual Asilus-fly to destroy 141 bees in one day.

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The early forms of the insects of this family are known of but few species. Of those that are known we can safely say they are vegetable feeders, although in the first report on the Rocky Mountain Locust, the larva of *Erax Bastardii* is figured (Fig. 17) and spoken of as having been observed by Miss Emma A. Smith to feed upon the eggs of the locust. In the same report, however, the larva of the common "white grub" (*Lachnosterna fusca*) is mentioned as *feeding upon the eggs of the locust also*,* and the writer simply deduces from that instance that it affords "another conclusive proof that an essential vegetable feeder will exceptionally take to soft animal food." This argument then, as the analogy between the two cases is perfect, we can apply to the larva of *Erax* and conclude it with the rest of the family to be normally vegetarian in the larva state. This is the more likely to be the case as the larva of the same species is described in the second Missouri Entomological Report as from "under a peach tree" and "under a creeping vine."

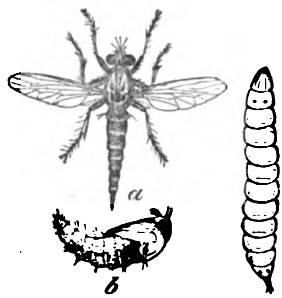

FIG. 17.—Erax bastardii.

In order to give a general idea of the appearance of the larva and pupa we will quote Harris' description of these forms of *Asilus sericeous*, Say, the larva of which devours the roots of tart rhubarb. Speaking of the larvae, he says:

They were yellowish white maggots, about three-quarters of an inch long, not perfectly cylindrical but a little depressed and tapering at each end. The head was small, brown, and partially drawn within the first ring, and was provided with two little horny brown hooks. There was a pair of breathing pores on the first ring, and another pair on the last but one. These maggots were transformed in the earth to naked pupæ having the limbs free. The pupa was brown and had a pair of short horns on the forehead, three spines on each side of the head, a forked tail, and a transverse row of little teeth across the middle of each ring of the hind body. When about to undergo their last transformation, the pupæ work their way to the surface of the ground by the help of the little teeth on their wings. I have repeatedly seen the empty pupa-shells sticking out of the ground around rhubarb plants.

So much for Asilus-flies in general. Three species have been captured in the cotton-fields of Alabama. These are *Erax apicalis*, Wied., *Diogmites discolor*, Lw., and *Dionyzias?* sp. By far the most abundant species was *Erax apicalis*, Wied. This species (represented by Fig. 18) varies from an inch to an inch and a quarter in length (25 to 32^{mm}) and has a wing expanse of nearly an inch and a half. The abdomen is black with silvery markings above and whitish below. The top of the thorax is yellowish-white and brown above as seen in different lights. The legs are spiny and light-brown in color, and the face is nearly white. In the summer of 1878 I observed large numbers of these insects flying around the cot-


FIG. 18.—Erax apicalis.

*First Ann. Rept. U. S. Ent. Com. on the Rocky Mountain Locust, 1877, p. 305.

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ton fields in the vicinity of Selma, Ala., occasionally darting to the ground and seizing some insect. With some difficulty a specimen was captured while engaged in sucking the juices of a young grasshopper (*Caloptenus* sp.) During the past summer Mr. Trelease forwarded several of these insects to the department from Minter, Dallas County, Alabama. He stated that they were very abundant in the cotton fields, and had been several times seen to catch the cotton-moth on the wing and devour it. The rapacity and the capacity of these flies have been seen in the quotation from Fitch; and even supposing each individual in the southern cotton fields in the course of a day to kill cotton-moths in numbers that shall seem small in proportion to the number of bees which Mr. Thompson actually saw them kill, we shall be obliged to put them down as among the very best friends of the planter. The benefits derived from the abundance of this insect will, however, be greatly detracted from wherever bees are kept, and it is also more than probable that its fondness for insects of this sort leads it to kill "wasps" and "hornets," some of which, as will be shown further on, are very efficient enemies of the cotton-worm. The harm done in the latter way is undoubtedly more than compensated for by the cotton-worms killed, but the former habit is one which cannot be condoned, and which quite effectually spoils the character of these otherwise beneficial insects.

The next order, COLEOPTERA, contains very many predaceous insects, and more species from this order have been found to prey upon, the cotton-worm than from any other.

TIGER-BEETLES (*Coleopt.*, fam. *Cincindelidae*).—The tiger-beetles are characterized by having large heads, broader than the chest, long curved jaws and long slender legs. They are always metallic green or brown in color with purple reflections in different lights, and are usually marked with light dots and stripes. They are to be found in sunny paths and sandy places. They fly and run very swiftly, and are very difficult to capture. Their larvae are curious in appearance and interesting in habits. They inhabit cylindrical holes in the ground, which they probably form for themselves. They maintain their places at the mouths of their pits and prevent themselves from being dragged forth by means of two hooks, which each carries upon the ninth segment of its body, giving it a humpbacked appearance. The heads of these larvae are large and flattened, and carry formidable jaws. Stationing themselves with their jaws at the mouths of their burrows, they lie in wait for approaching insects, which, when near enough, they seize and, retreating to the bottom of their burrows, devour. They transform to the pupa state within their burrows, the mouths of which they close as a preparatory step. Several species are abundant in the southern cotton fields, and have been stated by correspondents to devour the cotton-worm. Unfortunately, however, these insects are ground-beetles and their capacity for good in this direction is limited, as they can only attack those individuals which, for some reason, have fallen to the ground.

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The Carolina tiger-beetle (*Tetracha Carolina* Linn.) was mentioned by Mr. Glover in the Department of Agriculture Report for 1855 (p. 109), as among those insects "beneficial to the cotton plant" by destroying its enemies.* He remarks that "this species" appears not to be so partial to the light of the sun as some other species, but often conceals itself under stones. It is also seen much more frequently in the cotton fields during cloudy weather, toward evening, than in a fervid midday sun. Many specimens of this beetle have been forwarded to the department during the past summer from the Alabama cotton fields; Dr. A. W. Hunt, of Denison's Landing, Perry County, Tennessee, mentions it in his list of insects preying upon the cotton-worm. Fig. 19 represents very fairly the perfect insect. It is usually about three-fourths of an inch (19^{mm}) in length, is of a brilliant metallic color with purple and croppery reflections as viewed in different lights. The eyes, legs, and mouth parts are of a dirty white. The Carolina tiger-beetle can at once be distinguished from the only other North American representative of the genus *Tetracha* (*T. Virginica*) (see Fig. 20) by the comma-shaped yellowish mark at the end of each wing cover.

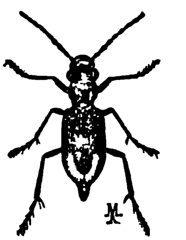

FIG. 19.—Tetracha Carolina.

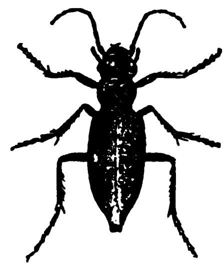

FIG. 20.—Tetracha Virginica.

Other tiger beetles belonging to the typical genus *Cicindela* are found in the cotton fields performing the same good offices. We figure several common species in order to give a general idea of the group. At Fig. 21 a larva and several species in the adult form are shown.

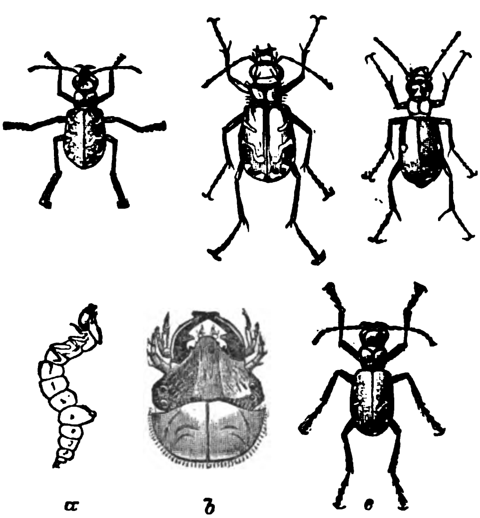

FIG. 21.—Several forms of tiger beetles.

GROUND-BEETLES (*Coleopt.*, fam. *Carabidae*).—Almost all of the beetles belonging to this family are carnivorous, and the family as a whole does an immense amount of good by destroying injurious insects. These insects are to be found during the day under sticks and stones and under the bark of trees, from which places they go out at night to hunt for their prey. The larvae live in similar situations and are also

* Mr. Glover uses the generic name *Megacephala* in speaking of this insect, but this genus contains only South American and African species.

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nearly always predaceous. The generalization is made by Packard that they are "generally oblong, broad, with the terminal ring armed with two horny hooks or longer filaments, and with a single false leg beneath." Of these beetles all which are to be found in the cotton fields will undoubtedly lose no chance to destroy the cotton-worms. A correspondent from Texas speaks of "the large green ground-beetle" as destroying the worms. These are, in all probability, *Calosoma scrutator*

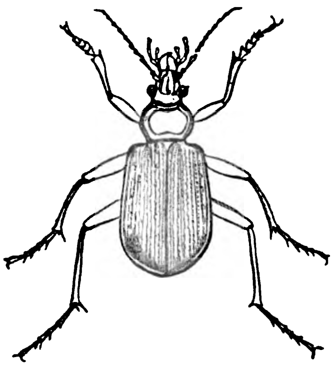

FIG. 22.—Calosoma scrutator.

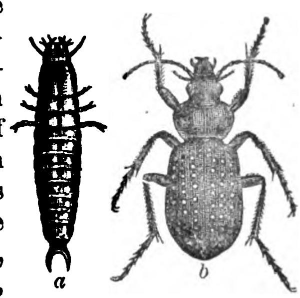

FIG. 23.—Calosoma callidum.

Fabr., shown at Fig. 22. According to Harris, this insect is known to ascend trees in search of canker-worms and similar insects. Another beetle of similar habits is *Calosoma callidum*, shown at Fig. 23. Mr. Glover in the 1855 report figures a species of *Harpalus*, probably *H. caliginosus* Say, see Fig. 24, and in the text refers to it as being abundant in the cotton fields and beneficial by destroying the different enemies of the cotton plant.

FIG. 24.—Harpalus caligimosus.

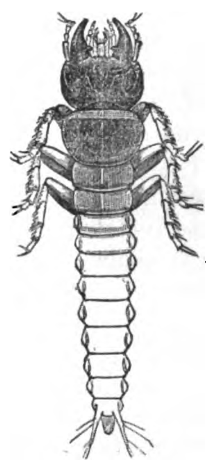

FIG. 24½.—Larva of Harpalus.

SOLDIER-BEETLES (*Coleopt.*, fam. *Lampyridæ*, genus *Chauliognathus* Hentz).—The family *Lampyridæ* is popularly known as the fire-fly family, and the adult beetles are too well known to need description. In the perfect state they are nearly all vegetable feeders, while the larvae are are nearly all carnivorous. The larvae of *Chauliognathus* are long, slender, flattened, tapering toward the ends, active, with large jaws. They are usually blackish, with pale spots at the angles of the segments. *Chauliognathus Pennsylvanicus* (Fig. 25) was found by Mr. Glover to be so plentiful in the cotton-fields near Columbia, S. C., that four to six might be taken from one bloom alone. They seem to feed entirely upon the pollen or nectar of the flower, and would so busily engage themselves in feeding as scarcely to notice the approach of mankind. When issuing from the flower they would nearly always be so covered with masses of pollen as scarcely to be recognizable.

FIG. 25.—Chauliognathus Pennsylvanicus.

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They, without doubt, served a good purpose in assisting the thorough fertilization of the flower. This beetle is about three-quarters of an inch in length, with black head, eyes, legs, and antennae. The thorax and wing-cases are orange-yellow, with a large dark spot in the center of the thorax, and a broad black stripe down the center of each wing-case, thus leaving a narrow margin of orange-yellow all around. The yellow-margined soldier-beetle (*Chauliognathus marginatus*) was found by Mr. Glover to take the place of the Pennsylvania soldier-beetle in Florida. This insect (Fig. 26) is about half an inch in length, and may be distinguished from the former species by the head and lower part of the thighs being orange. The harm done by the adults is slight, if any, and the good accomplished by the larvae is probably considerable. We have no definite report of their having been observed to destroy either the eggs or the young of the cotton-moth, yet from their well-known proclivities they probably do so, and from the numbers in which the adults occur, we can readily suppose that no small amount of good is done in this way. At all events, the soldier-beetles should not be destroyed.

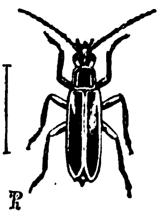

FIG. 26.—C. marginatus.

LADY-BIRDS, OR LADY-BUGS (*Coleopt.*, family *Coccinellidae.*)—The "lady-birds" are better known, perhaps, than any other family of beetles. They are small, round, and hemispherical, usually red, yellow, or black, with spots of one or the other of these colors. All are carnivorous except *Epilachna.* The eggs are usually long, yellow, and oval, and are laid in patches, often in the midst of a group of plant-lice, which the newly-hatched larvae greedily devour. The larvae (see Fig. 29) are long, soft-bodied, rather pointed toward the end, and are quite active. The jaws are small and inconspicuous. They are often quite gaily colored, and covered with scattered tubercles, spines, or tufts of hair. They attain their full growth in three to four weeks. When about to transform to pupae they attach themselves by the end of the body to a leaf or twig, and either throw off the old larva skin, which remains around the tail, or retain it around the pupa for a protection. The pupa (Fig. 27), is small and rounded, simulating the true beetle. The perfect insect comes forth in about a week. The larvae feed upon plant-lice and other small insects, of which they destroy immense numbers. The adult beetles also destroy other insects, although in lesser number than the larvae. Quite a number of species of the lady-birds are found in the cotton fields doing good work, a few of the most common of which we figure and briefly describe.

Coccinella novemnotata, Herbst. (Fig. 27 and pupa), is light yellowish-red in color, and may at once be distinguished by the nine black spots upon its wing-covers, arranged as shown in the figure, four upon each wing-cover, the two hind ones being the larger, and one in front on the middle line. *Coccinella munda* (Fig. 28) is a smaller species of precisely

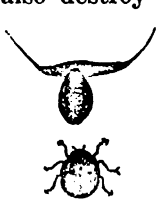

FIG. 27.—Coccinella 9-notata.

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the same color, but without any spots upon the wing-covers. Its thorax is black, with two small light spots. *Hippodamia convergens* (Fig. 29) resembles the preceding in general ground color. It is larger and more elongated. On the wing-covers are thirteen small black spots. The thorax is black, with a light yellow margin and two lines of the same color approaching a V in shape.

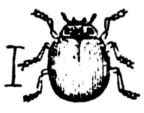

FIG. 28.—C. munda.

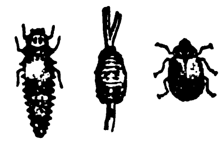

FIG. 29.—H. convergens.

Hippodamia maculata (Fig. 30) is pink in color, with ten large black spots on the wing-covers, of which two are upon the middle line. The thorax is pink, with two large black spots, and the head is pink, with black eyes. It is smaller than the last-named species. *Coccinella venusta* (Fig 31) is larger and broader. It is pink in color, with ten large black spots upon the wing-covers, of which the hind two blend into each other across the middle line. The inner middle spots are shaped like inverted commas. The thorax is pink, with four black spots, of which the two hinder ones meet across the middle line to form a V. *Chilocorus bivulnerus*, Muls. (the twice-stabbed lady-bird), is hemispherical in form and shiny black in color. A little in front of the middle of each wing-cover is an irregular bright red spot. The thorax is black, with a whitish border, and the head is whitish, with black eyes.

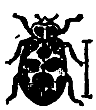

FIG 30.—H. maculata.

FIG. 31.—C. venusta.

That these lady-birds destroy many eggs and newly-hatched worms of the cotton-moth there can be no doubt. Mr. Trelease reports:

I have seen but one insect destroying the eggs of the *Aletia*, viz, the larva of one of the lady-birds (*Hippodamia convergens*). This was on the 26th of August. The larva was searching the lower surface of a leaf, apparently for *Aphides*, when it encountered an *Aletia* egg, which it immediately bit with its mandibles; but, as if disliking its taste, it left the egg uneaten and passed on. Later, I saw this same larva bite another egg, and this, too, was left without further disturbance, but of course both eggs were killed. Though many hours were spent in looking for further attacks upon the eggs of *Aletia*, the difficulties necessarily attendant upon such observations prevented me from seeing any more. From the actions and known proclivities of the lady-birds known as *Hippodamia convergens*, *H. maculata*, *Coccinella munda*, and *C. 9-notata*, all of which are found in abundance on cotton plants, and of *Chilocorus bivulnerus*, one adult of which was seen searching the leaves of cotton, I suspect that they all destroy these eggs more or less commonly.

In Dr. Phares's report an unknown enemy of the cotton-worm was spoken of. Concerning this insect, in a later letter, Dr. Phares says:

In my report upon the cotton-infesting insects made last autumn, in that portion in which mention is made of insect enemies of the *Aletia*, one is referred to and obscurely figured on paper. I find that my son had drawn it separately and distinctly, and it proved to be a *Coccinella* or *Hippodamia*. We are both of the opinion that it is the larva of *Coccinella novemnotata*, so abundant on the cotton plant.

In his report, Dr. Phares speaks of these larvae as feeding upon the *chrysalides* of *Aletia*. This might seem at variance with the well-known

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habits of these larvae (feeding, as they do generally, upon smaller insects, or, at all events, upon insects of but slightly larger size than themselves), to attack so large an object as the chrysalis of the cotton worm; but Mr. Glover has placed on record a similar instance. He says:

The perfect lady-bird also destroys *Aphides*, but not in such numbers as their larvae in which state it also destroys the chrysalis of the butterfly (*Argynnis columbina*) seen so often in the cotton fields. I have repeatedly observed them in Georgia killing the chrysalides of this butterfly, which hung suspended from the fence-rails and on the under side of the boughs of trees and shrubs. It appears to attack the chrysalis chiefly when soft and just emerged from the caterpillar skin. It is in this state that these wandering larvae attack it, and, biting a hole in the skin, feed greedily upon the green juice which exudes from the wound. Sometimes, however, it becomes a victim to its own rapacity, for the juice of the chrysalis drying up in the heat of the sun quickly forms an adhesive substance in which the larva is caught, and thus detained until it perishes.

It is probable, however, that the destroying of the cotton-worm chrysalis by lady-bird larvae is only of exceptional occurrence. In addition to the evidence already given, Mr. J. H. Krancher of Millheim, Tex., informs us that the lady-birds destroy the eggs of the cotton-moth, and Dr. E. H. Anderson mentions them among the cotton-worm enemies.

We figure the *only* vegetable-feeding lady-bird in order that those interested may know what it is, and not consider it a beneficial species. It is known as *Epilachna borealis*, Thunberg. It is much larger than any before mentioned, is of a light redish yellow in color, with seven large black spots upon each wing-cover. The thorax is of the same color and has four small black spots. The head is concolorous with the thorax, and the eyes are black. Both the larvae and perfect insects feed upon the leaves of cucumbers, melons, squashes, and pumpkins—eat unsightly holes in them, and, when numerous, completely destroy the plant.

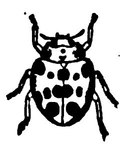

FIG. 32.—Epilachna borealis.

Another beetle, of injurious proclivities, is often mistaken for a lady-bird by the planters, although it belongs to an entirely different family. This is the twelve-spotted Diabrotica, *Diabrotica duodecim-punctata*, Fabr. This insect is shown at Fig. 33, and certainly does resemble Coccinella to the untrained eye. The principal points of difference between it and the common Hippodamias, which it most resembles, are that the Diabrotica is usually greenish, varying occasionally to yellowish; that it has twelve black spots arranged in parallel rows down the wing-covers, and that the thorax is green and unspotted. The twelve-spotted Diabrotica belongs to the family *Chrysomelidae*, or leaf-eating beetles. Dr. Packard states that they devour the leaves of dahlias, and Professor Riley has found them gnawing melons, squashes, and cucumbers.

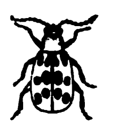

FIG. 33.—Diabrotica 12-punctata.

In the next order, LEPIDOPTERA, it would be fair to suppose that the cotton-worm had no enemies, since predaceous insects are extremely rare in this Order. In point of fact there are probably but three true

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Lepidopterous predatory insects upon record. These are *Euclemensia Bassettella*, Clemens, which feeds upon the eggs of an oak-bark louse,* *Semasia prunivora*, Walsh, which feeds upon the lice of the coxcomb elm-gall (*Colopha ulmicola*, Riley), and *Dakruma coccidivora*, Comstock, which preys upon the eggs and young of cottony *maple scale insect*† (*Pulvinaria innumerabilis*, Rathvon).

In spite of this fact, many Lepidopterous larvae when placed in confinement will destroy one another, and facts have developed which warrant us in putting the boll-worm down as an occasional enemy of the cotton-worm.

THE BOLL-WORM (*Heliothis armigera*, Hübn.).—Although the boll-worm may be put down as almost omnivorous, and although it becomes cannibalistic in confinement (so much so that in breeding but one can be kept in the same cage, and in sending through the mails one box had to be allowed for each individual), we hardly expected to see it develop any characteristic which could be called beneficial; yet, according to the observations of Mr. Trelease, it seems to have done so. Mr. Trelease says in his report:

> Owing to its tough integument, the pupa of *Aletia* seems to be freer from insect attack than the larva is, yet even its hard skin does not always save it. About the middle of August I first noticed what appeared to be an anomalous preparation for pupation in the boll-worm (*Heliothis armigera*), for I found several full-grown larvae of this species with leaves closely webbed around them, precisely as *Aletia* webs up before changing to a pupa. An examination of one of these, however, showed me that the boll-worms had not webbed them about themselves, but had insinuated themselves into leaves folded and preoccupied by *Aletia*, the latter having already passed into the pupa state; and they had done this for the express purpose of feeding on these pupae; *many cases of this sort were seen.*

So plain a case as this requires no comment. It is of interest scientifically but its practical bearings are slight. Earlier in his report, bearing on this same point, Mr Trelease says:

> No Lepidopterous enemies of *Aletia* larvae were observed by myself, but Dr. Lockwood of Carlowville, Ala., says that a number of years ago, he saw a large green larva devouring numbers of cotton-caterpillars. From what we know of the habit of the boll-worm (*Heliothis armigera*) it seems not at all unlikely that these larvae may have belonged to that species.

It will also be interesting in this connection to state that the boll-worms have been observed to kill one another on the plants, in open air, and perfectly unmolested, as will be shown in Part II.

As bearing upon this point of other Lepidopterous larvae attacking the cotton-worm, we quote the following sentence from Dr. Anderson's report: "I have never seen the worm attacked by any other insect than the *grass-worm* and then only when brought in contact." Concerning this same insect, *Laphygma frugiperda*, of Smith & Abbot

* Proc. Ent. Soc., Phila., ii, p. 423.

† North American Entomologist, i, p. 25, October, 1879.

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(*Prodenia autumnalis* of Riley), Mr. Glover, in the Department of Agriculture Report for 1855, p. 78, says:

The grass-caterpillars, when in confinement, very often kill and devour each other, and when one is maimed in the least it stands a very poor chance for its life. Several intelligent planters state that when the grass and weeds are entirely devoured, and no other vegetable food is to be found, they will attack each other, and feed upon the still living and writhing bodies of their former companions. One grass-caterpillar which was kept in confinement, although furnished with an abundance of green food, actually appeared to prefer to feed upon other caterpillars, no matter of what kind, so long as their bodies were not defended by long bristling hairs or spines.

It is in the next order, HYMENOPTERA, that we find the most effective enemies of the cotton-worm.

WASPS (*Hymenopt.*, fam. *Vespariae*).—These well-known insects, as a class, although they occasionally do some harm by injuring fruit or by killing honey-bees, may, on the whole, be called very beneficial insects. Not only do they devour injurious insects themselves, but they also store them up as food for their young. Concerning the actions of certain wasps in the cotton fields, we cannot do better than to quote again from Mr. Trelease's report:

Wasps frequent the cotton plant in considerable numbers, being attracted, like the ants, in part by the nectar secreted by the plant; and there is much reason to believe that all of the species which visit the plant feed more or less commonly upon the caterpillar or larva of *Aletia*. I am led to this conclusion by the following observations. On the 8th of August, when larvæ of the fourth brood of *Aletia* were very abundant in the swamp-cotton, I saw a large red and yellow wasp—*Polistes bellicosa*, Cresson (see Fig. 34)—hunting for them. Carefully walking around the holes eaten through by the caterpillars, she explored their borders with her antennae, as if feeling for the larvae; and each time that she found one in this way she quickly sprang after it, but at the same instant the larva threw itself from the leaf; so that, while I was watching her, I saw no less than eight escape, the ninth being caught and eaten. Occasionally she would stop hunting long enough to sip a little nectar from the foliar glands of the plant, and then the chase was resumed. I was very much surprised to see that she relied entirely on the tactile sense of the antennae for finding her prey. Though possessing well-developed ocelli and compound eyes, she seemed to make little use of them; and repeatedly I saw her alight on a leaf close to a caterpillar without paying any attention to him till she touched him with her antennæ, when, as before stated, she would instantly spring after it. Observations of this sort were made several times on this wasp. Another large brown wasp (*Polistes* sp.) was also seen to catch larval *Aletias*, as also were a yellow-jacket hornet (*Vespa* sp.), and a common mud-dauber (*Pelopæus cœruleus*, Linn.), and they all alternated hunting for caterpillars with feeding on nectar. Both species of *Polistes* were several times seen flying about with dead caterpillars, having previously reduced them to a pulpy mass with their mandibles. They were probably looking for some quiet place in which to eat them.

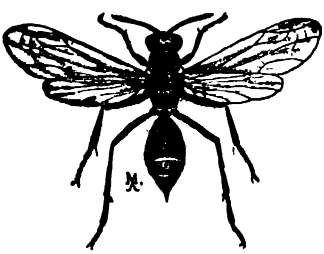

FIG. 34.—Polistes bellicosa.

Further on in the report occurs the following:

Early in September, while watching these moths as they fed on rotting figs, I saw many white-faced hornets (*Vespa maculata*) about the fig-trees. One of these hornets was seen to catch a two-winged fly nearly as large as itself. After killing it, the hor-

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net proceeded to deprive the fly of its legs and wings, which were allowed to fall to the ground. The fly was then carried away. Under these same trees I found the wings of *Aletia* moths, and it looks from these as though these moths are sometimes killed by the hornet; still, I never saw a hornet in the act of killing a moth, or with the dead body of one, and I am aware their usual food is flies.

We find, then, that certain species of wasps destroy the cotton-worm, and also, without much doubt, the cotton-moth. The following species of so-called "wasps" were caught on the cotton plant in Alabama, and, in all probability feed upon the worms:* *Monedula Carolina*, Fab. (*Hymenopt.*, fam. *Bembecidae; Elis 4-notata*, Fabr.; *Elis plumipes*, Drury (*Hymenopt.*, fam. *Scoliadae*); *Pelopœus cœruleus*, Linn. (fam. *Sphegidae*); *Polistes bellicosa*, Cress.; *Vespa Carolina*, Drury.

ANTS (*Hymenopt.*, fam. *Formicariae*).—The predaceous insects from which the cotton-worm suffers the most are, without doubt, the ants. These insects, from their war-like habits and the enormous numbers in which they occur, seem peculiarly fitted to hold in check even so dangerous an enemy as the cotton-worm. The efficacy of ants as cotton-worm destroyers has been noticed by but few writers upon the cotton-worm, and indeed there are some who insist that they never attack it. During my own stay at the South I never was able to see ants attack a worm *upon* the plant. Upon the ground, however, the case was far different, as is shown by the following brief extracts from my note-book:

August 28, 1878, 8 *a. m.*—I revisited the field; there are many larvae crawling over the ground. I have collected specimens of a small ant, which I find destroying these larvae. The head and thorax are brown, while the abdomen is shining black. They sting severely.

A perfectly healthy cotton-worm is crawling along the ground, an ant rushes up to it, and, I presume, stings it; the larva at once wriggles away a short distance—an inch or so (as the larva cannot get a firm hold on the ground, it is unable to spring as when upon a leaf); the ant follows and repeats the attack. I have seen these maneuvers repeated many times. It often happens that the larva escapes, but frequently it is overpowered by many ants and destroyed.

I saw a larva wriggling; a single ant was clinging to it, and, although the larva struggled violently, the ant kept its hold. Soon other ants sprang upon the larva, and within two minutes it was overpowered. This occurred over a crack in the ground from which the ants emerged.

In dry weather the ground cracks to a great extent. The ants make their nest in these cracks, and while excavating them cover the surface of the ground with fine particles of earth. It is difficult for cotton-worms to crawl over such places; for when they seize hold of the loose particles of earth by their fore legs, they are unable to balance themselves, roll over upon their sides, and if the earth be hot, speedily perish. In this indirect way the ants cause the destruction of millions of the worms.

I sent from Baconton, Ga., specimens of an ant which I found there attacking and destroying *Aletia* larvae which were crawling on the ground. This ant does not seem to have the power of stinging, but worries the larva to death by biting.

The first notice of the services of ants as cotton-worm destroyers that we have seen was by Mr. Winfree, in De Bow's Review for 1847. He stated that the ants were a wonderful check to the multiplication of the

* Identified by Mr. Cresson.

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cotton-worm. Mr. Glover, in the Agricultural Report for 1867, p. 60, says:

The eggs of the cotton-moth are frequently destroyed by several species of small ants, which are said to bite the eggs open when first deposited, and to abstract the substance. Many caterpillars, especially if weak or somewhat disabled, fall victims to the voracity of the restless myriads of ants always abounding in the fields and feeding upon the honey-dew secreted by the cotton-louse or aphis, and the bodies of such insects as they can overcome.

Dr. Phares, however, takes a very different view of the ant question, as advanced in the following quotation in his 1869 essay: *

Last year on a farm in Louisiana, as already mentioned, the caterpillar commenced its work as early as May, and continued until frost terminated its labor; yet one generation succeeded another so slowly and in such small numbers that the cotton was scarcely injured; while on other places where the destroyer appeared later the cotton plants were so early and completely destroyed as not to mature sufficient seed to plant another crop. Why this difference? The owner of the farm mentioned, as well as others, alleged that the *ants being very numerous, carried off and destroyed the eggs and young caterpillars.* The ants, it is true, swarmed in unwonted numbers in the cotton fields, as they did also in corn-fields, potato-patches, gardens, orchards, and forests. But on other places where there were plenty of ants constantly infesting the plant the caterpillar wholly destroyed the cotton. Again, in some fields the cotton was completely stripped, as we often see, up to a definite line on one side, while not a leaf was touched on the other side of this line. This occurs even where the same rows cross this line, one portion of the row being stripped and the other unharmed, although there were plenty of ants on both sides of this mysterious line, established by the caterpillars themselves. And again, on inquiry, *I have never found any one who has seen the ants eating or carrying off either the eggs or young caterpillars.*

Here, then, it appears, is a total want of facts, and the ant theory is so far without a shadow of foundation on observed facts.

The ants collected in the cotton fields were referred to the Rev. H. C. McCook, of Philadelphia, and he has kindly prepard the following report upon them:

FORMICARIAE.

The specimens of ants sent are of seven species, all of which are represented as in attendance upon or actually engaged in the destruction of the cotton-worm. These species represent two of the three families of Formicariae, viz, Formicidae and Myrmicidae. Of these, two were too much broken to allow specific determination.

The relation of ants to the larvæ of Lepidopterous insects has recently attracted the attention of students. During the summer of 1877 I observed several workers of *Formica fusca* in friendly attendance upon a small green grub which proved to be the larva of *Lycaena pseudargiolus*, a butterfly.* About the same time Mr. W. H. Edwards, widely known as a student of Lepidoptera, observed the same behavior, and during the following year pursued his investigations further. The results he has given in an interesting communication to the Canadian *Entomologist*. He showed that the ants attend the larvae with the same purpose as that which attracts them to the *Aphides*, viz, to feed upon a sweet excretion which issues from the insect. In the Aphis this is probably excrementitious. In the larva the sweet exudation is a secre-

* Rural Carolinian, 1869, p. 690.

* Mound-making Ants of the Alleghenies, Trans Am. Ento. Soc., 1877, p. 290, and John A. Black, Philadelphia.

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tion from the 11th segment of the body. Mr. Edwards saw the ants greedily licking up this secretion, and caressing the body of the grub with its antennæ. I have had the pleasure of verifying a great part of his statements by personal observations. Two of the ants thus obtained by Mr. Edwards in attendance upon caterpillars were *Formica fusca* and *Prenolepis nitens*.

Some of the ants herein described are referred to by the collector simply as in attendance upon the cotton-worm. It would be interesting, as a question in natural history, to know whether they were engaged, as in the case of the ants above noticed, in collecting a sweet secretion. In this case they would be more likely to befriend than to injure their hosts.

Several of the species, however, were actually seen by Mr. Comstock *killing* the worm. This was especially the case with the erratic ant, *Dorymyrmex insanus*, *Dorymyrmex flavus*, and *Solenopsis xyloni*, the "cotton-ant," as it may be termed, and *Monomorium carbonarium*. The above three species include the greater part of the specimens sent, of which fully one-half were of the cotton-ant. In one bottle the body of the worm was preserved contorted as in a death struggle, and a number of ants were clinging to it at various parts with feet and mandibles. The larva had evidently been attacked by a large number of the ants, and all were surprised by the collector in the midst of the fray.

It is the habit of nearly all known species of ants to feed upon the bodies of dead insects, worms, and upon animal fats and juices generally. They attack small insects and grubs, or disabled insects and worms, quite freely for the purpose of food.

They also attack, with great fury and in united force, any such creatures as may invade their premises or cross their path. It seems more probable that the cotton-worm was attacked in this manner by the ants here described than that they were deliberately hunted down for food. At all events, the amount of damage done to the worms even by the hordes of ants that inhabit the Southern States cannot be very large. One worm would furnish a day's rations for a whole colony of such small ants as these. The friendly offices of the emmets in preserving the cotton crop can, therefore, hardly have an appreciable commercial value. Nevertheless it is a matter for congratulation that their military services, however insignificant, are in the right direction.

The following information as to ants *vs.* cotton-worm, collected by the Department, bears upon this point, and may justify a more sanguine view of the beneficial services of ants than the above. The testimony has been gathered from a wide range of territory, extending from the Atlantic coast to Central Texas, embracing the States of North Carolina, Georgia, Alabama, Tennessee, Arkansas, Louisiana, and Texas. It would appear from these observations that (1) the ants do certainly feed upon the eggs of the cotton-worm, and (2) more or less freely upon the larvae. That (3) the attacks made by the ants are more likely to occur when the worms are found on the ground, and (4) are confined to bright, pleasant weather when the ants come out of their formicaries to seek food. One writer expresses the hope that the ant will ultimately exterminate the cotton-worm, of which it is now the greatest enemy; another thinks that in dry seasons the absence of caterpillars is due to emmet hostility; while a good observer like Mr. Trelease ventures the opinion that "ants are probably among the most important of the enemies of the cotton-caterpillar."

Are any predaceous insects or parasites known to prey upon it, either in the egg, larva, or chrysalis state?

The common little red ant is the only insect known to attack it.—[H. E. Brown, Camden, Ala.

Ants.—[Knox, Minge and Evans, Faunsdale, Ala.

It is believed that the common black ant preys upon the egg. I know of none interfering with the worm or chrysalis.—[C. M. Howard, Mulberry, Ala.

Ants are numerous at times and seem to feed on them.—[Andrew Jay, Jayville.

I have seen the ants at work on the egg and larva.—[J. F. Culver, Union Springs, Ala.

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Ants on the egg and larva, but the eggs are so much more numerous than the ants that the eggs are not missed.—[J. A. Callaway, Snowdown, Ala.

The small red ant.—[Woebome Young, Magnolia, Ark.

The ant preys upon the egg and worm to a certain extent.—[William A. Harris, Isabella, Ga.

Ants of many kinds are found preying on them in good weather, but not in bad, and this is the reason given why the worm increases so much faster in rainy wet weather than in dry and fair weather. The cotton fields have many enemies of the worm out in fair weather devouring eggs and worms, but rain and rust drive these enemies back to their retreats, and the worm breeds without let or hinderance.—[Douglas M. Hamilton, Saint Francisville, La.

Of late years the ant has proved to be the greatest enemy both to the egg and larva. I entertain the belief that they will ultimately destroy the worm should it prove to be indigenous rather than of foreign origin.—[Dr. I. U. Ball, Bayou Sara, La.

The common ant maintains an equilibrium when it is not too wet. The ant will destroy the eggs unless the rainy weather keeps it in its retreat. This is the reason that a dry season is never a caterpillar one.—[James C. Brown, Barnesville County, North Carolina.

The family in its different stages are preyed upon by ants.—[A. W. Hunt, Denison's Landing, Tenn.

The little black ant will devour the eggs.—[P. S. Watts, Hardin County, Texas.

Some species of the ant will prey upon the egg.—[O. H. P. Garret, Brenham, Tex.

Ants.—[P. S. Clarke, Hempstead, Tex.

Ants.—[Samuel Davis, Greenville, Tex.

Ants prey upon the egg, larva, and chrysalis.—[S. B. Tackaberry, Moscow, Tex.

Nothing but the small ant.—[S. Harbert, Alleyton, Tex.

In dry weather the little ants that are to be found everywhere prey upon them when they get knocked off on the ground; or when the sun drives the ants up the stalk for protection they attack the chrysalis, &c.—[Natt Holman, Fayette County, Texas.

Ants.—[J. H. Krancher, Millheim, Austin County, Tex.

Ants are their common enemy.—[George W. Hazard, Rutledge, Ala.

In addition to this testimony to the efficacy of the ants, we will add that of Mr. Trelease, who says:

From their great numbers and indefatigable industry, ants are probably among the most important of the enemies of the cotton-caterpillar. Individuals of many species swarm everywhere on the cotton plants, to which they are attracted night and day by *Aphides* and nectar. On many cotton leaves there are places where some larva has eaten the parenchyma of the lower surface, but the most careful search fails to discover the larva. Though not invariably so, these places are often eaten by very young larvæ of *Aletia*, and as these are not to be found, it looks as though they had been removed by some enemy, probably ants, though I have never seen ants attack very small caterpillars. In July a number of caterpillars were collected in the bottom-land, to which they were principally confined at that time, and placed on cotton growing in dry, sandy soil, care being taken to see that there were no ants on this cotton when the larva was placed on it, for my insects in breeding-jars in the house had suffered so much from the depredations of ants that I was always afraid of their attacking larvae that I wanted to study in the field; and these particular caterpillars had been removed to the cotton indicated because I wished to make observations on their habits, and wanted them as near the house as might be, which at that time the only larvae to be found in numbers were about a mile from where I was living. Within two hours of the time of placing them on this cotton, each of these larvae was found by several ants, and these soon collected numbers of their fellows, whose combined attacks so worried the larvæ that they threw themselves from the plants and were soon killed and carried off by their small but persistent enemies. On several other occasions partly grown caterpillars were killed and carried off in this way by this species and a

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red ant, yet I never saw ants attack them on the plant excepting when I had thus placed them on ridge-cotton for purposes of study; but when creeping over the ground, as they do after eating up the foliage of the plant on which they were born, if not full grown, hundreds of caterpillars were attacked by these ants and killed. I have never seen more than one species of ant attacking any individual caterpillar, either on the plant or on the ground.

Mr. Trelease further remarks, in speaking of the enemies of the chrysalis:

In the latter part of July several *Aletia*, just about to pupate, were taken from the swamp where they were found, and, with leaves webbed about them, they were transferred to cotton on dry soil near the house, where they were tied by their leaves to the petioles of this cotton; my object in placing them there being to determine the length of the pupa state. The same day they shed their last larva skins and this left them in an almost defenseless condition till the pupa skin should become firm and tough. About twenty-four hours after this moult they were again visited, and were found covered with red ants, which had killed and partly eaten them all, though they were on different plants, and care was taken to see that there were no ants on the cotton when the larvae were placed there.

Concerning the destruction of eggs by ants he has made no positive observations, but states his opinion in the following words:

Similarly, ants of quite a number of species frequent the cotton plant, whither they are attracted both by the sweet excretion of *Aphides* and by the nectar copiously excreted from the foliar and involucral glands of the plant, and although I never saw them molest the eggs of *Aletia*, I believe that they do so.

Family FORMICIDAE.

Ants without a sting. A single node upon the petiole. No contraction after the first joint of the abdomen proper. The nymphs sometimes inclosed within cocoons, sometimes naked.

Sub-family DOLICHODERIDAE, Forel.

Zeit. für wiss. Zool., xxx, supl., and Études Myrmecologiques, Bull. Soc. Vaudoise, Sci. Natur, 1878, p. 364.

Pedicel with a single node. The abdomen is not narrowed after its first segment. Nymphs always naked. Nests commonly made in the ground. Antennae 12 joints.

Genus DORYMYRMEX, Mayr.

The maxillary palps 6-jointed, the labial palps 4-jointed. The shield a little prolonged between the insertions of the antennæ. The clypeal fosse is united to the antennal fosse. The frontal area is triangular, short but distinct. The scale of the petiole vertical, smooth. The chitinous skin elastic. All the spurs pectinated. The workers have nearly always a tuft of long hairs under the head, as in the genus Pogonomyrmex. The mesothorax is a little compressed. There is a cone or toothed projection between the posterior or basal face and the anterior face of the metanotum. The spurs are pectinated. Ocelli are wanting.

No. 1. **D. insanus**, [Buckley].

1866. *Formica insana* [Buckley], Trans. Am. Entom. Society Philadelphia, p. 165.
1866. *Erratic ant*, Lincecum, Proc. Acad. Nat. Sci. Phila., p. —.
1875. *Dorymyrmex pyramicus*, Norton, Wheeler's Rep. Geo. Expl., Zool., p. 734.
1879. *Dorymyrmex insanus* [McCook], Agricultural Ant of Texas, p. 197.

This species may prove to be *D. pyramicus*, Rog. (*Prenolepis pyramica*), as suggested by Norton, or more probably a variety of the same.

Buckley's description is sufficiently indefinite, but two examples of his types in the

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collection of the American Entomological Society, Academy of Natural Sciences, Philadelphia, are identical with the specimens sent.

Worker. Length, $\frac{1}{8}$ inch.

Color.—Abdomen, tip of scale and cone, femur, tibia, vertex, and flagellum, black or blackish. The face (except vertex), scape, tarsus, thorax, brown or brownish. There is no tuft of hair beneath the face. They were found by Mr. Comstock actually destroying the cotton-worm.

D. insanus was collected by me in Texas (1877), and a variety quite akin to it in Colorado, 1879. In the former State, in the neighborhood of Austin, it was found near or on the flat circular disks of the agricultural ant, *Pogonomyrmex barbatus*. In Colorado the nests were found in great numbers in the Garden of the gods and vicinity, upon the clear space surrounding the gravel-covered mounds of *Pogonomyrmex occidentalis*, Cresson, which, like its Texas congener, is a harvesting species. Two, three, and four of the former nests or openings would be placed upon the latter. The external architecture of *D. insanus* is simply a moundlet of sand, two to four inches in diameter, gathered around a small opening into the ground like the familiar nests of *Lasius flavus*, the little yellow ant which burrows in such multitudes in our garden walks and lawns.

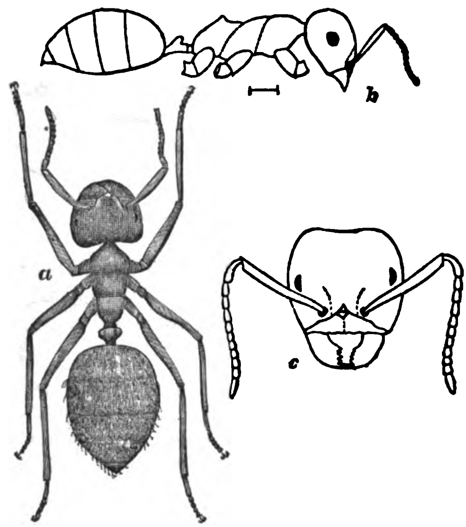

FIG. 35.—Dorymyrmex insanus.

In action the erratic ant is vigorous and active. It is remarkably courageous, and was often observed by me to attack successfully the Occidental ant. In one case a small colony of erratics pushed up its gate in the midst of one of the principal thoroughfares of a large occidental formicary. Thereafter the little erratics flung themselves upon nearly every occidental that passed with such vigor and abandon of courage as to finally compel the latter, though greatly superior in size and armed with a formidable sting, to give up the gangway, and excavate an opening beyond the erratic boundaries. One remarkable example of this especially attracted my attention. Upon the circumjacent clearing of an occidental nest which was being opened for the study of internal architecture, there were three nests or gate-ways of an erratic colony. My invasion of the formicary had, as is usual, aroused the occidentals to the highest pitch of belligerent fury. They attacked me with so many and painful stings as quite to sicken me. Yet the erratics freely assaulted these irate insects as they ran hither and thither whenever they trespassed upon their borders, and invariably drove them away. If such intrepid little warriors were to devote their atttention to killing cotton-worms they would doubtless do good execution.

The genus and probably this species is widely spread throughout tropical and subtropical America. It feeds upon the sweet exudations of plants, galls, and sweet excretions of the Aphis; but, like most ants, is fond of the juices of insects.

No. 2. **D. flavus**, n. var.

Worker. Length, $\frac{1}{8}$ inch.

This variety is identical with *insanus*, except in the color, which is a uniform honey-yellow, and the contour of the thorax. The apex of the abdomen and the flagellum of the antennæ are tipped with a blackish hue. The variety appears to be quite permanent, the distinction holding in a number (25 or 30) of specimens examined. The cone is evidently higher than the thorax. There is no tuft under the face.

Habitat, United States. Southern States.

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Genus IRIDOMYRMEX, Mayr.

Verhdl. d. k. k. zool.-bot. Ges. in Wien, Bd. xii, 1862, Z. 702.

The workers vary very little, and only in size. The worker and the male are of the same size; the female is much larger. The maxillary palps have 6 joints, the labial palps 4 joints. The clypeus is a little prolonged between the insertions of the antennæ. The clypeal fosse is joined with the antennal fosse. The frontal area is triangular, indistinct. The scale of the petiole is vertical, unarmed. The sculpture of the body is very fine; the chitinous skin is elastic and not brittle, as is the case for the most part in other ants; all the spurs are pectinated.

No. 3. I. McCooki, FOREL, *in litt.*

This ant is a small yellow ant, about three thirty-seconds of an inch in length. Dr. Forel refers to it in his *Études Myrmecologiques* for 1878, p. 382, and reference is also made to it in my *Agricultural Ant of Texas*, pp. 202–3, 302. I found numbers of this species traveling in long lines across or near to the nest of the agricultural ant. Usually their route was established upon blades of grass growing on the nests or along low tufts of grass on the margin. They traveled in single, or "Indian" file, one behind the other. They appear to be on friendly terms with their large neighbors. The specimens sent me in alcohol were taken in the act of attacking the cotton-worm.

Subfamily MYRMICIDAE, SMITH.

Ants having a sting, except with the males. Two nodes or joints upon the petiole. The nymphs always naked.

Catalogue Brit. Hymenoptera, 1851.

Genus CREMATOGASTER, Lund.

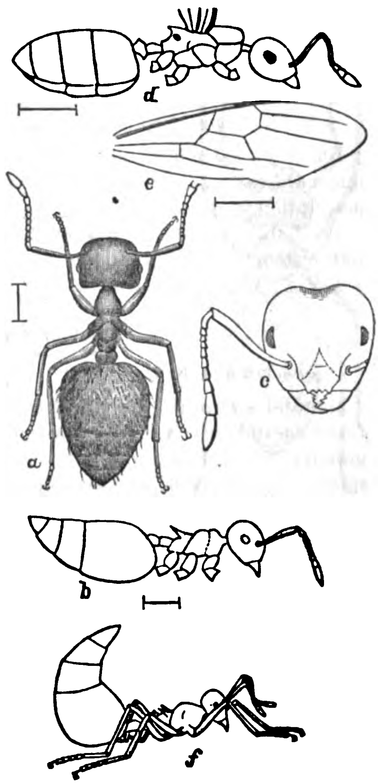

FIG. 36.—Crematogaster lineolata.

The second joint of the petiole articulates upon the superior face of the first segment of the abdomen. Abdomen is cordiform, flattened above, rounded below, and pointed at the extremity. The maxillary palps have 5, the labial palps 3 joints. The antennæ have 11 joints. The metanotum is furnished with two spines.

No. 4. C. lineolata, Say.

1836. *Myrmica lineolata*, Say, Boston Journal Nat. Hist., vol. i, p. 290.
1866. *Oecodoma (Atta) arborea*, Buckley, Trans. Am. Ento. Soc. Phil., p. 349.
1866. *Crematogaster lineolata*, Mayr, Verh. zool.-bot. Ges. in Wien, xvi, p. 901.

Worker major. Length, $\frac{3}{16}$ inch (Figs. 4, 5, 6).
Worker minor. Length, $\frac{1}{8}$ inch.

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Color.—The abdomen is black, shining, except at the base underneath, which is reddish brown; the petiole, thorax, flagellum, and tarsus yellowish brown; the head blackish at the vertex, as also the legs, except the tarsus. The body is lightly pubescent, the abdomen being sparsely provided with hairs. The ant when excited has the habit of turning its abdomen up, and even bending it over the thorax, as in Fig. 9. The favorite nesting place is under stones or underneath and within the decayed matter of old logs and stumps. This material is sometimes prepared by the ant as a paper-like pulp, and arranged into cells and chambers, which are attached to the surfaces of the logs. This ant is widely distributed throughout the United States; is abundant in the Middle States.

Texas. Queen, Figs. 7, 8.

No. 5. Crematogaster clara.

1870. *C. clara*, Mayr, Verhandl der k. k. zool.-bot. Vereins, Wien, p. 990.
1866. *Oecodoma bicolor*, Buckley, Trans. Am. Ento. Soc., Phila.

Buckley's name has the priority over Mayr's, but as Smith had published a species under the same name (Proceed. Linn. Soc., 1860, p. 109) several years before Buckley's description, the name given by Mayr is that by which the insect is properly known.

The habits of the ant are probably the same as those of *C. lineolata*. It was found in the stem of the cotton plant, but was not observed destroying the worm.

Texas. E. A. Schwarz.

Genus SOLENOPSIS, Westwood.

Ann. and Mag. Nat. Hist., 1841.

Mandibles enlarged at the extremity, and having the terminal margin dentated. Antennæ 10-jointed; the two last joints very large, and together form a club. The maxillary and labial palps have each two joints. Metanotum without teeth or spines. The clypeus has two longitudinal ridges. The sting very large.

No. 6. *Solenopsis xyloni*, n. sp. (?)

Worker major. Length, ⅛ inch, Fig. 10; side view of same, Fig. 11; view of head enlarged, Fig. 12. The head, body, nodes, and abdomen are of a dark claret-brown color, glossy, covered with stout hairs. The flagellum of antennæ and the tarsi are a lighter color.

Worker minor. Length, $\frac{1}{16}$ inch. Color as in the worker major.

Female. Length, more than ⅓ inch (9^{mm}), Fig. 12. The body is of a uniform amber color. The single specimen is unwinged.

The largest number of specimens sent belong to this species, but no habits are noted except that the ant kills the cotton-worm. In one bottle the caterpillar is preserved, with a number of the dead ants still clinging to it by their mandibles. *Solenopsis* is a mining ant, and lives in nests made in the ground. Some species of the genus occasionally place their homes within or very near the bounds of other species of ants. *S. fugax*, for example, according to Dr. Forel (Swiss Ants, p. 233), lives, without danger, in the very center of the formicaries of *Formica fusca, Polyergus rufescens, Tetramorium caespitum*, &c. They are always enemies of their hosts.

Genus MONOMORIUM.

No. 7. Monomorium carbonarium, SMITH.

Catalogue Brit. Mus., Hymenoptera., Formicidae, p. 127.

Worker. Length, $\frac{1}{16}$ inch.

This is a small, black, shining ant, and was taken in the act of killing the cotton-

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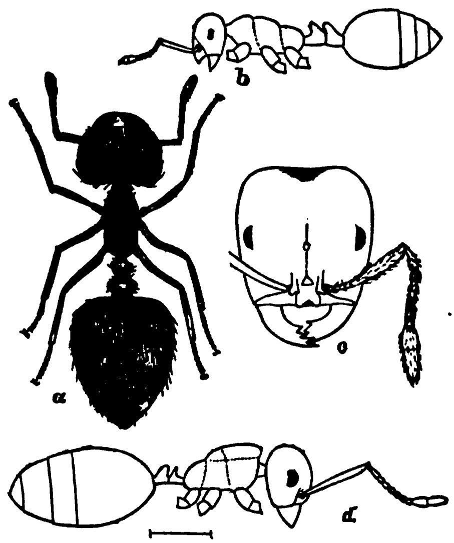
worm, a specimen of which (in alcohol) was fairly black with the hordes of tiny emmets which clung to it.

NOTE.—I am indebted to Dr. Auguste Forel for valuable aid in the determination of the above species. My own studies of ants having been heretofore chiefly directed to their habits and structure, I sent examples to Dr. Forel, and received an answer barely in time for use in verifying and correcting proof-sheets. I cordially acknowledge his friendly assistance.

The specimens of *Dorymyrmex insanus*, sent Dr. Forel regards as *D. pyramicus*, Roger, Berlin Ento. Zeit., 1863, p. 1860. *Solenopsis xyloni* he believes to be *S. geminata*, Fabr. I have nevertheless allowed my name to stand provisionally, until further examination, for the following reason, among others. The specimens sent me by Mr. Comstock were quite numerous, and were all workers, major and minor. Neither these nor specimens from Texas in the American Entomological Society collection had examples of the large-headed soldier caste, which belongs to *S. geminata*, specimens of which I have from Florida.



FIGS. 37 and 38.—Solenopsis xyloni.

ILLUSTRATIONS.

Fig. 35 (*a*). *Dorymyrmex insanus*. Dorsal view, enlarged.

Fig. 35 (*b*). *D. insanus*. Side view, enlarged. The natural length is indicated by the line beneath the figure.

Fig. 35 (*c*). *D. insanus*. View of head.

Fig. 36 (*a*). *Crematogaster lineolata*. Enlarged.

Fig. 36 (*b*). Side view of same.

Fig. 36 (*c*). Same; view of head.

Fig. 36. (*d*). Same; queen; side view.

Fig. 36 (*e*). Same; wing of queen.

Fig. 36 (*f*). Same; view of insect when excited, with abdomen turned up.

Fig. 37 (*a*). *Solenopsis xyloni*. Dorsal view, enlarged.

Fig. 37 (*b*). Same; side view.

Fig. 37 (*c*). Same; view of head.

Fig. 38. Same of queen; side view.

PARASITES.

The abundance of the true parasites of the cotton-worm, and the number in which they occur, renders their consideration of the highest practical importance.

Taking into consideration the number and variety of these friends of the planter, and the way in which they may make themselves obvious to every one who tries to work out the life history of the cotton-worm, it seems very strange that several recent writers should have entirely overlooked their presence. Mr. Grote, in his paper before the American Association for the Advancement of Science, stated that he had

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never been able to observe any parasites, although he admitted that such might exist; and Professor Riley, in the 1878 circular of this department, states the fact that no enemies of the cotton-worm have hitherto been reported. We mention these two instances in particular, because the undoubted ability of these naturalists renders their statements all the more singular. The fact is that not only were parasites well known to many observers throughout the South, but no less than six accounts had been published with tolerable popular descriptions of *Pimpla conquisitor* (a large ichneumon which extensively infests the last brood of the worms, issuing from the chrysalis in midwinter or early spring), and two very fair figures had also been published.

In 1847 Dr. D. B. Gorham, of Bayou Sara, La., in the same paper in which he proposed the migration theory, drew up a description of "the yellow-banded ichneumon," as we shall call *P. conquisitor* in this report. This was, as we think, the first notice of any parasite. Dr. Gorham's description was as follows:

Let us take a pocketful of these home and place them beneath tumblers, and wait patiently to see what they will produce. If I had found a treasure my delight could not have been greater than that I experienced at the idea of unraveling the mystery. But man is prone to disappointment, as we shall soon see. About the 15th of November the insect appeared, but, *mirabile dictu*, as different from the cotton-fly as it is possibly to suppose one insect could differ from another. It belonged altogether to a different family, a description of which I give as follows:

Antennæ filiform, black, six lines in length. Palpi four; two external and two intermediate, the external white, twice the length of the other two, in shape angular, the angle projecting externally. The two middle are straight, scarcely perceptible over a strong light; they are of a dark color. Wings, four; hymenopterous, incumbent, extending to and exactly even with the end of the tail; shape of the wings, which are small and extremely delicate and thin, is like that of a fan. Front legs half the length of the posterior of a uniform orange color; the intermediate legs very little longer than the anterior; the thighs of a deep orange color, the rest of the leg annulated with black and white, the rings being larger than those of the intermediate. The trunk is of a uniform shining black, as would be the upper surface of the abdomen also were it not for the very narrow white bands which connect the black scales together, giving to the abdomen an annulated appearance; these white lines do not encircle the abdomen, but terminate uniformly on the sides. On the under surface of the abdomen these white rings again commence, which are much larger than those on the upper surface, causing the abdomen to look almost white. The tail terminates in a bifurcated sheath inclosing a long blunt sting, projecting considerably beyond the tail, and forming a very prominent feature in the general figure of the insect. This is a small slender insect, much longer than the honey-bee, but not so thick.

Now, it is evident from its specific character, as well as from its parasitic nature, this insect belongs to that numerous class called ichneumons, of which there are upwards of five hundred species. As I am not at present in possession of any practical work on entomology, I cannot determine the species of this ichneumon, but to show that it differs in some respects from the family to which it belongs, I will quote a paragraph from a work before me, in which are set forth some peculiarities belonging to that class of insects as a genus:

The whole of this singular genus have been denominated parasitical on account of the very extraordinary manner in which they provide for the future support of their young. The fly feeds on the honey of flowers, and when about to lay her eggs, perforates the body of some other insect or its larvae with its sting or instrument at the end of

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the body, and then deposits them. The eggs in a few days hatch, and the young larvae, which resemble minute white maggots, nourish themselves with the juices of their foster-parent, which, however, continues to move about and feed until near the time of its changing into a chrysalis, when the larvae of the ichneumon creep out by perforating the skin in various places, and each spinning itself up in a small oval silken case, changes into a chrysalis, and after a certain period they emerge in the state of complete ichneumons.

It will be seen that there is a peculiarity attached to this ichneumon not included in the above description, that of appropriating the chrysalis as well as the larvae of other insects to the use of the young. All ichneumons that I ever read of spin their own chrysalis, but this is the prince of parasites, for not content with eating the substance of his neighbor, he seizes also on his house. So far as I have read concerning this curious family of insects, this is a nondescript.

Thus is answered the question why the cotton-fly did not again eat up the scant foliage which subsequently appeared on the stalks. This little usurper goes forth in search of "whom he may devour," and as soon as he finds a house built and well provisioned, he seizes upon it for his posterity, which he does in the following manner: When he finds a cotton-worm he pierces it with the instrument with which its tail is armed, and deposits an egg. The cotton-worm soon spins itself up into a case, there to await the period of its perfection, which never arrives, for soon the egg of the ichneumon hatches and falls to devouring his helpless companion. This work of extermination continues until there is not a vestige of the cotton-worm left. I venture to say while I am now writing (1st of December) there is not an egg, chrysalis, or fly in the confines of the United States.

In 1851 Mr. Thomas Affleck, late of Brenham, Tex., then of Washington, Miss., whom we have had frequent occasion to refer to in this report, in his Southern Rural Almanac for that year figured an ichneumon parasite of the cotton-worm. It is impossible to say whether the yellow-banded ichneumon or the ring-legged *Pimpla* is meant by this figure. In the text Mr. Affleck says:

We owed our exemption during the season of 1848 to the destruction of the cotton-moth when in the chrysalis state by an ichneumon, the insect here represented. From many scores of chrysalides which we had collected for observation these ichneumons issued, one from each. The parent had deposited her egg within the shell of the chrysalis, where it hatched, preyed upon the insect within, until time to undergo its own transformations.

The continued enormous production of cotton caused the excessive multiplication of the cotton-moth, with whose increase multiplied the ichneumon—a precious provision of the beneficent Creator, "who doeth all things well."

Again, in the Department of Agriculture report for 1855, Mr. Glover figured and described *P. conquisitor*, although he attempted to give it no name. He says (p. 111):

Some chrysalides of the cotton-caterpillar, which had been preserved during the autumn of 1855 as an experiment to see whether they would live until the following spring, having been hatched out prematurely by the heat of the room in which they were kept, two ichneumon flies were produced of a slender shape and about half an inch in length. The abdomen or body of the female was black, and marked with seven light-colored, yellowish, narrow rings around it; the head is black, with the eyes brown, the antennæ long, jointed, and nearly black; on the head were three ocelli; the thorax was black; the wings transparent, of a rather yellowish tinge, veined with black, and having a distinct black mark on the outer margin of the upper pair; the first joint of the hind leg was comparatively large, thick, and of a brownish color;

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the thighs were also brown; the tibiæ black, with a broad white band in the middle; the tarsi were white, tipped with black; the ovipositor protruded more than the tenth of an inch. The male presented much the same appearance as the female, but was more slender in form.

The figure given is not so good as this excellent description would warrant us in expecting, but this cannot be said to be any fault of Mr. Glover. The next published account of parasites is not until 1867, and is again by Mr. Glover. He says, in the Department of Agriculture report for that year (p. 61):

The cotton-caterpillar is also destroyed by a small yellow and black banded ichneumon fly, which deposits its eggs in the worm. This egg-hatching produces a footless grub, which feeds in the body of the caterpillar, at first avoiding all the vital parts and devouring the fatty matter alone, leaving the larva with strength to spin its cocoon and change into a chrysalis, with its internal foe still in its body. The grub then, after devouring the remainder of the interior, changes into a pupa, and finally emerges from the dried chrysalis skin as a full-formed, four-winged fly, somewhat resembling a very diminutive wasp.

Dr. D. P. Phares, in his lecture before the Farmers' Club of Woodville, Miss.,* from which we have quoted so frequently already, mentions Dr. Gorham's paper incidentally, and also mentions his views on parasitism—enough to put it again in print and to make it an additional source of wonder to us that later writers knew nothing of it. Dr. Phares says:

Many years ago the late Dr. Gorham, of Louisiana, published his observations of the chenilles made during the then current year. Having collected a number of chrysalides, he took them home and watched them closely to see the cotton-moth come forth from the pupa case. But, to his astonishment, instead of the Anomis, a swarm of ichneumon flies came out—not one cotton-moth in the entire lot. In his new-born joy and earnest desire to cheer the desponding cotton-planter, he speedily proclaimed through the press the results of what he deemed a great discovery; that henceforth the cotton crop-was safe; the cotton-caterpillars were done for; they could never seriously injure another crop; the ichneumon fly had destroyed them all.

Another account of parasitism was published by Mr. William Jones, the senior editor of the Southern Cultivator, in the March, 1868, number of that journal. He says (speaking of the hibernation of the cotton-worm):

About the middle of February we visited the same field again. A majority of chrysalid cases (which were still abundant) we found empty, with every indication of the insect having matured and escaped. A limited number we found apparently unchanged, and started back rejoicing that we had been able to replace those destroyed by the bird; but alas! upon accidentally crushing one we found within it an ichneumon, and this proved to be the case with all we had collected. Some of the ichneumons had completed their transformation and were about to come out as perfect insects.

In addition to these published accounts of parasites, the answers of the correspondents of this department to question 6*a* of the 1878 circular show that many insect enemies of the cotton-worm were well known throughout the South.

* Rural Carolinian, 1869, p. 689.

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Let us now enter into a detailed account of these parasites. Up to the time of the present writing thirteen distinct species parasitic upon the cotton-worm, in one or another of its stage, have been bred in the department. Of these, eight species are hymenopterous and five dipterous.

THE COTTON-WORM EGG-PARASITE (*Trichogramma pretiosa*, Riley).—In the latter part of the summer of 1878 a small lot of cotton-worm eggs were received at the department, with which it was proposed to determine the time and manner of hatching, the length of time elapsing between the different moults of the worm, and various facts of that character. The eggs were placed in a glass breeding-jar, but much more than the usual time seemed to elapse before the hatching. One morning, however, a number of very minute flies, so small as scarcely to be seen with the naked eye, were found flying around the jar, and the eggs were empty. Here, then, was a true egg-parasite, the mother fly having laid her egg within the egg of the cotton-moth, and her progeny having lived and undergone its transformations within that limited space. Whether more than one parasite issued from a single egg was not determined. These parasites belonged to the great hymenopterous family *Chalcididae*, a family composed of a very great number of parasitic species, distinguished by their generally very minute size, brilliant metallic, or variegated colors, elbowed antennae, nearly veinless wings, and naked pupae. They are parasitic upon other insects in their early states; some, from their minute size, are reared within the eggs of other insects, but the majority infest larvae and pupae. They especially attack Lepidoptera, but also attack species of some of the other orders.

The species under consideration is one of remarkable beauty. The general color is yellow, with brilliant red eyes. The wings are very delicate and transparent and present prismatic colors when viewed in different lights. The wings are fringed with excessively fine hairs; their surface is also covered with still finer hairs. In length they are only a trifle more than one-hundredth of an inch (.3^{mm}), but, like all of the subfamily to which they belong, are very active and are great leapers, springing sometimes to a distance of two or three inches.

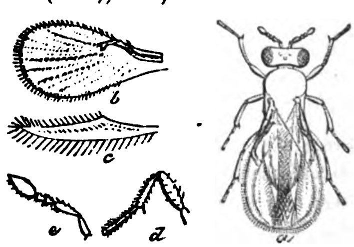

FIG. 39.—Trichogramma minuta.

An allied species (*Trichogramma minuta*) has been reared from the eggs of the dissippus butterfly (*Limenitis dissippus*, Godt.). In this case from four to six individuals have been reared from a single egg of the butterfly, and this seems to be about the normal number. It is probable, then, that more than one parasitic egg is laid within the egg of the cotton-moth. Fig. 39 (*T. minuta*, Riley) will give a very good idea of the general appearance of the magnified insect. The cotton-worm egg-

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parasite proved to be a new species, and consequently the following scientific description of it has been published by Professor Riley:

1. TRICHOGRAMMA PRETIOSA, n. sp.—Length about 0.3^{mm}. Yellow, the eyes red, the wings hyaline. Head wider than the thorax; antennæ 5-jointed, joints 3 and 4 in the ♀ forming an ovate mass and together shorter than joint 2; joint 3 large, thickened and very obliquely truncate; in the ♂ joints 3, 4, and 5 form a more or less distinct, elongate club, beset with long bristles. Hairs of the wings arranged in about fifteen lines. Abdomen not so wide as the thorax, but as long as the head and thorax together; in the ♀ the sides subparallel, and the apical joint suddenly narrowed to a point. Described from numerous specimens reared from eggs of *Aletia argillacea*.

Differs from *Trichogramma minuta*, Riley (Third Rep. Ins. Mo., p. 158, fig. 72, ♀), in its smaller size and uniform pale yellow color, and also in the form of the third and fourth joints of the antennæ. As defined and figured by Westwood, the antennæ of *Trichogramma* are 6-jointed. Walker, in his "Notes on the Chalcididæ," pt. vi, p. 105, employing Forster's characters, says the antennæ are 8-jointed; but an examination of the figure of the type (*Trichogramma evanescens*, l. c., p. 114) shows that one of the joints counted is the "annulus" above the scape, which I do not consider to be a true joint, and that what I have indicated as the apical joint, in agreement with Westwood, is represented in that figure as three coalesced joints. I have proposed the generic name of *Pentarthrum* for *minuta* in MS. now in Mr. Scudder's hands, but until the allied genera are better characterized than at present it is best to use the old genus *Trichogramma*.

With the other twelve parasites the egg is laid upon the larva of *Aletia*, and the perfect insect emerges either from the larva or from the pupa. Three of these species belong to the same family as the egg-parasite just mentioned, namely, to the *Chalcididae*.

THE OVATE CHALCIS (*Chalcis ovata*, Say).—This species seems to be one of the most abundant parasites of the cotton-worm in many parts of the South. It is one of the largest of its family, measuring over one-fifth of an inch (5^{mm}) in length. The glassy appearance of its abdomen and its swollen hind thighs gives it a characteristic look, and renders it impossible to mistake it for any other cotton-worm parasite. From the 4th of August until the 10th of September these little fellows were continually issuing from the chrysalides sent for breeding purposes. There may have been one brood previous, and there probably was one later, the chalcid wintering in the pupa state within the chrysalis of the cotton-worm. The parent fly lays her eggs upon the backs of nearly full-grown cotton-worms, probably more than one egg upon each individual, although we have never observed more than one of these parasites to issue from a single worm. The young larvae feed upon the worm's internal parts, choosing by preference the fatty tissue, and avoiding all vital organs until they become full-grown. During this time the cotton-worm has probably attained its full growth and webbed up. The parasite eats its host out pretty thoroughly before undergoing its own transformations. Both of its changes from larva to pupa and from pupa to fly are undergone within the dead chrysalis of the cotton-worm, and the perfect fly gnaws a round hole near the head of the chrysalis to make its exit. An examination of many chrysalides from which these parasites have issued shows that the hole of exit is invariably near the

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head, and, upon breaking them open, the abdomen is found to be filled with excrement of the larva, and the cast-off skins of larva and pupa. Fig. 40 shows the ovate chalcis enlarged, and also a chrysalis of Aletia pierced by the exit of the parasite.

We can find no published record of the fact of the parasitism of this insect upon the cotton-worm, and are not aware that it was bred prior to 1878.

FIG. 40.—Chalcis ovata.

The following is Say's original description of the insect:

C. OVATA.—Robust, black; feet yellow, thighs black at base, head with a golden reflection.

Inhabits Ohio and Pennsylvania.

Head black, with golden sericeous hair, which is indistinct on the vertex; antennæ testaceous beneath towards the tip; stethidium with dilated, dense punctures, a little sericeous with golden hair; scale covering the base of the wings, yellow; wings hyaline; nervures fuscous, at base pale yellowish; feet bright yellow; basal half of the anterior pair of thighs black; posterior thighs smaller than the abdomen, black, with a yellow spot on the tip above, dentated on the posterior edge; posterior tibiæ pisceous on its basal incisure; terminal spine robust, shorter than the first tarsal joint; first joint of the posterior coxæ with a robust tooth above near the tip; abdomen subovate, polished; first segment nearly glabrous, second segment hairy on each side, remaining segments hairy near their tips. Length one-fifth of an inch.

CIRROSPILUS ESURUS, Riley.—Another chalcid parasite, of much smaller size than the last, was reared in considerable numbers from the chrysalides of the cotton-worm during the summer of 1878. It proved to be a new species of the genus *Cirrospilus*, and has been described under the specific name *esurus* by Professor Riley, in a recent number of the Canadian Entomologist. His description is as follows:

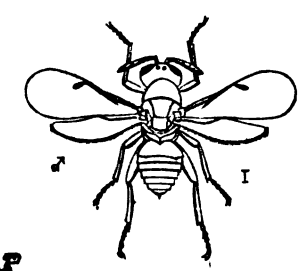

FIG. 41.—Cirrospilus esurus.

2. CIRROSPILUS ESURUS, n. sp.—Length 1.5mm. Dull black; knees, tibiæ and tarsi yellowish, the posterior tibiæ sometimes dusky. Eyes with scattered, short bristles. Antennæ of the ♂ 9-jointed, with the joints of the flagellum subequal and beset with bristles, the ninth joint small. Antennæ of the ♀ 8-jointed, the fourth and fifth shorter than the second and third, the three apical joints forming a club. Thorax above microscopically punctate; parapsides distinct and elevated; scutellum with a longitudinal, impressed line on each side. Wings hyaline, pubescent, but the cilia short; base of ulna uneven; radius not developed. Abdomen short and sessile, ovate. Described from numerous specimens reared from the pupa of *Aletia argillacea*.

This species shows relationship with the genus *Tetrastichus*, Halliday, and may ultimately be referred there. For the present I prefer to place it in the older genus.

It is then a little black fly only about six-hundredths of an inch in length, with yellow legs. From their small size, many of them can find their sustenance in a single cotton-worm, and many of the adults were bred from a single chrysalis.

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UNNAMED CHALCID PARASITE.—The following passages from my notes concern a parasite which, owing to a press of other affairs, has not yet been worked up.

August 27.—I found yesterday a cotton-worm about five-eighths of an inch in length which, although yet alive, was being destroyed by three green larvae which were upon it. I found the specimens about 10 a. m. Last evening I observed that the cotton-worm was nearly eaten. The parasites had very short bodies, which when they moved were pointed at one end. I had intended to describe the specimens this morning, but I find they have spun cocoons about their bodies.

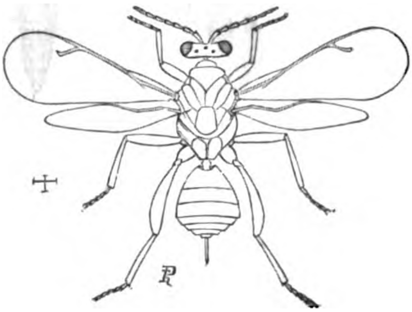

FIG. 42.—Unnamed chalcid.

August 28.—I found crawling over the ground a small cotton-worm infested by five parasites evidently of the same species as those mentioned in my note of August 27.

August 29.—The small green parasites which I found yesterday destroyed the cotton-worm, and, excepting two specimens which I put in alcohol, began to spin cocoons during the night.

The insects bred from these specimens were small, black, chalcid flies, shown at Fig. —. They were nearly eight-hundredths of an inch (2^{mm}) in length. The general color was black, but the legs, antennæ, and mouth parts were honey-yellow. The head, thorax, and abdomen were nearly equal in width, and the thorax was longer than the abdomen, which was pediceled and subtruncate at tip. The antennæ were 7-jointed.

The larvae were greenish white, oval, somewhat pointed at one end, with yellow spiracles or breathing-holes, and were fleshy and footless. They were sluggish in motion, moving by the alternate contraction and expansion of the segments. The number of segments of the body was plainly thirteen. The full-grown larvae were about 0.08 inch or 2^{mm} in length, and were about half as wide as long. The cocoons which they spun were ovoid in form, grayish white in color, and about the size of the full-grown larvae.

That these larvae spun cocoons is an interesting fact, as by far the large majority of the *Chalcididae* transform to naked pupæ within the bodies of their hosts. The fact of their being found preying externally upon the cotton-worms is an anomalous one. Had the worms upon which they were found been more nearly full-grown, and had the effects of their outside work been less apparent, their appearance might have been explained on the ground that they had finished their work inside and had merely issued to spin their cocoons, and were observed in the interval between their issuing and the commencement of the spinning. The cotton-worms upon which they were found, however, were less than half-grown, and could not have afforded these parasites subsistence from the birth of the latter upward. Moreover, the rapidity with which the

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cotton-worms were destroyed after they were found showed that they could not have been preyed upon long prior to the date of observation. On the other hand, it is difficult to see how these parasitic larvae with their sluggish habits could find the means of migrating from one cotton-worm to another, as it seems probable that they must do after devouring the individual upon which they are born. The whole question is one of considerable interest, but cannot be solved without further observations.

THE PROCTOTRUPID PARASITE OF THE COTTON-WORM (*Didyctium zigzag*, Riley).—September 10, 1879, a number of small parasitic flies issued from chrysalides of the cotton-worm. Upon examination these proved not to be *Chalcids*, but to belong to the allied family *Proctotrupidae*. The members of this family differ from the *Chalcids* in their usually slenderer body and longer antennæ. The antennæ, also, are not elbowed as in *Chalcididae*. It is a family of very minute species, which are all supposed to be parasitic, many of them upon the eggs of other insects.

The species under consideration is shown at Fig. 43. These flies are black, polished, with the antennæ and legs dark yellow. The antennæ of the female are 13-jointed, the first joint club-shaped, the second almost globular; 3 to 7 are much thinner than any of the others; 3 about as long as 2; 4 to 7 almost globular; 4 a little thinner at base; 8 to 12 about equal in size, round at base, and squarely cut off at apex; 13 as long as preceding, ending in a rounded blunt point. The antennæ of the male are very long, about as long as the whole insect. The wings are clear and sparsely beset with short, blackish bristles, and with quite a long fringe around the edge. The veins of the wings are yellowish.

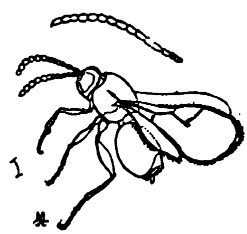

FIG. 43.—Didyctium zigzag.

These insects are about .06 of an inch (1.5^{mm}) in length.

These parasites were bred only upon a single occasion. Then many specimens were mounted. Whether they were all from one chrysalis or not it is impossible to say with certainty, but the probabilities are that they were, and it seems probable also that it is not a common parasite.

The specimens were handed to Professor Riley for determination. He deemed it necessary to found a new genus for them, of which the following are the characters. A specific description follows the generic.

DIDYCTIUM, nov. gen.—*Head* transverse; three ocelli approximate and triangularly arranged; labial palpi 3-jointed; palpi 3-jointed; antennæ inserted in front and close together, in the ♀ hardly reaching to the abdomen; 13-jointed, the two basal points stout, joints 3-7 suddenly narrowed and together not much longer than 1 and 2, 3 being twice as long as the others, 8-13 nearly twice as stout, peduncled, subequal in length, very slightly narrowing toward tip; in the ♂ as long as body, 15-jointed, joint 3 twice as long as any of the others, 4-13 subequal in length. *Thorax* as long as abdomen, slightly wider in the middle than the head; scutellum prominently raised, subovate and marginally ridged; legs with the tarsi uniformly 5-jointed; front wings

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without stigma, the veins forming with the costa two closed cells; hind wings with a costal vein reaching and broadening to near the middle of wing, where it is suddenly bent upward. *Abdomen* narrower than thorax, with a short peduncle.

D. zig-zag, n. sp.—Average length, 1.6^{mm}. Body uniformly polished black. Legs, palpi, and antennæ reddish in female, the coxae, femora, and antennæ toward tip infuscate in the male. Peduncled joints of antennæ with a whorl of minute spines around the crown, and longitudinally striate. Base of thorax and of abdomen with pale pubescent hairs. Wings hyaline, sparsely beset with minute spines, which increase radially and form a fringe around the posterior half; the veins of front wings forming a sprawling W, with partial cross-veins proceeding from the lower angles, the basal cross-vein longest.

The next three parasites which we shall mention belong to the family *Ichneumonidae*, or ichneumon flies, as they are commonly and familiarly called. These insects are characterized by unusually long and slender bodies, and the long projecting ovipositors of the females. These ovipositors are often very long, and are protected by a sheath of four stylets of the same length as the true ovipositor. The head is usually rather square, with long many-jointed antennae. The larva is a soft, cylindrical, fleshy, white, footless grub, the rings of the body being convex and the head small. The eggs are laid by the parent either on the outside or within the caterpillar or other larva upon which its young is destined to feed. When hatched, the larva devours the fatty portions of its victim, just as we have seen with foregoing parasites, until it gradually dies. The larva spins a cocoon about itself when about to enter the pupa state. In the larger species this cocoon consists of a dense inner case, and a loose, thin outer covering. Of the larger species but one individual occupies the body of the host, while in the smaller species many are found within one insect. The cocoons of most species are spun within the body of the parasitized insect; but others, as in the genus *Microgaster*, emerge and spin their small, oval, often bright-colored cocoons on the outside. The family, as a whole, is one the members of which are of immense service to agriculturalists in destroying great numbers of noxious insects.

THE YELLOW-BANDED ICHNEUMON (*Pimpla conquisitor*, Say).—This is one of the most numerous and most noticeable of the parasites of the cotton-worm. It was the species observed by Dr. Gorham and Messrs. Affleck and Glover, and probably also the one spoken of by Mr. Jones. It was first scientifically described by Thomas Say, in 1835, who found it in Indiana.* He described it under the generic name of *Cryptus*, but it has since been put in *Pimpla* by Mr. Cresson.

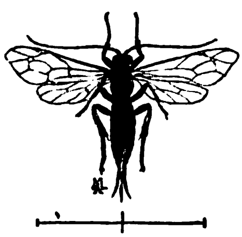

FIG. 44.—Pimpla conquisitor.

A recent note from Mr Cresson informs us that Say made the curious mistake of describing the male as a different

* Say's original description is as follows:

C. conquisitor.—Black; tergum, with the posterior margins of the segments, white; feet honey-yellow; posterior tibiæ and tarsi with black joints.

Inhabits Indiana.

Body black, punctured; palpi white; thorax, punctures minute; a longitudinal

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species from the female, under the name of *pleurivinctus*. The species varies much in size, and Say happened to meet with a small female and a large male, and, the face of the male being white, the mistake was thus made.*

The history of this species, and several published descriptions of it, have already been given in the beginning of this subhead. Its habits coincide with those laid down in the characterization of the family of ichneumons. The yellow-banded ichneumon was bred extensively from the chrysalides of the last brood of cotton-worms, and, so far as we are aware, has never been bred from any preceding brood. Dr. Gorham bred them from the chrysalides of the last brood only, as also did Messrs. Glover and Jones. During the past summer we have bred in the department nearly two thousand chrysalides from the Alabama cotton fields and not one specimen of the yellow-banded ichneumon was seen, although many other parasites were obtained, as will be shown hereafter. During the fall and winter of 1878 many specimens of *conquisitor* were bred from chrysalides of this last brood, and we are under the strong impression that none were bred from earlier broods, but this we are unable to state positively, as the notes on this point are in the possession of Professor Riley. This, however, is all negative evidence, and although it shows that the last brood is usually extensively parasitized by the yellow-banded ichneumon, it does not prove also that previous broods are not affected to a small extent; and this is probably the case. We are, as shown by the evidence adduced above, totally unable to say how many broods of this parasite are produced in a year, as we only know of the one bred from the last crop of cotton-worm chrysalides.

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white line before the wings; metathorax not distinctly punctured on the disk; wings very slightly tinged with dusky; nervures blackish; stigma rather large, with its base and tip whitish; second cubital cellule oblique; tergum densely punctured on every part; segments on their posterior narrow margins white; oviduct about half the length of the abdomen; feet honey-yellow; intermediate and posterior tarsi white, the joints black at their tips; posterior tibiæ black, white in the middle.

Length one-fourth of an inch.

* Say's description of *pleurivinctus* is as follows:

C. pleurivinctus.—Black; segments of the tergum margined with white.

Inhabits United States.

Body black; thorax with a short line before the wings and wing-scale yellow; wings hyaline, with a slight dusky tinge; nervures blackish; stigma rufous at the stricture; second cubital cellule quadrangular, somewhat oblique, meeting the radial cellule in an angle; abdomen almost sessile; tergum with the first segment excavated near the base; densely punctured; all the segments with narrow white posterior margins; oviduct exserted, short, hardly half the length of the abdomen; feet honey-yellow, posterior pairs with the knees, tips of the tibiæ, and each tarsal joint black.

Length over half an inch.

♂ Hind pair of feet with an annulus on the tibiæ and base of each tarsal joint white.

The male is much smaller than the female. I obtained a female from a follicle of the common folliculate Linnean *Bombyx* with transparent wings, which were extremely abundant a few years since in Maryland, causing much apprehension for the safety of the trees of their choice. Some of them were obtained for me by my friend Mr. Gilliams, for examination, when I described them under the name of *hyalina*, but did not publish the account.

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That the earlier broods, if such exist, may be reared in other insects is possible from the fact that very many members of this family are not confined to one species of insect, and from the fact that Say described the original individuals as from Indiana; and it is probable from their rarity, if not actual absence, among the earlier broods of cotton-worms.

The length of time which it takes one of these parasites to undergo its transformations has not been observed. This would undoubtedly facilitate our knowledge of the number of broods. If the larva spins a cocoon at all, it is very slight; so slight, indeed, that upon breaking off the end of the parasitized chrysalis the pupa of the parasite is exposed to view. The perfect insect emerges in late fall, in midwinter, and in early spring, through an irregular hole which it gnaws through the skin of the chrysalis, usually near the head.

The fact that these parasites are frequently alive within the chrysalides throughout the whole winter has given rise to the supposition on the part of many that the chrysalis itself was still alive, from the motion imparted to it by the contained insect, and have thus been led to believe implicitly in the hibernation of the cotton-worm in the chrysalis state. Many chrysalides were sent to the department during the past winter by persons holding this belief, but, without exception, those specimens which still seemed to have life contained each the pupa of a yellow-banded ichneumon. We have already quoted from Mr. William Jones's graphic description of an experience of this sort. Dr. Anderson was deceived in the same way, and chrysalides which he had kept until some time in December were shown by Mr. Schwarz to be parasitized.

The evidence given by Dr. Gorham and Mr. Affleck, as well as our own experience the past year, would seem to show that this parasite is, during certain years, very abundant indeed upon the last brood of worms, and although it might at first be said that the good accomplished by them is smaller than if they were abundant with preceding broods, yet, when we consider that every individual of the last brood which is parasitized reduces by just so much the number of possible hibernators and founders of families the succeeding spring, then we can appreciate the amount of good which this parasite accomplishes, and although we may not indorse the somewhat extravagant estimates of Dr. Gorham and Mr. Affleck, still we may consider ourselves deeply indebted to the yellow-banded ichneumons.

THE RING-LEGGED PIMPLA (*Pimpla annulipes*, *Br.*).—September 1, 1879, there issued from a cotton-worm chrysalis one specimen of the ichneumon to which Professor Riley gave the above popular name in his fifth Missouri Entomological Report. This is the only specimen which has been bred this year. It is an old acquaintance, having been bred from the walnut case-bearer (*Acrobasis juglandis*, Le B.) by Dr. Le Baron, and from the codling moth of the apple (*Carpocapsa pomonella*) by Professor Riley. It is a widely distributed species, being found all over the country, north, south, east, and west, and that it is common is shown from the fact that Professor Riley bred 20 females from a lot of

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162 apple-worm cocoons. In these he found great variation in size, some measuring but one-fourth of an inch in length, while others reached one-half.

Roughly describing this parasite, we may say that it presents a nearly black appearance above, the under side of the abdomen being honey-yellow. When viewed with a lens, the upper surface of the abdomen is seen to be covered with close punctures, while the thorax is nearly smooth. The legs are reddish yellow with the exception of the middle joint of the hind pair, which is black, with a broad yellow ring in its middle. The hind feet are dusky. The female ovipositor is dark shining red. The palpi are pale yellow. According to Cresson (the authority on American Ichneumonidae), *annulipes* may be distinguished from other specimens of the genus by the scutellum (the hind part of the thorax) being black, the tegulae (scales at the base of the front wings) white, and the anterior coxae (round joints at the base of the front legs) yellowish red.

FIG. 45.—Pimpla annulipes.

Professor Riley states that the ring-legged pimpla eats its way through the chrysalis and cocoon of the codling moth without having previously made any cocoon of its own; and we may reasonably suppose the same to be the case when it infests the cotton-worm, making it similar to *Pimpla conquisitor* in this respect.

CRYPTUS NUNCIUS, Say.—Another ichneumonid parasite, belonging to a different genus from the last two discussed, and known by the above scientific name, was bred from cotton chrysalides, on two occasions or more, in the department last season. It is a very common parasite, and has been often bred in large numbers from the cocoons of the larger Bombycid moths. I have bred no less than 35 individuals from one cocoon of *Telea polyphemus*. It is probable that several may occasionally be bred from one chrysalis of *Aletia*, but the notes taken on this point last year are in the possession of Professor Riley.

The following is Say's original description of this insect:

C. nuncius.—Black; abdomen, excepting the base and tip, rufous.

Inhabits Pennsylvania.

Body black, palpi white, blackish at tip; antennæ of the female with a long white annulus in the middle; thorax immaculate; two impressed lines; wings hyaline; nervures brown; stigma rather slender; second cubital cellule rather large, pentagonal, the two angles on the radial nervure nearly rectangular; recurrent nervures almost rectilinear; tergum, basal segment wholly or in part black; second, third, and generally half of the fourth rufous or honey-yellow, remaining segments black; oviduct nearly half the length of the abdomen; feet honey-yellow; posterior pair of tibiæ at tip and knees black; posterior tarsi pale yellowish.

Length about two-fifths of an inch.

I obtained many specimens from the larva of *Attacus promethia*, Linn., several years ago.

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This concludes our list of *hymenopterous* parasites of the cotton-worm. The remaining five belong to the order DIPTERA, or two-winged insects.

THE TACHINA FLIES (*Dipt.*, family *Tachinidae*).—Two of these two-winged parasites belong to the family *Tachinidae*. The members of this family are parasitic upon other insects, the females depositing their eggs upon the bodies of caterpillars, &c., and the young larvae hatching, penetrate into the interior of the body and live upon the fatty portions of the victim. The number of eggs laid upon a single caterpillar varies with the size of the caterpillar. Serville is said to have reared as many as 80 specimens from a single larva of *Acherontia atropos*. I have frequently observed as many as 15 to 20 eggs of *Nemoraea leucaniae*, Kirkp., upon a full-grown larva of the army-worm of the North (*Heliophila unipuncta*, Haw.). Eight seems to be the largest number which has been found upon the cotton-worm.

These *Tachina* flies have much the appearance of the ordinary house-flies, but are usually larger. Their eggs are tough, white, opaque, oval, and somewhat flattened on the side towards the body, to which they are firmly attached by a gum insoluble in water. With the sluggish caterpillars these flies have little difficulty in depositing their eggs when, how, and where they please. They always place them upon the back of the head, or on the first three or four segments of the body, in such a position, in fact, that the caterpillar can in no way reach them. With flying insects, however, the case is more difficult. We quote from Report of the the Entomological Commission on the Rocky Mountain Locust:

> The slow-flying locusts are attacked while flying, and it is quite amusing to watch the frantic efforts which one of them, haunted by a *Tachina* fly, will make to avoid its enemy. The fly buzzes around, waiting her opportunity, and, when the locust jumps or flies, darts at it and attempts to attach her egg under the wing or on the neck. The attempt frequently fails, but she perseveres until she usually accomplishes her object. With those locusts which fly readily she has even greater difficulty; but though the locust suddenly tacks in all directions in its efforts to avoid her, she circles close around it, and generally succeeds in accomplishing her purpose, either while the locust is yet on the wing, or, more often, just as it alights from a flight or hop.

The parasitic larva, when ready to hatch, eats its way through the egg on the side towards its victim and burrows into its flesh. They seem endowed by nature with a fondness for nothing but fatty tissue, which teaches them to leave the vital parts of the host alone. When full-fed and ready to transform they do not, as did the last-mentioned parasites, transform within the shell of the insect from which they have obtained their nourishment, but perforate the skin and enter the ground to the depth of from half an inch to two inches. Here they contract to brown oval puparia and remain for a longer or shorter space of time. According to Riley, the last brood usually winters in these puparia. The following spring the fly issuing works its way to the surface of the ground and takes wing.

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These insects are among the most effective parasites of many noxious insects. The Northern army-worm is frequently almost exterminated in localities by *Nemoraea leucaniae*, Kirkp., and *Exorista flavicauda*, Riley. The Colorado potato-bug has been killed off in great numbers by *Lydella doryphorae*, a member of this family, and the Rocky Mountain locust found in *Tachina anonyma* one of its most determined enemies. It would, indeed, have been strange had not at least one species of this family been found among the cotton-worms.

In November, 1878, two specimens of what seemed to be a new species of *Tachina* were bred from the pupa of the cotton-worm. From these specimens Professor Riley has described the species, in a recent number of the Canadian Entomologist, as *Tachina aletiae*, n. sp., as follows;

3. TACHINA ALETIAE, n. sp.—Length, 8^{mm}. Black; head golden, facial depression silvery, space between the eyes and the frontal stripe about equal to the breadth of the stripe, bristles of the head black, the pubescence behind and beneath the eyes white; antennæ blackish, palpi testaceous. Eyes at a moderate distance apart, thinly pubescent; front moderately prominent; third joint of the antennæ three or four times the length of the second joint. Thorax and the second and following abdominal joints more or less ashy, the thorax with four or five longitudinal black stripes. Wings subhyaline. Legs black, with a piceous tinge; tarsal cushions yellowish. Scutellum and the sides of the first, second, and third abdominal joints sometimes tinged with reddish-brown. No strong bristles on the first and second abdominal joints above.

Described from two specimens reared in November, 1878, from the pupa of *Aletia argillacea.*

During the season of 1879 many of these parasites have been bred. The latter part of July Mr. Trelease forwarded a quantity of parasitized larvae from Dawson's Station, Ala., with the following note:

JULY 24, 1879.

I mail you to-day a box containing some 95 pupae and webbed-up larvae of *Aletia.* * * * I find nearly one-half of the larvae from one-third to two-thirds grown bearing small white eggs on their backs. (It is only for the last few days that I have noticed this, but it has probably been the case with this entire third brood.) These eggs are of two sizes. The larger are usually, perhaps always, deposited singly on the dorsum of one of the thoracic segments of the larva, and placed transversely or obliquely. They are elongated, oval at the two ends, but more often bluntly rounded. Their length averages about 8^{mm}, their breadth 2^{mm}. They are very slightly flattened on the surface by which they are attached. Sometimes, when no egg can be seen, a discolored mark of the size and shape of the egg is seen on the back of the larva; in other cases a discoloration below the skin of the thorax appears to show the presence of a parasite larva. The smaller eggs are also white, and measure about 6^{mm} by 2^{mm}, from which you will see that they are broader proportionally, and consequently more oval than cylindrical. They are slightly more flattened on the under surface as a rule. These are deposited on the side and back of the head and thoracic segments, and vary, in the cases so far noticed, from one to four in number; sometimes, where there are several, being scattered almost in contact with each other.

These eggs were fastened very firmly to the back of the larvae, and were all so placed that the victim could by no exertion reach them with its jaws. In some cases they appeared to be even sunk beneath the skin, and Mr. Trelease records the fact in a later letter that he has seen the skin shed without the egg being also cast off. The adult flies,

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from these specimens sent July 24, began to issue September 1. This, taken in connection with the fact that the specimens reared in 1878 issued in November, would seem to argue three broods a year for this species of *Tachina*, the last two broods certainly destroying many cotton-worms.

An examination of the specimens issuing from this lot of worms revealed two individuals of a new species of *Tachina*, differing from *T. aletiae* in several respects. We shall not attempt to name it, but draw up the following temporary description, to last only until the specimens can be handed to an expert:

Tachina, n. sp.—Length 6 mm.

Color.—General effect nearly black; head, face, and facial depression silvery white, inclining slightly to golden on occiput; antennæ, 1st and 3d joints black, 2d joint testaceous; palpi testaceous; pubescence behind the head blackish; thorax, second and following abdominal joints ashy; thorax with two plain longitudinal black stripes and two indistinct; first abdominal joint black above, ashy beneath; femora piceous; tibiæ and tarsi nearly black. Eyes finely pubescent. In other respects resembling *T. aletiae*, Riley. Described from two specimens.

FLESH-FLIES (*Dipt.*, family SARCOPHAGIDAE, genus *Sarcophaga*).—From general appearance it would be impossible to separate a flesh-fly

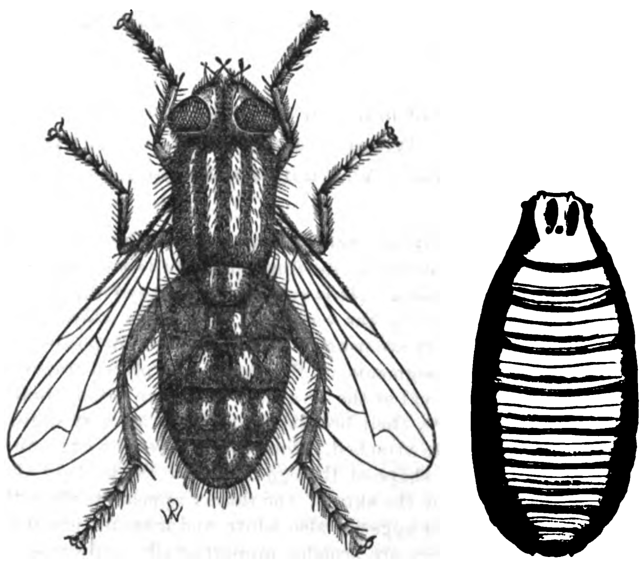

FIG. 46.—Sarcophaga carnaria.

from a *Tachina* fly, and only by the help of a lens is it possible to distinguish them; the principal difference being that in the family now under consideration the style of the antennae or antennal bristle is plumose or hairy, although naked at the tip, while in *Tachinidae* it is naked throughout its length. These flies have long been considered remarkable on account of their viviparous habits. The eggs are long and delicate and hatch quickly. If the female is unable to find a suitable place

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to deposit them within a given time after fertilization they hatch within her body, and we have the phenomenon of a viviparous insect. The ovaries are large and arranged in a spiral manner, and De Geer is said to vouch for the development of 20,000 larvae in one female. The distinction between the earlier forms of the flesh-flies and *Tachina* flies is said by Professor Riley to be that—

The *Tachina* larva is rounded posteriorly, with a small spiracular cavity, easily closed, and having a smooth rim; it contracts to a pupa, which is quite uniformly rounded at each end. The *Sarcophaga* larva is more truncate behind, with fleshy warts on the rim of the spiracular cavity, and with a more tapering head; it contracts to a pupa, which is also truncate behind and more tapering in front, where the prothoracic spiracles show, as they never do in *Tachina*.

It is the general habit of the flesh-flies to deposit their eggs or young upon dead and putrefying animal matter, but they are often known to thus infest living animals, thus par-taking of the nature of parasites. Their habits are then similar to the *Tachinidae*. The larva lives within the insect, and similarly issues when full grown to pupate under ground.

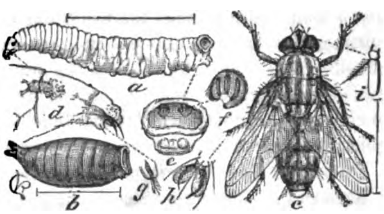

FIG. 47.—Sarcophaga carnaria var. sarracenae.

During the summer of 1878 several specimens of a flesh-fly were reared from pupae of *Aletia*. These proved to be specimens of *Sarcophaga sarraceniae* Riley, a probable American variety of that widespread scavenger *Sarcophaga carnaria*, Linn., a species common to Europe, America, and Australia certainly, and probably elsewhere to be found. *Sarraceniae* was first described by Professor Riley, in a paper read before the Saint Louis Academy of Sciences, as feeding upon the dead insects to be found in the leaves of *Sarracenias*. Fig. 47 represents this insect in its various stages, and the following is Professor Riley's description of the species:

Sarcophaga sarraceniae, n. s.

LARVA.—0.30–0.85 inch long; body composed of but 11 visible points, exclusive of the head; microscopically and transversely shagreened; transversely wrinkled, the hind wrinkle on each joint more particularly prominent laterally.

Head extremely small, or one-fourth as large as joint 1, showing a division into two maxillary lobes at the tip, and a larger labial lobe beneath, with a small bunch of setons fibers issuing from it; the black retractile jaws of the ordinary form issuing between these lobes, and the antennæ showing in two small rufous projections above the maxillary lobes, sparsely armed anteriorly with minute, conical, sharp-pointed spines, decurved in front, directed backward beneath. Prothoracic spiracle pale, rufous, retractile, sponge-like, studded with numerous lobules divided at the end into a variable number of branches (6 being usually apparent, never more than 8), which, in their turn ramify into lobules. Anal stigmatic cavity quite deep, the fleshy prominences on the carina surrounding it subobsolete; the stigmata but slightly excavated below the border, brown, inclosing three brown openings, the lower ends of which reach to a circular, clear space in the corneous and pale rufous peritreme. Anal prolegs quite small, with the longitudinal anal slit between and a corneous plate in front of them.

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PUPARIUM.—0.25-0.50 inch long; neither smooth nor highly polished, and varying from yellowish-brown to deep brown-black in color. Insections more or less distinctly traceable. Head and prothoracic joint retracted; the prothoracic spiracles protruding and forming two small ears about as long as joint 2; the mass of lobules hardened and rufous; joints 2 and 3 constricted and flattened, 4 suddenly bulging. End of body squarely docked by spiracular cavity, the rim of which forms quite a ridge.

IMAGO.—Length of body 0.23-0.56 inch. Head pale golden-yellow, especially when viewed from above, with a dark brown or bronze sheen, especially below; eyes ferruginous in life, duller and bronze-colored in death; stripe between the eyes and all appendages jet-black, though showing in fresh specimens shades of brown or yellowing-brown, especially at inner base of antennæ and on maxipalps. Thorax pale ash-gray, with three prominent dark, longitudinal dorsal vittæ, and two which are shorter on each side, the two intervening pale dorsal spaces showing also a narrow darker line along their middle; wings slightly fuliginous; tegulæ sordid white; legs black, with the front thighs grayish beneath; cushions large and pale yellowish; abdomen of the same gray—inclining, in some specimens, to pale golden-yellow, especially behind—checkered with black, the pattern varying with each change of light, but 3 longitudinal lines tolerably distinct from above, the side ones approaching or joining the medial one on the anterior part of each joint, and the whole looking checkered as the light falls on the sides; anus always, and frequently the hind margin of preceding or 4th abdominal joint, pale reddish-brown, the color deepening and becoming less noticeable in the dead specimen; the globular and highly polished ♂ genital organ of a brighter and deeper reddish-brown.

Described from numerous specimens reared from *Sarracenia variolaris* and *S. flava*.

REMARKS.—Though there is such great variation in size—depending, no doubt, on the amount of nourishment obtainable by the larva—there is not much in coloration. The species compare tolerably well with the description of *carnaria*, except in having a red anus, and should, perhaps, be considered only a variety of this last. Whether it be any of Walker's or Desvoidy's species mentioned in Osten Sacken's catalogue I have no means of positively knowing, but I have carefully read over the descriptions of Meigen, Macquart, and Wiedemaun without feeling warranted in referring it to any of them. Several of the brief descriptions of these authors might answer for it, barring the red anus, for a number of them consist of two or three lines, without measurements; and, for aught the student can see to the contrary, several of them apply to one and the same species.

* * * * * * *

The larva differs from Packard's description of that of *carnaria* in the character of the prothoracic spiracle in lacking the 12 blunt spines around the anal spiracular region, and in having the clear space in the peritreme of the anal spiracles, by which it seems to agree more with his description of *Calliphora*, and to indicate that this feature cannot be looked upon as of generic value, as Dr. Packard suggests it may be.—(Trans. St. Louis Acad., iii, 238.)

Several specimens of *sarraceniae* have been secured the present summer (1879), and also what is probably a new species of *Sarcophaga*.

On August 12, together with a lot of chrysalides from Alabama, were received the eggs of this new flesh-fly. They appeared to have been deposited singly upon the leaves which the cotton-worms had wrapped about them preparatory to transforming to chrysalides. These eggs were white and extremely delicate. In size they were about 1.3^{mm} by $.3^{mm}$, or 0.0515 inch by .0119 0 inch. One side is flattened and in fact slightly concave, so that in a profile view the egg resembles a razor-shell, one end being somewhat truncate and the other rounded. The

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next day after their arrival, August 13, these eggs hatched. The young larvae were of the same size and about the same shape as the egg. They immediately made their way into the cotton-worm chrysalis, to which the leaf was attached. They were seven in number. In four days they had demolished the chrysalis and increased greatly in size. Having finished this chrysalis, they emerged and crawled about, evidently searching for more food. Another *Aletia* pupa was furnished, which they destroyed in less than three days. In this way some five or six pupae were eaten out by them. On the 20th of August they appeared nearly full-grown, and on the 23d all but one transformed to puparia—only ten days having elapsed from the time of birth.

The full-grown larva was about a half inch (12.5^{mm}) in length, 0.119 inch (3^{mm}) in width at the posterior end of the body, which is truncated. From this point it tapers gradually down to the head, which ends in a nearly sharp point. Its color is white. But twelve segments to the body are discernible, the head being entractile within the first thoracic segment. At the juncture of the segments there is a projecting roughness around the body, more prominent, however, on the lower side, for purposes of locomotion. The larva, then, corresponds pretty well with Professor Riley's general statements concerning *Sarcophaga* larvae just quoted, but the puparium seems intermediate between that of *Sarcophaga* and *Tachina*. It will be remembered that one of these distinctions which he lays down as between *Tachina* and *Sarcophaga* is that the puparium of the former is "quite uniformly rounded at each end," while that of the latter is "truncate behind and more tapering in front, where the prothoracic spiracles show, as they never do in *Tachina*." In the present instance, however, the puparia, as shown in the figure, were much more nearly uniformly rounded at the ends than is customary with *Sarcophaga*, and the prothoracic spiracles were represented by the most insignificant tubercles.

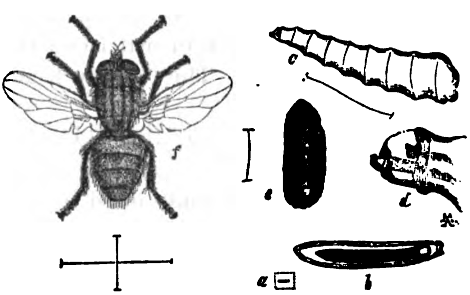

FIG. 48.

August 28, or five days after entering the pupa state, two flies emerged, and August 29 the other four issued. They showed the characteristic plumed antennal bristles of the *Sarcophagidae*, but differed in wing venation from any specimens of *Sarcophagidae* or *Tachiniidae* which I have seen. In general appearance these flies much resemble the *sarraceniae*, but are rather smaller. The six specimens bred differ among themselves strangely in regard to the width of the space between the eyes, as in three of them it equals one-third the width of the head, and in the others it is the merest line.

It is impossible to say from the experience had with them whether this

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parasite is common or not, though from the number of chrysalides destroyed by the larvae reared it will prove a very useful one if common.

Figure 48 represents the insect in all stages; *a* is the egg, natural size; *b* is the egg enlarged; *c* is the full grown larva; *d* is the head of the larva enlarged; *e* is the puparium; and *f* the adult insect.

PHORA ALETIAE:

August 12, 1879, a large number of small white maggots were found in chrysalides sent from Minters, Ala. These maggots, which appeared nearly full grown, were about 0.15 inch (4^{mm}) in length; they were rather slender, the 9th segment being the broadest. The posterior end of the body was large and rounded, and the anterior end tapered gradually to a point.

Examination with a lens showed that each segment was armed laterally with four short, stout spines (two on each side), and the posterior end of the body was furnished with six. August 16 these larvae commenced to pupate. The puparium was light brown in color, 1^{mm} by 2^{mm} in size. The front side showed the joining of the segments, and was somewhat rugose; the back side was smooth; the posterior end was rounded and armed with the same six small spines that were present in the larva; the anterior end of the body was more pointed. From about the third thoracic segment two long black excurved spines protruded, which presented the most characteristic feature of the puparium. The perfect flies began to issue in great numbers August 27, or about ten days from the time of commencing to pupate. They proved to be active little yellowish-brown two-winged flies, with robust bodies and short, stout wings. They are well represented at Fig. 49, as also are the larva and pupa.

It was at first thought that these larvae would not prove to be truly parasitic, but that they were to be found only in those cotton-worm chrysalides which were already dead from some other cause and decaying. Still a doubt remained, and in pursuit of other facts, Mr. Trelease, from whom the specimens had been received, was addressed. He replied as follows:

With regard to these flies, I may state that I have seen them in abundance in all of my jars—covered with gauze—in which I have reared larvae of either *Aletia* or *Heliothis*, being found there while the specimens of *Aletia* and *Heliothis* were larvae, and were, as I supposed, attracted by the leaves and bolls put in for the latter to feed upon. I would account for their presence among my pupae [meaning the pupae which he had sent to the department and from which the flies had been bred] by saying that they were there to feed upon the leaves in which the latter were inclosed; but if they have been *bred from* the pupae, I have nothing more to say. I find them in the field about the pupae of *Aletia*, and had supposed that they might sometimes feed upon the little fluid left in the pupa skins after the exclusion of the moth, since they congregate in these empty skins.

Among a lot of cotton-worm chrysalides received August 28 were many which were in all stages of demolition from being devoured by these *Phora* larvae. Some specimens contained fifty or more. As Mr. Trelease collected only those pupae for transmission which were still

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alive or appeared parasitized, we may consider this as good proof of the true parasitic habits of the species.

With the determination of the species as belonging to the genus *Phora*, however, all doubt as to its parasitic habits was lost, as many species of the genus are known to be parasitic upon other insects. The most celebrated species, perhaps, is *P. incrassata* of Europe, concerning the habits of which we quote the following from an article by Dr. Packard in the American Naturalist for 1868:

An insect allied to the *Tachina* has been found in Europe to be the most formidable foe of the hive-bee, sometimes producing the well-known disease called "foul-brood," which is analogous to the typhus fever of man.

This fly, belonging to the genus *Phora*, is a small insect about one line and half long, and found in Europe during the summer and autumn, flying slowly about flowers and windows and in the vicinity of bee-hives. Its white, transparent larva is cylindrical, a little pointed before, but broader behind. The head is small and rounded with short three-jointed anntenæ, and at the posterior end of the body are several slender spines. The *puparium*, or pupa-case, inclosing the delicate chrysalis, is oval, consisting of eight segments, flattened above, and with two large spines near the head and four on the extremity of the body.

When impelled by instinct to provide for the continuance of its species, the *Phora* enters the bee-hive and gains admission to a cell, when it bores with its ovipositor through the skin of the bee larva, laying its long oval egg in a horizontal position just under the skin. The embryo of the *Phora* is already well developed, so that in three hours after the egg is inserted in the body of its unsuspecting and helpless host the embryo is nearly ready to hatch. In about two hours more it actually breaks off the larger end of the egg-shell, and at once begins to eat the fatty tissues of its victim, its posterior half still remaining in the shell. In an hour more it leaves the egg entirely and buries itself completely in the fatty portion of the young bee.

The maggot moults three times. In twelve hours after the last molt it turns around with its head toward the posterior end of the body of its host, and in another twelve hours, having become full-fed, it bores through the skin of the young, eats its way through the broad covering of the cell, and falls to the bottom of the hive, when it changes to a pupa in the dust and dirt, or else it creeps out of the door and transforms in the earth. Twelve days after the fly appears.

The young bee, emaciated and enfeebled by the attacks of its ravenous parasite, dies, and its decaying body fills the bottom of the cell with a slimy foul-smelling mass, called "foul-brood." This gives rise to a miasma which poisons the neighboring brood, until the contagion (for the disease is analogous to typhus, jail, or ship fever) spreads through the whole hive, unless promptly checked by removing the cause and thoroughly cleansing the hive.

Foul-brood sometimes attacks our American hives, and, though the cause may not be known, yet from the hints given above we hope to have the history of our species of *Phora* cleared up, should our disease be found to be sometimes due to the attacks of such a parasite fly.

Mr. Edward Burgess informs me, after comparing specimens of the *Phora* bred from *Aletia* with the types in the Cambridge collection, that this is probably a new species. I will therefore provisionally designate it as *Phora aletiae*, and submit the following description to accompany the figures:

PHORA ALETIAE, n. sp.

LARVA.—Length of mature larva about 3.6^{mm}.; tapers gradually from the 9th segment towards the head; color milk-white; body very much wrinkled, the whole surface sparsely beset with short, backward-directed teeth, which are most conspic-

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uous and quite numerous at and near the lateral edge; antennae short, 2-jointed, 1st joint very short and thick, the 2d scarcely one-half the diameter of the 1st, slightly conical and rounded at tip; the 1st thoracic segment bears 6 quite long, pointed tubercles, arranged in a curve around its lateral and front margin; the stigmata are upon short processes, and, are placed close together near the middle of the segment; all other segments, except the two last, have on each side one quite long, slender tubercle, somewhat posterior to the middle, and, in a transverse row dorsally, 4 short, fleshy, conical tubercles and a somewhat longer one ventrally near the lateral edge, a little in front of the lateral one; the 12th segment has its spiracles, which are situated near its center, prolonged into rather long, fleshy tubercles; this segment bears on each side two tubercles, one at the anterior and the other at the posterior angle; the last segment is furnished with 4 tubercles, one on each of the posterior angles and two near the center of its posterior margin, the two lateral ones longest.

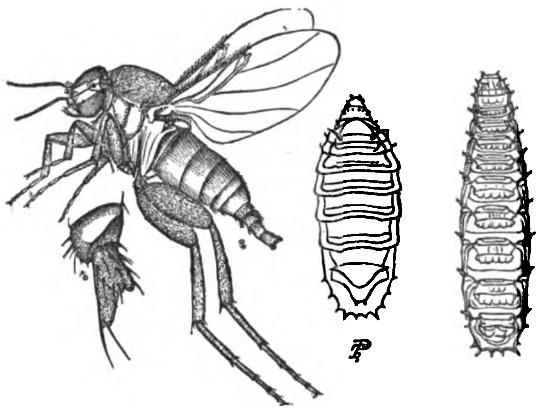

FIG. 49.—Phora aletiae.

PUPA.—Length 2.8^{mm}; color light brown; the whole surface is covered with small roundish granules, which are the remnants of the tooth-like processes which were noticed on the larva; from the 1st abdominal segment the body tapers rapidly to the head; the 1st abdominal segment bears dorsally, near its front margin, two very conspicuous black horns, slightly directed backward; the lower two-thirds of each horn is nearly straight, and the last third is curved gently outward; it is thickest at its base, and becomes slightly thinner towards its apex; all the lateral tubercles and the last pair of spiracles are very much reduced in size in comparison with the corresponding ones in the larva, the tubercles of the last segment, however, remaining of nearly the same size; the dorsal portion, between the horns and the last pair of spiracles, is greatly convex, the lateral margin being flattened; it is traversed in nearly equal distances by 4 prominent, rounded, double ridges; each of the 2 posterior ridges, which are somewhat broader and higher than the front ones, bear 4 round warts, which are the remnants of the dorsal tubercles of the larva, and the last pair of spiracles is situated on a rounded elevation; the ventral portion is slightly rounded and without any particular markings.

IMAGO.—*Female:* Length of body, 2.3^{mm}; front of head dark yellow, beset with 16 stiff, black, spine-like hairs; eyes black, coarsely faceted, covered with minute black hairs, and edged posteriorly with some longer spines; antennæ 5-jointed; 1st joint very much swollen, almost globular, and very hairy; the next 3 joints are very small, all three together not longer than the 1st, having only about one-fifteenth of the diameter of the 1st; the 2d and 3d are about equal in length; the 4th is a little shorter; all; are slightly thinner towards the base, beset with fine hair; the 2d joint is inserted on the upper side at about the middle of the outer margin of the 1st segment; the 5th joint, or bristle, is very long and delicate, and is closely beset with short, spine-like hairs; the labium, when extended, is quite long and fleshy, and seems to be composed of 4 pieces or lobes; the basal piece is somewhat narrower than the 2d, which broadens at its middle; the 3d piece is somewhat smaller than the 2d, straight posteriorly and gently rounding towards the apex; the last piece is very minute and knob-like; the labium is sparsely beset with quite long hairs; the maxillary palpi are 2-jointed, the 1st very short, scarcely noticeable, the 2d very long, petiolated, with its apical half broadened

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into an oval pad, curved inward, and beset on its outer edge with five or six barbed spines; thorax dark yellow, covered with small black hairs, which give it a slightly dusky appearance; a few long black spines are arranged around base of wings and sides of the thorax; abdomen dusky; venter yellowish, dusky towards the end; the 1st segment dorsally has near its base a very narrow transverse black band; the posterior margin is yellow; on the 2d segment is a very broad, nearly rectangular, transverse black patch, which leaves only a narrow yellow margin posteriorly; the 3d and 4th have each a somewhat squarish black spot, reaching from front to hind margin, having its sides somewhat concave; the spot on the 3d segment is nearly divided from the front to its posterior margin by a triangular yellow center, which is broadest in front; the 4th has only a very small triangular spot at its front margin; (in the darker specimens this black spot is surrounded by a narrow yellow line which is not noticeable in the lighter ones); the 5th and 6th segments have each a somewhat squarish, transverse, black spot, and both spots of these segments are divided only by a very small, transverse, yellow spot; there are a very few short hairs at the incisures between the segments dorsally and ventrally; the body is quite smooth when distended with eggs, but soon after a few of the eggs are deposited becomes much wrinkled longitudinally; the ovipositor, when fully extended, is seen to be composed of 5 joints, and is then about one-third the length of the abdomen; joints 2 and 4 are quite hairy, and also the small terminal joint; joints 1 and 3 are smooth; legs yellow, profusely beset with quite long black hairs; there are a few long spines around the apex of coxae of all the legs; the femora of all the legs, especially of the 3d pair, are very much swollen at their middle; the tibiæ of the 2d pair of legs do not reach the base of femora when folded, but those of the last pair are as long as the femora; the tibiæ of 2d and 3d pair of legs are furnished at the front of their tips with three spurs, one large and two small ones; the large spur of the middle tibiæ stands between the two smaller ones, and the one of the last tibiæ stands on the outside of the tip, just below the outer small spur; the large spur of middle legs is nearly twice as long as that of the last tibiæ; the tarsal joints of front legs are without spurs, but those of the other two pairs are furnished at their tips with two short spurs and are lined, besides these terminal spurs, on their front sides, with two rows of similar spines or spurs; wings, faintly yellowish, beset with extremely minute hairs; the costa is provided with a double row of long and acute spines, and the remaining portion of the margin, except a short piece near the inner side of basis, with extremely minute cilia; this basal portion is furnished also with 7 or 8 spines similar to those of the costa; rims, yellowish; halteres 3-jointed, the last joint oblong oval.

Male: The male is about one-third the size of the female. There are scarcely any distinguishable differences between it and the female, except that in the male the dorsal portion of the abdomen is entirely blackish.

From present indications, this insect bids fair to be one of the most important, as it is one of the most interesting, of the parasites of the cotton-worm.

IMPORTANCE OF THE NATURAL ENEMIES OF THE COTTON-WORM—SUMMARY.

From a perusal of this chapter it is doubtful if the reader has obtained a very definite idea of the actual amount of good performed by the natural enemies of the cotton-worm, except that it is by no means insignificant. It would, indeed, be a difficult task to estimate the number of cotton-worms, in one stage or another, that are destroyed every year by the different birds and insects; but we will bring together in this summary such points as relate to the amount of good performed, hoping to set the importance of the subject forth in a more definite light.

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Among the vertebrate enemies, it will be of interest in this connection to be able to form an idea of the *actual number* of insects destroyed by the average insectivorous bird. As concise a statement of facts upon this point as we have met with is given in Professor Aughey's report to the United States Entomological Commission, from which we have already quoted in the early part of this chapter.* Professor Aughey says:

Few unobservant people have any comprehension of the vast number of insects that birds actually destroy. During the breeding-season this destruction of insects by birds reached its culmination. The young of some species will eat about 50, others about 60, some about 75 insects each day. The average cannot be far from 60. At this rate five young birds would eat about 300 insects each day, or about 9,000 a month for each month, exclusive of the parents. There have been widely different estimates as to the number of insects that the old birds eat, but it ought not to be difficult to approximate the quantity. Only a small part of a bird's stomach is entire enough to be distinguished and counted. If the balance is composed as largely of insects, which is more than probable, then the whole number eaten during a day by an insectivorous bird must be near 200. I reached the same conclusion by actual tests. In the fall of 1874 I bought two Bartramian plovers from some boys who had trapped them, and kept them for a week in a cage before they were set free. I fed them on locusts and other insects, which I counted for four days with the following result:

First day	277
Second day	452
Third day	448
Fourth day	439
Total	1,616
Average per day	404
Average for each	202

I was compelled to go away or else the experiment would have been continued longer.

About one-fourth of the insects were locusts, and the balance were flies, ants, beetles, &c. I gave them whatever insects the boys that I hired gathered for me. My impression, however, is that they ate less than they would have done if they had been at liberty. But, lest there might be some mistake, and to avoid all possibility of error on the wrong side, we will base our calculations on an estimate of 150 insects each day for a mature plover. At this rate 20 old plovers would eat 3,000 insects each day, or 90,000 a month. And suppose further that these 20 plovers had nests which averaged four young ones each. At 60 insects a day for each young plover the 40 would consume 2,400 every twenty-four hours, or 72,000 a month. The 20 plovers and their progeny together would consume 162,000 insects each month. At this same rate 1,000 plovers and their young would consume in one month 8,100,000 insects. That many insects removed in one year from a farm of 160 acres would probably render it capable of producing crops even when these insects were doing their worst. As there are many birds that eat more insects than do the plovers, as well as many that eat less, 150 insects a day is probably a fair average for all insectivorous birds.

This extract is eloquent as a defense of birds and puts us on a sound basis of apparently unexaggerated facts. Too much, then, can hardly be said in favor of insectivorous birds in cotton-fields. We have entered into the English-sparrow question somewhat at length. Every day brings confirmatory evidence in support of the conclusions at which we have

* First annual report of the United States Entomological Commission, 1877. Rocky Mountain Locust, Department Interior, 1878.

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arrived. Reports have reached us of the attempted colonization of this bird in parts of the cotton-growing regions of Texas. The persons who carried this plan out did not learn from experience of the bad habits of the sparrow for the simple reason that he would not stay. In a very short time after their importation in considerable numbers hardly a sparrow was to be found in the State. Persons interested in the experiment believed that the climate was too warm, and suggested as the only means of bird relief the importation of some South American sparrow of similar habits. We very much doubt, however, if any bird could be introduced which would prove a greater blessing than any one of many birds indigenous to the cotton States, if equally encouraged.

With the exception of the ants, predaceous insects are hardly to be compared either to the birds or to the parasitic insects in regard to the number of cotton-worms which they destroy. True, the capacity of some of them is great, but they either labor under disadvantages (such as being comparatively confined to the ground, as the carabid beetles) or are not sufficiently numerous to do a very great amount of good. Still it is well to know them and not destroy them, as thousands of worms are destroyed by them, and it is only in a comparative way that we speak at all deprecatingly of them. The capacity of the rear-horses (*Mantis Carolina*) has been shown by the statement that one individual has in one night killed and devoured eleven Colorado potato-beetles, and we have mentioned the fact that a young specimen of the wheel-bug (*Prionotus cristatus* [*Reduvius novenarius*]) has been known to destroy ten caterpillars in five hours, thus showing the amount of good which may be done by the hemipterous enemies of the cotton-worm. The destructive powers of the asilus-flies have been shown from Mr. Thompson's statement that he has known one individual to destroy 141 bees in a day. The work of ants in this direction has been discussed at length, and they are shown to be the most valuable of the predaceous insect enemies of the cotton-worm.

The destruction of the cotton-worms by their true parasites is a subject upon which interesting experiments may be made. The extent of parasitism will undoubtedly vary much with the season of the year, the last brood always seeming to be much more extensively parasitized than any of the preceding broods. The probabilities are that they increase with the increasing numbers of the worms, and that they also are affected to a certain extent by the character of the season, although not comparably with the ants. From August 12 to August 28, 1721 pupae, probably belonging to the fourth brood, were received at the department from Mr. Trelease at Minters, Dallas County, Alabama, for the purpose of ascertaining the extent of the parasitism. The result hardly justified the anticipation. From this lot of 1,721 chrysalides there issued in all 1,455 moths, and from the remaining 266 chrysalides were bred the following parasites: Of *Chalcis ovata*, Say, 32 specimens; of *Tachina aletiae*, Riley, 3 specimens; Of *Sarcophaga* sp., 7 specimens; of *Pimpla anulipes*, Br., 1 specimen; of *Tachina* sp., 2 specimens; of

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Didictyum zigzag sp., 32 specimens; of the small Dipteron *Phora aletiae*, a very great number of specimens; making altogether of the large parasites 44, each singly from a chrysalis, and 120 *chrysalides* destroyed by the small parasites, making a total of 164 out of 1,721, or between 9 and 10 per cent. The remaining 102 died from some unknown cause. This percentage is small, but in the last brood it would unoubtedly be greater.

The extravagant ideas of Dr. Gorham on the subject of the extent of parasitism are easily accounted for. He collected his specimen chrysalides for observation late in the fall, after the hibernating moths had issued. Naturally, no apparently sound chrysalides were left excepting those containing parasites. These he collected, and parasites issued from all; hence his conclusions. A little note from one of Professor Willet's letters seems to indicate the greater abundance of parasites in the last brood than in the earlier ones. He collected a number of newly-formed chrysalides in November. Of these he says:

> About two dozen were placed in a box in my sitting-room, expecting to hatch out some moths for exposure. The following is the result: In some two weeks two moths came out; they seemed delicate, and one lived only two days, the other four or five. No other moths have appeared (December 11). November 24, I found four ichneumon flies (*Pimpla conquisitor*) out in one boll; December 2, one more, and December 7 another; the sixth, the last, with no ovipositor (a male). In breaking open the dried chrysalides I destroyed two pupae of parasites. These make eight parasites in some two dozen chrysalides—a large proportion. I had 75 chrysalides in a box in summer; about 50 came out moths; most of the others could not escape from and perished in the dried leaves. I saw not a parasite of any kind.

An encouraging statement concerning the extensive parasitism of an early brood (the third) is contained in a letter from Mr. Trelease of July 24, 1879. He stated that at that time *nearly one-half* of the half-grown worms in the fields under his observation bore the eggs of one of the *Tachina* parasites. One-half is certainly a large proportion, but he reiterates it with exactness in his notes, and stands ready to vouch for it. It seems not at all unlikely when we consider the numbers in which the northern species of *Tachina* occur in fields ravaged by the northern army-worm. In a field which was black with these worms I have searched for hours without finding a single unparasitized full-grown worm. Nine hundred and ninety-nine out of a thousand bore the white eggs of the destroyer.

These few points will be sufficient, perhaps, to give a more accurate idea of the importance of the natural enemies.

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CHAPTER VII.

REMEDIES.

The most careful and extended experiments on remedies for the ravages of the cotton-worm which have been carried on under the direction of this department are those conducted by Mr. Trelease during the present year (1879). These experiments were performed under especially favorable conditions. Mr. Trelease was located upon a plantation in the southern part of Dallas County, Alabama, a locality in which cotton-worms are especially destructive; he made arrangements by which he could call into service all the help on the place if necessary. In this way he was able to use the remedies on a large scale, and to carefully compare the results obtained by different methods. A neighboring plantation upon which no efforts were made to protect the cotton served also for comparison.

As we shall have occasion to refer to these experiments frequently in the course of this chapter, we give here that part of Mr. Trelease's report relating to them.

REPORT OF EXPERIMENTS BY MR. TRELEASE.

To prevent the caterpillar from materially injuring the cotton crop, various devices have been proposed. These may be considered as preventives or remedies; the first getting the crop in such a condition that the worms cannot harm it, the second protecting the crop by killing the caterpillars.

In most sections the first four broods of larvae do no harm to cotton on elevated dry soil, while the fifth brood does not appear till late in August or even in September. This has led some planters to contend that by highly fertilizing their land they can force the crop to early maturity, so that when the worms appear it will have stopped "making," and the removal of the leaves will then be a decided advantage by allowing the sunlight to reach the lower bolls, thus preventing them from rotting, as they sometimes do if too much shaded. But in practice it appears that land which, if unfertilized, produces small cotton, making little after the early part of August, will, if fertilized and suitably cultivated, grow large plants that continue to grow until checked by cold weather. While, therefore, fertilizing the land increases the cotton made up to the middle of August, it also leaves the plants in a vigorous, growing condition at the time when the worms appear, so that it is then desirable to use some remedy.

With a view to having their cotton through making when the worms appear, others leave two or even three plants where commonly only one is left, believing that early in the season each plant will grow and fruit

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as well as if it stood alone, the lack of sufficient nutriment checking their growth only late in summer. Their argument is, it is better to get an early crop on three plants than to rely on an early and middle crop on one plant, when the top crop is likely to be destroyed by the worms. Though it is an error to suppose that it is only late in the season that these plants suffer from an insufficient supply of food, yet I am inclined to believe that on the lands where no fertilizer is used this is a good practice.

Another expedient is the selection of a variety of cotton that the worms will not eat; and it is possible that such a variety may some day be produced. Small quantities of a variety known as *worm* and *nest proof* are grown on several plantations not far from Elm Bluff, Ala., and I had the opportunity of examining some of the plants early in September. They were growing on dry, rather poor soil, were of something less than the average size, but quite prolific. The green parts of the plant were deeply tinged with red, and this color was quite noticeable in the corolla. On this cotton I found living *Aletia* eggs, as well as spots where small caterpillars had eaten transparent places in the leaves, and quite large holes eaten through the leaf by large ones. No worms were found on the plant, having probably been removed by either ants or chickens, for the cotton was growing in a door-yard garden.

With a view to rendering the cotton distasteful to the caterpillar, if possible, quassia chips were steeped and soaked in water for about a week and a half, one pound of chips being used for each gallon of water. This decoction was then diluted, from a pint to a quart of it being added to each bucketful of water (2 gallons), and applied with a fountain pump to infested cotton, so that every leaf was thoroughly wet. In this form the infusion was intensely bitter and imparted a strong taste to the cotton leaves after the water had evaporated; but though several applications were made I could not see that it interfered with the feeding of the worms.

What I have called remedies may be conveniently divided into two classes, natural and artificial; and these may be further subdivided as shown in the following table:

I. Natural remedies		*a.* Animal. *b.* Vegetable.
II. Artificial remedies	*c.* For moths	1. Poisoned baits. 2. Lights and fires. 3. Traps.
	d. For larvae	1. Hand-picking. 2. Crushing by machines. 3. Poisoning.

By natural remedies I wish to indicate the breeding and protection of all natural enemies of the species, whatever their nature. Those belonging to the animal kingdom may be found specified in that part of my report relating to the natural enemies of *Aletia*. In addition to those mentioned there might be included all insectivorous birds. The

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European sparrow feeding extensively on insects, some planters believe that it would make a strong enemy of the caterpillar if introduced; but from what I know of its nature, and from what others who have studied its habits tell me, I believe it impracticable to make it remain on a plantation, and, even if this could be accomplished, its granivorous and quarrelsome propensities would make it a pest that the farmers would be only too glad to get rid of. All native insectivorous birds should be protected by law, and under no circumstances should one of them be killed or its nest disturbed.

Under the head of natural remedies belonging to the vegetable kingdom, I would place any fungi or molds that may be utilized for the destruction of *Aletia* in any of its forms, if such there be. In the latter part of July a copy of an article by Dr. Hagen on the use of fungi to destroy noxious insects, from the Canadian Entomologist, vol. xi, p. 110, was sent me from the department with instruction to test the matter carefully. I have not the article before me now, but from the belief of some mycologists that the fungus of the house-fly, the torulae of yeast or beer, and the common mold are forms of one and the same species, it was recommended that the insects to be destroyed should be showered with dilute yeast, from which would be developed a fungus parasitic on the insects. And, whether the identity of the fungi mentioned were real or not, it was stated that the Continental mycologist, Dr. Bail, *had demonstrated* that yeast or beer torulae sown on insects gave rise to some fungus which caused their death.

On the strength of this statement, and knowing that different species of insects sometimes die in large numbers from fungoid diseases, I tried the following experiments with yeast, with the results given. It should be stated that care was taken in every instance to see that the yeast was in an active state.

August 1, during a light shower, I applied a gallon of yeast in eight gallons of water to cotton, on which there were many half-grown caterpillars, as well as numbers of small ones, using a fountain-pump for distributing the liquid, and being careful to reach all parts of the cotton with it, wetting it, indeed, so thoroughly that the air for some distance was pervaded by a yeasty odor. Before I had finished the shower became heavier, and it rained hard for a considerable part of the night. There was more or less rain nearly every day for the succeeding week. Examination every few days showed that no fungus was attacking the worms.

August 7, I applied several gallons of water, in which was yeast in proportions varying from one-half pint to one quart to the gallon of water. This was applied in the morning while the sun was shining brightly, and no rain fell on it until night, though more or less rain fell every day for the next half week. There were worms of all sizes where this was used, but none were attacked by disease.

August 13, more was applied in varying quantities of water, the day being cloudy, but only negative results were obtained.

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September 9, after sunset another gallon of yeast in four gallons of water was applied to cotton covered with young larvae and eggs, but with no result, so far as I could see.

It will be seen that the first of these experiments was tried during a rain, which endured for some time, so that the yeast may have been washed from the leaves and from the caterpillars before having an opportunity to act; but if any of it adhered the damp weather following was most favorable to its development into the parasitic form. The second was tried when the sun was shining early in the morning, so that it was exposed to sunlight for the greater part of one day, and could not have been removed by rain till the following night. Like the former, this was subjected to damp weather for a number of days. The third lot was applied in the early part of a cloudy afternoon, and this was subjected to rains the next night and for several days. The fourth lot was applied after sunset, and there was no rain on it for three days. Moreover, these quantities of yeast were so applied as to wet eggs, larvae, and pupae of *Aletia*. Other applications were made on a small scale at different times, but with similar results.

From these experiments it appears that under the most varied circumstances, many of which are very favorable to the growth of fungi, yeast in an active condition failed to produce any fungoid disease on either the eggs, larvae, or pupae of *Aletia*. Furthermore, larvae contained in a tin box were drenched with yeast, being kept thoroughly wet for over twenty-four hours, after which a part of the liquid was drained out, and the box remaining uncleaned, the larvae were kept and fed in it for a week longer, at the end of which time they were still living and apparently suffering from no disease. This leads me to believe that though the *Penicillium* or *Aspergillus* developed from torulae sometimes attack living animal tissues, they cannot be utilized for the destruction of the cotton caterpillar. Yet, considering to what an extent some insects suffer from fungoid diseases, it seems by no means improbable that some practical and economical method of parasitizing noxious insects may some day be discovered.

Since the perfect form or moth of *Aletia* is known to feed upon sugared substances and fruits, and since it is known to be attracted by light to a certain extent, it has been thought possible to destroy the moth by allowing it to feed on poisoned sweets, or by employing the food or lights to attract it into traps of various sorts.

As will be seen by referring to my report on the food of these moths, they are attracted in large numbers by ripe apples, peaches, and grapes, beside one or two other less common fruits, but I signally failed to attract them to my mixtures of molasses or sugar and various substances. Though no experiments on a large scale were conducted, I feel confident that poisoned dishes of ripened and slightly fermenting fruits which have been bruised, may be advantageously employed for the destruction of these moths, by placing them about the cotton-fields when the

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moths are flying. I would recommend that this be tried, especially on warm days in winter, when the moths are allured from their hibernacula; in the early spring, and in the fall, after the brood which destroys the cotton have emerged as moths.

From what has been said in the earlier agricultural reports, and from the testimony of planters as to the attraction of lights for these moths, I had supposed that the easiest and most scientific method of destroying *Aletia* was to employ fires into which they should be attracted, or lights in combination with some form of trap, either with or without the added attraction of food, these to be used whenever the moths were flying, and their use enforced, if necessary, by legislation. Considering, for the above reasons, that the fondness of these moths for light was proved, I made no efforts to obtain personal demonstration of the fact, and it was only on learning how many species of moths and even of other insects may pass for *Aletia* with the ordinary observer, and on seeing from my notes how little attention was paid to the light of my lantern, that I began to doubt the efficacy of this remedy; but this, unfortunately, was after I had left the field. As it is, I can only say that the number attracted to lights, as compared with the entire number, was very small, so far as my experience goes. Though I saw a few dozen attracted into the house, thousands were in sight of the light and removed but a few rods; while for each of those thus attracted a dozen individuals, belonging to other species, came to the light. My own observation, then, goes to show that these moths are not attracted to any great extent by lights, but if this attraction should be proven to be considerable this would prove one of the best ways of dealing with the pest.

In the destruction of some noxious insects, especially those injurious to the vegetables of the kitchen garden, hand-picking is found very efficacious, and this has been suggested as a means of destroying the cotton-caterpillar. Where it can be properly done, this is undoubtedly a certain remedy; but for cotton as ordinarily grown it is impracticable for several reasons: 1. Its great cost; 2. The impossibility of getting over the plantation before parts of it should be eaten out; 3. The fact that labor is almost invariably needed to house fodder at the time when this would have to be done, and could not well be spared for this work.

Various machines have been patented for either shaking the caterpillars from the plant or by disturbing them, causing them to leap from it voluntarily, after which they are crushed by some contrivance. Though I have not seen these machines, I feel doubtful of their value for the reason that driving a vehicle of any sort through very high cotton which has locked across the rows is certain to injure it more or less, and the extent of the injury will depend upon the rapidity of driving and the amount of concussion which the plants receive, any severe jolting causing the bolls to fly off. From their very nature these machines must cause more or less of this jarring, and I believe that to be true of any machine intended to shake the worms from the plant.

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In the present state of our knowledge it seems that the most effectual means of destroying the cotton-caterpillar is by the use of poisons, either in the moist or dry condition. In the former case, the poisonous substance is dissolved or suspended in water; in the latter, it is mixed with flour, gypsum, or other innocuous powder, which serves to dilute it, and in some cases to aid it in adhering to the plant. The ground covered by my experiments with poisons may be seen from the following tables:

I.—TO TEST THE EFFICACY OF THE SUBSTANCES.

A.—Wet.
- (*a*) London purple, suspended in water.
- (*b*) Gray arsenic, suspended in water.
- (*c*) Paris green, suspended in water.
- (*d*) Texas worm-destroyer, dissolved in water.
- (*e*) Gray arsenic, in Fowler's solution.
- (*f*) Oil of turpentine, in water.
- (*g*) Kerosene, in water.
- (*h*) Carbolic acid, in water.

B.—Dry.
- (*a*) London purple, in Royall's mixture.*
- (*b*) Gray arsenic, in Royall's mixture.
- (*c*) Paris green, in Royall's mixture.

II.—TO TEST THE ADHESION OF THE SUBSTANCES.

A.—Wet.
- (*a*) Poisons suspended in water without flour-paste.
- (*b*) Poisons suspended in water with flour-paste.

B.—Dry.
- (*a*) Poisons mixed with flour.
- (*b*) Poisons mixed with flour and gypsum.
- (*c*) Poisons mixed with flour and rosin.
- (*d*) Poisons mixed with flour and dextrine.
- (*e*) Poisons mixed with flour, rosin, and dextrine.†
- (*f*) Poisons mixed with flour, gypsum, and rosin.
- (*g*) Poisons mixed with flour, gypsum, and dextrine.
- (*h*) Poisons mixed with flour, gypsum, rosin, and dextrine.
- (*i*) Poisons mixed with gypsum, rosin, and dextrine.
- (*k*) Poisons mixed with gypsum and rosin.
- (*l*) Poisons mixed with gypsum and dextrine.
- (*m*) Poisons mixed with gypsum.

All of my wet poisons were applied by use of Whitman's fountain-pump, No. 2. Where small quantities were used, one man carried a 2-gallon water-bucket, and another preceded him, working the pump.

* Royall's patent: Flour, one barrel, 196 pounds; Paris green, 9 pounds; dextrine, 10 pounds; rosin, 12 pounds.

The ingredients being in a fine powder, are sifted to remove lumps, after which they are thoroughly mixed. Other poisons may be substituted for Paris green.

† *Ibid.*

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Where larger quantities were used, a 40-gallon barrel was placed in a four-wheeled wagon with wheels 5 feet apart, and the lowest axle 23 inches from the ground. This was drawn by two mules, being made to straddle one row of cotton, the mules walking in the furrows that the wheels ran in. One man drove the wagon, and two others, provided with fountain-pumps, distributed the poison contained in the barrel, wetting nine rows for each trip across the field. Meantime, one or two other men, with a two-horse wagon, containing several smaller barrels, were engaged in carrying water from a pond to the ends of the rows of cotton, where it was transferred to the distributing wagon. With these two pumps worked slowly, the mules walking very slowly, we found that a barrel of water went over about three acres of cotton, wetting it fairly, but not so well as was to be desired. The men were therefore made to work the pumps faster, so that a barrel lasted for two acres. Not satisfied with this, we enlarged the holes in the rose-nozzle a little, so that without materially diminishing the force of the pump we were able to apply a barrel of fluid to the acre.* In this way about 30 acres a day may be poisoned by four hands and four mules.

My dry poisons were applied by a sieve made of a 2-quart tin bucket, the bottom of which was replaced by perforated tin, and which was provided with a socket at the side for the insertion of a wooden handle about three feet long.

My experiments with dry poisons were not extensive enough for me to determine accurately the amount of labor required to poison an acre; but Mr. Lide, the manager of George O. Baker's plantation at Selma, Ala., tells me that a hand can poison from one to two acres of cotton per day. He tells me, further, that one barrel of Royall's mixture goes over about three acres.

Before giving details of the experiments, I may briefly state the conclusions to which they led me, as follows: As an insecticide I prefer Paris green to any other substance used, and find it less likely to injure the cotton than any other. Next to this, I should place commercial arsenic (arsenious oxide, $As_2 O_3$), though this is more likely to scorch the cotton than the preceding. I should place London purple next in the list, as being less valuable as a poison and more liable to injure the cotton. Fowler's solution of arsenic (arsenious oxide dissolved in a solution of sodium or potassium carbonate in water) serves fairly as an insecticide, but my experience is that it is very liable to injure the cotton, probably owing to the alkaline nature of the solution. A considerable quantity of the mixture known as the Texas Cotton-Worm Destroyer was used, the directions accompanying the package being followed; but I failed to obtain satisfactory results from its use in any trial. Oil of turpentine, kerosene, and carbolic acid in water were applied but when applied so as to kill the caterpillars I found that they always injured the plant.

* It is far better to employ the larger size of pump, which, from its greater capacity, distributes more water than the one used by me, and with less labor.

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The cheapest mode of applying the poisons is undoubtedly in the wet form; and I find that they adhere as well when suspended in pure water as when paste is used, though this aids in their suspension. Whenever a solid is used in suspension, frequent stirring is needed to keep it evenly distributed through the water. In Royall's patent the flour is supposed to act as a diluent; the rosin, to melt by the heat of the sun and thus affix the poison to the leaves of the plant; the dextrine, to melt and gum the poison to the leaves under the action of water, either as dew or rain. My experiments showed me that flour alone adhered nearly as long as this mixture; and even that it might be replaced in part by gypsum or land plaster, but that gypsum alone, or replacing all of the flour in Royall's patent, was removed by the first rain as a general thing. The reason for this is that the first dew converts the flour into a paste, which becomes attached to the leaf, and considerable rain is needed to dissolve and remove it. I find that one pound of Paris green, applied in forty gallons of water to an acre of cotton, will kill the worms to a certainty without injuring the cotton to any appreciable extent, provided there is no rain on it for several days; but the dry poison, using about twice as much Paris green to the acre, is equally certain and safe, and will withstand far more rain, even if merely mixed with flour. Owing to the cost of the flour, however, and the greater cost of applying it, the dry poison is far more expensive than the wet.

A.—WET POISONS.

August 7, nine barrels of water were applied, going over about three acres to the barrel. The time spent was from 9 a. m. to sunset, and the first rain fell at about nine o'clock the next morning. The substances used, their quantities, and the number of dead worms just before the rain began are shown by the following table:

I.—*Wet poisons applied August* 7, 1879.

Number of barrels.	Name of poison.	Quantity of poison.	Quantity of paste.	Dead worms.
1	Texas worm-destroyer	Measure		None.
2	London purple	16 ounces	1 gallon	Very few.
3	Gray arsenic	21 ounces	1 gallon	Do.
4	Paris green	21 ounces	1 gallon	Few.
5	London purple	20 ounces	1 gallon	Very few.
6	Paris green	16 ounces	1 gallon	Do.
7	Gray arsenic	20 ounces	1½ gallons.	Do.
8	Texas worm-destroyer	1 measure		Very few or none.
9	do	1 measure		Do.

Rains occurred nearly every day for about a week after this was applied. On the 9th of August I found no dead worms, and examination with a lens showed very little poison on the leaves; nor was the cotton scorched except in one or two places where the poison was a little thicker than usual; but vines of the cow-pea growing in the field were considerably injured. The caterpillars continuing to eat, we again poisoned this cotton on the 11th, 12th, and 13th of August.

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In the following table the quantity of poison per barrel of water is given, but in some sections several barrels were used:

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.*	Length of time before rain.	Dead worms after 24 hours.
1870.						
Aug. 11	10	Paris green	24 ounces	2 gallons	54 hours average	A fair number.
	11	London purple	16 ounces	2 gallons		Some.
	12	Gray arsenic	20 ounces	2 gallons		Few.
Aug. 12	13	Paris green	24 ounces	2 gallons	30 hours average.	Many.
Aug. 13	14	Texas worm-destroyer	1 measure		12 hours average	Scarcely any.

*In all of my experiments where paste was used it was made by boiling wheat-flour in water, so as to be a trifle thicker than the starch commonly used for stiffening linen articles. Some farmers, to avoid the labor of boiling the paste, allow flour to ferment in water, obtaining a very good article in this way. In either case it should be strained through muslin. Mr. Patrick Calahan, of Selma, merely stirs two pounds of common starch in a bucketful of cold water, which is then added to 40 gallons of water containing the poison.

When applying the poisons to sections 10 to 14, inclusive, we used two mules to draw the distributing wagon, in which were the driver and two hands with pumps. Another hand, with a two-mule wagon, was engaged in drawing water from a pond to the ends of the cotton rows, where it was transferred to the other wagon. Owing to the low specific gravity of London purple, the bulk of a pound of it is far greater than that of an equal bulk of arsenic or Paris green, and the hands complained that it pumped out harder than either of the other poisons named. Certain it is, that, other conditions being about the same, a barrel went over three acres in section 11, while in 12, 13, and 14 it went over only two. On section 10 the pumps were worked less rapidly, so that a barrel of water went over three acres. Twenty-four hours after each section was poisoned I examined it to see what effect the poison had produced on the worms and cotton, and leaves plucked here and there were examined with a lens to discover how thoroughly the finely divided poison was applied. There was a considerable number of worms dead on section 10, and most of the others died before the first rainfall. The Paris green could be seen in very fine particles in the minute hollows everywhere on the surface of the leaf. The cotton plant was not in the least injured. On section 11 the percentage of dead worms after twenty-four hours was considerably less than on 10, but before the rain fell the greater part of the others were dead. The poison appeared as a fine purple bloom on the surface of the leaf, and in a good many places the leaves were scorched seriously. The arsenic used on section 12 did not scorch the cotton, nor did it kill many worms at first, but later it destroyed a good number. By far the best results were obtained on section 13, where the worms were quickly and thoroughly killed, and only at long intervals could a scorched leaf be found. Though the Texas worm-destroyer, used on section 14, was applied according to directions, it being stated that more than one measure, about 4½ ounces to the

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barrel of water, would injure the cotton, it killed remarkably few caterpillars.

A light but steady rain fell all of the night following August 13, continuing through the next day and night and a part of the 15th. An examination of the cotton after this rain showed that little poison was then adhering to the leaves. In all of my experiments I found that full grown caterpillars never ate the poison, but webbed up immediately after it was applied. These excepted, there were few living worms on any of these sections excepting 14 where I could not see that the poison had done any good. On the 21st of August most of the foliage had been eaten from this section, while little was removed from the adjoining section 13. When I compared section 12 with the unpoisoned cotton on a neighboring plantation—from which it was separated only by a ditch—at this latter date, I could see that the arsenic had done good, for the cotton was not nearly so badly eaten where the poison was used as just across the ditch, and at the time of poisoning it was infested worse than the other.

Much of this cotton was as high as the top of the wagon-box, and there was none that was not bent as the axle passed over it; yet I found that very little damage was done by driving down the rows, though occasionally bolls were jolted off, and now and then the driver ran the wheels on a row so as to injure it, but this was the result of carelessness. Unless cotton is very high and closely interlocked between the rows I should not hesitate to drive a large-wheel wagon over it if necessary in poisoning.

August 29, five sections were poisoned as shown in the following table. But one pump was used, the nozzle of which had been reamed so as to discharge a larger quantity of water for a given expenditure of labor. With this we were able to distribute 40 gallons of water per acre. As before, one man drove and another hauled water to the side of the field.

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.	Length of time before rain.	Dead worms after a week.
Aug. 29, 1879	15	Arsenic	16 ounces	4 gallons	48 hours	Few.
	16	Fowler's solution*	3 quarts			Scarce any.
	17	London purple	16 ounces	4 gallons		Few.
	18	Texas worm destroyer	1 measure			Scarce any.
	19	London purple	8 ounces	2 gallons		Very few.

*As_2O_3, 384 grains. K_2CO_3, 384 grains. H_2O, 3 quarts.

In preparing Fowler's solution on a large scale the potassium carbonate may be replaced by the much cheaper sal-soda. As recommended by Capt. N. D. Cross, of Selma, sal-soda and gray arsenic are taken in equal proportions by weight; the soda is dissolved in a little boiling water, the arsenic is then added, and, when dissolved, water is added in such quantity as to make one gallon of the solution for each ounce of arsenic used. He recommends the use of 1–1¼ gallons of this normal solution for each barrel of water.

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With our single pump we were able to cover only five rows of cotton for each trip across the field and do it well. Including the time spent in filling the barrel it took 45 minutes for each barrel of poison put out; or, in ten hours, three hands and four mules would poison about 13 acres.

On the 1st of September a light rain in the early afternoon became heavier about 4 p. m. and lasted till some time in the night, a few drizzling showers having fallen the day before.

When these poisons were applied there were scarcely any worms on the cotton poisoned, but many eggs. On the 4th of September I noted that these had hatched, but few larvae had yet eaten through the leaves so as to reach such poison as the rains had left. Of the few worms on the cotton before the rain I had noticed a small number of dead ones, the most being found on section 17, the next on 15, the next on 16, but neither 18 nor 19 did much good. Coming as they did, the rains removed the greater part of the poison before the young worms could eat it, so that little good was done by this poisoning.

September 5, some cotton badly infested with newly-hatched caterpillars was poisoned, as follows:

Date.	Section.	Name of poison.	Quantity of poison per barrel.	Quantity of paste per barrel.	Length of time before rain.	Dead worms after 48 hours.
Sept. 5, 1879	20	Paris green	24 ounces	3 gallons	8 days	Many.
	21	......do	16 ounces			Do.
	22	......do	24 ounces			Do.
	23	Kerosene	10 fl. ozs			Few.
	24	Turpentine	20 fl ozs			Do.

In all we poisoned a little less than 3 acres this time, using only about half a barrel on section 22. One hand worked the pump, wetting six rows at a time; another followed him with the bucket of poison. Previously I had caused a barrel in the middle of the field to be filled with water. In this I suspended the poison, having the men replenish it as often as necessary. About four gallons each of the kerosene and turpentine mixtures were used.

The next day, when I examined the Paris-green sections, I found many worms dead on each of them. When I rubbed the leaves with my hand, or sprinkled water over them, I could not see but that one adhered as well as another. Here and there a leaf was badly scorched, and some few forms were injured; but, taken as a whole the field suffered little. Here I noticed what was also seen before and afterward, namely, that a leaf may be completely covered with Paris-green sediment and yet show no scorching; but where the dead spots appear on the leaves there may be

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little of the poison. Paris-green being practically insoluble in water, I am unable to account for this.

On the 8th of September I noted that the cotton on which Paris green was used three days before was uninjured by the worms, though a few were still eating, most of these having hatched after the poison was applied. But where I used kerosene or oil of turpentine the cotton was almost leafless, these substances having injured some of the leaves, and killed a considerable number of larvae, but not enough to save the crop.

September 10, a number of gallons of water, containing from a half teaspoonful to a teaspoonful of carbolic acid per gallon, were applied with the fountain pump. This water was stirred so that the acid was suspended through it as *very* small globules. It was found to kill some caterpillars, but by no means enough to save the cotton; and, used in these proportions, it injured the cotton considerably. More water, containing kerosene and oil of turpentine in varying quantities, was applied; but, like the last, I found that it did not effectually destroy the worms, even when strong enough to seriously injure the cotton.

B.—DRY POISON.

In the afternoon of August 22, I poisoned four sections with dry poisons, as shown in the annexed table. Where flour was used with either rosin or dextrine, or both, the proportion was that used in Royall's patent. Where gypsum was used, it replaced the flour, bulk for bulk, in this series.

Date.	Section.	Name of poison.	Substances mixed with.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Aug. 22, 1879	1	London purple	Flour, Dextrine, Rosin	0 hours	Fair	Fair quantity.
	2	Paris green	Flour, Dextrine, Rosin		Good	Do.
	3	London purple	Flour		Fair	Do.
	4	Paris green	Gypsum		Good	Very little.

As will be seen from examining this table, a rain began falling before we had finished applying the poisons. This rain continued to fall all night, all of the next day, and part of the succeeding night. Another heavy rain occurred the next night. On the 26th, I found that the cotton of sections 1 and 3 was scorched considerably, far more than either 2 or 4. The second section had killed the most worms. I could not see but what section 3 adhered as well as either 1 or 2, and all were far better than 4.

August 26, four additional sections were poisoned; the only variation

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from Royall's mixture being in omitting some ingredient, substituting gypsum, bulk for bulk, for flour, or varying the quantity of poison.

Date.	Section.	Name of poison.	Substances mixed with.	Weight of poison per barrel, flour.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Aug. 26, 1879	5	Arsenic	Flour, Dextrine, Rosin	12.5 pounds.	120 hours.	Good	Much.
	6	Paris green	Flour, Dextrine, Rosin	9.0 pounds.		...do	Do.
	7	London purple	Plaster, Dextrine, Rosin	12.5 pounds.		...do	Little.
	8	Paris green	Flour	9.0 pounds.		...do	Much.

When these poisons were applied in the afternoon, the sun was shining brightly. The mixture with plaster was scattered more easily than those with flour, and distributed itself very evenly over the leaves. On the 31st of August a few drizzling showers fell, and there were more on the next day, scarcely any falling during the succeeding night, and a very little the following morning. August 28, after two clear days and dewy nights, I found all of these poisons adhering well; though the flour, by forming a sort of paste, had collected into blotches, while the plaster remained as evenly distributed over the leaf as ever. On the 2d of September, I noted that the cotton of section 5 was somewhat scorched. Section 6 was scorched very little. Though section 7 was in great part removed, it had scorched the cotton considerably; more than either of the other sections. Very few leaves were injured on section 8. This same day, I found that a very little of section 1 still adhered, and the cotton was little injured. A little was also found on section 2, where the cotton was very little hurt. Section 3 seemed to adhere as well as the preceding, but had scorched the cotton more. Section 4 had scorched the cotton little, but no traces of the poison were left.

September 2, two other sections were poisoned, using one part of flour by weight to two parts of gypsnm in place of an equal bulk of flour in Royall's patent.

Date.	Section.	Name of poison.	Substances mixed with.	Weight of poison per barrel, flour.	Length of time before rain.	Effect as an insecticide.	Quantity adhering after rains.
Sept. 2, 1879	9	Paris green	Flour, Gypsum, Dextrine, Rosin	18 pounds*	11 days	Good	....
	10	London purple	Flour, Dextrine, Rosin	9 pounds		...do	....

* By a mistake the quantities of rosin, dextrine, and Paris green were intended for twice the bulk of flour and plaster used.

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At the time these poisons were applied this cotton was beginning to be honeycombed by the caterpillars; but none large enough to eat through the leaves were to be found on the adjoining sections 5, 6, 7, and 8. Between 8 and 9 a small section was left unpoisoned, and this was defoliated within the next five days, while all of these sections retained their foliage up to the time when I left the field, September 15.

September 4, I noted that the cotton on section 10 was *badly* scorched, though the worms were killed on it. The poison was as thickly applied on 9 as on 10, yet, despite the double quantity of poison used, it was injured very little. The caterpillars were killed. Very little poison remained on sections 1, 2, and 3, of August 22, yet in a very few places there was enough to kill the worms that were then appearing in large numbers on it. None remained on section 4, the foliage of which was, for the most part, eaten up.

September 7, the poison was found adhering finely to sections 5 and 6, and the cotton was not at all badly scorched. There were very few worms on it. No traces of the poison on section 7 could be found, but there were no worms on it, and it was not materially injured by scorching. Not very much remained on section 8, but there were few caterpillars to be found. The cotton was uninjured. The poison adhered in quantity to 9 and 10, where the worms were all dead. Section 9 was slightly scorched, section 10 badly. The unpoisoned section before mentioned was covered with caterpillars, its foliage being entirely gone.

September 9, about midday, when the sun was shining brightly, I applied poisons to three sections to test the resistance of different substances to the action of the weather. The quantity and quality of the poison being unimportant, I shall give only the proportions of the substances used to dilute it.

Date.	Section.	Weight of flour.	Weight of plaster.	Weight of rosin.	Weight of dextrine.	Length of time before rain.	Quantity adhering after rain.
Sept. 9, 1879	11	4 ounces ...	24 ounces ...	1 ounce	1 ounce	4 days	Some.
	12	6 ounces ...	24 ounces ...	... .	....		Do.
	13	2 ounces ...	24 ounces ...	1 ounce	1 ounce		Much.

September 14, I noted that my sections up to No. 11 were about as before the rain. Of 11, 12, and 13, all were more or less removed, and strangely enough the last, containing the smallest quantity of flour, had resisted the rain better than either of the others. None of these stood it as well as most of the earlier sections which had already been exposed to numerous rains. Owing to my departure from the field at this time these later experiments are exceedingly unsatisfactory, and I hesitate to base a very pronounced opinion on them, but think that they go to demonstrate that plaster, unless accompanied by a large quantity

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of flour, will not do to apply poisons with unless it is absolutely certain that no rain will fall till they shall have time to kill the caterpillars they are intended to destroy.

In applying poisons it is desirable, if possible, to employ machines by which they may be more rapidly distributed. For, as the time when poisoning must be done, all of the regular plantation-hands ought to be engaged in saving fodder or picking cotton, day-hands are doing this work for themselves, and, aside from the mere question of cost, it is often impossible to get over a plantation in time to meet the worms on their emergence from the egg without exposing some of the poison to the danger of being removed by rain. This is especially true of dry poisons, for if applied by hand they require far more time per acre than liquids do. Moreover, on their emergence from the egg the larvae do not eat entirely through the leaf, but spend from two to four days on the lower surface; therefore, as suggested to me by Professor Comstock, it is desirable to apply the poisons to the lower surface of the leaf, so that they may be killed without so long an exposure of the poison to chances of being removed by rain. Since the moths feed on the nectar secreted by the glands on the lower surface of the leaf, it may also be possible to apply some soluble poison to this surface, some of which being absorbed by the nectar will poison the moths.

Aside from these reasons, I do not see why any machines should apply liquid poisons better or more expeditiously than can be done by the fountain pumps. A machine which fills these requirements is that invented by William T. Daughtrey, of Selma, which throws a finely divided spray up through the leaves; this in its descent wetting the upper surface. In its present form this machine is intended to be drawn by two mules, poisoning four rows of cotton; but it is entirely impracticable to use it as now made. Mr. Daughtrey, however, soon expects to have a lighter and more manageable machine, drawn by one mule and poisoning as many rows as the machine he now has. Having seen his jet I see nothing further to be desired in that line, and when combined with a properly constructed body it seems likely to meet every want. I have, though, grave doubts as to any machines proving superior to the fountain pump, when everything is taken into consideration.

The slowness and expense of applying dry poisons, on the other hand, make it desirable to employ some machine if possible. Such machines have been devised and patented; but, as I saw none of them in operation, it is unecessary for me to speak of them.

With some machine doing away with the greater part of the labor otherwise required, I think that, in spite of its greater original cost, the dry form of poison is far preferable to the wet, on account of its greater adhesiveness.

Starting on a certain part of every plantation, as they do, the caterpillars may be watched as they increase in numbers. My advice would be that as soon as they appear in any numbers in such places—probably

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the first crop or third brood—these places, of a few acres in extent, should be thoroughly poisoned. The next brood radiating from these centers may be in great part destroyed by poisoning a slightly greater area; and the third crop will thus be greatly diminished, and may itself be destroyed by poisoning generally over the plantation, the signal for poisoning being the abundance of eggs, some of which are beginning to hatch. Could such a system be followed by every person raising cotton, I feel certain that it would be very few years before the cotton caterpillar would cease to be the pest that it now is.

[End of Mr. Trelease's report.]

PREVENTIVE MEASURES.

The most important of the preventive measures which can be adopted is the encouragement of the natural enemies of the cotton-worm. Detailed accounts of these have been given in a previous chapter; hence, but little remains to be said here.

The most practicable thing which can be done in this direction is the protection by law of all the native insectivorous birds. An incalculable amount of injury has been done by the indiscriminate destruction of birds by the freedmen since the close of the war. In addition to the protection of the native species, others might be introduced. But here very great care must be exercised, else more harm than good may be accomplished. No species should be introduced *the habits of which are not thoroughly understood.* We wish to call particular attention to this point, as many planters have urged us to aid in the introduction into the cotton States of the English sparrow, a species the importation of which into the Northern States has been pronounced a calamity by nearly all of the American ornithologists.

The encouragement of the insect enemies of the cotton-worm, though less practicable than the protection of birds, is not less important; for this reason, great care has been taken to figure and describe all the predaceous or parasitic insects which destroy the cotton-worm. It would be worth the while of every planter to become familiar with the appearance of the more common of these, and instruct his hands not to injure them. In those cases in which hand-picking of the pupae of *Aletia* is employed, much good can be done by taking care not to destroy the parasites contained in them. The pupae, when collected, instead of being destroyed should be placed in barrels or boxes covered with coarse wire gauze or other netting. In this way the parasites which emerge from the pupae can be allowed to escape through the meshes of the netting, and are thus enabled to go on with their destruction of the pest; whereas, the moths which mature, being larger, cannot escape, and perish in their prison. Some idea of the importance of this precaution may be gathered from the results of an experiment already cited, in which it was found that of 1,721 pupae of the fourth brood, nearly ten per cent. were parasitized. Or what is more to our purpose, there were bred from these pupae 44 large parasites (*Pimpla*, *Chalcis*, and *Tachina*), and an immense number of

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small parasitic flies belonging to the genus *Phora*. It must be remembered that the later broods of *Aletia* contain a larger percentage of parasitized individuals.

Under this head will come also the suggestion of Mr. Nicholas A. Davis, of Jacksonville, Tex., who recommends not plowing the cotton fields while they are yet wet, and also advises planters not to plant cotton on wet land where ants do not live.

As another preventive measure, would it not be well to plant less cotton and cultivate more thoroughly, using fertilizers? In this way more cotton would be made early in the season, before the worms increase sufficiently to injure it, and then, with smaller fields to go over, the force upon a plantation would be sufficient to apply remedies in season to keep the worms in check.

DESTRUCTION OF EGGS.

Many attempts have been made to destroy the cotton-worm in the egg state. These have been accompanied with but little success. Owing to the fact that the tender terminal leaves are first destroyed by the worms, planters have believed the eggs were laid upon this part of the plant. This belief has suggested the idea that by cutting off and destroying the terminal shoots the eggs would be removed. But as shown in the chapter in natural history, the greater part of the eggs is laid on the lower surface of the larger leaves of the middle third of the plant; hence by topping the cotton only those worms which happen to be on that part of the plant would be destroyed.

Owing to their small size, and the position in which the eggs are deposited, any attempt to destroy the insect in this state will prove impracticable. And the destruction of the few larvae which are removed with the terminal shoots, does not pay for the labor of topping the cotton, especially as the entire cotton can be poisoned with less labor.

COLLECTING LARVAE BY HAND.

Although it may seem a hopeless task to preserve a field of cotton by collecting the larvae by hand, we feel that very much can be done in this way if the effort is made at the proper season. It would be a waste of labor to attempt to destroy in this way the individuals of the third crop of worms. Not so, however, in case of the first brood. This appears in such small numbers that by careful searching a very large proportion of them could be found. This, of course, would materially lessen the numbers of the subsequent broods. As early as the middle of May the cotton fields should be thoroughly searched; at this time the cotton plants are small, therefore, this could be done with comparatively little labor. Much could be accomplished by instructing the hands to carefully collect all larvae and folded leaves containing pupae found while working the cotton early in the season. We believe, however, that in-

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structions of this kind could only be made to produce the maximum results by offering a reward for every specimen captured before a certain date, say June 1; a smaller reward might then be offered for each specimen between that time and some subsequent date. We have no doubt that were each planter to expend a small sum in this way greater returns would be realized than could be obtained by the expenditure upon the crop of a like sum any other way. And we are inclined to believe that even in case where concerted action cannot be obtained good results will follow individual efforts. For, although the summer and autumn broods of moths migrate to great distances, there is reason to believe that the hibernating individuals and those of the early broods do not do so to any great extent. As evidence of this we cite the fact that considerable time elapses between the appearance of the worms in those localities which we have designated as centers of hibernation and in the more northern parts of the cotton belt.

DESTRUCTION OF LARVAE BY POISONS.

Arsenic and its compounds.—The only remedies which are now used to any great extent are poisons applied to the plant for the destruction of the larvae, and, almost without exception, these poisons are either arsenic or some compound of that mineral. The compounds of arsenic used to the greatest extent are Paris-green, Texas Cotton-Worm Destroyer, and, during the present season, London purple.

Very great difference of opinion exists among planters with regard to the relative value of these substances. This difference of opinion is not only as to their relative efficacy as insecticides, but also as to their effect upon the plants. Thus, although Paris green costs from six to ten times as much as white arsenic, many planters prefer to use the former simply because there is less danger of injuring the cotton plants. With a view to settling these points, I planned the experiments conducted by Mr. Trelease, a report of which has just been given, and on going over carefully the testimony of planters which I collected while in the field last year, and the answers of our correspondents, which are given in Appendix II (answers to question 7 *i*), I find that the experience of the majority confirms the results of these experiments in indicating that Paris green is the most desirable insecticide. It seems to act more speedily than the other poisons, and if used carefully, no appreciable injury will result to the plants; whereas, with arsenic and the other compounds of this mineral with which we experimented, it is difficult to apply a sufficient quantity to effectually destroy the worms without injuring the plants. We feel sure that the unfavorable results which have followed in some instances from the use of Paris green have arisen from one of the following causes, either an excessive use of the substance or the use of an adulterated article, chiefly the latter. From the trials which we have made, we are inclined to doubt that there is any danger of scorching the cotton if pure Paris green be used in the usual way,

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whereas we have no doubt that very serious consequences have followed the use of an adulterated article.

We have endeavored to find some simple method by which any planter could test for himself the purity of Paris-green. The following, although it does not meet all requirements, will be found useful. Pure Paris green is soluble in ammonia; hence, if you take 100 grains of Paris green and place it in a glass vessel and add one ounce of liquid ammonia (it may require more than one ounce if the ammonia be not strong), and stir it for a minute or two with a glass or wooden rod, the Paris green will completly dissolve, forming a beautiful blue transparent solution. Should there be sediment it will indicate that the Paris green is adulterated; and the amount of sediment will show the amount of adulteration. This test will serve to detect the presence of any of the substances ordinarily used for adulteration of this poison. Sometimes, however, white arsenic is used for this purpose, and as this substance is also soluble in ammonia its presence cannot be detected in this way. By using the above test, however, the planter can be certain that the compound in question will be efficient as an insecticide. There remains only the danger of his cotton being injured by the caustic action of adulterating arsenic. The best plan is to buy the poison directly of the manufacturer. In this case, if care is taken to deal only with reliable firms, little danger need be apprehended.

It is proper to state that although our experiments with the Texas Cotton-Worm Destroyer as well as those conducted by some of our correspondents in Alabama failed to produce satisfactory results; many strong recommendations of this remedy have been received from western portions of the cotton belt, especially Texas; and in the circular published by Preston and Robira are recommendations from many prominent planters. An analysis shows that this remedy is an arseniate of sodium, which is almost entirely soluble in water. Of course its value as an insecticide is due to the arsenic which it contains; its only advantage over other compounds of arsenic is its solubility in water, and we are inclined to believe that this advantage is more than counterbalanced by the fact that there is greater danger of injury to the plant from a solution of this kind than by a mere mechanical mixture with water. This point is illustrated by an experiment tried with Fowler's solution.

As to the results of the experiments with London purple, we are disappointed. We had hoped, owing to the cheapness with which it can be furnished, that it would prove a substitute for Paris green, but our experience indicates that it is even less desirable than commercial arsenic. We hesitate, however, to give a decided opinion with only the results of a single season's trial before us, especially as we have favorable reports from Prof. C. C. Bessey, of the Iowa State Agricultural College, who has experimented with it as a remedy for the potato beetle, and from Mr. A. K. Whitney, of Franklin Grove, Ill., who has successfully

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employed it against the canker-worm on fruit trees, and prefers it to either Paris green or arsenic for that purpose. Still, it should be remembered that the foliage of cotton being tender, is scorched much more easily than that of some other plants, and also, that a substance may kill certain insects quickly while it acts much more slowly upon others. London purple consists chiefly of arseniate of lime, together with considerable aniline purple, and a little impurity. As it is a waste product in the manufacture of various salts of rose aniline, its composition is not constant. A sample which was analyzed by Dr. Collier shows the following composition:

	Per cent.
Rose aniline	12.46
Arsenic acid	43.65
Lime	21.82
Insoluble residue	14.57
Iron oxide	1.16
Water	2.27
Loss	4.07
	100.00

A compound of arsenious acid and cyanide of potassium has been used to a considerable extent in Texas. It is known as Johnson's Dead Shot. It was patented June 2, 1874. The following extract from the specifications describes the compound:

In order to form my compound I use the following ingredients, and preferably in the following proportions, to wit: Eight ounces of arsenious acid, one ounce of cyanide of potassium, and eight ounces of dextrine, dissolved in forty gallons of water.

Arsenious acid, when applied to the leaves of cotton or other plants in the form of spray, will remain free from evaporation for a sufficient length of time to be eaten by such insects as feed upon cotton or other plants. Cyanide of potassium, when applied in like manner as a component part, might be termed the base of said compound, and serves to hold the arsenious acid in solution before it is conveyed to the plant, and, being among the most deadly of all insect poisons, it not only kills when eaten, but is death to insects the instant it strikes them, and so impregnates the air immediately around the plant upon which it has been deposited that the fly or miller which creates the cotton-worm is instantly killed on coming in contact with, or in the immediate vicinity of, the same; and, being a powerful alkali, is easily absorbed by vegetation, and acts as a tonic or fertilizer, thus entirely neutralizing the evil or damaging effects of the arsenious ingredient upon both land and plant. Dextrine, one of the component parts of my compound, has no poisonous effect, but is simply used to produce a thin mucilage of my other ingredients, sufficient to hold the said compound on the plant to which it may be administered.

No experiments were tried with this compound. We have no doubt, however, that it is effectual as an insecticide; but we would hesitate to recommend the use of a volatile poison so deadly as cyanide of potassium.

Objections to the use of arsenic and its compounds.—Much has been written respecting the dangers attending the use of arsenical poisons as insecticides. We do not here refer to the caustic action of the poison upon the leaves of the plant, but to the injuries which may result to man

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from the incautious handling of so deadly a poison; to animals by drinking water from vessels in which it has been mixed, and by drinking from streams flowing through cotton-fields thus treated, and especially to the danger of the poison accumulating in the soil to such an extent as to exert an injurious influence on the plant. When we consider the immense quantity of this poison which has been used during the last few years, and the low grade of intelligence of the majority of the field-hands who have been required to apply it, especially in the cotton States, it seems as if a great risk of loss of life had been incurred; statistics, however, fail to confirm such conclusions. We occasionally read in the newspapers accounts of serious results following the use of poisons as insecticides, but no well authenticated case has come to our notice. Although, doubtless, there is danger with the usual care, the risk is not greater than that of railway or steamship travel or many other practices which are necessary.

These remarks will apply also to the dangers accruing to animals from this use of poison. For, although we are informed that the annual loss by Paris green of cows, sheep, and horses is something considerable, no instance has come under our personal observation.

As to the accumulation of the arsenic in the soil, in sufficient quantity to prove injurious to plants, we cannot do better than to cite the investigations of Dr. William McMurtrie.* These investigations show:

> That, though arsenical compounds exert an injurious influence upon vegetation, yet this is without effect until the quantity present reaches, for Paris green, about 900 pounds per acre; for arsenite of potassa, about 400 pounds per acre.

Thus, if all the arsenic were to remain in the soil no injurious effects need be expected to follow within one hundred years. And when we take into consideration the amount of arsenic which is removed from the soil by drainage, an even greater time may be expected to elapse before that event occurs. And we may reasonably expect that ere that time the science of economic entomology will be so far advanced that a harmless substitute for arsenic will be known if there remains an occasion for its use against this enemy of the cotton plant.

Carbolic acid.—Experiments conducted by Professor Willet and myself last season with carbolic acid gave results similar to those obtained by Mr. Trelease. It was found in each case that where this substance was used in sufficient quantities to destroy the worms it injured the cotton plants greatly.

Kerosene.—Although the different forms of coal-oil have been found to be very valuable in many instances as insecticides, all of our efforts to employ it against the cotton-worm have produced poor results. In every case when a mixture of kerosene and water of sufficient strength to destroy the worms has been applied to cotton, the plants have been injured.

The following experiment, suggested by the use made of kerosene

* Annual Report of the Department of Agriculture, 1875, pp. 144–147.

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against the Rocky Mountain locust, was tried: A quantity of kerosene was put into a pan; all that would flow was then poured out, leaving only a thin film over the bottom of the pan. A dozen cotton-worms were then put into the pan. At the end of two minutes all were dead. But the danger of injury to the cotton-plant, and especially of knocking off the bolls by any machine employed for jarring the worms from the plants into receptacles containing coal-oil, will prevent the use of this substance in this way.

Pyrethrum.—The value as an insecticide of powder made from the dried flower-heads of different species of *Pyrethrum*, and sold under the name of Persian Insect Powder, has long been known, but its expense has prevented its general use except for insects infesting houses and parasites upon domestic animals. For the same reason, we neglected to experiment with it on the cotton-worms, believing that, however efficient it might be, its cost would prevent its use against insects infesting field crops. But there has been introduced into California a Dalmatian species of *Pyrethrum* (*Pyrethrum cinerariæfolium*,) from which a powder equally as good as the imported powder is made. And we have recently learned, what is equally important, that this powder can be produced at a price which will admit of its being used on field crops. The Californian powder is known as buhach.

The most important peculiarity of powder made from *Pyrethrum* is that, although deadly to insects, it is harmless to man and domestic animals. The neglect to experiment with this powder upon the cotton-worms this season is not a serious matter, as it is not yet produced in this country in sufficient quantities to admit of its taking the place of remedies we now have. We understand that arrangements have been made for growing the plants upon a large scale, and before the substance can be put upon the market in large quantities the necessary experiments to determine its efficiency and the best mode of application will have been made.*

MODES OF APPLYING POISONS.

Second in importance only to the choosing of the most effectual poison is the adoption of the best mode of applying the remedy. Although many methods have been adopted, they may be classified under two general heads: First, use of poisons diluted with water; second, use of poisons diluted with some dry substance.

Before entering upon the discussion of these methods, I wish to urge the importance of making early preparations for poisoning. As yet most planters do not seem to realize that fighting the worms is a part of the necessary labor for raising a crop of cotton. As a rule no provision is made for this work in the way of purchase of poison or implements for its distribution, or conveniencies for getting water, until the worms are

* The *Pyrethrum cinerariæfolium* was introduced into California and is raised by Mr. G. N. Milco, of Stockton, Cal.

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injuring the crop so badly that it is evident that something must be done at once to save it. The result is that while the planter is engaged in the preliminary work which should have been done months before, the crop is destroyed.

The following remark was made to me in almost the same words by the majority of the planters with whom I talked upon the subject: "The trouble about poisoning is, a man may have a large field, the worms appear in it, and in three or four days the crop is destroyed before the poison can be applied." Another expression which I often heard, and which is equally suggestive of a lack of appreciation of the proper way in which to contend against this insect, is the following: "The first and second crops of worms do no harm; it is not worth while to poison them; it is the third crop that does the injury."

The cotton-worm will continue to be a scourge until all who raise cotton, except perhaps those in the northern portions of the cotton belt, incorporate in their estimate of the cost of producing a crop the expense of poisoning the worms. The fact that in almost every section there are seasons during which the worms injure the cotton but little can almost be considered a misfortune; for it is doubtless largely owing to this that proper preparations are not made. Influenced greatly by their hopes, the planters believe each spring that it is not going to be a "worm year." The result is that already described. It would be better to make unnecessary preparations than to suffer for want of proper precaution; especially as, if there is no occasion to use the materials the season they are purchased, they can be kept without loss or damage until there is occasion to use them.

Doubtless in many cases one reason why the preliminary arrangements are not made at the proper time is the financial depression which has been so general throughout the South. Many planters find it necessary to borrow the money which is used in the cultivation of the crop, and under such circumstances do not feel willing to go to the expense of buying poison and machines for distributing it when there is a chance that they will not be needed, and in any case the interest on the investment is to be met. Still we believe that under these circumstances the loss incurred by the laying idle of capital invested in this way ought to be regarded in the light of insurance.

If the poison to be used be purchased during the winter, there will be time to procure it directly from the manufacturers, thus saving considerable in cost, and, what is of much more importance, an unadulterated article can be obtained. Frequently those who wait until they need poison before buying it, and are thus forced to purchase of local dealers, pay from 20 to 75 per cent. more for an inferior article than an unadulterated poison would have cost if bought directly of the manufacturer at a season when there is no great immediate demand for it. In a similar way, in case dry poisons are to be used, doubtless many opportunities would occur for procuring flour at a less cost than it would be necessary to pay at the time it is to be used.

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A very great saving of time may be accomplished by those who apply poisons with water by improving the facilities for getting it. The details of this will vary with local conditions. We are led to speak of it from our observation in the canebrake region of Alabama. Although this section is one of those which has suffered most from the cotton-worm, and at the same time one which is admirably adapted for providing supplies of water, little has been done in this direction. A large part of this region is supplied with artesian wells which bring the water several feet above the surface. Doubtless it would pay, in many cases, to sink wells in those parts of the plantation where water is most likely to be needed for poisoning; at least tanks should be arranged at the existing wells so that barrels could be rapidly filled in time of need. This, however, is seldom done. In those sections in which cisterns are used instead of wells, it would pay to make one or more cisterns in each of the larger cotton-fields, and to see that they were properly filled during the rainy season.

We wish also to urge prompt action in the use of poisons. We are convinced that it does not pay to wait for the third crop of worms before poisoning the cotton. The earliest brood in the spring should be destroyed. At this season it probably would be necessary to poison only the cotton growing on low land. Let those places in which the worms are known by tradition to appear first each season be early and thoroughly poisoned. The expense of this poisoning need not be great, for not only are such areas of limited extent, but, as the plants are small, little poison will be required. It will probably pay best to use dry poisons early in the season, as but little flour will be needed on each plantation, thus doing away with one of the greatest objections to dry poisons.

The poison should be first applied at a date not later than twenty days subsequent to that when the cotton first appears above ground. It will probably be found necessary, as the successive broods of worms appear, to poison larger and larger areas, until, with the third crop, all the cotton growing should be poisoned; doubtless, however, it would frequently occur that only the rank-growing cotton would need to be poisoned even then. If concerted action were taken throughout any extended region in poisoning early in the season, we do not believe that the worms would be able to develop in sufficient numbers to do any serious injury; at least, their progress might thus be retarded, so that the cotton would not be stripped until too late in the fall to do damage.

Wet poisons.—The least expensive mode of applying poisons, and the one most generally adopted, is with water. When Paris green, arsenic, or London purple is used, it is necessary to stir frequently the water into which the poison is put, as none of these substances are soluble in water. In applying the mixture every leaf should be thoroughly wet, and the proportions used should be such as to distribute from twelve ounces to

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one pound of Paris green over an acre; with the other poisons a smaller amount must be used, on account of the danger of scorching the cotton.

When Paris green was first applied with water common watering-pots were used. A man mounted upon a mule carried the pot and sprinkled the plants as he rode along the rows. Other hands kept this one supplied with the mixture. This was found to be a very imperfect method, requiring, as it does, a great amount of water, which is a serious objection when the water has to be drawn a considerable distance, as is usually the case. Moreover, by this method the poison is not evenly distributed; the hand (almost invariably an ignorant and careless negro, and, perhaps, half asleep) rides along and deluges some plants, while others are not wet at all.

The most practical way of applying wet poisons that has come under our observation is by means of a machine known as the fountain-pump. This is a simple instrument, the form of which is shown in Fig. 50.

FIG. 50.

It consists of two brass tubes, one working telescopically within the other; a hose is fastened to one end and a rose can be attached to the other; this rose is represented in the lower part of the figure; an arrangement of valves allows water to pass into the pump through the hose, but will not allow it to return. Thus, when the smaller tube is pulled out, the pump is filled to its greatest capacity; by pushing this tube back, the water can be ejected with considerable force through the nose in a fine spray. In this way, with a single pump, a man can throw the poison over five rows of cotton at once, walking rapidly along the rows. Thus five rows can be poisoned in about the same time that is required to poison one row with a watering-pot. In addition to the saving of time, much less water is used with the fountain-pump than is required with watering-pots; and as the pumps throw a very fine spray, the poison can be more evenly distributed in this way.

In using the fountain-pump, one man works the pump, another hand (often a woman) accompanies him and carries the bucket containing the mixture. Other hands keep these supplied with the poison. As some parts of the work are more tiresome than others, the hands are transferred from one part to another at intervals. The water is conveyed to and about the fields as far as possible in wagons.

It is estimated by those who have had much experience in applying poisons in this way, that where water is easily obtained, with one fountain-pump and eight hands (three of whom may be women) 25 acres of

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cotton may be poisoned in one day. The eight hands are distributed as follows: One works the pump; one carries the bucket from which the poison is pumped; three supply this one with the mixture; three are with the wagon getting water and mixing the poison.

Although the plan just described is the one most generally used, we think that adopted by Mr. Trelease during the present season is preferable, requiring as it does fewer hands. This method is illustrated in Fig. 51.

A 40-gallon barrel containing the mixture is placed on an ordinary four-wheeled wagon, the wheels being 5 feet apart, and the lowest axle 23 inches from the ground. The wagon is drawn by two mules, these walking in the furrows on either side of the row of cotton over which the wagon passes. One hand drives the team and two others, provided with fountain pumps, distribute the poison from the barrel. In this way nine rows of cotton are poisoned each trip across the field. In ordinary cases one or two other hands with a team can keep these supplied with water. By this method poison can be applied very rapidly and with a minimum number of hands. The experiments show that the cotton was not seriously injured by the team or wagon, although much of it was as high as the top of the wagon-box, and there was none that was not bent as the axle passed over it. Certainly the time and labor saved will, except in cases where the cotton is very high and closely interlocked between the rows, more than pay for the injury done to the cotton. I suggest the following improvement to the apparatus used this season: Have a cover fitted to the barrel to prevent the spilling of the poison. This cover should have three holes; one for a dasher (similar to that used in churns) for agitating the mixture; the two other holes to admit the hose of the pumps. The dasher may be worked by a boy or the men with the pumps.

Although the method above described is the most practicable yet devised, we feel that it can be improved upon. Our observations convince us that the thing most needed is a machine which can be drawn by one or two horses and which will throw a spray of water on the under side of the leaves.

The present modes of poisoning are defective in that they require a large force of hands, often when there is much other work to be done; and what is a much more serious matter, as the poison is applied to the upper side of the leaves of the plant, the young larvae are not killed until they are large enough to eat through the leaves. This would be of less importance could the poison be made to adhere to the leaves; but it often happens that the mixtures are washed off the plants by rains soon after being applied, while if they were applied to the lower surface of the leaves all larvae feeding at this time would be poisoned, besides there being less liability of the poison being washed from the plants.

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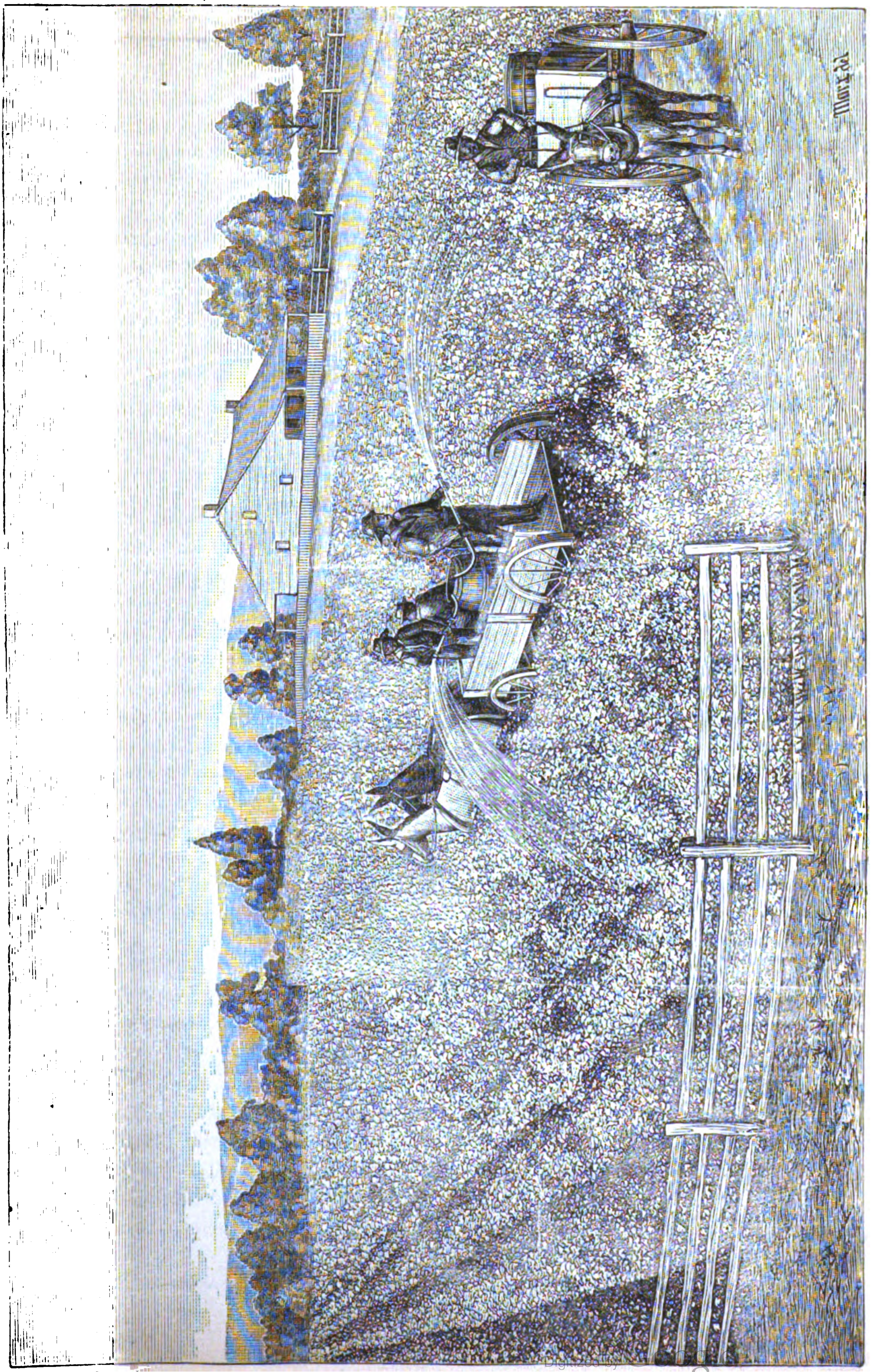

FIG. 51.—Method of poisoning with the fountain-pump.

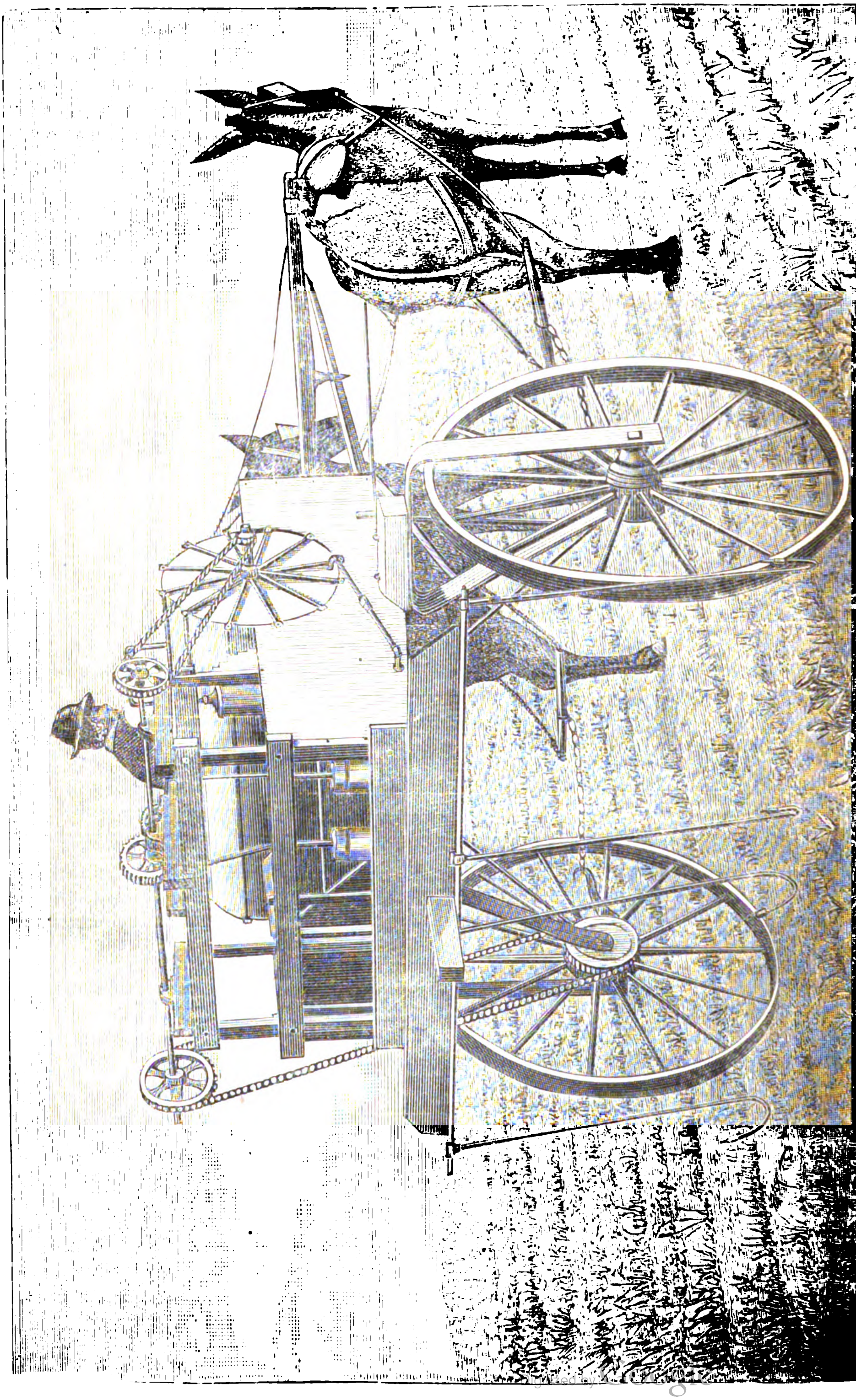

FIG. 52.—Daughtry spraying machine.

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A machine intended to meet these requirements has been invented by Mr. W. T. Daughtry, of Selma, Ala., and is represented by Fig. 52. This consists of a large cylindrical reservoir mounted upon wheels and provided with an agitator for keeping the compounds well mixed. Force pumps, which are worked by gearing attached to the hub of one wheel, force air into the reservoir; the pressure obtained in this way forces streams of fluid through the distributing pipes; each pipe extends nearly to the ground and is bent upwards at the end, which is furnished with a peculiar nozzle; in this way a fine spray can be thrown upon the lower surface of the leaves. The machine is made to pass over two rows of cotton, and the distributing pipes are so arranged that four rows can be poisoned at a time. Owing to its great weight, the machine in its present form is impracticable, but the idea which it embodies is a good one. Mr. Daughtry's machine was patented February 19, 1878, No. 200376.

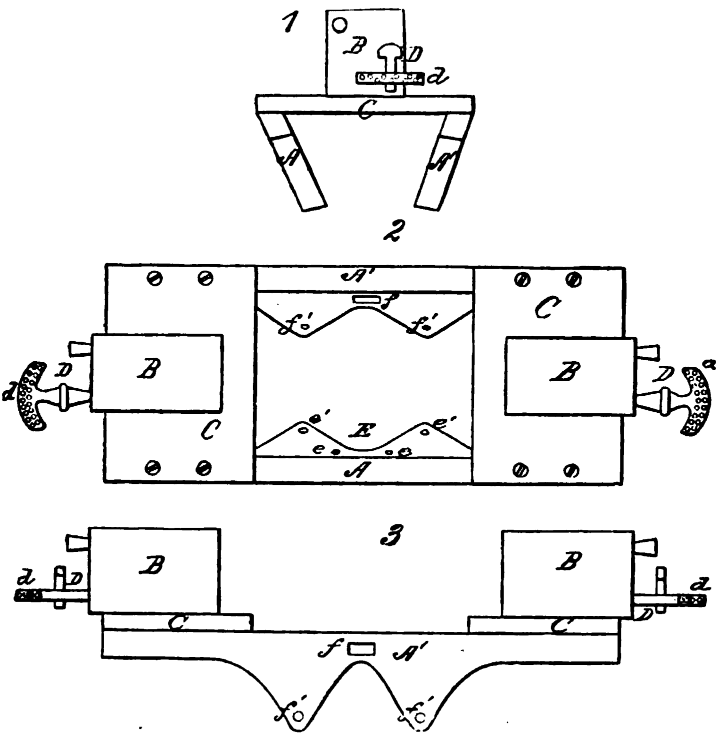

FIG. 53.—W. T. Willie's atomizer.

Another machine has been invented for distributing liquid poisons upon cotton, by Mr. William T. Willie, of Brenham, Tex.; patent No. 158345, dated December 29, 1874. It consists of a frame which may be rigidly secured to a saddle, in a transverse position, there being cans for holding the liquid and provided with distributing faucets arranged upon both ends of the frame, the one balancing the other, and one or both at the same time may be operated by the rider.

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No. 1 in the cut is an end view of the machine; No. 2 is a plane view, and No. 3 is a side view of the same.

A A′ designate, respectively, the front and rear bars of the frame, connected together on each side by means of a platform, C, upon which are to be placed oil-cans, B, or other convenient vessels for the reception of the destroying compounds. These vessels are removably secured thereto in any suitable manner, and their outer lateral edges are each provided with a distributing stop-cock, D, having a crescent-shaped perforated nozzle-piece, *d*, by means of which the liquid poison will be shed over a wide space. The front bar A has an angular notch, E, cut into its lower edge, near the apex of which, and one each side thereof, perforations, *e*, are made, by means of which it is secured to the pommel of the saddle. It is also provided with perforations, *e′*, upon its lower edge, by means of which it is laterally stayed by a rope passing thence to the girth-rings on each side of the saddle. The rear bar A′ is in like manner notched, as shown in Fig. 2, and is provided with a slot, *f*, at the apex of its notch, by means of which it is strapped to the cantle of a saddle, and with perforations, *f′*, along its lower edge, serving as a means of attachment for a rope, passing thence to the girth-rings on each side.

It will be seen from the above description that the frame is firmly attached both to the pommel and cantle of the saddle, and that it is braced and steadied to resist displacement by ropes or straps leading from the perforations *e′* and *f′* upon the front and rear bars of the frame, respectively, to the girth-rings on each side of the saddle, constituting a simple, convenient, and effectual attachment for the purpose of preventing any displacement. The notches of the front and rear bars A′ A are intended to be straddled over that portion of the pad-frame of a saddle which projects in front of the pommel thereof, and extends in rear of the cantle, the rider being seated between the two, with a poison-receptacle on each side, with their stop-cocks within easy reach of his hand. He can thus accurately regulate the flow of poison according to the amount required to effect the purpose, the movement of the horse serving materially to assist the distribution.

Hon. John W. Johnson, of Columbus, Tex., has patented a machine for distributing liquid poisons upon cotton plants. This machine has been used to a considerable extent in Texas; it is represented in Fig. 54. The following description will explain its workings:

This invention relates to certain improvements on that for which I filed an application for letters patent on the 22d day of September, 1873; and the invention consists in a tank provided with a double-acting force-pump, communicating with a pipe and branches similar to those described in my application aforesaid, the pump being connected by a pitman with one of the wheels upon which the tank is supported, whereby the pump is operated automatically as the apparatus is drawn along, the wheels upon which the apparatus is supported being much smaller in diameter than ordinary cart or wagon wheels, and attached to the tank by means of vertical bars, whereby the apparatus is enabled to pass over the rows of cotton-plants without injuring them, while at the same time the dimensions of the wheels are such as to give the required number of strokes to the pump-lever necessary to the producing of a constant and full volume of spray from the pipes.

In the accompanying drawing, Fig. 1 is a side view of my invention; Fig. 2 is a top view of the same; Fig. 3 is a sectional view of one of the branch pipes.

A represents the tank containing the liquid compound described in my application aforesaid. Instead of placing it upon an ordinary cart or wagon and working the pump by hand, I attach the tank to a platform or cart-bed, B, provided with two wheels, C. These wheels are much smaller than ordinary cart-wheels, being about twenty or twenty-four inches in diameter, in order to give the required number of revolutions necessary to the successful operation of the pump. In order to place the cart-bed at such

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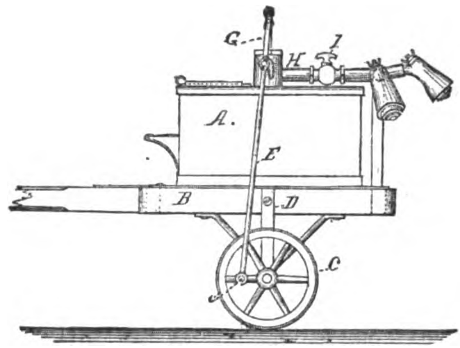
an elevation as to enable it to pass over the rows of cotton-plants without injuring them, I attach to each side the upper end of a bar, D, the lower end of which is bent outward and formed into a spindle or axle for the wheel. These bars are of such length that when the wheels are in place the height of the cart-bed from the ground is equal to that of a vehicle provided with wheels from five to six feet in diameter. The wheels C may be of cast-iron, and the bars D may be of wood or iron, as may be preferred. One of the wheels C has a crank-pin, *c*, formed on or attached to it at a suitable distance from the center, and to this crank-pin is attached the lower end of a pitman, E, the upper end of which is attached to the pump-lever, G. By this arrangement the pump is operated automatically as the apparatus is drawn over the field, thus dispensing with the labor of one man for operating the pump. The pipe and branches are arranged and connected with the pump in a similar manner to that shown in my application aforesaid, the supply-pipe H being provided with a stop-valve, I, to regulate the flow of the liquid. The branch-pipes, K, are made of cast-metal, instead of sheet metal, as shown in my application aforesaid, and instead of corrugating the metal as therein shown, I form the grooves *l* on the inner surface, either during the process of casting or by planing or cutting them out afterward, as may be preferred. The branch pipes thus formed are cheaper and more durable than those formed of corrugated sheet-metal.



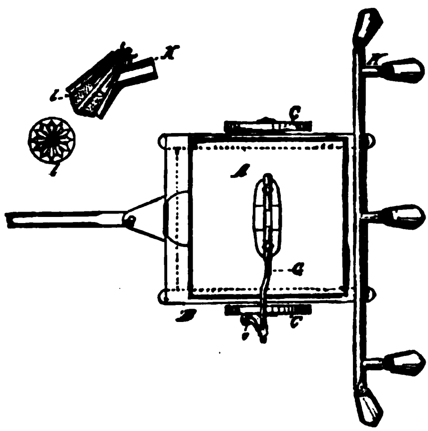


FIG. 54.—J. W. Johnson's machine.

Dry poisons.—The dilution of poisons with powdered substances instead of water has been adopted to a considerable extent, and in some respects is far superior to the latter. The greatest obstacle that planters have had to encounter in the destruction of cotton-worms is the removal of the poison from the plants by rain. It frequently occurs that before a planter has completed poisoning a field a sudden rain undoes the work just performed. This obstacle is especially serious, as the rainy seasons are notably those in which the worms most rapidly multiply. In fact, many planters have been discouraged, and abandoned the use of poisons on this account. This difficulty is, to a great extent, obviated by the use of flour as a diluting substance. The flour combining with dew or rain forms a paste, which glues the poison to the leaves. This fact has been so well established that it is unnecessary to enlarge upon it. A single instance may be cited as an example: During the present season, on Capt. George O. Baker's plantation at Selma, Ala., the mixture known as Royall's patent withstood five days of continual rain.

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Our experiments show that poison mixed with flour alone adheres nearly as well as the above-named mixture, resin and dextrine seeming to have but little action. It was also found that flour can be diluted to a certain extent by gypsum or land plaster. But poison mixed with plaster alone adhered but little better than when applied with water.

Another advantage gained by the use of dry poisons is that there is less danger of injuring the cotton than when water is used.

The great objection to this method of poisoning is its cost, the price of the flour adding materially to the expense; and, also, no way has yet been devised and brought into general use of applying dry mixtures as rapidly and easily as liquid poisons may be applied. We believe, however, that unless some method is devised for throwing a spray of liquid poison upon the lower surface of the leaves, where it will be less liable to be washed off by rain, dry poisons will be found most practicable; and we feel sure that the objections of the expense can, to a great extent, be removed. Further experiments are necessary to devise a cheaper method of distributing powdered substances over plants, and to determine to what extent the flour may be profitably replaced by plaster or some other cheap material. The cost of the flour can doubtless be lessened by using a poorer quality, which might be manufactured for the purpose from inferior or injured wheat. If a machine could be invented by which a mixture of one pound of Paris green and two pounds of flour could be quickly and evenly distributed over an acre of plants, the same end would be gained.

The simplest method of applying dry poisons, and the one most generally used, is by means of a tin vessel holding about a gallon, provided with a handle and having a bottom made of perforated tin. By means of this the poison can be sifted over the plants. This, however, is a slow process, as only one row at a time is poisoned.

Some planters practice sowing the mixture when there is a light wind, being in this way enabled to poison several rows at once. Aside from the fact that the conditions favorable for this method cannot be relied upon, the poison cannot be as thoroughly distributed as is desirable.

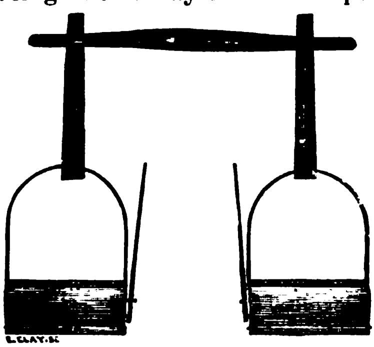

FIG. 55.—Young's sifter.

A device has been invented by Mr. J. W. Young, of Southfield, Mich., for dusting Paris green upon potato-vines; by means of this, two rows can be poisoned at once. The form is shown in Fig. 55:

The weight of the apparatus is balanced upon the shoulders by means of a neck-yoke, thus leaving the hands and arms free to move the handles. Each handle is attached to a brush that works horizontally across holes in the bottom of the can. The cans are adjustable to the

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width of the rows or height of crop. Doubtless this machine would be found much better than the hand-dusters, especially when poisoning small cotton.

Fig. 56 represents an apparatus for distributing powdered substances upon plants, invented by Mr. Samuel D. Allen, of Philadelphia, Pa. Patent No. 178704.

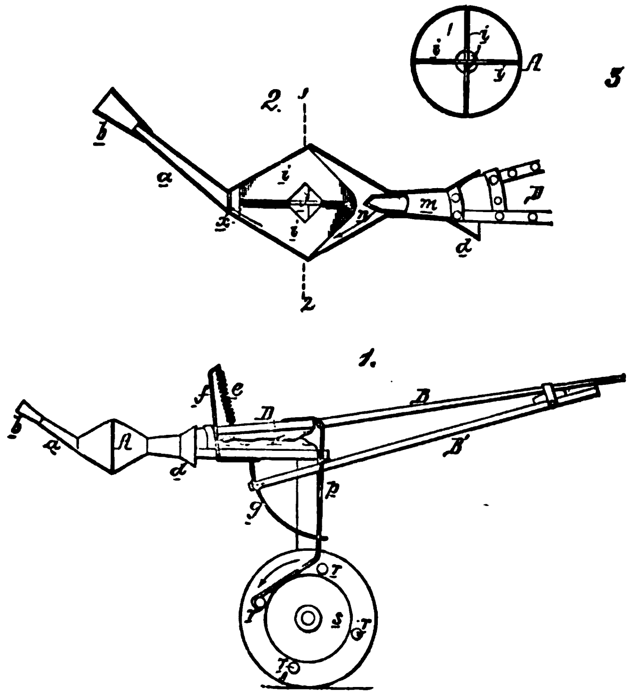

FIG. 56.—Allen's duster.

1 is a side view of the device; 2, an enlarged vertical sectional view of part of the same; 3, a transverse section on the line 1, 2, of 2.

The poisoning compound is contained in a reservoir, A, and is forced in small quantities at a time through a spout, *a*, by means of air forced into the reservoir from a pair of bellows, D, or other blowing mechanism, to which are connected arms, B, B′, by means of which the bellows may be operated, a spring, *e*, being attached to the end of an upright, *f*, to serve or assist in distending the bellows. The apparatus is mounted on a wheel, *s*, which imparts motion to the bellows through the medium of a rod, *p*, and studs, *n*, on the wheel. By each stud the rod is drawn downward until it is freed by springing away from the stud, when it will rise by the action of the spring *e*. The outer end of the lower arm B′ is adapted to a segmental rod, *g*, and is provided with a set-screw, by tightening which the arms and bellows may be confined in any relative position to which they may be adjusted—as shown, for instance, by dotted lines in Fig. 1. The reservoir A is provided at one end with a funnel, *d*, through which the material is introduced into the reservoir, and at the opposite end is an inclined spout, *a*, over the end of which is fitted a funnel-shaped guard or shield, *b*, which protects the end of the spout, and prevents the clogging up of the same when used among wet foliage.

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The object of making the spout inclined, as shown, is to enable it to discharge either up or down, or on either side, as desired, without changing the position of the bellows D, the change being effected by merely turning the reservoir around on the nozzle *m* of the bellows until the spout is pointed in the proper direction.

The reservoir A is divided in the present instance by two longitudinal partitions, *i i*, which break up the contents of the reservoir and prevent them from accumulating in the lower portion of the same—openings *j j*, however, allowing such communication as will permit the entrance of sufficient material into the lower portion of the reservoir to supply the place of that expelled at each blast of the bellows, thus insuring an even discharge of the whole contents of the reservoir.

In order to cause the air to act only on the portion contained in this lower division, the nozzle has an inclined face, *n*, in which the perforations for the escape of the air are formed, the air being thus directed against the bottom of the reservoir, and carrying with it a small quantity of the contents, which are expelled through the spout *a*. A perforated disk, *x*, is inserted into the entrance of this spout, to assist in distributing the contents evenly.

This machine has been largely used for the potato-beetle and for green-house work. It was invented when people were much afraid of handling Paris green; of late it has been used but little, as it is worthless for distributing bulky compounds like Hogal's patent and others now used. It may be found that much less bulky compounds will answer as well; in which case there will be a demand for a machine of this kind.

Mr. W. T. Willis, of Brenham, Tex., has also invented a machine for the purpose of distributing dry poison upon the plants. This machine is adapted to be secured across the front part of a saddle and to be operated by the rider.

No. 2 in the accompanying figure is a sectional view of the machine. No. 3 is a detail view.

A A designate two boxes of any suitable capacity, which are constructed with two fixed sieves, *p p*, and movable sieves *p′*, arranged between the fixed sieves and supported upon rods, so as to slide freely when the boxes are vibrated, and aid in pulverizing the material, and at the same time scattering it uniformly. The upper sieves *p* will support the bulk of the material free from the scattering-sieves *p′*. Each box has secured to it a suspension-standard, B, having a number of holes, *a*, through it, arranged one above another, and adapted to receive suspension-pins *b c*, and allow the boxes to be adjusted vertically for high or low plants. C designates a bar, from which rises a guide-rod, C′. This bar C is intended to be secured by the middle of its length to a ridding-saddle in front of the rider, and through its ends holes are made, through which the standards B B are passed, and sustained by means of the pins *c c*. Supplemental holes are made through the bar C, to allow the boxes A A to be adjusted for rows of plants varying in width. D designates a bar, the ends of

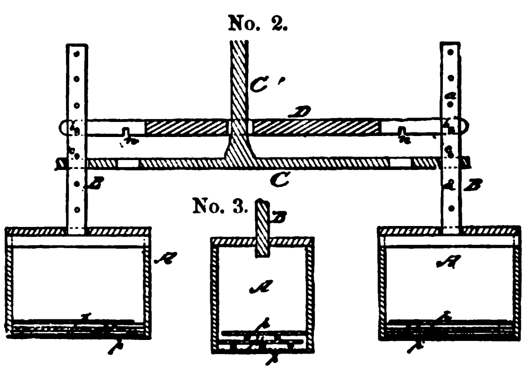

FIG. 57.—Willis' sifter.

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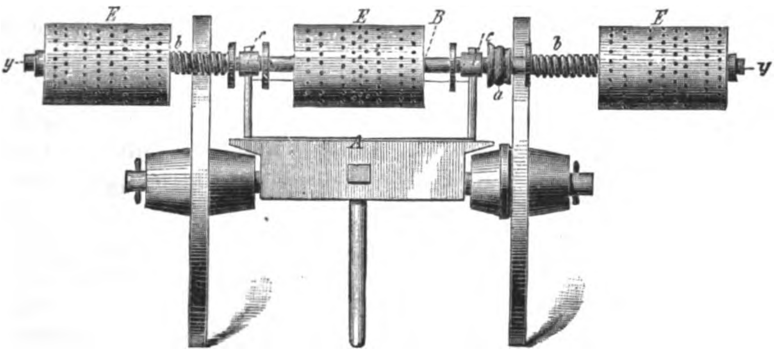
which are slotted longitudinally to receive the standards B B, and at or near the middle of the length of this bar D a hole is made to receive freely through it the rod C′. The ends of bar D are notched at *n*, and are attached to the standards B B by fitting these notches over the pins *b b*, as shown in Figs. 1 and 2.

The machine thus described is operated while the horse is traveling between the rows of plants by giving endwise motion to the bar D, which will communicate vibrating motions to the sifting-boxes and scatter the powder over the plants.—[Patent No. 160,986, dated March 6, 1875.]

Fig. 58 illustrates the machine patented by Mr. Nicholas A. Davis, of Rusk, Tex.

No. 1.



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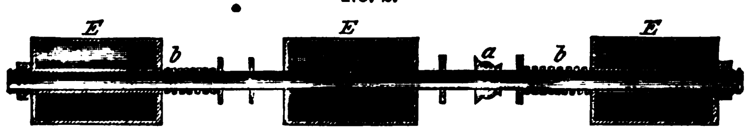

FIG. 58.—N. A. Davis' sifter.

No. 1 represents the invention attached to a cart; No. 2 is a cross-section through the line *y y*.

In the drawings, A represents an ordinary farm-cart, across the rear end of which is secured the horizontal shaft B, having its bearings in the arms *c c*, projecting behind the cart. On the shaft B, I place two or more loosely-revolving perforated cylinders, E, being revolved upon the shaft, which carries a pulley, *a*, over which a band or cord works, passing to the hub of the cart-wheel, from which it receives motion, and thus causes the shaft B to revolve when the cart is in motion, and the shaft, carrying the perforated cylinders, previously filled with the powdered poison, causes the poison to be sifted out and distributed over the cotton plants. Attached to the inner end of each of the outside cylinders is a spiral spring, *b*, coiled around the shaft, A, and so arranged as to secure an easy, gentle, lateral motion to the cylinders in case of a sudden jar given the machine, and thus prevent too great a discharge of the poison at any one point.

It is evident that a similar spring may be used at the opposite end of the cylinders, so as to check the jar in both directions.

From the above description of the invention, it is evident that it could be affixed to any kind of frame moving on wheels, and by a hand-crank and ordinary cog-gearing be successfully worked.—[Patent No. 154651, dated September 7, 1874.]

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Fig. 59 represents the patent of Mr. Charles F. Levy, of Natchitoches, La.

No. 1. No. 2.

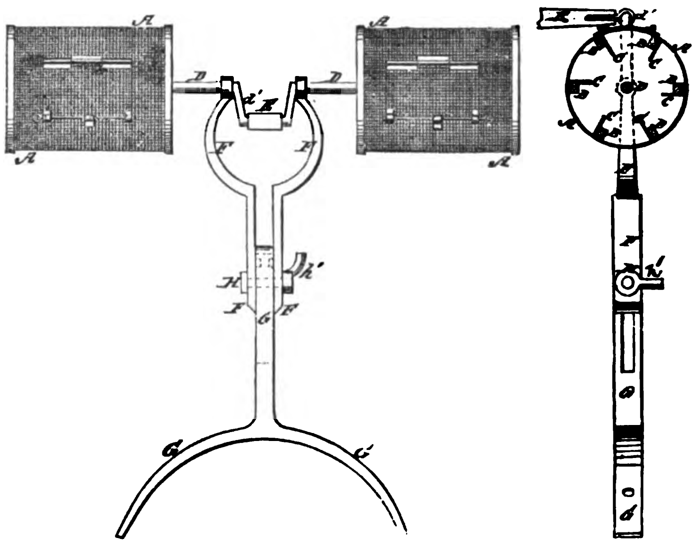

FIG. 59.—C. A. Levy's machine.

No. 1 is a side view of the machine; No. 2 is a side view partly in section hrough one of the cylinders.

A are two cylinders formed by attaching the wire gauze or finely-perforated sheet-metal to circular ends or disks. To the inner surfaces of the cylinders A are attached longitudinal strips B, to one side of each of which is attached a strip C, of tin or other suitable sheet-metal, which strips thus form flanges, which, as the cylinders revolve, raise the compound and allow it to fall back, so as to keep it stirred up and prevent the heavier ingredients from settling and thus escaping in too large a proportion and unevenly. The cylinders A are placed upon the end parts of a shaft, D, and are secured in place adjustably by keys or nuts, so that they may be moved toward or from each other to correspond with the distance apart of the rows of plants. Upon the middle part of the shaft D is formed a crank, *d'*, by means of which the cylinders revolved, either by taking hold of said crank *d'* directly, or by a short handle, E, pivoted to said crank. The shaft D revolves in eyes in the upper ends of two bars, F, the upper parts of which are curved to give room for the crank *d'* to operate. The lower parts of the bars F are parallel with each other, and pass down upon the opposite sides of the standard G, to which they are secured by a bolt, H, which passes through a hole in the lower parts of the said bars F, and through a slot in the said standard G, so that by loosening the hand-nut *h'* of the bolt H the cylinder A may be raised and lowered, as the height of the cotton plants may require.

The bars F may be kept from turning upon the bolt H by lugs formed upon the inner sides of the bars F, and which enter the slot of the standard G, or by a second bolt.

The lower end of the standard G is branched, and has screw-holes formed through said branches to receive the screws or bolts by which the machine is secured to the forward part of a saddle, or to the frame of a sulky, according as it is designed to operate the machine upon horseback or upon wheels.—[Patent No. 154690, dated September 1, 1874.]

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The insect-destroyer patented by Mr. Frank A. Eldridge, of Brenham, Tex., is also designed to distribute dry poisons over the cotton plant.

The nature of the invention consists in the employment, upon a suitable vehicle, of two or more receptacles for containing poison-powder, which receptacles have perforated or sieve bottoms, and contain within them rotary stirring-blades and brushes, actuated as will be hereinafter explained, whereby the poison-dust can be regularly, and at the same time economically, distributed upon two or more rows of plants at the same time.

No. 1 is a top view of the machine; No. 2 is a side elevation showing one of the poison-receptacles in section; No 3 is a front elevation.

A designates the axle of two transporting-wheels, B B, from which axle rises a frame, C, carrying three poison-powder receptacles, D D D′, which are preferably of cylindrical form, and which have finely perforated bottoms *a*. The two side receptacles, D D, are arranged so as to distribute the powder upon two rows of plants, and the rear receptacle distributes the powder upon the intermediate row, thus playing on three rows at the same time. Each receptacle contains radial blades *b*, which are applied to a central shaft, *c*, and provided with brushes *d*, which act upon the perforated bottom *a*.

The blades *b* stir the powder, and prevent it from clogging, and the brushes compel it to pass through the screen-bottoms in a uniform manner.

The upper ends of the shafts *c* of the receptacles D D have spur-wheels *e* on them, which engage with spur-wheels *f* on the ends of a horizontal shaft, E, which has its bearings on top of the frame C, and which is provided with pulleys *g g g′*. The pulleys *g g* receive rotation from pulleys on the inner ends of the hubs of wheels B B through the medium of belts *h h*.

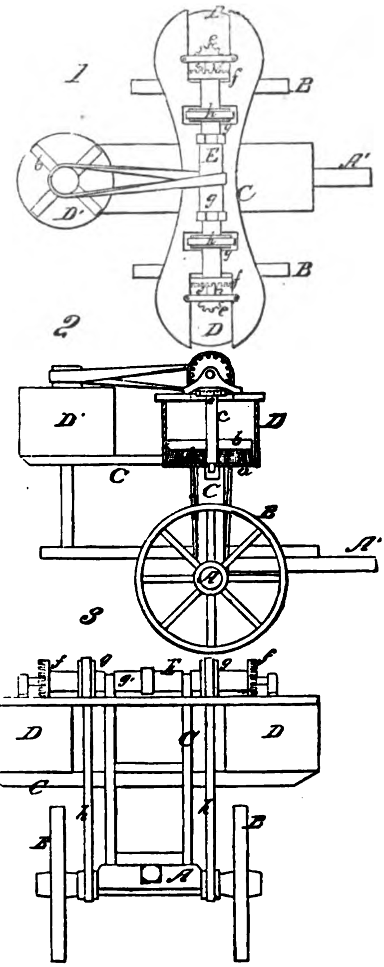

FIG. 60.—F. A. Eldridge's machine.

The rotation thus given to shaft E is transmitted to the shaft *c* of the blades and brushes which are in the receptacle D′.

The machine thus described will be propelled by two horses hitched to the draft-tongue A′, and, if desired, the axle A may be centrally arched, so as not to interfere with the plants over which it passes.

Mr. William T. Robinson, of Huntsville, Tex., has invented a machine that combines a sprinkler and duster, so that dry or fluid poisons may be applied at the will of the operator, or the plants may first be sprinkled

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and the dry poison applied immediately after this, causing the powder to adhere better.

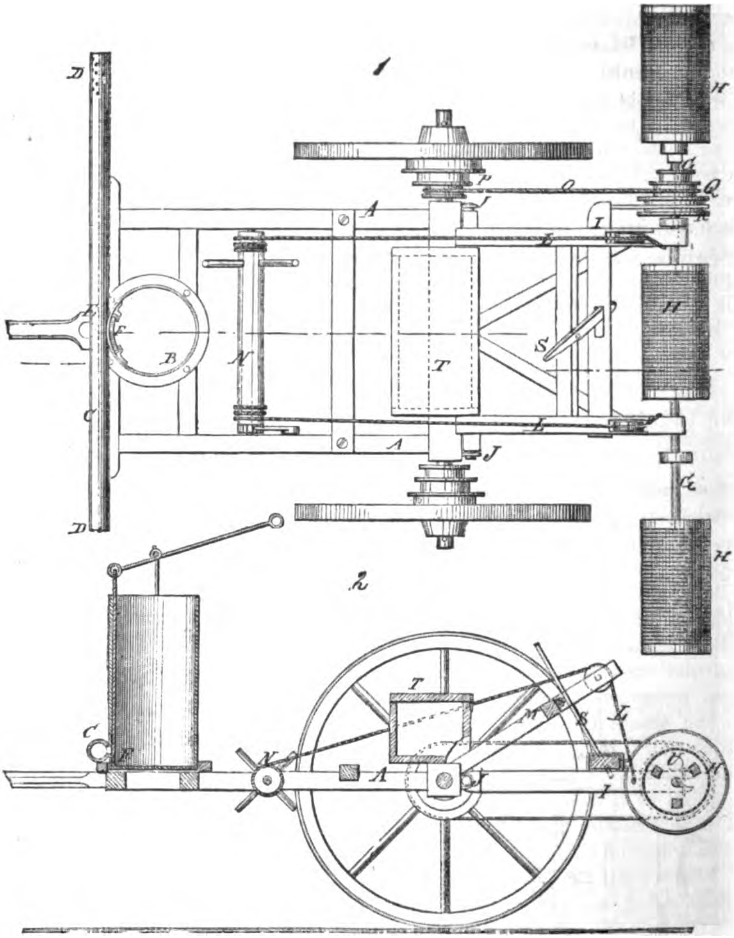

FIG. 61.—W. T. Robinson's combined sprinkler and duster.

No. 1 is a plane view and No. 2 is a longitudinal sectional elevation of Mr. Robinson's machine.

A is a two-wheeled truck, of proper height and width to run along above one row and provided with a tongue to hitch on the animals, so as to go on opposite sides of the row. B is a liquid-holding tank on the front part of the frame. C is a sprinkling-tube, connected with the tank and extending across the frame and beyond far enough to reach the two outside rows, and having small perforations, D, at the ends, and also at the middle, E, for sprinkling the liquid upon the three rows of cotton. A gate or valve, F, is arranged in the tank to shut off the liquid from the sprinkling-tube when it is not required to flow, and also regulate the discharge. The end of this tube is to be closed with a cap or plug, so that it can be opened, and be swabbed out from time to time, as it becomes foul. Behind the truck is a horizontal shaft, G, extending each way beyond the wheels, for reaching over the outside rows, and carrying three or more revolving screens or sieves, H, for sprinkling on powdered substances. Said shaft is mounted on the rear end of the frame I, which is jointed to the truck at J, and suspended from the frame M by ropes, L, which are wound up on the shaft N, or let out from it, to shift the screens according to the height of the plants. The shaft

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is revolved by a belt, O, from one of the wheels of the truck, working on cone-pulleys, P O, for varying the speed of the screens or sieves, as may be required. The pulley O on the shaft G connects with it by a clutch, R, which is connected with a shifting-lever, S, for throwing the shaft out of gear when turning around at the ends of the rows, to save waste of material. T is a box for carrying the stock of powder, from which to replenish the screens or sieves as they become exhausted from time to time. Said box may be also used for a seat for the driver. The sieves are supplied through an opening in the ends, which may be closed by a gate or door of any kind, or by an opening in the side similarly closed. Both attachments, the one with sieves for sifting on in powder, and the one for sprinkling in fluid, are detachably connected to the frame.

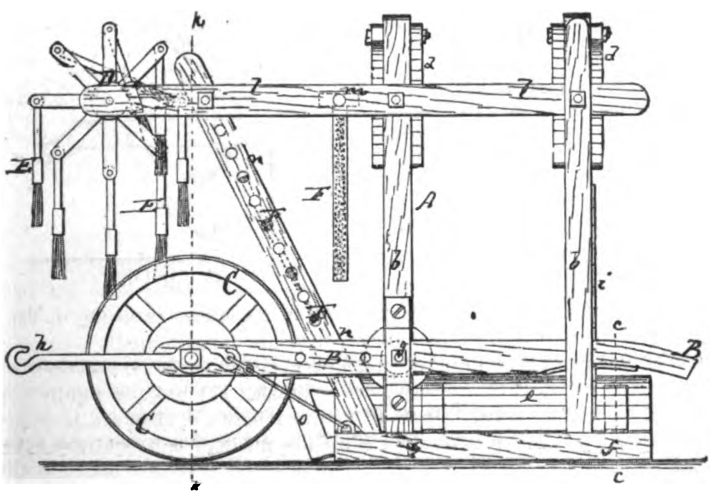
When it is desired to put on the poison with the sieves, in powder, the sprinkling attachment is used for the purpose of dampening the plant, causing the powder to adhere more firmly, so that the process may be continued through the whole day.

If it is desired to put on the poison in liquid, then the sprinkling attachment need only be used.

DESTRUCTION OF LARVAE BY MACHINERY.

Two machines have been invented and patented for the purpose of brushing the worms from the cotton plant and destroying them. Neither of these machines, so far as I have been able to ascertain, have come into general use. It is doubtful if a practicable machine of this kind can be constructed, owing to the danger of knocking off the bolls of cotton when in operation. The following is an illustration of the machine invented by Mr. Jackson Helm, of Hochheim, Tex.:

No. 1.



1 is a side elevation; 2 is a vertical transverse section of the lower part of the same, taken on the plane of the line *c c*, 1; 3 is a vertical transverse section on the line *k k*, 1.

In the accompanying cut the letter A represents a frame composed of two bottom-boards, *a a*, of four or more uprights, *b b*, and a suitable series of cross-braces, *d d*. The boards *a a* are on a level and parallel to each other, and have wings *e e* and *f f* hinged to their inner and outer edges, respectively. To each of the front posts *b* is pivoted,

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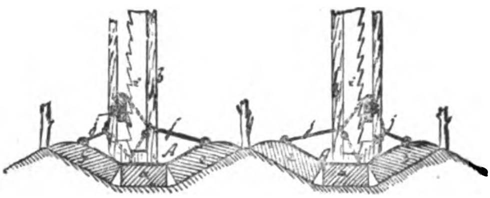
at *g*, a lever B, which carries a wheel, C, at its front end. There are thus two such wheels, C C, that rest on the ground in front of the apparatus. Draft-hooks *h h* are applied to the front ends of the levers B for hitching the draft animals to, by which the machine is drawn over the field. The levers B can be swung on their pivots, to raise the frame A on the wheels C, whenever stones, stumps, or other obstructions are to be avoided. In such case the levers B are or can be locked to toothed-plates *i*, which are applied to the rear posts *b*, as indicated in Fig. 2. When the machine is to be turned, it is also necessary to elevate the frame A off the ground, and throw the whole weight of the apparatus upon the wheels C. Whenever the frame A is thus raised, the wings *e* and *f* will be swung up, to clear the upper expanded parts of the cotton-plants. This is done by connecting the two wings that are hinged to each board *a* with each other by a string *j*, which passes over the lever B, so that in swinging up such lever, the string will be drawn with it to contract or swing up the wing. In the front ends of two horizontal bars *l l*, that are longitudinally secured to the upper parts of the posts *b*, is hung a tranverse drum or shaft D, and from which a series of pointed brushes, E E, are suspended. Brushes F F are also rigidly affixed to a cross-bar, *m*, back of the shaft D, and to inclined bars *n n*, that are secured to the sides of the frame A. These several brushes are made of split white-oak, or other suitable material.



No. 2.

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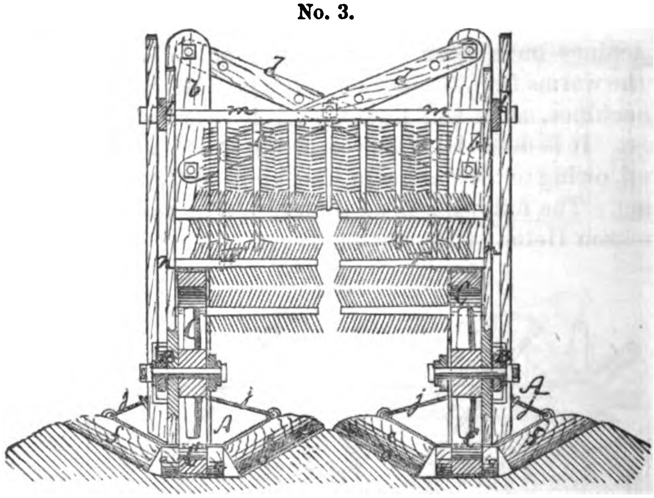

FIG. 62.—Helm's machine.

For use, the machine is placed to straddle a row of cotton between the inner wings *e e*. The boards *a a* rest in the furrows and the outer wings on the rising sides of the adjoining ridges, all as clearly shown in Fig. 2. The wings rest with their weight on the sides of the ridges. The machine being drawn ahead, the shaft D is revolved by its brushes E, which come in contact with the cotton-plants. Also, by subsequent contact with the brushes F F, the worms are all swept to the ground, on which they are finally crushed and destroyed by the weight of the boards *a*, and wings *e f*.

It will be noticed that as the machine is drawn successively over the several rows or ridges of cotton, each side of each ridge is twice pressed, once by an outer wing, *f*,

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and then by an inner wing, *e;* once while the apparatus straddles an adjoining ridge, and then again while it straddles the same ridge to which such side pertains.—[Patent No. 139062, dated November 16, 1872.]

The inventor of the other machine for knocking the worms off the cotton plant is Mr. William Ewing, of Columbia, La. Mr. Ewing, in his letters patent, says:

It is well known to planters and cultivators of the cotton-plant, that scarcely a season passes over in which material injury is not done to the crop by the cotton-worm. Generally the loss occurring by this source of damage will amount to one-half, but in many seasons the entire crop is ruined.

Various efforts have, therefore, been made to destroy the cotton-worm.

On carefully studying the growth and habits of the cotton-worm, I ascertained that one of its leading instincts is to drop or throw itself off from the plant, upon moderate disturbance of the leaves and branches. It is upon this instinct that my invention is based; and

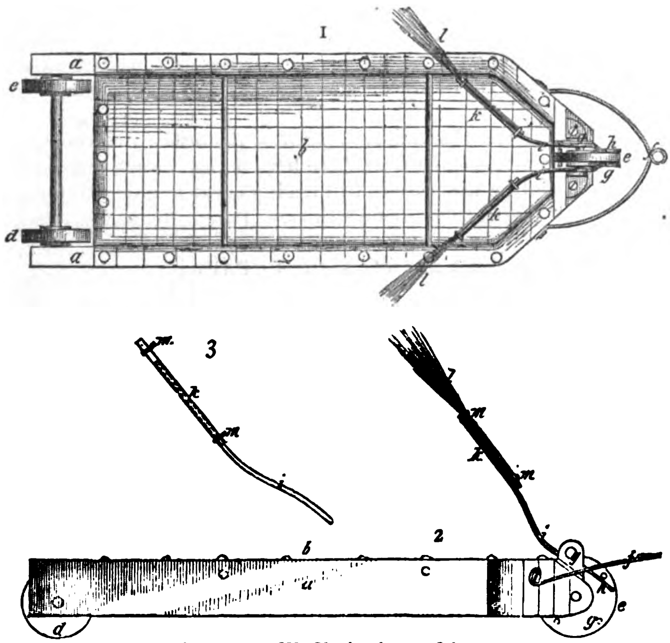

FIG. 63.—W. Ewing's machine.

My invention consists in the use of a machine or apparatus, so constructed that it may be drawn by hand, or by a horse or mule, between the rows of the plants, and agitating the leaves or stems, disturb the worms, and cause them to carry out their instinct, and drop or throw themselves off from the plants.

If such disturbance be made by any suitable means, the worms will usually drop to the ground, and where only a few acres are cultivated, reliance may be placed upon the destruction of the worms by the fowls or chickens of the plantation; but in large fields, some means for securing the worms and removing them will have to be resorted to. Such means are provided under my invention.

No. 1 of Fig. 63 represents the top of the machine; No 2, a side view of the same; and No. 3, a view of one of the arms detached.

It will be seen, by reference to the cut, that upon a frame, *a*, constructed of wood, or other suitable material, is stretched or fastened canvas, *b*, or some proper fabric, the frame having wheels *c d e* and a yoke, *f*, or drawing device.

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Upon the front wheel *e*, on either side, are pins, *g*, which act upon the lower ends *h* of the arms *i* as the wheel is rotated. These arms are pivoted to plates, *j*, and extend upward and outward, so as to pass along the sides and over the tops of the plants.

To the upper parts of these arms, other tubular arms, *k*, are affixed, so that the brushes *l*, secured thereto, may be adjusted, elevated, or lowered to the height of the plants.

These brushes are held in place by eyes or rings *m*.

Now, if the canvas *b* be smeared with tar, or any other material to which the worms will stick or adhere for a reasonable length of time, as the machine is drawn or pushed forward the worms will be dislodged from the plants, and falling upon the smeared surface of the canvas may easily be gathered up and destroyed.

The machine or apparatus here shown and described is intended to be passed between two rows of the plants, and will not, therefore, be likely to catch all the worms that may be disturbed and fall. If to such machine, however, a light frame of wire rods or cane be attached to the side bars, and extending upward above the top of the plants, and thence down to near the ground, and there have a frame to which canvas is affixed, two rows of plants will be operated upon at the same time, and all the worms be caught; or if two machines like that here shown be used, each traveling between two rows of the plants, and by some such frame-work as here named have a canvas sack or bed between the intervening two rows of plants, then one or more rows may also be acted upon.

In this arrangement of the machine or apparatus, the brushes or their substitutes would have to be differently located from those here shown. Such difference of location and means for operating the brushes will readily occur to any individual desiring to construct a machine having these modifications.—[Patent No. 95,995, dated October 19, 1869.]

DESTRUCTION OF PUPAE.

Although the collection and destruction of the pupae of *Aletia* at the season during which the greatest damage is done would be impracticable, much good could be accomplished in this way if attempted at the proper time. Early in the season, while the cotton plants are small, it is an easy matter to detect the presence of pupae by searching for the folded leaves containing them. As already suggested, when treating of the collection of larvae by hand, it doubtless would be profitable to offer the negroes a prize for each pupa obtained at this time. The folded leaves are so easily observed that with little care nearly every pupa in a field could be collected while chopping out the cotton in the spring. In the autumn many pupae could be destroyed by collecting together and burning the weeds in the leaves of which the larvae have webbed up. This should be done as soon as possible after the last brood webs up, and before the moths emerge from the pupae state.

DESTRUCTION OF MOTHS.

As to the possibility of destroying a sufficient number of moths to materially lessen the numbers of the worms, opinions differ greatly among planters. The following extracts from our correspondence will serve to show the disbelief in such remedies that prevails. These extracts are from letters from all parts of the cotton belt:

"I have seen fires used at night and drugs used to poison, but don't believe it ever did any good, for the worm finally ate up all the cotton."

"Efforts have been made to allure and destroy the moths, years ago, by lights and

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poisoned sugar, molasses, and vinegar. While they destroyed large quantities of the insects, it did not seem to affect the numbers of worms to any extent."

"Some years ago the planters (many of them) used tin plates made for the purpose, on which was placed vinegar sweetened with sugar or molasses. Fires were also made on stands in the field to attract the fly. But as they have been generally abandoned I suppose the results were not satisfactory."

"Efforts made to destroy moths have all of them proved failures. None of them are worth a cent."

"But little has been accomplished. Much money has been wasted in efforts to poison them."

"Lights at night and sweetened baits have been used, but with such unsatisfactory results as to be abandoned. I have known little success to follow the efforts to destroy the moths."

"Every effort to destroy the moth by allurement or traps are consummate failures. I have experimented in trying to decoy and known others to try fires, traps, and lamps at night, and every effort was worthless and a loss of time; vinegar, molasses, &c., on plates or otherwise, worth nothing."

"The different methods have been tried to destroy the moth but all have failed."

"But little value is attached to this method of destruction. It has only been tried on a limited scale. Poisons, torches, &c., have been used with but little success."

"Many futile and unsuccessful efforts have been made, such as poisoning and building fires, but all have proved to be failures."

"I do not believe any of the methods of destruction mentioned would do any good."

"No good has resulted from the efforts to allure and destroy the moths; no actual benefit from poisoned sugar, molasses, and vinegar, and fires."

"All efforts to destroy the moths have been useless."

"I believe one of these plans as good as another and all of them useless."

"Poison as ordinarily used is of little value; molasses and vinegar is less. Fires, unless used by all planters, decidedly hurtful."

"I know nothing of poisoning, as it has never been tried in this locality. Fires have been tried, but without effect. One man in this neighborhood tried lamps surrounded by small tin plates smeared with molasses. If he ever caught any I never heard of it. Many people went to see the result of his experiments but nothing came of it."

"All methods of alluring the moth by fires or sweetened substances have proved futile. Many are indeed destroyed, but sufficient remains to do their destructive work."

"Some experiments made with fires show that the fires, while they attract the moths, destroy but few, and fields in which fires have been kept have suffered more than those adjacent in which there were no fires."

The two most successful methods of destroying the moths that have been used are the placing of poisoned solutions, sweetened to attract the moths, about the cotton fields, and the lighting of fires or the attracting of the moths to lanterns arranged so that the moths may fly into the blaze, or so that they may be destroyed in different ways, either by striking the glass and falling into a sticky mixture, or by any way which the invention of the planter may have prepared. It will be best to consider these separately.

(a.) POISONED SWEETS.

We have already shown (Chap. III) how the moth of the cotton-worm is attracted to sweets of various sorts, as the nectar of various plants,

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ripe and decaying fruits of different sorts, and this proclivity very naturally suggests the placing of poisoned baits. Years ago this used to be practised very much more extensively than at the present day. Mr. Glover long recommended this remedy in the Department of Agriculture Reports, his first mention of it being a detailed account of the phenomenal success of Col. B. A. Sorsby, in the report for 1855. The old files of the Southern agricultural papers contain frequent mention of the use of the method. One of the most remarkable statements was contained in the Southern Cultivator (Vol. VIII, p. 132) to the effect that the writer had, with 80 plates of poisoned molasses and vinegar, averaged 1,000 moths a night throughout the season.

The answers of correspondents to question 7*a* of the 1878 circular show that this remedy has almost entirely fallen into disuse. Some planters, however, still believe in its efficacy. We may quote the following:

But few efforts have been made to destroy the moths, farmers of late years chiefly relying on poisoning the worms; however, the idea is gaining foothold that it is better to try and destroy the moth and thereby prevent the appearance of the worm in destructive numbers. The best mode seems to be to set up lights in the field above or in front of some sweet adhesive substance. Moths appear to be attracted by all sweet substances. I have seen them attracted by thousands, after the first brood had webbed up, to dried peaches that were dried on boards in the sun, and had been covered up at night with boards, the moths collecting by thousands under the covering of the dried peaches, hundreds being killed by a lamp in a short time. A mouse made a nest with the dead moths the same night.—[J. H. Krancher.

Watermelons cut open and spread around with arsenic sprinkled on will kill the moth.

I used, with full effect, the arsenite of soda combined with a little vinegar and molasses. I did not use any intoxicating liquids, as I was fully satisfied that every moth imbibing the poisoned sweet was instantly killed; none of the dead appearing at any appreciable distance from the pans.—[W. J. Jones.

Little or no effort has been made. My opinion is that something should be done with poisoned molasses and fires or lamps. A few nights ago I placed a cup three inches in diameter, with a little molasses in it, a distance from lights and cotton-plants, and found six moths in it next morning, all of them cotton-caterpillar moths A year or two ago I divided an overripe watermelon and placed it in a similar position, and by eight o'clock at night there were 50 or 75 moths feeding on it.—[Jno. Bradford, Leon County, Florida.

The following testimony is from Dr. Anderson:

As an instance of the effect of light and its fondness for sweets, I will mention what a neighbor told me, and for which, to a great extent, I had ocular demonstration. He was engaged in boiling sirup from the first of September to the last of October. His yard, where the evaporating pan was, opened upon a field of 60 or 80 acres of cotton. He each morning found his pan covered with moths, and from first to last thought he had emptied out one bushel of moths. Another case showing strikingly the effect of lights and sweets was told me by a highly valued Texas correspondent. A neighbor of his, by the use of lights and poisoned sweets, had made 1,000 bales of cotton on 1,000 acres, while his neighbors who had not used them had been badly damaged.

During the season of 1878 experiments were made by Professor Smith, at Tuscaloosa, Ala., in the latter part of the season, and by Professor

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Willet and myself earlier. Concerning Professor Smith's results, we quote from his letters:

October 10, 1878.—Since writing to you last I have done all I could towards observing the habits of the moths, experimenting with poisoned sweets, &c. As yet I have not been fortunate in getting a solution by which the moths are readily killed. I have tried corrosive sublimate and arsenious acid, and with them molasses and water in various proportions. The solutions I have smeared upon pine trees standing in the field, upon little shelves set up at places in the field, and upon a dish placed upon a stump. To one pine tree in particular the moths seemed to be attracted most strongly. The shelves attracted very few comparatively. I am still engaged in these trials with shallow dishes with perforated shelves, according to your suggestion, and I shall let you know if I find out anything.

October 16.—Since writing you last I have continued my experiments with various poisoned sweets; but, I am sorry to say, with but very poor success so far as killing the moth is concerned. I have used for poisons arsenious acid, corrosive sublimate, strychnia, and potassium cyanide; these I have mixed in varying proportions with rum and sweetened water. The bait appears to be attractive enough and I see the moths partaking of it, and yet no dead moths are visible next morning. The proportion of rum which I have mixed with these poisons has been sometimes one-half, and from that down. Of the poisons named above the potassium cyanide is perhaps most easily soluble in the liquids used. Smearing the sweetened liquids upon the trunks of trees is, according to my experience, the best way of exposing them; I have not seen many moths around the dishes set up on shelves and on stumps. I constructed a shelf against a pine tree and upon that placed a dish with the sweets, and provided with a floating perforated platform. The tree was at the same time smeared with the liquid, and upon visiting the place after dark I noticed a number of moths on the tree, on the smeared shelf, and on the dish with the platform, those on the dish being much less numerous. * * * About the time that the worms were moving off and webbing up, very few moths visited the sweets at night for several nights, but last night and the night before that they were more abundant. Perhaps the cool weather was the cause of their being absent for several nights, since they have come in numbers again after the warmer nights have set in.

November 4, 1878.—I send by to-day's mail a few specimens of the moths attracted by my baits. No. 1 is, I presume, *Aletia* (*Aletia argillacea*); No. 2 is *Agrotis ypsilon*, always present in cold as well as warm weather, and No. 3 (*Leucania unipuncta*) also; No. 4 (*Amphipyra*, sp.) resembles 3 and may be same species; No. 5 (*Orthosia ferruginoides*) I see occasionally on warm evenings; No. 6 (*Chrysis*, sp.) I found to-day. I should be very glad to get the names of the specimens as they are numbered. I inclose a few of the chrysalides of the last brood of worms.

The evening of October 26 was warm (66° at 7 p. m.), and more than 50 *cotton-moths were counted at my baited tree.* It rained before morning and then cleared off cold, so that on the 27th and 28th no moths were seen. On the 29th it was warm and cloudy and rained slightly, and I counted 7 or 8 *Aletia* moths. On the 30th, 31st, 1st, and 2d cold and frosty nights; no moths seen.

Professor Smith continued his sugaring all through the winter, capturing many other moths, but no *Aletia* later than December 1.

The observations of Professor Willet and myself were reported by Professor Willet as follows:

"*Peaches.*—Professor Comstock heard in Alabama that the *Aletia* moths had greatly injured the August crop of peaches. On the night of September 10 Professor Comstock placed two peaches—clear-stoned and quite ripe—one on each side of two stumps on whose sides molasses had

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been smeared, and visited them at 9 p. m. We (Professor Comstock and myself, Professor R. having left for Washington) found 20 *Aletia* moths on one peach and 15 on the other, notwithstanding the molasses. At 7 o'clock next morning nearly as many moths were at the peaches, though the sun was an hour high. One peach had a hole one-thirty-second inch in diameter, and the peach had been eaten out underneath the skin to a depth of one-fourth inch and a diameter of 1 inch. The other peach had 5 holes, not so large, and probably 50 excoriations one-fourth inch in diameter. They clustered most about the stem end, where they could thrust in their bills without effort.

"*September* 12.—The halves of the same peach, opened, were placed out last night, and 10 *Aletia* and 1 other moth were found at them this morning.

"Some *dried peaches* (with skins on) having been soaked in water, were placed out at same time, but no moths were found at them. After returning here, two hard peaches were put in a jar where some moths had hatched from chrysalides; the moths were almost famished and immediately clustered over the peaches, but failed to make any impression on them.

POISONING THE MOTHS.

"1. *Molasses.*—Mixed Fowler's solution of arsenic with common molasses, 1 tablespoonful to 1½ pints, and placed some in tin pan, with floating perforated cover of tin, as suggested by Professor Riley. After about two hours we found 2 *Aletia* and 2 other moths sipping; next morning probably a dozen of *Aletia* and other moths were found drowned in the molasses, having insinuated down by the sides of the cover; none dead on the ground.

"Mixed some of same poisoned molasses with sirups of strawberry, orange, and pine-apple, and with rum, vinegar, and lager beer, and smeared on trees and stumps in the cotton field and adjoining forest. At 9 p. m. found 1 *Aletia* and 2 other moths at the vinegar and 2 *Aletia* at the beer; at 7 next morning found only one feeble *Aletia* at the beer. The poison did not seem to be strong enough.

"2. *Peaches.*—September 12, we put out in the cotton field, in large paper boxes—

a. Peaches (halves) thickly sprinkled with white arsenic.

b. Peaches (halves) drenched with Fowler's solution.

c. Dried peaches (soaked) covered with white arsenic.

d. Dried peaches (soaked) with Fowler's solution.

Visited boxes next morning, with following result:

a. Five dead *Aletia*, 2 disabled *Aletia*.

b. Two dead *Aletia*, 1 dying *Aletia*.

c. Two *Aletia* in box not dead.

d. No moths of any kind.

"As peaches seemed so attractive, we desired to have tested the poisons further with peach preserves and canned peaches, but a northeast gale

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prevailed until the last day of our stay, and the moths had then almost entirely disappeared.

"My own opinion is that peaches, in some form, will be the best vehicle for poison for the moths."

A letter from Judge Bailey, of Marion, Ala., contains the following, bearing on this point:

One farmer informed me that the moths utterly destroyed a large fig crop in less than a week. Another informed me that all his best apples were punctured and sucked into a sort of honey-comb work by the cotton-miller. A physician in the northwest part of the country assured me that the army-worm sucked his grapes dry in three nights. I know the moths are strongly attracted by cider pomace from the cider-mill. They feed upon ripe persimmons with great avidity. I observed them around a tree of this kind on my lot as late as the 21st of November last. While they were feeding on the fruit of this tree I make some efforts to poison them, but with poor success. I tried several poisons handed me by an apothecary; only one had any effect. It was cobalt, finely powdered, and mixed with the fruit mashed with a small quantity of honey. The flies sought the bait in great numbers, but, like bees, they sucked their fill and left; only nine were found dead around the saucer containing the poison.

With respect to observations the present year, the following from Mr. Trelease's report will give the results at which he arrived:

Since the perfect form, or moth, of *Aletia* is known to feed upon sugared substances and fruits, and since it is known to be attracted by light to a certain extent, it has been thought possible to destroy the moth by allowing it to feed on poisoned sweets, or by employing this food or lights to attract it into traps of various sorts.

As will be seen by referring to my report on the food of these moths, they are attracted in large numbers by ripe apples, peaches, and grapes, beside one or two other less common fruits; but I signally failed to attract them in numbers to my mixtures of molasses or sugar and various substances. Though no experiments on a large scale were conducted, I feel confident that poisoned dishes of ripened and slightly fermenting fruits which have been bruised may be advantageously employed for the destruction of these moths, by placing them about the cotton fields when the moths are flying. I would recommend that this be tried, especially on warm days in winter, when the moths are allured from their hibernacula, in the early spring, and in the fall, after the brood which destroys the cotton have emerged as moths.

From all observations it seems probable that a preparation of overripe fruit—peaches, melons, mashed apples, or persimmons—will be superior to any other sweet mixture for the purpose of attracting the moths, although, as shown by Professor Smith, one-half each of rum and molasses and water, when smeared upon the trunks of trees, has proved attractive.

Actual results with poisons have proved rather unsuccessful, but this may be owing to the fact that the moths fly away to die. As regards the best poison, Judge Jones seems to have had excellent success with arsenite of soda, while Judge Bailey considers the so-called "cobalt"* the best thing that he tried. It is also called "blue-stone" or "fly-stone," and is customarily used in fly-poisons.

And now, as regards the advisability of an extensive use of poisoned

*The ordinary cobalt of druggists is nothing more nor less than impure metallic arsenic, costing from 6 to 15 cents per pound. Called cobalt on account of former laws against the selling of arsenic in England.

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sweets, it is a question for every planter to decide for himself from the evidence laid down.

There can be no doubt but that it would be an excellent plan to try it in those regions where hibernation is suspected on the spots where the worms first appear. The sweets should be put out in these places in early spring and also in late fall. The importance of the latter is evinced from the fact of Professor Smith's success in October. There can certainly be no doubt but that every moth killed saves the planter from a great many worms, but the hibernating moths are, of course, of immensely greater importance than those of any of the succeeding broods. Concerning the later broods, the cost of poisoning must be set against the numbers of moths killed, and each planter must decide for himself whether it will pay him to continue.

In 1860 J. M. Heard patented a moth-trap, which has been quite extensively used throughout the South. It consists simply of a broad, shallow pan, which is filled with the attracting mixture, and a broader cover to protect it from the sun and rain. The figure represents a vertical section.

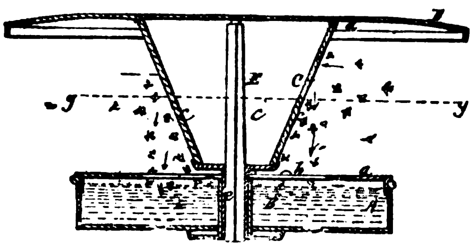

FIG. 64.—Heard's moth-trap.

As bait Mr. Heard recommends the use of molasses mixed with a little anise, fennel, or other essential oil. "The oil," he says, "should be put in as much alcohol as will dissolve it, and added to the molasses in the proportion of one-half ounce of the oil to the gallon of molasses." They will need to be cleaned out and replenished once a week.

FIRES, TRAP-LANTERNS, ETC.

For many years the practice of building large fires at different points through the cotton fields for the purpose of attracting the moths into the flame was prevalent. The use of such fires was, however, discouraged by a class of planters, whose opinions were thus expressed by a writer in De Bow's Review:

> I have tried this remedy, and have remained in my cotton field after dark to watch the effects of the fire on these flies. I did not see as many destroyed as I expected when I took into consideration the quantity I knew to be in the field. The most of those I saw approaching the fire seemed to be repelled or diverged off on nearing it, or they would rebound high above it and escape destruction. On seeing this I came to the conclusion that the heat of the large fires extended too far around, and that they felt it, and turned off before being near enough to be destroyed.

As a result of this belief and of the evident fact that, unless generally practiced, a fire upon one plantation would serve only to attract moths from neighboring plantations, concentrating them upon one crop, the custom has fallen into disuse.

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The first of these objections cannot be urged, however, against the use of trap-lanterns. As a good instance of the success of these last, we quote the following from the monthly reports of this department for 1867:

Parish of Jefferson, Louisiana.—Allow me to call your attention to the destruction of the cotton crop by the worms, which appear to increase yearly. In 1864 I planted about 100 acres in cotton. In July the worms made their appearance. Having no experience in raising this crop, I searched in the agricultural reports for information. Mr. Glover recommended the burning of trap-lanterns, and I made three of them with a coal-oil lamp and tin basin, with soapsuds underneath, and burned them every night. The first night I caught about 75 millers and innumerable other insects. The number increased to 300 millers, and then gradually diminished to none. For three weeks after the crops of my neighbors were destroyed, I found only a few of my plants attacked; about the last week of the three I caught no millers, but all at once the catch was 75; next night 150, then 300, and even up to 500. The worm, however, gradually made its appearance more and more, until, in the middle of August, my cotton was stripped of every leaf and bloom. The worm then turned into pupa. In ten days after this the miller again appeared. Meanwhile the cotton had sprouted again and was in full bloom, when the third brood made its appearance in immense numbers. In three days every leaf and young boll was eaten, and the worm was eating the bark of the plant and the glazed protection of the nearly matured bolls. The heavy rains of September soaked into the bolls and rotted them. I made only 3 bales of cotton. In July the prospect was good for at least 75 bales.

My opinion is that if every planter would commence burning a lantern in each five acres, from the latter part of June to the middle of September, for a few years in succession, both the boll-worm and the cotton-worm would be destroyed. The boll-worm destroys about one-half the crop with us. This year none of my neighbors raise cotcotton. I have planted about five acres, and shall burn one lamp, and inform the department of the result. Cost of lantern and basin about $1.50, and the oil will not cost over $1, so that if the increase is only 10 pounds to the acre it will more than pay the expense. The first night I used the lantern on a barrel, but the insects were alive in the morning, and it was considerable trouble to kill them. Afterwards I used the soapsuds, as it killed all the insects at once.

The following extract from a letter of Mr. E. A. Schwarz possesses interest in this connection:

Col. C. Lewis, of Hearne, Tex., after experimenting for a long time with more or less complicated contrivances to attract by light, and at the same time to kill the cotton-moth, concluded finally that the following simple apparatus is the most effective and cheapest. As now in use, this apparatus consists of three pieces: 1st, a shallow tin pan (16 by 10 inches); 2d, a common kerosene-lamp, with a half-inch wick, and large enough to burn the whole night; 3d, a common lantern, open below, which is put over the lamp to protect it from wind and rain. The lamp is put in the middle of the pan and prevented from sliding by three pieces of tin fastened on the bottom of the pan. This apparatus is put on top of a post, about 6 feet high, in the field. Before dark the lamps are made ready, the pans about half filled with water, and about one tablespoonful of kerosene is put on the water.

To put this kerosene on the water is the most important part, and the colonel experimented with all sorts of chemicals—alcohol, camphor, iodine, &c.—without finding anything which would kill the moths, which, attracted by the light of the lamp, fly against the lantern and fall finally into the water. Kerosene alone proved most effective in killing these moths. The lamps are left burning in dark nights the whole night over, but are, of course, of but little use at full moon. In the morning the pans are emptied and the lamps extinguished. Colonel Lewis believes that one lamp for each

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5 acres is sufficient. One man can attend to 500 acres. The cost of a lamp (which is manufactured by H. K. Davis & Co., Hearne, Tex.) is 50 cents, but will last, of course, for many years. The cost of burning one lamp and labor amounts to 35 cents per month. Colonel Lewis put his lamps out last year the 20th or 25th of June, and had them in use about six weeks, with interruptions caused by clear moonlight nights. Almost all the large farmers used these lanterns last year, and it is estimated that in the bottom-lands near Hearne more than 1,000 lanterns were out in 1878, which is the first year in which this method of killing the millers has been tried on a large scale, and it is not possible to say anything that is definite regarding its value. There has been last year no poisoning of the worms carried on whatever in this section, notwithstanding the crop was a fair one—about one bale per acre.

Myriads of the cotton-moths have been killed, of course, by this method, and it appears certain that it proved most effectual against the ravage of the boll-worm, which in 1877 did more harm here than *Aletia* (the cotton crop in 1877 was here a perfect failure, owing to the combined ravages of *Aletia* and *Heliothis*), and which was killed in great numbers by this method. Before the introduction of the method just described, the large planters in the bottom-lands tried to poison the worms, but with little success.

The method described above to destroy the cotton-moth is, in my opinion, superior to all similar methods and to all applications of poisons; but the lanterns ought to be lighted up at the beginning of May, if not earlier, and not toward the end of June.

The following extract from Mr. Trelease's report give the results of his observations upon this point:

From what has been said in the earlier agricultural reports, and from the testimony of planters as to the attraction of light for these moths, I had supposed that the easiest and most scientific method of destroying *Aletia* was to employ fires into which they should be attracted, or lights in combination with some form of trap, either with or without the added attraction of food; these to be used whenever the moths were flying, and their use enforced, if necessary, by legislation. Considering, for the above reasons, that the fondness of these moths for light was proved, I made no efforts to obtain personal demonstration of the fact; and it was only on learning how many species of moths and even of other insects may pass for *Aletia* with the ordinary observer, and on seeing from my notes how little attention was paid to the light of my lantern, that I began to doubt the efficacy of this remedy; but this, unfortunately, was after I had left the field. As it is, I can only say that the number attracted to lights, as compared with the entire number, was very small, so far as my experience goes. Though I saw a few dozen attracted into the house, thousands were within sight of the light and removed but a few rods; while for each of those thus attracted a dozen individuals belonging to other species came to the light. My own observation, then, goes to show that these moths are not attracted to any great extent by lights; but if this attraction should be proven to be considerable, this would prove one of the best ways of dealing with the pest.

On the whole, the conclusion at which we arrived in regard to the use of the lanterns is much the same as that which we have stated of poisoned sweets. Early in the spring and late in the fall they should be tried. Their use in the months between June and October will depend upon how efficacious other remedies have been, and upon the actual success of the trap used. In the seasons mentioned first the planter must not be discouraged at the small proportion of cotton-moths to other moths, remembering the fact, which we have so often reiterated, of the immense economic importance of every hibernating

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individual. It is well, also, to bear in mind that almost without exception the other moths which are thus captured are more or less injurious to vegetation.

We will here illustrate some of the more practical moth-trap lanterns which have been patented.

There have been a large number of moth-traps patented, which are made upon the plan of placing a light above a pan containing fluid, which may be either viscid or poisoned. The moths attracted by the light fall into the pan, and are thus destroyed.

The following figures and descriptions illustrate a number of the more simply constructed and more practical of these inventions.

The patent of B. F. McQueen, No. 166,124, July 27, 1875, consists of a lantern, pan, and reflector:

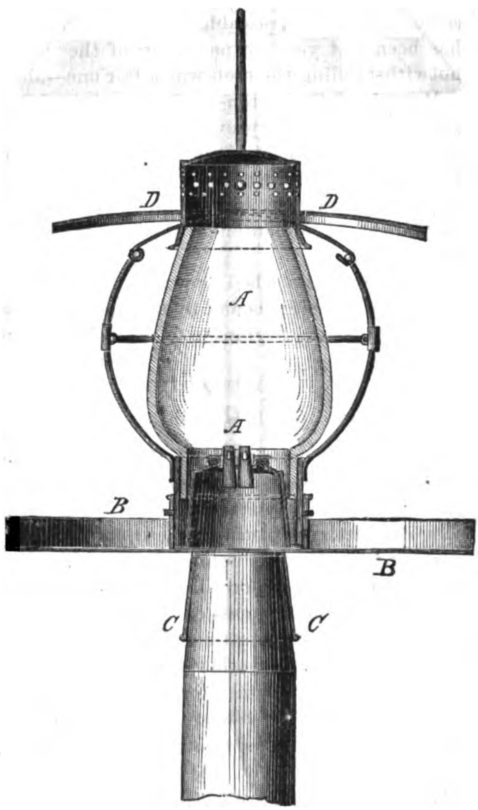

FIG. 65.—B. F. McQueen's trap-lantern.

A represents an ordinary lantern, constructed in any of the known and usual ways. Around the base of this lantern is attached a shallow basin, B, of any suitable dimensions—say, for instance, thirteen inches in diameter and two inches deep. Immediately below this basin, and attached to it, is a tube, C, of proper dimensions, to facilitate the using of the lantern in the field, by being placed on the post or stake. At the top of the lantern is a horizontal screen, D, of tin, forming a reflector to economize the light by throwing it outward. Another and important object and effect of this reflector is to precipitate the insects into the pan below. Many of the insects will flutter, and ascend the sides of the lamp with considerable rapidity, thus coming in contact with the reflector and causing them to fall into the pan, which contains water, sirup, or some other suitable liquid for destroying them.

The advantage claimed for this invention is that the light is equally diffused in all directions, thus alluring more insects than it would were the light partially obstructed.

Fig. 66 is a representation of the invention of Mr. James G. G. Garrett, of Port Gibson, Miss., No. 133,023, November 12, 1872. In his letters patent Mr. Garrett says:

This invention relates to that class of devices for destroying or catching nocturnal insects which consist essentially of a dish or pan containing molasses or other sticky substance and a lamp, the light of which decoys the insects into the pan. All such

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traps now in use are provided with bails or similar contrivances for the purpose of suspending them where wanted. They are thus subject to be oscillated or even overturned by the wind, causing the spilling of the substance in the pan—essential to the proper operation of the trap—and often, also, the extinguishment of the lamp or lantern. Suspending such a trap in fruit-trees is not so objectionable, because it is protected by the foliage against violent oscillations; but when used in open fields of growing crops, such as cotton, tobacco, &c., it becomes a very serious drawback, to remedy which is the object of my invention. To this end my improvement consists in rigidly securing the pan and its lamp or lantern to a stake of proper length, providing a device, complete in itself, especially adapted for use in open fields of growing crops, and not liable to serious interference from high winds.

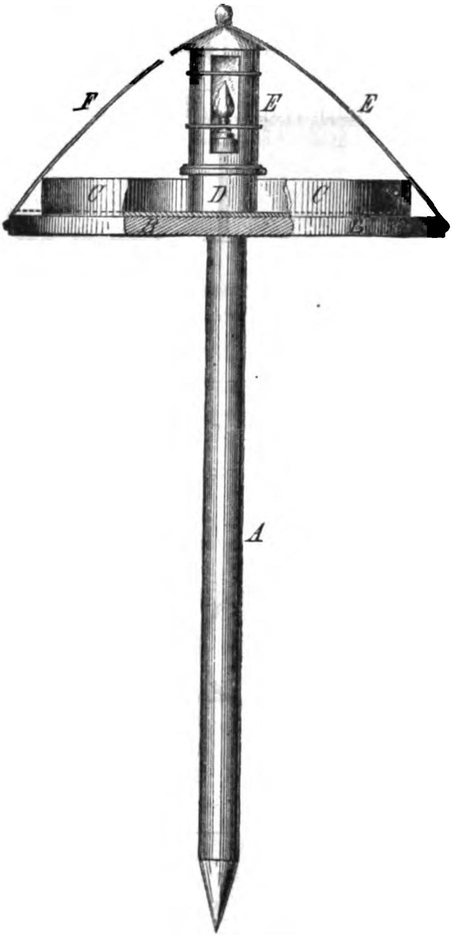

FIG. 66.—J. G. G. Garrett's trap-lantern.

The figure is a side view, partly in section.

A is a stake driven into the ground, and to the upper end of which is nailed or otherwise securely attached a board or plank, B, which should be about eighteen inches, more or less, across. Upon the plank B is placed a sheet-iron pan, C, about eighteen inches across and two inches deep. In the center of the pan C is placed a block or support, D, about two inches high, upon which is set an ordinary lantern, E. The lantern E is secured in place by being connected with the edges of the plank B by two or more cords, F.

This device is set among the plants to be protected, is lighted about dark, and enough coal-tar, molasses, or other suitable viscous material is poured into the pan C to a little more than cover its bottom. The insects will be attracted by the light, and flying toward it, will fall into the pan C, and being unable to escape from it will be destroyed. One or more of these devices should be used for each acre of the field to be protected.

Another lamp and pan apparatus was invented and patented by Jesse R. Duke, of Norristown, Ark. It consists of a pan of sheet-metal, having a tube or socket rising from the center of the bottom, which supports a lamp projecting above the top of the pan; the lamp having inclined sides and a very narrow or sharp top.

In the following cut, 1 is a perspective view of the invention, and 2 is a side elevation, partly in section.

A is a sheet-metal pan, and B is a tube or socket rising from the center of the bottom thereof. This tube or socket is soldered water-tight around a hole in the bottom

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of the pan. C is a lamp, having a cross-section of the shape of an isosceles triangle with a narrow base which gives the sides of the lamp a steep slope. E are burners, and *d* and *e* are reflectors. F is the stake upon which the apparatus is placed when in use, said stake fitting through the hole in the bottom of the pan and into socket B. There is a socket in the center of the lamp also, and into this fits the socket B. The lamp may be removed for filling or cleansing.

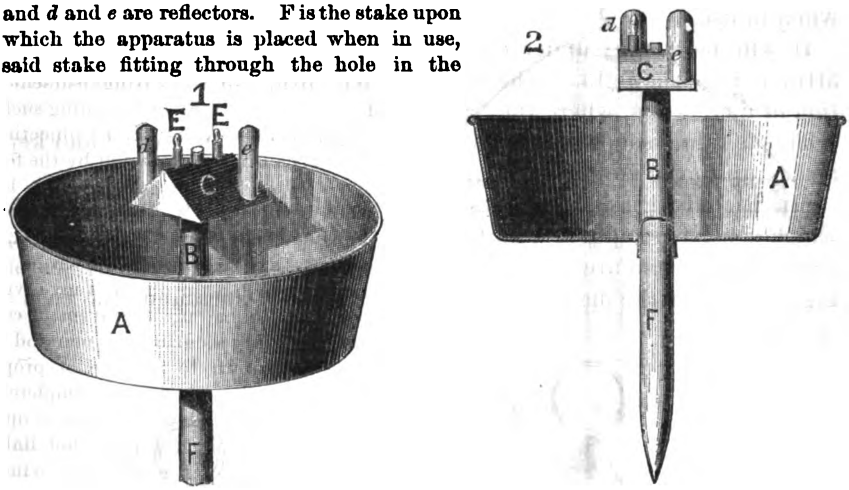

FIG. 67.—Lamp and pan apparatus of J. R. Duke.

To use the invention the stake should be driven in the ground, the apparatus placed upon it. At night the burners of the lamp being lighted will attract the moths, which, being scorched in the flame, will fall upon the steeply inclined sides of the lamp and slide off into the fluid in the pan. — [Patent No. 193643, dated July 31, 1877.]

The following is the invention of Mr. John R. Stephens, of Lone Star, Miss. It consists in constructing a vessel of suitable material for holding a strong alkaline solution of lime or lye. This vessel should be made circular, in the form of a bowl. The depth of this vessel depends upon the height of a lamp which is fastened to the center of the bottom of the vessel.

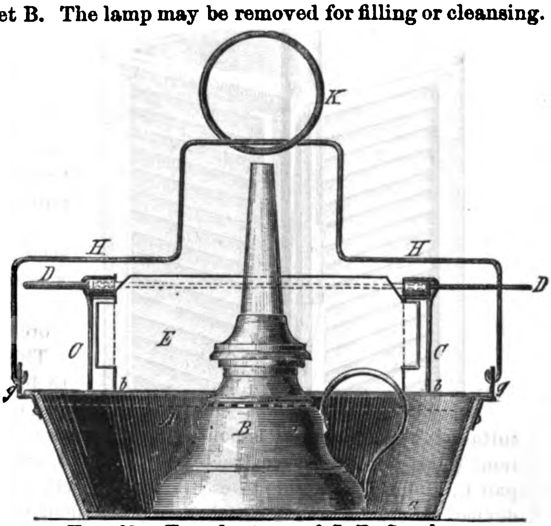

FIG. 68.—Trap-lantern of J. R. Stephens.

A is a circular vessel with the bottom *a*, to the center of which is fastened the lamp B. *g g* are the two eyes, fastened to the rim of the vessel A, and serve as holders for the handle H and the ring K, by which the moth-trap* is suspended. [Patent No. 188434, dated January 31, 1867.]

* Mr. Stephens's patent has also the standards *b b* to support the ring D, which is attached to the vessel for the purpose of carrying the portable shade E, to be used when the trap is employed for catching the bee-moth, for the purpose of not disturbing the bees.

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To the rim of the vessel are fastened two eyes, one opposite the other, serving to hold a handle and a ring, by which the trap is suspended when in use.

It will be readily understood that the moths, insects, flies, &c., are attracted by the light to the trap, and will drop into the alkaline solution of lime or lye, where they are killed.

This alkaline solution of lime or lye is filled into the vessel and kept nearly up to the lamp-wick regulator.

Mr. Richard Pitman, of West Point, Iowa, has patented a moth-trap which consists simply of a lantern constructed with open sides, through which the insects are enticed by the flames, and either die by scorching or through the means of poisoned fluid which surrounds the base of the lamp.

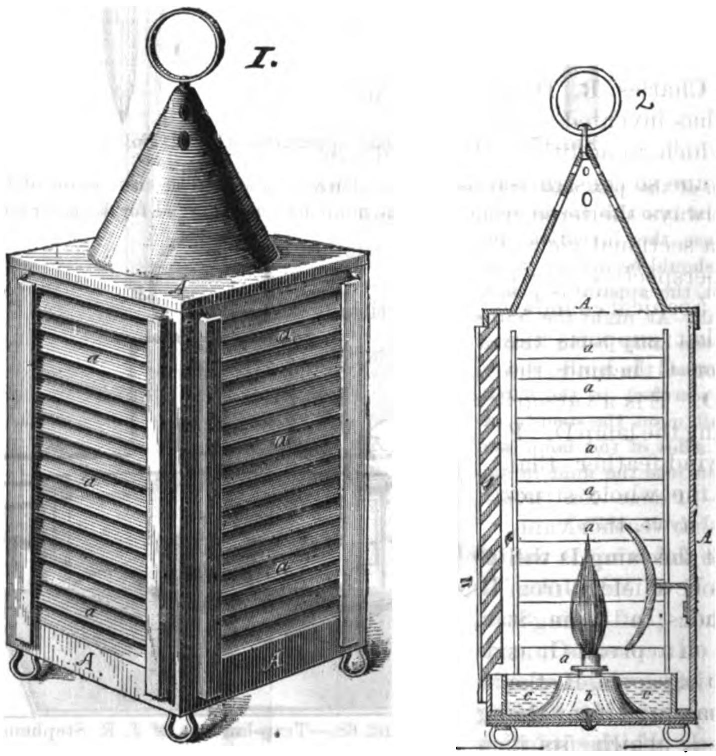

FIG. 69.—Trap-lantern of R. Pitman.

1 is a perspective view of the trap; 2 is a central vertical section of the same.

The trap is constructed of a frame, A, similar to that used ordinarily in flat-sided lanterns, and in substantially the same manner, and may be square or otherwise polygonal in form. In the slides, wherein glasses are usually inserted, are placed slides constructed of stationary slats, *a* (which should be made of tin or other bright metal), placed horizontally parallel to each other, at a downward inclination of about fifty degrees, so that the lower edge of each slat *a* shall fall below a horizontal plane ex-

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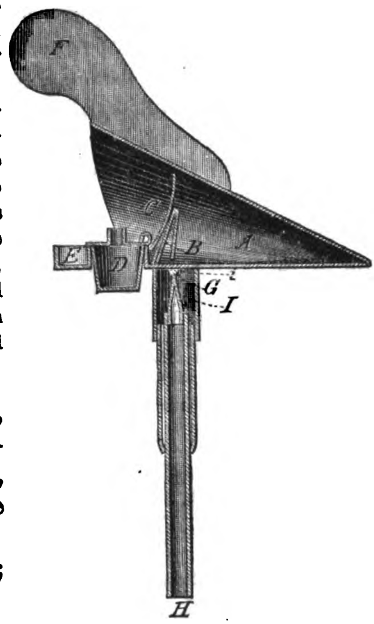
tended from the upper edge of the next slat below, and thus break the course of a direct current of air, and protect the light from extinguishment thereby. Sufficient space is left between each slat to admit the ready passage into the trap of moths and other insects alighting thereon, while the outward inclination of the slats presents an obstruction to their egress.

The trap so constructed may be used as an ordinary lantern during the winter season by substituting glass slides for the open slats. The reflection of light from the bright surface of the slats presents greater attraction to the insects than a simple light. The back part or one of the sides of the lantern may be left closed or solid, as shown in figure 2 of the drawings, to afford protection to the light from wind coming from any given quarter. [Patent No. 62563, dated March 5, 1867.]

1.



Mr. Charles R. Dudley, of Canton, Miss., has invented a rather novel moth-trap, which, in addition to lamp and pan, has a vane so constructed as to keep the light always sheltered from the wind.

1 is a sectional view of the invention; 2 is a perspective view of the same.

A is a conical chamber; B, a partition-wall that supports the reflector C behind the lamp D. E is a vat surrounding the lamp D. F is a wind-feather that shifts the whole structure as a weather-vane, so that the lamp D will always be shielded from the wind. In turning it moves on a pivot, G, at the top of a pole, H, the pole passing into the socket I, which fits it loosely. *i* is metal, glass, or other substance, which prevents the weight of the machine from causing the point G to pierce the bottom of chamber A in using it.

2.

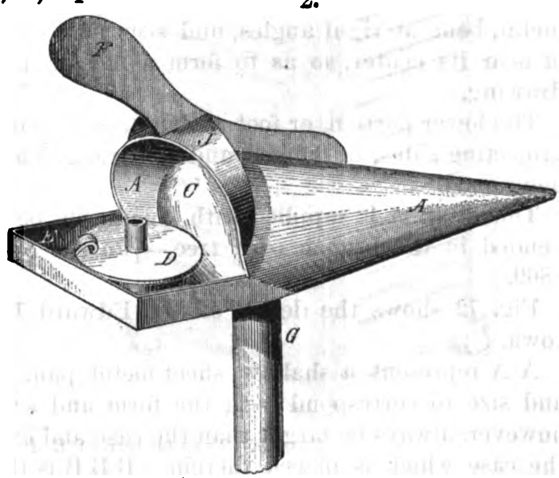


FIG. 70.—C. R. Dudley's lantern.

The lamp D, for coal-oil or other burning fluid, is provided with a wick-tube so as to throw a bright flame in front of the reflector C. This attracts the moths, which are destroyed by falling into the vat E of sweetened vinegar, tincture of valerian, and tincture of myrrh, or other

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attractive substance. This structure is mounted on a pole sufficiently high to reach above to tops of the cotton-plants, and is so sensitively poised on a pivot, G, as to turn with the slightest pressure of the wind against the wind-feather F. The wind-shield J stops the current about the light, so that it will burn always with a bright flame.

The lamp and the reflector are both removable for the purpose of filling with oil or of cleaning.—[Patent 134130, dated December 24, 1872.

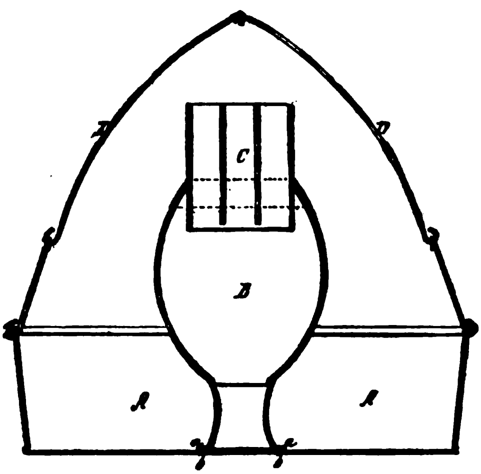

FIG. 71.—G. C. Cranston's lantern.

Fig. 71 represents a vertical longitudinal section of the invention of Mr. George C. Cranston, of South Bend, Ind.

A represents a circular tin vessel, the sides of which may be one or more inches in height.

B is a receptacle for the oil, or such other material as may be used for giving light.

This receptacle is furnished with wick-tube C, which may be divided in several wick-chambers, for the purpose of diffusing as much light as possible when the device is in actual use.

b b represent two pieces of metal, bent at right angles, and secured to the bottom of vessel A, at or near its center, so as to form a recess, or groove, as shown in the drawing.

The lower portion, or foot of lamp, or receptacle B, is provided with projecting sides, or flanges, and so arranged as to slide in grooves just mentioned.

The vessel A is supplied with a suitable bail, D, by which it is suspended in the branch of a tree.—[Patent No. 88140, dated March 23, 1869.

Fig. 72 shows the device of Mr. Edward D. Pugh, of Fort Plaine, Iowa.

A A represent a shallow sheet-metal pan, which may vary in form and size to correspond with the form and size of the case. It must, however, always be larger than the case and extend outside and beyond the case which is placed therein. B B B is the glass and sheet-metal case. It may vary in form and size, as desired. The bottom is sheet metal, and has a number of perforations or holes punched in to ventilate. It has short feet attached on the under side and near the corners to keep it above the liquid placed in the pan. The frame is made of sheet metal and in the form of a sash, so as readily to receive and hold the panes of glass. *a a* represents part of the frame, near the middle of its elevation and extending entirely around the case, with tubes attached

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on the inside and apertures communicating with the outside. *b b* are the tubes attached on the inside. These are usually about one-half inch in diameter, made of metal, and may vary in diameter and length to suit the bottles to be placed upon them. The number of tubes and bottles used may vary from one to twenty or more. The dotted lines indicate how a second tier of tubes and bottles may be introduced. C is a sheet-metal cover corresponding in form and size with the case, and can be readily lifted off and on. It has a chimney or opening in the top and center to allow the smoke and heat of the lamp to escape. It is held in place by means of hooks or other suitable catches. The top may be fixed and stationary, and one of the sides of the case, or a section thereof, may be hinged so as to admit the bottles and lamp; but, for

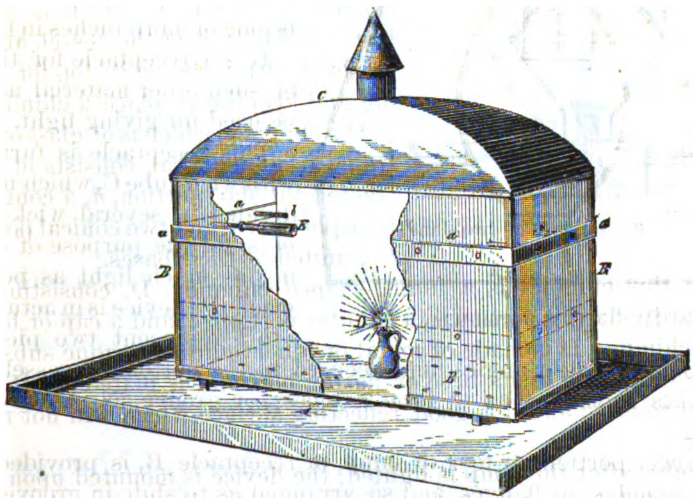

FIG. 72.—E. D. Pugh's lantern.

economy in construction and convenience in use, it is preferable to make the top in the form of a movable or hinged cover. D is a portable lamp, that is lighted and placed in the case to operate the trap. Any suitable form of lamp or candlestick may be used to provide the light that is required. E represents a long-necked common bottle placed on one of the tubes *b* on the inside of the case. These bottles may vary in form and size and number, as desired.

To operate the trap, put honey and wax or other suitable bait into the bottles and then place the bottles on the tubes *b* on the inside of the case. Set the case in the center of the pan A A and partly fill the pan with soapsuds or some other liquid that will destroy insects that fall into it. Place the lighted lamp or its equivalent in the case and set the trap wherever desired. The moth and other insects will be attracted by the light and fly against the glass. Many will fall into the liquid in the pan and perish. Those that alight safely on the sides of the case will be attracted by the bait in the bottles and will pass through the apertures

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and tubes and into the bottles, where they will remain until removed and destroyed.—[Patent No. 130390, dated August 13, 1872.]

Mr. Thomas Byrne, of New York City, and Mr. Deidrich Strunk, of Lavaca, Tex., have invented a trap so arranged that the light is strongly reflected in the liquid, hoping by this device to attract and destroy a greater number of moths.

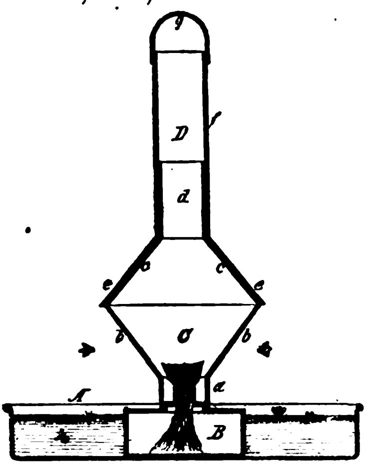

FIG. 73.—Byrne & Strunk's trap-lantern.

A represents an open vessel, which is adapted for containing carbolic acid, coal-tar, or any other liquid which will destroy insects.

Within this vessel and centrally arranged is a lamp, B, which is secured fast to the bottom of the vessel, and constructed with a rim on its top for receiving and keeping in place a chimney, C.

The chimney, which is of glass or other transparent material, consists of a contracted tubular portion, *d*, a contracted base portion, *a*, and two conical portions, *b c*, united at their bases.

Upon this chimney is a funnel-shaped chimney, D, consisting of a downwardly-flaring portion, *e*, a tubular portion, *f*, and a cap or hood, *g*.

This chimney D is made of metal or other suitable opaque substance, and the inner side of its base or flaring portion *e* is plated or otherwise polished so as to afford a good reflecting surface which will not readily tarnish.

At night, after the lamp is lighted, the device is mounted upon a post or suspended from a bush in any conspicuous place, where it will be visible to surrounding insects.

All that portion of the device above the lower edge of the chimney D will be dark, and the rays of light will be reflected downwardly and outwardly into the liquid in the vessel A beneath, thus illuminating the liquid, and also that portion of the transparent chimney C which is below the lower edge of the opaque chimney D.

This portion *b* of the chimney C being illuminated, made of glass or other smooth substance and inclined, it operates to throw down into the liquid beneath the insects which fly against it.

Instead of securing the lamp to the pan A this lamp and its chimneys may be suspended above the pan or other suitable vessel containing liquid.

It is obvious that the portions *c* and *d* of the chimney C might be dispensed with in the manufacture of this insect-destroyer, by fitting the lower edge of the deflector directly to the upper edge of the deflecting portion C.—[Patent No. 109869, dated December 6, 1870.]

A lantern patented by Mark Rigels, of Newton, Ala., is provided with

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projecting, round, or oblong windows, arranged around it so as to throw the rays of light in all directions, and with a subjacent circular dish to receive some liquid. It also consists in the application thereto of a series of vertical plates, one arranged between each pair of windows, to serve as reflectors for spreading the light, and also as guides to conduct the insect down into the liquid. It also consists in cup-shaped windows, made round or oblong and detachable, so as to be conveniently and easily cleaned.

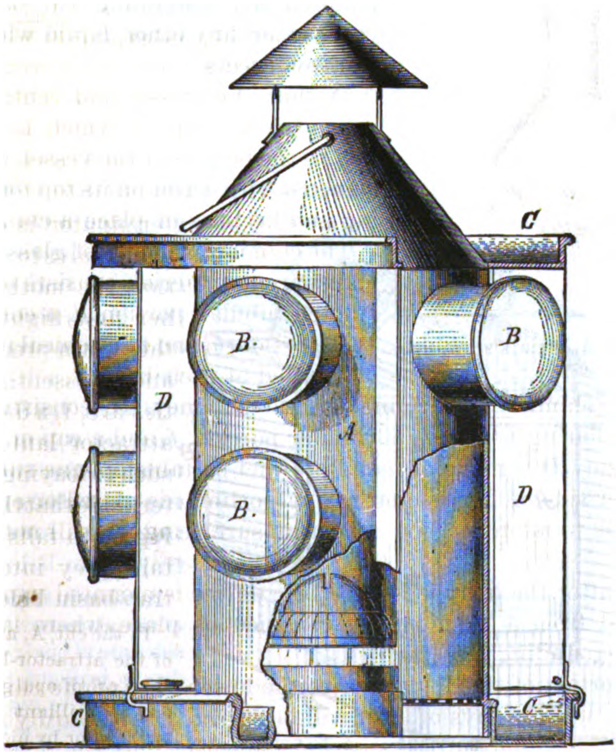

FIG. 74.—Mark Rigels' lantern.

A represents the body of the lantern, which is preferably made round and provided on its sides with the projecting windows B, which may be made round or oblong, as shown, and with glass or metallic sides. C is a circular dish placed about the bottom and top of lantern body, and above and beneath the windows. The device operates very well with the lower dish only. D is a series of vertical plates or reflectors. When the projecting windows are made of glass the light strikes laterally upon these plates and is reflected in many directions. The windows B will need to be cleaned at suitable intervals, and to facilitate this operation I make each of them in two parts, *b b′*, one of which is easily slipped over the other or removed therefrom.

The operation of this device is as follows: The lantern is placed in

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locations where insects abound, when they are attracted by the light from all sides. Myriads fly toward and against the lantern and vertical plates, when they are precipitated into the liquid and drowned.—[Patent No. 135366, dated January 28, 1873.

The following communication and figure was recently received at the department:

25 GRANT PLACE,
Washington, D. C., October —, 1879.

DEAR SIR: I inclose herewith drawing and description of a tested cotton-worm exterminator, for the consideration and use of your entomologist.

I will be pleased to present Mr. Huston's letter referred to, if required, or to do anything further desired of me in the premises.

I am, sir, yours, very respectfully,

J. STITH.

Hon. W. G. LE DUC,
Commissioner of Agriculture, City.

*Stith's Cotton-worm Exterminator.**—This exterminator is of the class which lures to self-destruction the mother moth on her first flight to deposit the worm-producing egg, and its essential peculiarities are, 1, a day and night attractor lantern, and, 2, such embaying of the lantern side that the approaching moth falls a more certain prey into the usual trap-basin below.

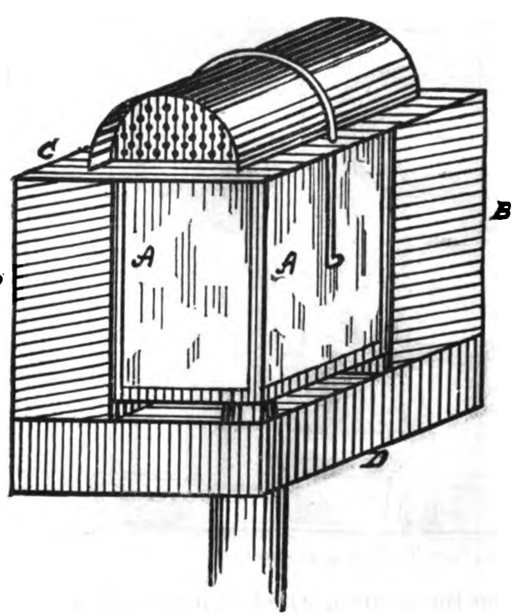

FIG. 75.—J. Stith's lantern.

In the cut, A, and A, are sides of the attractor-lantern; these sides are of opal glass which by day is brilliant white and in twilight or by night, lighted by a lamp within, is most attractively luminous; each pane of the lantern is flanked by an outreaching catch-wing B, against which, or against a lantern face itself, one or the other, the moth, attracted by the lantern and lured as well by an odorous bait below, precipitated itself according to its habit of flying to or of passing close alongside of a brilliant object; a cover C, projecting well over all, prevents upward escape even if elsewise possible to its now violently arrested flight, and all below lies a trap basin D, charged to a suitable depth with the common enticing bait and effectual death-bath as well, of sweetened water and vinegar, poisoned with cobalt. Centrally up from the basin's bottom rises a conical socket to cap securely on to a stake so planted firmly afield as to hold the exterminator just sightable above the general surface of the crop foliage.

The opal panes may be advantageously tinged with a trace of pink, to better simu-

* Mr. W. H. Huston (Selma, Ala.), who has thoroughly tested this exterminator in the cotton-field, reports that *it will attract and safely capture every ~~bug~~ or fly, of every description, that comes within its range.* J. S.

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late the color of the young cotton bloom; the catch-wings, the under side of the cover, and the inside of the basin are to be of cotton-leaf green, and all other visible parts a quiet earth-color; the lanterns are to be of such size and so disposed that one may be readily sighted and sought from any direction within the field or approaching it. The exterminator is to remain baited and posted day and night, the lamp to be lighted as quietly as possible before twilight, and charged to surely burn the whole night through; its use to begin before the first moth of the season may be reasonably expected, and to continue till the last-belated straggler is surely gone. Operations, however thorough, confined to a limited area, unless absolutely secluded, can give only partial relief.

To secure specimens of other "fly-by-nights," fit a wire gauze floor a little below the rim of the basin, and place beneath it a sponge saturated with chloroform.

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CHAPTER VIII.

BIBLIOGRAPHY OF THE COTTON WORM.

[This bibliography does not pretend to be complete. It contains all of the papers which have been consulted in the preparation of this part of the report, and, in all probability, almost all articles of value that have ever been published on the subject. Still, a subject of so great economic importance must necessarily have had a vast newspaper literature, which the work of many years could hardly collect and classify; and, therefore, we have confined ourselves to the principal scientific and agricultural periodicals.]

DANIEL MCKINNEN. Tour through the British West Indies in 1802–'3; Giving a Particular Account of the Bahama Islands. London, 1804.

Gives an account of the ravages of the *chenille* on Acklin's Island, Bahamas, and also of the appointing of a commission by the general assembly of the islands, in 1801, to investigate the causes for the repeated failure of the cotton crop, the principal cause being the ravages of the *chenille*.

BRYAN EDWARDS. History, Civil and Commercial, of the British Colonies in the West Indies. Phila., 1805–'6.

Contains an account of the ravages of the *chenille* in the West Indies in 1788 and 1794.

JACOB HÜBNER. Zuträge zur Sammlung exotischer Schmetterlinge, bestehend in Bekundigung einzelner Fliegmuster neuer oder rarer nicht europäischer Gattungen, Augsburg, Verfasser. 1818–1823. Centur. II.

Contains the original description of *Aletia argillacea*. For copy see chapter I.

THOMAS SAY. Correspondence relative to the Insect that destroys the Cotton Plant.

Southern Agriculturalist, I, p. 203, 1827 (*not verified*).

Noctua xylina. New Harmony Disseminator, 1830.

Reimpr. Transactions of the Agricultural Society of the State of New York. 1856.

Reimpr. Say's Entomology of North America, Ed. Le Conte. Vol. I pp. 369–371, 1859.

Consists of a letter from C. W. Capers to Thomas Say, transmitting specimens of the cotton-worm, and Say's reply, describing the insect as *Noctua xylina*.

Dr. CHISHOLM. Sir David Brewster's Edinburgh Cyclopedia, article *Cotton*. Edinburgh, 1830.

Draws up a description of the *chenille* in Latin. Gives an extended account of its habits as observed by him in Demerara (British Guiana) in 1801–'2, and proposes, as a remedy, fumigation with sulphur.

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ANDREW URE, M. D., F. R. S. History of the Manufacture of Cotton. London, 1836.

On pages 156 and 174 of vol. i. are given accounts of the *chenille* in British Guiana, and on the Sea Islands of Georgia (short and of little value).

WHITEMARSH B. SEABROOK. A Memoir on the Origin, Cultivation, and Uses of Cotton, from the Earliest Ages to the Present Time, with Especial Reference to the Sea Island Cotton Plant, including the Improvements in its Cultivation, and the Preparation of the Wool, &c., in Georgia and South Carolina. Read before the Agricultural Society of Saint Johns, Colleton, November 13, 1843, and the State Agricultural Society of South Carolina, December 6, 1843, and by both societies ordered to be published. Charleston, 1844.

On pages 42–45 is a short historical sketch of the "caterpillar (*Noctua xylina*)," with an account of the methods used in Colleton County to exterminate them; also some remarks upon the natural history of the insect.

THOMAS AFFLECK. Destruction of the Cotton Crop by Insects. American Agriculturist, vol. v, p. 341, September, 1846.

A short historical account of the cotton-worm, with a description of the state of affairs in Mississippi in August, 1846, and remarks upon the natural history of the insect. In this article Mr. Affleck first formulates the migration theory.

WHEELOCK S. UPTON. The Cotton Caterpillar. DeBow's Review, ii, 1846, p. 354.

Advises soaking seeds of cotton in a solution of bluestone as a preventive.

ANON. Cotton Caterpillar. Southern Cultivator, 1846, p. 157.

ANON. The Cotton Moth. American Agriculturist, 1847, p. 22.

Remarks upon Mr. Affleck's paper of September, 1846.

D. B. GORHAM, M. D. The Cotton Worm, its History, Character, Visitations, &c. DeBow's Commercial Review, iii, p. 535, 1847.

REIMPR. Southern Cultivator, 1847, p. 114.

Contains an account of previous visitations of the cotton-worm, and extended remarks upon its natural history. Proclaims the migration theory in full and gives arguments for it. Draws up a description of *Pimpla conquisitor* (the first mention of a parasite on the cotton-worm).

ANON. The Cotton Worm, its History, Character, Visitations, &c. Southern Cultivator, 1847, p. 137.

Editorial answer to Dr. Gorham's theory.

P. WINFREE. The Cotton Caterpillar. De Bow's Review, 1847, vol. iv, p. 251.

Brings up arguments against Dr. Gorham's theory. Gives personal experience with the cotton-worm in the Bahamas a few years previous.

M. W. PHILIPS. The Cotton Worm. Southern Cultivator, 1848, p. 28.

Quite an extended article, giving a description of the larva and chrysalis.

EDWARD DOUBLEDAY. Transactions of the London Entomological Society, 1848. Proceedings, p, 33.

Mentions having received the American cotton-moth from T. W. Harris, and states that it belongs to no European genus, coming nearest to *Ophiusa*.

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ANON. Destroying the Cotton Moth. Southern Cultivator, vol. viii, p. 132, 1850.

Advocates "sugaring" for the moth with molasses and vinegar.

THOMAS AFFLECK. The Cotton Moth—*Ophiusa ?* (*Noctua*) *xylina*. Affleck's Southern Rural Almanac and Plantation and Garden Calendar for 1851 (published at the office of the Picayune, New Orleans), pp. 49, 50.

Quotes from a letter from Harris; gives arguments for the hibernation of the moth; describes the egg accurately; figures larva, chrysalis, and moth, and also figures an ichneumonid parasite, in all probability *Pimpla conquisitor*.

ANON ("McG"). Diseases of the Cotton Plant and their Remedy. De Bow's Review, vol. xi, p. 7, 1857.

T. W. HARRIS. A Treatise on some of the Insects of New England, which are injurious to Vegetation. Boston, 2d Edition, 1852, p. 457.

A very brief account of *Noctua xylina*, Say.

A. GUENÉE. Spécies general des Lepidopteres; les Noctuélites, vol. ii, p. 400, 1852; ibid., p. 401; ibid., vol. iii, p. 397, 1852.

In vol. ii, p. 400, the cotton-worm moth is described as *Anomis grandipuncta*, on page 401 it is again described as *Anomis bipunctina*; and again, in vol. iii, p. 397, under the latter name (see Chapter I).

B. C. L. WAILES. The Cotton Plant, its Origin and Varieties, and its Enemies and Diseases. In Wailes' Agriculture and Geology of Missisipi, first report, 1854, pp. 146–148.

A short sketch of the cotton-worm, which he calls *Depressaria gossypiodes*. Advises, as a remedy, attracting the moth by fires.

W. I. BURNETT, M. D. The Cotton Worm of the Southern States. Proceedings of the Boston Society of Natural History, vol. iii, pp. 316–319.

A short account of the insect, mostly from hearsay. Proposes the migration theory.

ANON. The Cotton Worm, its Character, Habits, &c. De Bow's Review, vol. xvii, pp. 451–459, 1854.

J. H. ZIMMERMAN, M. D. The Cotton Worm, its Character, Habits, &c. American Cotton Planter, August, 1855 (from De Bow's Review).

Gives an account of the metamerphoses of the cotton-worm and boll-worm. Advises as remedies rotation of crops and sugaring for the moths.

TOWNEND GLOVER. The Cotton Caterpillar (*Noctua xylina*). Annual Report of the Commissioner of Patents (Agriculture), 1855, pp. 71–76.

Gives popular descriptions of all stages of the insect, and an historical account of its ravages. Details the remedies known. Figures all stages.

M. D. LANDON. The Cotton Caterpillar (*Noctua xylina*). Report of the Commissioner of Agriculture, 1864, p. 90.

A short account of the natural history of the insect, with figures of larva, chrysalis, and moth. Advocates the hibernation of the moth.

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AUG. R. GROTE. Proceedings of the Entomological Society of Philadelphia. Vol. iii, 1864, p. 541.

Announces the identity of *Noctua xylina*, Say, and *Anomis bipunctina*, Guenée, proposes the name *Anomis xylina*, Say.

JOSEPH B. LYMAN. Cotton Planting. Report of the Commissioner of Agriculture, 1866, p. 193.

Under the head of "Enemies of the cotton-plant, and how to destroy them," the cotton-moth is described. Advises sugaring for the moths, fires at night, catching the moths in hand-nets, and picking the leaves on which the eggs are deposited.

B. D. WALSH. The Three So-called Army-worms. Practical Entomologist, vol. ii, 1866, p. 112.

TOWNEND GLOVER. Insects Injurious to Cotton Plants. No. 3. Cotton Caterpillar, or Cotton Army-worm (*Noctua Anomis*) *xylina* (Say). Monthly Report of the Department of Agriculture, 1866, p. 331.

Substantially the same article as that in the annual report for 1855; very few changes. The larva is figured in two positions, as also are the chrysalis and moth.

GEORGE W. MORSE. The Cotton Caterpillar. Monthly Reports of the Department of Agriculture, 1867, p. 249.

Advises that summary measures be taken to destroy the first brood of worms by offering a reward for the first worm, and as soon as that is found turning a force into the fields to search for them.

JAMES M. FERGUSON. The Cotton Worm. Monthly Reports of the Department of Agriculture, 1867, pp. 288, 289.

Gives observations on the natural history of the cotton-worm, and offers the same advice as the preceding.

TOWNEND GLOVER. Report of the Commissioner of Agriculture, 1867, pp. 58–61.

Describes the cotton-worm in all stages, with accurate figures. Speaks of the northward migration of the moths and of the great good done by the ants in destroying both the eggs and the larvæ. Gives a popular description also of *Pimpla conquisitor*.

ANON ("*Zenos*.") The Cotton Caterpillar. Southern Cultivator, 1868, p. 298.

An account of the natural history of the insect. States that the last brood winters, in the chrysalis state, underground, and advises winter plowing.

B. D. WALSH and C. V. RILEY. Entomological Ignorance in the South. American Entomologist, vol. i, 1868, pp. 14–16.

A severe criticism of an article which was going the rounds of the Southern press headed, "How to destroy the Cotton Worm—a Suggestion."

B. D. WALSH AND C. V. RILEY. Cotton insects. The Cotton Army Worm *Noctua* [*Anomis*] *xylina*, Say. American Entomologist, i, 1868, pp. 209–212.

An account of the transformations of the cotton-worm, with figures and description of each stage. Hand-picking, destroying the moths by fire, and sprinkling the plants with cresylic soap solution, are advised as remedies.

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D. L. PHARES, M. D. The Cotton Army Worm (*Anomis xylina*, Say.) American Entomologist, i, 1868, p. 242.

States that the insect hibernates as a moth, and describes the egg. Advocates hand-picking if it can be done by concerted action on the part of the planters. Advises also sugaring and fires in May or June.

JOSEPH B. LYMAN. Cotton Culture. Orange, Judd & Co. New York, 1868. "The Cotton Moth," pp. 86–89.

A short account of the metamorphoses with figures of the different stages.

T. W. HARRIS, M. D. Entomological Correspondence. Boston, 1869, p. 169.

In a letter to Doubleday mentions having received specimens of the moth and asks for a generic determination. Date of letter October 24, 1846.

EDWARD DOUBLEDAY. Entomological Correspondence of T. W. Harris. Boston, 1869, p. 173.

In a letter to Harris dated April 2, 1847, states that the cotton-moth is near to *Ophiusa* but is a new genus.

COL. J. R. GALTNEY. The Cotton Army Worm. Southern Herald, Liberty, Mississippi, May and June, 1869.

Nos. 1 and 2 are devoted to proving the hibernation of the insect in the chrysalis state. No. 3 advises as remedies hand-picking, fires at night, sowing castor-bean and cow-pea in the cotton-field, and late fall and winter plowing.

ANON. The Caterpillar. Southern Cultivator, 1869, p. 13.

Advocates hand-picking as the only sure remedy.

ANON. The Cotton Worm. Southern Cultivator, 1869, p. 18.

Advises the use of Dr. Heard's moth-trap.

WILLIAM JONES. Cut-worms and Caterpillars. Southern Cultivator, 1869, pp. 106, 107.

Editorial answer to questions about cotton worm. Arguments for the hibernation of the chrysalis, and notes on extensive parasitism of the last brood of worms.

A. S. PACKARD, JR., M. D. Guide to the Study of Insects. Salem, 1869, pp. 313–315. *A. xylina.*

Short account of natural history and habits.

ANON. The Cotton Caterpillar. Carolina Farmer, vol. i, 1868, p. 142.

D. L. PHARES, M. D., A. M. The Cotton Caterpillar (*Anomis xylina*). Lecture delivered before the Farmers' Club of Woodville, Miss., May 4, 1869; abstract published in Rural Carolinian, August, 1870, vol. i, pp. 683–695.

This article is accompanied by a full page lithograph of cotton-stalk infested by larva, chrysalis, and adult, and engravings of the cotton-worm (*Anomis xylina*), the boll-worm (*Heliothis armigera*), and the grass-worm (*Laphrygma frugiperda*) in all stages. The article has the following heads: *History; Will the Caterpillar Cause Cotton Culture to cease? Why is the Caterpillar worse some years? Errors; Proposed Modes of Destroying; Propagation.*

WILLIAM JONES. The Cotton Caterpillar. Southern Cultivator, 1870, p. 67.

Editorial answer to letter from A. S. M., asking for information concerning cotton-worms. States that little is known, and dwells upon disputed point of hibernation.

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C. V. RILEY, M. A., PH. D. The Cotton Army Worm (*Anomis xylina*, Say). Second Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri. 1870, pp. 37–41.

An account of the habits and natural history of the insect with popular descriptions of all stages, and figures of eggs, larva, chrysalis, and adult.

J. PARISH STELLE. Southern Notes. The Coming Cotton Worm. American Entomologist and Botanist, vol. ii, 1870, p. 124.

States that the worm is always worse after a mild winter. Gives differences between "grass worm" and cotton worm.

F. G. H. TAYLOR. A Remedy for the Caterpillar. Southern Cultivator 1871, p. 385.

Advises the use of arsenic in solution.

ANON ("K"). How to destroy Caterpillars. Southern Farm and Home, 1871, p. 135.

Believes that the webs on trees through the winter contain the germs of the cotton worms. Hence advises to burn all such webs.

E. H. ANDERSON, M. D. Cotton Caterpillars and their Habits. Rural Carolinian, ii, 1871, p. 695.

A short review of the natural history of the cotton worm, with notice of a longer paper soon to be brought out.

C. R. DODGE. A Word about "Cotton Caterpillars." Rural Carolinian, vol. iii (1871), pp. 87, 88.

Corrects statements in the last-mentioned paper.

AUG. R. GROTE. *Anomis xylina.* A Review. Rural Carolinian, iii (1871), pp. 88–92.

An extended criticism of Doctor Anderson's paper. Gives a hint at the migration theory which he elaborates in 1874.

E. H. ANDERSON, M. D. More about Cotton Caterpillars. Rural Carolinian, iii (1871), pp. 204–207.

A controversial reply to Mr. Grote's criticisms.

C. R. DODGE. Cotton Caterpillars—One Word More. Rural Carolinian, iii (1871), pp. 263, 264.

Corrects statements in the last-mentioned paper.

AUG. R. GROTE. Dr. E. H. Anderson and Cotton Caterpillars. Rural Carolinian, iii (1871), pp. 308, 309.

A review of Doctor Anderson's last paper.

TOWNEND GLOVER. Report of the Commissioner of Agriculture, 1871, pp. 83, 84.

Gives an account of the occurrence of the worm in 1871, and speaks of a recently invented machine for sprinkling poisons. Advises strenuous efforts to destroy the first crop of worms.

J. PARISH STELLE. The Cotton Caterpillar. Southern Farm and Home, October, 1872, p. 457. From the Mobile Register of recent date.

Gives an account of the insect's natural history and advises the use of Paris green in solution as a remedy.

ANON. The Cotton Caterpillar (*Anomis xylina.*) Carolina Farmer, vol. iv, 1872, p. 278.

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J. PARISH STELLE. The Cotton Caterpillar. The Rural Alabamian, i, 1872, pp. 78–80.

Arguments to prove that the ravages of the cotton worm are worse after a severe winter than a mild one. A description of the moth and notes upon the habits of the worm. Hand-picking and fires are advised as remedies.

TOWNEND GLOVER. Report of the Commissioner of Agriculture, 1872, pp. 118–120.

An account of the ravages of the cotton worm in 1872.

C. V. RILEY. Remedy for the Cotton Army-Worm. Proceedings of the American Agricultural Congress; Indianapolis meeting, 1873.

Urgently advises the use of Paris green.

J. PARISH STELLE. The Cotton Caterpillar. All about how to save the Cotton Crop. Mobile Register, July 5, 1873.

Gives figures of the insect and describes all stages, with a short account of habits. Strongly advises the use of Paris green. Quotes from Riley's paper and mentions the fact that he himself tried experiments the previous year with the poison.

TOWNEND GLOVER. Report of the Commissioner of Agriculture, 1873; pp. 163–169.

Gives a detailed account of the injuries of the cotton worm in 1873, and also summarizes the answers to a circular sent to Southern planters in the fall of that year inquiring into the efficacy of Paris green as a remedy for the worm, and also making inquiry as to what other remedies had been used. The conclusion is in favor of the green.

W. R. HOWARD. *Anomis* (*N*) *xylina*. Philip's Southern Farmer, vol. vii, 1873, pp. 361, 362.

Gives a short account of the natural history of the cotton worm, states at length the conflict of opinion on the subject of the hibernation of the insect, quoting the opinions of all the prominent writers, and asking all planters to try and solve the problem.

TOWNEND GLOVER. Monthly Reports of the Department of Agriculture, 1874, p. 125.

States his belief that the insect hibernates in the more southern portions of the cotton belt, and as the season advances migrates northward.

ANON. Cotton Worm. American Cyclopedia, 1874, vol. v, p. 419.

A short article on the past history, natural history, habits, and remedies for the cotton worm.

A. E. BEACH. Remedy for the Cotton Worm. Science Record, 1874, pp. 370, 371.

Paris green.

A. R. GROTE. The Cotton Worm. American Naturalist, 1874, p. 562.

A. R. GROTE. On the Cotton Worm of the Southern States (*Aletia argillacea* Hübner). Proceedings of the American Association for the Advancement of Science, vol. xxiii, 1874, part ii, pp. 13–18.

REIMPR. Hartford Courant, xxxviii, No. 195.

REIMPR. (?). New York Tribune, extra No. 21, pp. 61, 62.

REIMPR. American Naturalist, vol. viii, pp. 722–727.

Habits and synonymy of the cotton worm. Proposes the migration theory.

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W. P. REESE, M. D. The Cotton Caterpillar Again. Rural Carolinian, vol. v, 1874, pp. 565, 566.

The cotton worm hibernates in the chrysalis state under leaves, &c., hence, as a remedy, burn leaves in fall. Also gives formula for use of Paris green in solution.

J. PARISH STELLE. The Cotton Caterpillar and how to Combat it Successfully. Rural Carolinian, vol. v, 1874, pp. 511–515.

An account of habits, with descriptions and figures of the insect in all stages. Advises the use of Paris green. Gives the formula for the Texas cotton-worm destroyer.

CHAS. R. DODGE. Injury to Cotton by Insects. Rural Carolinian, vol. v, 1874, pp. 417, 418.

Tabulates the first appearances of the worm, and states Professor Glover's theory, which the table upholds.

CHAS. R. DODGE. The Paris Green Remedy for the Cotton Caterpillar. Rural Carolinian, vol. v, 1874, pp. 193–195.

Summarizes the replies to the Department of Agriculture circular of 1873.

TOWNEND GLOVER. Report of the Commissioner of Agriculture, 1874, pp. 128, 129.

A review of Mr. Grote's paper on the migration of the cotton moth.

A. R. GROTE. List of the Noctuidæ of North America. Bulletin of the Buffalo Society of Natural Sciences, vol. ii, 1874–'75.

On page 24, the cotton moth is entered under Hübner's name of *Aletia argillacea*, and its synonymy is given.

C. V. RILEY. The Cotton Worm. Sixth Annual Report on the Noxious, Beneficial, and other Insects of the State of Missouri, 1874, pp. 17–24.

This article has the following heads: *Paris Green; Patents on the Paris Green Mixture; Hibernation of the Insect; Natural Enemies; Range of the Insect; Other Questions.*

A. R. GROTE. The Cotton Worm, its Habitat, Means against it. Scientific American, xxxi 1874, p. 168.

A. R. GROTE, A. M. The Cotton Worm. Geological Survey of Alabama, Report of Progress for 1875. Montgomery, 1876, pp. 199–204.

An account of the natural history of the cotton worm, with arguments favoring the migration theory.

A. S. PACKARD, JR., M. D. The Cotton Army Worm, *Aletia argillacea* Hübner; *Anomis xylina* Say. Report on the Rocky Mountain Locust and other insects now injuring or likely to injure Field and Garden Crops in the Western States and Territories. [Extracted from the Ninth Annual Report of the U. S. Geological and Geographical Survey of the Territories for 1875], pp. 775–778.

A general account of the insect, compiled from Riley, Grote, and Glover.

J. CURTIS WALDO. The Cotton Worm. A Treatise on the Enemy of the Great Staple, with the Practical Experience of many of the most intelligent Planters of the South as to the means of destroying the Worm. New Orleans, 1878.

History of the cotton worm; How they look; Preventives; Jute as a preventive; Destroyers of the cotton worm.

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TOWNEND GLOVER. Manuscript Notes from my Journal,—Cotton, and the principal Insects, &c., frequenting or injuring the Plant in the United States. Washington, 1878. [A few copies printed from stone for private distribution.]

On plate x figures the cotton worm in all stages.

C. V. RILEY. The Migrations and Hibernations of *Aletia argillacea*. Read before 1879 meeting of the National Academy of Sciences.

Review of same. Washington World, May 10, 1879.

Review of same. Science News, June 1, 1879.

Review of same. Scientific American, June 14, 1879.

Reviews the different hibernation theories, and states his belief in the probable hibernation of the moth in the southern parts of the cotton belt.

C. V. RILEY. Report of the Commissioner of Agriculture, 1878. Insects affecting the Cotton Plant.

A short report on the progress made in the cotton insect investigation; embodies a report by A. R. Grote.

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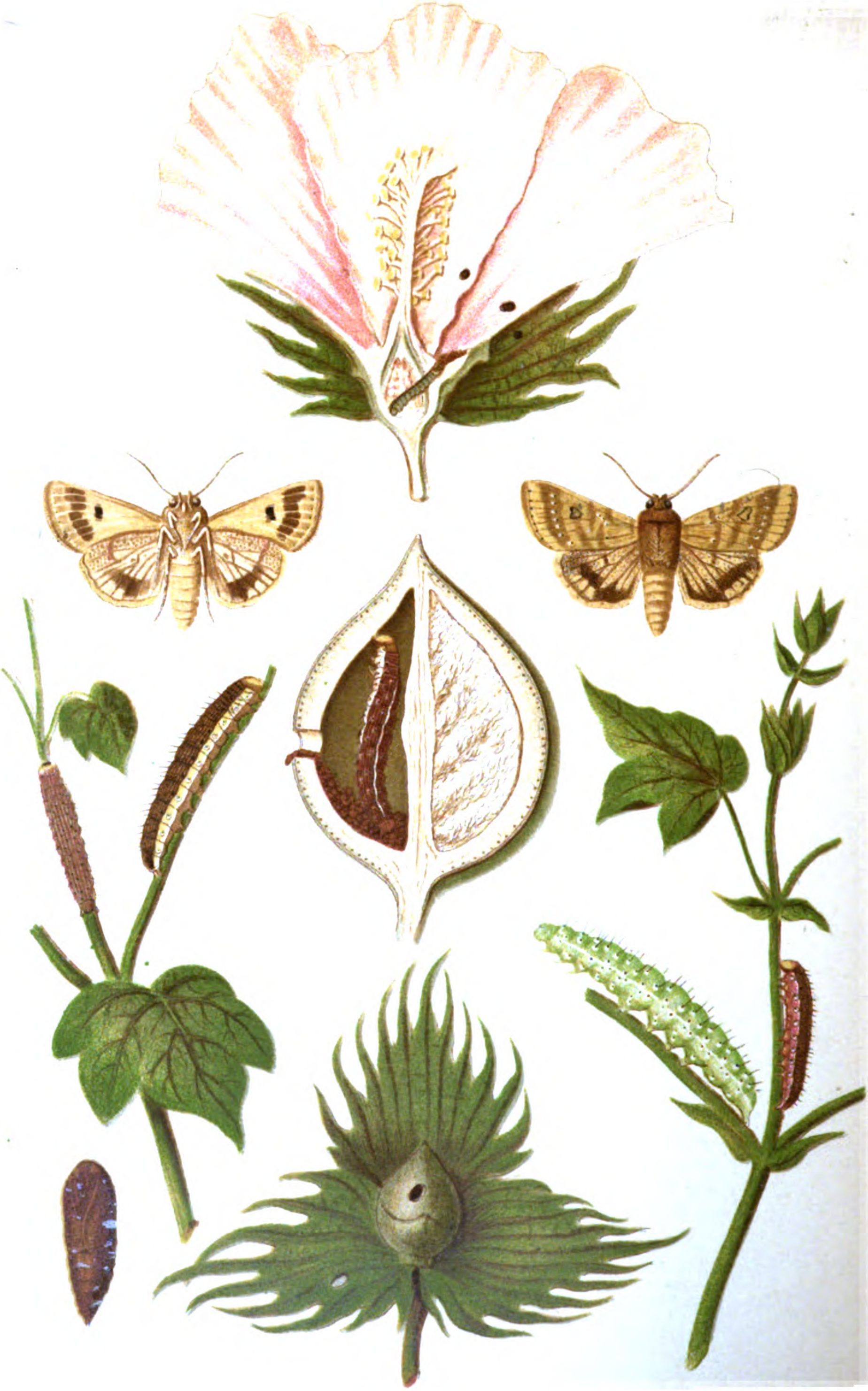

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THE BOLL WORM.

Heliothis armigera (Huebner)

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PART II.

THE BOLL-WORM.

HELIOTHIS ARMIGERA, HÜBNER.

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THE BOLL-WORM.

CHAPTER I.

IMPORTANCE OF THE SUBJECT.

Scarcely inferior to the cotton-worm in the extent of its injuries to the cotton crop is the so-called "boll-worm" (*Heliothis armigera*, Hübn.). Every year, and, it is almost safe to say, in every plantation in the whole cotton-belt this pest makes its appearance, and, although its ravages during some years are insignificant beside those of the cotton-worm, yet the *periodical* appearances of the latter, the confining of its hibernating area to the more southern portions of the cotton-belt, and its numerous parasites, all combine to render its superiority to the boll-worm as a cotton enemy very slight. There are, moreover, difficulties in the way of destroying the boll-worm—difficulties arising from its peculiar methods of work, and from the great number of its food plants—which do not exist in the case of the cotton-caterpillar, and which help to render the former as formidable as the latter. Indeed, in a large part of the cotton-belt there can be no doubt but that the boll-worm is the one by far the more to be feared. This is especially true in those more northern portions, which the cotton-worm reaches only late in the season; too late, generally, to do more than clear away the too abundant foliage, and allow the sun to ripen the bolls more quickly. Even in many parts of the more southern regions we find planters expressing the opinion that the boll-worm is the more to be dreaded of the two.

In Dallas County, Alabama, many planters seemed to believe that the boll-worm does more injury than the army worm, and they there think that there is no way of protecting the cotton from its ravages, working, as it does, within the bolls where poisons will not reach it. Mr. Schwarz, writing from Hearne, Robertson County, Texas, says: "The fields here are more injured by *Heliothis* than by *Aletia*."

An idea of the estimation in which this pest is held throughout the cotton-belt may be gained from a perusal of the following extracts from our correspondence:

There is one other insect that has destroyed more cotton in this locality within the last four years *than all other insects combined*. It is known here as the boll-worm. The moth is larger and darker than the cotton-moth and deposits its eggs by piercing the form or square at the base of the bud. The egg hatches in a few days, and the worm devours the young boll before it fairly blooms. Then it crawls upon the limb to another boll, bores in and eats out the contents, then to another, and so on until all (or nearly so) that are upon the stalk are destroyed. The habit of the moth is nearly that of the cotton-moth, but the worm does not resemble the cotton-worm in any respect.

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Its numbers are increasing so rapidly and its destruction is so great that it is becoming a terror to the cotton planters in this locality. If you know anything of this worm, and can find out some means of destroying it, you will have the gratitude of the cotton planters in this county, and probably throughout the cotton-belt.—[J. W. Jackson, Titus County, Texas.

The boll-worm (*Heliothis*) *has done more damage* this year than the *Noctua xylina.* The crop in this county is cut off at least one-third. A field of 60 acres planted by my brother-in-law, that, with no casualty, would have made 45 bales, will barely make 15, while some fields are entirely untouched. * * * In the field mentioned above we found many stalks from 6 to 7 feet in height without a single boll.—[Walter Barnes, Cherokee County, Texas.

The boll-worm (*Heliothis*) *has done more injury* to the cotton plant here than any other insect this year. Some years they do a great deal of damage. It is said by some farmers that 50 per cent. of the crop is lost on account of the boll-worm.—[J. M. Glasco, Gilmer, Upshur County, Texas.

The boll-worm is sometimes more injurious than the army worm. Though not so numerous nor so regular in its visitations, it is *far more formidable in its ravages* than the leaf-worm, since there is no way of saturating the cotton bolls with poison to destroy them.—[W. J. Jones, Virginia Point, Galveston County, Texas.

THE BOLL-WORM.—From every quarter we hear complaints of the ravages of these pests, which in a given series of years, *no doubt do more injury to the cotton than even the dreaded caterpillar.* They are unusually destructive at this time, both in the hills and bottom lands. * * * We hear very little complaint of the cotton-worm in this neighborhood.—[Louisiana Sugar Bowl, September 13, 1879, from the Shreveport Times of July 22.

The boll-worm visited the crops here early in July (during which month we had repeated rains), and has continued its ravages up to the present period. The opinion of the the planters, as well as my own, is that it has *done more damage* this year than the *Anomis* will do, though many fields are now stripped of their leaves by the latter. I regard the crop as damaged at least one-third.—[E. H. Anderson, M. D., Kirkwoodf Miss.

The boll-worm, I doubt not, *has destroyed more cotton* in Alabama than the *Aletia argillacea.*—[D. Lee, Mount Willing, Lowndes County, Ala.

I would mention the boll-worm, which bores into the boll and destroys each lobe pierced, and many think that the boll-worm is *more destructive on an average* than the caterpillar, for the reason that it attacks the cotton, more or less, every year. I have counted frequently as many on some stalks as 20 fine bolls destroyed by boll-worms. In 1847 there was no caterpillar; but the boll-worm, from written memoranda furnished me by Hon. A. C. Mitchell, of Glenville, Ala., nearly destroyed the crop, being as destructive as the caterpillar the present year.—[H. Hawkins, Hawkinsville, Ala.

A good many planters in this locality *dread it as much as they do the caterpillar.*—[Knox, Menge and Evans, Faunsdale, Ala.

It has been my opinion that the damage caused by the boll-worm is as heavy as any caused by the caterpillars.—[H. C. Brown, Camden, Ala.

I believe the boll-worm has done a *great deal more damage* in the aggregate than the cotton-worm.—[C. C. Howard, Autagaville.

The boll-worm does us, upon the whole, *more damage* than the cotton-worm.—[A. J. Cheves, Montezuma, Ga.

A brief review of the Entomological Record, prepared by Mr. Townend Glover during the eleven years, 1866–1876, for the Monthly Reports of this department, shows plainly that the damage done by the boll-worm during that space of time was not greatly inferior to that done by the cotton-worm. In that case, however, there is difficulty in estimating them comparatively, from the fact that both were indiscriminately

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reported by correspondents as "worms." The two taken together, though, form a pair capable of doing damage such as few crops beside cotton are afflicted with.

Corn is the only other crop which the boll-worm afflicts at all comparably to cotton, and, although in this article we shall consider this insect only in its relation to the cotton crop, in speaking of its importance it may be well to state the harm occasionally done to corn. One of the most marked instances was in 1860, in Kansas. It was a year of great drought, and the corn crop was almost entirely destroyed by the corn-worm. According to the Prairie Farmer of January 31, 1861, one county which in 1859 raised 436,000 bushels of corn, only produced 5,000 bushels in 1860, and this was poor and full of worms, and this seems to have been a fair sample for the State. This very season, a writer from Cherokee County, Kansas, addressed Coleman's Rural World, complaining bitterly of the destruction of the corn-worm. He states that there was not an ear in his cornfield which the worms had not eaten.

Professor Riley says:

It attacks corn in the ear, at first feeding on the silk, but afterwards devouring the kernels at the terminal end; being securely sheltered the while within the husk. I have seen *whole fields* of corn nearly ruined in this way in the State of Kentucky; but nowhere have I known it to be so destructive as in Southern Illinois.

Professor French says:

As a general thing I think it has not been so destructive during the past season as it is sometimes, but in one field of late corn I found nearly every ear eaten by them, there being from one to half a dozen worms to each ear. In many of them, when my observations were made, while the corn was yet soft, the process of molding and decay had progressed to such an extent that it was difficult to conceive that such corn could ever become anything fit for man or beast to eat.

In the Department of Agriculture Report for 1855 we find the following statement:

In an interesting communication from Col. Benjamin F. Whitner, of Tallahassee, Fla., he states that the boll-worm was scarcely known in his neighborhood before the year 1841; and yet, in the short period of fourteen years, it had increased to such a degree as to have become one of the greatest enemies to the cotton on several plantations in that vicinity.

In 1867, a correspondent from Jefferson Parish, Louisiana, stated that "the boll-worm destroys about one-half the crop with us. This year none of my neighbors raise cotton."

These instances will be sufficient to show the estimation in which the boll-worm is generally held throughout the South. The estimates of damage caused by this insect are, however, almost always exaggerated. Very many young "squares" perish from some cause; it may be from non-fertilization, from some peculiarity of the weather, or from injury caused by some other insect than *Heliothis;* but many planters attribute the destruction of all their young bolls to the boll-worm, and adduce as evidence of this the fact that a large proportion of the bolls exhibit

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on one side what appears to be a slight puncture. As I never saw any insect inflicting this injury, I am unable to state whether this impression of the planters be correct or not. Several reasons have led me to doubt it. First, it seems improbable that the young boll-worms should eat out the contents of so small a proportion of the bolls which they puncture. I have often observed from twenty to fifty of these blasted "squares" lying on the ground under a single cotton-plant, while the most patient search revealed only one or two boll-worms upon the plant. Second, the punctures referred to above differ in appearance from those which I have seen the young boll-worms make. The newly-hatched boll-worm, according to my observation, when it punctures a young boll, gnaws a hole through the pod sufficiently large to insert its head. The punctures in the blasted square appears much smaller, as if made by some haustellate insect.

The observations of Mr. Trelease upon this point were as follows:

When a flower, bud, or young boll of cotton is punctured by the boll-worm, the involucre or "square" which surrounds its base spreads open or "flares," and sooner or later the injured fruit falls to the ground. Even before the cotton commenced to bloom, many of these blasted squares were to be seen upon the ground, and in every case where the involucre had flared open I found the form punctured, though most of these punctures early in the season were very small and had no excrement in the square beneath them; thus differing from punctures formed by the boll-worm. There is no doubt that these very small perforations are made by hemipterous insects; and I strongly suspect two species, which are very common on the cotton-plant, and which have the habit of running around the stalk as you try to obtain a view of them, much as squirrels do under similar circumstances, so that they always keep the stem interposed between themselves and an observer. This shyness prevented me from verifying my suspicions, though I watched the insects a great many times. On the other hand, many blasted squares result from climatic injuries, and these may be distinguished from those caused by insects, since the square retains its normal position and form.*

Mr. Glover states that he has observed three species of Hemipterous insects pierce cotton-bolls, thus causing them to fall. The cotton *Lygaeus* (*Lygaeus sp.*) although usually carnivorous, he has seen to pierce the terminal shoots and buds of cotton. He describes it as follows:

The perfect insect is rather more than one-twentieth of an inch in length, with reddish-brown eyes, yellowish antennae, and a head and thorax black; the triangular space between the wings is black; the wings are brownish-yellow, barred in the center with two triangular black marks; the ends of wings diamond-shaped, of a light color; the upper part of the thigh is black; and the rest of the leg yellowish.

Of *Calcorus bimaculatus*, H. Schf., and *C. rapidus* Say, which he also found piercing cotton-bolls, he says:

I observed three insects (*C. bimaculatus*) when confined under glass, sucking the sap from the buds and young bolls, their only food. The young eventually completed their transformations into perfect insects. They were observed, moreover, to eject large drops of green sap from their abdomens, which could only have been procured from the buds themselves. * * * The perfect insect is seven-twentieths of an inch in length; the antennae are brown and green, the eyes brown; the thorax somewhat triangular; the anterior part green, and shaded with reddish-brown posteriorly; the

* Appendix I, report of William Trelease.

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legs brown and green; the wing-cases with a cross, shaped like the letter X, forming four triangles, those nearest the thorax being reddish-brown; the side triangles are green.

There is likewise another species (*C. rapidus*) which was found perforating the young flower buds and bolls of cotton similar to the above. The head and anterior portion of the thorax are reddish-brown, the remainder of the thorax yellow with a double mark in the middle; the wing-cases are brownish-black, with two longitudinal yellow lines from the upper outside corner of the wing-cases to the posterior edge, forming a dividing mark, somewhat shaped like the letter X.

Mr. Trelease, on several occasions, noticed a bug piercing the bolls, which, from his description, is probably *Calcoris rapidus*.

It will be but just to add that many planters appreciate the difference between the bolls actually destroyed by *Heliothis* and those destroyed by other means, as shown by the answers of several of our correspondents. Still, on the whole, it seems probable that the majority confound the various causes and put these results all down to the boll-worms' account. But even allowing for this, its ravages, it can easily be seen, are of a very grave character.

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CHAPTER II.

NATURAL HISTORY.

NOMENCLATURE.

Of popular names the boll-worm has one for almost every plant upon which it feeds and for every country which it inhabits; and as it is, as will soon be shown, almost cosmopolitan and a very general feeder, these names are many. Throughout cotton-growing States it is very generally known as the *boll-worm* when it occurs upon cotton; when it occurs upon corn it is called the *corn-worm*, and as such it is known in those Western States in which it infests the corn crop. In many Southern States it is known in the early part of the season as the *corn-bud worm*. Where found upon tomatoes it is called the *tomato-worm*. These four names are the ones by which it is best known in this country. As we shall consider it only in its relation to cotton, we shall speak of it as the boll-worm, except where it is necessary to make use of one of the other titles.

As to the scientific classification of the boll-worm moth, we may safely say that it is a near relation to the cotton-worm moth. It belongs to the same order, Lepidoptera; the same section, Heterocera; the same family, Noctuidæ; and the same tribe, Noctuæ.* Its genus is *Heliothis* of Huebner, and its specific name, *armigera*, given it by the same author.

The scientific nomenclature of this insect has suffered from the introduction of but a single synonym so far as we are aware. It was originally described by Huebner as *Heliothis armigera*. In 1863, in a paper entitled "Additions to the Catalogue of U. S. Lepidoptera," Mr. Grote described a male specimen, taken on Long Island, New York, as *Heliothis umbrosus* n. sp., attaching to the description the "observation"—

Approaches to the European *H. armigera*, which species has, however, a discal mark on the posterior wings, and is otherwise specifically distinct. It appears also from the description of *H. exprimans* Walker, C. B. M. Noct., p. 687, to have some resemblance with that species, but the expressions "(alae anticae) orbiculari et reniformi magnis ferrugineo marginatis," and "(alae posticae) litura discali," do not apply to the species I have just described.†

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* For brief characterizations of these subdivisions see Part I, Chapter I.

† The description is as follows:

"Anterior wings, yellowish-gray, crossed by several indistinct irregular darker shaded lines. Discal spot blackish, beyond which is a row of minute black dots, one on each nervule, running parallel with the outer margin of the wing and connected with each other by a faint waved line, the curvatures turned inward toward the base of the wing; fringes dark. Posterior wings yellowish-white, without markings, except a broad blackish band running parallel with the outer margin, and which is partly interrupted near the center by a space of a similar color to the rest of the wing; fringes white.

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Before 1873, however, Mr. Grote had discovered that *Heliothis armigera* was a very variable species, and that what he had described as *H. umbrosus* in 1863 was simply one of its varieties. He therefore noted the fact in the bulletin of the Buffalo Society of Natural Sciences, Vol. I, p. 120. He there says:

While a comparison of American specimens (*umbrosus*) with European individuals (*armigera*) affords me no apparently valid distinguishing characters, yet I remark that the larvae have not yet been compared. I am not yet prepared to believe that the species has been introduced from Europe, feeding, as it does here, on some peculiarly American genera of plants.

Some time previous to this, Mr. Glover had acknowledged the identity of the European and American insects in the Department of Agriculture Reports, as also had Walsh and Riley in the American Entomologist, and Riley in the Missouri Entomological Reports.

GEOGRAPHICAL DISTRIBUTION.

We shall not enter into the discussion as to the original habitat of the boll-worm, as such would necessarily prove fruitless on account of the insufficiency of the data. Mr. Grote goes on to say:

Yet, according to Guenée, its habitat is very extended, since it has been taken in Australia, where, however, it has been introduced since the colonization, and from America. It occurs apparently rarely in Europe, whereas it is here common. Has it reached Europe by a westward route from California? We shall probably soon write after its habitat—the world!

It is a suggestive fact, reflecting upon Mr. Grote's conclusion, that the earliest mention of the boll-worm in this country which we have found is 1841, whereas Huebner described the European form prior to 1825.

As above stated, the geographical range of the species is very great. Mr. Bond, at the March 1, 1869, meeting of the London Entomological Society, exhibited specimens from the Isle of Wight, Java, and Australia, and these localities, taken in connection with other parts of Europe and the United States, seem to justify Mr. Grote's prediction.

FOOD PLANTS.

For many years it was not known that the destructive corn-worm and the cotton boll-worm were the same insect. It was suspected by many before actually demonstrated, but is even now unknown to the majority of agriculturists. The first record of the identity of the two insects which we have been able to find is in the Department of Agriculture

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Under surface of the wings pale, showing the black discal spot on the anterior wings plainly, outside of which is a blackish transverse band and a small blackish streak near the upper margin. Under surface of post wings immaculate, except a faint blackish shade near the outer margin. Head, thorax, and tegulae yellowish-gray, darker than the anterior wings. Body grayish, clothed at the sides with whitish hairs and darkening towards the tip. Exp. 1¼ inches."—[Proc. Ent. Soc. Phila., vol. 1 (1861–1863), p. 219.

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Report for 1854, in an article headed "Insects infesting the cotton-plant," by Townend Glover. Mr. Glover says:

There is a striking similarity between the boll-worm and the corn-worm, in appearance, food, and habits, both in the caterpillar and perfect state, which leads to the supposition that the boll-worm may be the young of the corn-worm moth, and the eggs deposited on the young bolls as the nearest substitute for green corn, and placed on them only when the corn has become too old and hard for their food. * * * Col. B. A. Sorsby, of Columbus, Miss., has bred both insects, and declares them to be the same; and moreover when, according to his advice, the corn was carefully wormed, on two or three plantations, the boll-worms did not make their appearance that season on the cotton, notwithstanding on neighboring plantations they committed great ravages.

To Col. B. A. Sorsby, then, must be given the credit for first making this important discovery.

The next mention of the fact with which we have met is in the American Cotton Planter for August, 1855, in an article on the cotton-worm, by J. H. Zimmerman, M. D. (See bibliographical list to Part I.) Dr. Zimmerman says (p. 229):

Judging from analogy, I supposed it to be more than probable that the worm that preys on the ends of the ears of our green corn, and the buds or tassels before they come out, was the same kind or species so destructive to the cotton, and that it would be equally as destructive to the corn crops were it not for the fact that the corn matures with the first crop or generation of the worm, and before it becomes numerous by a succession of generations. This supposition proved to be correct on a further investigation. I have obtained the worm from the ears of the green corn, and have fed it on the cotton-bolls, and it would soon take on the same physical complexion and features, in every particular, of those which were obtained from the cotton.

The statement of Colonel Sorsby was repeated in the Department of Agriculture Report for 1855. In 1858, in a communication to the American Cotton Planter for November of that year, Mr. E. Sanderson says:

Now, Mr. Editor, my opinion is that I can trace the worms from the corn-fields to the cotton-fields, though I may be mistaken in this; but the first place that I can find the worm, the same species, is in the corn-fields, in the roasting-ears. I have looked and examined in every hole and corner to find where they make their first appearance, and I can find them nowhere but in the corn-fields. There they may be found in the roasting-ear, &c.

The first time that Mr. Glover recorded his belief in the identity of the two insects was in the Department of Agriculture Report for 1864, p. 554, in the following words:

The corn-worm is very injurious in several parts of the country, especially in the Middle and Southern States. * * * We have seen a similar insect, if not the same, in the Southern States, where it is known as the cotton-boll worm, and is exceedingly destructive to cotton. Moreover, we have fed the corn-worm, found on corn, on cotton-bolls, and *vice versa*, and the moths produced were identical.

Mr. Glover repeats in the Monthly Report for July, 1866:

For the sake of proving this fact, I have frequently taken the worms from unripe ears of corn and fed them entirely on cotton-bolls, as also the worms from cotton and

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fed them on corn, and in no case did the change of diet appear to affect the health of the caterpillars in the least, as they went through all their transformations in exactly the same manner, and when the perfect moths made their appearance they could not be distinguished from each other, although I may here observe that even from the same brood of caterpillars the perfect moths vary considerably in size, color, and markings.

Professor Riley, in his Third Missouri Entomological Report (1871), again states the case as follows:

The "boll-worm" has become a by-word in all the Southern cotton-growing States, and the "cotton-worm" is a like familiar term in those States, as well as in many other parts of the Union; but few persons suspect that these two worms, the one feeding on the corn, the other on the cotton-boll, are identically the same insect, producing exactly the same species of moth. But such is the fact, as I myself first experimentally proved in 1864.

The consideration of the boll-worm in corn is inseparably connected with the consideration of its work in cotton, so little more need be said here of its methods of work. In those corn States which do not grow cotton, it is greatly dreaded. Whole crops are ruined in Kansas, Kentucky, South Illinois, and Missouri, and scarcely a year passes without much damage being done.

According to Riley, there are two broods of the worms a year in those States, and very early and very late corn fare the worst, the intermediate varieties usually escaping severe injury. In seasons of protracted length, a third brood is sometimes produced, which, for want of other food, lives upon the hard kernels of well-ripened ears. Mrs. Treat has shown that an early brood in New Jersey bores into the stalks of corn, and also eats through the leaves surrounding the staminate flowers before the ears had begun to make their appearance. This would argue perhaps *three* broods a year north, making the exceptional late brood of which Professor Riley speaks a fourth. The so-called "bud-worms" of the Southern corn crop are nothing but this same early brood of *Heliothis*, having almost precisely similar habits to those observed in New Jersey by Mrs. Treat.

In the *rôle* of a tomato-worm, *Heliothis* has done a great deal of damage. In Maryland, in 1869, according to Mr. Glover, these worms did great injury to the tomato-crop, eating alike the ripe and the unripe fruit, gnawing great holes in them and rendering them unfit for market use. One worm would sometimes entirely ruin a number of tomatoes on one plant alone. Concerning this taste of the boll-worm, Mr. Riley says:

This glutton is not even satisfied with ravaging these two great staples of the country, cotton and corn, but, as I discovered in 1867, it voraciously attacks the tomato in South Illinois, eating into the green fruit, and thereby causing such fruit to rot. In this manner it often causes serious loss to the tomato-grower, and it may justly be considered the worst enemy to the tomato in that section of the country.

In the American Entomologist, ii, 172, we find the following interesting statement:

We learn from a recent number of Scientific Opinion that, at a late meeting of the London Entomological Society, Mr. Jenner Weir exhibited specimens of our cotton boll-worm moth (*Heliothis armigera*, Hübn.) which were bred from larvae which fed on

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the fruit of the tomato. As we have already shown (American Entomologist, i, pp. 212, 213), this same species attacks our corn, and does great damage to our tomatoes by eating into the fruit; and the fact of its being bred from the tomato in England, where this fruit is with difficulty grown, is interesting and suggestive.

But the tomato-worm is not confined to the fruit, as is shown by the fact that several specimens were recently sent to the department, with the remark that they were found boring into the terminal shoots of tomato plants at Macon, Ga., early in September.

Another common garden vegetable that is also injured by the boll-worm is the garden pea. We extract the following from the American Entomologist, ii, pp. 42, 43:

From the following passage in an address on insects, delivered at Vineland, N. J., by that excellent observer, Mrs. Mary Treat, of that place, and published in the Vine and Weekly of August 21, 1869, it appears that this very same larva also feeds upon the undeveloped tassels of corn and upon green pease.

"This year, green pease have been eaten into by a hateful looking worm, and a similar one ate into the staminate flowers of the corn before it tasseled out, commencing their depredations while the tassels were still enfolded in the leaves. I have examined considerable corn, and in some gardens this worm has done much damage. While feeding, it is of a green color; but when it comes to full size it turns brown, and goes into the ground to assume the chrysalis form. I already have the moths of the caterpillar that lived upon the pease, and am waiting for those that lived upon the corn to make their appearance, so that I may decide whether they are distinct species. It is a query with me what the second brood of caterpillars will live upon as green pease and untasseled corn will be out of their reach."

There can be no doubt about the identity of the moth, the larvæ of which fed upon pease, because Mrs. Treat obligingly forwarded to us in the middle of August specimens actually bred by her from green pease, which differ in no respect from the common type of the corn-worm moth. Unfortunately, she has mixed together promiscuously the moths bred by her from green pease and those which she subsequently bred from corn tassels; but at our express desire she has examined the mixed lot, and informs us that she can detect no difference of any consequence among them.

Testimony to the same effect has been given by Mr. Glover (Department of Agriculture Report 1870, p. 84) and by Mr. Riley (Third Missouri Entomological Report, p. 105). Mr. Trelease observed them eating garden pease in Alabama. A boll-worm would bore a hole into the pod and devour its whole contents before leaving it for another.

Of allied plants, the boll-worm has been observed to eat the chick-pea (*Cicer arietinum*) in Europe, the common cow-pea of the South, and the common string-bean (*Phaseolus vulgaris*), and *Erythrina herbacea*, a leguminous plant common in the South. M. J. Fallou (*Insectologie Agricole*, 1869, p. 205) records *Heliothis* as feeding upon the chick-pea. He found the young worms to feed upon the leaves and the large ones to bore into the pod. With the cow-pea, upon which Mr. Trelease found it feeding very abundantly, and in which the pod is more fleshy and the pease separated by fleshy partitions, it often pursues a different course from that which it takes with the common garden pea; it often bores into one chamber of the pod, eats the seed in it, and then, instead of cutting through the partition to reach the next, bores another hole from the outside. The same observation precisely was made concerning their habits

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when feeding upon *Erythrina*. As to the string-beans, Professor Riley records that it was found eating them around Kirkwood, Mo., by Miss Mary Murtfeldt.

This department has also received specimens of the boll-worm from D. Landreth & Sons, of Philadelphia, as quite seriously infesting fields of Lima beans. The communication accompanying may prove of interest:

PHILADELPHIA, PA., *October* 31, 1879.

SIR: By mail we send you some pods of Lima beans which have been entered, and the beans partially destroyed, by a worm new to us.

We had twenty acres growing on our New Jersey farm near Burlington, and have suffered a loss of 3 to 5 per cent.

This is the first season the worm has appeared, and we send it, trusting that your entomologist may be able to tell us something of its habits.

Respectfully,

D. LANDRETH & SONS.

Hon. W. G. LE DUC,
Commissioner of Agriculture.

The beans sent were each pierced by one hole of an eighth of an inch or more in diameter, and the contents in every case had been destroyed.

Of other useful plants which the boll-worm occasionally feeds upon we would mention pumpkins (*Cucurbita pepo*), as recorded by Mr. Glover in the Department of Agriculture Report for 1870, p. 84, and red peppers (*Capsicum annuum*), as recorded by G. H. French in the Seventh Report of the State Entomologist, of Illinois, p. 102. Mr. Glover also states that "a young boll-worm was found in the corolla of the flower of a squash, devouring the pistil and stamens."

Mr. French also records the fact of finding what he considered to be the boll-worm in the pods of *Hibiscus grandiflorus*, the large flowered rose mallow.

Mrs. Treat discovered, in the course of her observations upon *Heliothis*, that many individuals of the first brood ate into the stems of the garden flower known as *Gladiolus*, and not only into the stems but into the flower-buds also.

As regards its European food-plants, Professor Riley quotes from M. Ch. Goureau's *Insectes Nuisibles*, Second Supplement, 1865, p. 132, to the effect that it not only infests the ears of *Indian corn*, but devours also the heads of *hemp* and the leaves of *tobacco* and of *lucerne* (*Medicago sativa*).

And now let us turn to the consideration of the boll-worm on cotton.

THE EGG.

The egg of the boll-worm moth differs in form from that of the cotton-worm moth, as shown in the accompanying figure, by its much greater diameter through from top to bottom, looking, as one author aptly expresses it, "as though molded in a tea-cup, while the cotton-worm egg was molded in the saucer." The two diameters of the egg are nearly equal and are about the same as the greatest diameter of the egg of

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Aletia. In color also it differs from the egg of *Aletia*, the latter being of a delicate green, scarcely distinguishable from the leaf, while the former is nearly white and easily detected upon the plant. A noticeable feature of many of these eggs is an irregular reddish-brown band near their summits, which gradually disappears with the development of the embryo. The sculpturing of the egg is almost identical with that of the cotton-worm moth. The number of eggs laid by the female *Heliothis* must approximate pretty closely to that laid by the female *Aletia*. According to Mr. Glover, a single female boll-worm moth dissected by Dr. John Gamble, contained upwards of 500 eggs. From their greater thickness, this number of eggs would necessarily take up more room than the same number of *Aletia* eggs, and hence we find that the female *Heliothis* is more robust than the *Aletia*.

FIG. 76.—Egg of boll-worm moth.

From all accounts, the favorite ovi-positing time is at or shortly after twilight, when the moths are flying in great numbers. Concerning the place of deposit of the eggs, however, published accounts have differed. Mr. Glover says:

The egg is generally deposited singly on the outside of the involucel or outer calyx of the flower or young boll, where it adheres by means of a gummy substance which surrounds the egg when first laid, and which hardens by exposure to the atmosphere. It has been repeatedly stated by planters that the egg was deposited on the stem, and that the young stem forms the first food of the newly-hatched caterpillar; but after a careful examination of several hundred stems I found only one egg placed in this situation, and that from the fact of its being laid on its side instead of the base, had evidently been misplaced.

Professor Riley, in his Third Missouri Entomological Report follows Mr. Glover quite exactly, saying: "It is usually deposited singly on the outside of the involucre or outer calyx or young boll."

Observations made during the past two years would seem to disprove this statement of Mr. Glover's pretty effectually. I found it to be the exception that the eggs are laid upon the involucre. Although I have found them upon all parts of the plant, the majority of them seem to be deposited upon the lower surface of the leaves, as is the case with the cotton-worm eggs. I made a careful search of many plants while in the cotton-fields of Alabama, and the following note will serve to indicate the usual distribution of the eggs. "On one plant I found eleven eggs which were distributed in the following manner: one on the involucre, two on the stalks and eight on the leaves." Mr. Trelease states in his report that he found them upon the petioles and both surfaces of the leaves, and upon the outer surface of the involucre, and in a letter remarks:

I have found them upon the upper and lower surfaces of the leaves, and rarely upon the involucre. So far I have seen them nowhere else, and find that quite a percentage is laid upon the *upper* surface of the leaf.

The duration of the egg state varies with the season of the year, much as it does with the egg of the cotton-moth. We have no data as to the

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actual length of time between the laying of the egg and the time of hatching, but it probably approximates to *Aletia* in this respect, although the time may be somewhat longer.

THE LARVA.

As just stated, we have disproved the old idea that by far the majority of the eggs are laid upon calyx and involucre, and it consequently follows that the received opinions as to the newly hatched worm boring immediately into the boll or flower-bud must also be thrown aside. The worm after gnawing through its egg-shell makes its first meal upon the part of the plant upon which the egg was laid, be it leaf, stem, or involucre. Should it be laid upon the leaf, as is usually the case, it may be three days before the worm reaches the boll. Should they be laid upon the involucre, the young worm bores into the boll at an earlier date. Mr. Glover publishes what seems to be a phenomenal instance as the normal one. He says:

> A boll-worm which was bred from an egg found upon the involucre or "ruffle" of a flower-bud grew to rather more than a twentieth of an inch in length by the third day, when it shed its skin, having eaten in the mean time nothing but the parenchyma or tender fleshy substance from the outside of the calyx. On the fifth day it pierced through the outer calyx and commenced feeding inside. On the sixth day it again shed its skin, and had increased to about the tenth of an inch in length. On the tenth day it again shed its skin, ate the interior of the young flower-bud, and had grown much larger. On the fourteenth day for the fourth time it shed its skin, attacked and ate into a young boll, and had increased to thirteen-twentieths of an inch in length. From this time it ate nothing but the inside of the boll, and on the twentieth day the skin was again shed and it had grown to the length of an inch and one-tenth, but, unfortunately, died before completing its final change.

The extreme slowness of growth during the first six days is evidently a mistake on the part of Mr. Glover in measurement, and, as such, should here be corrected. He makes the larva at the end of six days and after two molts one-tenth of an inch in length, whereas, according to our measurement, it is usually nearly, if not quite, that length upon emerging from the egg, and at the end of six days has attained a very respectable size. The reason for quoting this paragraph was not only to call attention to the mistake, but also to show the length of time which a worm may, under certain circumstances, feed upon the *outside* of a boll before piercing to the inside. As a rule, we may safely say that where the egg is laid upon the involucre the worm pierces through within twenty-four hours after hatching.

The newly-hatched boll-worm walks like a geometrid larva or looper, "a measuring-worm," as it is often called. This is easily explained by the fact that, while in the full-grown worm the abdominal legs or prolegs are all nearly equal in length, in the newly-hatched worm the second pair is slightly shorter than the third, and the first pair is shorter and slenderer than the second, a state of things approaching that in the full-grown cotton-worm, though the difference in size in the former case is

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not nearly so marked as in the latter. This method of walking, the worm loses with its first or second molt. There is nothing remarkably characteristic about these young larvae. They seem to be somewhat thicker in proportion to their lengths than do the young cotton-worms, and they have not so delicate and transparent an appearance. Their heads are black, and their bodies seem already to have begun to vary in color. The body above is furnished with sparse, stiff hairs, each arising from a tubercle. I have often watched the newly-hatched boll-worms while in the cotton-fields. When hatched from an egg which had been deposited upon a leaf, they invariably made their first meal on the substance of the leaf and then wandered about for a longer or shorter space of time, evidently seeking a boll or flower-bud. It was always interesting to watch this seemingly aimless search, the young worm crawling first down the leaf stem and then back, then dropping a few inches by a silken thread, and then painfully working its way back again until at last it found its boll or bud, or fell to the ground, where it was destroyed by ants.

Mr. Trelease was instructed to report upon the point of the eating of the leaves by the young larvae, and the following is the report of his observations:

Very soon after its exclusion, the young larva begins to feed upon the substance of the leaf or bract, or other organ on which it finds itself; and when this chances to be a leaf or bract, it leaves the epidermis on the other side for some time. During the first half day or day of its existence it feeds in this way, forming small, irregular, transparent spots in the blade of the leaf or in the bract, after which it pierces a hole—usually more rounded than that first formed by *Aletia*—through the organ. The age at which this is done appears, from my observations, to be earlier than that at which the caterpillar pierces the leaf; but I find that it differs greatly with different individuals, some piercing the leaf when less than ten hours old, some not until they are about two days old. After this, if it does not find itself close to a flower-bud, immature fruit, or some other object suitable for its food, the larva moves about in search of this food; finding which, it shortly goes to eating. Whatever may be its food, this worm, according to my observations, always forms regular, round openings in its exterior for its own entrance or exit; and these vary in size with the size of the larva, being just large enough to allow the animal's body to pass with ease. Another peculiarity of this larva is its wandering character, especially earlier in the season when feeding on the flower-buds or forms of cotton; for these, being small, the contents of each is soon eaten by the worm, which necessarily moves on in search of more food.

We may safely say, then, that the young larvae feed for a longer or shorter space of time upon the part of the plant on which they are born, but migrate sooner or later to flower-bud or boll. That the worm may occasionally attain full growth, having fed upon the leaves alone, is shown by the fact that Mr. Trelease, on May 30, found a partly grown boll-worm feeding upon the leaves of cotton. At this time, the forms were very few and very small. Comparatively early in the season, when feeding upon buds or small bolls, a single worm often does a great

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amount of damage, proceeding from bud to bud or from boll to boll. Mr. Glover says:

The pistils and stamens of the open flower are frequently found to be distorted and injured without any apparent cause. This has been done by the young boll-worm. When hidden in the unopen bud, it has eaten one side only of the pistil and stamens, so that when the flower is open the parts injured are distorted and maimed, and very frequently the young flower falls without forming any boll whatever. In many cases, however, the young wo rm bores through the bottom of the flower into the immature boll before the old flower falls, thus leaving the boll and involucre, or envelope, still adhering to the foot-stalk, and the worm safely lodged in the growing boll. The number of buds destroyed by this worm is very great, as they fall off when quite small, and are scarcely observed as they lie brown and withering on the ground beneath the plant. The instinct of the boll-worm, however, teaches it to forsake a bud or boll about to fall, and either to seek another healthy boll or to fasten itself to a leaf, on which it remains until it has shed its skin, when it attacks another boll in a similar manner, until at length it acquires size and strength sufficient to enable it to bore into a nearly matured boll, the interior of which is entirely destroyed by its attacks, as, should it not be completely devoured, rain penetrates through the hole made by the worm and the cotton soon becomes rotted and will not ripen. These rotted bolls serve also as food or shelter for numerous small insects. One thing is worthy of observation, and that is, whenever a young bud or boll is seen with the involucre or outer calyx (by some called the "ruffle") spread open, and of a sickly yellow color, it may be safely concluded that it has been attacked by the boll-worm and will soon perish ish and fall to the ground. When the bolls are older they remain adhering to the plant. If many of these "forms" or buds lying on the ground are closely examined, the greater portion of them will be found to have been previously pierced by the boll-worm; some few exceptions may, however, have been caused by the minute punctures of plant bugs, by rains, or adverse atmospheric influences. The buds injured by the worm may be readily distinguished by a minute hole where it has entered and which, when cut open, will be found partially filled with small black grains, something like coarse gunpowder, which is nothing but the digested food after having passed through the body of the young worm.

The destruction of the essential parts of the flower before the boll proper is formed, which is spoken of in the quotation, is sometimes as great a source of loss as the destruction of the maturing bolls. The two following extracts from the notes of one of the observers bear upon the point:

August 1.—Several *Heliothis* larvæ found in opened white flowers, having perforated the petals, and being engaged in eating the anthers and stigma. The larger ones had eaten all but the staminal tube and the inclosed style and ovary, and even this tube was pierced at the base. * * *

August 4.—*Heliothis* larvæ of a reddish tinge and 1 to 1.3 cm. in length are quite abundant on boll-flowers and unopened buds. The latter they pierce, and thus cause the involucre to flare and the bud to fall. The former are observed to have round holes eaten in their petals, and in several cases the stamens were entirely eaten out.

In one case, a nearly full-grown green larva was found in a flower through which it had pierced near the base (calyx and corolla) a hole 4 mm. in diameter. Within, it had eaten off stamens and stigma, leaving the staminal tube and its inclosed style and ovary.

It is quite a common sight to see these large green or pink worms in the flower, as also the younger individuals, the latter, however, usually having penetrated the bud and forced the premature blossom.

As the boll-worms increase in size, a most wonderful diversity of color and marking becomes apparent. In color, different individuals will vary

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from a brilliant green to a deep pink or a dark brown, exhibiting almost every conceivable intermediate stage, and from an immaculate, unstriped specimen to one with regular spots and many stripes. The green worms are more common than those of any other color; but those of varying shades of pink or brown are so abundant as to make it impossible to fix upon a type. Early in the season, as will be hereafter shown, the prevailing color is green. A common variety is light green in color. Running from the first ring back of the head to the posterior end of the body on each side is a broad whitish line; just above is a broad dusky line; down the center of the back is another dusky line, or stripe, as it should preferably be called; this dorsal stripe has a narrow white line down its center, and it is bordered on each side by a narrow white line. Between the dusky dorsal and lateral stripes run four or five very faint, wavy, longitudinal, white lines, so faint as not to interfere with the general color of the body. Each body-ring has eight black spots, which, upon being examined with a lens, are seen to be tubercles, each with a stiff hair upon its tip. These spots are arranged in two transverse rows of four, the spots in the front row being slightly closer together than those in the back row; the outer spot of the back row is small and placed nearer the front row.

Of these features the most constant seems to be the whitish stripe on each side. When the boll-worm is brown these stripes assume a yellowish hue. They are shown in all illustrations of the boll-worm yet published, and are present in all specimens in the department collection. Another pretty constant feature is the relative position of the tubercles just described. They are not always of a contrasting color to the rest of the back, and hence cannot always be spoken of as spots. When they are not discernible as spots, however, an examination with the lens shows them still present as tubercles, each surmounted by a hair. This point affords apparently a good and reliable means of distinguishing the young boll-worm from the young cotton-worm, which otherwise might prove a matter of difficulty during the earlier stages and in the early part of the year, before black cotton-worms are to be found. In the cotton-worm the two middle spots of each of the two rows of four are of the same distance apart, so as to form the four corners of a rectangle. In the boll-worm, however, the two middle spots of the hind row are more widely separated than the corresponding spots of the front row. This distinction may be recognized at a glance, when the eye has become accustomed to it. The dusky dorsal stripe is often wanting, as also are the dusky lateral stripes, and, as just stated, the spots are often indiscernible.

Mrs. Treat seems to have noticed a uniformity of color as between individuals of the same brood, and a diversity as between those of different broods. She says:

I did not think that this green larva that eats into the pease and stalks of corn, before the latter are half grown, was, as you inform me, this same striped boll-worm that eats into the ears of corn. * * *

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Such uniformity depending upon brood, or diversity from diversity of brood or food-plant, can by no means be laid down as a rule. The early brood, however, seems to consist almost entirely of green individuals, and those feeding upon other plants than corn and cotton are more usually green also. The pink individuals are more common upon cotton and the roasting-ears of corn. As Mrs. Treat has stated, a green worm may turn brownish after the later molts, but *half*-grown brown worms are very abundant in the bolls of cotton. In this connection, Mr. Glover states:

These variations of color are not easily accounted for, as several caterpillars changed color without any apparent cause, being fed upon the same food and in the same box with others. Several planters assert that in the earlier part of the season the green worms are found in the greatest number, while the dark brown varieties are seen later in the autumn, as we know is also the case with the caterpillars of the cotton-worm.

As already noted in Chapter VI, of Part I, the larva of *Heliothis* has one redeeming character in its occasional cannibalistic and predaceous turn of mind. Boll-worms, when in confinement, have the habit, in common with other lepidopterous larvae, of devouring one another. All through the past summer larvae were being sent to the department from the South, but whenever more than one boll-worm were mailed in the same box, one only would reach us alive, all the others having been destroyed. This was the case even when the box was filled with cotton-leaves and bolls or corn-leaves. It might, however, be said that the food dried up on the journey, and that hence they were driven to destroy one another; but the fact is that even when confined in breeding cages, where fresh food was always at hand and where the conditions were made as natural as possible, they seemed as hungry as ever for their companions, and it was impossible to rear more than one in the same box or cage.

Still more conclusive, however, and of extreme interest, is the fact that Mr. Trelease actually saw, upon several occasions, on the plant and undisturbed, large boll-worms catch smaller ones, which they devoured "hoof and hide," or simply pierced the skin with their mandibles so that the juice could be sucked, the refuse being dropped.

In addition to this we have the fact fully established during the past season that the boll-worm, in a state of nature, preys more or less frequently upon the chrysalis of the cotton-worm. We have already quoted, in an earlier part of the report, Mr. Trelease's observations upon this point, but it seems eminently proper that they should be repeated here:

Owing to its tough integument, the pupa of *Aletia* seems to be freer from insect attack than the larva is, yet even its hard skin does not always save it. About the middle of August I first noticed what appeared to be an anomalous preparation for pupation in the boll-worm (*Heliothis armigera*), for I found several full-grown larvæ of this species with leaves closely webbed around them, precisely as *Aletia* webs up before changing to a pupa. An examination of one of these leaves, however, showed me that the boll-worms had not webbed them about themselves, but had insinuated

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themselves into leaves folded and pre-occupied by *Aletia*, the latter having already passed into the pupa state, and they had done this for the express purpose of feeding on these pupae. *Many cases of this sort were seen.*

In the specimens sent to the department, the full-grown boll-worm was found entirely within the folded leaf and the hind end of the body of the chrysalis was eaten into; and it certainly would be difficult to account for this on any other grounds than those taken in the quotation. We find also in the same report the following:

No lepidopterous enemies of *Aletia larvae* were observed by myself, but Dr. Lockwood, of Carlowville, Ala., says that a number of years ago he saw a large green larva devouring numbers of cotton-caterpillars. From what we know of the habits of the boll-worm (*Heliothis armigera*) it seems not unlikely that these larvæ may have belonged to that species.

Judging from the data at hand, the duration of the larva state of *Heliothis*, or, in other words, the *worm* state, seems to vary from eighteen to twenty-four days in the cotton-belt, depending much upon the climate, the state of the weather, and the food plant. When full-grown it transforms to a chrysalis, with very different preliminaries from those which prepare the cotton-worm for pupation.

THE CHRYSALIS.

Almost all of the statements regarding the pupation of the boll-worm have been to the effect that the full-grown worm descends into the ground to the depth of several inches, and there forms itself an oval cocoon of gravel and earth, cemented together by its gummy silk.

Prof. G. H. French, of Illinois, has studied the chrysalis of *Heliothis* carefully of late, and sums up his observations as follows: *

In digging for the chrysalis around the corn-hills, I found that instead of their occupying an oval earthen cocoon, as has usually been written of them, and as they apparently do in the breeding box, they were down in the ground from five to six inches below the surface, in a hole about a third of an inch in diameter, reaching from the chrysalis to the top of the ground, where it was covered with a thin film of dirt from an eighth to a quarter of an inch thick. This hole was larger at the bottom than at the top, apparently so as to give full motion to the chrysalis, and usually bent in its course, so the lower part would have an inclination of perhaps forty-five degrees. At the bottom would be found the chrysalis, the small end downward and the head upward. In one case I found the hole so bent that the chrysalis occupied a horizontal position. The hole was smooth inside, and was, perhaps, made so by cementing the earth together, but of that I could not tell, for the whole ground was moist, though dry enough to be firm.

In reference to these observations of Professor French, Mr. Trelease says, in a recent letter:

In deep breeding-jars, with four or five inches of loose soil, I found that the larvæ of *Heliothis* went several inches from the surface before forming their cocoon, but did not notice a passage leading down. As I did not notice very closely, such a tube may have been there, but I think if so I should have seen some trace of it. In all cases there was a thin film of silk. In the field I saw numbers plowed up, but did not dig for any with care. Of course the plowing would have destroyed such a tube, but I sometimes found the silk about the pupa, though always more or less torn.

* Seventh Report of the State Entomologist of Illinois, 1877, p. 105.

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The rearing of boll-worms at the department would seem to show that in loose, friable earth the passage made by the worms in their descent becomes obliterated by the falling together of the earth behind them; but it seems probable that, in compact soil, any larva entering the ground would leave a round passage behind it. A thin film of silk has always been noticed lining the cell in which the chrysalis is found.

In addition to the prominent distinguishing point that the chrysalis of *Aletia* is invariaby found only above ground, and is normally found in rolled leaf and slight cocoon, while the chrysalis of *Heliothis* is invariably found only below the surface of the ground, normally in a smooth shell, lined with a thin film of silk, it may be well to mention the characteristic points which distinguish the chrysalides themselves.

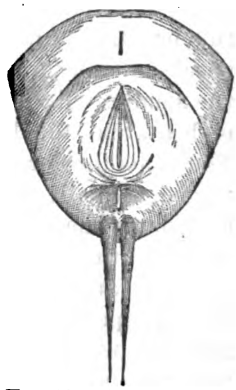

FIG. 77.—Posterior end of chrysalis of *Heliothis* from below.

The pupa of *Heliothis* is reddish or light brown, and polished, and the pupa of *Aletia* dark brown, sometimes almost black, with the lower margin of the abdominal rings, 4 to 6, of a reddish-yellow or saffron color; it is not polished, but has a greasy appearance. The pupa of *Heliothis* is rather stout, and the last segment is rounded and furnished with two slender, straight spines. The pupa of *Aletia*, contrary to this, is quite slender, especially the abdomen; the last segment is not rounded, and its tip is prolonged into a tail-like appendage, which bears at the tip 4 spines, the ends of which are curved so as to form a loop; four similar spines are placed transversely in a row, a little in front of the terminal 4 hooks; this makes eight spines for *Aletia* and only two for *Heliothis*; the stigmata or breathing-holes are rather conspicuous on the pupa of *Heliothis*, and sccarcely noticeable on the pupae of *Aletia*.

We insert a detailed description of the chrysalis of the boll-worm, for the benefit of those interested:

Heliothis armigera.—Pupa: Length, about 20^{mm}; color, reddish brown, darker towards the head; polished. The following particulars will be noticed when examined under the microscope: the head, which narrows in the region of the maxillæ to a rounded, somewhat elevated ridge, is covered with minute and rather indistinct granulations, and has near the front a few shallow, transverse, impressed lines, which, however, do not entirely cross from one side to the other; there are also a few irregular impressions on the head behind the eye, and about midway between the posterior angle of the eye and the posterior margin of the head is an impressed puncture from which a very short stiff hair arises, and another shallow impression somewhat in the shape of a V may be found at the middle near the posterior margin; the sculpture of the thoracic segments is somewhat different from that of the head; the whole surface is closely and very finely faceted, and quite a number of irregular, shallow, impressed transverse lines run over the whole surface; the 3d ring is very much wrinkled; the surface of the abdominal rings is similarly sculptured; the front margin of rings, 4–7, is coarsely punctured; the 4th has only few of these punctures, but on the other three rings they are quite numerous around the whole margin; the front portion of these punctures is deep, and they run out posteriorly more or less into a shallow, channel-

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like impression; the posterior margin is covered quite regularly with slightly elevated, darker brown granules of different forms; some are square, others five, and others six-sided; the other rings, except the last, have nothing peculiar in their structure; the last segment is bluntly rounded, and furnished at the ends with two quite long, black, slender spines, which at their apical third are whitish, faintly bent upwards, with their tips sometimes slightly twisted and directed downward; ventrally, this ring and the one before it have each a short, longitudinal impressed line; the circumference of the stigmata is elevated, dark brown, with the center of a sandy color and spongy texture; the cases of the wings, legs, and antennæ are covered with shallow facets.

THE MOTH.

After the figure of the moth on Plate II, an additional extended description will be unnecessary. It is a very variable species, and it is owing to this fact that American specimens were so long considered to form a species distinct from the European. In size the variation is not great, the smaller individuals having an expanse of wing of an inch and three eighths, and the larger ones expanding an inch and three quarters. The general color of the body and upper wings varies from a light gray tinged with olive green to a rich yellow gray, almost tawny. In some specimens the markings of the fore wings are almost obliterated, and in others they appear with great distinctness. On the hind wings there is much variation in the size of the light spot within the dark band; in some specimens it is not discernible, and in others its length equals half the breadth of the wing. The width of the black band of the posterior wings also varies greatly. The moth is so very different from *Aletia* that even a hasty glance at the plates will enable the planter to distinguish them. The most prominent distinguishing feature, and one that can be recognized at a glance, is the broad black band on the hind wings of the boll-worm moth. When at rest the latter does not tightly close its wings roof-shaped over its back, as does the cotton-worm moth, but holds them slightly open, so that the black band is plainly seen.

The moths begin to fly shortly after sundown. During the day, when disturbed, they fly out with the quick darting motion peculiar to most noctuids under such circumstances—a flight almost precisely like that of the cotton-moth. At night, however their flight is freer and more sustained. As has been noted of the adult *Aletia*, these moths feed at night upon the nectar secreted by the glands of the cotton-plant, the cow pea, the greater coffee-weed, and probably upon others. Their methods of feeding are almost precisely like those of the cotton-moth, the antennae being kept in constant vibration. They also, upon occasion, hover before a gland, steadying themselves by their fore legs. When at rest and sucking nectar, they do not, as before stated, fold the wings like *Aletia*, but keep them slightly raised and partly open. We have not heard of this moth being found to feed upon fruit as *Aletia* does, though it is probable that this may occur, as the tip of proboscis is spined in a somewhat similar manner.

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THE NUMBER OF BROODS.

The chrysalis of the boll-worm usually gives forth the perfect moth in early May in the more southern portions of the cotton-belt. The eggs of these first moths are for the most part laid on the leaves of corn, though occasionally one is deposited upon the just-appearing cotton plant, and others are laid upon the other food-plants to be found. By far the greater majority are laid upon the corn leaves; and it is a rare occurrence to find a boll-worm upon cotton in the months of May and June. The individuals of this first brood of *Heliothis* upon corn are called, in many parts of the South, "terminal bud worms," the reason for which will shortly be shown.

The newly hatched larvae begin feeding at once upon the corn leaves upon which they were born, and gnaw many small irregular holes through them, giving them the appearance of having been riddled by a charge of small shot. Upon these external leaves of corn they may be found for some time, specimens upwards of half of an inch in length having been collected May 21. As they increase in size they progress downward into the closely folded leaf and, sooner or later, reach the tender terminal leaves or bud, where they do a very destructive work.

The plants thus infested may be readily recognized by the riddled appearance of the larger leaves. When such a stalk is found, if the leaves, beginning with the outermost, be stripped off nearly to the bases of their sheaths, a quantity of brown, dry excrement will be found, increasing in quantity as the center of the plant is approached, until at last the usually pale green worm is reached, either within the sheath of a leaf or in a cavity eaten into the closely rolled terminal leaves. When full grown, it gnaws a circular hole through the leaves directly outwards from the point where it has been feeding and falls to the ground, where it transforms to a chrysalis, as before described.

It is difficult to estimate the usual amount of damage done by the first brood, as it differs so much in different localities. It seems, however, never to be alarmingly great, on account of the comparatively small numbers. Observations on a small scale in Alabama showed about one plant in forty to be infested by them.

The second brood makes its appearance in Alabama from the first to the middle of June. The eggs are, as before, for the most part laid upon the corn leaves. Some few are laid upon cotton—more, usually, than is the case with the first brood. The young larvae feed upon the leaves as before and upon the tassels. As they approach full growth they are found within the young ears, feeding upon the silk, the milky kernels as fast as they appear, and upon the tender cob. Upon reaching full size they bore through the shuck and fall to the ground. The moths of this second brood may be seen flying in considerable numbers in the early part of July.

It is the next, the third brood proper, which does most damage to

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corn. This is called the "corn-worm," the "ear-worm," the "tassel-worm." About the 1st of July the eggs are laid, probably near the end of the husk of corn. Very few eggs are laid upon cotton growing in the same field. The larvae feed upon the silk and tender grains near the ends of the ears, destroying many ears and rendering many others unfit for use. It is a noticeable fact that, while the individuals of the two earlier broods have for the most part varied little in color, being chiefly of a pale green, this third brood consists of worms of the various shades of green, pink, and rose. These larvae attain full growth probably in the shortest time of any of the broods, and boring through the husks fall to the ground to pupate as before.

By the 1st of August or thereabouts, when the time for a fourth brood has arrived, the ears of corn have begun to harden, while cotton bolls and forms are very plentiful. Instinct teaches the moths of the third brood to lay their eggs upon cotton instead of upon corn as their parents have done. We have mentioned the fact that a few worms are to be found upon cotton previous to this time. An occasional individual will be found to have attained his growth on cotton in May, before a flower-bud has appeared, and which has evidently fed entirely upon cotton leaves.

Mr. G. W. Hazard, of Rutledge, Ala., makes the statement: "Bud-worms injure the cotton while very young, in cool wet springs, generally in the last of April and through May."

Mr. Trelease found the first larvae eating the flower-buds or forms as early as June 11; but very few were found from this time on until the appearance of the fourth brood upon cotton, thus demonstrating plainly that a corn diet is much preferred so long as certain tender portions can be obtained.

The habits of this fourth brood have already been given in the general remarks concerning the boll-worm upon cotton. It is by far the most destructive brood. About the 1st of September the moths of this brood are to be seen in great numbers at night sucking the nectar of cotton, cassia, and cow-pea.

The fifth brood begins early in September, and is also confined to cotton. In all but the most southern portions of the cotton-belt this brood appears normally to be the last, its chrysalides living through the winter in their underground cells. With an exceptionally fine season it seems probable that there may be another brood, but upon this point we have, as yet, no evidence.

These remarks upon the number of broods are made from observations the present year in Central Alabama, and the following facts must be taken into consideration: that the observations were limited geographically to a single point, central, it is true, but were unconfirmed by observations from other points. Moreover, 1879 was by no means a bad worm year. From opposite extremes of the cotton-belt we should expect to find variation in opposing directions from this as an average. In

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years when the worms were very numerous we should expect to find them infesting cotton at a period earlier than that which we have designated, and where corn is not grown in the vicinity, they probably feed upon cotton from the first appearance of the flower-buds. These points will account for the fact of the frequent *early* reports of the ravage of the boll-worm in cotton.

The same difficulty also arises in ascertaining the precise number of broods of the boll-worm that was found with the cotton-worm. Some moths issuing from winter quarters later than others, or failing so soon to find a suitable place of deposit for their eggs, will lay their eggs later than others. Some larvae, moreover, may, by surrounding circumstances, fail to develop as fast as others. These and other points combined start an irregularity of the broods, the tendency of which is to continually increase rather than to diminish, until in the later generations upon cotton we may find them in all four stages at once—eggs, larvae of all sizes, chrysalides, and moths. The number and relative appearances of the broods normally, however, we believe to be that which we have given.

The boll-worm disappears in the fall before the cotton-worm does. Mr. G. W. Smith-Vaniz, of Canton, Miss., gathered eggs from one of which a larva hatched August 30. It became a chrysalis September 22, and passedthe winter in this state, issuing as a moth May 14. Another brood of the cotton-caterpillars was reared after this boll-worm went into winter quarters.

In his Third Missouri Entomological Report, p. 107, Professor Riley makes the statement:

> Most of the moths issue in the fall and hibernate as such, but some of them pass the winter in the chrysalis state and do not issue till the following spring. I have known them to issue, in this latitude (38½° N.), after the 1st of November, when no frost had previously occurred.

It may be true that *Heliothis* occasionally hibernates as a moth. No instance of such hibernation has, however, come under our notice, nor do we find any other statement of this fact than this of Professor Riley's, just quoted. It is certain that the insect normally hibernates in the chrysalis state, and that if a hibernating moth is found it is an exceptional occurrence.

Many of the noctuidæ hibernate as moths, and some, as, for instance, the army worm of the north (*Heliophila unipuncta*, Haworth), are supposed to winter either in the moth or chrysalis state. The latter point is not yet definitely settled, however, and even if it were it would simply create a precedent, not necessarily a probability, in favor of a dual hibernation of *Heliothis*.

INFLUENCE OF WEATHER.

It seems to be a pretty generally-settled point among planters, so far as we can ascertain, that the boll-worm is influenced by the weather in a similar manner to *Aletia;* that is to say, that they flourish best in wet

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seasons, and in dry sunshiny weather do least damage. The testimony on this point is hardly as unanimous as with the cotton-worm, but it is sufficiently so to enable us with justice to make the general statement. As to the causes which produce this result, we can do no better than to refer the reader to the discussion upon this point in chapter V of the previous Part. Mr. Trelease says in this connection:

Like the cotton-caterpillar, the boll-worm is more abundant in wet than in dry places; at least, such was my experience, and it is also said to do better in wet than in dry seasons. This is readily explained by the hostility of ants, which are more abundant in dry than in wet places, and in fair than in rainy seasons.

Early in June several half-grown "bud-worms" were collected on Indian corn and transferred to cotton-plants with a view to watching their actions. Care was taken to place them upon plants on which there were no ants. Seating myself beside them, I awaited developments. At first they evinced no desire to do more than conceal themselves beneath the leaves from the glare of the sun. But it was not long before a stray ant appeared on the plant, and, finding the larva, proceeded to run round and round it, biting it whenever it could.

Soon, however, finding that unaided it could do little, the ant left the plant, and, after watching it a short time, I lost sight of it; but in a few minutes it returned accompanied by several others of the same species. In a little while the worm was so worried that it fell from the plant, and was soon killed and carried off by its tormentors, which followed it to the ground.

Several times I saw this repeated, the boll-worm being killed in each case within an hour after the time when they were placed on the cotton. The black ant was also seen to kill these larvae upon several occasions, and once or twice when the worms had not been interfered with by me.

Mr. Lyman, in Department of Agriculture report for 1866, says that many eggs of the boll-worm moth are destroyed by ants.

The theory of the ants influencing the comparative abundance of worms in wet and dry weather is, as we have said before, an extremely plausible one if its basis be correct. There cannot be the slightest doubt but that ants abound upon dry soil rather than upon that which is moist, and in dry, sunshiny weather rather than in rainy weather; nor can there be the slightest doubt but that many species destroy both cotton and boll worms. Then the theory will hold just so far as this destruction goes—just to the extent that the ants kill the worms. The fact that there is a slight difference of opinion as to the influence of the weather can then be easily explained by the comparative abundance of ants in different localities. The theory does not, however, entirely account for facts as observed, but will have to be taken in connection with the nectar-gland theory, as put forth in Part I, and also with the facts of the superior nourishing power of a tender and succulent plant, as compared with one dry and dwarfed from drought.

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CHAPTER III.

REMEDIES.

NATURAL REMEDIES.

The remarks made in Chapter VI, of Part I, concerning the efficacy of insectivorous birds and of predaceous insects will apply equally well here. Strange to say, but one parasite upon Heliothis has been found. This was bred from a chrysalis received September 15, 1879, and proved to be *Tachina aletiae*. (See Chap. VI, Part I.)

Professor Riley, in a foot note in his fourth Missouri report, mentions *Heliothis armigera* as being among the species from which he had bred *Tachina anonyma*. (For the habits of the Tachina flies see Chapter VI, Part I.)

As to actual observations upon birds, Mr. Glover says:

Insectivorous birds also serve as very useful agents in the diminution of the boll-worm. In proof of this fact I will state that I have seen a king-bird, or bee-martin, chase and capture a boll-worm moth not ten paces from where I stood, and which I was in pursuit of at the same time; also, that some young mocking-birds, kept in their nest near an open window, were fed daily by their parents with insects, among which were quantities of the boll-worm moth, as was proved by the ground underneath being strewn with their dissevered wings.

It will be well to reconsult the list of birds given in the chapter above referred to in this connection.

As to predaceous insect enemies, we have just referred in the last chapter to the most effective—the ants—and further discussion will be unnecessary. Of the others, those doing most good will probably be the wasps, the asilus flies, the devil's coach-horses, the lady-bird larvae, and the golden-eyed lace-wing fly larvae. The ground-beetles will play a more important part, in all probability, in destroying the boll-worms than they do in destroying the cotton-worms, on account of the former descending into the ground to pupate.

Mr. Glover gives an account of a spider which is said to destroy the boll-worm, in the following words:

Another description of a small spider, about the tenth of an inch in length, of a light drab color, with two or more dark spots on its back, was found very numerous inside of the involucre or ruffle of the cotton-bloom, where it is said to be useful to the planter in destroying very young boll-worms. In many cases, where the eggs of the boll-worm moth had been deposited and hatched out, and the young worms had eaten through the outer calyx and already pierced a hole in the young bud or boll, it was frequently observed that no worm could be discovered inside; but, upon opening such a ruffle, this small spider was almost invariably found snugly ensconced in its web; hence it was surmised that the young worm had entered between the ruffle and the boll or bud, and had been destroyed by the spider, the nest of which was found in such situations.

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ARTIFICIAL REMEDIES.

TOPPING.—Topping the cotton at a certain time of the year has been urged as a means of destroying the eggs both of the cotton-worm and and boll-worm moths. It has already been shown that this would not prove efficacious as a remedy for the cotton-worm, and the result would be the same with the boll-worm. It is true that some eggs would be destroyed in this way, but actual count has shown that the destruction of those eggs which are deposited upon the upper part of the plant would not pay for the labor of topping.

POISONING.—It has always been said that the strong point of the boll-worm lay in the fact that it worked within the boll where no poison could reach it, and that this method of destruction would prove of no avail. Our study of the habits of the insect has shown us, as before stated, that by far the greater number of the eggs are laid upon the leaves, and that the newly-hatched larvae, before migrating to flower-buds or bolls, almost invariably feed to a greater or less extent upon the leaf where they were born. This shows, then, that a well-distributed poisonous mixture would, in all probability, destroy great numbers of the young worms. Observation has also shown that well-grown boll-worms, migrating from boll to boll, are also frequently killed by eating poisoned leaves. There is, then, a double reason for poisoning worm-infested cot ton. The proper time for poisoning for the boll-worm, in regions where there is reason to suspect an extensive migration from corn to cotton, is a few days, say a week, after the full-grown worms are found in the hardening ears of corn, or when the moths are observed to fly abundantly after the ear has begun to harden. The poisoning for the third brood proper of the cotton-worm and of the boll-worm may be done simultaneously.

Inasmuch as an extended discussion of poisons and methods of applying has been given in Chapter VII, of Part I, any remarks on this head will be unnecessary.

HAND-PICKING.—We should be far from advising any planter to attempt to rid himself of the boll-worm by collecting them from *cotton* by hand. The plan which we do mean to suggest under this heading is killing the earlier brood of the insect upon *corn* as a preventive against future injuries in cotton.

This idea was first suggested by Col. B. A. Sorsby, as stated in the Department of Agriculture report for 1855:

> Col. B. A. Sorsby, of Columbus, in Georgia, has bred both these insects (corn and boll worms) and declares them to be the same; and, moreover, when, according to his advice, *the corn was carefully wormed on two or three plantations*, the boll-worms did not make their appearance that season on the cotton, notwithstanding that on neighboring plantations they committed great ravages.

Mr. E. Sanderson, in 1858, having come to the conclusion that the two insects were identical,* advised the early planting and forcing of

* American Cotton Planter, November, 1858.

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cotton and the late planting of alternate rows of corn, with the view of keeping the worms supplied with a stock of the food-plant which they evidently preferred.

In 1859, Mr. Peyton King, of Enterprise, in commenting upon Mr. Sanderson's paper, said:

If they are the same, their ravages may be to a great extent lessened by the plan suggested by Mr. Sanderson—that of planting the corn crop later. And to his plan I would suggest another—that of sending hands at the proper time through the corn for the purpose of opening slightly every ear with a dead silk, to extract and destroy the worm, and thereby destroy the miller. This might pay in reference to the corn alone.*

No attention seems to have been paid to either of these suggestions, and the remedy has never come into use.

The same idea suggested itself to me during my stay in the field in the summer of 1878, but, as I arrived in the latter part of July, I was only able to theorize. Mr. Trelease was instructed to pay attenton to this point, and in his report we find the following:

Since the earliest broods of larvae are found on the maize or Indian corn, first in the stalk, later in the ears, and since the tendency of the species to multiply in geometrical progression makes it desirable to destroy the early broods if possible, I would suggest hand-picking of these earlier broods as the best way known to me of dealing with the pest. As was stated when speaking of the natural history of *Heliothis*, if one of these larvae has taken up its abode in a stalk of corn, the fact can be detected by a very superficial examination, owing to the holes formed in the leaves. Let, then, each plow-hand be instructed, when cultivating the corn, to stop whenever he finds such a stalk, and catch and kill the worm, even though it should occasionally be necessary to destroy the plant in doing this, for the hill may be replanted, and the larvae thus killed might, if suffered to live, become in a few generations the parent of hundreds of boll-worms. Later, after the corn is laid by and has begun to fruit, boys may be sent through the fields to kill the "tassel worms," the presence of which may be detected by the excrement at the end of the ear, or by the silk being eaten away. To catch these it will be only necessary to open the husk for a short distance back from the end of the ear, and, from the ease of discovering affected ears, the expense will not be great. It is objected to this that ears so opened are exposed to the weather and to the attacks of birds. Though it must be admitted that this is true to a certain point, the destruction of all ears so interfered with does not follow, and the great lessening of the next crop of boll-worms will, I am certain, more than pay for what corn is sacrificed.

The boll-worm cannot be expected to be exterminated by this process, since it has so many other food plants from which it could, at any time, migrate to corn or cotton; but, inasmuch as corn appears to be its favorite food, its numbers could be very greatly lessened, and its injuries to cotton could be almost done away with by this process. We advise planters by all means to try it, and we assure them that their time will not be lost. In sections of the cotton-belt which are badly troubled with the boll-worm, and where corn is not grown, it will be well to plant the latter crop and use it as a trap, as advised above.

ROTATION OF CROPS.—In the light of the relation of the corn and boll worms, and of the numerous food plants of *Heliothis*, we may here men-

Ibid, February, 1859.

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tion the fact that rotation of crops has been strongly urged as a preventive against the ravages of the boll-worm. The knowledge which we have gained of the multivorous habits of the insect readily shows us that such a course would be vain, as during the season when cotton was not grown some other food-plant would be available. As a curiosity we may mention the fact that some years ago a writer in the Southern Cultivator, after earnestly urging rotation of crops, advises *corn as the best crop to rotate with cotton!*

DESTRUCTION OF THE CHRYSALIDES.—In the more southern portions of the cotton belt, where the frosts are rarely severe, but little can be done toward the destruction of the chrysalides beyond instructing the plow-hands to crush them whenever they observe them in plowing, or causing a boy to follow the plow and collect them as they are brought to the surface. In the more northern portions, however, *fall plowing* may accomplish much good. Experiments, having the testing of the efficacy of this remedy in view, have been made by Professor French. We can do no better than to give his own words:

Fall plowing.—To make it plain how this is to reach them, I shall have to explain some observations made on the fall brood of chrysalides that were found during the month of November in a field where the worms had been very abundant in the corn before it was harvested. In digging for the chrysalides round the corn-hills, I found that instead of their occupying an oval earthen cocoon, as has usually been written of them, and as they apparently do in the breeding-box, they were down in the ground from five to six inches below the surface, in a hole about a third of an inch in diameter, reaching from the chrysalis to the top of the ground, where it was covered over with a thin film of dirt from an eighth to a quarter of an inch thick. This hole was larger at the bottom than at the top, apparently so as to give free motion to the chrysalis, and usually bent in its course, so that the lower part would have an inclination of perhaps forty-five degrees. At the bottom would be found the chrysalis, the small end downward and the head upward.

In one case I found the hole so bent that the chrysalis occupied a horizontal position. The hole was smooth inside, and was perhaps made so by cementing the dirt together; but of that I could not tell, for the whole ground was moist, though dry enough to be firm. I took several of the chrysalides and put them in a box with some loose dirt, and then moistened it, after which I allowed them to freeze. The dirt, when they were allowed to freeze, was dry enough, so that if it had been in the garden and turned over with a spade it would crumble. When examined, after the freezing, all were dead. Some others taken up in the bottom of their subterranean habitations, without sifting the loose earth round them in their holes, and allowed to freeze, were not killed by freezing.

My conclusions were, that so long as they were in the smooth compartments they had made for themselves, free from any loose dirt that would became wet and stick to them, they could pass the winter in safety, even though they might be frozen; but, when the dirt was packed loosely round them and became wet and stuck to them, then freezing killed them. Their holes, running cell-like as they do from the surface down into the ground five or six inches, must be broken up by plowing, and when once broken up with the loose dirt round them the rains and the freezing winter weather would have the same effect on the chrysalides that moisture and freezing had on those in the box of loose dirt. Fall plowing, then, for these reasons, will probably be the most efficient means of destroying these insects; besides, if done late enough, it will rid the ground of cut-worms, &c.

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DESTRUCTION OF THE MOTHS.—It is the general opinion throughout the South that the best if not the only way of getting rid of the boll-worm is by the use of lights and poisoned sweets for attracting the moths. Several correspondents even go so far as to say that the ravages of the worms can always be checked by attracting the moths with lights. Colonel Sorsby always had great success in killing these moths with molasses and vinegar. He says: *

We procured eighteen common-sized dinner plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground in the cotton-field, one to about each three acres, and reaching a little above the cotton-plant, with a six-inch square board tacked on top to receive the plate. These arrangements were made in the evening, soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field, each days' success increasing, until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was but very little injured by the boll-worm. The flies were caught in their eagerness to feed upon the mixture by alighting into it and being unable to escape. They were probably attracted by the odor of the preparation, the vinegar probably being an important agent in the matter. As the flies feed only at night, the plates should be visited late every evening, the insects taken out, and the vessels replenished as circumstances may require. I have tried the experiment with results equally satisfactory, and shall continue it until a better one is adopted.

The boll-worm moths appear to be attracted to the same sweets as the cotton-moths, and are equally attracted to light. It follows, then, that the remarks made in Chapter VII, Part I, will apply equally well here, and that the devices there recommended for the destruction of the cotton-moth may be here recommended for the destruction of the boll-worm moth.

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* Department of Agriculture Report, 1855, p. 285.

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PART III.

NECTAR AND ITS USES.

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PLATE III.—DESCRIPTION OF FIGURES.

I. Vertical-longitudinal section of nectar gland from petiole of *Ricinus communis* (x 8).

II. Vertical transverse section of the same near the distal end of the true gland (x 8).

III. A portion of I, more highly magnified (x 100).

IV. Vertical transverse section of gland from mid-rib of a leaf of *Gossypium herbaceum* (x 17).

V. A portion of IV, more highly magnified (x 100).

VI. Flower cluster of *Marcgravia nepenthoides*, reduced.

VII. Involucrate cluster of flowers of *Poinsettia pulcherrima*, in the staminate state, natural size.

VIII. The same at an earlier period, while in the pistillate state.

IX. Vertical section of a cluster in which the pistil is abortive, in the staminate state, natural size.

X. The same, entire.

XI. Double petiolar gland of *Ricinus communis*, seen from above, natural size.

XII. The same, from the side.

XIII. Double involucre of *Gossypium herbaceum*, natural size, one of the bracts of the inner wheel.

In all of the figures, *a* indicates the adenophore; *e*, the epidermis; *f*, the fibro vascular bundle; *g*, the gland proper; *l*, the lamina of the leaf; *o*, the ovary; *p*, the petiole.

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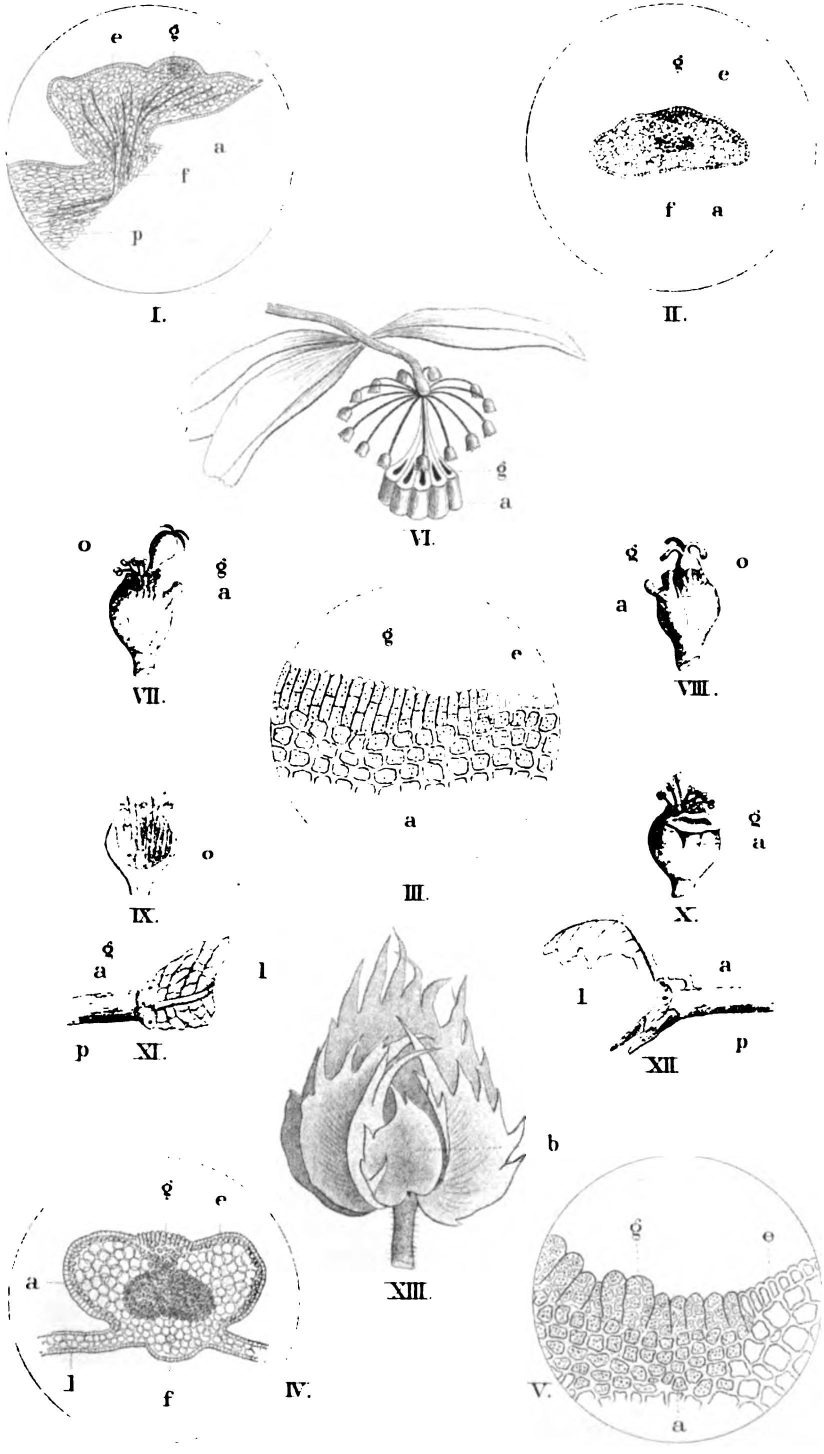

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NECTAR; WHAT IT IS, AND SOME OF ITS USES.*

[As the investigation of cotton insects has progressed, the importance of the nectar glands of cotton in their influence upon the natural enemies of the cotton and boll worms, has gradually become more and more apparent, until at last it seemed imperative that some space should be devoted in the report to a consideration of the general subject of nectar. The following chapter was, therefore, prepared, at my request, by Mr. William Trelease, who has made the subject of the mutual relations of plants and insects a special study.—J. H. C.]

Though as a scientific word it should possess precision, the word nectar is far from conveying one idea when met with in the writings of different authors. Purely mythological with most of the Greek and Roman writers, it signified the beverage of the gods. By Virgil it was used apparently much as we now use it. "Others [of the bees] compress the clearest honey, and swell out the cells with liquid nectar."†

Linnæus defined a nectary as a "*pars mellifera flori propria*," whence nectar is a honey-like substance produced by such a floral gland. Dr. Gray defines the word as follows: "Nectar: the honey, &c., secreted by glands or by any part of the corolla";‡ or, again, "Nectar: the sweetish secretions by various parts of the blossom, from which bees make honey."§ Sachs says, "Glandular organs are found in the flowers which secrete odorous and sapid (generally sweet) juices, or contain them within their delicate cellular tissue, from which they are easily sucked

* Since nectar is found in several parts of the cotton plant, and presents some peculiar phenomena there, it has been thought best that I should treat briefly in this place of its occurrence and economic value; hence the present essay. My plan has been to indicate what I understand by the word nectar; to describe some of the more instructive instances of its occurrence, in an order depending entirely upon the nectariferous organs; to then arrange these according to the purpose which the nectar serves in each case; to discuss some of the cases more at length; and, finally, to briefly mention the habits of some nectar-loving animals when in quest of this beverage. Though limited time and prolonged ill-health have prevented me from making this essay what I had wished it to be, I trust that it may not be found wanting in what it professes to be—an outline of the uses of nectar as we now understand them.

WM. TRELEASE.

ITHACA, N. Y., *November* 12, 1879.

† Georgics, iv, l. 164.

‡ Lessons in Botany, 1868, p. 222.

§ Structural Botany, 1879, p. 421.

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out. These juices are included under the term nectar."* Delpino proposes to replace the Linnæan definition of a nectary by the following: "*Pars mellifera plantarum angiospermarum propria*";† whence nectar is a honey-like fluid produced by such glands situated anywhere on an angiospermous plant. This not only excludes honey-dew, which Delpino regards as a pathological symptom, but also the nectar which Francis Darwin has found secreted by true glands on *Pteris aquilina*, a fern. Darwin‡ discusses the case of some Orchid flowers which contain a sweet fluid between the walls of their nectaries, whence it is abstracted by insects after they have pierced these walls. This fluid is spoken of by him as nectar. Reinke defines nectar as "a clear fluid of sweet taste, elaborated by certain aerial parts of plants."§

Though the elimination of a sweet fluid (honey-dew) on the leaves of plants may be due to a diseased condition of the leaves in many instances, yet as it is of frequent occurrence, and as the nectar in the last case mentioned is not elaborated by specialized glands, it seems best that this should also be included in a definition of nectar. The following definition is, therefore, proposed in the belief that it comprehends all of importance that any previous definition has included, and nothing—save the honey-dew, just mentioned—not included by some good authority. NECTAR: a fluid always sapid, usually sweet, often odorous, which is elaborated in any part of a plant, remaining where formed or making its way to some other part; its *raison d'être* being the necessity for the removal of some useless or injurious substance, or for some provision to attract nectar-loving animals to the plant for some definite purpose.

It has long been known that specialized organs for the elaboration of nectar—nectar glands—exist in the flowers of many plants as well as outside of the floral envelopes of some. These glands, when occurring outside of the flower, always consist of modified epidermal tissue, as shown by Martinet: they may be said to be made up of an inactive supporting portion, the adenophore of Martinet (Pl. III, Figs. 1, 5, *a*), and of an active superficial portion, the gland proper (Pl. III, Figs. 1–5, *g*). These glandular cells are far different from the epidermal cells of which they are but modifications; thus, in glands from the petiole of the castor-oil plant I found them to be divided by transverse septa; and in the foliar glands of the cotton plant to be marked by coarse reticulations on their walls, making them appear at first sight as though not simple cells. In the latter case, too, their distal portions are quite separate from each other, so that they resemble, to a certain extent, crowded villi. Within the flower, glands may be of varied structure, sometimes superficial, sometimes deep, possessing less uniformity than elsewhere.

According to their situation, these glands may be either floral or extrafloral; the former occurring within the floral envelopes, the latter, without

*Text Book of Botany, English translation, 1875, p. 500.

†Ulteriori Osservazione, 1875, p. 85.

‡Fertilization of Orchids, 2d edition, pp. 36–44.

§*Pringsheim's Jahrbücher für wiss. Bot.*, 1875, x 119, note.

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them. Floral glands may occur as modifications or appendages of any of the floral organs; extrafloral glands may occur as modifications or appendages of the outer floral envelope, or of various extra floral organs, as shown in the following table:

Floral.....	Receptacle.
	Pistil.
	Stamens.
	Corolla.
	Calyx.
Extrafloral.	Calyx.
	Ordinary bracts.
	Specialized bracts.
	Involucre.
	Peduncle.
	Leaf.

The secretion of glands of the first group seems always designed to aid in the fertilization of the flowers in which it is produced by attracting to them insects or birds, which, by reason of some floral adaptation, while feeding on the nectar, or on small insects likewise attracted to it, unconsciously transfer pollen from the anthers to the stigma of this or some other flower of the same species. Some of these flowers are of an open structure, with their nectar accessible to insects of all sorts and sizes; others are of such size and form as to be limited to certain groups of insects, sometimes even so restricted as genera. Some are so formed that fertilization is possible by direct pollination without extraneous aid; others never produce offspring unless they receive such aid. So much has been written concerning floral nectar and its uses that I shall give but one example under this head, the flower of the cotton plant.

The cotton flower is very fugacious; opening shortly after sunrise, it has passed its prime before sunset, and by the end of the second day the corolla and stamens have usually fallen to the ground.*

* As is well known, the corolla of one of these flowers is creamy white on opening; later in the same day it becomes more or less tinged with pink or rose, which becomes a uniform deep rose on the second day. As will presently be shown, these flowers are not dependent on insect aid for their fertilization, yet the great size and conspicuous color of their corolla indicates to the believer in the commonly accepted theory of the evolution of floral forms that this has not always been the case; in other words, that there was a time when, for some purpose, they needed to attract insects or other animals, to which their showy corollas rendered them visible from a distance. But why should the color change so markedly as the flower advances in age? There is reason for believing that fertilization occurs during the first day of blooming, and this being the case insects are not needed by any flower more than one day old. Many other cases could be given where the color of a corolla changes and becomes intensified after the fertilization of the flower to which it belongs, but it is unnecessary to more than mention them here. The most satisfactory explanation of this phenomenon that is known to me is that by their varied, lasting, and augmented coloration they attract flower-haunting animals to the plant. These instinctively, or by experience, visit only the younger flowers, readily distinguishable by their color from the older ones. See Nature, ix, 460, 484; x, 5; xvii, 78; and Delpino, Ult. Oss., 1875, p. 28.

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The reproductive organs are so placed that on the expansion of the corolla pollen has usually been deposited on the stigmas, self-fertilization being thus secured. By his many observations and experiments, Darwin has shown that where self-fertilization is thus provided for, occasional crossing is often of sufficient importance to warrant the production of large and conspicuous corollas, and of nectar accompanied by fragrance to secure such crossing by inducing suitable animals to go from flower to flower. Such appears to have been the case here, for within the corolla, where the petals separate from one another and from the staminal column, is found a set of small hairs which are slightly viscid as shown by the adhesion of pollen grains to them. What causes this viscidity? Early in July I noticed a single hive bee within a cotton flower, where, as I then supposed, it had gone to collect pollen, but I failed to see that it did. About the same time I saw many humble-bees entering the flowers for pollen as I thought, and they, too, went unnoticed, though they transferred much pollen from flower to flower in these visits. Shortly afterward I noticed certain sand-wasps belonging to the genus *Elis* within the flowers, and as I did not know that they fed on pollen I was led to watch their actions. Instead of collecting this substance they were exploring with their tongues the clefts between the petals; this led me to examine a flower more closely, the result being the finding of the hairs just mentioned. As no nectar was found elsewhere in the flowers, and as these insects were constant in their visits, I infer that viscidity of the hairs is caused by an exudation of true nectar.* Darwin describes a similar secretion from hairs on the labellum of *Cypripedium.*†

Numbers of specimens of the beetle *Chauliognathus marginatus* were found within the flowers, where, however, they ate only pollen, so far as I could see. Individuals of the yellow butterfly *Callidryas eubule* were often seen resting on the free border of the petals and sipping the nectar with their long and flexible proboscides. The following-named insects were all seen in greater or less numbers in the flowers after nectar: *Elis 4-notata*, *Elis plumipes*, *Melissodes nigra*, *Megachile sp.*, and *Bombus sp.*

In thus collecting pollen and nectar, these insects, with the exception of the butterfly, coming in contact with both anthers and stigmas, became well dusted with pollen, which necessarily was transferred in quantity from flower to flower. The species most frequently met with in these flowers were *Elis plumipes* ♂ and *Melissodes nigra.*

As an example of extrafloral nectar produced on the calyx, I shall cite that of the leguminous plant, *Coronilla varia*, described by Farrer.‡

* In the Popular Science Review for July, 1869, p. 270, Ogle states that, as previously noticed by Vaucher, no nectaries are found in Synacnic Malvaceæ. This appears to be an exception to that rule, for, so far as I could see, the stigmas were perfectly receptive when the corolla expanded.

† Fertilization of Orchids, second edition, p. 229.

‡ Nature, x, 1874, p. 169.

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Here the outer surface of the calyx is covered with small glands, the secretion of which attracts bees to the flower; but, strangely enough, instead of alighting directly on the calyx and lapping up the nectar, they settle on the wings and keel, whence they protrude their tongues back into the flower and out between the separated bases of the petals, thus indirectly reaching the nectar on the calyx. Despite their usual intelligence, we are led to the conclusion that in this case the bees are deceived, believing the nectar to be within the flower, as is the case in so many of the Leguminosæ, instead of on its exterior. But this deception, if deception it be, is of value to the plant, for in resting on the wings and keel the bees depress these petals, bringing their breasts in contact with stigma and pollen, and effecting the cross-fertilization of different flowers, in their visits from plant to plant.

Another example is afforded by the cucurbitaceous plant cultivated in the South, under the name of bonnet-squash or dish-rag plant. Each lobe of the calyx has on its outer side a varying number of glands, which secrete nectar for some time before the flower opens during the period of blooming, and for some time after fecundation has occurred. This nectar is so greedily sought by ants of several species that numbers of them are to be found at all times on every calyx which is in active secretion, but they seldom enter the flower, apparently being prevented from doing so by the large, spreading corolla.

The common passion-flower or May-pop of the South (*Passiflora incarnata*) affords a good illustration of nectar occurring on small, unmodified bracts. At the base of every flower are found three or four small bracts, each bearing two large nectar glands. Though the secretion of these is not very plentiful, it is sufficiently so to attract swarms of ants, which, as in the last case, do not enter the flowers, apparently finding the spreading sepals and petals and the dense corona insurmountable obstacles.

In the tropical *Marcgravia nepenthoides* (Pl. III, Fig. 6), Belt tells us that "the flowers are disposed in a circle, hanging downwards, like an inverted candelabrum. From the center of the circle of flowers is suspended a number of pitcher-like vessels, which, when the flowers expand, in February and March, are filled with a sweetish liquid. This liquid attracts insects, and the insects numerous insectivorous birds. The flowers are so disposed, with the stamens hanging downwards, that the birds, to get at the pitchers, must brush against them, and thus convey the pollen from one plant to another."* These pitcher-like vessels are modified leaves or bracts, the nectar of each gland being secreted inside a sort of pouch, and passing to the surface through two pores or ducts.†

Good examples of nectar borne on bracts collected into an involucre are afforded by some of the Euphorbias. Thus in E. (*Poinsettia*) *pul-*

* Naturalist in Nicaragua, 1874, p. 128.

† For the structure of these glands see Wittmack, *Botanische Zeitung*, No. 35, Aug., 1879, s. 557.

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cherrima (Pl. III, Figs. 7–10), the flowers are collected into clusters consisting of a central, stalked, pistillate flower, surrounded by a varying number of stalked monandrous staminate flowers, the whole cluster being inclosed in an involucre so as to resemble somewhat a single flower. On the side of each involucre is a large, yellowish, cup-shaped gland, which secretes a considerable quantity of nectar during the blooming period of the cluster to which it belongs. In the house this is sought by myriads of the small red ant *Myrmica molesta*, and in the open air of its native place probably by small bees and flies such as are known to visit other Euphorbias. When one of these clusters begins to expand the pistillate flower at its center is protruded (Pl. III, Fig. 8, *o*), and expands its three bilobed stigmas, which are ready for fecundation. A few days later, these having withered, the stalk of the pistillate flower becomes sufficiently elongated to protrude the entire ovary * (Pl. III, Fig. 7, *o*), and by this time several of the stamens have become exserted and shed their pollen. From this it appears that in this species self-fertilization is impossible, since there are no perfect flowers; the first remove from this, crossing between flowers of the same cluster, is likewise impossible, owing to the maturing of the pistillate flower before any of the staminate flowers are mature; and the closest cross that can occur is between different clusters on the same plant, which, as appears from the crowded structure of these clusters, is about equivalent to crossing different flowers on the same plant of such a species as the Marcgravia figured, for a number of these involucrate clusters are collected together and surrounded by a whorl of bright crimson bracts, rendering the whole very conspicuous to such insects as are in search of nectar. These insects, in obtaining the nectar, necessarily brush the floral organs and must secure the cross-fertilization of the species.

Another example of nectar borne on a floral involucre is afforded by the cotton plant, where each flower is surrounded by a whorl of three large laciniate bracts, on the outside of each of which, near its base, is a nectariferous pit.†

Alternating with these bracts, and just within the circle formed by their bases, are three other pits, smaller than the former, but like them, active.‡

The first few flowers that open possess only rudiments of glands; but

* In cultivation the pistillate flower is often entirely abortive (Figs. 9 and 10), and its ovules seem to be always aborted in our greenhouses, for though an abundance of apparently good pollen is produced I cannot learn that the species ever set seed with us. My authority for this failure to set seed is Peter Henderson, the well-known New York florist. See Gray, Silliman's Journal, 3d series, xiii, 1877, p. 138; and some notes by myself, Bulletin Torry Botanical Club, vi, 1879, p. 344.

† Glover, Agricultural Report, 1855, p. 234, mentions these glands, as well as the inner set and their secretion of a "sweet substance, which ants, bees, wasps, and plant-bugs avail themselves of as food."

‡ These glands belong, in reality, to an inner whorl of three bracts, alternating with the outer ones, but generally wanting. In stunted plants, especially as cold weather comes on, one or more of these inner bracts may often be found. ((Pl. III, Fig. 13.)

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all after the first few possess the outer set, though it is not till the cotton has been blooming about a month that the inner set appear. Confining our observations to flowers which possess both sets fully developed, we find that a number of days before a flower-bud opens all of its involucral glands are visited more or less frequently by ants, and occasionally a wasp or hive bee may be seen about them, although to our eyes they are dry. Evidently, then, they secrete a thin sugary film. The evening before such a bud opens, its visitors increase in number, and we may, perhaps, see a little nectar in its glands. But during the night preceding its unfolding, its cups fill out with the sweet fluid which is collected by large numbers of ants, and early the next morning a large drop may be seen suspended from the lower margin of each, or in some cases running down the bract; and throughout this, which may be called *the* day of blooming, bees, wasps, and ants of many species may be found in constant attendance on the glands. Though drawn so close to the flowers, these insects never enter them, so they can have no direct influence on their fertilization. Perhaps the strangest thing about these glands is, that during the night, when this abundance of nectar is collecting, they are visited by thousands of the moths of *Aletia argillacea* and *Heliothis armigera* whenever these moths are flying and laying their eggs. This appears to be a strange paradox. Nectar is secreted apparently to attract insects to a plant; and some of the insects so attracted have the instinct to oviposit on the plant, on the foliage, flowers, and fruit of which their larvae feed. How could this secretion have been acquired by natural selection? It looks as if such an acquisition must imply the survival of the unfittest! As has been shown elsewhere, the flowers of the cotton plant suffer from the attacks of the larvae of both these moths; but most of the eggs of both species are laid on other parts of the plant than the flowers or floral appendages, consequently a larva to reach the flower must ascend the peduncle, and run the gauntlet of ants, wasps, and bees found at its summit; though I never saw one ascending when these insects were at their post, and therefore never had an opportunity to see what would happen then. I found that when these larvae are on the leaves of the plant they are sometimes attacked and killed by the ants without any provocation. So it appears that the secretion of these glands first attracts the worst enemies of the plant, and then attracts their enemies, which afford it partial relief from the misfortune that it has brought on itself.

An example of nectar secreted on the flower-stalk is found in the cow-pea. At the summit of each peduncle are several small, crater-shaped, circumvallate glands, which secrete until the fruit is well advanced toward maturity, as well as during the flowering period. Occupying, as they do, the very end of the peduncle, they are beyond the clustered flowers and seed-vessels. In Alabama I found that they are much frequented by ants of several species. Like the cotton plant, the cow-pea is visited by the moths of both *Aletia* and *Heliothis*, but only the latter

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oviposits on it, and this in but small numbers, its larvae feeding on the green seeds. The same complication, therefore, exists here as in the case of the cotton plant; but in this case the attack appears to be limited to the early fruiting period, and a body-guard of ants is maintained during this period.

Coming, now, to leaves, we may briefly refer to the sweet fluid known as honey-dew, which is sometimes found on the foliage of plants. In many cases this will be found not to originate in the leaves, but to drip from the anal tubes of *aphides*, or plant-lice; and with this we have nothing to do, since it is not a production of the plant. But in some cases this substance is an excretion from the leaves, apparently due either to the climatic conditions obtaining at the time of its production or to a diseased state of the plant. It is not, so far as I know, produced by structures, such as glands, in any case. Though bees and ants collect this substance with avidity, it does not appear that they render the plant any service while doing so.*

Small glands are found at the tips of the serrations on the leaves of many plants, and some of these produce a plentiful supply of nectar; some of them being frequently visited by insects, and others scarcely at all. Like the last, this nectar is believed by Darwin to be merely excretory, and as going to show that such is the case we may mention the fact that the leaves of peaches, nectarines, and apricots—which may be glandular in some, and not glandular in others of the offspring of a single parent—if glandular, are less liable to the attacks of mildew than if they bear no glands.†

Leighton found that—

> On the upper edge of the vertical phyllodia of *Acacia magnifica*, subtending the showy spikes of yellow flowers, which proceed from their axils, appeared a pellucid drop of liquid, varying in size from that of a large pin's head to that of a grain of mustard-seed. This to the taste was sweet and sugary. The flowers themselves had no odor, except toward nightfall, when they gave out a weak disagreeable smell, only perceptible on close contact. In wiping off the sugary secretion it was observed that it proceeded from a small sunken linear-oblong orifice or slit, surrounded by a swollen margin. * * * The secretion takes place only during the period that the plant is in blossom. So soon as the flowers fade and begin to fall, the secretion ceases and disappears. It would seem then to be in some way or other connected with the fertilization of the flower; and as, when the secretion becomes excessive, it falls and blotches the lateral expansion of the phyllodium, it is probably to attract insects to effect this, * * * it seems almost evident that it would require an insect of some considerable size and of some peculiar structure to remove and apply the pollen, the secretion not being in the blossom itself, but at a short distance from it, on the phyllodium.‡

This case appears quite similar to that of the cotton flower previously given, and I cannot avoid the conclusion that the real object of the nec-

* Darwin, Cross and Self Fertilization, 1877, page 402, mentions undoubted cases of the occurrence of this excretion, besides giving references to other writings bearing on this point.

† For references on this subject see Darwin, Animals and Plants under Domestication, Orange Judd edition, 1868, i, 413: ii, 280.

‡ Annals of Natural History, third series, xvi, 1865, page 12.

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tar was to secure protection to the flowers, rather than to secure their fertilization, though the latter might occasionally occur incidentally.

On the lower surface of the leaf of the cotton plant, not far from its base, the mid-rib bears a large sunken nectar gland, and each of the lateral veins of the larger leaves bears a similar gland.* Traces of these glands may sometimes be found on the cotyledons, but I never saw a perfect gland on a seed-leaf. As shown by the visits of ants, the gland of the first leaf begins to secrete when the seedling plant has about four leaves expanded; but it is not till some days later that enough nectar is produced to be noticeable, and from this time on the gland secretes abundantly until the leaf becomes old or diseased. When a gland is in vigorous secretion it may be examined at almost any time of the day, and barely enough fluid will be found in it to fill the pit two-thirds full; but during the night, and until some time after sunrise in the morning, great drops of the sweet fluid may be found hanging from its border. This nectar is very attractive to certain insects, chiefly ants, wasps, and mud-daubers. It is also sought at night by the moths of both *Aletia* and *Heliothis*, the former of which had been seen to alternate sipping this nectar with ovipositing. As I have elsewhere stated, the larvæ of both these moths feed on the leaves of this plant, and both have been attacked, removed from the plant, and killed before my eyes by ants or wasps induced by this nectar to visit the leaves.

On the lamina of the leaves of the bonnet squash a variable number of pustule-like glands is found. These secrete an abundance of nectar, and are constantly attended by ants of several species, which, from the distribution of the glands, are led to explore every inch of the leaf-surface. I only found that the leaves of this plant were attacked by the larvae and imagines of the large lady-bird, *Epilachna borealis*, and as very few of these were seen on them I could not determine their relations with the ants.

In *Acacia sphærocephala*, the bull's-horn thorn, Mr. Belt tells us that—

The leaves are bipinnate. At the base of each pair of leaflets, on the mid-rib, is a crater-formed gland, which, when the leaves are young, secretes a honey-like liquid. Of this the ants are very fond, and they are constantly running about from one gland to another to sip up the honey as it is secreted. But this is not all; there is a still more wonderful provision of solid food. At the end of each of the small divisions of the compound leaflet there is, when the leaf first unfolds, a little yellow fruit-like body united by a point at its base to the end of the pinnule. Examined through a microscope, this little appendage looks like a golden pear. When the leaf first unfolds, the little pears are not quite ripe, and the ants are continually employed going from one to another examining them. When an ant finds one sufficiently advanced, it bites the small point of attachment; then, bending down the fruit-like body, it breaks it off and bears it away in triumph to the nest. All the fruit-like bodies do not ripen at once, but successively, so that the ants are kept about the young leaf for some time after it unfolds. Thus the young leaf is always guarded by the ants, and no caterpillar or larger animal could attempt to injure them without being attacked by the little warriors.

* Glover, Agricultural Report, 1855, p. —, points out the presence and secretion of these glands.

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This Acacia bears large paired thorns, which, when young, are filled with a sweetish pulp. Boring a hole through the wall of one of these young thorns the ants eat out the contents of this one and its mate, this action causing an enlargement of the thorn, so that a capacious chamber is formed, and in this the ants live, remaining constantly on the tree, so that Mr. Belt remarks—

I think these facts show that the ants are really kept by the Acacia as a standing army, to protect its leaves from the attacks of herbivorous mammals and insects. * * * I sowed the seeds of the Acacia in my garden, and reared some young plants. Ants of many kinds were numerous, but none of them took to the thorns for shelter nor the glands and fruit-like bodies for food; for, as I have already mentioned, the species that attend on the thorns are not found in the forest. The leaf-cutting ants attacked the young plants and defoliated them; but I have never seen any of the trees out on the savannahs that are guarded by the *Pseudomyrma* touched by them, and have no doubt the Acacia is protected from them by its little warriors.*

At the base of the petioles in the greater coffee-weed of the South (*Cassia occidentalis*) are globular glands, which secrete a sufficient quantity of nectar to render them attractive to numerous ants, wasps, and bees, which would be encountered by any wingless insect in ascending the stem or passing out on any leaf. Most of the upper leaves subtending the racemes of flowers are reduced to mere bracts, which, however, have their glands large and active; and these bear the same relation to the flowers and young fruit that those lower down do to the leaves.

Several species of *Sarracenia* (pitcher-plants, or trumpets) have the lids or mouths of their pitcher-like leaves provided with a sweetish secretion which, at certain times, in at least one species (*S. variolaris*), extends along the margin of the wing in front of the leaf so as nearly or quite to reach the ground. Thus a line of nectar runs from the ground to and within the mouth of the pitcher, which is here provided with a fine velvety pubescence, the hairs pointing downward. Just below this is a rough portion, lined with stiff bristles which also point downward. The lower part of the tube, destitute of these hairs, is filled by a watery liquid, wholly or in great part secreted by the walls of the pitcher, and usually protected from dilution with rain-water by the overarching lid of the pitcher, the real blade of the leaf. An insect, lured up the wing and to the mouth of the pitcher, while feeding on the repast so generously offered, slips on the velvety surface, tries in vain to catch a firmer hold, slips farther, and falls into the pitcher, whence the stiff *chevaux-de-frise* makes his escape very difficult. Reaching the water he is sooner or later drowned, and being macerated there contributes to the food of the plant.†

The related *Darlingtonia californica* has a somewhat similarly shaped leaf. Its long, twisted tube is arched above, so as to prevent the access of rain-water to the secretion which fills its lower part, and the part answering to the hood of Sarracenia or the blade of an ordinary leaf is

* The Naturalist in Nicaragua, 1874, p. 219.

† See J. H. Mellichamp's "Notes on Sarracenia variolaris," Proc. Am. As. Adv. Sc., xxiii, 1874, Nat. Hist., p. 113; also Riley, *ibid.*, p. 18; and Trans. St. Louis Acad., iii, 235.

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produced in front of its mouth in the form of a fish or swallow tail. As in the last case, the edge of the border of the wing, the mouth, and the blade or fish-tail appendage are provided with a secretion of nectar, as is also the inside of its arched hood; so that insects are attracted as before by the sweets, only to meet their death on entering the tube. The nectar leading from the ground appears designed to attract creeping insects, such as the ants, which form a large part of the prey of Sarracenias, while the swallow-tail appendage appears to be for the purpose of attracting flying insects.*

Like the preceding, the climbing Indian pitcher-plants (*Nepenthes*) secrete nectar about the mouths and on the lids of their cups, and for the same purpose, for they, too, are insectivorous, and, indeed, more truly so than either of the genera previously mentioned, inasmuch as their secretion has been shown to be a true digestive fluid, while that of the others is scarcely demonstrated as yet to be more than a liquid in which maceration may go on.

When the foregoing examples are considered, it appears at once that all nectar may be divided into two classes, according as its relations to the secreting plant are direct or indirect, according as it merely relieves the plant of a waste or injurious substance, or serves to establish definite relations between it and other living beings. Furthermore, the first class is entirely excretory, and is produced either by the unmodified leaf tissues or by specialized glands; the second class is never excretory, and may be subdivided into two groups—as has been done by Delpino—the first aiding in reproduction, and being either intra or extra floral; the second taking no direct part in reproduction, being always extrafloral, and serving indirectly either for the protection of some part of the plant or for its nutrition by attracting animals which, in the one instance, serve as a body-guard to the tender foliage and flowers, and in the other are killed, their remains undergoing decomposition or even digestion in the leaf cavities of the plant, and serving in either case as food for it. This arrangement may be expressed in tabular form as below:

Directly useful	Excretory	From the surface.	
		From glands.	
Indirectly useful	Reproductive	Floral	Borne on Sepals.
			Borne on Petals.
			Borne on Stamens.
			Borne on Pistils.
			Borne on Receptacle.
		Extrafloral	Borne on Calyx.
			Borne on Bracts.
			Borne on Involucre.
	Non-reproductive	Protective	To flowers.
			To fruit.
			To foliage.
		Nutritive	By securing material for absorption by leaves.

* See Canby, Proc. Am. As. Adv. Sc., xxiii, 1874, Nat. Hist., p. 64.

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In order that the significance of some of the examples given may be fully understood it will be necessary to speak briefly of the habits of a few insects. Ants, the most numerous of all the visitors of extrafloral nectar glands, are of various habits. So far as I know all of the species with which I had to do in Alabama are omnivorous, eating nectar and other sweet substances, but largely feeding upon animal food. In pleasant weather they may be found abroad night and day. But this is not true of all ants. The leaf-cutting and umbrella ants, or Saüba of Central and South America (*Occodoma*), are entirely herbivorous. Excavating large tunnels, and living in immense communities, they are the terror of gardeners in the hotter parts of our continent; for they have the habit of marching in great armies which swarm over and defoliate every unprotected plant, preferring cultivated plants, since they, as a rule, neither possess properties rendering them unpleasant to the taste of the ants, nor special provisions to secure a body-guard of protecting insects, and one or the other of these means of defense is usually found in native plants. Having reached the leaves or petals each ant snips out as large a piece as he can carry and makes off with it to the nest. In damp, warm weather these ants forage at all hours, but when the air is hot and dry they seem to realize that the leaves would dry up and become useless before they could get them to the nest, and so they hunt only during the cooler hours of the day and at night.* Moggridge found that a graminivorous ant of the south of France (*Pheidole megacephala*) works mostly at night,† while McCook finds that the parasol-ants of Texas forage only at night, visiting, then, the tops of the highest trees in their leaf-collecting labor.‡ So great a pest are these ants in Central America that it is found impossible, except by the most strenuous exertions, to cultivate any but native plants.

From this it appears that any plant not protected by an unpleasant principle in its flowers and foliage is very liable to extinction where these ants abound, unless it can secure a body-guard of some kind, and this usually consists of nectar-loving ants. To give perfect protection this force must reside constantly on the plant, finding their food, drink, and lodging, which, it will be remembered, were all found on the Acacia previously mentioned. A less perfect protection would be afforded by ants attracted to the plant for some of their food, but residing elsewhere; but it is probable that so few of them would be on the plant at any given moment that an army of the leaf-cutters would have no difficulty in overrunning it in their sudden onslaught. Let us suppose a case in which the attacking ants travel in small bands and only by night; then, evidently, a good protection would be afforded by a small number of pugnacious, nectar-loving ants, called to the plant chiefly or

* See, on these ants, Bates, Naturalist on the Amazons, and Belt, Naturalist in Nicaragua.

† Ann. Nat. Hist., series —, xiv, 1874, p. 92.

‡ Quoted by Bettany, Nature, Oct. 16, 1879, p. 583.

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solely at night. In this case the plant would be under the necessity of secreting nectar only during the night.

As I have stated before, the extrafloral nectar of the cotton plant is far more abundant during the night and in the early morning than at any other time, and this is true whether we consider the involucral or foliar glands. At first, from the visits of ants to glands in which I could detect no nectar, and from the fact that when the largest drops of nectar were seen early in the morning, the leaves were covered with dew; I was led, after satisfying myself that these drops were not confluent dew-drops, to conclude that a thin film of saccharine matter covers the glands at all times when they are in a healthy condition and of sufficient age, and that this is hygroscopic, absorbing so much watery vapor from the damp night air as to present the phenomenon mentioned. But I was led to doubt this conclusion by noticing that the secretion of the involucral glands lasts only during the blooming period of the flower about which they are placed, and I could see no reason why their nectar should be hygroscopic for so brief a time. This led me to examine glands in damp weather, before, during, and after a rain; but no drops of nectar were found, though drops of rain-water were occasionally found hanging from the border of the glands. So the hygroscopic theory would not do. On the contrary, I found that in the early morning after a cloudy or rainy day, there was comparatively little nectar in the glands, which seems to show that the secretion during the night is the result of the solar impulse of the preceding day. I could then scarcely avoid the conclusion that this nectar was originally developed by natural selection, that it might attract some nectar-loving animal to protect the plant from the depredations of some leaf and flower eating creature whose visits were chiefly made at night; and such I believe to be the case, both attackers and defenders having been ants in all probability.

But, it may be urged, you have said that this nectar is, at the present time, an important factor in securing the well-being of the plant, since it attracts ants and wasps which are among the most powerful of the natural enemies of its great spoliators, the boll-worm and cotton caterpillar; why can it not have been developed to secure protection against them or some similar insects? The fact that it is protective to the plant in this way is undeniable; but from what we know of the economy of nature it seems improbable that a nocturnal secretion of nectar should have been secured as a means of protection against larvae which feed for the most part by day; while its very abundance at night was certain to greatly increase their number on plants where this peculiar secretion chanced to be most marked during the process of selection, by attracting to those plants a greater number of the moths whose offspring the larvae are.

On the other hand, it may be urged that inasmuch as this nectar is now so attractive to the moths of *Aletia* and *Heliothis*, it probably does more harm to the plant in attracting them where they may lay their

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eggs, than good in drawing the enemies of their larvæ; and, this being the case, natural selection ought to remove the power of secretion. But a moment's reflection will show us that natural selection cannot for this reasom remove the glands or their activity. For a long time the cotton plant has been subjected to the methodical selection of man, who, in selecting seed to sow, pays no attention to the presence or absence of active nectar glands on the parent plant, but seeks to produce prolific plants of vigorous growth and good staple; so that no peculiarity which does not tend directly to lessen the vital force of the plant, and thus bring itself directly into conflict with the purpose of man's selection, can be removed by natural selection. But if, under the same circumstances, the production of this nectar is a direct drain on the vital force of the plant, a very different result must follow; for the methodical selection of man then becomes a factor in the broader selection of nature, and tends to the extinction of those varieties which, owing to their greater secretion of nectar, were even a little less vigorous or less prolific than their fellows which chanced to secrete less, so that the result must inevitably be the partial or total absence of nectar in the most vigorous and prolific varieties. My observation has shown me that there is not a whit less nectar secreted by the glands on the finest "Dixon-cluster" stalk than by those of the poorest scrub; from which I infer that the production of nectar causes very little drain on the energy of the plant aside from the mere vital force which must preside over every physiological act. This, I think, goes to show the correctness of Darwin's idea that all nectar was at first merely an excretion; and also that the material used in the elaboration of nectar by large, specialized, and active glands which serve other than excretory purposes is of such a nature that it can readily be spared by the plant without any impairment of its vigor.*

But if the glands of the cotton plant seem to have been produced to secure the protection of the leaves and flowers of the plant from leaf or petal eating insects like ants, those of the cow-pea seem designed to protect the flowers and especially the young fruit from all insects, but chiefly from such fruit-eating larvae as those of *Heliothis*.

While watching *Vicia sativa*, Darwin found that hive bees, while visiting the stipular glands, "never even looked at the flowers which were open at the same time; whilst two species of humble-bees neglected the stipules and visited only the flowers."† About 10 a. m. one day in August, while the sun was shining brightly, I noticed that several humble-bees,

* This, I think, explains the fact that the glands of *Pteris aquilina* still secrete while the frond is young, though they are not needed for its protection against any insect, as discovered by Francis Darwin. They were probably developed centuries ago, when the young fronds may have experienced the most urgent need of protection from some leaf-eating animal, and, causing little drain on the vitality of the plant, are still retained, though in some, perhaps all, parts of the world they are no longer of use.

† Cross and Self Fertilization, 1877, p. 403, note.

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flying about a mixed thicket of *Cassia occidentalis* and *C. obtusifolia*, visited only the flowers of the latter. At the same time many hive bees and small wild bees were seen visiting the extrafloral glands of the former, but none visited the flowers, nor were any humble-bees seen to visit either flowers or petioles of this species. On other occasions I saw hive bees, humble-bees, various small bees, wasps, ants, and moths at the petiolar glands of *C. occidentalis*, but not one of these was seen in the flowers of this species; while in the case of *C. obtusifolia*, as before stated, humble-bees were seen to visit the flowers, but not the extrafloral glands, which appear inactive—at least in Central Alabama. I also found that while both the outer and inner involucral glands of the cotton plant were visited, when in active secretion, by hive bees, but one individual was seen to enter a flower; and while humble-bees entered the flowers constantly, but one was found at each set of involucral glands. Humming-birds were often seen about the flowers of cotton, but none were ever seen to insert their bills within the corolla, all confining their visits to the glands about the flower. Their actions are somewhat curious, inasmuch as a given individual visits at any one time only one set of these glands. Thus on two occasions I watched several which went only to the outer set; but on two other occasions several were seen to confine their visits exclusively to the inner set. Not having marked individuals, I could not, of course, determine whether a given bird always limits itself to one set of glands, but I scarcely think that this can be the case.

In brief, then, we see from the examples given that nectar, wherever it occurs, may be considered as excretory, reproductive, protective, or nutritive; that in some cases, *e. g.*, the leaves of the peach, excretory nectar may possibly be protective also; that reproductive nectar usually occurs in the flowers but not always; that protective nectar seems in some cases designed to keep ants from defoliating and deflouring the plant; in others, to keep larvae from destroying the foliage or immature fruit; that nutritive nectar may serve in some cases to lead to the capture of wingless, in others of winged, insects; and finally that the vital force of a plant is taxed so little in the production of nectar that glands once developed and endowed with the power of active secretion may continue to secrete for generations after the necessity for their secretion has ceased to exist.

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APPENDICES.

In the appendices will be found a large amount of the material which has been drawn upon in generalizing for the main body of the report, and which we have left in its original form for accurate reference. Many interesting additional facts will also be found which, not bearing directly on the subject in hand, have not been incorporated into the body of the report.

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APPENDIX I.

REPORTS OF SPECIAL AGENTS AND LOCAL OBSERVERS.

In this appendix will be found the reports of Prof. A. R. Grote, Mr. E. A. Schwarz, Dr. E. H. Anderson, Judge William J. Jones, Prof. J. E. Willet, and Mr. William Trelease. My own report on my observations during the season of 1878, having formed the basis of the present report, will not here be incorporated. Prof. E. A. Smith, of Tuscaloosa, Ala., as local observer, made an extended series of observations, the results of which were very important. But as these results were communicated to the department from time to time as they were obtained, Professor Smith did not make a formal report.

REPORT OF E. A. SCHWARZ, OF WASHINGTON, D. C.

SIR: I have the honor to submit herewith a preliminary report on the insects living on or injurious to the cotton-plant on the Bahamas.

The cultivation of the cotton-plant dates back to the beginning of last century. Catesby, who visited the Bahamas in 1720, mentions that the cotton-plant was at that time perennial and growing without cultivation on the island of New Providence. From this remote time up to 1834 a considerable amount of cotton was raised on almost all the larger islands. Very little information regarding cotton insects in this oldest period can be obtained at the present time. What facts I have been able to obtain will be mentioned below.

In the year 1834 the cotton cultivation was suddenly and completely abandoned in consequence of the emancipation of the slaves. The only relic of the cotton cultivation in slavery times is the wild cotton tree, called "fly-away cotton" by the inhabitants of Long Island, and which I saw occasionally, though not often, on the more elevated hills of this island. It is a very tall shrub, or rather tree, from 15 to 20 feet in height. The bolls of this wild cotton are, however, very small, and the cotton is full of seeds and unfit for ginning.

The outbreak of the civil war in the United States caused a very vigorous resumption of cotton raising on the Bahamas. In 1863 an American company erected a steam gin in the southern extremity of Long Island, and the colonial government distributed at the same time seven hand gins (Eagle gins) for the free use of the planters of Long Island and Great Exuma. Almost immediately after the conclusion of the war this industry began to decline, owing partly to the indolence of the natives, partly to the increasing ravages of the cotton-bug, and at the present time it is confined to Exuma and especially to Long Island.

The American company broke up its establishment in 1866, and of the seven gins furnished by the government only two are in use now, and both of these on Long Island.

But it is safe to say that the cotton culture of the present time, insignificant as it may be compared with that of a single county of the Southern States, is firmly established on Long Island. A large portion of the population, which amounts to about 3,000 souls, depends for its living entirely upon the income derived from cotton culture. Moreover, the large number of sheep which are raised on that island, and which are the most important article of export except sponges, are fed exclusively with cotton seeds. The amount of cotton raised at present on the Bahamas does not, in my estimation, exceed 150 bales.

I took the first opportunity that offered itself to proceed to that island, which I reached on the 31st of March, after a tedious voyage of more than three days in a small open sailing-boat.

Long Island, which, like the other islands of that archipelago, is composed of honey-

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combed coral limestone, extends about 65 miles from north to south, with a width varying from 2 to 15 miles. The settlements and fields are scattered over the whole island, which is very hilly, and entirely covered with dense shrubbery. A "field," when cleared of these shrubs, presents the aspect of a perfectly grayish-white rock, apparently without any soil. However, in the numerous cracks and "pockets" of the rock some humus has accumulated and renders cultivation possible. Owing to this character of the ground the cotton-plants are planted very scattered and irregularly, there being on one acre often not more than 100 plants. However, these latter are, in this most favorable climate, of very vigorous growth, and reach sometimes a prodigious size if they are not trimmed. There are two varieties of short, staple cotton planted in Long Island: "Anguilla" and "Georgia" cotton, the latter, as the name indicates, imported from the United States; the former probably imported from the West Indies. Georgia cotton is perfectly white, Anguilla a little yellowish; both are considered as of equal value. The seeds of either kind are black, but not as smooth as that of sea-island cotton. This latter variety was introduced in the Bahamas in 1862, but as it has to be replanted every year is not fit for cultivation. Cotton on the Bahamas is planted during the months of January, February, and March; it blossoms in August, "blows" in September, and the crop is picked in January. At the same time the plant "freshens" up, and there is a second crop in May. The plant is then trimmed, and blows again in September; and so on. After the third year the plant is considered exhausted, and the field replanted. Each plant leaves, therefore, five crops. Cotton is cultivated on Exuma and Long Island exclusively by negroes, there being no white men on these islands except the "magistrate" and the Episcopal preacher. The cultivation is in my opinion carried on in the most careless way.

As to the insects injurious to the cotton-plant, my inquiries and investigation concerning the cotton-worm gave the following unexpected result. The cotton-worm was well known in slavery times and recently up to 1866. It was injurious every year before 1834, and was to be seen the whole year around, but less numerous after the stormy season, which is in September and October, and most numerous just before the beginning of the gales.

In general *Aletia* was not considered by the natives as a very serious enemy of the cotton-plant, as the damage done by it was always small when compared with the ravages of a much more formidable enemy, of which I shall speak later. It is the unanimous opinion of the inhabitants of Long Island that after the famous hurricane of October 1, 1866, this insect has never been observed on that island nor Exuma. In confirmation of this opinion I must remark that I myself, after five days' most scrupulous investigation, failed to discover the slightest trace of *Aletia*. On inquiry I was informed that before the fall of 1866, in March and April, the worms called "chenille" by the natives were pretty numerous and easily found. As the natives were able to observe this insect in former years, they would have seen it also after 1866 if it had not disappeared.

With this conclusion, and after my failure to find *Aletia*, I do not hesitate a moment to declare it as a fact that at the present time there is no excessive multiplication of *Aletia* on the Bahamas, and an emigration of the insect from those islands to the United States is in the highest degree improbable.

As for myself, I do not doubt the statement of the natives that *Aletia* has become extinct on these islands, either in consequence of the hurricane of 1866 or from reasons unknown to me.

The most formidable enemy of the cotton culture on the Bahamas is one much more injurious to that plant than *Aletia* has ever been either on those islands or in the United States, an enemy which makes the continuance of the cotton culture on the Bahamas very questionable. It is the "cotton-bug," a heteropteron, probably a *Lygaeus*, which, if I am not mistaken, has been found also in the United States. It punctures the green bolls, thus preventing them from opening; the bolls wilt and finally dry up, the half-formed cotton and dried-up seeds giving food to a number of other insects; more often the cotton-bug crowds in the half or not quite half open bolls sucking the seeds, thus preventing the cotton from blowing, or at least renders the cotton yellow and unfit for use.

According to the opinions of the natives the eggs of the cotton-bug are deposited in the cracks of the rock. I myself found a number of eggs on the leaf of a plant growing under a cotton-tree, but failed to raise the insect, and am therefore not sure that said eggs are really those of the cotton-bug.

The insect is less numerous after the stormy season and most numerous before the beginning of the gales. During my visit April 1 the cotton-bugs were said to be not very numerous, but it appeared to me that they occurred in astonishing numbers, for they were to be seen on every cotton-plant.

Early in the morning and late in the afternoon these insects literally cover all the bolls except the very young ones. On and in a single boll I counted 54 specimens, larvae, pupae, or perfect insects. It is evident that this insect does not like to expose itself to the rays of the midday sun, as it is to be found during the warm hours of the

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day on or under the leaves of the lower part of the plant under the dead leaves which lie upon the ground or beneath stones. I never saw this insect far from the cotton-fields, but in or near the fields they may be seen on different plants and shrubs. I have been informed that in slavery times the slaves were "taxed" to collect by hand every day a quart of these bugs. At the present time their habit of crowding during the hot hours of the day under the dead leaves upon the ground gives the natives a way to destroy them in large numbers. Dry leaves, twigs, &c., are placed in suitable places protected from the sun and set on fire at noon; or, still better, a few cotton-seeds are thrown up in such heaps of dry *débris* and attract vast numbers of the insects, which are very fond of sucking these seeds. However, as this remedy is not applied universally, it has but little or no effect, and it will be very difficult, in my opinion, to find any effective remedy against this pest, unless it can be attacked in the egg state.

The damage done by this insect is enormous; it destroys regularly the entire summer crop, *i. e.*, that picked in January, and destroys half or more of the second crop. It was very destructive in slavery times, but decidedly less numerous in the years following 1862 up to about 1868. Since that year the insect has regularly every year caused the damage stated above; in the year 1879 even the May crop was almost entirely destroyed by the combined influence of a great drought and this pest.

The number of other insects living upon or found on the cotton-plant on Long Island is quite considerable, and have been collected by myself with great care. They may be divided in the following classes:

First. Insects living actually upon the cotton-plant: *Aphis* sp.; [2]Homopterous insects covering the more tender twigs and even the trunks of the older trees with their eggs; Microlepidopteron, mining in the leaves; Hypothenemus, is boring in the tender twigs; a large Buprestid, living in the dead stalks; Drapetes sp., feeding upon the bark of the twigs; unknown insects, of which the eggs were found in clusters of three to fifteen on the under side of leaves, and of which I raised the young larvae.

Second. Insects found on cotton attracted by the cotton *Aphis:* Numerous ants; several species of Coccinellidae; larva of *Chrysopa* sp.

Third. Insects living in the bolls injured by the cotton-bug; two species of Lepidoptera (also found in the United States), and several Coleoptera.

Fourth. Insects found on the cotton-tree, which I observed live elsewhere also, or which do not appear to me to live exclusively upon cotton; two species of Lepidoptera; several Hemiptera and Coleoptera. None of these insects do any serious harm, with the exception, perhaps, of the insect designated above as "[2]Homopteron," which, by fastening its eggs, covered with a white flocculent matter, around the young leaf-buds, causes them to wilt and to die.

A full list of the species of the insects found by myself on the cotton-plant on the Bahamas can only be given when the specimens are properly mounted. A large part of my notes have not been incorporated in the foregoing report, which I beg to consider only as a preliminary one, written in a very hasty manner. The conclusions which can be drawn from my observations, especially the conclusions as to the hibernation of *Aletia* in the United States, will be forwarded to the department in due time.

I have the honor to remain, yours, very respectfully,

E. A. SCHWARZ.

SAVANNAH, GA., *April* 13, 1879.

C. V. RILEY,
Entomologist, Department of Agriculture.

REMARKS ON THE HIBERNATION OF ALETIA.

The principal result of my trip to the Bahama Islands is the conclusion that an immigration of *Aletia* from the Bahamas to the United States has been impossible, at least since the year 1866. With almost equal certainty it may be concluded that an immigration of the insect from Porto Rico or Hayti or any other island of the West Indies is impossible, because such an immigration would doubtless have restocked with cotton-worms the Bahama Islands before reaching the coast of Florida or Georgia.

Now, in view of the fact that in Florida and on Saint Catharine's Island (the only one of the sea islands of Georgia where at the present time cotton is planted to any extent) the cotton insect has appeared regularly every year since 1866, though not numerous enough to do any serious damage, it appears very probable that *Aletia* is indigenous within our country.

There is still the possibility that *Aletia* could immigrate every year to the United States from Mexico or Yucatan or South America. To this I have to remark:

First. That to my knowledge nothing definite is known about *Aletia* and its habits in the countries mentioned. We do not know even whether the insect occurs there at the present time or not. It is, however, safe to say that as cotton is raised in those

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countries only to a very limited extent, and not in continuous belts, the insect labors, therefore, under conditions unfavorable to an excessive multiplication.

Second. *Aletia* acquires migratory habits *alone* by excessive multiplication, as I have had ample opportunity to observe during last spring and summer.

Third. Should the insect in the countries named above multiply excessively, and therefore acquire migratory habits, its first appearance in the United States would be very sudden and in large numbers, and perhaps confined to the regions nearest the coast. The information I received last winter from numerous planters, which was fully corroborated by my own observation during last spring, proves that the first generation of worms is everywhere very scarce in numbers, and that the insect does by no means appear first near the coast, but at various localities within the more southern portion of the cotton-belt.

In view of the facts mentioned above, the theory of the annual immigration of *Aletia* from tropical countries appears to be seriously weakened, and only supported by the undeniable fact that nobody ever found *Aletia* hibernating in any of its stages in the United States. On this latter point I have already expressed my opinion in a former letter to the department, and will only repeat here that the failure of others and myself to find *Aletia* in its winter quarters is no proof at all against the theory of the hibernation of this insect in the United States.

In connection with this subject, I would like to mention that, at various places throughout the cotton-growing States, numerous planters, and among them very observing and intelligent ones, assert that they have seen the cotton-moth flying about houses, &c., on warm evenings in winter time and early spring. How much truth there is in these assertions I do not know, but the fact is that they only *saw* the insect flying about, and never actually captured an *Aletia*, and still less sent it to entomologists for identification. All moths either attracted by light or by sweets and captured by myself in winter time in the Southern States proved without exception to be other species than *Aletia*. I object, therefore, to the argument just mentioned being brought forth at the present time in favor of the theory of hibernation of *Aletia*.

What I have said above on the hibernation of *Aletia* refers only to the more southern portion of the cotton-belt of the United States, as everybody who has traveled through the Southern States must be convinced that the insect never hibernates in the more northern portion of the cotton district. Its appearance there is exclusively due to immigration of the insect from its breeding-places in the southern portions of the cotton-belt.

If circumstances are favorable to its development the insect can acquire migratory habits in its second generation, or, at any rate, very early in the season, and the result would be a more or less destructive appearance of cotton-worms throughout the cotton-growing States. Usually, however, the insect is kept in check by its natural enemies and by climatic influences or by both, or the vigorous and combined efforts of the planters in poisoning the worms, and it acquires migratory habits only late in the season, say in the month of September, when its ravages in the northern portion of the cotton-belt does not materially injure the crop.

It is, of course, impossible for me to circumscribe accurately the northern limits of the breeding-grounds of *Aletia*, but they may be roughly indicated as follows:

In Texas the breeding-ground of *Aletia* includes the whole extent of the cotton district south of the Galveston, Harrisburg, and San Antonio Railroad, but extending farther northward along the river bottoms. In Louisiana and Mississippi it includes the bottom-lands of the Mississippi River and its tributaries, but I am unable to indicate the northern limits. In Alabama a portion or perhaps the whole of the canebrake region. Farther east it includes the cotton districts of Florida and perhaps a small portion of Southern Georgia.

Within the area thus indicated the cotton-worm hibernates every year and appears at various localities, wherever it has succeeded in escaping the winter, as early in the season as the cotton-plant is fit to serve as food for the young larva. It is hardly necessary to say that these early generations of cotton-worm are overlooked by farmers, and it is indeed a difficult task to find the first generation of worms, as it is usually confined to small spots and as its ravages are inconsiderable.

All efforts to keep the insect in check ought to be confined to this southern portion of the cotton-belt in order to prevent an excessive multiplication and with this an early immigration of the insect to the more northern portion of the cotton-raising States.

E. A. SCHWARZ.

COLUMBUS, TEX., *September*, 1879.

J. HENRY COMSTOCK,
Entomologist, Department of Agriculture.

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REPORT OF A. R. GROTE, OF BUFFALO, N. Y.

SIR: In accordance with your favor of July 18, in which you directed me to visit the States of Georgia and Florida for the purpose of making observations on the insects injurious to the cotton-plant, I proceeded to Savannah, and, during the following month of August, made examinations of cotton-fields at different points between Savannah and Atlanta. Having charged me especially with that phase of the cotton-worm inquiry which comes under the head of migrations, I directed my chief attention to making observations and collecting information on the appearance and movement of the cotton-worm (*Aletia argillacea*).

It was first my object to ascertain if the worm could be found at the time of my visit at any of the points visited by me. A careful survey of the plantation of Dr. Lawton near Savannah, from August 1 to August 7, and other cotton patches in the vicinity, convinced me that the worm had not then appeared. The statements made to me were to the effect that its earliest appearance was usually to be looked for about the middle of the month.

Henry Gaston, engaged in planting cotton for nearly twenty years, said that the first brood of worms usually webs up about the middle to the latter part of August, giving a second brood in September. The worm was first noticed in the stronger cotton on the bottom-lands. The worm was never found by him on anything but cotton, and he had noticed it leaving one patch of cotton and going to another when leaf failed and there was nothing for the worms to continue feeding upon. He had used Paris green, dusted in a dry state upon the leaves, and it killed the worms. Care had to be used by him to avoid the poison getting into his eyes or on sores or tender places of the body. He had observed the fly before the appearance of the worm, but had never noticed it in the early spring.

This testimony is given as a sample of the information collected from various individuals. While August seems to be the usual time for the appearance of the worm on the mainland, on the coast of Georgia, in the neighborhood of Savannah, the testimony of Dr. J. S. Lawton, on the sea islands off the coast of South Carolina to the northward of Savannah, is to the effect that the worm appears sometimes as early as July and is then usually excessively injurious to the long-staple cottons.

In Southwestern Georgia the worm is noticed as early as the last week in June in some years, and the main damage inflicted in the State seems to come from this quarter. The worm occurs there every year, though the date at which it is noticed varies. The question whether the earliest so-called "brood" is the first appearance of the worm in any quarter has been raised by yourself, and is one to which I hope to be able to pay close attention in the spring.

For the present we must accept the testimony that the worm seems to advance from Southwest Georgia over the western and occasionally over the central portions of the State. It seems to come from Decatur to Baker, Calhoun, Dougherty, and Lee Counties. According to present testimony its appearance is not simultaneous over this section of the State, the southern portions being first visited.

From testimony collected by myself in Athens, on the occasion of the meeting of the Agricultural Society of Georgia, the following counties are visited by the cotton-worm every year, though the exact time is not, according to testimony, the same: Calhoun, Decatur, Dougherty, Lee, Macon, Schley, Taylor. Counties in which the worm is not noticed every year are Burke, Clarke, Fulton, Green, Hancock, Jones, Monroe, Putnam, Richmond.

It will be seen that the central portion of the State is less subject to the devastation of the cotton-worm than the southwestern and western. Under the theory of its gradual spreading from south to north we may suppose a seaboard source of infection and one from the southwest and the State of Alabama.

Collections of other insects on the cotton-plants, which I found in my journey from Savannah to Atlanta, were made and forwarded to you. At Atlanta I found the larva of *Citheronia regalis* feeding on the cotton-plant at the end of August. This species occurs singly, and although of large size never does much damage. There is but one brood in the year, and the larva feeds besides on the gum, persimmon, walnut, and hickory.

From the Hon. Robert Toombs I learned that there was an emigration of French cotton-planters in Martinique to Southwest Georgia in 1801–1802 on account of the ravages of the cotton-worm in the West Indies. Mr. Toombs sold his plantations in Southwest Georgia on account of the ravages in 1835 committed by the cotton-worm in Early and Clay Counties. The cotton-worm has been shown by me to be a tropical insect in my paper before the American Association for the Advancement of Science, read at the Hartford meeting, and the fact must be conceded that prior to the cultivation of cotton in the United States it could have made no foothold in our territory.

I received in November, 1878, fresh instructions from you to proceed to Georgia for the purpose of ascertaining whether I could find eggs from the last moths on any portion of the plant and any facts bearing on the hibernation of the moth. On the plan-

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tations near Savannah I found that the worm was first noticed the current year on September 4. I found a large number of chrysalides yet on the plant on November 10 to 25. The nights were frosty and the leaf withered and scant. In places sheltered by trees the leaf was still green, and here I found (November 16) a few caterpillars not yet spun up. A large number of the chrysalides were empty; about 40 per cent. contained the parasites, the most numerous of which were pupae of *Pimpla conquisitor*. There were also a number of *Tachina* larvae noticed. Less than a quarter of the chrysalides contained the undeveloped moth.

I carefully searched the stems without finding any eggs of the moth. An examination of the woods, logs, and brushwood yielded no chrysalides of the cotton-worm. From the appearance of the chrysalides on the plants it must be conceded that the last worms do not quit the plant nor prepare themselves for winter in any way. In my opinion the chrysalides which do not yield the moth and are retarded by the severity of the weather cannot conceal themselves in any way in the ground, and must probably perish from the cold or in the process of removing the dead plants to prepare for a fresh crop of cotton.

Under your instructions I visited the Georgia sea islands during the end of November and beginning of December. I found that the worm had appeared this year in September, as on the mainland, but later in the month. It had also not spread, and had attacked certain corners of the fields, where I now found the chrysalides. None of these contained undeveloped moths; they were either empty or ichneumonized. There had been no second brood of the worm on the islands, according to testimony collected by me, and which was borne out by my own observations.

I returned to Washington in December, reporting to you my observations, and having previously mailed to you specimens collected by me. On this trip I found the case of what is probably a large *Oiketicus*. The presence of this genus in the United States is indicated by Abbott, in Harris's Correspondence, edited by Mr. S. H. Scudder. I had previously examined the Cuban species *O. Poeyi*, but until now had never met any species in our American collections outside of the West Indies. The specimen was fastened to the main stem, near the top, of a cotton-plant, on a plantation near Savannah. It was duly mailed to you, and if it is reared will be interesting from a scientific point of view.

As the result of my late observations I may say that the fact, I think first announced by myself, is confirmed that the "cotton-worm" passes the winter, when it survives at all, as a moth, and that the last fall worms do not leave the plant to web up. The full history of the worm in Georgia can be made out when the country is fully explored in the spring, and before the first appearance of the worm in numbers. It will then be made clear where the first large numbers of the worm come from; whether they are the results of fresh invasions of the moth, or are the product of a first generation from eggs of hibernating individuals. In the mean time my present and former observations go to prove that the successful hibernation of the moth is not accomplished in all localities of the cotton-growing States, and that there is a general dispersion of the insect in the moth stage from south to north.

Under your intelligent supervision of the inquiry and with the facilities which you possess from different sections of the South, I have no doubt that this important matter will receive final and full elucidation.

My thanks are due to Mr. Y. Rauers, of Saint Catharine's Island; Dr. W. S. Lawton, of Savannah; Messrs. T. G. Hall, of Macon, Ga.; J. E. Redwine, Hull County, Georgia; E. C. Grier, Griswoldville, Jones County; Y. Pinckney Thomas, Waynes Bluff, Burke County, Georgia; State Geologist George A. Little, of Atlanta, Ga.; and others who have assisted me in my work.

Yours, respectfully,

A. R. GROTE.

BUFFALO, N. Y.

REPORT OF E. H. ANDERSON, M. D., OF KIRKWOOD, MISS.

SIR: I herewith have the honor to make my general report, summarizing my observations upon *Aletia* during the past season. It would be a mere repetition, and therefore a work of supererogation, to enter into any description of the insect, either as moth or larva, as this has been already well done by expert entomological observers, and I shall confine my remarks to a few of its features more intimately concerned in its propagation.

Owing to highly-favoring atmospheric conditions, the insect was to be found throughout this cotton-belt, but, as usual, infested and ravaged certain portions to a much greater extent than others. Its history and mode of operation in my immediate locality would furnish a synopsis of its operations everywhere, as all the laws under which

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it lives and moves and has its being were in full operation here. It appeared as early as July in a few fields, and, passing through three generations, left not a leaf behind. In others, it appeared later, doing less damage, but leaving no vegetation. In others, later still, doing but slight damage, but eating and destroying until arrested in its course by frost. In other cases it appeared early, doing no noticeable damage. It was preceded by our grass-worm, which I have only observed in the early summer or spring, and of which I have never seen two broods in one season, and which never proves damaging to cotton, though it will to a limited extent cut it down when young and eat the leaves of older cotton. This grass-worm and *Aletia* are often confounded, and some of our most intelligent planters insist that *Aletia* is the progeny of the grass-worm, and they base their belief upon the fact that where you find the grass-worm early in the season, in from twenty to thirty days you are sure to find *Aletia*. They think the difference in appearance is owing to an advance in the season. A comparison of the insects and their different modes of pupation settles this question conclusively. *Aletia*, with its bright stripes, yellow head spotted with black, its false ventral feet, consequent looping gait, with each of its sixteen sections having sixteen black spots or tubercles, from which a hair or bristle projects, and its general business-like carriage, once known, cannot be mistaken for any other.

The first cotton-worms were observed here last season about the 20th July, in a field of about 25 acres and in the lowest spot, the first generation destroying about 3 acres of cotton. There were none to be found there in any other field, and none nearer than 30 miles south, near Canton. This 25-acre field was isolated and surrounded by forest.

Did the moth come by migration or was it bred there? June and July had been characterized by frequent rains; but from the first appearance of the worms the showers were becoming occasional, and nothing indicated the arrival of the miller or moth. From the first to the last of August, while showers were occasional, the worm continued to appear in different fields; in the older fields first, in the newer and fresher later.

MIGRATIONS.

This might be accounted for by short migrations of the moth, but more naturally from its being indigenous. That the worm appears in different latitudes, earlier south and later north, as thermal temperature increases, there is no doubt; and under this law of development it reaches its ultimate northern limit last. Close observations of the moth and worm furnish no indications of a migratory tendency. The moth secretes itself by day, and at night confines its flight to a limited area; and instead of spreading or depositing its eggs over a large area, seems to concentrate them, and occupies just as much as will be eaten by each generation and no more. The worm seems averse also to migrate; and, as has been noticed by others and myself, will eat up to a line and will not cross it, and, it has been asserted, will not eat other cotton if placed upon it. Where they have stripped a field I have seen them wandering in the grass, on fence-rails, and the sward on the outside of a field, looking, probably, for food or to pupate. The migratory theory is doubtless based upon the supposition that the insect does not hibernate in any form in this latitude, and even two degrees south of this. Upon this point observers differ; and it is not only an interesting question entomologically, but one of vital interest to this commission, as its objects cannot be successfully accomplished until we arrive at something like certainty as to the history of the insect.

For twenty years past I have been a casual observer of the cotton-worm, and, as far as my memory serves me, recollect it as an annual visitor, often in such small numbers as to attract no attention, but occasionally to have proved very damaging. My attention was first arrested by a phenomenal mode of generation, of which I could get no explanation from my more experienced planting friends, I therefore took the subject into mature consideration. In this case, the eggs of the moth, though no moth had been seen, had been deposited on the cotton and were there hatched, the larva destroying all the leaves and young bolls along fifteen or twenty furrows, but did not touch the adjoining rows on either side. This was in July, 1858. They passed into chrysalids on the stalks and then disappeared, no other cotton being visited that season. I have frequently since seen them appear in the same mysterious way, and have verified my predictions as to their appearance at a particular time and place.

THE EGG.

Regarding, as I do, the insect as indigenous and the chief function of the moths to be reproduction, the eggs would be speedily laid, after copulation, upon the cotton-leaf, awaiting the natural process of development. This, under favoring atmospheric conditions, proceeds annually, to a limited extent, under solar evaporation. This theory may be exemplified by a topographical feature, which has been strongly emphasized by some observers, and offers a solution of what might otherwise be unaccountable. Parts of a field often escape and seem to be avoided by the worm, while adjoining cotton may be totally eaten out. This is notably the case on the eastern side of fields, but may occur at any shaded point. I noticed a field, this season, where the worm had

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destroyed all the foliage in the field, except a strip along the eastern fence where the cotton was tall and luxuriant. The fence was skirted by forest from 60 to 80 feet high, and consequently the rays of the sun did not strike the cotton until about ten o'clock. I found a few worms there and eggs abundantly. My conjecture was that, as the sun did not strike the cotton until the morning dew had all evaporated, the true condition for hatching by solar evaporation was absent and the larger proportion of the eggs remained unhatched. The explanation would be, that the egg being albuminous and hence nitrogenous, as well as all eggs are, and being coated with a gelatinous or mucous outer coat as well as a denser inner coat, the egg membrane proper would be subject to both the chemical and vital laws under which all germination occurs; that is, heat and moisture induces in all nitrogenous matter fermentation and decomposition, and this increased heat hastens the vivification of the germ which would organize under its vital law.

Suppose, however, solar evaporation to be intensified by an artificial process, would not hatching necessarily proceed more rapidly? In the nature of things it inevitably would, and as far as eggs came within its influence they would be speedily hatched. The process referred to is that of plowing land when wet, under a hot sun. The effect is to destroy capillarity and expose the up-turned furrow to rapid evaporation, by which means the volume of air surrounding the cotton would be loaded with vapor and the temperature increased 10° or 12° F. This process effects in a short time, perhaps a few minutes, what ordinary solar evaporations or telluric radiations would not effect in a season. You likewise, by this bad tillage, give back to the air the fatness of the earth, for you thereby extricate the valuable gases which a bounteous Heaven has sent, and it really seems to me that the worm is a just retribution.

I have repeatedly brought the egg of *Aletia* in from the field this season and placed it under the solar microscope. As seen by the naked eye, it is a minute green globule, as large as a celery-seed and somewhat greener than the leaf upon which it is found. [I have rarely seen more than four eggs upon any one leaf, sometimes near together, but oftener far apart. All invariably attached to the under part of the leaf by a gumming substance secreted by the mother moth in incubation.] The egg varies from a deep green to an almost transparent color, according to age; and those gathered late in the fall are darker and almost black. On being broken they were found to contain a translucent fluid. Under the microscope it exhibits the conical shape and curved ridges, radiating from apex to base, so well described by others, and presents the appearance of a granulated diamond, sparkling from innumerable points. Being so minute I can say nothing of its internal structure, but, from its bursting under pressure, knew that the investing membrane is indued with elastic power and affords to the germ requisite protection; and as it only changes color and shrivels as the season advances, retaining its contents clear, I am disposed to think it may survive a winter. I am now testing its capability for hibernation in different modes; have some on leaves in my house, some under ground, others in boxes under earth, and others suspended in the air in muslin cages. All look black except those that have hatched. As cold could only affect the vitality of the germ by its intensity, and the chemical forces that would promote vital activity are dormant under its influence, I conjecture that the egg falling to the ground with the detritus of the plant and covered by earth would remain quiescent until acted upon by its appropriate stimulus, heat and moisture, and this would not be sufficiently potential until June or July in this latitude.

Professor Riley, in his admirable report upon the grasshopper of the West, showing a degree of patient and thorough investigation rarely equaled, gives a minute description of the process of oviposition, and announces clearly the physiological law under which the hatching of the egg must occur, and in his experiments, where he transferred the eggs, after repeated freezing and thawing, to moist earth, intelligently consulted nature and artificially produced the best condition for hatching. The moist vapor created by radiated heat, permeated, perhaps, by gases, was the most propitious menstruum.

THE CHRYSALIS.

Many of the chrysalids brought in by me came forth perfect moths. From the shell, in other cases, issued the ichneumon fly; in some cases the sole occupant, in others the co-tenant of a dead moth partly consumed. I brought them in from the field as late as the 16th of November, full of vitality. To-day, January 7, 1879, I examined several taken from boxes of earth, glass jars, and gauze cages, all placed in my piazza, in the outer air, subjected to all the changes of the season, with the thermometer for the last twenty-one days at or below freezing, and once or twice as low as 28° below freezing, and on warming them they showed animation, and their movements became very sensible. I have no doubt about carrying them through the winter successfully. Many of our most observant planters affirm that they plow them up every spring, and find them alive. Many of them perish, but enough survive to perpetuate the species. The earth affords protection by concealing and by warmth—in the one case protecting against enemies, such as hogs, birds, &c., and in the other against inclemency of season. Could planters be induced to harrow their lands in winter, thereby exposing them, a great majority would be destroyed.

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THE MOTH.

The moths that issue from the surviving chrysalids are doubtless the progenitors of our first brood of larvae, reproducing slowly until favored by propitious circumstances. Being of the owlet family, and flying only at dusk and at night, the study of its habits is rendered very difficult. From the chrysalids I obtained a number which I kept in confinement. They were supplied with sweets, and ate voraciously; indeed, it was interesting to see with what adroitness they projected their suction-tubes and maneuvered its patulous end in the molasses as it trickled down the jar. They laid their eggs abundantly on the sides of the jar and on the muslin covering of the top, but none survived the twenty-second day. They commenced dying on the fifteenth day, and by the twenty-second all were dead. This was in September. In October and November they did not live so long.

As we have good reason to believe that each generation proceeds from the moth of the immediately preceding generation, and from experiment and observation I am forced to the conclusion that the moth does not survive its generation, I bred them, and they were in cotton-fields all around me; but since the 1st of December, though diligently searching, I have been unable to find a living moth. Throughout the season I have been trying to find out what it feeds upon, knowing its fondness for sweets in confinement, but without success.

Learning from Professor Riley of his discovery that the moth visited the plant to feed upon a sweet which exudes from a notable gland on the middle rib of the cotton leaf, I watched often, hoping to detect them in the act of sucking, but without success. The establishment of this fact and the secretion of this sweet at a certain stage of maturity of the plant, and the further fact that this secretion is more active at night, as vegetable physiology would induce us to suppose, would throw a flood of light upon the history and habits of the insect. As an instance of the effect of light and its fondness for sweets, I will mention what a neighbor told me, and for which, to a great extent, I had ocular demonstration. He was engaged in boiling sirup from the first of September to the last of October. His yard, where his evaporating-pan was, opened upon a field of 60 or 80 acres of cotton. He each morning found his pan covered with moths, and from first to last thought he had emptied out one bushel of moths.

Another case showing strikingly the effect of light and sweets was told me by a highly valued Texas correspondent. A neighbor of his, by the use of lights and poisoned sweets, had made 1,000 bales of cotton on 1,000 acres, while his neighbors who had not used them had been badly damaged. I experimented with poisoned sweets, using salicylic acid and molasses and other poisons and sweets, and though fatal to moths it was so, likewise, to birds and innocuous insects. Humanity here enters a plea that should not be ignored by avarice. Lights and simple sweets would destroy numbers without injury to others. For the worm or larva some arsenical preparation, and as far as my knowlege goes that of Preston and Robira, called the "Texas Cotton-Worm Destroyer," is the best before the public. This is used by pumping it on the cotton. If a cheap and effective machine could be invented for its thorough application the worm might be exterminated, but the trouble and expense and the prejudice against the use of poisons would preclude general use.

EXPERIMENTS.

My experiments during the last season were entirely of an agricultural character and were made with a view to test my own theory. They were not initial, for I had practiced them during the last thirteen years, and could anticipate the result from former experience.

I selected various fields, some undulating, some bottom land, and others hillside. In some cases sandy, in others loamy, and in others clayey. In all cases the work was done where there was no appearance of moth or worm. The work was sometimes done with the bar-plow and sometimes with the solid sweep.

Case 1.—Solid sweep used July 25, second day after rain; condition of land tillable, except in one low spot, the former bed of a small pond, which was then wet enough to clog the sweep. Worm appeared in this spot in ten days after plowing.

Case 2.—Bar-plow used; valley land, sandy and loamy. Ground wet, and so wet that the furrow rolled over without breaking. This was on the 26th July. Grass-worm appeared there in ten days.

Case 3.—Undulating land, loamy and fresh. Bar-plow used 1st of August. Soil too wet to break before the plow. Worm appeared in ten or twelve days.

Case 4.—Land rich vegetable mold and sand, with some clay; partly upland and bottom. Edge of upland plowed 10th of August while wet. Bottom land too wet and not plowed. In twelve days worms appeared on the plowed land; none on the unplowed.

Case 5.—Rolling land, sandy and loamy. Had plowing done on the 12th of August in the bottom. Land wet, clodding before the plow; plowed part of the field. In ten days worm made its appearance as far as plowing extended and no farther.

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While conducting these experiments I had plowing also done where the land was in good tilth and pulverized before the plow, and no worm appeared, though visiting these fields three or four weeks later, I found a second brood of worms, the progeny of the first. Now, in all of these cases, had the plowing been deferred until the soil had become dry enough to pulverize, the speedy generation of the worm would not have occurred. I had one field of my own cultivated with a due observance of the principle here announced, and though the worms visited it they did it no damage, and this was noticeable in other fields in my neighborhood, cultivated upon the same principle.

I have endeavored, in the foregoing report, to introduce and elucidate all the points involved in my theory, and have recapitulated in order to familiarize and impress them upon the minds of planters, as they are to be the chief recipients of any benefit that may arise from them, and through whose instrumentality they are to be tested. Of them I ask a careful study of the plan proposed, and an impartial verdict of its efficacy.

From my observation this season, aided by previous knowledge of the subject, I offer the following postulates:

1. That the insect *Aletia* is indigenous.
2. That it does not hibernate as moth.
3. That it does hibernate as chrysalis or pupa.
4. That the egg is probably capable of hibernation.
5. That solar evaporation is the normal mode of hatching, and that this occurs annually.
6. That a favorable meteorological condition, of uncertain periodical recurrence, increases largely the number hatched.
7. That plowing wet land under a hot sun produces an artificial heat and is the most prolific source of speedy generation.
8. And finally, as a corollary deduced from the above, that, by the intelligent application of the principle indicated to the culture of cotton, we may more effectually arrest the ravages of the cotton-worm than by any plan yet suggested.

REPORT OF JUDGE WM. J. JONES, OF VIRGINIA POINT, TEXAS.

I beg leave to submit the following report of my observations upon the origin and best means of destroying the cotton army worm.

The circulars and blanks from your department designed for distribution among the most intelligent planters, mailed to my address early in August, did not reach me till the 24th of October, being of that class of mail matter interdicted by our local quarantine regulations, and were not permitted to cross the borders of the State until the time mentioned. This detention prevents me from presenting any facts or expression of opinion from those for whom the questions formulated were designed. Owing to this delay I decided in the latter part of August to visit in person some of the planters near the several lines of railway, and to open some communication with others farther removed, submitting such questions as could be embodied in letter form, asking for such information as they could furnish on point in question.

To these letters some brief answers have been returned, but disclosing no facts differing from those already well known concerning this destructive insect.

The present year has been chiefly noticeable from the fact that a large portion of the State heretofore afflicted with its visitations has been entirely exempted from its presence.

Under instructions from Professor Riley, of the Division of Entomology, I made very strenuous efforts to procure specimens of *Aletia* and transmitted them to him, all of which were safely delivered. In answer I learn that he found among them some chrysalides differing from *Aletia argillacea*, the moth of which appears to belong to another genus. This species, he says, has not been received from any of the other cotton States, and seems to be confined to this section of the cotton-belt.

The cotton planters generally agree to the hibernation of the chrysalides of this insect. I may say with all confidence that the views of those who differ from the well-accepted theory of the worms penetrating the ground where they fall from the cotton-plant, result from their failure to scrutinize their movements as closely as others; and it is to this fact that a different hypothesis exists; but nearly every planter is well satisfied of the local development of the moth.

Such is my own unqualified conviction from the experience and close observation of thirty-five years as a planter. The few who have suggested the theory that the egg is deposited in the stalk of the cotton-plant, or that the matured insect finds protection in sheltered spots in our midst, are few in number. The natural formation of the moth must necessarily forbid the idea that its embryo could be lodged in any hard or porous

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substance. The ovipositor cannot penetrate any solid substance, and if made to adhere to the bark or outer surface the eggs would perish from exposure to the weather.

Every practical planter who has watched closely the cotton army worm knows that the egg is invariably deposited by the mother moth on the cotton leaf, mostly on the under or shady side. This egg is very small, of a pale green color, oblong in shape, and is attached by a very delicate web, which holds it firmly to its place.

The larva is hatched from this egg in from three to five days, being somewhat influenced by the conditions of the weather. If too wet or very dry the eggs often perish outright. At the first stage of life the larva are scarcely visible to the naked eye, and are only known to be at work by the rank smell of decaying vegetation, the odor from which can never be mistaken. In from nine to eleven days the full-grown worm weaves a delicate web about itself, and when fully enveloped or protected by its own plexus descends an attenuated thread to the ground, where it makes its own hiding place and in time transforms into the moth. This process is repeated till three generations have appeared, consuming every cotton leaf and leaving the stalk as bare and sere as though withered by the nipping frosts.

Great numbers of these chrysalides are plowed up every planting season, when they perish from exposure on the surface of the ground or are consumed by the feathered tribes that follow in the wake of the plow.

I have watched the flight of the moths, when they have unearthed themselves, have followed them for long distances, and have always found them extremely clumsy on the wing, alighting in the grass, weeds or cotton every fifteen or twenty steps, and I am convinced that they are incapable of long or extended flight. They cannot, therefore, come every season from another or distant climate. They have found here a congenial sphere and a limitless supply of food.

With all these established facts, both science and observation have yet failed to explain why the moth disappears for years, then reappears in full force and undiminshed numbers upon the field of its operations.

My own recollection is distinct, and is confirmed by all the older planters, that in this State for a period of ten years (from 1853 to 1863), the cotton army worm disappeared almost entirely from our fields. From 1864 to 1874 it appeared every year in great numbers south of the 32d parallel.

In 1875 it was found only in small numbers, and in detached localities, inflicting slight damage. In 1876 and 1877 it covered the land in the midst of a prolonged drought, while the leaves were crisp, devastating the crops where not checked by the use of some poisonous compound.

This leads me to note some suggestions upon the use of poisons and the proper mode of applying the same, based upon the correctness of the theory that the moth is now naturalized in the cotton region, as through these agencies this pest may be in time annihilated and the planting interest saved an annual loss of thirty to forty millions of dollars. But this can only be accomplished by the combined effort of skill, labor, and capital and the general use of a cheap and simple poisonous compound.

From experiments which I have made of every destructive agent, I have found nothing so cheap or more effectual, and with all so little likely to effect injuriously the cotton-plant or the distributor of the poison, as a mixture of the arseniate of soda and water in certain given proportions.

This mixture is now prepared at the Soda Chemical Works under a patent issued to John D. Braman, in May, 1874. This preparation has been extensively used, and, where printed instructions were strictly followed, has never failed to kill the worm in brief time without any sensible injury to the plant or its fruit, and in no wise affecting those who applied it, as has often been the complaint against Paris green. The present cost does not exceed 25 cents per acre, while the green, if genuine, will reach near $2 per acre.

Considering the manifest advantages and the immense saving in the crops it is certainly the duty of legislative powers (either Congress or the several State legislatures of the cotton-growing States) to devise some measure which will place both the poisonous compound and some efficient agent for its distribution upon the cotton within the reach of every laborer engaged in its cultivation. Such a measure cannot fail in due time to eradicate this ravenous insect.

There are many well-known devices for the extinction of the moth, the prolific mother of the cotton army worm, all of which, upon a limited scale, have proved more or less successful, but equally requiring capital to make a larger scope of experiment by the use of torches or lighted lamps placed in the cotton-fields, at suitable distances, with poisonous liquids to attract the moth. This view of the question seems to have attracted the special notice and observation of Professor Riley, under whose instructions I have just concluded some experiments, which have been fully reported to him and are well worthy of farther trial at the proper season next year. I was well satisfied from the results of my experiments that a large portion of the mother moths may be destroyed.

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All theories discussed in this report are valueless except as suggesting methods to the practical planter of checking the ravages of the cotton army worm.

All of which are most respectfully submitted by

WILLIAM J. JONES.

VIRGINIA POINT, TEX.,
November 8, 1878.

Hon. WILLIAM G. LE DUC,
Commissioner of Agriculture.

REPORT OF PROF. J. E. WILLET, OF MACON, GA.

THE COTTON-WORM.

PAST HISTORY.

1, 1 *a*, and 1 *b*.

Mr. William Jones, Athens, Ga., now advanced in years, planted cotton in Liberty County, Georgia, from 1825 to 1865, and kept notes on the cotton-worm. He writes: "Cotton was introduced into Georgia, as a crop, between 1790 and 1800." Correspondents in the older eastern counties give 1800 to 1810 as the date of the introduction of cotton into their counties.

Mr. William Jones says: "The cotton-worm first made its appearance (in Liberty County) in 1804, and during the month of September the crops were half eaten up, when a hurricane swept over the country and destroyed the worms."

Mr. I. C. Plant, of Macon, Ga., and Dr. E. L. McTyre, of Thomasville, Ga., think they are transported from one country to another in cotton-seed. Mr. Plant married in Glynn County, Georgia, and has been familiar for years past with the best planters on the islands and on the Atlantic coast of Georgia. Mr. Plantstates that the father of Hon. James Hamilton Cowper, of Saint Simon's Island, and Mr. Armstrong brought the first cotton-seed to Glynn County from the Bahamas, and that the cotton-worm was first observed after the second importation of seed, some seven years subsequent to the first introduction. Mr. Plant further states that he has seen in an English paper that the cotton-worm first appeared in Egypt some years since, and just after an importation of American cotton-seed.

Dr. E. L. McTyre, of Thomasville, Ga., writes: "I settled in the province of San Paulo, Brazil, in the year 1866, and remained there eight and a half years. The cultivation of cotton was of recent date then, and they were planting their fourth crop when I arrived. Prior to the year 1863 there had been some cotton planted in the country, perhaps of an indigenous variety, but no one had ever observed a cotton-worm, and I believe they had never existed there. In 1862 the price of cotton offering great inducements to Brazilian farmers, they sought to procure seed, but none could be had, and I was informed the seed then being used was brought from New Orleans. The first year no caterpillar was seen, but after the second they commenced to eat the leaves, and had increased to such an extent that when I moved from there the cultivation of cotton was nearly abandoned."

The statements of Mr. Plant and of Dr. McTyre are interesting, and are worthy of further investigation. Our consular agents in Egypt and Brazil can inquire into the introduction of the cotton-worm into those countries, and can procure specimens showing whether the worm is *Aletia argillacea* or an allied native species.

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Names of counties. Old.	Names of counties. New.	Latitude.	1.—Cotton first grown.	1 a.—Worms first seen.	1 b.—Destructive years.	2 f.—Destructive months.	3.—Per-cent. of losses.	5.—Moths first seen.	5 a.—Worms first seen.	Names of correspondents.
Wilkes	....	33° 45′	1805	1854	1858, 1874	....	....	....	....	G. F. Wingfield, Washington, Ga.
Walton	....	33° 45′	....	1868	1868, 1871	September	....	....	August	Hon. H. D. McDaniel, Monroe, Ga.
Greene	....	33° 35′	....	1868	1868, 1872	September	5 to 10	....	August	C. M. Sanders, Penfield, Ga.
Warren	....	33° 20′	1800	1868	1868	September	25	....	....	John S. Johnson, Warrenton, Ga.
Burke	....	33° 15′	About 1800	About 1830	About 1845, '55, '65	July and Aug.	33 to 50	Last July	....	Hon. J. B. Jones, Herndon, Ga.
Putnam	....	33° 15′	....	....	1872,-'73,-'74	September	25	....	August 1	Wm. Denham, Eatonton, Ga.
Screven	....	33° 50′	1808–1818	Earliest recollection.	....	September	....	....	....	Hon. Geo. R. Black, Sylvania, Ga.
....	Talbot	32° 40′	1829	1836	....	August	50	....	July and Aug.	W. P. Mathews, Howard Station, Ga.
Effingham	....	32° 30′	....	....	1838	....	....	....	....	
....	Macon	32° 20′	1820	1842	1868, 1873	August	10 to 20	Last June	July 1	Rev. A. J. Cheves, Montezuma, Ga.
....	Chattahoochie	32° 15′	1830	1868	1868, '71, '73	Aug. and Sept.	20 to 33	....	August 1	Dr. J. H. Wooldridge, Jamestown, Ga.
....	Schley	32° 15′	....	....	1844—several since.	August	50	February	May	Robt. Burton, Ellaville, Ga.
....	Sumter	32° 05′	1833–1834	1840	1872–'73	August	15	February	June 20	Capt. Jno. A. Cobb, Americus, Ga.
Liberty	....	32° 00′	1790 to 1800	1804	1825, 1846	September	33	Middle Aug	....	William Jones, Athens, Ga.
....	Berrien	31° 25′	About 1828	About 1858	1840, '43, '47, '52	August	25	....	....	H. T. Peeples, Nashville, Ga.
....	Mitchell	31° 15′	About 1850	....	....	August	....	June 1, 15	June 15	W. N. Spense, Camilla, Ga.
Glynn	....	31° 15′	1804	....	....	....	....	....	....	Wm. M. Giguilliat, Brunswick, Ga.
Leon, Fla	....	30° 30′	As early as 1827.	1830	Nearly every year now.	July and Aug.; formerly Aug. and Sept.	....	Last of May	May 12	Maj. Robt. Gamble, Tallahassee, Fla.

REMARKS ON THE TABLE.

The materials for this table are quite scanty, as I received only about twenty replies to seventy-five circulars sent out, and Southwestern Georgia (Baker, Dougherty, Lee Early, Decatur, and Lee counties), where the worm most abounds, is scarcely represented in the correspondence.

1. Cotton was introduced into Georgia, on the coast, about 1800, and then rapidly into the older eastern and northeastern counties. It was introduced into the newer western, southwestern, and northern counties from 1820 to 1834. Leon County, Florida, grew cotton in 1827, if not before.

2. The cotton-worm was first seen in 1804, on the coast, a few years after the first cotton. It was first seen in Leon County, Florida, in 1830. It was not noticed elsewhere in Georgia probably before 1830; and in the four northern counties reported not before 1854 and 1868.

3. The destructive years reported are 1804, '25, '36, '40, '42, '43, '44, '45, '46, '47, '52, '54, '68, '71, '72, '73, '74. Especially bad, 1804, '25, '46, '54, '68, '71, '72.

4. The destructive months are July, August, and September, governed mainly by latitude.

5. First moths and worms appear in Florida in May; in some years, in southwestern Georgia, in May, and in counties further north in July and August.

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2, 2*a*, *b*, *c*, *d*, *e*, *f*.

Most correspondents agree that warm, wet summers favor the multiplication of the worm; some specify that in hot, dry weather the young larvae die soon after hatching. As to the effect of winters, several correspondents think that mild winters favor the worms. Major Gamble, of Tallahassee, Fla., who has planted cotton in Middle and Southern Florida from 1827 to the present time, says, "showery weather in June and July after a mild winter" is favorable to the insect, and that "cold weather is injurious in proportion to its rigor." *Per contra*, Mr. Jones, who planted in Liberty County, Georgia, from 1825 to 1865, writes: "The years preceding the most destructive appearance of the worm were characterized by warm summers and severe winters." On 2*a* he says: "I have seen the worm in both wet and dry seasons, and the only difference noted was that in wet seasons the growth of the cotton was more luxuriant, and the worms had more to feed on."

3.

Losses are stated very differently, as seen from the table. They are doubtless different in different sections, being greater where the worms come oftener and in greater force. Twenty-five per cent. for destructive years is probably a fair mean.

4.

Capt. L. S. McSwain commenced careful meteorological observations in Thomasville, Ga., in April last, and gave me a record of winds, as follows: April, S. E.; May, S. E.; June, S. W., and July, S. The United States Signal Office has regular stations at Savannah and Augusta, Ga., and Prof. F. J. M. Daly, of Pio Nono College, Macon, Ga., reports also to the same office. These reports will give the department full information on the winds.

Correspondents agree almost unanimously that the worms do not eat on any particular side of the field; if at the sides, always with reference to the condition of the crop. Most commonly they appear in the body of the field, in low, rich places, or in luxuriant cotton at any point. My own observation this year corresponds with this statement.

The general testimony of correspondents is that the worm feeds only on cotton. One says he has known them to eat corn-blades and crab-grass; another told me they attacked his sugar-cane. *Per contra*, I confined them twenty-four hours on the leaves of sugar-cane and of okra, but they disturbed neither. Mr. Jones has likewise confined them on various species of *hibiscus*, allied to cotton, but they ate none of them.

5, *a*, *b*, *c*, *d*, *e*, *f*, *g*.

Several report seeing moths in February, but there is no certainty that they were the cotton-moth. Major Gamble, Leon County, Florida, reports seeing moths in the cotton-field the latter part of May. Mr. William Jones reports from his notes, first worms in Liberty County, Georgia, as follows: "The worms first made their appearance in September, 1804, then not again until late in September, 1825; then September 5, 1840; September 19, 1843; August 18, 1846; August 26, increasing largely; September 14, fields almost stripped; by the 19th the fields were completely stripped. August 20, 1847; August 18, 1852, these two years no harm done. I stopped planting in 1865; I have kept no notes since." Major Gamble gives from his notes, first worms in Leon County, Florida, 1869, May, 12; 1872, June 29; 1873, May 24; 1874, July 2; 1875, June 24; 1877, June 19; 1878, June 15. He also says: "Previous to the introduction of new improved seeds they were observed about the middle of August. Referring to an old journal which I have by me, and kept by me, I discovered a few August 11, 1841. The winter of 1841 was cold, and in 1842 there was no damage to the crop by the caterpillar. The winter of 1842, I find, was mild and drier, the first frost, November 10, killing the cotton, which was then green. July 15, 1843, I find a caterpillar chrysalis—the crop of this year was destroyed." Mr. Jones planted before this early maturing of cotton, and his dates would now be earlier.

Correspondents usually report three broods. The larvae draw together the flexible green leaves of any plant in the cotton-fields to form a resting place for pupae.

Most correspondents make no mention of the chrysalis in winter. Hon. J. B. Jones, Burke County, says: "They are to be seen in the chrysalis state *after frost*, I think, but do not believe they survive the winter." Mr. William Jones, Liberty County, says: "I have collected a number of chrysalides and hung them in a northern exposure, where they survived a temperature of 12° Fahr. After this I left home and watched them no longer." Mr. William Denham, Putnam County, reports finding chrysalides alive under the bark of trees after frost, and Mr. Spencer, Mitchell County, finding some in an old stump. There is no certainty that they were the pupae of *Aletia*. Some farmers believe, from seeing brown pupae plowed up in winter and spring, that the larvæ of *Aletia* may accidently fall into cracks or holes in the earth and there pupate and spend the winter.

6.

Correspondents report the natural enemies as birds (specifying bluebirds, rice-birds, and quails), chickens, turkeys, wild and tame; dogs, hogs, ants, and wasps. The two

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last visit the plants, it is probable, the ants in search of spiders, and the wasps to suck the sweets secreted by the leaf and boll glands. I have seen honey-bees and species of wasps thus busily engaged from day to day.

7.

No great attention has been paid to the destruction of the moths, lavae, and chrysalides in interior Georgia, inasmuch as the insect was not very destructive till some ten years since. On the coast and islands it was the custom of planters, many years since, to burn all stubble in the cotton-fields during the winter.

In 1872–'73 the most determined attempts at destruction were made in Southern Georgia with lamps and molasses for the moths. Paris green and arsenious acid for the larvae, and hand-picking for the larvae and chrysalides. As samples, Capt. John A. Cobb, Sumter County, writes: "I tried the caterpillar lamp, burnt over 100 of them for several weeks, spent several hundred dollars in the experiment, but do not believe it paid. If all my neighbors had used the lamps the result might have been different. But I believe my lamps attracted more flies from the adjacent fields than were killed by them." Mr. R. Burton, of Schley County, writes: "I have used plates of sweetened water, fires on stumps, lanterns, caught and destroyed thousands (having found 50 millers in one plate of molasses and water) with but poor success."

Paris green mixed with flour and slippery-elm bark and arsenious acid in water, one pound to the barrel, were used in Dougherty and adjoining counties in 1873. The former was sifted and the latter sprinkled by hand on the cotton-plant. Maj. R. J. Bacon, of Albany, says he thereby saved a large crop of cotton, but thinks the expense about equaled the value of cotton saved.

Rev. C. S. Goulden, of Thomasville, Ga., employed women and children to collect the caterpillars. They kept the plants free from worms, but the expense about equaled the saving.

Capt. G. M. Bacon, Mitchell County, encouraged the gathering of the chrysalides by paying so much per quart for the pupae, free from all leaves and trash. He thus secured and destroyed the very large quantity of 9 bushels and 27 quarts. He doubts whether there was any pecuniary gain.

J. E. WILLET.

MACON, GA.

REPORT OF WILLIAM TRELEASE, OF BROOKLYN, N. Y.

HABITS AND NATURAL HISTORY.

Belonging to the Lepidoptera, *Aletia* has a complete metamorphosis, passing through four well-marked states of development, viz, egg, larva or caterpillar, pupa or chrysalis, and imago or moth. These will be considered somewhat in detail in the order in which they have been mentioned, and this discussion will then be followed by some general remarks concerning the number of broods which occur each year, and the way in which the species is perpetuated from one year to another.

In the section of Alabama where I studied *Aletia*, I found comparatively few planters who knew the appearance of the egg from which the cotton caterpillar is hatched. Most of them readily admitted that the reason they had never seen the egg was because they had never looked for it; but occasionally one was found who emphatically stated that the "cotton-fly" never lays eggs, but deposits little caterpillars on the leaf, "for," he would say, "I've been about cotton a good many years, and I never saw an egg, but I have seen thousands of little caterpillars." Negative evidence was all-convincing to such men; and their signs of disgust, when told that the men who had paid most attention to this subject always found eggs, were very amusing.

To find these eggs when there are few of them—as in the early part of the season—is by no means an easy task; for, until the species becomes largely represented, there is rarely more than one egg to a leaf, and perhaps only one leaf on every ninth or tenth plant bears even one egg. When, however, the moths, or "flies," as planters call them, are seen in large numbers about the cotton-fields, eggs may be found on nearly every plant, the fewest being on stunted plants which have ceased active growth. These eggs are, to the naked eye, depressed hemispheres, about as large as a small pin-head, their flat surface being next the leaf. They are of a bluish-green or copperas color, and this alone would make it easy to distinguish them from other eggs or plant-lice, even were it not for their peculiar form. As a rule, planters see the first signs of the caterpillar on the upper, tender leaves of a cotton-plant, and, without looking for the eggs from which the larvae that they see were hatched, they conclude at once that the eggs are laid almost exclusively on those leaves; but, as we shall see, this is not the case. In July, when the eggs were being laid from which the fourth brood of larvae should emerge, I noticed that most of those that I found were deposited singly on the lower surface of rather tender leaves near the top of the plant or the ends of the

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branches, though not on the very young leaves. Late in August, when the eggs for the fifth brood were being laid, I found from one to nine eggs on some leaves, while other leaves bore none; and those which bore eggs were, as a rule, large leaves near the middle of the plant. The average number on one of these leaves I judged to be about four. To get more accurate results I examined, leaf by leaf, three plants, with the results given below, and these partially confirm my previous observations. In these tables the branches are counted from below upward, and the leaves, from the base of a branch to its tip. Only unhatched eggs were counted, and such larvae as were too small to have been born on a different leaf from that on which they were found.

Plant No. 1, *August* 28, 1879.

Branch.	Leaf.	Eggs.	Larvae.	Branch.	Leaf.	Eggs.	Larvae.
	Number				*Number*		
Number 1	1	0	0	Number 8	2	3	2
2	1	0	0		3	4	0
	2	0	0	9	1	5	0
	3	0	0		3	0	0
3	1	0	0		3	3	0
	2	1	1	10	1	5	0
4	1	2	0		2	0	0
	2	1	1		3	0	0
	3	1	0		4	1	0
5	1	1	0	11	1	0	0
	2	0	0		2	0	0
	3	0	0		3	0	0
	4	0	0	12	1	0	0
	5	0	0		2	0	0
6	1	3	1	13	1	0	0
	2	1	0		2	0	0
	3	1	0	Stalk	1*	1	0
7	1	1	1		2*	1	0
	2	0	0		3†	0	0
	3	1	0		4†	0	0
8	1	9	0		5‡	0	0

* A medium-sized leaf. † A small leaf. ‡ A very small leaf.

This was a spindling plant about four feet high. The leaves marked No. 1, on branches 8, 9, 10, 11, 12, and 13, really belonged to the stem, the branches being in their axils, and they were the largest leaves on the plant. The leaves marked as belonging to the stalk were situated above the highest branch.

An examination of this table will show that the eggs were distributed according to branches as follows:

No. 1.

Branch.	Eggs.	Larvae.	Branch.	Eggs.	Larvae.
Number 1	0	0	Number 8	16	2
2	0	0	9	8	0
3	1	1	10	6	0
4	4	1	11	0	0
5	1	0	12	0	0
6	5	1	13	0	0
7	2	1	Stalk above 13	2	0

	Leaves.	Eggs and larvae.
The bottom	14	8
The middle	14	40
The upper	14	3
Total	42	51

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Plant No. 2, August 28, 1879.

Branch.	Leaf.	Eggs.	Larvae.
	Number		
Number 1	1—	0	0
	2±	0	0
	3—	0	0
	4±	0	0
	5±	0	0
	6±	1	0
	7±	0	0
	8±	2	0
	9—	0	0
2	1=	0	0
	2—	0	0
	3—	0	0
	4—	0	0
	5—	0	0
3	1=	0	0
	2—	0	0
	3—	0	1
	4—	1	0
	5—	2	0
	6=	0	0
	7±	1	0
4	1=	0	0
	2±	0	0
	3=	0	0
	4±	0	0
	5±	0	0
	6—	0	0
5	1=	0	0
	2±	0	0
	3±	1	0
	4±	0	0
6	1±	2	0
	2±	0	0
	3±	1	0
	4±	0	0
	5—	0	0
	6=	0	0
7	1±	0	0
	2+	1	0
	3±	0	0
	4±	2	1
	5=	0	0
8	1±	3	0
	2—	1	0
	3±	1	0
	4±	0	0
	5±	3	0
	6±	0	0
	7—	0	0
	8=	0	0
9	1±	0	0
	2±	0	0
	3±	1	0
	4±	0	0
	5±	0	0
	6—	0	0
	7=	0	0

Branch.	Leaf.	Eggs.	Larvae.
	Number		
Number 10	1±	1	0
	2±	2	0
	3±	4	0
	4±	1	0
	5—	0	0
11	1±	0	0
	2±	1	0
	3±	0	0
	4±	0	0
	5—	0	0
	6=	0	0
12	1+	3	0
	2—	0	0
	3+	2	0
	4±	0	0
	5=	1	0
	6±	0	0
	7±	1	0
	8—	1	0
13	1+	0	1
	2=	0	0
	3+	3	0
	4±	3	0
	5±	1	0
	6—	0	0
	7=	0	0
14	1+	0	0
	2—	0	0
	3+	0	0
	4±	0	0
	5—	0	0
	6—	0	0
15	1+	0	0
	2±	0	0
	3±	0	0
	4—	1	0
	5=	0	0
16	1+	2	0
	2±	0	0
	3—	0	0
17	1+	0	0
	2±	0	0
	3—	0	0
	4=	0	0
18	1+	0	0
	2±	0	0
	3=	0	0
19	1±	0	0
	2—	0	0
	3=	0	0
Stalk	1±	0	0
	2—	0	0
	3±	0	0
	4=	0	0
Buds	....	0	0

Examining this table, we find the following distribution:

No. 2.

Branch.	Leaves.	Eggs.	Larvae.
Number 1	9	3	0
2	5	0	0
3	7	4	1
4	6	0	0
5	4	1	0
6	6	3	0
7	5	8	1
8	8	8	0
9	7	1	0
10	5	8	0
11	6	1	0
12	8	8	0
13	7	7	1
14	6	0	0
15	5	1	0
16	3	2	0
17	4	0	0
18	3	0	0
Number 19	3	0	0
Stalk	4	0	0
Total	111	50	3

	Leaves.	Eggs and larvae.
Bottom third	37	12
Middle third	37	28
Upper third	37	13

NOTE.—In Table 2 + indicates a large leaf; ±, a medium-sized leaf; — a small leaf; and = a very small one.

Plant No. 3, September 1, 1879.

Branch.	Leaf.	Length of leaf.	Eggs.	Larvae.
	No.	*Inches.*		
Number 1	1	3¼	0	0
	2	3¾	0	0
	3	4½	1	0
	4	2¼	0	0
	5	4½	0	0
	6	5¼	0	0
	7	4¾	0	1
	8	1¾	0	0
Number 2	1	4½	0	0
	2	2½	0	0
	3	3¾	0	0
Number 3	1	5	0	0
	2	4½	1	0
	3	3¾	0	0
	4	4½	1	2
	5	5	0	0
	6	3½	0	0
	7	5½	0	0
	8	3	0	0
	9	4½	3	1
	10	4¾	0	0
	11	1¼	0	0
Number 4	1	5	1	0
	2	2¼	0	2
	3	5¾	0	1
	4	2½	0	0
	5	6	2	0
	6	3½	0	0
	7	2¼	1	0
	8	4	2	0
	9	5	2	1
	10	5½	1	1
	11	4½	0	0
Number 5	1	3¼	1	0
	2	5	0	2
	3	4¾	0	1
	4	3½	1	0
	5	5	1	2
	6	2½	0	1
	7	5¼	0	0
	8	5	0	0
	9	4¼	0	0
Number 6	1	5½	0	0
Number 6	2	3	0	0
	3	5½	0	0
	4	2½	0	0
	5	4	1	0
	6	5½	0	0
	7	2¾	0	0
	8	5	1	0
	9	5½	1	0
Number 7	1	4	0	0
	2	5	1	0
	3	5	0	0
	4	4	0	0
	5	4½	1	2
	6	5	0	0
	7	5	0	0
	8	4¾	0	0
	9	2½	0	0
	10	6	0	0
	11	4	1	0
	12	6	1	0
	13	4¼	0	0
	14	1½	0	0
	15	6	0	0
	16	2¾	0	0
	17	3¾	1	0
	18	2	0	0
	19	1	0	0
	20	5½	0	0
Number 8	1	6¼	1	1
	2	3	0	0
	3	6	0	0
	4	2¾	1	0
	5	5	0	2
	6	3¼	1	1
	7	5	0	1
	8	3	0	0
	9	6	2	0
	10	5½	1	0
	11	5¼	2	1
	12	4	0	1
Number 9	1	7	0	0
	2	4	2	2
	3	4	0	0

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Plant No. 3—Continued.

Branch.	Leaf.	Length of leaf.	Eggs.	Larvae.	Branch.	Leaf.	Length of leaf.	Eggs.	Larvae.
	No.	*Inches.*				*No.*	*Inches.*		
Number 9	4	3¼	2	0	Number 13	11	2	0	0
	5	6¼	0	0	Number 14	1	6⅛	0	1
	6	2	0	0		2	4¾	0	0
	7	5⅛	1	0		3	5¾	0	0
	8	3	1	0		4	6	2	0
	9	4¼	0	0		5	6¼	1	0
Number 10	1	6⅛	0	0		6	5⅛	3	1
	2	6	0	0		7	5¼	0	0
	3	3	0	0	Number 15	1	5¾	1	0
	4	3¾	0	2		2	3¾	3	0
	5	5⅛	1	0		3	5	1	0
	6	5¼	0	0		4	5	0	0
	7	5⅛	1	0		5	3⅛	0	0
	8	3	0	0	Number 16	1	7	0	0
Number 11	1	7⅛	1	0		2	6	2	1
	2	8⅛	0	0		3	5¾	0	0
	3	5⅜	0	0		4	5⅛	2	0
	4	5	0	0		5	4¼	0	0
	5	1½	0	0		6	1⅛	0	0
	6	6	1	0	Number 17	1	6⅛	0	1
	7	5¾	0	1		2	5⅛	0	0
	8	5⅛	0	0		3	5¼	0	0
	9	1¼	0	0		4	3	0	0
	10	4⅜	1	0	Number 18	1	7	0	0
Number 12	1	7	1	0		2	2	0	0
	2	3¼	0	0		3	3½	0	0
	3	4	1	0		4	6	0	0
	4	4⅛	0	0		5	6	0	0
	5	5¼	1	0		6	5	0	0
	6	6	1	0		7	2⅛	0	0
	7	5	1	0	Number 19	1	6¾	0	0
Number 13	1	7	0	0		2	2⅛	0	0
	2	2⅛	0	0		3	5⅛	0	0
	3	4¼	0	0		4	3⅛	0	1
	4	4¾	0	0		5	3¾	0	1
	5	5¼	0	0	Number 20	1	7¼	0	0
	6	5¾	0	0		2	2¾	0	0
	7	2	0	0		3	3⅛	1	0
	8	6¼	0	0	Number 21	1	5¾	0	0
	9	6	0	0		2	5⅛	0	0
	10	4¾	0	0		3	2¾	0	0

Arranging these by branches, as was done with the other tables, we find the following distribution:

No. 3.

Branch.	Leaves.	Eggs.	Larvae.
Number 1	8	1	2
2	3	0	0
3	11	5	3
4	11	9	5
5	9	3	6
6	9	3	0
7	20	5	2
8	12	8	7
9	9	6	2
10	8	2	2
11	10	3	1
12	7	5	0
13	11	0	0
14	7	6	2
15	5	5	0
16	6	4	1
17	4	0	1
18	7	0	0
Number 19	5	0	2
20	3	1	0
21	3	0	0
Total	168	66	36

	Leaves.	Eggs and larvae.
Bottom third	56	41
Middle third	56	35
Upper third	56	26

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In all of these tables care was taken to count only those larvæ which were so small that there was every probability of their having been hatched on the leaf where they were found; and the tables were prepared at the time when most of the eggs for the fifth brood had been laid and a few were beginning to hatch.

From an examination of the first table it appears that on this plant there were three and a half times as many eggs (including the young larvae) on the middle third of the plant as on the other two-thirds combined.

The second table shows that the eggs were more evenly distributed on the second plant examined than on the first, yet the middle third bore more than the rest of the plant.

It may be seen from the third table that on the third plant the distribution of the eggs was still more uniform, and here the number on the middle third is intermediate between that on the other two-thirds, the larger number being found on the bottom third of the plant.

Averaging the three tables, we find that there are 20 eggs for the bottom third of a plant, 34 for the middle third, and 14 for the upper third. The middle third averages as many as the other two-thirds taken together.

On the first plant those leaves which bore eggs at all averaged 2.7 per leaf, on the second plant 1.7, and on the third plant 1.5. On the three plants the average number is 1.9 eggs per leaf. This, I think, may fairly be taken as representing the abundance of eggs in the section where my observations were made, for the first plant was an average representative of the field in which it grew, and the caterpillars were very abundant there. The second was taken from a field where there were fewer worms, and the third was taken from a field where there were very few caterpillars before the fifth brood appeared, so that the eggs counted were nearly all deposited by moths which had come from other fields.

Oviposition being dependent upon the instinct of a living animal and not upon natural laws, figures like these will not enable us to predict where any individual moth will lay its eggs; but as instinct is pretty constant with insects they may be taken as showing what commonly occurs.

Of several hundred eggs that I examined, probably not a half a dozen were laid on any part of the cotton-plant but the lower surface of the leaves. Most of these were deposited on the lamella of the blade, a very few on the veins. Two or three were found on the upper surface of the leaves; one was seen on the peduncle or flower-stalk, about one-eighth of an inch from the base of the flower; and two were noticed on the outer surface of the involucre around the flower. As a rule they were not laid close together, yet once or twice two were found almost in contact.

Under natural conditions, late in summer, I found that the eggs of *Aletia* usually hatch in the course of the first four days after being deposited; but the time required seems to vary according to the temperature, as I found that some hatched in about two days, while others that were taken into the house required upwards of a week, and a considerable number blacken and never hatch, from some cause that I was unable to determine. After the exclusion of the larva the eggshell is of a gray or whitish color, and sometimes remains adhering to the leaf for a considerable length of time; after it has been removed there is often a faint impression to be seen where it was attached to the leaf.

When first hatched, the young larva feeds on the parenchyma of that surface of the leaf on which it chances to find itself, and it is not till it is from two to four days old that it perforates the cuticle on the other side of the leaf. The first direct signs of the caterpillar are, therefore, transparent places of small extent and more or less rounded outline, on the larger leaves of the plant. Why this epidermis should be left uneaten I am unable to say; but as the larvae are usually hatched on the lower surface of the leaf it appears that this habit may be due to an instinct teaching the larva to preserve this screen against the rays of the sun while it is very young. That it is an instinct seems to be shown by the fact that larvae hatched on the upper surface of the leaf, in confinement, ate the parenchyma from this surface and left the cuticle untouched on the lower side. Though small places are often found where young larvae have eaten the lower side of the leaf without perforating the epidermis, while the larvae cannot be found, I have no evidence that a caterpillar ever leaves the leaf on which it was born till it is old enough to eat through it; and in the cases just mentioned I believe that the larvae have been removed by some predaceous animal.

Having reached the age of three or four days, many larvae go from the tough leaves, where they have passed the early part of their existence, to the tender leaves near the top of the plant and the ends of the branches, and, eating the substance of these leaves from between the veins, which are left intact, they honeycomb or rag them, and this is generally the first sign of their presence that is noticed by planters, though when they are sufficiently numerous to make this honeycombing very noticeable a peculiar odor is perceived in the cotton-field, which seems to be due not only to the crushing of the leaves by the mandibles of the caterpillars, but to the large quantity of excrement which they void, and which, from the rapid passage of their food through their

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bodies, is only partially digested. When there are not very many caterpillars they do no more than to partly eat these upper leaves, excepting early in the season, when few leaves are expanded and the cotton-plants are very small, when a single larva has then been known to completely defoliate two or three plants. When more abundant they eat all of the parenchyma from between the veins of these leaves and rag the lower leaves to a certain extent; and when very numerous they reduce every leaf on the plant to a mere skeleton, consisting of the stronger veins, besides eating up the flowers and flower buds* and the involucres or "squares" from about the bolls, while frequently they eat large irregular holes in the half-grown bolls, and sometimes go so far as to gnaw the bark from the stem of the plant.

When there are enough caterpillars to eat the entire foliage from a plant those which are not full grown migrate in search of food on other plants, while those already grown seek some kind of leaves in which to transform to pupae. Thus it happens that after a large field has been eaten out one may see thousands of larvae of all sizes crawling in every direction over the ground. At night most of these larvae ascend the cotton-plants near which they chance to be, and remain quiet till the next day, when their search is renewed. This is the only marching that I observed.†

The natural food of *Aletia* larvae appears to be only the leaves of the cotton-plant, at least in this country. Though they were seen to eat bracts, calyx, corolla, stamens, and pistils of the cotton-flowers, as well as the walls of the boll and the half-grown seeds which it contained, and even the bark of the plant, as stated above, they were never seen to feed upon any other plant. Larvae of various sizes were several times transferred from cotton to three other malvaceous plants, but they remained on them a very short time, and did not attempt to eat their leaves. Confined in breeding jars with leaves of these plants they preferred starving to feeding upon the food given them; and the only time that I ever saw one attempt to eat anything but parts of the cotton-plant was when one of these ate a very little parenchyma from the lower surface of an okra leaf.

A strange peculiarity of this species is the variation in color which occurs in its different broods of larvae—thus: up to the middle of July no larvae were found which were not of a light green color; but of what the planters call the "first crop" in July I found a small percentage to have black or dark brown dorsal stripes. Of the "second crop," in August, about one-half were dark striped, some of them possessing lateral stripes, so that they appeared almost entirely black; and by far the greater part of the "third crop," in September, were very dark. Several larvae, of next to the last brood, were reared from the egg in dark boxes in the house, so that the only light which they received was once or twice a day, when their boxes were opened a few minutes to change their food leaves. At first they were green, though with a cloudy appearance; but as they grew older they became striped with black, so as to resemble the darkest larvae of the preceding brood. This shows that the direct action of light is not needed to produce this color change, and that it is a progressive change, keeping pace with the growth of the larvae. What its physiological importance is I am unable to say.‡

*In August, when the fourth brood of larvae were at work, I saw many of them eating both the petals of flowers and the entire contents of unopened flower buds, though there were plenty of leaves still remaining on the plants.

†In talking with planters I find that many of them apply the name "army-worm" to this species in seasons when its later broods appear in great numbers in places where no signs of the earlier broods have been seen. Their numbers are sometimes so large that two or three days suffice for them to strip the foliage from thousands of acres of cotton where no signs of the worm had been previously noticed. When there are enough of them to do that there would be a sufficient number crossing the roads about the field to give the impression of an army in motion, though there might be no system to their marching.

‡Some facts bearing on this subject of larval coloration have been collected by Sir John Lubbock (Scientific Lectures, London, 1879), but they do not suggest to me an explanation of the present case. He says, (page 49): "In various genera we find black caterpillars, which are of course very conspicuous, and, so far as I know, not distasteful to birds. In such cases, however, it will be found that they are covered with hairs or spines, which protect them from most birds. In these cases the bold, dark color may be an advantage, by rendering the hair more conspicuous." Though *Aletia* is somewhat hairy, I doubt if its coating is much of a protection, and I did not notice that the hairs were more conspicuous on the black than on the green larvas; on the contrary, I believe that they are less apparent as seen against the black background of the insect's body. Sir John finds that of sixty-six British butterfly larvae, "ten are black; and, as we have already seen, all these are spiny or hairy." When speaking of the linear markings of caterpillars (page 45), he says: "It is important that there should be certain marks to divert the eye from the outlines of the body. This is effected, and much protection given, by longitudinal lines, which accordingly are found on a great many caterpillars. These lines, both in color and thickness, much resemble some of the lines on leaves (especially those, for instance, of grasses), and also the streaks of shadow which occur among foliage. If, however, this be the explanation of them, then they ought to be wanting, as a general rule, in very small caterpillars, and to prevail most among those which feed on or among grasses. * * * But you will find that the smallest caterpillars rarely possess these white streaks. As regards the second point also, the streaks are generally wanting in caterpillars which feed on large-leaved plants. * * * In fact we may say, as a general rule, that these longitudinal streaks only occur on caterpillars which live on or among narrow-leaved plants."

As I have stated, both the production of the linear marks and the change in the ground color in *Aletia* are progressive as the larvae increases in size and age, but so far as I know these larvae never feed on

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When resting upon the leaf, or feeding, the larvae are often very restless. When disturbed, the smaller ones allow themselves to drop from the leaf, first taking the precaution to attach a silken thread to it so that they can arrest their descent or ascend at will. The older larvae, under similar circumstances, hold the posterior half of their bodies to the leaf by means of their prolegs, while they quickly sway the anterior half from side to side. If further disturbed—or sometimes even at the first—they throw their bodies from the leaf, alighting on a lower leaf in many cases, but sometimes falling to the ground. The young larva runs away from its enemy; the older one tries to frighten him at first, but, failing in this, runs away afterward. It is interesting to notice that while larvae often escape from winged enemies such as the wasps, by exercising this saltatory power, they often ensure their quick destruction by using this same power when attacked by ants, for when once the ants have got a larvae that they are attacking on the ground his fate is certain.

In feeding, I find that the larvae rest either on the upper or lower surface of the leaf, but more frequently on the latter. They have been found on the upper surface eating ravenously, though exposed to the rays of the midday sun, when the land in which the cotton grew was so heated that caterpillars which fell from the plant onto it were killed by the heat in a few minutes; but as a general thing they seem to eat most early in the morning and late in the afternoon. A few have been seen eating after dark, but when examined during the night most of them appeared to be lying quietly on the leaves.

When about twelve days old, the larva of *Aletia* draws a leaf about its body, fastening it with a yellowish silk spun from near its mouth. This process is known to planters as "webbing up." In the course of the next twenty-four hours its body shortens and increases in diameter, assuming a somewhat fusiform shape; those parts which were light green become bluish or of a copperas color; and finally it sheds its skin and becomes a pupa. This is at first invested in a delicate green membrane, but in a few hours its color begins to change to a brown, which sometimes becomes so deep as to appear almost black; and this change in color is attended by a toughening and hardening of its body wall. When a larva has webbed up in a leaf on the cotton plant it often happens that other larvae eat the leaf from about it, and if there were not some special provision the pupa would then fall to the ground. But nature has provided for such a contingency by giving it a set of hooks at its sharp or posterior extremity, and these, catching in its web, anchor it to the plant. Still, when thus exposed, the pupae must suffer more from their natural enemies, and especially birds, than when concealed by a leaf; hence, probably, the instinct which prompts many larvae to leave the plant on which they had fed and web up in the leaves of the cow-pea, morning-glory, grass, or other plants growing in the cotton-field, while there may be plenty of uneaten leaves on the plants which they desert. In July and August I found that the pupa state lasted usually about ten days, though quite often it would reach fifteen, seeming to be influenced by the temperature. At the end of this time the skin of the pupa is ruptured, and through the opening thus formed the moth emerges. Though neither eating nor possessing the power of locomotion, the pupa of *Aletia* can vibrate its body rapidly as it is suspended from its web by its anal hooks after the leaf has been eaten from about it; and this, like the similar motion of the larva, probably serves to frighten away some of its enemies.

When the moth emerges from the pupa shell, its wings are wet and useless, and if it be then approached it can escape only by running, aided by a sort of hopping, in which its wings assist it a little. But in a short time the superabundant fluid dries from the wings, and they assume the form characteristic of the perfect insect, and are then used in flight. How long the moths live when unconfined I have no means of knowing, but in breeding-jars I have found that those of the third and fourth broods die within five days after their exclusion from the pupa.

Both larvae and pupae being sexually imperfect, the duty of reproducing the species devolves upon the moths; and these consist of males and females, which copulate, the females lay their eggs, and all die soon after. I could not determine how soon after their exclusion these moths usually copulate, and only once did I see anything that looked like coition, while even then what I observed may not have been copulation. The facts are as follows: While watching a large number of moths collected about a jujube-tree, on the fruit of which they feed, and which I had illuminated by a lantern hung on one of the branches, I often saw one moth dart at another in its flight, hover over it, and appear to come in contact with it, the whole lasting only a second or two, after which they separated and flew away in different directions. In my breeding-jars, when kept supplied with fresh cotton-leaves, the female moths began oviposition

anything but the cotton-plant, the leaves of which are broad and not linear like those of grasses. Finally, "as Weissmann points out, we may learn another very interesting fact from those caterpillars. They leave the egg, as we have seen, a plain green, like so many other caterpillars, and gradually acquire a succession of markings. The young larvae, in fact, represents an old form, and the species, in the lapse of ages, has gone through the stage which each individual now passes through in a few weeks. Thus, then, the individual life of certain caterpillars gives us a clew to the history of the species in past ages."

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some time during the second day after their exclusion; but I do not know whether they begin sooner or later when unconfined. They were only seen laying their eggs once or twice, and this was done in a very interrupted manner, for they frequently flew from leaf to leaf and from plant to plant, each moth depositing but a single egg on a leaf, while frequently they would stop to feed on the nectar secreted by the cotton-plant.

Like many lepidopterous insects, these moths feed upon nectar and the juices of fruits. Of the first-mentioned substance, nectar, by far the largest quantity, is elaborated by glands situated in the flowers of many phaenogamous plants, and there are comparatively few plants which possess nectar glands situated outside of the floral envelopes; yet I never saw an *Aletia* moth visit a flower for nectar, while scores of them have been seen to feed upon the extrafloral nectar of the following plants: 1, the cotton-plant (*Gossypium herbaceum*); 2, the cow-pea; 3, the larger coffee-weed (*Cassia occidentalis*).

The cotton-plant possesses extrafloral glands on the midrib and often on two of the lateral veins on the under-surface of each of its leaves, as well as on the outside of each of the bracts forming the involucre or square, and at the bottom of the calyx alternating with these bracts, in the flowers produced later in the season. These glands appear as shallow pits, and usually contain a drop of a clear, somewhat viscid, sweet fluid, the nectar. When feeding upon this I found that the moths usually rested on their feet, having their wings held horizontally over their backs, as was commonly the case when they were at rest. In some few instances they merely balanced themselves before the bract from the gland of which they were obtaining nectar, steadying themselves somewhat by their prothoracic legs, but maintaining their position chiefly by vibrating their wings. In all cases, when feeding upon nectar, I found that the moths repeatedly coiled and uncoiled their long, flexible maxillae, and their antennae were usually kept in rapid motion.

The cow-pea and whippoorwill pea possess numbers of small, circumvallate glands collected at the end of each peduncle, which is produced slightly beyond the last flower. These glands secrete an abundance of nectar. When the moths of *Aletia* are plentiful they can always be found in large numbers wherever these pea-vines—cultivated between the rows of corn, and sometimes in cotton-fields, where a "stand" of cotton was not obtained—grow, and I have seen many of them feeding on the nectar.

At the base of the petioles or leaf-stalks of the larger coffee-weed are single globular glands of a reddish or brown color, and their convex surface secretes a considerable quantity of nectar. When feeding upon this I found that the moths preferably alighted on the stem just below the leaf-stalk. Standing here, with their heads upward, they rapidly moved the tips of their maxillae over the entire surface of the gland, often coiling and again uncoiling them while doing this. Meantime their antennae were kept in constant vibration, touching the gland, petiole, stem, and, in fact, everything within reach of them, as though to guard against surprise by their enemies. When another moth, of their own or some other species, crowded them aside, it seemed to disturb them very little, but the slightest contact with my finger always made them take flight. Occasionally a moth alighted on the petioles or on the flowers or pods in the axils of the leaves, and it then stood head downward while eating the nectar, but by far the most of them rest on the stem, as described above.

The following-named plants possess extrafloral nectar glands and grow more or less abundantly where my observations were made: 1, the smaller coffee-weed (*Cassia obtusifolia*); 2, the partridge pea (*C. chamæchrista*); 3, *C. nictitans*, sometimes known as the wild sensitive plant, but to be distinguished from several more sensitive leguminous genera, including *Mimosa*, the true sensitive plant, growing more or less commonly in the same region; 4, the wild senna (*C. marilandica*); 5, the common passion-flower, or May-pop, (*Passiflora incarnata*); 6, the cultivated bonnet-squash. With the exception of the first, these all secrete a considerable quantity of nectar, and, though I did not detect the moths of *Aletia* in feeding upon it, there is no reason why they may not sometimes do so, since other insects are attracted by it.

I have seen the adult *Aletia* feeding on the following-named fruits: 1, the peach, both ripe and decaying; 2, the apple; 3, the fig; 4, the scuppernong grape; 5, the jujube. When feeding upon the peach the moth forms a small oval opening through the rind with the tips of its maxillae; through this it is able to reach the interior of the peach, from which it extracts the juice. Though many apples were examined, I never saw one the skin of which had been perforated by the moth; but where birds had eaten holes in the fruit I often saw moths running their proboscides into the flesh thus laid bare.* *Aletia* moths were often seen to perforate the skin of the common purple fig in order to reach the juicy interior, though sometimes they made use of the opening which naturally exists at the large end of the fruit. They were found feeding on the juicy pulp of the grape, through the thick skin of which they seem to have

* Moths were also seen several times sucking the juice from apples which had been pared and sliced afterward being placed in the sunlight to dry.

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no difficulty in working their maxillae, forming small oval holes as in all of the fruits previously mentioned. As the fruit of the jujube ripens, its hard skin cracks in places, and these are utilized by the moths, which are thus spared the labor of forming openings for themselves. In all of these cases the juices are removed from the fleshy part of the fruit, reducing this to a fibro-spongy mass. When feeding, the moths often collect in such numbers as to completely cover the fruit, and several may be seen at the same time with their proboscides inserted into one opening in the skin of the fruit. A curious thing that I repeatedly noticed, but which may not always occur, is that when feeding on fruits the moths usually vibrate their antennae very little, while in feeding on nectar they keep them constantly in rapid motion. Though I saw no instance of it myself, I am informed that the moths sometimes feed upon decaying pomegranates, but do not trouble those which are sound.

When flying from one place to another, and especially after being disturbed, the moth moves with a peculiar darting flight, which renders it exceedingly difficult of capture; but when visiting the involucral glands of cotton or the glands on the petioles of the coffee-weed, I have noticed that it often hovers with a steady motion from the lower part of the plant upward, though in a few cases I saw this order reversed. When at rest, as is the case from sunrise to sunset, the moth clings to the lower surface of the leaves of cotton, the cow-pea, and such other plants as it finds convenient to its purpose, or occasionally to the petioles or stems of these plants. When settled on a leaf I have found that the moths most often stand with their heads turned toward the base of the leaf. When standing on a leaf-stalk they likewise usually have their heads pointing to the stem of the plant. When at rest on the stem I have noticed that their heads are most often turned toward the ground. I have a few times noticed frightened moths alight on the horizontal petioles of cotton-leaves, clinging to the sides of them with their heads directed upward.

The sense of sight appears to be quite well developed in these moths. Not only do they often see an approaching person, but they possess some notion of color. Their color sense is evinced by the following facts: One day, between sunset and dark, while watching large numbers of moths, I noticed that many of them flew directly at the bright-orange but odorless and uneatable berries of the thorny hedge-plant, but, having reached the berries, they immediately flew away again. It was also noticed that they select the red (ripe) jujube berries for food, discerning them at some distance, though surrounded by green ones; yet here the sense of smell may possibly have aided them. When only one or two attack a peach I have observed that they, like birds, choose the rosiest side. While standing without a coat, a little after sunset, I found that numbers of moths flew against the sleeves of my white shirt, and when standing after dark beneath a tree in which a lantern was hung so that its rays fell on me, I found that many of them flew against my white hat. These observations seem to show that at least the colors orange, red, and white are recognized by these moths. This color sense is implied in the remedy spoken of in the Patent Office Report for 1855, page 76, viz., hanging white flags in the cotton-fields for the moths to lay their eggs on. Though I often used an open lantern in making my observations, I did not find that many moths of this species were attracted to it. Occasionally one would buzz against it when there were hundreds all about it, but by far the greater number of them ignored it entirely. Some few were attracted into the house by lights, but they formed a very insignificant part of those within a few rods of the house, where they could not fail to see these lights. My experience seems to show that an unsteady, flaring light, as from a blazing pine-knot, is far more attractive than the steady light of a lantern.

Concerning the sense of smell in these moths, I have only negative evidence to offer. At different times all through the season, and constantly until the first of July, baits of the following sorts were exposed: vinegar and molasses in varying proportions; rum and molasses; beer and molasses; dried apples soaked in beer sweetened both with sugar and molasses, vinegar or rum being added occasionally. These baits were exposed in shallow vessels, smeared on the trunks of trees and on old stumps, &c., while the last mentioned was hung in various places about the cotton-field. Some were watched several hours after dark, others were poisoned and the ground about them examined early in the morning; yet not above half a dozen adult *Aletias* were captured in this way, most of the victims being moths of other species, cockroaches, a few beetles, and some small leaf hoppers. This seems to show that *Aletia* is not very sensitive to odors such as these baits produce, and which are found so attractive to many moths of the noctuid group. Early in the season overripe plums were crushed, sweetened, and allowed to ferment before being exposed to the visits of insects; but the species attracted by this bait were similar to those just mentioned. In early September, when the moths of *Aletia* were very abundant, scuppernong grapes were treated in the same way, and these did attract numbers of these moths.

Whatever may be the sense or combination of senses guiding it in the instinct which leads it to deposit its eggs on nothing but the cotton-plant, I cannot say, but so far as I know, the moth never oviposits on anything else.

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Since, in the course of its life, *Aletia* exists in the four states of egg, larva, pupa, and imago, four theories have been possible concerning the form in which it lives from one year to another; for unless one or more of these forms survived the winter, the species would necessarily cease to exist.

Thus, some planters believe that it may pass the winter in the egg, and it is known that some lepidoptera do hibernate in this state. But it is improbable that *Aletia* does so, at least in the United States, for the following reasons: The larva, on its emergence from the egg, must be where it can readily obtain food, else it will perish of starvation. Now, so far as I am aware, it never feeds on anything but parts of the cotton-plant; therefore the eggs must be deposited either on some part of this plant or on something closely adjoining it, from which the newly hatched larva can readily reach the plant. But the cotton-plant is an annual, perishing at the end of the first season, and in preparing the ground, in winter, for the planting of the next spring, the stalks of the dead plants are broken down and plowed under. This would be likely to destroy any unhatched eggs laid on the plant late in the fall. For the same reason eggs deposited on plants growing as weeds in the cotton-field or in the ground would in all probability be killed.

As there are numbers of insects, including some lepidoptera, which are known to hibernate as larvae, it has been suggested that this species may pass the winter so. Lepidopterous larvae, which survive the winter, are usually protected from the cold in one of the following ways: 1. Wood-borers are inclosed in the cavity which they have already formed in the tree on which they feed. 2. Some leaf-eaters form hibernacula of the leaves of their food plant. 3. Others either burrow into the ground or shelter themselves beneath stones or clods of earth. As *Aletia* is a leaf-eating caterpillar, it must hibernate in either the second or third way if it passes the winter in the larval state. Arriving in the cotton-belt about the middle of May, and leaving about the middle of September, as I did, I was unable to make any observations bearing upon this point; but I cannot learn that these caterpillars have even been known to web leaves about themselves excepting when about to pupate; and even if they were to do so, the plowing under of the dead plants would be likely to destroy many of them. My own observations show me that during the spring and summer they never enter the ground nor creep beneath stones, and I am told that they are never found when the ground is plowed late in the winter. These facts make it appear extremely improbable that *Aletia* ever passes the winter as a larva.

Many farmers believe that this insect hibernates as a pupa, burrowing into the ground for protection from the cold. Years ago the observations of scientific men showed that frost kills such *Aletia* pupae as are still webbed up in the leaves when cold weather comes on; and I have never seen one taken from the ground, nor have I learned of an authentic case where this has been done, the planters who have found them mistaking other pupae for those of *Aletia*.

A large number of insects, including some lepidoptera, are known to hibernate in the perfect state, and from the improbability of its surviving the winter in any other form, as shown above, and from the fact that thousands of moths are seen late in the fall, and a small number early in the spring, it appears pretty certain that *Aletia* hibernates as a moth. This being granted, we come to one of the points about which scientific men have had many disputes, viz, whether the moth hibernates in the cotton-growing regions of the United States, or whether the species becomes extinct in our country each year, the caterpillars of the next year being developed from eggs laid by moths coming from within the tropics. Not being in the cotton-belt during the winter, I was unable to demonstrate from my own observation which of these theories is the true one; but I am inclined to believe in the first-mentioned, for the following reasons: On the 17th of May I located myself on a plantation situated in Dallas County, Alabama, on the Selma and Gulf Railroad, about 23 miles south of Selma. Here, on the 21st of the same month, a fully-grown *Aletia* larva was found, which shortened preparatory to pupation that night. This was the earliest caterpillar seen on that plantation. But on the 17th of May a full-grown larva was found on the plantation of Col. C. T. Lewis, situated nearly west of Selma, and therefore considerably further north than my locality. Now, if the moths which deposited the eggs from which these larvae were hatched came from some southern region, as the Bahamas, we would expect to find the earliest larvae in the most southern sections of the cotton-belt, neglecting the difference in temperature which would tend to produce the same result; but those which were found this season showed the reverse to be the case, making such migration appear improbable. Moreover, planters assure me that on warm afternoons in winter they often see scores of these moths sunning themselves beneath the eaves of negro cabins and other buildings. A number of planters have told me of finding these moths within the hollows and beneath the loose bark of dead trees in midwinter. When discovered they were perfectly torpid, but when taken into a warm room they soon showed signs of life, and in a short time were able to fly rapidly about the room. One man told me that last January, while having a thick bed of fallen leaves raked open, he found a large number of these moths lying torpid among

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the leaves. Probably it will appear at first sight as if nothing could be more conclusive than this testimony, and such would be the case if one could be sure that the moths found were always *Aletias*. But while I have the greatest confidence in the testimony of some of these men, I should hesitate before saying that anything is proved by the statements of men not accustomed to making careful scientific observations.

If any reliance is to be placed on the testimony of planters, that given above, coming from many sources, will, if taken in connection with what has been stated concerning the distribution of the first brood of larvae, make it appear extremely probable that *Aletia* survives the winter at least as far north as Dallas County, Alabama.

It is commonly believed by planters that the caterpillars are, as a rule, more plentiful after a cold than after a mild winter. This is sometimes brought forward as evidence that the moths do not hibernate with us, for severe winters ought to destroy more of them than mild ones; therefore, if they really survived the winter in this country, there would be more larvae after a mild than after a severe season; but when this is considered carefully it seems to confirm the theory of hibernation. If the moths come from some tropical region every spring, it is hard to see what connection there would be between the severity of our winter and their greater or less abundance the next spring and summer; but if they hibernate in our cotton-belt, this is readily explained; for of the thousands which seek hibernacula in the fall, some will certainly fail to secure a sufficient protection from the cold and will freeze to death; in other words, each moth, in seeking its winter quarters, stands a certain chance of not finding a sufficiently warm place. In a very cold season moths will perish in places where they would be safe if the cold were less intense, but those which have secured safe quarters will remain dormant there till the warmth of spring calls them forth to lay their eggs; they take the chance of failure but once. But in a mild winter each warm day entices many from their retreats, and some necessarily fail to return to as well protected places as they previously occupied, so that the next succeeding cold spell kills them; they take this chance many times in such a winter.

As the winter advances the number of moths constantly diminishes, until in April, when the cotton begins to appear above the ground, comparatively few are left to lay their eggs upon it; and the general testimony of planters is that scarcely any of this brood are seen after the middle of April.

From the eggs laid indiscriminately on the leaves of young cotton by these moths, the first brood of larvae hatch. On the plantation where I did most of my work, only four of this brood were found, and it will be instructive to notice where they were found. May 21 a full-grown larva was found on some small cotton which, I am told, was planted April 30, and was well up by about May 8. This cotton, however, immediately adjoined some which was planted a month earlier, and it is probable that the caterpillar was hatched on the older cotton. This was on a rather damp piece of ground. May 23 another was found in the same field, but in a dry, sandy place. On the same day another was found on some cotton of the earlier planting, on a dry clay hill. June 3 another full-grown larva was found, this time on cotton growing in dry, sandy soil a mile from the place where the others were found, and at a considerably higher altitude. This cotton was sown about April 1. When found the larva was webbed up, but had not yet transformed into a pupa. Two things will appear from this: 1. Individuals of this first brood differed in age by nearly two weeks. 2. They were found on bottom land, clay, and sand, in a swamp, on an elevation rising from this, and on a ridge considerably removed from the swamp.

The second brood of larvae was first noticed by me on the 11th of June, when I captured a half-grown larva on the bottom land near where the first worm was found the month before. I had, however, learned of the capture of partly-grown worms of this brood a week and a half earlier, in the canebrake west of Selma and near Montgomery, both of which places, it will be noticed, were further north than the point at which I was located. I found a few other larvae of this brood at intervals up to the 7th of July, when the first pupa was seen. These larvae were, with one or two exceptions, all found in damp bottom-land near where I found the first, and I had previously been told that the first caterpillars were always found about this spot, though none were commonly seen before the latter part of June.

July 14, having been absent from this plantation for a week, I returned, and on examining the bottom-land just mentioned, I found quite a number of caterpillars belonging to the third brood. Some were very small, others were nearly half an inch long, and one or two which were half-grown were seen. At the same time two pupae belonging to the second brood were seen. Owing to the fact that there are very few larvae of the first and second broods, this is the first that planters usually see of the caterpillar, though I am told that this brood sometimes appears a couple of weeks earlier; hence they call this the "first crop." Larvae of all sizes, with some pupae and a few moths belonging to this brood, were found up to about August 1, shortly after which eggs and larvae of the fourth brood were seen. With few exceptions this brood was confined to bottom land.

Like the preceding, the fourth brood, or so-called "second crop," was chiefly con-

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fined to this bottom-land, though covering a much larger portion of it than the other did, and being sufficiently numerous to have eaten the foliage from ten or fifteen acres of cotton if it had not been poisoned. Similarly to what was found with the third brood, this consisted of larvae of all ages, from the little one newly hatched to the full-grown caterpillar webbing up preparatory to pupation, and with these were to be found pupae, and imagines laying their eggs; so that the fifth brood really began in small numbers at least a week earlier than the date presently to be given. This difference in age between individuals of the same brood is at first sight a little puzzling, and renders it very difficult to separate the later broods by any sharp-drawn line; but when we consider that in the first brood I found a variation in age of nearly two weeks—the whole period of existence of a larva in the heat of summer—and might have found even a greater variation had I obtained more specimens, it is easily seen that their descendants must show the same difference in age.

By September 1, the larvae of the fifth brood, "third crop" or "army," were appearing in considerable numbers, and when I left the field two weeks later they were still hatching in small numbers; some eggs were yet being laid, while many larvae were full grown, and some had already pupated. Unlike the second, third, and fourth broods, but agreeing with the first, these larvae were not confined to wet places in the swamps, but were almost equally abundant in the swamps and on the ridges, on cotton growing in damp ground and on that growing in dry places.

About the first of July, in a conversation with me, Professor Riley said that he believed the common idea that *Aletia* does better in wet than dry weather to be founded in fact, and that the reason for it was that in wet weather *Aletia* suffers less from its insect enemies than when it is dry. A few weeks later, when noting how the larvae were attacked by ants on cotton where ants were very plentiful, I became convinced that ants were among the most important of their natural enemies. About the same time I noticed that there were very few ants on the cotton where most of the larvae of the second and third broods—the latter of which was then in its prime—were found, the ground being too wet for their nests, while wherever the ground was dry there were myriads of them. From this I drew the following conclusions: The female moths which survive the winter lay their eggs on cotton growing on ridge or in swamp, according as they hibernate near the one or the other. Of the first brood of larvae, those on dry ground infested by ants are mostly killed by these little insects, while those on ground too wet for the ants to live in comfortably stand a better chance for escaping. Webbing up where they have passed their larval state, these appear in time as moths, and, finding a sufficiency of food in the nectar secreted by the plants immediately about them, they for the most part migrate little, but deposit their eggs close to where they themselves were born; and this explains the reason that the majority of the second brood are found in wet places. In like manner, when the second brood appear as moths, they will feed and lay their eggs near where they have passed their lives; which accounts for the limitation of the third brood. When this brood appear as moths, being much more numerous than either of the earlier broods, they necessarily spread a little more, this scattering being in a more or less perfect circle about the spot which has thus far contained the larger number of caterpillars. The fourth brood when about to oviposit is generally so large in numbers that if they were to lay their eggs where have passed their lives there would not be food enough for their offspring, especially as this brood is usually large enough to defoliate the cotton where they are found. Therefore they scatter far and wide, laying their eggs on cotton miles from any place where caterpillars have been previously noticed, and usually their offspring are numerous enough to eat up the cotton in a very few days wherever they appear, and to show no decrease from the attacks of the ants or any of their other enemies.

When there is much rain, the dry, sandy soil becomes saturated with water, so as to be almost a quicksand, and this, of course, injures the nests of the ants, interfering with their visits to the nectar glands of the cotton-plants. I have noticed, too, that in rainy weather comparatively few of any kind visit these glands. Rain, then, lessens the liability of the caterpillars being attacked by ants and wasps, as well as other of their enemies, which are driven to seek shelter, and this accounts sufficiently well for their greater numbers in wet seasons.

It is a common belief that the caterpillars never eat out cotton which grows in the shade of trees or shrubbery. Though I looked at many shaded places in cotton-fields, about September 15, when most of the cotton had been stripped of its leaves, I found about as many places where the shade was no protection as where it was protective. Wherever their proximity prevents the worms from eating cotton, I suspect that the trees or bushes serve as lurking places for insectivorous birds.

Among other traditions which I have in mind are the following: Some planters believe that they are certain to find caterpillars on their cotton wherever they see lace-winged flies. It is needless to say that there is no connection between the two, the lace-winged flies visiting the cotton everywhere in search of cotton aphides, near which they lay their eggs, their larvae being the well-known aphis-lions.

A few men believe that where the larger coffee-weed grows in a cotton-field the

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caterpillars do not molest the cotton. Though I have seen a good deal of this plant in some cotton, I never noticed that it saved the latter.

It is sometimes stated that rusted cotton is never eaten by *Aletia*. The term rust is applied by farmers to a fungoid disease (rust proper), to the "red spider," and to leaves which dry up from disease in other parts of the plant, so that it is hard to say what is meant by this statement. As a rule, the moths certainly do lay their eggs on healthy cotton in a vigorous state of growth.

NATURAL ENEMIES.

For convenience of discussion, the natural enemies of *Aletia* may be divided into two classes: 1, those which are not parasitic; 2, those which live at its expense as parasites. The first of these may be subdivided into the different zoölogical groups of which it is composed; the second, so far as my observations go, consists entirely of insects. This arrangement may be seen by an inspection of the following table; and in the discussion which follows, the order there adopted will be adhered to:

1. Imparasitic.
   1. Mammals.
   2. Birds.
   3. Arachnids.
   4. Insects.
2. Parasitic. { Insects.

The only mammals that I have seen feeding upon *Aletia* are one or two species of bats, which are usually spoken of by the planters as "leather-winged" bats, to distinguish them from the night-hawk, which goes by the appellation of "bull-bat." On the 25th of August, having occasion to study the moths of *Aletia* while feeding on the fruit of the jujube-tree (*Rhamnus zizyphus*) I hung a lantern on a branch of a small tree of this species, where hundreds of the moths were collected. While making the observations for which I had gone out, I noticed that a number of bats, of several species, were flying in the vicinity of the tree, under which they repeatedly darted, each time catching a moth, which was immediately carried off. Planters tell me that in seasons when the caterpillars are very numerous and the cotton is eaten up before they have reached their full size, they migrate in large numbers, so as to fill the wagon-ruts in the roads and collect in large piles in the fence-corners. When this is the case, pigs, and even dogs and cats, are said to feed upon them.

But two species of wild birds were seen eating the larvae of *Aletia*; these were the mocking-bird (*Mimus polyglotus*) and the indigo bird, or blue-bird as it is called in Alabama (*Cyanospiza ciris*). Once the nest of some sparrow was found in a cotton-plant, and as these birds feed their young on insect-larvae, it is probable that they may be counted among the enemies of the cotton caterpillar. The wild-turkey (*Meleagris gallopavo*) is not uncommon in the part of Alabama where my observations were made, and its tracks are often seen in the cotton-fields. Though I did not see turkeys feed upon the caterpillar, I saw places where their tracks were numerous, and where the cotton was more or less broken, as if by their leaping upward after the larvae on the higher branches of the plant, and I am assured by planters that these birds have been seen to feed upon the worms. Both chickens and domesticated turkeys eat the larvae on the cotton near houses, and the latter birds are said to sometimes seriously injure the cotton in jumping after the caterpillars.

Very frequently leaves of cotton are found folded and webbed by *Aletia*, while the pupae have been removed through clearly-cut triangular apertures, evidently made by the bill of some bird. I am told that the rain-crow (*Coccygus americanus*) destroys many pupae of this insect. I have been told that the night-hawk or bull-bat (*Chordeiles virginianus*) has been seen to catch the moths of this species when flying.

Twice spiders were seen to kill *Aletia*. One day in July I saw a small jumping-spider (No. 2, July 23) (*Attus nubilus*) leap upon a half-grown larva, which it killed and sucked the juices from. About twilight of August 27, while watching numbers of moths engaged in eating rotting peaches on the ground, I heard a rather loud rustling among them, and several took flight from the point where the noise was heard. Going to the spot, I found that a large ground-spider had captured one of the moths, which was beating its wings in futile efforts to escape. Owing to the darkness, the spider was allowed to escape, so that I did not determine the species. In Alabama the large, green, spiny spider (*Oxyopes viridans*) is abundant on cotton-plants, and it is not improbable that it may sometimes catch *Aletia* in its larvae and perfect states.

To preserve the order thus far followed, it will be necessary to separate the imparasitic insect enemies of *Aletia* into those which destroy the egg, those which destroy the larva, those which destroy the pupa, and those which destroy the moth; though this will, in a few cases, necessitate the insertion of the same insect in two or more of these groups.

I have seen but one insect destroying the egg of *Aletia*, viz, the larva of one of the

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lady birds (*Hippodamia convergens*). This was on the 26th of August; the larva was searching the lower surface of a leaf, apparently for aphides, when it encountered an *Aletia* egg, which it immediately bit with its mandibles; but, as if disliking its taste, it left the egg uneaten and passed on. Later I saw this same larva bite another egg, and this, too, was left without further disturbance, but of course both eggs were killed. Though many hours were spent in looking for further attacks upon the eggs of *Aletia*, the difficulties necessarily attendant upon such observations prevented me from seeing any more. From the actions and known proclivities of the lady-birds known as *Hippodamia convergens*, *H. maculata*, *Coccinella munda*, and *Coccinella 9 notata*, all of which are found in abundance on cotton-plants, and of *Chilocorus bivulnerus*, one adult of which was seen searching the leaves of the cotton, I suspect that they all destroy these eggs more or less commonly. The larvae (aphis-lions) of the lace-winged flies are also very plentiful on cotton, where they prey upon aphides, and very likely they may also destroy eggs of *Aletia*. Similarly, ants of quite a number of species frequent the cotton-plant, whither they are attracted both by the sweet excretion of aphides and by the nectar copiously secreted by the foliar and involucral glands of the plant; and, though I never saw them molest the eggs of *Aletia*, I believe that they do so.

Wasps frequent the cotton-plant in considerable numbers, being attracted, like the ants, in part by the nectar secreted by the plant; and there is much reason to believe that all of the species which visit the plant feed more or less commonly on the caterpillar or larva of *Aletia*. I am led to this conclusion by the following observations: On the 8th of August, when larvae of the fourth brood of *Aletia* were very abundant in the swamp cotton, I saw a large red and yellow wasp (*Polistes rellicosa*) hunting for them. Carefully walking round the holes eaten through the leaves by the caterpillars, she explored their borders with her antennae, as if feeling for the larvae; and each time that she found one in this way she quickly sprang after it, but at the same instant the larva threw itself from the leaf, so that while I was watching her I saw no less than eight escape, the ninth being caught and eaten. Occasionally she would stop hunting long enough to sip a little nectar from the foliar glands of the plant, and then the chase was resumed. I was very much surprised to see that she relied entirely on the tactile sense of her antennae for finding her prey. Though possessing well-developed ocelli and compound eyes, she seemed to make little use of them, and repeatedly I saw her alight on a leaf close to a caterpillar without paying any attention to him till she touched him with her antennae, when, as before stated, she would instantly spring after it. Observations of this sort were made several times on this wasp. Another rather large brown wasp was also seen to catch larval *Aletias*, as also were a yellow-jacket hornet (*Vespa carolina*) and a common mud-dauber (*Pelopaeus caeruleus*), and they all alternated hunting for caterpillars with feeding on nectar. Both species of *Polistes* were several times seen flying about with dead caterpillars, having previously reduced them to a pulpy mass with their mandibles. They were probably looking for some quiet place in which to eat them.

From their great numbers and indefatigable industry, ants are probably among the most important of the enemies of the cotton caterpillar. Individuals of many species swarm everywhere on the cotton-plants, to which they are attracted night and day by *Aphides* and nectar. On many cotton-leaves there are places where some larva has eaten the parenchyma of the lower surface, but the most careful search fails to discover the larva. Though not invariably so, these places are often eaten by very young larvae of *Aletia*, and as these are not to be found, it looks as though they had been removed by some enemy, probably ants, though I have never seen ants attack very small caterpillars. In July a number of caterpillars were collected in the bottom-land to which they were principally confined at that time, and placed on cotton growing in dry, sandy soil, care being taken to see that there were no ants on this cotton when the larvae were placed on it, for my insects in breeding-jars in the house had suffered so much from the depredations of ants that I was always afraid of their attacking larvae that I wanted to study in the field; and these particular caterpillars had been removed to the cotton indicated because I wished to make observations on their habits, and wanted them as near the house as might be, while at that time the only larvae to be found in numbers were about a mile from where I was living. Within two hours of the time of placing them on this cotton, each of these larvae was found by several ants, and these soon collected numbers of their fellows, whose combined attack so worried the larvae that they threw themselves from the plants and were soon killed and carried off by their small but persistent enemies. On several other occasions partly-grown caterpillars were killed and carried off in this way by this species and a red ant, yet I never saw ants attack them on the plant, excepting when I had thus placed them on ridge-cotton for purposes of study; but when creeping over the ground, as they do after eating up the foliage of the plant on which they were born, if not full-grown, hundreds of caterpillars were attacked by these ants and killed. I have never seen more than one species of ant attacking any individual caterpillar, either on the plant or on the ground.

No lepidopterous enemies of *Aletia* larvae were observed by myself, but Dr. Lockwood,

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of Carlowville, Ala., says that a number of years ago he saw a large green larva devouring numbers of cotton caterpillars. From what we know of the habits of the boll-worm (*Heliothis armigera*), it seems not at all unlikely that these larvae may have belonged to that species.

Several bugs (*Hemiptera*) were seen to kill the cotton-worm. Early in the season great numbers of a large, ill-smelling bug with dilated hind legs (*Acanthocephala femorata*) were seen in the weeds and shrubbery about the borders of cotton-fields, being very noticeable on account of its buzzing flight. After *Aletia* appeared in numbers, fewer of these bugs were seen, but they were several times seen to catch caterpillars and suck the juices of their bodies. At different times through the summer, another bug (*Arma spinosa*) was seen to kill these larvae, as also was another (*Sinea multispinosa*) which occurs in considerable numbers about cotton.

These are all of the insects that I found preying upon the cotton caterpillar, or that I have reason, from my own observations, to think prey upon it; but my friend Mr. John Wilkins, of Selma, Ala., tells me that in the canebrake he has once seen the common green mantis (*Mantis carolina*) leap upon these larvae on plants near the borders of cotton-fields, but these insects do not venture far from the bushes around the field.

Owing to its tough integument, the pupa of *Aletia* seems to be freer from insect attack than the larva is, yet even its hard skin does not always save it. About the middle of August I first noticed what appeared to be an anomalous preparation for pupation in the boll-worm (*Heliothis armigera*), for I found several full-grown larvae of this species with leaves closely webbed around them, precisely as *Aletia* webs up before changing to a pupa. An examination of one of these leaves, however, showed me that the boll worms had not webbed them about themselves, but had insinuated themselves into leaves folded and preoccupied by *Aletia*, the latter having already passed into the pupa state; and they had done this for the express purpose of feeding on these pupae. Many cases of this sort were seen.

In the latter part of July several *Aletias*, just about to pupate, were taken from the swamp where they were found, and with leaves still webbed about them they were transferred to cotton on dry soil near the house, where they were tied by their leaves to the petioles of this cotton, my object in placing them there being to determine the length of the pupa state. The same day they shed their last larva skins, and this left them in an almost defenseless condition till the pupa skin should become firm and tough. About twenty-four hours after this moult they were again visited, and were found covered with red ants, which had killed and partly eaten them all, though they were on different plants, and care was taken to see that there were no ants on the cotton when the larvae were placed there.

Many specimens of a red bug of all ages have been seen about the pupae of *Aletia*, and they were often found within the loose cocoons of these pupae; and, though they were not seen to molest them, their presence looks suspicious.

But one insect was found killing the imago or moth of *Aletia*, viz, a two-winged fly (*Asilus sericeus*), which is very abundant about cotton-fields and was several times seen to catch the moths on the wing, afterwards eating them.

Early in September, while watching these moths as they fed on rotting figs, I saw many white-faced hornets (*Vespa maculata*) about the fig trees. One of these hornets was seen to catch a two-winged fly nearly as large as itself. After killing it, the hornet proceeded to deprive the fly of its legs and wings, which were allowed to fall to the ground. The fly was then carried away. Under these same trees I found the wings of *Aletia* moths, and it looks from this as though these moths are sometimes killed by the hornet; still, I never saw a hornet in the act of killing a moth, or with the dead body of one, and am aware that their usual food is flies.

By no means the least important enemies of any insect are its parasites, and these deserve careful attention in the present case. But to properly breed large numbers of pupae for their parasites facilities are needed which could not well be obtained on a plantation, so that the determination of the percentage of parasitized pupae and the parasitic species was left to the department, a sufficient number of pupae for that purpose being forwarded to Washington. For some few observations made on the eggs of two parasites—probably dipterous—I would refer to my letters of July 24 and August 5. Two or three species of ichneumon flies were seen about cotton-plants, but as they were all watched to see if they would oviposit in *Aletia*, none were captured, and they were, therefore, not identified. None of them were seen to molest the caterpillar.

After caterpillars had died from eating some of the poisons used for their destruction, the following animals were seen to eat them: 1. Chickens, and these sometimes eat so many as to die from the effects of the poison. 2. Ants of several species. Though I have never seen any of these little insects killed by being poisoned in this way, I think that this is often the case, for I have seen many of them eating the dead caterpillars. 3. *Aphis-lions* were several times found sucking the juices of caterpillars that had died of poison.

(The whole section of Mr. Trelease's report referring to remedies for the cotton-worm was incorporated bodily into Chapter VII of Part I.—J. H. C.

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HELIOTHIS.

NATURAL HISTORY.

Unlike the cotton caterpillar, the boll-worm is not confined to one species of plant for its food, but is omnivorous, feeding for the most part on living vegetable substances, but occasionally becoming carnivorous when partly grown. From this it results that its eggs are not deposited exclusively on one species of plant; nor, when laid on the cotton-plant, are they confined chiefly to one part of it, as was found to be the case with those of *Aletia*. On the contrary, I have found them laid singly on the outside of the calyx and on the leaf petioles of the garden pea, on the peduncles and leaves of the cow-pea, on the upper surface of leaves of Indian corn, near their divergence from the stem, and on the outer surface of the husk near the tips of young roasting-ears, and on the petioles and both surfaces of the leaves of the cotton-plant, as well as on the outer surface of the bracts composing the involucre which surrounds the flowers of this species, and which is known to farmers as the square. Not having allowed moths of this species to lay in confinement, nor having marked any eggs immediately after their disposition on cotton in the field, I cannot say how long a time is required for incubation.

Very soon after its exclusion the young larva begins to feed upon the substance of the leaf or bract, or other organ on which it finds itself, and when this chances to be a leaf or bract it leaves the epidermis on the other side for some time. During the first half day or day of its existence it feeds in this way, forming small, irregular, transparent spots in the blade of the leaf or in the bract, after which it pierces a hole—usually more rounded than that first formed by *Aletia*—through the organ. The age at which this is done appears from my observations to be earlier than that at which the cotton caterpillar pierces the leaf, but I find that it differs greatly with different individuals, some piercing the leaf when less than ten hours old, some not until they are about two days old. After this, if it does not find itself close to a flower-bud, immature fruit, or some other object suitable for its food, the larva moves about in search of this food, finding which it shortly goes to eating. Whatever may be its food, this worm, according to my observations, always forms regular, round openings in its exterior for its own entrance or exit, and these vary in size with the size of the larva, being just large enough to allow the animal's body to pass with ease. Another peculiarity of this larva is its wandering character, especially earlier in the season, when feeding on the flower buds or forms of cotton, for, these being small, the contents of each is soon eaten by the worm, which necessarily moves on in search of more food.

My attention having been given more to *Aletia* than to this species, especially in the early part of the season, I find that the notes from which I am to judge of the number of broods of the boll-worm are very incomplete. But from such notes as I have it appears that there were four broods, of which only the last did much injury to cotton, most of the earlier broods feeding upon the Indian corn.

When, about the middle of May, I began studying this insect, I found what I suppose to have been its first brood of larvae feeding upon the tender leaves which terminate the young stalks of maize; it is then sometimes called the "terminal-bud worm" of the corn. It is rarely that more than one larva is found on any plant. Plants attacked by these bud-worms are easily singled out as one walks through the field; for the leaves are pierced by many small holes, much as though a light charge of bird-shot had been fired through the plant. When such a stalk is found, if the leaves, beginning with the outermost, are carefully stripped off nearly to the bases of their sheaths, a quantity of excrement will be found between them, increasing as we go inward; and the pale green larva which causes it will be found either within the sheath of a leaf or in a cavity that it has eaten in the closely-rolled terminal leaves, which, sooner or later, it always reaches. When it has attained its full size, the larva pierces the leaves about it with a round hole, through which it makes its exit, going into the ground for pupation. It is my belief that this brood went into the ground late in May, being followed by another brood which pupated about the end of June; but this is in great part based on memory.

Early in July, when roasting-ears were forming on the corn, another brood, the so-called ear-worm or tassel-worm, was found feeding upon the silk and tender grain near the end of the ears. While for the most part the preceding broods varied little in color, being chiefly of a pale green, this brood consisted of larvae of various shades of green, pink, and rose. When fully grown—which occurred in the latter part of July—each of these bored a round hole through the husk of the ear, escaping through this and falling to the ground to pupate.

The next brood, appearing not far from the 1st of August, when the ears of corn were beginning to harden and when cotton forms and bolls were very plentiful, was chiefly confined to the latter. Before this time, a few larvae of this species had been found on cotton; thus, on May 30, I found a partly grown boll-worm eating the leaves of a cotton-plant ten or fifteen rods from any corn, and at this time there were very few

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forms on the cotton, and these were very small, so that the individual in question had probably fed entirely on the leaves. On the 11th of June, the first worm was found eating the young flower buds or forms, and a few others were found from that time onward; but by far the most of these earlier larvae were confined to the corn. This brood, then, which I suppose to have been the fourth, was in its prime about the middle of August, doing much damage to the forming cotton.

Meantime larvae of each of these broods were found feeding, in greater or less numbers, on the green fruit of the garden-pea, the cow-pea, the tomato, and the wild *Erythrina herbacea*, leguminous plant related to the first two named. When eating the garden-pea, the larva bores a hole through the papery pod for its entrance, then eats the entire contents of the pod before leaving it for another. But in eating cow-peas, which are contained in a more fleshy pod and separated by fleshy partitions, it often bores into one chamber of the pod, eats the seed in it, and then, instead of cutting through the partition to reach the next, bores another hole from the outside. A similar observation was made concerning *Erythrina*. Nor does the boll-worm content itself with this diet. Riley and Glover have pointed out other plants on which it feeds, and not infrequently large individuals were seen by me eating the pupae of the cotton caterpillar and even smaller larvae of their own species; while, as stated under the head of the natural enemies of *Aletia*, it is probable that they sometimes kill the larvae of that species.

When a flower-bud or young boll of cotton is punctured by the boll-worm the involucre or "square" which surrounds its base spreads open or "flares," and sooner or later the injured fruit falls to the ground. Even before the cotton commenced to bloom many of these blasted squares were to be seen on the ground, and in every case where the involucre had flared open I found the form punctured, though most of these punctures early in the season were very small, and had no excrement in the square beneath them, thus differing from punctures formed by the boll-worm. There is no doubt that these very small perforations are made by hemipterous insects, and I strongly suspect two bugs very common on the cotton-plant, which have the habit of running round the stalk as you try to obtain a view of them, much as squirrels do under similar circumstances, so that they always keep the stem interposed between themselves and an observer. This shyness prevented me from verifying my suspicions, though I watched the insects a great many times. On the other hand, many blasted squares result from climatic injuries, and these may be distinguished from those caused by insects, since the square retains its normal position and form.

When full grown the boll-worm enters the ground, forms a slight silken net, serving, in connection with the loose earth bound together by it, as a cocoon, in which the larva shortens and becomes fusiform, its colors fading, preparatory to pupation.

The pupae of this species are plowed up in numbers, especially early in the spring, and many planters mistake them for those of *Aletia;* but, having no use for the anal hooks of the latter, the posterior end of their body is terminated by two slender points, often so closely appressed as to look to the naked eye like a single spine. This character readily distinguishes them from *Aletia*, as does their greater size and usually lighter color.

The moths of this species, like those of *Aletia*, feed upon the nectar secreted by the glands of the cotton-plant, cow-pea, greater coffee weed, and probably other plants, though I have never seen them feeding on others than those named, nor on fruits, which are also probably attractive to them. When feeding on nectar these moths vibrate their antennae rapidly, and, indeed, behave in all respects like *Aletia*, excepting that they hold their wings slightly spread and inclined upward, instead of folding them close to their backs as the latter species does. Rarely, too, like the other species, they hover before the gland, steadying themselves by their fore legs. I did not find that these moths showed as marked an appreciation as *Aletia* does, nor were they any more abundantly attracted to my lights or baits.

Like the cotton caterpillar, the boll-worm is more abundant in wet than in dry places—at least such was my experience—and it is also said to do better in wet than in dry seasons. This is readily explained by the hostility of ants, which are more abundant in dry than in wet places, and in fair than in rainy seasons. Early in June several half-grown "bud-worms" were collected on Indian corn and transferred to cotton-plants with a view to watching their actions. Care was taken to place them on plants on which there were no ants. Seating myself beside them, I awaited developments. At first they evinced no desire to do more than conceal themselves beneath the leaves from the glare of the sun. But it was not long before a stray ant appeared on the plant, and, finding a larva, proceeded to run round and round it, biting it whenever it could. Soon, however, finding that unaided it could do little, the ant left the plant, and, after watching it a short time, I lost sight of it; but in a few minutes it returned, accompanied by several others of the same species. In a little while the worm was so worried that it fell from the plant, and was soon killed and carried off by its tormentors, which followed it to the ground. Several times I saw this repeated, the boll-worms being killed in each case within an hour from the time

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when they were placed on the cotton. The black ants were also seen to kill these larvae on several occasions, and once or twice, when the worms had not been interfered with by me, I was able to note but one other enemy to this larvae, namely, the boll-worm itself; for on several occasions, on the plant and undisturbed, I saw large boll-worms catch smaller ones, which they devoured hoof and hide, or sometimes only bruised with their mandibles so that they could extract the juices from their bodies, the refuse being dropped. In trying to breed this species, I found that it would never do to place more than one larvae in a breeding jar, else the smaller ones were certain to be eaten by the larger.

As previously stated, these larvae vary greatly in color, but this variation has no connection with the plant on which they feed, so far as I could see; for green larvae were found on all of their food-plants, and deep-pink larvae were found on the cotton-plant and on the roasting-ears of corn. Originally, this color variation may have been produced by its being protective to one individual to be pale green because it fed on the pale-green parts of some plant; while another, feeding on deep-green organs, would be protected by being of a dark-green color; and another, feeding on a rose-colored organ—and the silk of some ears of corn as well as certain shades of the later stages of a cotton-flower, in which these larvae are not infrequently found, are well represented—would be protected by being of a rose-color. It is evident, however, that such color variation to be protective must be associated with an instinct leading the parent moths to lay such eggs as should produce light-green larvae on light-green plant organs; such as should produce dark-green larvae, on dark-green organs, and such as should produce pink larvae, on pink organs. Or, if this were not the case, larvae hatched on organs of different colors must have the power to become, themselves, colored like these organs. Such cases are known to occur, but this is not the case with *Heliothis*, as has been already stated; though it is possible that at one time these color variations may have been accompanied by suitable instincts in the moths, these instincts having been lost at a later time.

REMEDIES.

Of the means of destroying the boll-worm or the moth, which is its perfect form, I can say but little. Its natural enemies, whatever they may be, should be protected; and, like *Aletia*, this species may possibly be destroyed some day by some parasitic fungus, which may be utilized for this purpose. The remarks made about the use of poisoned sweets and fires for destroying the moths of *Aletia* will apply equally well to the imagines of this species.

Since the earlier broods of larvae are found on the maize or Indian corn, first in the stalk, later in the ears; and since the tendency of the species to multiply in geometrical progression makes it desirable to destroy the early broods if possible, I would suggest hand-picking of these earlier broods as the best way known to me of dealing with the pest. As was stated when speaking of the natural history of *Heliothis*, if one of these larvae has taken up its abode in a stalk of corn the fact can be detected by a very superficial examination, owing to the holes found in the leaves. Let, then, each plow-hand be instructed, when cultivating the corn, to stop whenever he finds such a stalk, and catch and kill the worm, even though it should occasionally be necessary to destroy the plant in doing this, for the hill may be replanted, and the larva thus killed might, if suffered to live, become in a few generations the parent of hundreds of boll-worms. Later, after the corn is "laid by" and has begun to fruit, boys may be sent through the fields to kill the "tassel-worms," the presence of which may be detected by the excrement at the end of the ear or by the silk being eaten away. To catch these, it will be necessary only to open the husk for a short distance back from the end of the ear, and from the ease of discovering affected ears the expense will not be great. It is objected to this, that ears so opened are exposed to the weather and the attacks of birds. Though it must be admitted that this is true up to a certain point, the destruction of all ears so interfered with does not follow, and the great lessening of the next crop of boll-worms will, I am certain, more than pay for what corn is sacrificed.

After the species has taken up its abode in the young bolls of cotton, hand-picking is the only remedy that I know of, and, being far more expensive than with the earlier broods, this does not seem practicable. When the cotton is poisoned to destroy the caterpillar, some of the young boll-worms, feeding on leaves or bracts, are poisoned, and I have seen a few large ones destroyed in a similar manner; but from the fact that they feed for the most part on the contents of the boll, making only a round hole through its exterior, poison cannot be well used in dealing with them.

Plow-hands should be instructed to destroy every pupa plowed out of the ground, as in this way many belonging to this species will be killed.

In closing, I have to express my gratitude for the many aids and kind encouragements which I received from George O. Baker, Col. N. H. R. Dawson and his manager, Mr. J. P. Melton, Capt. R. M. Nelson, Capt. N. D. Cross, and many of the other planters about Selma, Ala.

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APPENDIX II.

ANSWERS TO CIRCULAR.

The following answers to the circular letter printed in full in the introduction to this report are arranged as follows: First, according to the sequence of the questions; second, alphabetically, according to States. The name of each correspondent and of the county from which he wrote is given; the full addresses of correspondents may be found by referring to the list given in Appendix III.

PAST HISTORY OF THE COTTON-WORM.

QUESTION 1.—*Give, so far as you can from trustworthy records, the earliest year in which cotton was grown in your State, county, or locality.*

ALABAMA.

Cotton was grown as early as 1825 in this county.—[H. Hawkins, Barbour.

Some few settlements in this county, Bullock, then Macon County, in 1836, but not generally settled until 1840 to 1842.—[J. R. Rogers, Bullock.

I think about 1817 or 1818.—[C. C. Howard, Autauga.

Cotton was probably grown in the State when it was first settled, 1818, or earlier. This part of the State was settled as early as 1817.—[R. W. Russell, Lowndes.

The growth of cotton was on a limited area as early as 1818 in this locality; by 1825 and 1828 it became a general crop.—[Robert S. Williams, Montgomery.

First grown in this county in 1832.—[John D. Johnston, M. D., Sumter.

In its earliest settlement, about 1816. A few years later in this county.—[H. A. Stollenwerck, Perry.

Cotton was grown on a small scale as early as 1820; and after Indian war of 1836 it was more extensively raised.—[I. F. Culver, Bullock.

Cotton was grown in this locality as early as 1817, but not as a *field* crop before 1825, extending rapidly from that time.—[P. T. Graves, Lowndes.

In my locality cotton was grown immediately succeeding the removal of the Creek Indians in 1836-'37.—[A. D. Edwards, Macon.

We have no records here of the exact years in which cotton was first grown; it was commenced on a small scale and gradually increased from 1820, and reached its greatest about 1858.—[H. C. Brown, Wilcox.

My recollection dates back to 1827, but it was grown even before that time.—[James M. Harrington, Monroe.

About the year 1820.—[M. W. Hand, Greene.

1830.—[Knox, Minge, and Evans, Hale.

Being a native of both the State and county where I now live, and am now fifty-eight years old, can say that as far back as I can recollect cotton has been grown here. For the last fifty years I should say it has been the leading staple.—[Andrew Jay, Conecuh.

First cotton grown in this locality in 1812.—[R. B. Dunlap, Greene.

Cotton was grown in small quantity as early as 1825 in Autauga County. There are no records showing this, but there are persons now in this vicinity who testify to its truth.—[Charles M. Howard, Autauga.

Cotton first grown in this locality in 1813, or to a very small extent as early as 1800.—I. D. Dreisbach, [Baldwin.

The county of Bullock was created from sections of Pike, Montgomery, Barbour, and Macon, in 1866. In 1819, Pike County grew 7,192 bales of cotton. The whites began to settle Montgomery County in 1816 or 1817. Macon and Barbour were formed from the territory of the Creek Indians in 1832. Cotton was grown on the land now covered by Bullock as early as 1816 or 1817.—[R. H. Powell, Bullock.

Cotton was grown in this (Conecuh) county, from trustworthy records, as early as the year 1817.—[P. D. Bowles, Conecuh.

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Cotton has been grown in this county (Dale) since 1825. I have lived here from then until now.—[J. C. Matthews, Dale.

Very little in the State was grown previous to 1820, and that little was grown for domestic use.—[David Lee, Lowndes.

Cotton was first grown in the southern part of Sumter County about 1830.—[J. N. Gilmore, Sumter.

Alabama was admitted into the Union as a State in 1819, and it is known that cotton was cultivated before that time.—[H. Tutwiler, Hale.

Cotton was generally grown in Alabama in 1819 and 1820, when the State was admitted into the Union, and had become a staple article. And as Alabama is one of the best cotton regions in the cotton-belt, its cultivation increased rapidly, and became a paying industry to the first settlers.—[Dr. John Peurifoy, Montgomery.

About the year 1816 or 1817.—[J. S. Hausberger, Bibb.

ARKANSAS.

Cotton was first grown in 1867 for market in this county.—[John T. Wickham Clay.

Cotton was grown in this county as early as 1846.—[Norbourne Young, Columbia.

Prior to the war there was little more cotton made in this county than for home use. Since the war there has been a good deal of cotton raised for shipment, say 1,000 to 2,000 bales per year.—[S. W. Cochran, Fulton.

I am unable to obtain any trustworthy account of the early history of the production of cotton in Miller County, which was a portion of Lafayette County until recently. The earliest date I can obtain is 1835.—[E. T. Dale, Miller.

First cotton grown in 1835. There was but little raised until 1840.—[T. S. Edwards, Pope.

FLORIDA.

No definite knowledge.—[F. M. Meekin, Alachua.

The first cotton grown in this county for market was in 1851.—[John B. Carrin, Taylor.

There is very little cotton raised in this section, and the habits of the growers are a series of old time superstition; all evils are chargeable to the influence of the moon.—[W. E. Woodruff, Duval.

There is very little cotton grown in this part of Florida, and no worms have ever affected it.—[John M. McGehee, Santa Rosa.

Cotton was cultivated in Middle Florida as early as 1827.—[Robert Gamble, Leon.

GEORGIA.

Cotton first planted in the county in 1848, but not generally raised until 1854.—[Timothy Fussell, Coffee.

Cotton was introduced into Georgia as a crop between 1790 and 1800.—[William Jones, Clarke.

From the best information that I can get, about the year 1822 or 1823.—[S. P. Odom, Dooly.

Cotton was grown in Jackson County first about 1781, but to a very small extent. This county was then called the Cherokee Nation, abounding with savages, wild beasts, &c.—[E. M. Thompson, Jackson.

Cotton was not grown in our county earlier than 1820.—[A. J. Cheves, Macon.

Cotton, to a small extent, was grown by aborigines, the Indians, long before I was born. I was born in 1828.—[William A. Harris, Worth.

From the best information I can get, the first cotton raised in Georgia was in the year 1739 or 1740, on the Island of Saint Simon's, by a Mr. Harton. The first year it was grown in this county was 1828. The first I ever saw grown was in 1812.—[Morgan Kemp, Marion.

1805, in the county.—[John T. Wingfield, Wilkes.

Cotton has not been raised as a crop in this county till within the last ten years; have had but little trouble with the worm.—[James R. Brown, Cherokee.

There is but little cotton planted in Chatham County.—[George P. Harrison, Chatham.

We do not raise cotton in this county to any considerable extent; know nothing of its enemies.—[M. D. Lansford, Catoosa.

There was but little cotton grown in this county up to 1845.—[H. W. Hammett, Cobb.

LOUISIANA.

No cotton grown in this parish.—[G. W. Thomas, Saint Mary's.

In Carroll Parish, Louisiana, in 1827.—[C. B. Richardson, E. Carroll.

According to tradition, it was raised here at the beginning of this century—say seventy-five years ago.—[Douglas M. Hamilton, West Felinciana.

I have no records.—[I. U. Ball, M. D., West Feliciana.

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MISSISSIPPI.

Descending the Mississippi River (from Canada) Charlevoix arrived at Natchez and there spent Christmas in 1722. During this visit he saw the cotton-plant growing in the garden of Sieur Le Noir, clerk of the Mississippi Company (or as then styled the Company of the Indies). Bienville mentioned the culture of cotton in the colony in 1735; Stodard, in 1740; and George Vaudreuil (as quoted by Judge X. Martin), in a dispatch in 1746, mentions cotton among other things brought in boats down the Mississippi River to New Orleans. It has been cultivated in Louisiana and Mississippi ever since.—[D. L. Phares, A. M., M. D. Wilkinson.

The earliest period cotton was grown in this State and county was about 1830.—[John C. Russell, Madison.

Cotton has been the staple product of this county since I emigrated to it in 1846, and it had been for many years previous.—[E. H. Anderson, M. D., Madison.

I am not aware of the existence of any trustworthy records on the subject; probably, judging from the memory of old persons, it was grown in this county as early as the year 1815.—[C. Welch, Covington.

Winston County was organized and settled in 1833 and 1834. Cotton was planted soon after.—[William T. Lewis, Winston.

Cotton was grown in Mississippi before its admission as a State, 1817. This country was inhabited by Indians until 1834, 1835, and 1836. They raised no cotton after the sale of their lands, under the treaty of 1833, and amended in 1834. In 1835 white settlers raised cotton on a small scale.—[Kenneth Clarke, Chickasaw.

About 1832.—[C. F. Sheirod, Lowndes.

When and from whence the plant was first introduced into Mississippi is not certainly known; most probably by the early French colonists from St. Domingo, which was a touching point for the company's ships. It would seem that its cultivation here and in Louisiana on a small scale for domestic uses preceded that of Georgia. Charlevoix, on his visit to Natchez, 1722, saw it growing in the garden of Sieur Le Noir, the company's clerk. Mention is again made of it 1735, 1740, 1746. (See Wailes's Geology of Mississippi, 1854).—[J. W. Burch, Jefferson.

From the best information I have been able to procure from old citizens I find that cotton was cultivated in this State about the same time it was introduced into Louisiana. The first cotton-gin made in this State was by the order of the United States Government, at a place in Monroe County that has borne the name of Cottongin ever since. It was made to encourage the Choctaw Indians to raise cotton. Cotton was raised by all the Indian tribes in this State at a very early day. This, Clark County, was a portion of the last purchase from the Choctaw Indians. Cotton was planted here by the whites soon after the purchase. The first account I have been able to procure of the cotton crop is for the year 1833; that year the crop was 380 bales.—[W. Spillman, Clark.

In the county of Amite the first cotton was grown in small quantities as early as A. D. 1809, but was limited to small farms, there being no cotton-gins in this county at that early day.—[George V. Webb, Amite.

NORTH CAROLINA.

Cotton has been grown in this county since 1820, but only on a small scale until 1867.—[Jonathan Evans, Cumberland.

Cotton for domestic use was first raised in 1806.—[Jasper Stone, Gaston.

Cotton was not much grown before 1810.—[F. I. Smith, Halifax.

Cotton has been cultivated in this county to a small extent probably since about the year 1800, or perhaps earlier; but very little was produced until about 1850, when, owing to the exhaustion of the turpentine trees, our farmers were forced to turn their attention to its cultivation. Since then the product has steadily increased.—[John Robinson, Wayne.

There is no cotton raised in this county.—[Joseph Livingston, Henderson.

We raise no cotton in this county.—[S. W. Blalock, Mitchell.

There is not a bale of cotton grown in this county.—[T. L. Rawley, Rockingham.

Notwithstanding we are in a Southern State and southern latitude, we have a northern climate; consequently there never has been a pound of cotton raised in our county, and we know nothing of the history of the worm.—[W. H. Hartgrove, Haywood.

No cotton raised in this county for sale.—[James M. Barnett, Person.

We do not grow cotton in this county.—[J. W. Cooper, Cherokee.

Only a small quantity grown in this county.—[W. G. Curtis, Brunswick.

As cotton is not raised in this county for market, no observations have been made relative to the insects that prey upon the crop.—[J. J. Erwin, Burke.

SOUTH CAROLINA.

Cotton was first grown in this district in the year 1783, although in a very limited manner for a number of years. It soon, however, became generally planted.—[James W. Grace, Colleton.

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I cannot give the time of introduction of cotton in this county, but it was raised before the Revolutionary War of 1776.—[Paul S. Felder, Orangeburgh.

In this county about the year 1807 cotton was first grown.—[James C. Brown, Barnwell.

TENNESSEE.

Cotton was first raised in this county about the year 1810. We have no records on the subject here. Cotton has been raised in the State to some extent ever since it was a State.—[D. W. Holman, Lincoln.

Cotton first grown in the State in 1790 and in the county in 1808.—[A. W. Hunt, M. D., Perry.

There is no cotton grown in Robertson County.—[George W. Walker, Robertson.

Cotton is not raised to any extent; sometimes a little for domestic use.—[J. K. P. Wallace, Anderson.

Scarcely any cotton is grown in this county. Cotton-worms are strangers here.—[J. S. Thomason, Monroe.

But little cotton grown in this county; never saw or heard of a cotton-worm here.—[Ephraim Link, Greene.

There is no cotton raised here.—[H. W. Hart, Bledsoe.

Cotton is not grown in this county to any considerable extent.—[J. S. Lindsay, Campbell.

No cotton nor cotton-worms in this county.—[W. C. Emmert, Unicoi.

There is not sufficient cotton raised in my county to justify a report.—[A. Gardner, Weakley.

We raise but little cotton in this county.—[J. W. Hammer, Sevier.

No cotton raised in this county.—[Robert McNeilly, Dickson.

Very little cotton has ever been raised here.—[John F. Hauser, Grundy.

This county does not raise cotton.—[L. C. Hall, Jackson.

Too far north for cotton.—[Miles F. West, Macon.

Cotton was raised from 1823 to about 1830. Cotton became as low as four cents per pound when farmers abandoned the raising of it.—[Thomas J. Mason, Loudon.

As cotton is not raised in this county, or at least to so small an extent it is not worthy of notice.—[J. P. Hooke, Blount.

Cotton was grown in this section in 1818.—[John McMillan, Decatur.

About 1815 in the county.—[E. W. Cunningham, Henderson.

TEXAS.

In this State, Texas, we suppose very little cotton was planted before the annexation to the Union. I moved to this State in 1854, and found large fields in cotton at that time.—[W. T. Hill, Walker.

After 1840 cotton was grown to some extent in our county. The five years preceding 1850 in a considerable quantity.—[J. H. Krancher, Austin.

The cotton making in this county is small in extent, and also careless in procedure. The data for information is very inadequate for giving satisfaction.—[Prior Lea, Goliad.

Austin's Colony, the central portion of Texas, began to be settled by American colonists in 1820–'21, and cotton culture soon after commenced. The writer arrived here in April, 1834, direct from Massachusetts, and cotton then was universally cultivated throughout Central Texas.—[A. Underwood, Brazoria.

Cotton was grown in this county in the year of 1835.—[Stephen Harbert, Colorado.

1840.—[H. J. H. Brensing, Bowie.

Cotton was first raised for sale in the year 1840. About that time the first gins were established. Cotton was probably raised in small quantities in other parts of the State before that period.—[S. B. Tackaberry, Polk.

I arrived in Washington County, Texas, November, 1838. I found but little cotton raised, and but two or three gins; they were owned by Dr. Asa Hoxie, Judge J. P. Coles, and Mr. Foster. Cotton was grown in other counties east of the Brazos River more or less.—[O. H. P. Garrett, Washington.

In 1877 in this county.—[William Tanner, Clay.

No cotton planted here.—[A. Turpe, Maverick.

In this section of the State very little cotton is grown, and in my own county (Menard) comparatively none; the soil is adapted to its growth, but the climate is too dry.—[J. F. P. Kriuse, Menard.

There is no cotton raised in this county. There is no cotton grown in this State from the San Antonio River to the Rio Grande. The climate is rather too dry and windy.—[W. R. Hayes, Bee.

Cotton has not been planted in this county extensively as yet; only by way of experiment.—[James O. Gaffeny, San Patricio.

Cotton has been raised in this county since 1858. It was grown in the State earlier.—[P. S. Watts, Hardin.

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Cotton was raised in Harrison County in 1846, and in Upshur County in 1847; but sparsely, as there were no gins.—[J. M. Glascoe, Gilmer.

The first cotton raised in this county in 1857. The culture of it was abandoned in 1860, and taken up again in 1868.—[A. Schroeter, Burnet.

1853, in this county. From the beginning of the war until 1867 no cotton was raised.—[R. Wipprecht, Comal.

In the year 1821 Jared E. Grace came to this State (Texas) and brought the first cotton seed, and planted it the next year. In 1823 planted the unginned seed; then gins were imported, and the first gin-house was built in the Brazos, about three miles from here.—[P. S. Clarke, Waller.

Cherokee County organized in 1846. Cotton grown many years before.—[Walter Barnes, Cherokee.

Cotton was first raised in the county in 1865—[Samuel Davis, Hunt.

In the State (I have no authentic information in the county), in the year 1845, and in this locality in 1846.—[J. W. Jackson, Titus.

Captain Burnham had a small patch of cotton growing in 1835 and 1836.—[Natt. Holman, Fayette.

QUESTION 1 *a.—During what year did the worm first make its appearance in your locality, and, as far as you are aware, in the State; in other words, how many years elapsed after cotton first began to be grown before the worm began to work upon it?*

ALABAMA.

About thirteen years elapsed before the worm made its appearance in sufficient force to damage cotton; it appeared in 1830.—[J. S. Hansberger, Bibb.

First appearance in my locality was about the year 1861, as nearly as I can recollect.—[J. A. Callaway, Montgomery.

One of my neighbors says that it was first noticed in this part of Alabama in 1843–'44. My impression is, that it was here before that time. At least we had what was then called the "army worm," and I think that it destroyed cotton as well as grass; but I cannot speak positively on this subject.—[H. Tutwiler, Hale.

Cotton-worm appeared here in 1828, and did considerable damage to the cotton crop.—[Jason Jones, Montgomery.

1846. Not less than thirty years.—[H. A. Stollenwerck, Perry.

The worm first made its appearance in this locality in 1847. I am not aware of their having made their appearance before that time in the State.—[A. D. Edwards, Macon.

About the year 1848 or 1849.—[H. C. Brown, Wilcox.

The cotton in this part of the State has never been troubled by the cotton-worm.—[W. M. Douglass, Madison.

In Alabama the worm began to attract attention in 1837.—[J. M. McGehee, Santa Rosa, Fla.

1852. Twenty-two years after cotton was first grown.—[Knox, Minge & Evans, Hale.

According to my memory the cotton crop was eaten up in my locality in 1826 or 1827. I think that was about their first appearance.—[Andrew Jay, Conecuh.

Caterpillar made its first appearance in 1845. Was not general even in this county but were *very* destructive in 1846.—[H. Hawkins, Barbour.

The worm first made its appearance in this locality in 1845.—[R. B. Dunlap, Greene.

During 1846, and were more numerous then than they have ever been since. About ten years after cotton was planted the worms made their appearance in this neighborhood.—[J. R. Rogers, Bullock.

1824. My locality was at that time Burnt Corn, Monroe County, Alabama, latitude 31° 42′. The worms came late and were not numerous and did no damage. The same year they were reported in Southwest Georgia. In 1825 they were numerous here by the 1st of October; did not go farther than latitude 32°.—[David Lee, Lowndes.

Cotton-worms first made their appearance in this county in the year 1825, which makes eight years from the first planted to the coming of the worms.—[P. D. Bowles, Conecuh.

The cotton-worm was first noticed from about 1828 to 1830; and some think their existence was known within one or two years after cotton was first cultivated.—[Charles M. Howard, Autauga.

First appearance to attract attention, 1836.—[I. D. Driesbach, Baldwin.

From 1836 to 1842 the worm was here, but too late each year to do much damage other than litter the cotton.—[J. C. Matthews, Dale.

About 1840. Don't know of any in the State before that time.—[James M. Harrington, Monroe.

Worms first appeared in 1844, about the 15th of September.—[George W. Thagard, Crenshaw.

In 1846. They came to this locality about September 23, and did their work of eat-

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ing the entire crop in three days. They kept south on a line of 23° 25′ north latitude. Have not been so numerous since.—[R. H. Powell, Bullock.

Somewhere about 1840.—[C. C. Howard, Autauga.

The first destructive or general crop of worms was in 1847. During the first week of September of that year they destroyed the foliage of the cotton-plant over the entire country. From 1847 to 1860 I do not think they were ever general in this section.—[R. S. Williams, Montgomery.

First appearance between years 1843 and 1849; about twelve or fifteen years after first planting.—[John D. Johnston, Sumter.

Worms first destroyed cotton here about the 1st of September, 1846.—[J. N. Gilmore, Sumter.

The cotton-worm made its first appearance about 1840.—[I. F. Culver, Bullock.

The first year the cotton-worm made its appearance in this locality was 1845 or 1846 in the latter part of September, more than 27 years after the introduction of cotton.—[R. W. Russell, Lowndes.

About the 20th of September, 1846, the *Aletia argillacea* made its first appearance in this locality, or, as far as I know, in this State; thirty-eight years from the first planting of cotton.—[P. T. Graves, Lowndes.

ARKANSAS.

In 1840 one party says that he saw cotton-worms.—[E. T. Dale, Miller.

The cotton-worm was bad in 1847.—[Norborne Young, Columbia.

About twenty years ago.—[T. S. Edwards, Pope.

Have not known of the cotton-worm in this section for eighteen years.—[L. N. Rhodes, Cross.

I have lived here twenty-seven years and never heard any complaint of the worm.—[J. W. Ransom, Craighead.

There has never been any cotton-worm in this county; suppose we are too far north.—[O. L. Dodd, Baxter.

Never have been affected here with worms.—[John T. Wickham, Clay.

The worms have not made their appearance in this county for some time.—[T. W. Quinn, Grant.

We know nothing of the cotton-worm in this county. I have been producing cotton forty years and feel perfectly safe in stating that the cotton crop has not been injured by worms of any kind.—[Alfred A. Turner, Bradley.

This county, situated on the headwaters of the Ouachita, in a mountainous region, is not properly a cotton country. It is better adapted to grain and grazing, hence but little cotton is grown, and but little trouble is experienced from worms or insects; so little, no one has paid any attention to their history or habits. Once in a while, not often, some worms appear and destroy the foliage after the plant has matured, doing little or no injury. In fact the farmers say it is an advantage, as it facilitates the picking and in a cleaner state, as there are no dead, crumbling leaves to get mixed with the lint.—[G. Whittington, Montgomery.

FLORIDA.

The worm first appeared in this county in 1866; in the State in 1832.—[John B. Carrin, Taylor.

1830; but then its ravages were inconsiderable.—[Robert Gamble, Leon.

GEORGIA.

The cotton-worm first made its appearance in 1804; and during the month of September the crops were half eaten up, when a hurricane swept over the country and destroyed the worms.—[W. Jones, Clarke.

The worm has probably been here at intervals ever since 1820, but I cannot fix upon any certain date earlier than 1842.—[A. J. Cheves, Macon.

The worm first injured the cotton in this county in 1836, and then only to a limited extent.—[Morgan Kent, Marion.

In the year 1843.—[S. P. Odom, Dooly.

The worm did much damage in 1847, and appeared in force nineteen years after, in 1867.—[T. Fussell, Coffee.

First appearance in this county in 1862; cannot tell when first appeared in the State.—[D. P. Luke, Berrien.

1854, in this county.—[J. T. Wingfield, Wilkes.

The worm first appeared in this county eight or nine years ago. Do not know when it appeared in the State.—[William A. Harris, Worth.

The worm never was seen or heard of until about ten years ago, say 1867.—[E. M. Thompson, Jackson.

The cotton-worm has not made its appearance here for several years, and never to do any material damage.—[William Johnson, Murray.

We have never had any cotton-worm in this county.—[R. H. Springer, Carroll.

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The worm has never damaged the cotton in this locality.—[H. W. Hammett, Cobb.

General Robert Toombs says the cotton-worm came from the West Indies to Florida, and from Florida to Georgia. He thinks I shall find it holding over in Florida, but that I am correct in stating that throughout the cotton-belt the worm of one year is not the parent of the worm of the next, and in the main cotton-belt it dies out in whatever state it may hibernate. The insect had broken up the cotton culture in the West Indies in 1801-'02, and the migration of French cotton planters to Georgia on this account took place in these years.—[A. R. Grote.

LOUISIANA.

The worm first appeared in Carroll Parish, Louisiana, September 5, 1846, and was universal in the parish. In 1847 it appeared in August in the middle of the field. On the 30th of August the first crop went into the chrysalis state, and the second crop swept every leaf before the 21st of September.—[C. B. Richardson, East Carroll.

From old settlers I have learned that while the old *black* seed-cotton was planted the army worm was not known. This cotton rotted badly, and the *Mexican* seed was introduced about 1820. Between 1820 and 1828 the army worm destroyed the crops, but in what year or years I cannot learn exactly.—[Douglas M. Hamilton, West Feliciana.

The first appearance of the cotton-worm in this county was about August 11, 1844.—[John A. Maryman, East Feliciana.

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1804. It is very probable that they appeared many years earlier, but of this I have no documentary or other proof that is reliable. They destroyed crops in Georgia as early as 1793, and in the Bahamas in 1788. Hence it is probable they did likewise in the country now called Mississippi at an earlier date.—[D. L. Phares, Wilkinson.

My earliest recollection, 1845.—[J. W. Burch, Jefferson.

Between the years of 1845 and 1850 the worms made their first appearance.—[John C. Russell, Madison.

Worm was not known here until 1847 or 1848, about thirty years after the introduction of cotton.—[C. Welch, Covington.

My first knowledge of the injury to cotton by the worms was in 1858, though I have no doubt they did damage earlier.—[Kenneth Clarke, Chickasaw.

The worm first made its appearance on my plantation in the year 1865. It was late making its appearance, and few in number, and did but little injury.—[Samuel Scott, Madison.

1875 was the last year it was very destructive.—[William T. Lewis, Winston.

In 1846 and 1847 they first made their appearance; were not seen again until 1867.—[C. F. Sherriod, Lowndes.

In the year 1839 a few made their appearance in our cotton-fields, but did no damage. Afterward, in the year 1846, they appeared again in "power and demonstration" and well nigh ruined the crops in this locality. The worm appeared as early as July 8 in small numbers; again about the 28th of the same month in considerable force; and again about the 18th of August following they appeared the third time, and did not leave a vestige of the foliage of the cotton.—[George V. Webb, Amite.

From all I can learn, the worm first made its appearance in this county in 1846, and afterward in considerable numbers in 1866, '68, '73, '74, and there were a few this year.—[W. Spillman, Clarke.

NORTH CAROLINA.

In the year 1847 a worm exactly similar to the cotton-worm made its appearance in large numbers; this worm fed on grass, Indian corn, and cotton, doing more damage to corn than to cotton. I am unable to say that it was the genuine cotton-worm.—[John Robinson, Wayne.

I find no one who ever saw a cotton-worm in this country before 1860. They have never done much damage here.—[Jasper Stone, Gaston.

1863.—[F. I. Smith, Halifax.

1867.—[J. Evans, Cumberland.

Cotton-worms have never appeared in any injurious character or in such numbers as to be destructive; we are too far north for them. When they have appeared it was late in the autumn, and they were rather an advantage than otherwise, as they removed the superabundant leaves and exposed the fruit to the influence of the sun.—[R. T. Weaver, Hertford.

I cannot recall but one year (1872) in which the cotton-worm did any material damage.—[H. M. Houston, Union.

No cotton-worm in this section worth speaking about.—[T. H. Lassiter, Gates.

This is the "Land of the Sky," and the cotton-worm is not known.—[D. D. Davies, Jackson.

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I am happy to report that no species of worm or insect has ever proved injurious to the cotton in this county.—[J. D. Click, Iredell.

Cotton-worm has never been in this locality.—[M. McKay, Harnett.

So far as I am able to learn, the cotton-worm has not made its appearance in this county.—[Thomas Long, Yadkin.

SOUTH CAROLINA.

As early as 1793 the worm is said to have swept over Carolina and Georgia, but is first recorded in this county in 1804 as prevailing generally.—[James W. Grace, Colleton.

The first appearance of the cotton-worm in this county was about 1857.—[P. S. Felder, Orangeburgh.

The worm first made its appearance in the State in 1800; in this locality in 1827. It was twenty-five years before the worm was known after the introduction of the plant.—[James C. Brown, Barnwell.

TENNESSEE.

The *Aletia argillacea* first made its appearance in the county in 1850. Had made its appearance ten years earlier in older counties of the State.—[A. W. Hunt, Perry.

This county has never been materially damaged by the cotton-worm.—[E. W. Cunningham, Henderson.

The worm has never injured the cotton in this State.—[J. McMillan, Decatur.

Henry County is on the extreme northern boundary of the cotton-belt. We are not troubled here with any insect or worm that injures the cotton-plant farther south. Our only trouble is the short season.—[N. Y. Cavitt, Henry.

Have never seen the cotton damaged by the worm but once, then only to a very small extent.—[L. Dodson, McMinn.

TEXAS.

From its earliest cultivation the oldest citizens do not remember.—[Walter Barnes, Cherokee.

1834. A boat-load of cotton-seed was brought from New Orleans and planted, and that year the worms made their first appearance and destroyed the crop.—[P. S. Clarke, Waller.

In 1842 the cotton-worm came in force, more than any year previous. As the planting and cotton increased the worm increased also, coming to do its mischief about every third year; some years doing but little damage, others quite destructive. If June was a rainy month we expected the worm, as a small miller or butterfly generally preceded it.—[O. H. P. Garrett, Washington.

1870 or 1871.—[Samuel Davis, Hunt.

1867 in the county.—[R. Wipprecht, Comal.

1861 in this county, doing but little damage.—[J. M. Glasco, Upshur.

1847.—[H. J. H. Brensing, Bowie.

In 1859 was the first I knew of them in this State, but it is probable in the coast counties they appeared much earlier.—[P. S. Watts, Hardin.

Cotton-worms first made their appearance in this county in 1846; can't tell as to other parts of the State, but as this is an old-settled county suppose not earlier than that date.—[S. B. Tackaberry, Polk.

The appearance of worms in large numbers noticed for the first time in 1871.—[A. Schroeter, Burnet.

Cotton-worms have never been here but once (1869), and then only in one field.—[John Speer, Blanco.

In 1871 or 1872 the white cotton-moth, together with a large brownish butterfly, came in swarms like grasshoppers from north 10° east, by the needle, traveling south 10° west, for about two days.—[A. Turpe, Maverick.

The first appearance of the cotton-worm in Texas, according to the oldest inhabitant, was in 1846. They again injured the crops in 1852 and 1862. Since 1864 they have appeared every year, some years doing little or no damage.—[W. T. Hill, Walker.

About 1850 the worm was first noticed in this county, but did not appear sufficiently numerous to destroy the crops until several years later.—[J. H. Krancher, Austin.

They were first noticed here in 1849.—[C. B. Richardson, Rusk.

My recollection is that the cotton-worm did not appear in this section of Texas until 1844; then first on plantations near the Gulf coast, in Brazoria and Matagorda Counties.—[A. Underwood, Brazoria.

The first appearance of the cotton-worm in this county was in 1848 or 1849.—[Stephen Harbert, Colorado.

If my memory serves me right, in 1857.—[Natt. Holman, Fayette.

The first moth or worm seen in this locality was in the summer of 1867.—[J. W. Jackson, Titus.

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QUESTION 1 *b.—Specify the years when it has been unusually abundant and destructive.*

ALABAMA.

From 1860 to 1865 this section did not grow cotton generally. But there were no patches of cotton grown that did not develop worms at some time during the season. In 1867, '68, '69, '71, '72, and '73 they were general. In 1872 and '73 they did immense damage to the growing crops. In 1870 this section was unusually dry; worms only in patches. Crops for this year large.—[H. S. Williams, Montgomery.

In 1849 they were especially bad, and nearly every year since more or less.—[John D. Johnston, Sumter.

During the years of the war—1862 and 1863—there was very little cotton planted in this locality, but sufficient to know that the cotton-worm was here. In 1866, '67, '68, '69, and '70 there were more or less worms; 1873 was the worst year we ever had; 1875 and '77 they ate the cotton clean.—[R. W. Russell, Lowndes.

In 1836 were very destructive.—[M. W. Hand, Greene.

In 1846 the worms were abundant, but not destructive; the crop was good; in 1866 they were abundant and destructive, coming in *force* by the middle of August, with the crop, much of it young from replanting, in vigorous growth from frequent rains; 1868, abundant, but not destructive; 1873, most fatal year in the history of the worms.—[P. T. Graves, Lowndes.

First in the year 1825; again in 1831 or '32 (old citizens differ as to '31 and '32); also 1867, '68, '73, '74, '75, '78.—[P. D. Bowles, Conecuh.

1825, very abundant, but not destructive because of the lateness of the time (October 1). In 1846 very abundant and destructive by the 25th of August. In 1869 and '73 the same.—[D. Lee, Lowndes.

In 1840, '47, '54; after that in 1866. They should have made their appearance in 1861, but we planted no cotton during the civil war. From 1866 to 1871, no worms; 1871, '72, '73, and '74, destructive; in 1875, none; 1876, '77, and '78, worms.—[James M. Harrington, Monroe.

Their prevalence was at intervals of several years, and the belief was common that they were in some respects like the seven-year locust. So irregular in their advent from 1830 to 1860 that the idea of their septennial recurrence was entertained by our cotton-planters. They were unusually destructive in 1848, '49, '54, '55, '58, '69, '71, '76, '77, '78.—[Charles M. Howard, Antauga.

In Alabama they have been very destructive every year since 1840 whenever the last of July and the month of August were wet and cloudy.—[J. M. McGhee, Milton, Santa Rosa County, Florida.

Very destructive in 1842, '44, and every year since, with the exception of 1858 and '59. No cotton grown in this locality during the war.—[I. D. Dreisbach, Baldwin.

1866, '67, '68, '69, '70, '71, '72, '73, '74, '76, '77, '78.—[H. A. Stollenwerck, Perry.

1844, earliest recollection of the worm. In 1868 the worms appeared in strong force about the 20th of August; they have missed but three years since.—[Geo. W. Thagard, Crenshaw.

They were unusually destructive in 1847 and in several years since; dates not recollected. For the last ten years they have been more or less numerous each year.—[A. D. Edwards, Macon.

The cotton-worm has been very destructive here since 1865, some seasons earlier than others.—[J. C. Mathews, Dale.

1864, '67, '68, '72, '73, '74, '76, '78.—[John Witherspoon Du Bose, Montgomery.

Their next appearance was, I think, in 1868, and have been more or less common every year since. In 1872 they were probably more numerous than at any time since 1846, and more destructive; they came in August.—[R. H. Powell, Bullock.

From 1860 to the present year; more destructive in the years 1869, '73, '74, and '75, but more or less every year; some localities worse than others, as was the case this year; some parts of this county the leaves completely stripped, while others have escaped entirely.—[H. C. Brown, Wilcox.

1866 and '73.—[John Peurifoy, M. D., Montgomery.

Every year since 1863, except 1875, when there was but a few.—[J. H. Smith and J. F. Calhoun, Dallas.

More destructive in 1846 than any year since; destructive in 1867; in 1873 destroyed the entire crop; in 1878 crop was injured until about 25th of September; east and southeast of here the crop was destroyed the last of August and first of September.—[J. N. Gilmore, Sumter.

The worms were very destructive in this locality in 1866, '71, '72.—[J. S. Hansberger, Bibb.

1866, '68, '72, '73, '76, '78.—[J. A. Callaway, Montgomery.

There were none in 1865, but in 1866 they were very abundant and destructive; also in 1872, and I think in 1874 and '76.—[H. Tutwiler, Hale.

1852, '63, '64, '66, '68, '69, 72, '73, '76, '78.—[Knox, Minge, and Evans, Hale.

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In 1846 the caterpillar almost destroyed the crop. It appeared in July and eat the bark off the cotton-stalk, which has not been the case since. It next appeared in 1868, late in August, and destroyed the top crop; was very destructive in 1873, but in '74 less so; in 1873 made its appearance in May.—[H. Hawkins, Barbour.

After 1826 or '27 a considerable interval took place before they appeared in destructive numbers again. It has been observed that their ravages have been more frequent as the country has grown older; that is, as the lands are older and country more open.—[Andrew Jay, Conecuh.

There has been no year since 1845 in which they have not made their appearance; usually more destructive about every third year.—[R. B. Dunlap, Greene.

In 1872 they were more destructive than any year since 1846. But little cotton was planted during 1863 and '64, but nearly the entire crop was destroyed either in 1863 or '64; I forget which.—[J. R. Rogers, Bullock.

The worm was most destructive in 1872 and '73.—[I. F. Culver, Bullock.

From 1866 to '78, inclusive; 1867, '70, '73, '76, and '78 were the most destructive years.—[R. F. Henry, Pickens.

ARKANSAS.

In 1847; about '53 and '72.—[Norborne Young, Columbia.

In 1865, '66, and '67 they were very destructive, but since that time there have been but few each year.—[E. T. Dale, Miller.

In 1875 and this year.—[T. S. Edwards, Pope.

FLORIDA.

In 1832, '39 or '40, and '72.—[John B. Carrin, Taylor.

GEORGIA.

According to my experience, the worm was especially abundant in the years 1825, '40, 43, 46, '47. In 1852 the worm made its appearance, but did no material harm.—[William Jones, Clarke.

The years 1843, '49, and '52.—[S. P. Odom, Dooly.

The greatest destruction in this county occurred from the years 1868 to '74, inclusive.—[Morgan Kemp, Marion.

1838, '72.—[D. P. Luke, Berrien.

It has never done any material damage except in the years 1868 and '73.—[A. J. Cheves, Macon.

1868 and '74. We have never had them but a few times.—[John T. Wingfield, Wilkes.

1868, '69, '71, '73, '74, '75 most destructive. In 1876, '77, and '78 they did not injure the cotton at all.—[T. Fussell, Coffee.

There has been but two or three years that the army-worm has visited our country, and it was a question whether they did a service or a damage; I think they did some damage. In 1869 and '74 they were here in force.—[E. M. Thompson, Jackson.

Don't remember. The worm was a benefit to me, as my cotton was too thick. My people care but little for the worm. They destroy them when they become too destructive.—[Wm. A. Harris, Worth.

LOUISIANA.

In Carroll, Louisiana, 1846 and '47.—[C. B. Richardson, East Carroll.

The years in which they were most destructive are 1844, '67, '70, '72, '74, '77, and '78.—[John A. Maryman, East Feliciana.

In 1844, '64, '66, and '67 they were unusually abundant and destructive.—[Dr. I. U. Ball, West Feliciana.

In 1841, upon a return visit from school to the plantation, I saw the army-worm for the first time. It was then late in the fall; the cotton was yet green with leaves and white with open bolls. Scarcely any damage was done to quantity of crop made, but the quality was made very bad by the litter and excrement of the worm, dropped on the open cotton. In 1846 they appeared very early in the season and cut the crops in this section short from 50 to 60 per cent. A few may have been seen by some persons after that year, but no damage was done by them until *after* the war broke out. The fact that no notice was taken of them generally and no damage done by them in this section proves that they were very few in numbers, even if they existed at all. As a general rule in this section, our people planted very little cotton during the war, and no appearance of the worm was observed until 1865. But in the lower portions of the State, after the occupation of the country by the Yankee forces, the army-worm appeared very generally, and at such early dates as to cut the crops off very short. Since 1865 they have appeared here annually; sometimes early and sometimes late; some years doing very little damage, and again working great destruction of the cotton crops. On some plantations they are worse than on others, and this occurrence is governed by no rule or natural laws understood or observed by our people.—[Douglas M. Hamilton, West Feliciana.

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1804, '14, '25, '46, '68, and I might add '38, '67, '73, &c. They may be found every year; but most years do little damage, sometimes none except in very small areas.—[D. L. Phares, Wilkinson.

1845 and every year, more or less, until 1864, the most destructive of all years. I only made 3 bales on 125 acres land; cotton eaten up in July. Again in 1867, '68, '69, '73, (bad), '76, and '77. Again this year worse than any since '73.—[J. W. Burch, Jefferson.

Abundant in the years 1847 or '48 and 1866, '67, '68, '77, and have done some injury this year.—[C. Welch, Covington.

In 1858; then slightly for two other years. In 1868 they were very bad. In 1872, '73, '74, and '78 they greatly injured cotton. From 1861 to '65, inclusive, there was very little cotton planted and no record kept of that little (during the war).—[Kenneth Clark, Chickasaw.

They were very destructive in 1867, '73, '74, '76, and this year (1878).—[C. F. Sherriod, Lowndes.

1867 and '68, and other years I do not remember.—[Dr. E. H. Anderson, Madison.

They were more abundant and destructive in the year 1867 and the present year (1878) on my place than any other years. They commenced in force in the year 1867, on the 5th of September, and in five days they had eaten my crop up. They commenced about the middle of September of the present year, and have been increasing ever since.—[Samuel Scott, Madison.

Have been planting since 1872. Have had cotton-worms every year, more or less, but more destructive in 1873, on account of early destruction of crop, eating mine out early in August; other years not stripping the cotton until September.—[Daniel Cohen, Wilkinson.

In 1846, '53, '60, '66, '72, and '78 in this county.—[George V. Webb, Amite.

NORTH CAROLINA.

1865.—[F. I. Smith, Halifax.

1867, '70, and '73.—[J. Evans, Cumberland.

The cotton-worm has never done any real damage here except in 1869, and that year it appeared very early, the third brood hatching out last of August. The cotton fields were completely swept of leaves early in September. In 1863, '66, '67, '68, and '69 we had more or less of them. Have not seen a single one since 1869.—[John Robinson, Wayne.

SOUTH CAROLINA.

They disappeared after the gale of 1804, and were not noticed again till 1825, when the entire cotton crop was destroyed by them. From 1825 to 1846, they were noticed as damaging certain localities every third year. In 1846 they destroyed every cotton crop, causing the fields to look as if swept over by fire. Again, they prevailed in the years 1850, '61, '64, '67, '70. Since then they have appeared in certain localities and destroyed cotton crops now and then, but have not been so general except on the islands (sea). There they appeared every year, some years in larger numbers than in other years.—[James W. Grace, Colleton.

The cotton-worm was most abundant about the years 1872 and '73. They have never been so numerous as to do much damage.—[Paul S. Felder, Orangeburgh.

1838, '40, '41, '46, '49, '52, '57, '62, '74.—[James C. Brown, Barnwell.

TENNESSEE.

From 1850 to 1861 the worms very gradually increased, with the exception of two or three seasons when the weather was unfavorable to their development.—[A. W. Hunt, Perry.

TEXAS.

Every year except 1872, when we had an extremely dry summer, and in 1876. Most destructive in 1867.—[Natt. Holman, Fayette.

In the year 1867, about the 10th of August; two broods this year. Again the last of August, 1868, two broods; too late to do much damage.—[J. W. Jackson, Titus.

The years when most abundant and destructive is when the months of June and early July are moderately or tolerably wet. I knew them, however, one or more years, to come when the season was moderately dry.—[O. H. P. Garrett, Washington.

Since 1861 the years of greatest abundance were 1866, '73, and '77. In '66 and '73 they devoured every green leaf and young boll, and then died of starvation; in '77 came too late to do much damage.—[J. M. Glasco, Upshur.

Cotton was destroyed by worms partially in 1846, '50, '65, '66, '68, '69, '70, '71, '72, '74, '75, '76, '78, and in '67, '73, and '77 totally.—[S. B. Tackaberry, Polk.

No record has been kept. I can only give from my own knowledge since 1866. In '67, '71, '73, '74, '76, and locally the present year.—[Walter Barnes, Cherokee.

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They have been with us every year since 1867; but not seriously affecting the crops previous to that date.—[P. S. Clarke, Waller.

1868, '73, '74, and '75.—[P. S. Watts, Hardin.

1867 and '68.—[R. Wipprecht, Comal.

Very abundant in 1871 and '73; destructive in '74 and '76.—[A. Schroeter, Burnet.

In the years 1867 and '73 they swept the cotton-fields of Southern Texas like a besom of destruction, very little cotton being made. They have swept the fields many years since, but '67 and '73 are noted years, as nothing was made.—[W. T. Hill, Walker.

From 1850 to 1860 the worm appeared several times in sufficient numbers to injure the cotton, but not to destroy it; 1863, very destructive; 1866, the worst year up to that date; 1868, the worst year of all, the worm appeared (first brood) latter part of May; 1875, '77, very bad, crop injured 50 per cent.—[J. H. Krancher, Austin.

Here in 1849, '64, and in '76.—[C. B. Richardson, Rusk.

The cotton-worm was more destructive in 1867 than ever before or since, although very abundant in the years of 1877 and '78.—[Stephen Harbert, Colorado.

QUESTION 2.—*State what you know from experience of the effects of weather on the insect.*

ALABAMA.

The cotton caterpillar prevails most when the seasons are wet, rather than dry. But it is not clear to my understanding that a wet season is in itself the *cause* of the appearance of the caterpillar. A wet season and black prairie soil, *or other causes*, superinduce a sappy growth of foliage and weed, and it is, generally speaking, only the cotton *heavily charged with sap* which is attacked by the caterpillar. It will eat such cotton up in a drouth, while oftentimes in a wet season cotton grown on clayey soils adjacent is untouched.—[John W. Du Bose, Montgomery.

This question will be answered in this way: Six out of ten farmers will say that damp, cloudy weather, with continuous rains in July and August, is the most favorable, while the remaining four will say they have seen crops destroyed during a very dry season in August; consequently, the general conclusion is that the weather has but little effect upon the cotton-worm.—[P. D. Bowles, Conecuh.

Am not certain; but as the sun's rays cannot pass through a green leaf, and the eggs are laid on the under side, where the worm also lies during the heat of the day, I doubt whether the weather has much effect upon them.—[R. H. Powell, Bullock.

When there is cloudy weather in July and August they are most destructive. When these months are hot and dry and the plant becomes tough, they cannot do much damage.—[J. C. Matthews, Dale.

A dry, hot summer is supposed to be unfavorable to their increase to a great extent.—[A. D. Edwards, Macon.

The opinion which seems most prominent in this locality on this branch of the subject is that the more rain the more likely will the caterpillar appear, and *vice versa*. During the rainy seasons there is, of course, more cloudy weather as well as more tenderness in the leaves of the plant, both of which are regarded favorable to their propagation and ravages.—[Andrew Jay, Conecuh.

Rainy and cloudy weather is certainly more favorable to its propagation. If the summer (early summer) is wet we look for the caterpillar with considerable certainty.—[H. Hawkins, Barbour.

My opinion is that in wet, cloudy weather they are more destructive than in clear, dry weather.—[R. B. Dunlap, Greene.

The weather most favorable for the rapid growth of the cotton-plant seems to be the most favorable for the worms. In other words, the worms are most destructive on cotton growing rapidly, because it is more tender and succulent.—[J. R. Rogers, Bullock.

Damp and cloudy weather is best for worms; if the weather is very dry and hot it acts against them.—[I. F. Culver, Bullock.

I am of the opinion that the worm is not much affected by the weather, after it has come out in full force, but upon this point a good many farmers differ. The general opinion is that warm, wet weather is most favorable to its increase.—[J. A. Callaway, Montgomery.

The opinions of planters in this section differ very widely on this point. They are generally more destructive in wet seasons, though I have seen them in full force when we have been dry in this locality, owing to the fact, no doubt, of an abundance of rain having fallen further south.—[M. W. Hand, Greene.

Warm, damp weather is most favorable to the propagation of the cotton-worm of every species. Cool, damp weather (not cold) is most favorable for the increase of the cotton-lice, which do their mischief in May and June.—[David Lee, Lowndes.

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Sultry, showery weather produces them. If we have a wet July and August we are sure to have them.—[H. A. Stollenwerck, Perry.

Wet and cloudy weather are favorable to their multiplication; dry and hot weather has the opposite effect.—[H. C. Brown, Wilcox.

Wet weather seems to be favorable to the breeding of worms.—[George W. Thagard, Crenshaw.

My observation is, the kind of weather makes no difference.—[James M. Harrington, Monroe.

Damp and cloudy weather favorable; hot and dry weather unfavorable.—[Knox, Minge, and Evans, Hale.

It is the generally entertained opinion that wet weather is most favorable for their production, but I am of the opinion that weather has but little to do with it. Our summers are all wet enough in my judgment for them. They flourish best in hot weather. I have seen them multiply rapidly when there was not rain for more than four weeks, notably in 1873, in July, when there was no rain from the 16th of June until the 19th of July.—[R. W. Russell, Lowndes.

The prevalent idea among practical farmers is that a wet May and June is favorable to the *development* of the worms. My own experience is that from 1847 to 1860 we had both *wet* and *dry* seasons, and *yet no worms*. I do not believe the hygrometric condition of seasons *produces* them; yet I do believe that a wet season favors their rapid production or increase.—[R. S. Williams, Montgomery.

Warm, cloudy, and showery weather seems to best suit the work of the worm; it seems to be more vigorous, and destroy the cotton sooner during such weather.—[J. N. Gilmore, Sumter.

Don't think weather exerts any influence on their propagation, &c., or on their appearance, &c., from year to year.—[John D. Johnston, Sumter.

ARKANSAS.

The weather the preceding year and the year the worms are plentiful have a marked influence on their destructiveness. A mild, dry fall and winter followed by a damp, hot season is always favorable to moths and worms.—[E. T. Dale, Miller.

Dry summers tend to an increase, at least from the 15th of July. In cold, wet summers there there are very few, comparatively.—[T. S. Edwards, Pope.

FLORIDA.

The years that the insect has been most destructive, the seasons have not been excessive either for wet or dry.—[F. M. Meekin, Alachua.

Most warm weather.—[R. Gamble, Leon.

GEORGIA.

I have seen the worm in both dry and wet seasons, and the only difference noticed was that in wet seasons the growth of the cotton was more luxuriant, and the worms had more to feed upon.—[William Jones, Clarke.

We are of the opinion that the weather has but little influence upon the migration of the parent of the caterpillar.—[S. P. Odom, Dooly.

I do not recollect that the weather had any effect upon them; the cotton was very tall, and a good seasonable year for crops, I think.—[E. M. Thompson, Jackson.

Cloudy weather is the time for the worm; they cannot stand the hot sun.—[W. A. Harris, Worth.

Warm weather, moderately dry, with heavy dews, and nights very warm, is favorable to the worm. When cool nights set in the worm webs up and disappears.—[M. Kemp, Marion.

Weather that favors a late growth of the cotton-plant is favorable to an increase of the worm.—[A. J. Cheves, Macon.

Wet summers have proven to be favorable.—[D. P. Luke, Berrien.

In dry hot weather the increase is slow.—[Timothy Fussell, Coffee.

LOUISIANA.

Worms do not do much damage during very hot dry weather. They remain on the underside of the leaf, especially so when young, and eating only in the morning and evening. Damp stormy weather is necessary for the full development of their destructive powers.—[H. B. Shaw, Concordia.

We have no printed or written records, that I am aware of, accessible to our people, and I cannot say what the seasons were in former times, before and during the prevalence of the army worm. Our people are not learned, or scientific, as a rule, outside of professional walks of life, and the only article I ever recollect to have read on the army worm, written by one of our people, was written by a Dr. Gorham, and published in De Bow's Review, New Orleans, after 1841. This is no doubt among my father's books, in his library here, but I have no access to it at present. I mention this in order that you may cause the article to be looked up and referred to. Dr. Gor-

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ham insisted, as well as I can remember, that the cotton-worm was wafted here during times of high rains, from certain quarters of compass, from Central America or other more southern countries, where it was always to be found, and where the cotton plant grew pereniall y. My experience is, that during dry summers and falls, the worms never appear early enough to destroy the plant before a fair crop is made.—[Douglas M. Hamilton, West Feliciana.

The insect is not affected by the weather.—[Dr. I. U. Ball, West Feliciana.

When the worms appear, neither wet nor dry weather affects them any way.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Warm, cloudy and wet weather always favorable to the coming of the insect.—[John C. Russell, Madison.

Rainy spring and summer always produces this worm.—[J. W. Burch, Jefferson.

I cannot say they are affected by weather. Some of the years mentioned as destructive years were just opposites, as for instance, 1876 and 1878; 1876 was cool and dry, 1878 wet and very warm.—[C. F. Sherriod, Lowndes.

Extremely heavy rains destroy some of the worms, and perhaps some of the moths. The worms cannot endure exposure to the unobstructed rays of the sun in the warm part of the day. The influence of these two causes is not large enough to be of much importance.—[C. Welch, Covington.

I think showery weather in June tends to increase their breeding considerably; cool weather at that time and later assists. The plant must be growing so that there are tender leaves on the top of the plant to favor their increase. If not growing and the leaves become toughened from hot dry weather the worms do not damage it.—[Daniel Cohen, Wilkinson.

Cloudy and wet weather in July and August invariably brings the fly. If we have a seasonable July, say one or two good rains and none in August, we always make fair crops of cotton.—[Kenneth Clarke, Chickasaw.

The moth seems to delight in warm cloudy damp weather, leaving its retreat more readily when the atmosphere is in that condition. In clear weather and hot sunshine they keep very close until twilight, when they may be found flitting from plant to plant. The larvae, like the moth, seems to prefer cloudy hot weather, but hot dry weather does not seem to check their devastations. Heavy rain-storms certainly do check them. Cool weather seems to retard their operations.—[Dr. E. H. Anderson, Madison.

May and June very wet, cloudy, and moderately warm will *invariably bring this insect* in such numbers that (the same conditions continuing in July and August) the crop will certainly be destroyed. Any careful observer can, by the close of June, any year, at any given locality, decide whether the *Aletia* can increase to such numbers as to damage the crop seriously during the succeeding months. This has been done annually for the last thirty years without a single failure.—[D. L. Phares, Wilkinson.

Rainy weather and hot sunshine alternating.—[W. Spillman, Clarke.

I know from long experience and close observation that continuous rains in the month of July bring to notice the worms. The winter has nothing whatever to do with the appearance of this destructive insect.—[George V. Webb, Amite.

NORTH CAROLINA.

Wet weather seems to produce them when it is very warm.—[F. J. Smith, Halifax.

SOUTH CAROLINA.

When the worm does appear here, it is in a wet warm summer, and it appears first in black soil, which is low and damp. In gray soil they never come until after they have grown and been propagated on the darker soil.—[Paul S. Felder, Orangeburgh.

Moist and cloudy weather is most favorable to the rapid development of the insect.—[J. W. Grace, Colleton.

Dry hot weather is unfavorable to the growth, production, and activity of the worm.—[James C. Brown, Barnwell.

TENNESSEE.

So far as I have observed, the weather exerts a decided influence upon the cotton caterpillar.—[A. W. Hunt, M. D., Perry.

TEXAS.

Dry hot weather is unfavorable.—[R. Wipprecht, Comal.

The only effect is—heat advances, cold retards maturity.—[W. Barnes, Cherokee.

Wet sultry weather most favorable to the increase of the worm.—[S. B. Tackaberry, Polk.

I do not believe the weather has much to do with them, because this has been the wettest year for a long time past, and they did very little damage in this part of the country.—[P. S. Watts, Hardin.

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As previously stated, the season moderately wet, or more than ordinarily so, the miller or butterfly is pretty certain to make its appearance in July, a few weeks before the egg is deposited.—[O. H. P. Garrett, Washington.

After the worm has once made its appearance, the kind of weather does not seem to affect its further development much unless the summer is very hot and dry, in which case the young ones will soon be killed, and even many of the full-grown ones will perish before they are ready to spin themselves in.—[A. Schroeter, Burnet.

The worm has made its appearance during wet years, and the dry seasons of the year have also witnessed its coming. I believe that a very dry spring will retard its appearance, for in that case it will be more difficult to wake themselves from their winter sleep.—[P. S. Clarke, Waller.

The weather undoubtedly has an influence on the insect, otherwise we would have them every year; but as it is we have but few years of the worm. It is true that a few make their appearance other years in isolated places, but not enough to attract attention.—[J. M. Glasco, Upshur.

We know that when we have a very wet spring and summer we are sure to be troubled with the worm.—[W. T. Hill, Walker.

After the worm has hatched in sufficient numbers to injure the plants (this being only the case in the latter part of spring and in summer) the weather being warm does not affect the worm particularly. Only a long and protracted drought will retard the hatching of the eggs, as in 1860, when a severe four months' drought prevented the hatching of a second brood.—[J. H. Krancher, Austin.

My memorandum books show wet and warm weather in 1846, particularly.—[C. B. Richardson, Rusk.

My experience is that wet summers generate the cotton-worm, as it does most others of the insect tribes.—[A. Underwood, Brazoria.

If the month of June is dry it is a good indication that the worms will not hurt the crop or if they do come it will be late.—[Stephen Harbert, Colorado.

My experience is that warm cloudy weather is more favorable to the moth in giving it more time in daylight to deposit its eggs, consequently more latitude is taken during its laying season.—[J. W. Jackson, Titus.

They multiply much faster in wet weather owing to the earth being damp and cool. They are on the move all the time. They rarely ever do much damage in hot dry weather, as the moths perish for want of water, and the heat of the sun and earth kills thousands of the young and eggs. They are not dreaded much in dry weather.—[Natt Holman, Fayette.

QUESTION 2*a*.—*The character of seasons most favorable to its increase.*

ALABAMA.

Warm, damp, cloudy weather.—[I. F. Culver, Bullock.

Wet cloudy weather.—[R. S. Williams, Montgomery.

The character of seasons most favorable for the increase of the worms are such as promote the tender succulent condition of the leaves of the cotton plant, viz, frequent rains and consequent humidity.—[P. T. Graves, Lowndes.

The seasons that the worms have been most abundant are almost invariably wet during the latter part of the summer, yet the season of 1870 was an exception to this rule. The worms made their appearance early during this year.—[R. F. Henry, Pickens.

Warm, wet weather.—[J. A. Callaway, Montgomery.

In wet seasons they are more abundant and destructive.—[H. Tutwiler, Hale.

Such is the influence of the weather on the propagation of the worm that we confidently expect them when July and August happen to be rainy, showery, or damp and cloudy.—[Dr. John Peurifoy, Montgomery.

Have not been able to discriminate.—[James M. Harrington, Monroe.

A wet May and June especially favorably to their development—[Charles M. Howard, Autauga.

Wet and cloudy.—[H. C. Brown, Wilcox.

I do not think that wet or dry has anything to do with them during spring, or say up to June.—[J. C. Matthews, Dale.

They do not increase in warm, dry, clear weather, but always in sultry, rainy weather.—[H. A. Stollenwerck, Perry.

If seasonable in late spring and early summer, throughout the cotton-belt generally, we are almost certain to have a full and early crop of the insect.—[M. W. Hand, Greene.

Weather cloudy, warm and damp.—[A. D. Edwards, Macon.

Warm and wet.—[David Lee, Lowndes.

The caterpillar increases when the dews are heavy, when the seasons are rainy, when

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the wind is from east-southeast. There must be, in my opinion, both moisture in the atmosphere and on the foliage, or much sap in the foliage to preserve the lips of the freshly-hatched caterpillar from the heat of the sun.—[J. W. DuBose, Montgomery.

Wet.—[Knox, Minge, and Evans, Hale.

Warm and cloudy weather is more favorable to the increase of the caterpillar than hot and dry, for the reason that in warm, cloudy, or rainy days the cotton-fly is busy flying—either hunting mates or laying eggs. In dry or hot days they are seen only late in the evening or very early in the morning. It is generally believed that they do not move about much at night—little or none after 9 p. m. Hot sun is necessary for hatching the eggs. After the hatching, neither the hot sun nor dry weather can check or prevent their maturity and rapid development.—[H. Hawkins, Barbour.

If June is wet or there is much rain the caterpillar is looked for with certainty.—[Andrew Jay, Conecuh.

They increase most rapidly in warm, damp, cloudy weather.—[R. B. Dunlap, Greene.

Warm, seasonable, growing weather.—[C. C. Howard, Autauga.

When the weather is warm and showery, calculated to promote a luxuriant and tender growth of the cotton-weed, there seems to be more worms generated, or, at least, they eat the cotton-plant foliage in a shorter time.—[John D. Johnston, Sumter.

Eighteen hundred and sixty-nine, '71, '73, '74, '76, were known as wet seasons in the canebrake of Marengo during the spring and early summer. In 1872 it did not rain on my crop from April 9 until May 27, yet the caterpillar appeared June 16. The season (summer) was at no time excessively wet. In 1874 it did not rain from July until September 14, yet meanwhile the caterpillar came in great numbers. In 1876, the spring and entire summer were unprecedentedly wet, yet on my crop the caterpillar did not appear until August 1, or thereabout.—[J. W. Du Bose, Montgomery.

The past year they made their appearance in June and continued to increase by periods until about the 15th or 20th of August, when they slowly ate the crop; but they did it so slowly as to do but slight damage, notwithstanding it was a remarkably wet and hot summer.—[R. W. Russell, Lowndes.

Rather inclined to think they increase more rapidly in damp weather.—[J. F. Smith, J. F. Calhoun, Dallas.

Warm cloudy weather is decidedly more favorable to its increase, particularly warm nights.—[J. N. Gilmore, Sumter.

ARKANSAS.

Warm springs, with a great deal of south wind, some rains, though not heavy, with a constant increase of heat as the summer advances.—[T. S. Edwards, Pope.

Warm and wet.—[Norborne Young, Columbia.

Damp or wet and hot seasons.—[E. T. Dale, Miller.

FLORIDA.

Wet seasons seem to be most favorable to its increase.—[John B. Carrin, Taylor.

Damp cloudy weather is most suitable to their increase. Hot dry weather is very depressing to them, and they are unfavorably affected in proportion as they are exposed to heat.—[J. M. McGehee, Santa Rosa.

Wet.—[John Bradford, Leon.

The general impression here among farmers is that a wet season is favorable to the development of the insect. I do not entertain this view, but believe that excessive rain has a tendency to retard their development. The rains the present year have been excessive, and though the worm has eaten many fields of cotton, the destruction has not been general, but has been retarded, making it quite late in the season before the destruction was complete.—[F. M. Meekin, Alachua.

Showery weather in June and July, after a mild winter.—[R. Gamble, Leon.

GEORGIA.

Cloudy, damp, or wet weather is most favorable to its increase.—[Timothy Fussell, Coffee.

Rainy weather.—[D. P. Luke, Berrien.

Wet seasonable years seem to be the most favorable.—[E. M. Thompson, Jackson.

Wet and damp weather.—[William A. Harris, Worth.

Warm seasonable weather during July and August, when there is rain and damp every three or four days.—[A. J. Cheves, Macon.

Warm and moderately dry.—[M. Kemp, Marion.

Seasonable rains which keep the foliage of the cotton green and tender is the kind of weather most favorable to its increase. The egg is always deposited on the top and tenderest leaves of the cotton, or cotton upon which the leaves are hard and tough.—[S. P. Odom, Dooly.

LOUISIANA.

Showery weather during the months of August and September.—[H. B. Shaw, Concordia.

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Wet weather is more favorable to its increase.—[Dr. I. U. Ball, West Feliciana.

Wet weather is most favorable to its increase.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Alternate sunshine and showers, and damp, hot weather, with the thermometer ranging from 77° to 87° Fahr., seems to be the most favorable to its increase, especially when the rainfall is not sufficient to retard cultivation.—[Dr. E. H. Anderson, Madison.

A warm mild winter for their increase, but if July and August are favorable to farmers, worms do but little damage. If the summers are so wet as to make the weeds grow very rank, they work on particular spots anyway.—[Kenneth Clarke, Chickasaw.

The character of seasons most favorable to their increase? Rainy seasons.—[John C. Russell, Madison.

It is generally believed that hot weather with light and frequent showers is most favorable to the increase of the worm.—[C. Welch, Covington.

Mild winter, wet spring and summer.—[J. W. Burch, Jefferson.

Warm weather, neither too dry nor too wet, has always prevailed when the worm was most abundant.—[J. Culbertson, Rankin.

A favorable season for cultivating the crop. Damp, cloudy weather seems to favor them.—[I. G. G. Garrett, Claiborne.

A rainy season is always most favorable to the increase of this pest of the cotton.—[George V. Webb, Amite.

NORTH CAROLINA.

Warm and wet.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Those wherein we have a very wet June, causing a luxuriant and pulpy state of the leaves, followed by cloudy and rather damp cool nights in July.—[James W. Grace, Colleton.

A warm wet season.—[Paul S. Felder, Orangeburgh.

Warm and moist weather most favorable. The moist or rainy season is unfavorable to insects that are enemies to the caterpillar; and the young, nutritious growth of cotton more abundant.—[James C. Brown, Barnwell.

TENNESSEE.

Warm, cloudy, and damp weather.—[A. W. Hunt, M. D., Perry.

TEXAS.

Warm weather with showers.—[R. Wipprecht, Comal.

Mild winters and dry springs.—[P. S. Watts, Hardin.

A warm season with plenty of rain, to call forth a profusion of young tender leaves, on which the newly hatched larvae can feed, is therefore most favorable for the increase of the insect.—[A. Schroeter, Burnet.

Wet May and June.—[S. B. Tackaberry, Polk.

There seems to be no difference.—[W. Barnes, Cherokee.

Cloudy weather succeeding excessive rains.—[Samuel Davis, Hunt.

A warm damp summer, without much heavy rain.—[J. M. Glascoe, Upshur.

Wet seasons.—[H. J. H. Brensing, Bowie.

I once thought cold winters were proof against the worm. I have seen them fail after cold and warm winters alike. I have also seen them come and destroy the crop partly after cold and warm winters. In 1867 the crops were killed on the 12th, 13th, and 14th of March, by freezing weather. There was snow, hail, and rain, freezing, and we had three days of cold weather. The crops were planted the second time, and I think more rain fell that year than in any previous one of my experience during the months of June, July, and August. The worm appeared about the 20th of July, but not in force.—[O. H. P. Garrett, Washington.

A moist and warm spring, and particularly frequent showers during June and July.—[J. H. Krancher, Austin.

Warm wet weather.—[W. T. Hill, Walker.

I cannot say what weather is favorable to their increase. I think the weather has little effect on them.—[C. B. Richardson, Rusk.

The most unfavorable weather for them is a warm rainy season.—[S. Harbert, Colorado.

Cloudy or rainy season will hatch the eggs better than dry and clear weather, and when hatched cloudy or damp season favors the full development of the worm, and its ravages are greater, for it feeds the entire day. Otherwise, if the season is dry and hot, their progress is impeded, so much that it is often noticed by the casual observer.—[J. W. Jackson, Titus.

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QUESTION 2 *b.—The character of the summer and winter—whether wet or dry, mild or severe—that have preceded years in which the worm has been abundant and destructive.*

ALABAMA.

Upon this point we cannot speak positively, but incline to the belief that dry, mild summers have preceded years in which the worm has been destructive, and that the character of the winters is immaterial.—[J. A. Callaway, Montgomery.

I have no record of the character of the weather before 1866. The winter of 1865–'66 was mild, with less than average rain. The spring from last of April to 10th of June, excessively wet; latter part of June and first of July, dry and hot; last of July and to 20th August, rainy; 1868 much the same, except spring rains that were seasonable. The winter of 1872–'73 was severe for this latitude; the spring dry, with excessive wet through early summer, say to 1st of August.—[P. T. Graves, Lowndes.

Average thermometer for December, January, February, and March: 1868, 47.08; 1869, 48.90; 1870, 47.44; 1871, 52.62; 1872, 47.7.

	Fahr.
In 1873, preceding winter severe	50.86
1874, preceding winter very mild	53.05
1875, preceding winter steady cold	54.05
1876, preceding winter very mild	50.08
1877, preceding winter uncommonly cold	48.53
1878, preceding winter mild	

Total fall of rain during December, January, and February:

	Inches.		Inches.
In 1868	18.41	In 1873	20.07
1869	25.83	1874	15.11
1870	17.32	1875	20.92
1871	15.58	1876	21.03
1872	22.17	1877	8.20

Total June, July, and August:

	Inches.		Inches.
In 1868	11.53	In 1873	12.33
1869	15.84	1874	16.65
1870	18.70	1875	
1871	14.45	1876	4.47
1872	23.56	1877	4.82

[J. H. Smith and J. H. Calhoun, Dallas.

Cold, dry winters mostly.—[J. S. Hausberger, Bibb.

It is pretty generally believed that severe winters are destructive to insects. As to the correctness of this idea I am a little doubtful, as the winter of 1869 was the coldest we have had for ten years, yet in that year—that is, 1870—there were worms. And in 1876 the winter was much colder than 1877, yet in 1878 there were quantities of worms; so I cannot say I believe the cold or wet has much to do with them.—[R. W. Russell, Lowndes.

The winter of 1872 and '73 was unusually severe in this section, the thermometer sinking to 7° above zero. We all thought this would insure us against the worms, yet 1873 was our most destructive worm year. Last winter was exceedingly mild, the thermometer reaching 32° only two or three times during the winter, yet the worms were not developed until late in the season, and did not do much harm to the crop.—[R. S. Williams, Montgomery.

Have seen them destructive following almost every character of winter and summer. Cannot say what kind of seasons preceded the worms in the years they were most destructive.—[John D. Johnston, Sumter.

The winter of 1872–'73 was moderately cold for this climate, as was the winter of 1877–'78, both of which years the worm was most destructive.—[R. F. Henry, Pickens.

The winter of 1827–'28 was very warm and wet. It was so warm that peach trees bloomed every month during the winter; but no cotton-worm the next summer. The winter of 1848–'49 was another warm winter, and no worms the next year. Some say that when the winter is warm the moths hibernate so much and can get nothing to subsist upon that they perish of hunger. Others say that a cold winter freezes them to death; so it is all speculation.—[D. Lee, Lowndes.

Do not think the preceding year has any influence on their coming. Think they are here all the time, and the weather from May to September causes them to hatch out. If wet, we are sure to have them; if dry, not so certain.—[H. A. Stolenwerck, Perry.

It seems cold weather does not affect them.—[H. C. Brown, Wilcox.

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Worm winters, as they are to be seen here in warm seasons in winter (I mean the fly) —[J. C. Mathews, Dale.

The conclusion is that the preceding winter has very little to do with their propagation.—[Charles M. Howard, Autauga.

Mild.—[A. D. Edwards, Macon.

No difference.—[James M. Harrington, Monroe.

If the weather is dry from the 15th of July to the 15th of August, worms do but little damage to cotton.—[George W. Thagard, Crenshaw.

The summer and fall of 1865 were very dry; the caterpillar was destructive in 1866. The summer and fall of 1866 were very wet; the caterpillar was very destructive in 1867. The spring and early summer of 1869 were wet; no caterpillars in 1870; not many in 1871. The year 1871 wet; caterpillars eat up the crops by August 10, 1872. The year 1872 a dry one; caterpillars early and very destructive in 1873. The year 1875 very dry; caterpillars unequaled in 1876.—[I. W. Du Bose, Montgomery.

Mild, warm winters preceding the crops indicate favorable season for cotton so far as the caterpillar is concerned, as the moth comes forth in warm days and many of them perish for want of food.—[I. D. Driesbach, Baldwin.

Wet summers followed by dry fall and mild winter.—[P. D. Bowles, Conecuh.

Mild winters, wet springs, and hot summers, though we have had one or two exceptions.—[M. W. Hand, Greene.

A wet May followed by July and August showery is the most favorable summer for the worms. The winter has no effect on them.—[Knox, Minge, and Evans, Hale.

Dry summers and mild winters; 1872 was very dry and the winter following very mild, and in 1873 there was the most destruction we have had by the caterpillar.—[H. Hawkins, Barbour.

My opinion is that the season following a cold winter we have less worms than we do after a mild winter.—[R. B. Dunlap, Greene.

We regard our severest cold winters as being the best preventive to their appearance the next year in injurious numbers. I think the years when their ravages have been great are those following a mild winter; but with little weather very cold, they have been most certain to prevail the next year if the season in other respects is favorable to their increase, to wit, wet and cloudy.—[Andrew Jay, Conecuh.

More destructive after a uniformly cold winter; I think they are sometimes destroyed by freezing weather after two or three weeks of warm weather in winter.—[J. R. Rogers, Bullock.

Summer dry and hot, winter mild and dry.—[J. F. Culver, Bullock.

The summers when the worm has been most abundant have been warm, and more than the usual quantity of rain fell. The winters have been various. The worm has come both after mild wet winters, and cold dry winters. I am satisfied that the preceding winter has nothing to do with the presence or absence of the worm the following summer.—[J. N. Gilmore, Sumter.

ARKANSAS.

Mild weather and dry through fall and winter.—[E. T. Dale, Miller.

Dry and mild.—[Norborne Young, Columbia.

The winters have been very mild preceding the years they have been so destructive and abundant; in fact scarcely any winter at all, the ground not frozen two inches deep during the winter, and the summer before also warm and dry.—[T. S. Edwards, Pope.

FLORIDA.

A mild winter, which is generally a wet one.—[R. Gamble, Leon.

GEORGIA.

Very cold, damp weather, with but little sunshine. This for the most part has been a very hot summer, and hence but few worms.—[William A. Harris, Worth.

Moderately wet and mild.—[S. P. Odom, Dooly.

Warm summers and severe winters.—[William Jones, Clarke.

Wet summers are most favorable.—[Timothy Fussell, Coffee.

The summer and winter were wet and mild; no very cold weather.—[E. M. Thompson, Jackson.

Mild winters.—[M. Kemp, Marion.

LOUISIANA.

I have noticed no difference; the winter of 1876–'77 was as warm as we generally have, and the worms stripped everything. Again, last winter, 1877–'78, was very mild, and the fields look as bare as in December. Now of the summer, we generally suffer most during a wet summer.—[H. B. Shaw, Concordia.

During the past fourteen years, during which time the worms have been here in numbers almost every year, we have had winters as severe as common in this latitude.

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The winter just past was an exceptional one for coldness, and still the worms have annually appeared. But in all years when they have done most damage the summers and fall were unusually wet.—[Douglas M. Hamilton, West Feliciana.

From my best recollection the summer was pleasant and dry, the winter mild and wet.—[Dr. I. U. Ball, West Feliciana.

The summers preceding are generally dry, and winter variable.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Having kept no memorandum of weather, cannot say as to character of preceding summers or winters when the worm has been destructive; but nothing in the history of the worm has induced me think that its invasion depended upon the character of the preceding seasons. Yet my opinion would be that it would be more apt to appear after a mild winter.—[Dr. E. H. Anderson, Madison.

Late springs, when cotton gets a late start, the stalk being succulent and sappy when they attack its leaves, and with but little matured fruit on it, the worms prove most disastrous.—[C. F. Sherriod, Lowndes.

Some kinds of cotton are more attractive to worms than others. Cotton with short branches and rich foliage, such as the Dickson and Sugar-loaf, which forms a thick shade near the main stalk, is in greater danger than cotton with long or scattering branches. During a dry year the Dickson beats all other cotton, but during a wormy year it amounts to nothing in this locality.—[Kenneth Clarke, Chickasaw.

Winters that have been mild are followed by the worm more abundant and destructive. Last winter with us very mild, the spring very wet, the summer very hot or wet, and a big crop of worms from July as the result.—[John C. Russell, Madison.

Hot and moist.—[J. W. Burch, Jefferson.

Summers wet and mild, winters severe; I have never seen them so numerous in summers following warm, open winters. This I regard as one indication that they hybernate here to a limited extent. When not benumbed by cold, vitality and activity are aroused in the moth, and during "warm spells" it must sally forth to seek food. In these flights it may be captured by birds, benumbed by cold air, or otherwise prevented reaching its safe retreat, or, as often occurs to bees, the "warm spells" would tend to mature the chrysalis also, and hatch eggs prematurely, thus causing their destruction by cold, want of food, &c. We frequently see moths of various species venture out during winter and perish by these means.—[D. L. Phares, Wilkinson.

The winter of 1876–'77, as well as the summer of 1877, was unusually dry, the rains nearly all being quite light. The winter of 1877–'78 was perhaps as to moisture an average winter, but the summer of 1878 was remarkable for the number of extraordinary heavy rains that fell up to the 1st of July, when they were succeeded by drought for from three to five weeks, ordinary weather following. The winter of 1876–'77 was very cold; that of 1877–'78 was the most regular that has come in thirty years; the spring and summer until July 1 were unusually cool; but after July 1 the weather was the hottest remembered. The injury in 1877 was much greater than in 1878.—[C. Welch, Covington.

The year 1873 was a most destructive one; the winter preceding that, 1872–'73, was as cold a winter as any I have known for years.—[Daniel Cohen, Wilkinson.

The summers of 1837 and 1878 were the two wettest since the worm first made its appearance.—[Samuel Scott, Madison.

The character of the preceding winter or summer does not seem to have had any influence on the worm.—[J. Culbertson, Rankin.

They are thought to be most abundant after a mild winter.—[W. Spillman, Clarke.

As a rule a dry summer has preceded the year the worm put in his appearance, but I do not believe that has any influence on the worm; but continuous rains will bring the worms to the cotton-fields.—[George V. Webb, Amite.

NORTH CAROLINA.

The worm always appears after a long wet spell in August and September.—[J. Evans, Cumberland.

Cold or mild winter has no effect.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

The summers have generally been warm and rather dry; the springs opening early. so that the cotton would be well grown and advanced toward maturity at an early date; as to the winters nothing uniform has been noticed, and we believe that this in no way affects the worm.—[James W. Grace, Colleton.

Warm and wet summers and a mild and dry winter are apt to be favorable to a good "crop" of the caterpillar.—[James C. Brown, Barnwell.

TENNESSEE.

A mild winter, accompanied by a good deal of snow, with a summer succeeding as described in 2 *a*, have preceded years in which the worms have been most abundant and destructive.—[A. W. Hunt, Perry.

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TEXAS.

Wet and mild.—[R. Wipprecht, Comal.

Wet and mild.—[H. J. H. Brensing, Bowie.

They are most certain to come if June and July are wet. I do not think wet or dry winters have much influence with them.—[O. H. P. Garrett, Washington.

A mild winter has nearly always preceded the early appearance of the moth.—[A. Schroeter, Burnet.

Generally a dry summer, but not always so. I believe it depends mostly on June, July, and August weather.—[J. M. Glasco, Upshur.

From careful observation, we are of the opinion that cold winters have but little influence on the worm.—[S. B. Tackaberry, Polk.

They have followed both the years of drought and of copious rains. The last winter was so mild that it was claimed by some that the worms would not make their appearance; that the moth would come early, deposit its eggs, and the caterpillar would have to die of starvation, there being nothing to feed upon.—[P. S. Clarke, Waller.

Have not found the winter to have much effect on the moth. We have learned to foretell the certainty and severity of the worm by May and June. If those months are warm and very wet we are certain to have the worm.—[W. T. Hill, Walker.

A cold winter preceding a moist and warm spring and summer is favorable to the multiplication and increase of the worm, the appearance of the fly or miller being prevented by cold weather in winter, while in mild winters the moths frequently appear. Have noticed them in January, when no food being found they would die of starvation, or the cold winds and rains would destroy them. It has been noticed that mild winters the worm does not appear early and is not sufficiently numerous to strip the fields until the boll has ripened.—[J. H. Krancher, Austin.

My book showed excessive wet weather *all summer* of 1846, before the first season of worms in September in Louisiana.—[C. B. Richardson, Rusk.

I cannot attribute anything occurring in other than the warm season as affecting the generation or protection of the cotton or army worm. In what form it exists in the winter or all the year except two or three weeks of its appearance in summer and its devastation during that short period is unknown to me, and, so far as I know, has never been accounted for by practical or scientific men. I do not think the origin is from distant torrid climates, where cotton is perennial, as they never destroy the cotton, I think, in tropical climes.—[A. Underwood, Brazoria.

The summer wet and winters mild.—[Stephen Harbert, Colorado.

They are more numerous in a wet summer and fall, and after a mild winter. They are never so bad after a cold winter, as it is more destructive to the moth in his winter quarters, which consist of driftwood, trash, rocks, bluff, banks, &c.—[Natt. Holman, Fayette.

Wet summer and mild, dry winter have always preceded the cotton-worm in this locality.—[J. W. Jackson, Titus.

QUESTION 2 c.—*Do wet summers favor its multiplication?*

ALABAMA.

We think not.—[J. S. Hausberger, Bibb.

Yes.—[J. A. Callaway, Montgomery.

They do.—[H. Tutwiler, Hale.

Wet seasons seem to be essential to their multiplication.—[Dr. John Peurifoy, Montgomery.

In my opinion wet summers are favorable to multiplication.—[R. B. Dunlap, Greene.

They certainly do.—[H. Hawkins, Barbour.

They do.—[Andrew Jay, Conecuh.

I think they do.—[C. C. Howard, Autauga.

As to the moth or fly, it is entirely unknown to us whether it is affected by weather or not, but I incline to the opinion that it is not until it gets too cold for her.—[R. W. Russell, Lowndes.

Wet summers almost always favor the multiplication of the cotton-worm.—[R. F. Henry, Pickens.

I think wet summers favor its multiplication.—[R. S. Williams, Montgomery.

I have always thought so.—[John D. Johnston, Sumter.

Inclined to think it does.—[J. H. Smith and J. F. Calhoun, Dallas.

Unquestionably.—[P. T. Graves, Lowndes.

It does —[I. F. Culver, Bullock.

Wet summers favor its multiplication.—[J. N. Gilmore, Sumter.

Wet summers do most certainly favor their multiplication.—[I. D. Dreisbach, Baldwin.

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It is generally conceded by most farmers that a wet summer favors its multiplication.—[P. D. Bowles, Conecuh.
I think not.—[James M. Harrington, Monroe.
Wet summers favor their multiplication.—[A. D. Edwards, Macon.
They undoubtedly do.—[Charles M. Howard, Autauga.
They do generally.—[M. W. Hand, Greene.
They do.—[H. C. Brown, Wilcox.
O, yes! as before stated. Wet June, July, and August they are much more destructive.—[J. C. Matthews, Dale.
The impression prevails generally that hot summers, with long spells of damp, cloudy weather, favor the multiplication of the cotton-worm.—[R. H. Powell, Bullock.
This is a settled fact in this section.—[H. A. Stollenwerck, Perry.
Yes.—[J. W. Du Bose, Montgomery.
They do.—[David Lee, Lowndes.
Yes.—[Knox, Minge, and Evans, Hale.

ARKANSAS.

Warm, wet spring and summer favors multiplication.—[E. T. Dale, Miller.
Yes.—[Norborne Young, Columbia.
I think not.—[T. S. Edwards, Pope.

FLORIDA.

Wet July and August favors their increase and their destructiveness, by making the plant tender. They eat more and grow larger in such weather.—[J. M. McGehee, Santa Rosa.
It is the universal opinion that they do.—[J. Bradford, Tallahassee.
They do.—[John B. Carrin, Taylor.
So believed, the leaf being then more succulent and tender.—[R. Gamble, Leon.

GEORGIA.

Wet summers favor its multiplication.—[Timothy Fussell, Coffee.
I do not think they do.—[William Jones, Clarke.
They do.—[D. P. Luke, Berrien.
They do.—[A. J. Cheves, Macon.
They most assuredly do, in great quantities.—[William A. Harris, Worth.
They do.—[M. Kemp, Marion.
I think they do.—[E. M. Thompson, Jackson.
Wet summers generally produce what is termed the "black rust," especially on lowlands, thereby hardening the leaves and preventing the multiplication of the moth.—[S. P. Odom, Dooly.

LOUISIANA.

Yes.—[H. B. Shaw, Concordia.
Is is evident that wet summers favor their appearance and rapid increase, and very dry ones the reverse.—[Douglas M. Hamilton, West Feliciana.
Wet summers favor its multiplication.—[Dr. I. U. Ball, West Feliciana.
Wet summers favor its multiplication if the rain is continued through the last of July and first of August.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Most assuredly.—[J. W. Burch, Jefferson.
I think not.—[C. Welch, Covington.
Yes; beyond a doubt.—[D. L. Phares, Wilkenson.
Heavy rains and continuous wet weather do not seem favorable to its development. It would seem that heavy rains would prevent the process of hatching, and if the eggs did hatch would destroy the young insects. I have never seen them appear during a protracted term of wet weather.—[Dr. E. H. Anderson, Madison.
Undoubtedly.—[Daniel Cohen, Wilkenson.
They do, in affording a succession of tender leaves for them to feed on.—[C. F. Sheriod, Lowndes.
I believe wet summers favor their multiplication. I think there was a drought here in one or part of both of the months of August and September of one of the years of 1873, '74 or '75 that so destroyed them that they did but little injury that year.—[Samuel Scott, Madison.
They do.—[John C. Russel, Madison.
No.—[J. Culbertson, Rankin.
Wet summers certainly do favor its multiplication.—[George V. Webb, Amite.

NORTH CAROLINA.

Never have them in the summer.—[F. I. Smith, Halifax.
Yes.—[J. Evans, Cumberland.

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SOUTH CAROLINA.

They never appear in dry weather.—[Paul S. Felder, Grangeburgh.
Undoubtedly yes.—[James W. Grace, Colleton.
Wet summers do favor its multiplication.—[James C. Brown, Barnwell.

TENNESSEE.

Yes, if the rains are not too heavy.—[A. W. Hunt, M. D., Perry.

TEXAS.

Wet summers certainly do favor their multiplication.—[O. H. P. Garrett, Washington.

Yes; heavy rains injure the insect.—[R. Wipprecht, Comal.

They do.—[S. B. Tackaberry, Polk.

They do not.—[W. Barnes, Cherokee.

Probably; but I see when they make their appearance, whether wet or dry, they destroy all the plants before they stop.—[P. S. Watts, Hardin.

Yes.—[H. J. H. Brensing, Bowie.

A warm, damp summer, without much heavy rain, is the most favorable to its multipliation.—[J. M. Glasco, Upshur.

Only by causing luxurious growth of the plant, while a dry year would make the leaves tough.—[P. S. Clarke, Waller.

Yes, for the reason that the young worms will find during such seasons plenty of acceptable food in the tender leaves. As soon as these get hard and tough in consequence of dry weather the worms can no longer subsist on them.—[A. Schroeter, Burnet.

In August, if the summers have been wet and the growth of the plant unusually large and full of sap.—[Samuel Davis, Hunt.

Yes.—[W. T. Hill, Walker.

They do.—[J. H. Krancher, Austin.

I cannot say it does; although it was very wet before they appeared in 1846.—[C. B. Richardson, Rusk.

Undoubtedly.—[A. Underwood, Brazoria.

Wet summers are most favorable for their multiplication.—[Stephen Harbert, Colorado.

Yes.—[Natt. Holman, Fayette.

Wet summers have always favored its development and increases its ravages in this locality.—[J. W. Jackson, Titus.

QUESTION 2 *d.*—*Effect of different kinds of weather on the eggs.*

ALABAMA.

Damp and cloudy weather increases the worms.—[Dr. John Peurifoy, Montgomery.

The only effect of weather on the eggs is that produced by heat, retarding the hatching or expediting it as the temperature is increased or lessened. Wet or dry does not affect them only so far as the temperature is influenced by it.—[P. T. Graves, Lowndes.

Hot, clear weather does not seem to favor the propagation of the insect, while warm, cloudy weather seems to favor it.—[R. F. Henry, Pickens.

I do not know; yet believe wet weather favors their hatching.—[R. S. Williams, Montgomery.

Have noted no change made on the eggs by the weather.—[John D. Johnston, Sumter.

I doubt whether the weather affects the eggs, unless very cool weather does to some extent prevent their hatching.—[J. N. Gilmore, Sumter.

We are of the opinion that hot, dry weather is most favorable for hatching the eggs.—[J. S. Hausberger, Bibb.

Hot, moist weather is best suited to hatching of eggs.—[J. A. Callaway, Montgomery.

Dry, hot weather not favorable to the hatching of eggs or increase of worms.—[J. D. Dreisbach, Baldwin.

Extreme dry weather on sandy lands does retard their progress. I think the reflection of the heat upon the eggs has a tendency to destroy them, whereas on bottom lands the plant protects the egg.—[James M. Harrington, Monroe.

Hatch sooner in wet weather.—[Knox, Minge, and Evans, Hale.

As the eggs are generally deposited on the under side of the leaf and on the more dense part of the stalk, without any positive knowledge on the subject, I am inclined to the opinion that after they are deposited too strong rays of the sun upon the leaf

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would be unfavorable, as well as not enough of regular heated atmosphere; likewise too much damp weather.—[Andrew Jay, Conecuh.

Warm, cloudy weather is favorable for hatching of the eggs.—[R. B. Dunlap, Greene.

Eggs hatch better in warm, hot weather.—[H. Hawkins, Barbour.

During the period of their increase the cotton is always sufficiently tender to supply all the wants of the young insects, and I can't see what benefit rain would be to them; that is, how it would facilitate their hatching, as it is a known fact that their eggs are deposited on the under side of the leaf, where no rain would reach them.—[R. W. Russell, Lowndes.

The eggs are deposited on the under side of the leaf, near the middle of the stalk, where there is greater protection than elsewhere from rain, wind, and solar heat. The young worm feeds usually upon the under side of the leaf, and if the weather be hot and the leaf tough doubtless many perish. A hot spell of weather is always injurious to the young worm.—[Charles M. Howard, Autauga.

They seem to propagate much more rapidly in hot, damp weather.—[M. W. Hand, Greene.

The moth universally deposits all eggs on the under side of the leaf, which is not perceptibly affected by either wet or dry hot weather.—[P. D. Bowles, Conecuh.

Damp weather is supposed to be most favorable to the hatching of the eggs.—[A. D. Edwards, Macon.

Warm, wet weather is favorable to the hatching of the eggs and growth of the larvae. Hot and dry weather kills many off.—[David Lee, Lowndes.

We think the damp, cloudy weather hatches them. If they are hatched out in dry weather they do not develop if the weather continues dry, but if not they are sure to develop and destroy the crop.—[A. H. Stolenwerck, Perry.

They will hatch out in wet or dry but increase in wet weather.—[J. C. Matthews, Dale.

ARKANSAS.

Don't know.—[Norborne Young, Columbia.

Eggs will mature in either wet or dry weather, though hot, moist weather seems most favorable.—[E. T. Dale, Miller.

FLORIDA.

The eggs seem to hatch out quicker in wet weather. I have noticed eggs which failed entirely to hatch out during hot, dry weather.—[John Bradford, Leon.

Do not know. Very hot sun supposed to be injurious.—[R. Gamble, Leon.

GEORGIA.

Most numerous in damp weather.—[Morgan Kemp, Marion.

The hot suns burn up a great quantity of the eggs.—[William A. Harris, Worth.

I do not know that I ever noticed the effect of the weather upon the eggs.—[E. M. Thompson, Jackson.

Hot and dry weather is unfavorable, cloudy and damp is favorable to the eggs.—[Timothy Fussell, Coffee.

We think that *very* dry weather is injurious to the egg—[S. P. Odom, Dooly.

LOUISIANA.

Cannot say positively, but think that damp weather is most favorable to all stages except the moth.—[H. B. Shaw, Concordia.

I do not think the weather affects the eggs in any way, as they are always deposited on the under side of the cotton leaf.—[John A. Maryman, East Feliciana.

Weather does not affect the eggs.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

I have seen them numerous in hot, dry weather; also when in wet weather.—[C. F. Sherriod, Lowndes.

Hot days and nights, with warm showers, are favorable to the rapid hatching of the eggs.—[John C. Russell, Madison.

Eggs seem to germinate quicker when there are light rains, although not very materially.—[J. W. Burch, Jefferson.

Cool or hot, dry weather seems to retard the hatching of the egg. Alternate sunshine and showers or heavy dews, when evaporation goes on rapidly, seems to be the most favorable, natural, or atmospheric condition.—[Dr. E. H. Anderson, Madison.

Moist, cloudy, temperate weather promotes development. Dry, hot weather destroys their vitality. Both these statements apply also to the caterpillar, but more especially when very young. I cannot say what is the lowest temperature that either egg, caterpillar, chrysalis, or imago may survive.—[D. L. Phares, Wilkinson.

Wet summers are conducive to hatching the worm.—[George V. Webb, Amite.

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SOUTH CAROLINA.

Have not experimented on this subject, but there is no reason to suppose that the egg is much affected by the weather, as the leaf generally sufficiently guards it against rain, and there is always sufficient heat to hold it.—[James W. Grace, Colleton.

Damp warm weather is more favorable to the production of eggs. The fly is more active and the ants less numerous.—[James C. Brown, Barnwell.

TENNESSEE.

Warm, cloudy weather insures a success of the egg crop. Heavy rains, with intervening intense heat, destroys the eggs.—[A. W. Hunt, Perry.

TEXAS.

I believe the eggs in order to batch require shade. Exposure to our sun will destroy their vitality.—[P. S. Clarke, Waller.

Warmth advances, cold retards hatching from ten days, the earliest, to eighteen and occasionally twenty days, the latest.—[W. Barnes, Cherokee.

Clear sky from 8 to 10 o'clock p. m., the time when the eggs are laid, is favorable.—[R. Wipprecht, Comal.

Don't know that the weather has any effect on the eggs.—[S. B. Tackaberry, Polk.

After the eggs are deposited I know of no weather, unless a frost, that will affect them.—[J. M. Glasco, Upshur.

Should hot, dry weather come, the eggs or a portion of them will be destroyed.—[Samuel Davis, Hunt.

I have thought hot, dry weather with a south wind through the day would destroy the egg, as the wind would turn the bottom of the leaf up and expose it to the rays of the sun. The egg is deposited on the under side of the leaf toward the top and tender part of the plant. Evenings that are cloudy are favorable for the egg to hatch; the worm gets strength quicker and not so many destroyed by heat. Frequent rains will wash them off more or less.—[O. H. P. Garrett, Washington.

The hatching of the eggs is only retarded and prevented by excessive heat and dry weather; the condition necessary for the successful hatching being warmth and moisture; heavy dews or fogs being sufficient.—[J. H. Kranchor, Austin.

If the moth is there, the egg is sure to be laid and hatched, no matter how wet or dry the weather.—[W. T. Hill, Walker.

The impression is that dry, hot weather retards and diminishes this fatally destructive army.—[A. Underwood, Brazoria.

The wet, warm weather is more favorable to the eggs.—[S. Harbert, Colorado.

After the eggs are deposited, if the weather is cloudy or rainy, the eggs will hatch entire, but if the season is dry and hot the eggs will not hatch evenly, and many will dry up and drop off or will be much delayed in hatching.—[J. W. Jackson, Titus.

Dry weather a very good preventive.—[Natt. Holman, Fayette.

QUESTION 2 e.—*Effects of different kinds of weather on the moth.*

ALABAMA.

Sunshine, not rain, endangers the moth; cool weather depresses its activity and delays or protracts its egg-laying.—[P. T. Graves, Lowndes.

Warm, cloudy weather is most favorable for the moth to deposit their eggs on the cotton-leaf.—[J. A. Gilmore, Sumter.

Cloudy and wet the best for them.—[I. F. Culver, Bullock.

We think that warm, dry weather facilitates the increase of the moths, while cool, damp weather has a tendency to destroy them.—[J. S. Hausberger, Bibb.

The moth may be affected by the weather, but, if so, we are not prepared to say to what extent. The general impression is that hot, moist weather is best suited to its propagation.—[J. A Callaway, Montgomery.

Cloudy weather is their favorite time for laying eggs.—[Dr. John Peurifoy, Montgomery.

None.—[Knox, Minge, and Evans, Hale.

The favorite part of the stalk for the webbing-up, as we call it, of the caterpillar is among the top leaves; and from this I conclude that the usual degree of the heat of the sun common at such season is conducive to a healthful condition of the moth.—[Andrew Jay, Conecuh.

Warm, cloudy weather, moths most abundant.—[R. B. Dunlap, Greene.

When the weather is warm and dry the moth is hid in the shade of the foliage of the cotton-plant until late in the evening. In wet weather it moves all day from place to place without regard to morning or evening.—[H. Hawkins, Barbour.

They are more active in pleasant, growing weather.—[C. C. Howard, Autauga.

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In warm, cloudy weather we see a great many more, and they seem to be depositing during cloudy daytime, and can be seen in great numbers throughout the day in cotton that is growing fast and has a tender foliage. When the sun shines warm and the weather is dry, you will find them flying late in the evening and after nightfall, but are seen very little in mid-day, unless in lowlands; never woodlands.—[John D. Johnston, Sumter.

I do not believe the weather has much influence on the moth. Do know that they live with little protection throughout the winter.—[R. S. Williams, Montgomery.

Judging from the fact that the moths come in the house to a lamp as numerous on damp, wet nights as on hot, dry nights, I would say that no kind of weather, save the heavy fall of rain, *will prevent* them from taking their accustomed nightly strolls.—[P. D. Bowles, Conecuh.

I know of nothing on this point beyond the fact that the moth is most active at night and early morning. It is quiet during the heat of the day.—[C. M. Howard, Autauga.

Weather that is favorable to a vigorous growth of the cotton-plant in July and August causes the moth to increase proportionally.—[M. W. Hand, Greene.

They will hatch out in wet or dry weather, but increase faster when it is wet.—[J. C. Mathews, Dale.

Dry weather, I should say, was most favorable to the moth.—[A. D. Edwards, Macon.

I see none.—[James M. Harrington, Monroe.

No kind of summer weather will kill the moth.—[D. Lee, Lowndes.

Dry weather, with hot sun, seems to destroy them.—[H. C. Brown, Wilcox.

Moist, warm, and cloudy weather most favorable for moths.—[I. D. Driesbach, Baldwin.

ARKANSAS.

Early springs, warm and dry, seem to favor and increase the moths.—[T. S. Edwards, Pope.

Heavy storms will kill many moths.—[E. T. Dale, Miller.

Cool weather checks them.—[Norborne Young, Columbia.

FLORIDA.

Cold weather injurious in proportion to its vigor.—[R. Gamble, Leon.

GEORGIA.

Wet weather seems to be favorable.—[D. P. Luke, Berrien.

Cloudy and damp weather for the moth.—[T. Fussell, Coffee.

The hot sun kills them to a great extent.—[William A. Harris, Worth.

Most numerous in damp weather.—[M. Kemp, Marion.

I consider the dry weather most favorable to the moth.—[William Jones, Clarke.

LOUISIANA.

Should think that they would need dry weather.—[H. B. Shaw, Concordia.

Weather does not affect the moths.—[Dr. I. U. Hall, West Feliciana.

MISSISSIPPI.

They enjoy best wet or moist temperate weather, which gives them food from plant secretions, decaying fruit, &c. When very dry and hot, these sources of food being cut off, they are forced to seek it in more exposed places even in daytime. During the first half of September, 1878, they came nightly and daily in large numbers to suck the sirup and cane-juice from my mill-pans, other vessels, and from the bagasse. They come in these large numbers, although there have been very few caterpillars in my vicinity and no crops damaged this season by them, because, as we foresaw and wrote weeks before, the cotton-plant was not in such condition as to afford subsistence to the insect, either as caterpillar or imago.—[D. L. Phares, Wilkinson.

The moth appears to be busy most when the weather is pleasant, warm, or dry.—[John C. Russell, Madison.

In warm, damp weather it seems to be full of animation, and torpid in cool weather.—[Dr. E. H. Anderson, Madison.

Wet weather affords them more to eat and they remain longer.—[C. F. Sherriod, Lowndes.

They seem to flourish regardless of season.—[J. W. Burch, Jefferson.

Dry weather causes the moth to disappear in the daytime.—[George V. Webb, Amite.

SOUTH CAROLINA.

Nothing but cold seems to hurt it.—[James W. Grace, Colleton.

Cannot observe any difference on account of weather directly on the moths. From

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instinct they seem to anticipate the advantages of circumstances to their broods, and are more or less vigorous accordingly in their propagation.—[James C. Brown, Barnwell.

TENNESSEE.

Bright, warm weather most favorable to the moth.—[A. W. Hunt, M. D., Denson's Landing.

TEXAS.

They grow faster and commence their ravages sooner when the evenings are more or less cloudy. The heat does not affect them so much. They commence their work soon after hatched out near the top of the plant and work down. As they gather strength they attack the tougher parts of the plant.—[O. H. P. Garrett, Washington.

The moths being shy, the chance to study their nature is rather difficult; though heavy storms of wind and rain or cold nights will destroy them, I believe.—[J. M. Glasco, Upshur.

No effects of weather on the moth are noticeable, except that cold, wet weather will retard the laying of the eggs a little.—[A. Schroeter, Burnet.

They only fly in dry weather. Frost kills them. In wet weather they seek shelter. —[W. Barnes, Cherokee.

Weather does not affect the moth. He never makes his appearance until the weather is suitable for his work.—[S. B. Tackaberry, Polk.

Wet weather would be the most destructive.—[P. S. Watts, Hardin.

Dry, favorable. Heavy rains kill the moth.—[Reed Wipprecht, Comal.

Hot, dry weather will destroy the moth.—[J. Davis, Hunt.

Cold and heavy rains and storms prove destructive to the moths.—[J. H. Krancher, Austin.

All wet seasons suit the moth better than dry.—[W. T. Hill, Walker.

Wet and dry, alternate rain and sunshine, seem to generate; while hot and dry weather long continued retards and diminishes their early appearance and numbers. [A. Underwood, Brazoria.

The effect of the weather on the moth does not seem to hurt them, as they live through our mild winters.—[S. Harbert, Colorado.

Dry weather and cold.—[Natt. Holman, Fayette.

A wet or damp season is more favorable to the full development of the moth. I saw, in 1868, when the second brood of moths was coming out (the season then being dry and hot), the chrysalis would dry and parch up after the perfect moth was ready to come forth.—[J. W. Jackson, Titus.

QUESTION 2 *f.—Month of year when greatest injury is done.*

ALABAMA.

August, in this locality.—[J. S. Hausberger, Bibb.

August.—[J. A. Callaway, Montgomery.

On our bottom-lands the worm is most destructive in the last half of August. Upon upland they are quite uniform in making their appearance a week later, and by the 10th proximo the crop is devoured.—[Charles M. Howard, Autauga.

Usually in September. Cotton that is very forward escapes. It is supposed that Georgia suffers less than other States, because they hasten the crop by the use of fertilizers. 1868, September 14, I find the following memoranda in my diary: "The worms are committing great havoc on the cotton. They have eaten nearly all the leaves, and are now attacking the small bolls. Fields that were green a week ago have now scarcely a leaf left. The crop in this neighborhood will not be more than one-third.—[H. Tutwiler, Hale.

August and September.—[Dr. John Peurifoy, Montgomery.

The earlier they come in force the greater injury they do—perhaps heretofore in July.—[C. C. Howard, Autauga.

The month of August is when the worm does most damage to the crop—that is, the earlier they come the more damage is done to the crop, and the later the least damage, for the crop has more time to mature.—[J. A. Gilmore, Sumter.

If the destructive crop is developed during the month of August the injury to the crop is great.—[R. S. Williams, Montgomery.

From the middle of August to the middle of September.—[John D. Johnston, Sumter.

August.—[P. T. Graves, Lowndes.

August and September.—[J. H. Smith and J. F. Calhoun, Dallas.

August.—[R. F. Henry, Pickens.

August and first of September.—I. F. Culver, Bullock.

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August is the month when they have done their greatest damage.—[R. W. Russell, Lowndes.

From the 15th of August to the 10th of September.—[H. C. Brown, Wilcox.

From the 15th of August to the 15th of September.—[D. Lee, Lowndes.

September.—[J. D. Driesbach, Baldwin.

August.—[James M. Harrington, Monroe.

August.—J. C. Matthews, Dale.

July and August.—[Knox, Minge, and Evans, Hale.

When they appear in June to any considerable extent they are apt by September to become so numerous as to clean out our fields. We calculate always that the third crop or generation will clean our fields, and we count six weeks a generation from the time the caterpillar webs up until the egg hatches and the young worm begins to eat the leaf. Hence that brings us to September, but of course the time of the first appearance has much to do with the time when they eat up our fields.—[Andrew Jay, Conecuh.

The most injury is done in July and August. The greatest injury done any year was in 1873, eating up the crop in July. If they do not come till late in September they do but little harm.—[H. Hawkins, Barbour.

The greatest injury is done in August and September.—[R. B. Dunlap, Greene.

August and latter part of July.—[J. R. Rogers, Bullock.

I never knew the caterpillar to attack cotton earlier than July. I have seen it on cotton in June, but evidently there must be a certain state of material of the plant before the worm will eat. It may be said, therefore, that July—the latter part—is the earliest season in this latitude that damage is done.—[J. W. Du Bose, Montgomery.

In my immediate locality, during the month of September, between the 5th and 15th if the crop is forward, and from the 10th to the 30th, if the crop is backward. They benefit us, coming after the first of October, when the plant has a vigorous growth, by cutting off the leaves and exposing the bolls to the sun, a great many of which would otherwise fail to mature.—[M. W. Hand, Greene.

In August and early in September; much more destruction, however, in August, as less of the crop is then mature.—[R. H. Powell, Bullock.

The greatest injury is done during August and September—dependent on localities.—[A. D. Edwards, Macon.

There cannot be any doubt in this section but that the month of August is when the greatest injury is done to cotton by the worm.—[P. D. Bowles, Conecuh.

August and September.—[H. A. Stolenwerck, Perry.

ARKANSAS.

During August, in the full of the moon, worms are most destructive.—[E. T. Dale, Miller.

From the 10th of July to the 15th of August.—[T. S. Edwards, Pope.

August and September.—[Norborne Young, Columbia.

FLORIDA.

August is the month, in this section, in which the greatest destruction has been done. I have never known cotton materially injured by the caterpillar earlier here, and of course any time later is less destructive. The later the destruction the less the damage, as withered and nearly matured bolls are all that escape destruction.—[F. M. Meekin, Alachua.

July and August. The top crop, which is made in the last days of August and to the 10th of September, is never injured to much extent by the worm.—[J. M. McGeehee, Santa Rosa.

August.—[John Bradford, Leon.

July.—[John B. Carrin, Taylor.

July and August—formerly August and September; difference caused by earlier maturity of cotton, attributed to improved seeds.—[R. Gamble, Leon.

GEORGIA.

When the moth appears in the month of August it does the greatest injury. When appearing in the latter part of September or October it does but little damage, as all blooms after September 15 never reach perfection.—[S. P. Odom, Dooly.

September.—[E. M. Thompson, Jackson.

July and August.—[A. J. Cheves, Macon.

July and August.—[William A. Harris, Worth.

August and September.—[M. Kemp, Marion.

Last of June and July.—[D. P. Luke, Berrien.

July and September.—[Timothy Fussell, Coffee.

September.—[William Jones, Clarke.

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LOUISIANA.

August and September.—[H. B. Shaw, Concordia.

When they appear early the greatest is done in July.—[Dr. I. U. Ball, West Feliciana.

The greatest injury is done in August.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

The month of September. When their appearance is made late in August, I consider that one entire month's making of the cotton crop is destroyed. The top fruit of the cotton and its entire last makings are cut short completely by the worm.—[John C. Russell, Madison.

They make their appearance in this locality about the 20th of July in limited quantities. The crop of worms that do most damage make their appearance between the 6th and 10th of September. They have done this with remarkable uniformity, it being immaterial what kind of weather we have.—[C. F. Sherriod, Lowndes.

Most generally September. Sometimes much damage is done in October; oftener and greater in August. In a few instances the crop has been destroyed in July, and once or twice in June.—[D. L. Phares, Wilkinson.

September most destructive, but every year I have some cotton eaten out the last of August, but worms not in sufficient numbers to eat the whole crop.—[Daniel Cohen, Wilkinson.

About August.—[William T. Lewis, Winston.

August.—[C. Welch, Covington.

In September.—[Samuel Scott, Madison.

From the 15th of July to the 15th of September.—[J. W. Burch, Jefferson.

The last of August and September.—[Dr. E. H. Anderson, Madison.

The greatest activity is generally seen in September, but to be injurious the leaves of the plants must be stripped in August.—[J. Culbertson, Rankin.

August and September.—[W. Spillman, Clark.

In the month of September.—[George V. Webb, Amite.

NORTH CAROLINA.

September; very little injury.—[F. I. Smith, Halifax.

September.—[J. Evans, Cumberland.

SOUTH CAROLINA.

If cotton is planted as late as June, it is more apt to be attacked by worms in the fall, say September, when the older cotton entirely escapes.—[Paul S. Felder, Orangeburgh.

From the 1st of August to the middle of September.—[James W. Grace, Colleton.

The greatest damage is done in August. When they make their appearance after the 15th or 20th of August, it is too late for them to be destructive.—[James C. Brown, Barnwell.

TENNESSEE.

September.—[A. W. Hunt, M. D., Perry.

TEXAS.

This year in October. First crop appears sometimes as early as the 10th of July, but not numerous; second crop in about thirty days (ten days chrysalides, ten days flies, and ten days eggs, on the average); in which cases greatest injury occurs from the 15th of August to the 15th of September.—[W. Barnes, Cherokee.

They usually make their appearance from the 15th to the last of August, and finish up their work by the 5th of September. They hardly ever come in force for eighteen or twenty days from the time first discovered. They first web up and hatch a second generation; then the work is soon done. They generally do their work in this county (Washington) from the 25th of August to the 7th of September.—[O. H. P. Garrett, Washington.

The injury is dependent on the stage of maturity of the crop. Should they come in June they will destroy it. This year they ate all the leaves the latter part of August and September, doing no damage to the crop; in some instances they were a benefit.—[P. S. Clarke, Waller.

July.—[S. B. Tackaberry, Polk.

July and August.—[R. Wipprecht, Comal.

Latter part of July and first of August.—[P. S. Watts, Hardin.

July and August.—[H. J. H. Brensing, Bowie.

July.—A. Schroeter, Burnett.

July and August are the months of greatest damage, but generally August. If July gets hot and dry, and the cotton commences shedding the leaves, then through August the worm disappears.—[J. M. Glasco, Upshur.

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August.—[Samuel Davis, Hunt.

In June, July, and August.—[J. H. Krancher, Austin.

In August.—[W. T. Hill, Walker.

The first crops of worms appear in August, and eat the leaves and web up; and come out again in September, and eat leaves and young boll.—[C. B. Richardson, Rusk.

July and August; sometimes they do not destroy the cotton verdure until September, as was the case this year. Then the crop is not so greatly injured; in fact, is but little damaged by them.—[A. Underwood, Brazoria.

The greatest injury done by them is in the months of July and August.—[S. Harbert, Colorado.

July, August, and September if the cotton has been late in planting.—[Natt. Holman, Fayette.

In the month of July in this locality.—[J. W. Jackson, Titus.

QUESTION 3.—*Give, as correctly as you can, estimates of the loss to the crop in your county and State during notable cotton-worm years.*

ALABAMA.

Where cotton has been planted late and on low wet lands the loss during this season (1878) was in many instances estimated as one-third of the fruit then on the plant, while on cotton that was planted earlier and on dry land the loss was not estimated at more than one-tenth.—[R. F. Henry, Pickens.

Loss in Bullock about 5,000 bales; loss in State about 75,000 bales.—[I. F. Culver, Bullock.

In 1873 in what is known as the "black belt," from the wet and worms together the crop was almost a complete failure. I would say that, perhaps, had there been no worms our crops would have been more than three times what they were. Other years the damage is not so great; perhaps 25 per cent.—[R. W. Russell, Lowndes.

Generally from 25 to 50 per cent.—[H. Tutwiler, Hale.

In 1867–'68 the loss in this section was one-fourth; in 1869 little injury was done; in 1870, none; in 1871, one-fourth; in 1872, one-third; in 1873, two-thirds of the crop. I do not think since 1873 that exceeding 15 or 20 per cent. damage has been done to any crop. If the season of growth is favorable to the development of a large weed, I think that if the worms do not destroy the foliage before the last of September they favor the opening of the cotton-bolls, and in this become means of direct benefit.—[R. S. Williams, Montgomery.

About one-third of the crop, in 1872–'73.—[Dr. John Peurifoy, Montgomery.

In 1872 and '73, crop cut short one-half; other years from one-fourth to one-third.—[Knox, Minge & Evans, Hale.

They injure the cotton from one-fourth to one-third.—[J. C. Matthews, Dale.

When the season is all right for an average crop or yield, and the caterpillar strips the fields in September, the loss must be 20 per cent., if not more. As to the aggregate loss I could not undertake to say, in this county and State.—[Andrew Jay, Conecuh.

It is very difficult to estimate with any accuracy the amount of loss by the caterpillar in our State, or even the county, as the loss is never uniform. Some localities suffer much worse than others; some plantations are eaten out a week before others in the same neighborhood. In 1873, I am satisfied I lost one-half of my crop; in 1868, one-sixth; in 1874, one-sixth; in 1878, one-fifth; other years, less. Would say for this county, in worst years, loss $50,000; in the State, $500,000.—[H. Hawkins, Barbour.

In county from one to three fourths of the crop.—[J. D. Driesbach, Baldwin.

I have no statistics of losses. My general impression, however, is that in the aggregate they have not been very considerable.—[C. C. Howard, Autauga.

Cannot say for the State. In this county and section from one-fourth to one-half. Last year they destroyed the crop about the 20th of September. As it was late the damage was small. This year they destroyed the crop the last of August, and the damage was great—not less than one-fourth and probably more. The year 1875 was dry; the worms came late, I think in October, and not enough of them to make much, if any, impression.—[H. A. Stolenwerck, Perry.

I cannot even approximate the losses by the worm, but they are immense. No estimates yet made and published exceed the damage we suffer from them.—[C. M. Howard, Autauga.

From one-third to one-half on an average.—[James M. Harrington, Monroe.

About one-fourth of the crop.—[A. D. Edwards, Macon.

In the black lands of Montgomery and Lowndes Counties, Alabama, the worm rarely if ever destroys less than one-half, and often three-fourths, of the crop.—[J. M. McGehee, Milton, Florida.

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I planted for 350 bales cotton in 1872; believe I would have gathered that quantity, but by the 15th of August the entire foliage and smaller fruiting had been eaten by caterpillars. I realized 220 bales. I planted for 250 bales in 1873. The caterpillars found my crop very fine in July; they spread rapidly. I realized 85 bales. One of my neighbors thinks that in 1876 he would have made only 25 bales had he not used poison. By the aid of the poison he made 150 bales. The stage of maturity of the fruitage when the caterpillar appears is, of course, conclusive of the amount of damage resulting.—[J. W. Du Bose, Montgomery.

In 1868 probably one-fourth of the entire cotton crop was lost by the cotton-worm, that eats off the leaves and squares or forms of cotton. In 1871 they appeared earlier than at any other date in my recollection; they appeared as early as the 10th of August in sufficient force to strip the cotton-stalk of everything but the full-grown bolls. In 1871 I think one-half the crop was lost by the cotton-worm.—[George W. Thagard, Crenshaw.

On late cotton generally about two-thirds of a crop is lost. On uplands planted early not much loss, as the crop has generally fruited and matured before they come.—[H. C. Brown, Wilcox.

In 1866 the loss in this county amounted to 30 per cent., owing greatly, however, to the large amount of late cotton, caused by old seed having been planted that failed to germinate, making it necessary to plant again. In 1873 the loss was 70 per cent. This year on the bottom and lime lands a loss of 20 per cent. is claimed. Other years the damage has been local or incidental.—[P. T. Graves, Lowndes.

If the worm comes early in the season the crop is cut off one-half. In 1878 the crop was damaged one-eighth in this vicinity; but east of here in this county, where the worm came in August, the crop was damaged one-fourth.—[J. N. Gilmore, Sumter.

In 1836, about one-third; 1844, about one-third; 1852, one-half; in 1867, about one-fifth; in 1868, about one-fourth of the crop was destroyed; in 1869, about one-third; in 1873, fully one-third.—[M. W. Hand, Greene.

In 1866, about one-third; in 1871, about one-half; in 1872, one-fourth; in 1873, one-eighth; and in 1876, one-half.—[J. S. Hausberger, Bibb.

Where the crop is well advanced, the land being well prepared, and planted just as early as the season will permit, cultivated well and rapidly, and, as the saying is, "pushed from the word go," the loss is much less than when planted late and poorly cultivated. The general average of loss we estimate for county and State to be 33⅓ per cent.—[J. A. Callaway, Montgomery.

Farmers divide the crop into three sections or crops: (1) bottom, (2) middle, and (3) top crop, all of which very easily mature. In the year 1825 the oldest farmers now living estimate the loss at 98 per cent. Mr. Chesley Crosby, a large planter, only gathered 10 bales from 500 acres. In 1867 at least 66⅔; 1868, 25; loss in 1873, about 40; some placing it at 90, some 75; 1874, about the same as 1873, each farmer estimating from his individual loss. In 1874 Mr. le Dramond gathered 900 pounds of seed cotton from 14 acres, which would have produced 1,000 pounds per acre. This is about an average for this county for 1874. But taking the drought and rainy seasons year after year, together, with all things incident to cotton-growing, I think that 50 is a very fair average since 1868.—[P. D. Bowles, Conecuh.

I have not the data and hence can hardly give the approximate losses in the cotton crop in notable worm years. If the season is favorable, the cotton planted early and well cultivated, much is gained, and the loss would be light; for when the bottom crop is heavy the top crop is light; hence there would be less for worms to destroy. But if the spring is cool and wet, and the summer wet, the crop will of necessity be badly cultivated; and consequently the crop will be late. Under such disadvantages the crop would be cut off one-third.—[David Lee, Lowndes.

ARKANSAS.

I think the loss to the crop in this county this year will be $100,000. At least one-fourth of the crop is destroyed. Planters were not aware of the extent of damage until they had picked a good deal.—[T. S. Edwards, Pope.

During the years 1865–'66–'67, the worms destroyed at least one-fourth of the crop each year, and in some portions of the Red River lands the entire crop on many plantations.—[E. T. Dale, Miller.

FLORIDA.

The losses vary, of course, according to the completeness of destruction and the amount of matured cotton at the time of destruction. In some fields I have seen four-fifths destroyed; in others, not exceeding a fifth, though both were entirely eaten over by the worm. But I think it safe to say the destruction generally amounted to one-third in the bad years.—[F. M. Meekin, Alachua.

GEORGIA.

I don't think our county lost any from the effects of the worm, as it was late before they came, and barely touched the bolls of cotton. In places they come in August, and make havoc with the cotton.—[E. M. Thompson, Jackson.

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In a bad worm year, wet and cool, they destroy all the top cotton, and necessarily it is cut off one-half.—[William A. Harris, Worth.

The loss in my county in 1825 and '46 was fully one-third.—[William Jones, Clarke.

The most notable cotton-worm years the estimate of the loss was about one-third.—[Timothy Fussell, Coffee.

The losses from worms in this county have been very small, not one bale out of a thousand.—[M. Kemp, Marion.

Half the crop, at least.—[D. P. Luke, Berrien.

In the years when most destructive, their damages are at least 25 per cent.—[S. P. Odom, Dooly.

Never greater than from 10 to 20 per cent.—[A. J. Cheves, Macon.

LOUISIANA.

In 1841 the losses were greatest from injury done to the *quality* of the cotton from the litter and excrement dropped by the worms on the open bolls. Their appearance was late and a good crop of bolls had already been matured on the stalks before they appeared in sufficient numbers to destroy the plants. The last crop of worms were very large, and roads, ditches, and all places were filled with them, when they began their march after eating out the cotton-fields. In 1846 the cotton-crops here were cut short from 50 to 60 per cent. In the last fourteen years, the destructive years were particularly 1867, '71, '72, and '73.—[Douglas M. Hamilton, West Feliciana.

The losses vary from four-fifths to one-third. In 1844 the farmers scarcely raised cotton-seed enough to plant their crops of 1845.—[John A. Maryman, East Feliciana.

The loss during the years mentioned was fully two-thirds.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

I will give the estimate of the loss for the first destructive year (1846). The planters say that in this locality not more than one-third of a crop was raised that year, or a loss of about 66 per cent. of whole crop.—[George F. Webb, Amite.

I have never seen an estimate, but would say the damage done to each crop, visited as early as August, would be over one-third.—[Dr. E. H. Anderson, Madison.

In 1845 loss was two-thirds; in 1864, nine-tenths; since then from one-fourth to little or nothing. This season in some places one-third.—[J. W. Burch, Jefferson.

About 25 per cent.—[William T. Lewis, Winston.

In 1873, damage to my crop 40 to 50 per cent.; other years 10 to 25 per cent.—[Daniel Cohen, Wilkinson.

In 1847 or '48 the loss was probably 50 per cent., and in one year between 1865 and '70, the loss was probably 60 per cent. This year I judge the loss does not exceed 10 per cent.—[C. Welch, Covington.

It is commonly thought that the loss of the leaves, which usually takes place in September, is an advantage, as it hastens the maturing and opening of the bolls. The area stripped in August is never considerable.—[J. Culbertson, Rankin.

When they commence early, one-third; late, one-fourth.—[W. Spillman, Clarke.

At least one-half of the ordinary crop when worms are bad. There are very few years that there are no worms. In fact, I don't recollect that I ever saw a single year without a few.—[Kenneth Clarke, Chickasaw.

It is a difficult matter in general to estimate the loss done to a crop. I think though in some notable years with the worm, an overestimate has not been made in saying that the loss was one-fourth, and I would not consider it exaggeration in hearing it estimated to be one-half.—[John C. Russell, Madison.

In 1825 and '46 fully 50 per cent. In 1867, '68, and '73 probably 25 per cent. Many other years and for several successive years, *in certain localities*, I have known the crop wholly destroyed in July, so that not enough seed was matured to plant next year's crop.—[D. L. Phares, Wilkinson.

The crop is injured about one-third. All the young fruit is ruined by them. We used to calculate there was a certainty of most of the blooms making, that came before the 10th of September. Now we cannot count on any after the 1st of August. Our crops have fallen off at least one-third since they have been visited by the worms.—[C. F. Sherriod, Lowndes.

NORTH CAROLINA.

The worm is so late in making its appearance in this latitude that it is doubtful if they ever do any injury. In fact, many farmers consider them as a benefit, as they eat off the top leaves, and letting the sun in on the lower bolls, causes them to open better. As they have never been looked on as an evil, I have never studied them closely, and hence cannot make an intelligent report.—[J. Evans, Cumberland.

Very slight.—[F. I. Smith, Halifax.

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SOUTH CAROLINA.

About three-fourths of the crop has been destroyed in most years when worms have been general, and in some neighborhoods seven-eighths has been lost.—[James W. Grace, Colleton.

The greatest loss to the county in the aggregate for one year most notable for the cotton-worm was about one-fourth. On some farms, mostly in southern localities, nearly one-half.—[James C. Brown, Barnwell.

TENNESSEE.

It is quite difficult to give even an approximation of the loss sustained in the State or county during years of severest visitations, for, while old large farms have lost maybe one-half or three-fourths, new small farms, inclosed by dense forests, have suffered very frequently not at all. However, as we are anxious to aid you all in our power, and as perhaps there are few other sources in our State from which you could be expected to get more accurate information, I will hazard 20 per cent. as the heaviest general loss through the whole State.—[A. W. Hunt, M. D., Perry.

TEXAS.

In this locality it was generally estimated to be one-half of the crop. Further south, say between latitude 30°, 31°, and 32°, where the moth made its appearance in June, the loss was there estimated to be two-thirds of the crop, and in some localities on low bottoms the entire crop was lost. I cannot give you the estimate in dollars and cents, but can approximate by saying that the average estimate of cotton crops in these localities is about 400 pounds lint per acre, then worth 15 cents per pound. This would make these losses $60 per acre, besides the expense of making it. I suppose the average loss throughout the State in these years would be at least $25 per acre.—[J. W. Jackson, Titus.

I cannot reconcile myself to the fact that any material loss to the cotton crop in this county has been from worms, but the insect has been charged with all damages. I have, in the Brazos bottom, a cut of cotton that had every appearance of one and a half bale to the acre. The worms stripped it, and left the glaring fact of not over one-half bale to the acre. The damage was done by the too favorable growing season. By stripping the leaves the sun could reach the lower bolls and thereby save them from rotting.—[P. S. Clarke, Waller.

In this county there were a great many persons who did not make more than one bale to the 100 acres, in the year 1867. North of this the crops were good, making a bale to the acre in places.—[S. Harbert, Colorado.

About 50 per cent.—[C. B. Richardson, Rusk.

The loss in our county was very slight. There were but few fields that were visited, and those in isolated spots where the plant grew more luxuriantly, and only the upper branches, which were tender, were attacked. In fact I heard some planters assert it was a benefit, as it caused the lower bolls to open, that otherwise would have rotted. The history of the worm in Hunt County is no criterion. I can gather no reliable information of loss in the State.—[Samuel Davis, Hunt.

In a probable crop of 12,000 bales from 25 to 50 per cent. in different years.—[W. Barnes, Cherokee.

In 1847 two-thirds of the crop was lost; in other years from one fourth to one-third.—[H. J. H. Brensing, Bowie.

In the year 1863 the worm, having been very destructive, destroyed about 25 to 30 per cent. of the crop; in 1868, the first appearance of the worm having been the earliest on record, the crop was nearly destroyed during the first part of July, and injured more than 50 per cent. The same was the case in 1877, the destruction, owing to the extensive application of poisonous preventives, not being so heavy as in 1868.—[J. H. Krancher, Austin.

During many years three-fourths of the cotton crop is destroyed by them. This is the case where the verdure is eaten up in July. If eaten up in August half a crop, and in September three-fourths of a cotton crop is generally saved, unless diminished by other causes.—[A. Underwood, Brazoria.

Three-fourths.—[Reed Wipprecht, Comal.

The worm has got to be a fixture upon us; we have escaped but one year for the last twelve or fourteen—that in 1865, when we had a very dry summer. Would think the loss to the county one-third, at the very least one-fourth. As to the State I have no means of knowing, but it is immense, as frequently whole sections are well-nigh destroyed.—[O. H. P. Garrett, Washington.

Two-thirds during the years of greatest damage, though all fields are not attacked alike. It depends on the locality of the field and maturity of crop.—[J. M. Glasco, Upshur.

In 1868, loss one-half in this county; 1873, the same; in 1874, loss one-third, and in 1877, three-fourths.—[P. S. Watts, Hardin.

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In 1867 and 1873 loss was total; in 1877 about 75 per cent.—[S. B. Tackaberry, Polk.

For the years 1871 and '73, 25 per cent each; 1874 and '76, 40 per cent each.—[A. Schroeter, Burnet.

I cannot make any attempt at estimates of losses, as I have never kept any data; but millions of dollars have been lost and many farmers brought to ruin and poverty.—[W. T. Hill, Walker.

QUESTION 4.—*State as nearly as you can from the records the prevailing direction and force of the wind in your locality.*

ALABAMA.

During February, March, and April the prevailing winds are from the east and south. After this we have but little wind except with thunder showers, which often come from the northwest.—[R. W. Russell, Lowndes.

Northeast and southwest.—[H. C. Brown, Wilcox.

Southeast.—[Knox, Minge, and Evans, Hale.

It would be folly on my part to attempt to answer the question as to the prevailing direction of the wind during the first six months of the year, but will give the outlines of my recollections, namely, nine out of ten rainfalls in the county are preceded by winds from the Gulf (southwest); the remainder from the west to northwest, sometimes, but very rare from the northeast. Most winds *not* followed immediately by rainfall are from the west and northwest to north; this in the months of January, February, and March. Some six years ago Dr. W. D. F. Kelly, now of Demopolis, Alabama, was doing business in this place (Evergreen); his house was fronting on the Mobile and Montgomery Railway, and it was in the month of May or June that he called my attention to the fact that we had a pleasant breeze from the southwest, beginning at ten o'clock every morning, which caused me to take notice of a fact more particular in fair weather. The Doctor was satisfied that it was the Gulf breeze, although nearly one hundred miles away. There is no doubt in my mind, as the moth is oftener found hundreds of miles away from the cotton-field, that it is caused by the favorable winds from the south to northward, and I am perfectly satisfied that Mr. A. R. Grote is very much mistaken when he comes to the conclusion that the species perish each year with the plant and that they come to the cotton States from more southward countries. Dr. R. A. Lee, of this place, who has given much time and attention to the cotton-worm, informs me that he has often seen the chrysalis under old logs, sticks, bark, and other pieces of wood, or in dry places, in the months of January and February, where he had hands plowing in the old cotton-field previously planted, and that he has seen the moth of warm nights in the months of January and February come in the house to the light of lamps. I have also noticed the fact myself. Taking it for a point of basis that the 17th day of May is the earliest date at which the worm has ever been seen in this county, it would show that Mr. Grote's theory is not in harmony with the above facts. If this reasoning be correct in many warm springs, why may not the moths come in great numbers before the month of May, or even in June; also, where are the great cotton-fields south or west of the Gulf for them to come from? The Mexican and Central States fail to give any account of the ravages of worms destructive to the cotton-plant (keeping in mind that the worm will not feed upon any other plant than cotton). And this in corresponding years in which the greatest damage has been done us, looks to me to be very easy to find out for the years 1867, -'68, -'69, -'74, -'75, and -'78. What damage was done to the very little long-staple cotton planted south of the United States? The well-known fact that the moth is rarely or never seen (save in its hiding place) in the daytime, and that they are on the wing at night, can be taken to strengthen or deny Mr. A. R. Grote's position, but more strongly to deny. As the moth would have to cross a portion of the Gulf, if brought by winds from the south of the United States, and as the sunlight is repulsive to them, I would think, as a natural consequence, that the moth failing to reach land in the night, would find a watery grave. There is no doubt in my mind but that the chrysalis remains in a torpid state in the fall depository or hiding place until the warm sun in May brings them to life, and the moth comes out and starts upon his journey of life and destruction.—[P. D. Bowles, Conecuh.

The Alabama and Conecuh Rivers run south and southwest and empty into the Gulf of Mexico. The cotton-worm approaches us by traveling up these rivers and their tributaries.—[George W. Thagard, Crenshaw.

It is generally believed they migrate northward, coming from South and East Florida. Whether this be so or not I can't say. They often appear 100 miles north of here sooner than here, and always in the black lands first.—[J. C. Matthews, Dale.

It is not clear to my mind that the moths migrate, as I have never had any reliable evidence of such migration, with an experience of thirty-five years. I have often

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seen them in numbers sufficient to attract attention during warm days in February and March, and am satisfied that they had come out from their *winter quarters* to enjoy the warm sun and in quest of food, and in this manner many of them perish, and no large numbers are left to propagate in the early summer; and hence no great destruction to the cotton that season. Greatest loss after cold, hard winter.—[I. D. Driesbach, Baldwin.

ARKANSAS.

From the southwest.—[Norborne Young, Columbia.

FLORIDA.

All the winds that continue for any length of time are either from the east, southeast, northeast, or westerly. The south winds here are of short duration generally.—[F. M. Meekin, Alachua.

GEORGIA.

The parent of the cotton-worm migrates here from more southern regions, and is a fly. The egg is deposited, and when the worm is grown it webs itself up generally in the leaves of the cotton, and is transformed into a black worm, and in about seven or eight days there issues from that a pale yellow butterfly, as can be seen by the samples I send you in box marked A. That fly can now be seen here hourly, migrating southward.—[S. P. Odom, Dooly.

I do not believe in the migration of the moth, but think it is sustained through the winter in the cotton regions.—[William Jones, Clarke.

The wind comes from south and southeast during first part of the year.—[E. M. Thompson, Jackson.

Variable; from south to northwest and from northeast to south.—[M. Kemp, Marion.

From southwest.—[William A. Harris, Worth.

Southeast.—[Timothy Fussell, Coffee.

LOUISIANA.

The prevailing winds are generally from the south, southeast, or southwest; not often from the north.—[John A. Maryman, East Feliciana.

No opinion of an ordinary cotton planter who is not scientific nor at all informed on entomology or the history of insect life is worth much on the subject of the history of the cotton-worm. We are governed only in forming our opinions by what we observe under our own eyes and in our own sections. The moths may possibly be wafted great distances by favorable winds, but the general belief is that the insect hibernates here, and is to be found here *now* annually, no matter how or where it may have come from at some former time. We do not observe weather and seasons close enough to tell accurately about winds, cold, heat, rains, dry seasons, and many other points, and no records are kept of such matters, as far as I know, except latterly by persons in government employ at signal-stations, forts, arsenals, or by parties engaged in explorations or surveys ordered by the general government. I cannot, therefore, say anything on these topics worth writing to you more than I have already written. It has been observed by many planters here within the past fourteen years that many places are favorable to the appearance of the worm and its after increase, and particular spots or localities on these different plantations. There are no reasons apparent for this incident, and though it is generally and almost annually observed, I have never heard any plausible reason assigned, nor any even attempted. These places are scattered here and there over our whole parish, with all varieties of soil, localities, conditions, and surroundings, and still some seem to be selected as breeding spots for the worms every year—or landing places, if it is true that the moths are blown here annually from other parts of the world.—[Douglas M. Hamilton, West Feliciana.

MISSISSIPPI.

I am convinced by long observation that the *moth is not migratory*, for this reason: when the worm has appeared in the most frightful numbers, *I know that they hatched in the fields*, and after running their course they died in the cotton-fields by the million. They always first appeared in small numbers, and increased for two succeeding generations to the most frightful numbers. The wind was as follows: February, west and northwest; in March, south and southwest; in April, south and southwest; in May, west; in June, east.—[George V. Webb, Amite.

As to migration, they only migrate as far as the winds carry them.—[W. Spillman, Clarke.

From the 20th of September to the 20th of March, or from the autumnal to the vernal equinox, the general bearing of our winds is from northeast to north and northwest, with occasional breezes from the opposite points of the compass, and from the vernal to the autumnal, from south to southwest, with occasional northwest and north winds. During the first period condensation appears to commence in the east and brings us our rains from that quarter, and during the latter period from the southwest,

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always clearing up after a northwest current. The force of the wind, except during storms, I would estimate at six miles per hour.—[Dr. E. H. Anderson, Madison.

No records at hand; but from any one's observations and recollections, most of the days in February with moderate force from northeast, east, southeast, and south. During this month almost every year there is a fierce wind from northwest, sometimes once, oftener perhaps twice, rarely thrice, of one or two days' duration, and bringing severe cold.—[D. L. Phares, Wilkinson.

We rarely have more than two or three days when the wind does not get to the south in spring and summer months. A great many theories are advanced about the migration of the moth. Several years ago some farmers believed they were wintered in the hollow or pith of both the cotton and corn stalk, and they burned both to get rid of them. If that was correct, and all burned, it might do some good.—[K. Clarke, Chickasaw.

NORTH CAROLINA.

From southwest; force rarely reaches twelve miles per hour, unless in stormy weather.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

South and southwest.—[James W. Grace, Colleton.

TENNESSEE.

I have been a close observer of this species of the insect family in question, and while I am aware that the moth is occasionally found in parts of our country remote from the cotton-belt, I am satisfied such cases are rare and wholly adventitious. There certainly is no sufficient evidence that there is a system in the migrations of this insect or fly. While it might be barely possible that an erratic moth might make its way, under very extraordinary circumstances, from a more southern State to this State, and propagate its species here, the fact that after several years of total exemption here, of a sudden our fields become infested, could not be accounted for on the migratory theory in the absence of ocular evidence of clouds of the moths engaged in the northward migration, &c.—[A. W. Hunt, M. D., Perry.

The wind blows mostly from the southeast; we have some very hard winds from the southwest and west.—[J. McMillan, Decatur.

TEXAS.

The worm generally makes its appearance first in the lower coast counties and appears to work its way up the country, being favored by the winds generally prevailing at the time, east, southeast, and south-southwest. They almost invariably make their first appearance in Brazoria, Fort Bend, Wharton, and Colorado Counties, lying east, southeast, and south of this, then working their way up along the Colorado or Brazos River bottoms and plantations. During the last two or three years they generally appeared about three or four weeks previous to their appearance here eighteen to twenty miles south of us on the Colorado River, then coming across the prairie along the edge of the upland timber with the prevailing sea breeze.—[J. H. Krancher, Austin.

South and southeast varied by northern, at intervals of two or three days.—[Saul Davis, Hunt.

South to southeast in general, fifteen to twenty miles.—[W. Barnes, Cherokee.

From south and south by east during the spring and summer months. In May we are apt to have the most constant and strongest winds from the south; the stronger the winds the less it rains.—[O. H. P. Garrett, Washington.

The prevailing direction of the wind in Southern Texas is constantly from the south; *i. e.*, from the Gulf of Mexico. Sometimes we have a north wind for two or three days, blowing usually at the rate of twenty miles.—[W. T. Hill, Walker.

Southeast in fair, pleasant weather, east in rainy, and north in cold weather.—[A. Underwood, Brazoria.

My observation is that they make their appearance in the spring, and are found in bottom lands that are heavily timbered first, around drift-logs, &c., and remain for some time in the timber and high, rank weeds, always showing more just after a rain.—[Natt Holman, Fayette.

I have no doubt that the moth is at times, if not habitually, migratory, as I have observed it to appear in large numbers all of a sudden, and in seasons when previous to their arrival the conditions for their development and increase had been very unfavorable, so much so that it was a hard task to find a half a dozen of them in a field of ten acres, while the next morning the air was full of them, the wind blowing at that time the same that it does nearly all the year round, from southeast.—[A. Schroeter, Burnet.

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QUESTION 4 *a.—Direction and force of the wind in February.*

ALABAMA.

From the north, and frequently strong.—[C. M. Howard, Autauga.
South, west, and southwest in warm spells; if cool, the wind is north.—[J. C. Matthews, Dale.
In 1876, the most disastrous worm year I know of, winds east and southeast.—[J. W. Du Bose, Montgomery.
Variable, though mostly a stiff wind from the north and northeast.—[M. W. Hand, Greene.
Southeast.—[Knox, Minge, and Evans, Hale.
The wind generally comes from the west.—[I. F. Culver, Bullock.
Wind in February is variable and from all points of the compass.—[R. S. Williams, Montgomery.
The winds in February are generally from the south and southwest during the warm weather of the month, veering around to the west and northwest, and with considerable force.—[J. N. Gilmore, Sumter.
From southeast to northwest.—[J. A. Callaway, Montgomery.
February prevailing winds southwest 21, southeast 17.—[H. Tutweiler, Hale.
February, northwest when cold, west when cool and dry, east and south when rainy and disagreeable.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

From south and southwest; sometimes from east; seldom from north or west.—[T. S. Edwards, Pope.
North and northeast.—[E. T. Dale, Miller.

FLORIDA.

Hard, from the west.—[John B. Carrin, Taylor.
Northerly.—[R. Gamble, Leon.

GEORGIA.

From south to northwest.—[M. Kemp, Marion.
From northwest.—[William Jones, Clarke.
February the wind comes from the south and southeast.—[E. M. Thompson, Jackson.
Generally from the north and northeast.—[S. P. Odom, Dooly.
Northwest.—[William A. Harris, Worth.
Mostly from northwest.—[Timothy Fussell, Coffee.

LOUISIANA.

The prevailing winds in February are from the north and northwest.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

February is characterized by no particular prevailing current, but varying from one point to another. Tornadoes are not unfrequent in this month, and their course is invariably from west to east.—[Dr. E. H. Anderson, Madison.
North, velocity varying from one to fifteen miles per hour.—[C. Welch, Covington.
From north and east.—[Kenneth Clark, Chickasaw.
North and northeast.—[J. W. Burch, Jefferson.
From west and north.—[C. F. Sherriod, Lowndes.
Mostly east and southeast.—[W. Spillman, Clarke.
I do not think the winds from the south are sufficiently strong to mitigate or counteract the trade-winds. The prevailing direction of the wind in July is east and southeast.—[George V. Webb, Amite.

NORTH CAROLINA.

South and southwest.—[F. J. Smith, Halifax.
Northwest.—[J. Evans, Cumberland.

SOUTH CAROLINA.

From northeast.—[Paul S. Felder, Orangeburgh.
South and southwest.—[James W. Grace, Colleton.
February, from west and northwest; occasionally gently from the south.—[James C. Brown, Barnwell.

TENNESSEE.

If February is mild and pleasant the wind blows mostly from the south, southeast, and southwest, and in a cold month the wind blows north, northeast, and northwest.—[John McMillan, Decatur.
North and northeast, latter predominating.—[A. W. Hunt, M. D., Perry.

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TEXAS.

Our winds as a rule from the south. The northers spring up, but last only three days at most.—[P. S. Clarke, Waller.

South and southeast, varied at intervals by wind from the north that continued two or three days.—[Samuel Davis, Hunt.

Winds stiff and change frequently, and come from all points of the compass.—[O. H. P. Garrett, Washington.

February, 1861, nineteen days from the south; the remainder from the north and northwest; 1862, fifteen days from the south and southwest, the remainder from the north and northeast.—[J.M. Glasco, Upshur.

East.—[H. J. H. Brensing, Bowie.

South three to six days; then north three or four days.—[W. Barnes, Cherokee.

North.—[R. Wipprecht, Comal.

Alternately south and north.—[A. Schroeter, Burnet.

The prevailing winds in February are mostly northeast and south, seldom changing to west. The north winds are generally dry and cold. East wind is almost always rain wind; the same southeast.—[J. H. Krancher, Austin.

From the south, and fifteen miles an hour.—[W. T. Hill, Walker.

From southwest and northwest.—[C. B. Richardson, Rusk.

The most general course of the winds in this locality is from the south and east.—[S. Harbert, Colorado.

The general direction of the winds in this locality is, in February, west and northwest; in changes, such as rain or snow, invariably north or northeast. From the middle to the last of the month the wind drops further south and southwest; in case of change to rain or "wet spell" invariably east and northeast, clearing from the north. All the mild weather in this month has a brisk southwest wind. The force of the wind south and southwest is from a mild breeze to a gale.—[J. W. Jackson.

In spring, most from the south; in summer, mostly south; fall, south and east, occasionally north; winter, south and generally north.—[Natt Holman, Fayette.

QUESTION 4 *b.—Direction and force of the wind in the month of March.*

ALABAMA.

Southeast.—[Knox, Minge, and Evans, Hale.

East and southeast in 1876.—[J. W. Du Bose, Montgomery.

Generally from east to west.—[H. C. Brown, Wilcox.

From the east and north, frequently changing, and often violent.—[C. M. Howard, Autauga.

For the greater part of this month a strong wind from the north and northeast.—[M. W. Hand, Greene.

The winds in March are more generally from the southeast and south, except what is called the March wind, which blows very strong from the west and northwest.—[J. N. Gilmore, Sumter.

West and northwest.—[I. F. Culver, Bullock.

From southeast to northwest.—[J. A. Callaway, Montgomery.

March, southeast, 28; southwest, 24.—[H. Tutwiler, Hale.

March is our blowing month, when winter dallies in the lap of spring. Winds southwest and south.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

South and southwest, very little from north or east.—[T. S. Edwards, Pope.

South and southeast.—[E. T. Dale, Miller.

FLORIDA.

Very hard, from the west and northwest.—[John B. Carrin, Taylor.

Variable, north and southerly.—[R. Gamble, Leon.

GEORGIA.

Most of the time from the south and southwest, especially if it be a warm month.—[S. P. Odom, Dooly.

Mostly from west.—[E. M. Thompson, Jackson.

South and northwest.—[M. Kemp, Marion.

Northwest.—[William A. Harris, Worth.

Mostly from south and east.—[Timothy Fussell, Coffee.

Northwest.—[William Jones, Clarke.

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LOUISIANA.

During March and April the prevailing wind is south and west, lasting sometimes a week, strong enough and long enough to bring a moth from South America, I should think. I have no record of the wind, but if the moths are brought here by the wind, which I think they are, it is during the months of March, April, and May.—[H. B. Shaw, Concordia.

In March from the south.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

In March we have south to southwest winds, met by counter condensing currents from northeast to north and consequent heavy rains, especially during the latter part of the month, clearing off with cool northwesterly winds. The average force of the wind greater.—[Dr. E. H. Anderson, Madison.

March winds variable southwest and northwest with considerable force, oftener northeast, and still oftener southeast and south; sometimes very strong for several successive days.—[D. L. Phares, Wilkinson.

Prevailing winds south, maximum velocity probably 15 miles per hour.—[C. Welch, Covington.

South.—[Kenneth Clark, Chickasaw.

North.—[C. F. Sherriod, Lowndes.

East and southeast.—[J. W. Burch, Jefferson.

Southwest, northwest, and north; when from southeast the hardest.—[W. Spillman, Clarke.

NORTH CAROLINA.

Northwest.—[J. Evans, Cumberland.

Northeast.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

South and southwest, often northeast and southeast.—[James W. Grace, Colleton.

From every direction.—[Paul S. Felder, Orangeburgh.

March, west, northwest, and north.—[James C. Brown, Barnwell.

TENNESSEE.

North, northwest, and west, northwest predominating.—[A. W. Hunt, M. D., Perry.

Mostly from northwest.—[John McMillan, Decatur.

TEXAS.

Our east and southeast winds will as surely bring rain as the norther brings cold.—[P. S. Clarke, Waller.

South to southeast 15 to 30 miles, with an occasional norther 30 to 40 and sometimes 60 miles.—[W. Barnes, Cherokee.

March, 1860, the wind blew sixteen days from the south and fifteen days from the north; March, 1861, nineteen days from the south, the remainder west and northwest.—[J. M. Glasco, Upshur.

Northwest.—[H. J. H. Brensing, Miller.

South, south by east, and south by west.—[O. H. P. Garrett, Washington.

Changeable.—[R. Wipprecht, Comal.

From the south, sometimes more than the usual rate.—[W. T. Hill, Walker.

In the month of March northers are less frequent, east and south wind mostly prevailing; if a norther occurs, it is generally followed by frost. A sleet of several days' duration occurred as late as the 15th of March, 1867.—[J. H. Krancher, Austin.

Generally from west.—[C. B. Richardson, Rusk.

South and east.—[S. Harbert, Colorado.

South, and blowing like blazes.—[Natt. Holman, Fayette.

March gives us about the same direction and force of wind as February, except from the 10th to the 22d high winds, north and northwest. The latter part of the month gives high brisk winds from south-southwest, with sudden shifts to the northwest.—[J. W. Jackson, Titus.

QUESTION 4 *c.*—*The direction and force of the wind in the month of April.*

ALABAMA.

West and northwest.—[J. C. Matthews, Dale.

Variable and light.—[C. M. Howard, Autauga.

From west to northeast.—[J. C. Brown, Wilcox.

Southeast.—[Knox, Minge, and Evans, Hale.

Generally a steady cool breeze from the north.—[M. W. Hand, Greene.

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East and southeast in 1876.—[J. W. Du Bose, Montgomery.

The wind in the month of April is generally from the southeast and south.—[J. N. Gilmore, Sumter.

Variable, but mostly from southwest.—[R. S. Williams, Montgomery.

From southwest to northeast.—[J. A. Callaway, Montgomery.

April, southeast, 32.—[H. Tutwiler, Hale.

April showers are proverbial. And this year the "borrowing days" did not forget to blow from the west and southwest. And the freshet came on the 11th instant. No cyclone here, but pretty hard wind. Cyclone in Lee County, and at Fort Gaines, Ga., with considerable damage. Some loss of life.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

South and southeast.—[T. S. Edwards, Pope.

South and southeast.—[E. T. Dale, Miller.

FLORIDA.

Variable and gentle.—[J. B. Carrin, Taylor.

Chiefly south; at times north.—[R. Gamble, Leon.

GEORGIA.

Variable, from land to sea.—[William Jones, Clarke.

Southeast.—[William A. Harris, Worth

April, from the west mostly.—[E. M. Thompson, Jackson.

From southeast.—[Timothy Tussell, Coffee.

From east and northeast.—[S. P. Odom, Dooly.

Variable and moderate; moves from south to north by the way of the west, then from northeast to south.—[M. Kemp, Marion.

LOUISIANA.

In April, from south and southeast.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Southeast and south.—[J. W. Burch, Jefferson.

From all the points of the compass, with little force.—[Dr. E. H. Anderson, Madison.

South.—[Kenneth Clark, Chickasaw.

Prevailing winds south, maximum velocity 10 miles.—[C. Welch, Covington.

With moderate force from some southerly point.—[D. L. Phares, Wilkinson.

Sooth.—[C. F. Sherriod, Lowndes.

Southwest and generally, about Easter, north.—[W. Spillman, Clark.

NORTH CAROLINA.

Northwest and southwest.—[J. Evans, Cumberland.

Southwest.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Southwest and northwest.—[James W. Grace, Colleton.

West.—[Paul S. Felder, Orangeburgh.

April, south and southwest and southeast.—[James C. Brown, Barnwell.

TENNESSEE.

From the southwest mostly. We have some very hard storms from that direction in the spring.—[John McMillan, Decatur.

Northeast and west equally.—[A. W. Hunt, M. D., Perry.

TEXAS.

In April, 1860, we had twenty-two days from south and southwest, and eight north, northwest, and northeast; in 1861, fifteen days south, southeast, and southwest.—[J. M. Glasco, Upshur.

South by east and south.—[O. H. P. Garrett, Washington.

East.—[H. J. H. Brensing, Miller.

Southeast.—[Samuel Davis, Hunt.

South.—[R. Wipprecht, Comal.

Southeast to southwest; 15 to 25 miles.—[W. Barnes, Cherokee.

April, mostly south, southeast, and southwest winds prevail; an occasional north wind occurs, frequently the forerunner of a late spring frost. In the year 1859, the latest spring frost, in my recollection, occurred on the night of the 24th April, killing corn badly, but not injuring cotton much; that year the worm did little damage, a heavy crop being made. The year previous, a norther came up on the 11th of April,

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on the morning of the 12th several inches of snow covered the ground; also a good cotton year.—[J. H. Krancher, Austin.

Southwest.—[C. B. Richardson, Rusk.

Southeast.—[A. Underwood, Brazoria.

South and east.—[S. Harbert, Colorado.

April, south and east.—[Natt. Holman, Fayette.

April gives us balmy breezes from the south; high winds from southwest continue but a few days, then suddenly shift to northwest with rain; continued rain gives east and northeast winds.—[J. W. Jackson, Titus.

QUESTION 4 *d*.—*The direction and force of the wind in the month of May.*

ALABAMA.

Southeast.—[Knox, Minge, and Evans, Hale.

Wind usually quiet and rarely strong or continuous from one direction many days. —[C. M. Howard, Autauga.

A pleasant breeze from the south.—[M. W. Hand, Greene.

From south to northeast.—[H. C. Brown, Wilcox.

South and west.—[J. C. Mathews, Dale.

In 1876, in May, east and southeast winds prevailed.—[J. W. Du Bose, Montgomery.

From south and southwest.—[J. R. Rogers, Bullock.

South and southwest.—[I. F. Culver, Bullock.

Winds in the month of May are generally from the southeast and south.—[J. N. Gilmore, Sumter.

South and west of south.—[R. S. Williams, Montgomery.

From southwest to northeast.—[J. A. Callaway, Montgomery.

May, southeast, 26; southwest, 17.—[H. Tutwiler, Hale.

The winds are generally nothing more than cooling zephyrs, and are from the west when dry; south and southwest when cloudy.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

South, southeast, and southwest.—[T. S. Edwards, Pope.

South and southeast.—[E. T. Dale, Miller.

FLORIDA.

From the southeast and east, gentle breezes.—John B. Carrin, Taylor.

Northerly.—[R. Gamble, Leon.

GEORGIA.

From south to northwest and from northeast to east and south; there are more east winds in May than in any other month.—[M. Kemp, Marion.

The wind is changeable, from south and west generally; occasionally from the east.—[E. M. Thompson, Jackson.

From southwest, if seasonable, and if not, generally from the east.—[S. P. Odom, Dooly.

Variable.—[William Jones, Clarke.

South, east, and west.—[Timothy Fussell, Coffee.

South winds mostly.—[W. A. Harris, Worth.

LOUISIANA.

In May the winds are from the south and southeast.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Except during occasonal rain-storms, the winds are gentle south and southwest breezes.—[Dr. E. H. Anderson, Madison.

Winds usually gentle, sometimes with much force; as in April from southeast, south, to southwest mostly.—[D. L. Phares, Wilkinson.

Southwest; velocity 8 miles per hour.—[C. Welch, Covington.

South.—[Kenneth Clark, Chickasaw.

Southeast, south, and southwest.—[J. W. Burch, Jefferson.

South.—[C. F. Sherriod, Lowndes.

Mostly south and southwest.—[W. Spillman, Clark.

NORTH CAROLINA.

Southwest.—[F. I. Smith, Halifax.

Southwest.—[J. Evans, Cumberland.

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SOUTH CAROLINA.

Southwest.—[Paul S. Felder, Orangeburgh.
Southwest and south.—[James W. Grace, Colleton.
May.—South and southwest and west.—[James C. Brown, Barnwell.

TENNESSEE.

We have some very hard winds from the south, southeast, and southwest.—[John McMillan, Decatur.
Northwest and west, latter predominating.—[A. W. Hunt, M. D., Perry.

TEXAS.

Southeast.—[Samuel Davis, Hunt.
In 1860, south winds twenty-five days, and six days west, northwest, and northeast. In 1861, twenty days south wind, southeast, and southwest, the remainder north, northwest, and northeast.—[J. M. Glasco, Upshur.
Southeast.—[H. J. H. Brensing, Bowie.
South and moderately brisk to stiff breeze nearly all day.—[O. H. P. Garrett, Washington.
South.—[R. Wipprecht, Comal.
In May the south breeze is the prevailing wind, with an occasional west wind, which occurs mostly in the shape of severe thunder-storms, sometimes doing much damage by their violence, and washing, heavy rains.—[J. H. Krancher, Austin.
From the south, with the usual rate of summer winds.—[W. T. Hill, Walker.
Southwest.—[C. B. Richardson, Rusk.
Southeast.—[A. Underwood, Brazoria.
South and east.—[S. Harbert, Colorado.
Southerly.—[Natt. Holman, Fayette.
The month of May gives us south and southwest winds, with occasional shiftings to north and northwest in time of rain; and if continued rains from the east and southeast, brisk winds from the south at least three days out of every seven.—[J. W. Jackson, Titus.

QUESTION 4 *e*.—*The direction and force of the wind in June.*

ALABAMA.

In June, no continuous current for any length of time from any point of the compass.—[C. M. Howard, Autauga.
East and southeast.—[J. W. Du Bose, Montgomery.
South and west.—[J. C. Matthews, Dale.
Pleasant breeze from the south; much warmer than during May.—[M. W. Hand, Greene.
From south to northeast.—[H. C. Brown, Wilcox.
Southeast.—[Knox, Minge, and Evans, Hale.
South and southwest.—[J. R. Rogers, Bullock.
South, southeast, and southwest.—[I. F. Culver, Bullock.
In June, winds from south and southwest.—[J. N. Gilmore, Sumter.
From south, gentle.—[J. A. Callaway, Montgomery.
Winds generally from the west when dry, as in May; and from the south or southwest when rainy or cloudy.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

South.—[E. T. Dale, Miller.
South.—[T. S. Edwards, Pope.

FLORIDA.

From the east, gentle.—[John B. Carrin, Taylor.
South.—[R. Gamble, Leon.

GEORGIA.

From the southwest.—[S. P. Odom, Dooly.
From south and west.—[M. Kemp, Marion.
From west and south.—[E. M. Thompson, Jackson.
South and southwest.—[William A. Harris, Worth.
Variable.—[William Jones, Clarke.
Southeast and west.—[Timothy Fussell, Coffee.

LOUISIANA.

Generally in June the winds are from the south.—[John A. Maryman, East Feliciana.

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MISSISSIPPI.

In June, winds daily with moderate force from south-southwest mostly. Same in July and August. In these last sometimes a cyclone of several days, approaching from east or southeast and closing from northwest. Generally the winds are so regular daily from May to September, so like the sea breeze, that we speak of them as sea breezes.—[D. L. Phares, Wilkinson.

No prevailing winds, but thunder-clouds, forming and moving from all points of the compass, preceded and accompanied by more or less rain.—Dr. E. H. Anderson, Madison.

Southwest; velocity 8 miles per hour.—[C. Welch, Covington.

South.—[Kenneth Clark, Chickasaw.

South and southwest.—[J. W. Burch, Jefferson.

South.—[C. F. Sherriod, Lowndes.

South, southwest, and northwest.—[W. Spillman, Clark.

NORTH CAROLINA.

Southwest.—[J. Evans, Cumberland.

SOUTH CAROLINA.

South, southwest, and south by west.—[James W. Grace, Colleton.

South winds.—[Paul S. Felder, Orangeburgh.

June; same as May, with occasional east winds (generally southwest).—[James C. Brown, Barnwell.

TENNESSEE.

West, southwest, and south rarely. Southwest predominating.—[A. W. Hunt, M. D., Perry.

Some very hard winds from the south and southwest.—[John McMillan, Decatur.

TEXAS.

South.—[Samuel Davis, Hunt.

In June, 1860, twenty-two days of south wind, three east, and two north, the remainder without wind; 1861, twenty-two days south wind, the rest shifting about. The average force about three miles per hour. Our prevailing winds for three-fourths of the year are from the south. There is scarcely a day without some wind, beginning at 8 or 9 a. m. and continuing till 5 or 6 p. m.; then the wind lulls.—[J. M. Glasco, Upshur.

Usually about six weeks from the 15th of June to last July or earlier, variable winds and squally weather (thunder-squalls), after which the weather settles into regular south, southeast, or southwest winds, with from two weeks' to two months' drought.—[W. Barnes, Cherokee.

South, southeast, and southwest.—[R. Wipprecht, Comal.

South.—[H. J. H. Brensing, Miller.

South, moderately brisk.—[O. H. P. Garrett, Washington.

Continuous rains from the east and southeast, heavy and sudden thunder-storms from the south and west; the prevailing wind is mostly south.—[J. H. Kancher, Austin.

Southwest.—[C. B. Richardson, Rusk.

Southeast.—[A. Underwood, Brazoria.

South and east.—[S. Harbert, Colorado.

South and southwest.—Natt. Holman, Fayette.

June gives us south winds, shifting to southwest and west in case of rain if the weather is dry, the winds are invariably south, breeze mild generally, but often brisk and boisterous three or four days before a rain.—[J. W. Jackson, Titus.

QUESTION 4*f*.—*Whether, in your opinion, there are winds from the south that are sufficiently strong and constant to counteract the prevailing trade-winds which are toward the equator?*

ALABAMA.

I can scarcely credit the suggestion that the wind is sufficiently strong or continuous from the south to have much influence in the transportation of the moth.—[C. M. Howard, Autauga.

Yes.—[Knox, Minge, and Evans, Hale.

It is my opinion it does not, or if it does is not of long duration. One thing, however, is true, that in the summer and autumn, should we have a constant breeze from the south for twenty-four hours, we will as certainly have rain, whether the current is strong or not. The south winds always bring rain in twenty-four to thirty-six hours.—[H. Hawkins, Barbour.

While I think the wind is often strong enough from the south to drive before it the

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caterpillar-fly, I am not at all inclined to the opinion that in that way they get here (unless it be the fly of the army worm); and while I am not sufficiently informed of the state they continue in during the winter, or the transformations they may pass through, I believe they exist here.—[Andrew Jay, Conecuh.

Trade-winds have but little influence in this part of Alabama.—[J. R. Rogers, Bullock.

Should think not.—[C. C. Howard, Autauga.

South winds but seldom prevail for longer than twenty-four hours; occasionally for two days, with decided prevalence.—[P. T. Graves, Lowndes.

I think in this section they are.—[R. S. Williams, Montgomery.

I am of the opinion that there are winds from the south to counteract the trade-winds.—[J. N. Gilmore, Sumter.

I think there are.—[I. F. Culver, Bullock.

There are no storms of wind sufficiently strong to affect the trade-winds, unless it may be the equinoctial gales, which usually, in the last days of September or first of October, are pretty severe, and most commonly come from the northeast with rain.—[Dr. John Peurifoy, Montgomery.

Under the theory of its gradual spreading from south to north, we may suppose a seaboard source of infection, and one from the southwest and the State of Alabama.—[A. R. Grote.

I have no doubt but at times, more particularly in times of great blows, that the winds blowing from the Gulf inland will be sufficient to counteract the *prevailing trade-winds*, but not one time in ten days or twenty days does this happen, as all the winds, or nine out of ten from the southwest, bring rain; we having after July little or no rain until frost, wind is most of the time from west to northwest.—[P. D. Bowles, Conecuh.

There are, from June to September.—[M. W. Hand, Greene.

Do not think the winds *now* have any effect on the moth.—[H. A. Stolenwerck, Perry.

Trade-winds do not affect us. The wind is from every point of the compass. During summer the wind is mostly from the southwest.—[R. H. Powell, Bullock.

No.—[I. D. Driesbach, Baldwin.

I can't say definitely. I think we have, as during February and March the winds blow down a great many trees here. The southern border of this country is within 50 miles of the Gulf of Mexico, hence we have heavy Gulf winds.—[J. C. Matthews, Dale.

ARKANSAS.

I am of the opinion that there are winds from the south of sufficient force and length to counteract the trade-winds blowing toward the equator.—[T. S. Edwards, Pope.

I do.—[Norborne Young, Columbia.

Yes.—[E. T. Dale, Miller.

FLORIDA.

In this section we have no worms, I think because we have not cultivated much cotton. If the northern wind from the cotton districts blew them here they would have no respect for the size of our fields. If the south winds carry them up into Alabama, they must be advised of the scarcity of forage here and pass over us. I am satisfied the moth commences his ravages often within twenty feet from where it was hatched. Winds no doubt often move them short distances from where they start into new-ground cotton where none ever lived before.—[J. M. McGehee, Santa Rosa.

None.—[John B. Carrin, Taylor.

No trade-winds.—[R. Gamble, Leon.

The sea voyage from Jacksonville was rather rough, and I found it impossible to do any writing on board. When we were opposite Jupiter Light, Florida, about six miles from the shore, two Lepidoptera came on board, an *Arctia nais* (?) and a Microlepidopteron. The officers of the steamer told me that sometimes many "flies" came on board in favorable nights, as well on the coast of Florida as from these islands. This shows how easily insects can be carried to and from the Bahamas.—[E. A. Schwarz, Nassau, New Providence, Bahamas.

GEORGIA.

I think that the north winds come in so constant and so heavy that the moths are very likely brought from that direction. Very often in stormy weather in spring and summer we find various kinds of strange birds and fowls blown here and left; they are foreign to our climate, and it is more than likely that the regular cotton-worm comes in from that quarter.—[E. M. Thompson, Jackson.

I cannot say that there are, though we have some very strong winds from the south, but our most disastrous winds are from the southwest.—[M. Kemp, Marion.

My impression is that south winds are very gentle universally. East and northwest winds only are sufficiently strong to drive the moths before them.—[A. J. Cheves, Macon.

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We are of the opinion that there are no winds from the south strong enough to counteract the prevailing trade-winds.—[S. P. Odom, Dooly.

Not often; only occasionally.—[W. A. Harris, Worth.

I do not believe there are.—[William Jones, Clarke.

It is thought not.—[D. P. Luke, Berrien.

LOUISIANA.

I think there are.—[H. B. Shaw, Concordia.

I do not think there are winds from the south that are sufficiently strong and constant to counteract the trade-winds.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

The trade-winds referred to are those along the Gulf stream, off the Atlantic coast I presume, and have nothing to do with our inland currents; but if referring to the equatorial and polar currents, that form the trade-winds near the equator, I do not think that there are any southerly winds in this latitude that are strong enough to counteract the polar current moving towards the equator.—[Dr. E. H. Anderson, Madison.

There are certainly such winds here.—[C. Welch, Covington.

I do not believe there are. The winds are rarely very strong, but constant.—[Kenneth Clarke, Chickasaw.

Yes; beyond a doubt nearly every year, perhaps I should say every year, such winds occur.—[D. L. Phares, Wilkinson.

Hardly think so; we generally have light winds.—[J. W. Burch, Jefferson.

Our strongest winds are all from the south.—[C. F. Sherriod, Lowndes.

Rarely ever have strong winds from the south long at a time; our strongest winds are from southwest and southeast.—[W. Spillman, Clark.

NORTH CAROLINA.

Yes.—[J. Evans, Cumberland.

SOUTH CAROLINA.

During June, July, and August we have strong south winds, beginning about eight o'clock in the morning and lasting until late at night, plenty strong enough to bring moths from a great distance.—[Paul S. Felder, Orangeburg.

Only in the months of February, March, and September.—[James W. Grace, Colleton.

In this locality the winds from the south are sufficient to counteract the trade-winds.—[James C. Brown, Barnwell.

TENNESSEE.

Prevailing winds of July are from southwest and south, latter predominating. I cannot remember to have observed winds from the south sufficiently strong to have conteracted the prevailing trade-winds toward the equator.—[A. W. Hunt, M. D., Perry.

There are times when our south and southwest winds are strong enough to counteract any other.—[John McMillan, Decatur.

TEXAS.

The south winds many years ago, I believe, were more frequent and stronger than later years; hence I am satisfied it rains more frequently and more rain falls through the year than it did thirty and thirty-five years ago. I do not think the north winds prevail to that extent during the winter months, neither are they generally as cold. I cannot say with a degree of certainty whether the south winds are sufficiently strong to counteract the trade-winds which are toward the equator.—[O. H. P. Garrett, Washington.

These are caused by the large surface of prairie in the State, which turn our northeast trade, or what would be such, to south-southeast or southwest.—[W. Barnes, Cherokee.

We are too far inland to be affected by trade-winds; our winds are more like sea-breezes. We are about 250 miles inland.—[J. M. Glasco, Upshur.

Yes.—[Saul Davis, Hunt.

There are.—[H. J. H. Brensing, Miller.

They are strong and constant enough.—[Reed Wipprecht, Comal.

Do not believe our winds are sufficiently strong or continuous to have any effect on the trade-winds.—[P. S. Clarke, Waller.

I think winds from the south are strong enough to counteract winds toward the equator.—[P. S. Watts, Hardin.

In some years the winds are sufficiently strong to have that effect. I have noticed that the strong winds from the south and southwest generally occur in a dry year.

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Particularly constant west winds are generally a sign of continuous dry weather.—[J. H. Krancher, Austin.

They are.—[W. T. Hill, Walker.

Decidedly so here.—[C. B. Richardson, Rusk.

Ours are doubtless the trade winds, being on the border of the torrid zone.—[A. Underwood, Brazoria.

I think there is.—[S. Harbert, Alleyton.

Yes; the wind in this locality, in June and July, is invariably from the south and southwest, and at times constant and strong except in case of heavy rains; then it shifts to the northwest and but for a short time. We have no prevailing wave winds here at this season of the year.—[J. W. Jackson, Titus.

QUESTION 4 *g*.

The prevailing direction of the wind from July till frost.

ALABAMA.

Am not certain, but think from south and southwest during July and August, and west and north during September.—[J. R. Rogers, Bullock.

South, west of south, and west.—[R. S. Williams, Montgomery.

The wind in July is generally from south and west, in August and until frost continually changing.—[J. N. Gilmore, Sumter.

The wind blows but little until the approach of fall, when the prevailing direction is east.—[R. W. Russell, Lowndes.

From the south.—[John D. Johnston, Sumter.

West and northwest.—I. F. Culver, Bullock.

From south.—[J. N. Callaway, Montgomery.

The prevailing winds of summer are very much like those of June, increased sometimes to thunder-storms, which soon pass off. Wet weather promotes the multiplication of the cotton-worms. The weather becomes showery in August and impedes very much the application of poison.—[Dr. John Peurifoy, Montgomery.

Generally from northwest.—[H. C. Brown, Wilcox.

From west to northwest.—[P. D. Bowles, Conecuh.

West and northwest.—[J. C. Matthews, Dale.

East and southeast.—[J. W. Du Bose, Montgomery.

The wind during the time indicated veers from one point to another so often as rarely to be debtor to itself. In other words it is so variable that we have no wind of long duration from any quarter.—[C. M. Howard, Autauga.

Various directions.—[James M. Harrington, Monroe.

From south and southwest.—[M. W. Hand, Greene.

Southeast.—[Knox, Minge, and Evans, Hale.

East and west.—[J. D. Driesbach, Baldwin.

They are only occasionally from the south.—[H. Hawkins, Barbour.

In our locality the wind has no constant direction. When we have settled weather it most generally is from northwest; when indicating rain it changes to the south or southeast, and about the middle of September, when equinoctial storms are looked for, the winds are from northeast, east, and southeast.—[Andrew Jay, Conecuh.

ARKANSAS.

From southwest.—[T. S. Edwards, Pope.

From the south and west.—[Norborne Young, Columbia.

South and southwest.—[E. T. Dale, Miller.

FLORIDA.

From east or west.—[F. M. Meekin, Alachua.

From all the points of the compass.—[John B. Carrin, Taylor.

Easterly.—[John Bradford, Leon.

South, southeast, and southwest.—[R. Gamble, Leon.

GEORGIA.

Most generally from the south and southwest; occasionally from the northeast.—[S. P. Odom, Dooly.

Every direction.—[D. P. Luke, Berrien.

South and northeast.—[William A. Harris, Worth.

From southwest, northwest, and northeast.—[M. Kemp, Marion.

Mostly from northeast.—[Timothy Fussell, Coffee.

Variable.—[William Jones, Clarke.

July, prevailing winds south and west.—[E. M. Thompson, Jackson.

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Prevailing direction of winds, Saint Catherine's Island, coast of Georgia, August, 1878.—10th, southwest; 11th, southwest; 12th, southwest; 13th, southwest; 14th, southwest; 15th, south; 16th, northeast; 17th, south; 18th, northwest; 19th, west; 20th, west; 21st, southwest; 22d, east; 23d, east; 24th, southeast; 25th, southwest; 26th, northwest; 27th, south; 28th, southwest; 29th, south; 30th, south; 31st, south.

LOUISIANA.

In July the winds are from the south and southeast. After July they vary.—[John A. Maryman, East Feliciana.

The prevailing direction of the wind from July till frost is from the south.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

From east to south and south to southwest is the general direction of the wind from July to frost, yet it frequently boxes the compass during that period, and from the 15th of September to frost is often from northeast to north.—[Dr. E. H. Anderson, Madison.

From some southerly point varying to east.—[D. L. Phares, Wilkinson.

From southwest.—[C. Welch, Covington.

Mostly south.—[Kenneth Clarke, Chickasaw.

From the south.—[C. F. Sherriod, Lowndes.

Southerly and westerly until about the equinox, when we have northeast storms occasionally.—[J. W. Burch, Jefferson.

July, August, to September 15, mostly south; after that, west to north.—[W. Spillman, Clark.

NORTH CAROLINA.

Southwest.—[J. Evans, Cumberland.

Southwest.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

South and southwest and south by west.—[James W. Grace, Colleton.

South winds.—[Paul S. Felder, Orangeburgh.

From July till frost from the east around to southwest; mostly from southeast to southwest.—[James C. Brown, Barnwell.

TENNESSEE.

Prevailing directions of winds from July until frost are as follows: July, southwest and south, latter predominating; August, southwest and west, former predominating; September, southwest rarely, west and northwest, west predominating; October, west and northwest, latter predominating.—[A. W. Hunt, Perry.

Winds vary a good deal, mostly from southwest, northwest, and west.—[John McMillan, Decatur.

TEXAS.

South and southeast till three or four days before frost, then changed to northwest and north for three or four days.—[Samuel Davis, Hunt.

South.—[P. S. Clarke, Waller.

Southeast.—[A. Schroeter, Burnet.

Southeast.—[H. J. H. Brensing, Bowie.

South to southwest.—[W. Barnes, Cherokee.

July, August, and September, south, southeast, southwest; October, changeable; November, northers set in; frost.—[R. Wipprecht, Comal.

The winds are varied from July to frost, but mostly from south, south by east and south by west, and more or less from the east.—[O. H. P. Garrett, Washington.

The winds from July till frost are from the south. We have in all the months squalls from the northwest and north, but they only last a day or two.—[J. M. Glasco, Upshur.

The winds in July and August are about the same as in the preceding two months; in September north winds begin to occur, in October becoming more frequent, the first frost generally occurring about the middle of November. In 1859 in the latter half of November we had two severe snow-storms in one week. Up to date the present year, the 18th, no frost.—[J. H. Krancher, Austin.

From the south it occurs at special times all through the year (on change of weather) that we have a west wind, an east and northeast wind, but this does not last long.—[W. T. Hill, Walker.

South and southwest.—[C. B. Richardson, Rusk.

Southeast.—[A. Underwood, Brazoria.

From south to east.—[S. Harbert, Colorado.

South to southwest.—[J. W. Jackson, Titus.

More generally from the south; sometimes a damp east wind, backed by a "Yankee norther."—[Natt. Holman, Fayette.

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QUESTION 4 *h.—The side of the field on which the worms first begin to work.*

ALABAMA.

In this section we have what is called a fence law; the plantations are not fenced, but owners are required to keep stock within inclosures. It is, therefore, impossible to tell upon which side of the field the worms first begin to work. We think, however, they usually begin where the cotton is most luxuriant and tender.—[J. B. Callaway, Montgomery.

Moist places, and where the cotton is most luxuriant.—[H. Tutwiler, Hale.

The worms first begin the work of destruction in bottom places, where the cotton is rank. They soon spread to the hill-sides and more elevated places. They have a peculiar odor which experts recognize before they see them.—[Dr. John Peurifoy, Montgomery.

In the damp spots, where the cotton is most luxuriant, without regard to side of the field.—[C. C. Howard, Autauga.

The worms, as a rule, make their appearance in the lowest spots of land, where there is the rankest growth of cotton.—[R. W. Russell, Lowndes.

No particular locality. They have been known to make their first appearance in the middle of large fields of cotton; as often there, probably, as on the sides of the field.—[John D. Johnston, Sumter.

The worm has no particular side to commence work on. They invariably commence on the best cotton.—[J. N. Gilmore, Sumter.

The side of a field, north, south, east, or west, has no influence over the first appearance of the worm.—[P. T. Graves, Lowndes.

No particular side.—[I. F. Culver, Bullock.

The only time I ever noticed where the worm first made its appearance was on the south side of the field.—[R. F. Henry, Pickens.

They generally attack the cotton-field on the south or west side and travel to the north or east.—[George W. Thagard, Crenshaw.

No particular side; generally in low bottoms and in particular places on every plantation. I think every planter knows the spot on which they first appear on his place.—[H. A. Stolenwerck, Perry.

Black prairie soils or soils producing a sappy growth are favorable to the worm. Clayey soils are not. The worm is always later in destroying cotton shaded by trees.—[J. W. Du Bose, Montgomery.

If cotton is of uniform height, the worms invariably begin work where there is the most shade either early or late in the day. But if plant is rank and green in spots, the worm will begin in the rank green spots before they attack the small plants with brown or yellow leaves, irrespective of morning or evening shades.—[P. D. Bowles, Conecuh.

No particular side. Generally begin their work of destruction in the most luxuriant cotton, regardless of locality.—[I. D. Driesbach, Baldwin.

The south side probably oftener than any other; such is my observation.—[C. M. Howard, Autauga.

The worms commence in the center of the field and always in the same place, and from there spread over the whole place.—[A. D. Edwards, Macon.

All over the field at the same time. Just as apt to find them on the north side as the south side.—[J. C. Matthews, Dale.

Where the cotton is rankest.—[D. Lee, Lowndes.

On the west side.—[R. H. Powell, Bullock.

There is no particular side; as often in the center as anywhere else.—[H. C. Brown, Wilcox.

No particular side.—[Knox, Minge, and Evans, Hale.

Generally on the south, though not always.—[M. W. Hand, Greene.

The side of the field has nothing to do with the commencing of the caterpillar.—[H. Hawkins, Barbour.

I have no experience that the caterpillar has any preference as to where it shall commence its work.—[Andrew Jay, Conecuh.

Always the west side.—[J. R. Rogers, Bullock.

ARKANSAS.

I find no difference with regard to the sides of the field; all the field is affected alike.—[T. S. Edwards, Pope.

Not one side more than another.—[Norborne Young, Columbia.

FLORIDA.

The east side.—[John B. Carrin, Taylor.

No particular side; they always begin in the bottoms and rich places.—[John Bradford, Leon.

They never attack from the sides of the field.—[R. Gamble, Leon.

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GEORGIA.

No particular side; usually near the woodland or swamp.—[M. Kemp, Marion.

The part where they do the most noticeable work depends upon the tenderness and vigorous growth of the plant during July, August and September.—[A. J. Cheves, Macon.

No particular side; as often in the middle as on either side.—[Timothy Fussell Coffee.

West side, traveling east; have seen them departing, mud in road full of them.—[William Harris, Worth.

They commence work on the south side and travel northward.—[E. M. Thompson, Jackson.

On the west or south side and sometimes in the center.—[S. P. Odom, Dooly.

Generally the southwest.—[D. P. Luke, Berrien.

On the most luxuriant spots in the center of the field.—[William Jones, Clarke.

LOUISIANA.

On my own plantation they began to work on the southeast side, and I have noticed that they make their appearance on or near the same spot.—[Dr. I. U. Ball, West Feliciana.

They appear on no particular side of the fields.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

The insect appears first in the wetter parts of the field, wherever they may be situated, and they are often found commencing in the bottoms, which are naturally wettest. When a basin exists in the middle of a field they are most apt to start there. I never saw them appear at the edge of a field.—[Dr. E. H. Anderson, Madison.

They usually begin in the rankest cotton.—[C. Welch, Covington.

They begin as often in the middle as anywhere else.—[Kenneth Clark, Chickasaw.

As to sides of the field on which the worms first begin to work, my observations are that they commence oftener in the middle than on any particular side.—[John C. Russell, Madison.

Rarely, if ever, commence on any side or margin, and very often eat out all the interior and never reach the margins if bounded by forests. They usually begin at some point in the interior of the field, and year after year at about the same point.—[D. L. Phares, Wilkinson.

As often in the middle as anywhere else and always appear in the same spot first; as in my field they have appeared in the same spot for ten years; it is low, wet bottom land.—[J. W. Burch, Jefferson.

The south.—[C. F. Sherriod, Lowndes.

It commonly attacks where the plants are in vigorous growth, but sometimes the reverse is the case.—[J. Culbertson, Rankin.

They never commence near the woods, but select the richest spots and gradually spread over the field.—[J. G. G. Garrett, Claiborne.

No particular side, except where they pass from one plantation to another, which is ften the case with the first crop of them.—[W. Spillman, Clark.

They first begin in some flat or depression in the fields; not at the side.—[George F. Webb, Amite.

NORTH CAROLINA.

North and west.—[F. I. Smith, Halifax.

Have never noticed any difference.—[J. Evans, Cumberland.

In a field bounded by woods on the east they never touched a plant near the wood.—[J. Stone, Gaston.

SOUTH CAROLINA.

As often from one side as another, and just as frequently in the middle or at several points at once through the entire field.—[James W. Grace, Colleton.

Any spot which has a low, moist, black soil.—[Paul S. Felder, Orangeburgh.

No particular *side*, but in the most healthy and thrifty spot in the field; if it be three or four acres in the middle of 100 acres.—[J. C. Brown.

TENNESSEE.

The dampest side of the field, provided it is well exposed to the sun, is generally first to suffer.—[A. W. Hunt, Perry.

TEXAS.

The worm begins to work on the highest point in the field almost certain in this country. The worms are to be found some distance in the field, hardly ever near timber or the fencing. The highest, richest black land is where they first appear, and, strange to say, they will frequently leave some cotton untouched near timber about the fences.—[O. H. P. Garrett, Washington.

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If the moths are in great numbers, the worms begin their work all over the largest fields at once. This year there were not many worms; they wandered from one field to another. No particular side was ever noted to be favored by the worms.—[R. Wipprecht, Comal.

There is no particular side that they prefer. Some farmers say they will feed with the wind.—[P. S. Clarke, Waller.

From lowest wet and swamp parts of the field.—[H. J. H. Brensing, Bowie.

The worm most always begins its work in the middle of a patch, generally in places where the cotton is most luxuriant. For the past two years it has commenced on the southwest side, the moth coming in the direction of the Colorado River.—[J. H. Krancher, Austin.

Generally near the center or away from the edges of the field.—[W. T. Hill, Walker.

The first worms are generally near the middle of the cotton-field, and the second crop spread in all directions.—[C. B. Richardson, Rusk.

On every side and all over simultaneously.—[A. Underwood, Brazoria.

They generally attack the youngest cotton first, no matter which side that may be.—[S. Harbert, Colorado.

Generally the south side and center, except that side is low damp land. High points appear to be the first points attacked.—[J. W. Jackson, Titus.

Sometimes in one place and again in another. Generally where the cotton is the rankest and largest. Not anyways choice of sides.—[Natt. Holman, Fayette.

Generally in or near the center.—[P. S. Watts, Hardin.

No particular side.—[W. Barnes, Cherokee.

QUESTION 4*i*.—*Do local topographical features influence the extent of the worm's ravages?*

ALABAMA.

They seem to prefer cotton grown in black lands, as they generally make their first appearance on that character of land and eat the cotton grown there first before migrating to other lands; and there are instances of their making their appearance for three or four years in succession on the same piece of land.—[John D. Johnston, Sumter.

I am living on a line between the black or prairie lands and the sandy lands in this county. This black belt is from 15 to 20 miles wide, running nearly east and west. The first worms are invariably heard of in the black belt, and this is even so on the south side of the black lands. There is not an intelligent farmer in this section but can point out the field and the place in that field where he will find his first crop of worms before they appear. *They invariably put in their first appearance in the same locality in particular fields.* This has reference to what we call the *first crop of worms.* The moth that is developed from this crop may be, and no doubt is, carried about by the winds. But why or how could the moth, surviving the winter, invariably select these particular starting points?—[R. S. Williams, Montgomery.

I think they do.—[I. F. Culver, Bullock.

They are more numerous and destructive on black prairie and bottom lands. They make their appearance from two to three weeks earlier on the black land than on sandy and light-colored lands. I am of the opinion that this is due, at least in part, to the fact that the crops are earlier on black lands.—[J. R. Rogers, Bullock.

They frequently do less damage to the foliage where they begin on places as indicated above, the following brood seeming to prefer untouched parts.—[C. C. Howard, Autauga.

Have never known the cotton-worm to feed upon any other plant than cotton.—[R. F. Henry, Pickens.

Low lands as a rule are more favorable for the rapid and destructive development of the worm, for the reason that the moth, guided by instinct, deposits her eggs where the food is in the best condition and most abundant to nourish the infant worm. Where, by fertility of the soil and sufficient rain, the upland crops are as luxuriant in foliage as the bottom or low land, they are visited as early and as destructively as the low lands. Places in many fields escape their ravages.—[P. T. Graves, Lowndes.

I think not. But I do think that topographical features have a great influence in producing a larger or smaller number of the caterpillar. Dense and moist localities appear to be the most favorable for the protection of the moth during the winter.—[I. D. Driesbach, Baldwin.

Does not.—[H. C. Brown, Wilcox.

Low lands are always attacked first; and, where the weeds are large and thick, this is a protection from the heat of the sun.—[J. C. Matthews, Dale.

They are more destructive and appear earlier in black or prairie lands than on gray or sandy.—[R. H. Powell, Bullock.

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The low wet places, where the plant is most luxuriant, are first attacked. The rich slough lands are generally much injured before the thinner and dry uplands.—[H. A. Stolenwerck, Perry.

None that I have discovered.—[James M. Harrington, Monroe.

The richer the land and the ranker the cotton the greater the ravages of the worm. —[D. Lee, Lowndes.

As to local topographical features' influences, will say that the worm is first reported in this State in the lime-belt or prairie lands in and around Montgomery County, where the lands are level, while in this county the greater part of our lands are undulating and hilly. The present year the worms have destroyed all the cotton-leaves in Beat No. 3, which is adjoining this, No. 11, where they have only honey-combed it up to this time. Beat No. 11 is due east of No. 3. During the years 1867, '68, '69, the worm failed to attack cotton planted on second-years lands, but have since, equal with old lands. —[P. D. Bowles, Conecuh.

They do, materially, being much less destructive in the hilly or sections interspersed with forests than on the level, open prairie. My own plantation is surrounded by forest, except a small space on the northwest. I never have had the worm come in force until most of my neighbors' crops have been entirely denuded—at least fifteen days later. Sometimes they do me little or no damage, while a few miles distant destroy fully one-fourth. My plantation is mostly level, about one-half prairie slough land.—[M. W. Hand, Greene.

Stiff, post-oak land.—[Knox, Minge, and Evans, Hale.

They do; but I am unable to define the features in a locality most favorable for their ravages.—[C. M. Howard, Autauga.

They are more destructive in the black prairie lands than in the pine lands.—[A. D. Edwards, Macon.

Local features and nothing else determine the ravages of the worm. Low, damp spots, in different parts of the same field, are attacked at the same time, while other portions are left unmolested until the general crop of caterpillars make their appearance—the third crop or generation—and when, in a few days after the hatching of this crop, not a leaf is to be seen in the whole field.—[H. Hawkins, Barbour.

I think this may be said of local influences: A field entirely surrounded by woods is decidedly less subject to the worm than open plantations, and it is to be seen in all such fields, that on their borders the worm refuses to eat up the leaves, unless it be the army worm, as has been alluded to; they take everything before them. Another observation of mine is, that cotton planted among peach-trees, if not entirely preserved, is by no means entirely destroyed or killed by them. I think the same true as to cotton about or under a persimmon tree, from which I conclude that acids properly used might prevent.—[Andrew Jay, Conecuh.

On many or all plantations I know the caterpillar invariably appears in certain spots before it is elsewhere found. These spots are not distinguished by any discoverable (at least to me) cause or harbor for producing the moth or protecting it.—[J. W. Du Bose, Montgomery.

It sometimes occurs that an acre only, or a quarter or a half of a field, remains untouched by the worms, when in all the balance the leaves are totally destroyed up to the margin of a line. And the cause of this we cannot tell, except it be toughness of the leaves, developed by the peculiarity of the soil; for the worms prefer the tender leaves in every stage of their existence.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

I think not. I can see no difference in rough or smooth or old or new land. The worst piece of ground, or rather cotton, is in old land, and the next in new.—[T. S. Edwards, Pope.

Yes. Our field, infested with worms, is separated from another by a narrow strip of timber 150 yards wide, and in the second field there are no worms. While in other fields, where are no obstructions between them, such as cornfields, timber, &c., the worms travel from one field to another, gradually, as they strip the field where they first appear.—[E. T. Dale, Miller.

FLORIDA.

In small fields where they are surrounded by dense woods and where cotton was never planted before it is always much less affected by the worm for a year or two. New-ground cotton is certainly less affected by the worm.—[J. M. McGehee, Santa Rosa.

We think not.—[John B. Carrin, Taylor.

No.—[R. Gamble, Leon.

GEORGIA.

If so, I have failed to note it. A patch of cotton shaded by trees and houses clear up to plantation residence is generally first attacked and suffers badly.—[William A. Harris, Worth.

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I think local topographical features have but little to do with the worm.—[E. M. Thompson, Jackson.

They do, as low swamp lands and fresh or newly-cleared lands are the most subject to them.—[M. Kemp, Marion.

I think not.—[D. P. Luke, Berrien.

Only so far as they promote the growth of the cotton.—[A. J. Cheves, Macon.

I think not.—[William Jones, Clark.

We are of the opinion that it does not.—[S. P. Odom, Dooly.

LOUISIANA.

Think not. This plantation is entirely isolated. It has one mile of woods on one side, two miles on the other and on the back, with a lake three-fourths of a mile wide along the entire front, but we are eaten up by the worms about as soon as our neighbors.—[H. B. Shaw, Concordia.

I write only of my own parish, where the lands in cultivation are almost altogether uplands. We have very few plantations on the river or alluvial lands, so far as to amount to a very small percentage of the aggregate. On river and bayou lands, which are alluvial to the west and south of us, the army worm appears usually earlier than with us and increases more rapidly, and is therefore more destructive. The reasons for this are due perhaps to the rankness and succulence of the cotton-plant on alluvial lands in comparison with its growth on our poorer and drier lands.—[Douglas M. Hamilton, West Feliciana.

Where the lands are low and moist and the plant luxuriant the extent of ravage is the greatest.—[John A. Maryman, East Feliciana.

They appear earlier and are more destructive on rich creek bottoms and alluvial lands.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

I think the first brood introduced into a field would destroy the cotton upon which it was bred, until it went into chrysalis, without regard to any topographical features, and the second and third brood, &c., would widen the area unchecked by any local features, except a ditch or stream of water, which would check the progress of the worm. The worm sometimes eats the cotton along a line and does not pass the furrow, because it finds there enough to eat before going into chrysalis.—[Dr. E. H. Anderson, Madison.

They do. We often see fields in part of which all the foliage, young bolls, even half-grown bolls, and the bark of older ones are completely consumed, when in other parts of the same field the plants remain intact, even though continuous in the same rows with that destroyed. The caterpillars refuse to pass a certain line. On one side of this line the plants are completely denuded; on the other, untouched. They may cross this line, but will eat no cotton-leaf beyond it. If placed on the plant, they speedily abandon it, and will starve rather than eat it. Yet one sees little or no difference in the cotton on the two sides of this line.—[D. L. Phares, Wilkinson.

Never heard of local topographical features having influence to extend the worm's ravages.—[John C. Russell, Madison.

Very little.—[C. Welch, Covington.

In reply to topographical features, you will notice how strongly Dr. Phares alludes to the insect eating up a line or along a line and leaving other plants untouched bordered by forests. The first is due, I think, to the fact of their finding enough to eat where they are quartered, and their indisposition to migrate unless impelled by hunger. The second, to the fact that the plant is not subject to the rays of the sun until the dew has passed off. This feature I have always noticed on the east side of a field.—[E. H. Anderson, Madison.

Deep, rich, black land favors their production. Our county is partly sandy and hilly; the worms seldom trouble it. The eastern portion is black, open, prairie-hammock and some bottom, where they *give us fits*.—[Kenneth Clark, Chickasaw.

To a certain extent low, moist lands first, where cotton is slow in starting to *grow off*. Hills or table lands are the last attacked.—[J. W. Burch, Jefferson.

In flats and depressions their numbers are greatest and the damage most alarming.—[George F. Webb, Amite.

NORTH CAROLINA.

No; but, unlike the worm further south, it seldom attacks the rankest growth of cotton in the bottoms, but prefers to feed on the smaller sized cotton on the ridges.—[J. Evans, Cumberland.

SOUTH CAROLINA.

Think not.—[James W. Grace, Colleton.

This year they have eaten up the leaves of the cotton in the low, black, moist places, and stopped as soon as the gray, sandy land was reached.—[Paul S. Felder, Orangeburgh.

Not to any perceivable extent.—[James C. Brown, Barnwell.

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TENNESSEE.

Yes.—[A. W. Hunt, M. D., Perry.

TEXAS.

Low places are more exposed to the ravages of the worm.—[R. Wipprecht, Comal.

No.—[P. S. Clarke, Waller.

To some extent. More in some localities than in others.—[J. W. Jackson, Titus.

Yes.—[Natt. Holman, Fayette.

Low lands that retain sap or where the plant is tender.—[Samuel Davis, Hunt.

I think not.—[P. S. Watts, Hardin.

Cotton that is youngest is attacked first; new lands or lands of thrifty growth.—[J. M. Glasco, Upshur.

In this part of the country, neither mountain, forest, nor stream have proved to be a protection against their visits.—[A. Schroeter, Burnet.

They do. I noticed this year in a field of 15 acres cotton, the foliage of which was nearly all eaten up on the 2d day of October, several spots of from one-quarter to one-half acres each on which there was not a worm. Not having had my attention directed to the matter, I did not examine to ascertain the cause.—[W. Barnes, Cherokee.

In wet and damp places where cotton is most fresh, green, and tender.—[H. J. H. Brensing, Bowie.

I am inclined to the opinion it does. It generally makes its appearance south and southeast of this county (Washington). It will appear in the same latitude of this county sooner than here. This, I think, is owing to altitude, as this county is higher.—[O. H. P. Garrett, Washington.

High hills and mountains and broad rivers no doubt have some effect to check their depredations; also wide belts of timber; but this county being mostly a prairie county with occasional belts of timber the worm generally appears all over the county at the same time; the prairie farms bordering on Colorado County, the country between them and the Colorado plantations, being an unbroken prairie, have of late years been first affected, generally three weeks in advance of the farms lying further north.—[J. H. Krancher, Austin.

No.—[W. T. Hill, Walker.

I do not think it does.—[C. B. Richardson, Rusk.

Not at all.—[A. Underwood, Brazoria.

They do not.—[Stephen Harbert, Colorado.

QUESTION 4*j*.—*Does or can the worm feed upon any other plant than cotton, and have you ever known it to do so?*

ALABAMA.

Worms are confined to the cotton-plant for food.—[P. T. Graves, Lowndes.

Never knew it to feed on anything but cotton.—[J. H. Smith and J. F. Calhoun, Dallas.

The worms feed on nothing but cotton.—[R. W. Russell, Lowndes.

No.—[J. A. Callaway, Montgomery.

The cotton-worms are generally very select in their diet, and generally confine themselves to the cotton. We noticed on one occasion they ate the leaves of the egg-plant, which very much resembles the cotton in the texture of its leaves.—[Dr. John Peurifoy, Montgomery.

Have never known the cotton-worm to feed upon any other plant than cotton.—[R. F. Henry, Pickens.

It feeds on nothing else than the cotton-plant, and when they have cleaned out a field they seek new pastures, always traveling east.—[R. H. Powell, Bullock.

No.—[Knox, Minge, and Evans, Hale.

I have never known them to.—[A. D. Edwards, Macon.

Don't think the worm can feed upon any other plant than cotton; have never known or heard of them feeding on any other plant.—[H. Hawkins, Barbour.

They survive on nothing else; sometimes web in other leaves, but I don't think it amounts to anything.—[Andrew Jay, Conecuh.

Never have known them to eat anything else.—[J. R. Rogers, Bullock.

Have not known it to do so.—[C. C. Howard, Autauga.

The worm does not feed on any other plant than cotton. I have tried them on various other plants and grasses, but they have never eaten them; would die of starvation sooner.—[J. N. Gilmore, Sumter.

On cotton alone.—[R. S. Williams, Montgomery.

They do not. Never have known them to. In fact they go into the ground, those

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which do not die on it. They often disappear in twenty-four hours. I have seen the ground covered to-day and all gone to-morrow.—[J. C. Matthews, Dale.

I have never known them to feed on any other plant.—[H. A. Stolenwerck, Perry.

Can't, and never have.—[James M. Harrington, Monroe.

I never knew the worm to eat any other plant except cotton; they web up in other plants but never eat it.—[H. C. Brown, Wilcox.

I have never known it to feed on any other than the cotton-plant. It is peculiar in its looks and habits from all other worms.—[I. D. Driesbach, Baldwin.

I have never known of their feeding on anything but the cotton-plant.—[C. M. Howard, Autauga.

I believe it cannot and never does.—[J. W. Du Bose, Montgomery.

I have never known the *Aletia argillacea* to eat any other plant.—[D. Lee, Lowndes.

None.—[M. W. Hand, Greene.

ARKANSAS.

I have never seen nor heard of them feeding on anything else.—[E. T. Dale, Miller.

Only on the cotton.—[Norborne Young, Columbia.

FLORIDA.

Have never heard of their feeding on anything else.—[John Bradford, Leon.

I have never known it to feed on any other plant than the cotton-plant.—[J. M. McGehee, Santa Rosa.

It does. We have.—[John B. Carrin, Taylor.

I believe that it does. I believe that the great loss by the ravages of the cotton caterpillar could be avoided by simultaneous action by all interested and at small cost. The insect is indigenous to the country, consequently finds in the forest plants adapted to its wants and would be present in the country were there not a stalk of cotton in it.—[R. Gamble, Leon.

GEORGIA.

The worm was never found by him (Henry Gaston) on anything but cotton, and he had noticed it leaving one patch of cotton and going to another when leaf failed and there was nothing for the worms to continue feeding upon. He had used Paris green, dusted in a dry state upon the leaves, and it killed the worms. Care had to be used by him to avoid the poison getting into his eyes or on sores or tender places of the body.—[A. R. Grote.

I do not think they will eat anything but cotton.—[William Jones, Clarke.

Never have known it to feed on anything but cotton.—[William A. Harris, Worth.

The worm sometimes feeds on corn-fodder; they eat also crop-grass. It may not be the same species of worm, but I think it is.—[E. M. Thompson, Jackson.

Worms feed upon nothing but cotton, when they start on the cotton.—[Timothy Fussell, Coffee.

I have never known them to feed on anything but cotton in this locality.—[M. Kemp, Marion.

LOUISIANA.

I have never known the cotton-worm to feed upon anything but the cotton-plant.—[John A. Maryman, West Feliciana.

I have seen millions dying all over the field, surrounded by every species of vegetation, but not a cotton-leaf.—[H. B. Shaw, Concordia.

The army worm feeds exclusively on the cotton-plant, and its existence terminates when it has destroyed this utterly. Millions of them, of all ages, colors, and sizes, take up their march after destroying a field, and I have never seen or heard of their seizing on any other sort of vegetation to sustain their lives at this period. I have never made any experiments in trying to hatch out and feed and rear the worms in bottles, boxes, or close rooms, though others have done so here. I do not know what has been the result of these various experiments, never having witnessed or informed myself about them. Like the worms peculiar to the tobacco-plants, mulberry, cabbage, &c., the army worm seems to be peculiar to the cotton plant, and where it appears generally and in numbers, they are found in every piece of cotton, no matter how large or small, or what its peculiarities are as to location and surroundings.—[Douglas M. Hamilton, West Feliciana.

After they have totally destroyed the cotton-plant, I have known them to feed upon other plants to sustain life until they could form their web.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

The worm feeds alone on cotton.—[George V. Webb, Amite.

It feeds on the crab grass.—[William T. Lewis, Winston.

Never.—[D. L. Phares, Wilkinson.

No; and I have noticed them closely.—[J. W. Burch, Jefferson.

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Never knew the worm that destroys the cotton-leaf to feed on anything else.—[John C. Russell, Madison.

I have never known them to.—[Daniel Cohen, Wilkinson.

I have found the *Aletia* webbing up in different weeds, grape leaves, blackberry and mulberry, and also eating the latter, owing no doubt to the field being stripped of leaves.—[E. H. Anderson, Madison.

I have never seen them on any other plant or feed on any other. I have seen thousands of the moths in thick grass and on pea vines; they seem to like the cover of pea vines in day, but have never seen the worms or eggs onthe pea-vines or on grass.—[C. F. Sheriod, Lowndes.

They feed upon nothing but cotton. I have often seen them devouring each other, after the field was stripped of its leaves, among weeds, grass, and pea-vines.—[I. G. G. Garrett, Clarborne.

NORTH CAROLINA.

The worm feeds on the cotton-plant only.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Have never known it to do so.—[James W. Grace, Colleton.

I have never known the cotton-worm to feed on anything but cotton.—[Paul S. Felder, Orangeburg.

The worm never feeds on anything but cotton.—[James C. Brown, Barnwell.

TENNESSEE.

From the evidence of others, I cannot well deny that the worms do sometimes feed upon other plants for a short time; though the fact, if a fact, is contrary to my observation.—[A. W. Hunt, M. D., Perry.

TEXAS.

I believe under certain conditions the moth would make its appearance *very* early, and finding only grass would deposit its eggs thereon, and that the worm, on hatching out, would eat the leaves of the grass.—[P. S. Clarke, Waller.

I do not think the worm does or can feed upon any other plant than cotton. I have seen them start to travel after cleaning off the cotton, and pass over weeds, grass, and other shrubes, but never attempted to eat anything. They would pile up and die by the million. Nothing but cotton would they eat.—[O. H. P. Garrett, Washington.

They never do.—[S. P. Watts, Harden.

Have been seen several years to eat grass—crop-grass, we call it here. Have seen them one year eat wormwood in geat quantity. They do it only when there is no more cotton to eat.—[R. Wipprecht, Comal.

In cases of *extreme hunger* they have been known to eat crop-grass, though slightly, and sometimes they devour each other.—[J. M. Glasco, Upshur.

I have seen a few on the tomato after the cotton-plant had become too dry. I do not know that they fed on it.—[Samuel Davis, Hunt.

The worm does not feed on anything but cotton.—[W. T. Hill, Walker.

They never feed upon any other plant.—[A. Underwood, Brazoria.

It does not. I have tested it to my satisfaction. Naturally it feeds upon the cotton-plant, and cannot be forced (by confinement) to feed upon anything else. I have followed and watched them after leaving a field that they had devoured. They were starved out, but eat nothing, and so perished.—[J. W. Jackson, Titus.

Never known to feed on any plant but cotton. When the cotton has all been destroyed the large ones fall upon anything that they can find a leaf sufficient for them to double over, the younger ones perishing by starvation, or ants and hot sand, &c.—[Natt Holman, Fayette.

No.—[Stephen Harbert, Colorado.

WISCONSIN.

Charles Jackson, four miles from Racine, raised large quantities of melons for market, mostly of the nutmeg variety. He complained to me that there was a miller that *swarmed* in his melon patch at night, and did much damage. I visited the locality at night, and discovered that it was the *Aletia argillacea*, and that they did literally *swarm*; and wherever there was a ripe melon that had a slight crack on its surface there the moth was sucking and crowding into the heart of the fruit, and in that way they did considerable damage. This was on September 10, 1877. Last September they were not so numerous, and did less damage. I noticed where the melons were perfectly sound they did not work.—[P. R. Hoy, Racine.

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QUESTION 5.—*State the time when the first moths are noticed in your locality.*

ALABAMA.

Every warm spell through the winter they are seen coming, late in the afternoon, from fodder-stacks, eaves of sheds, and like places.—[J. H. Smith, J. F. Calhoun, Dallas.

The moth is quite shy, and until they become pretty plentiful are rarely seen. The first worms that I have ever known were reported as early as May 1.—[R. W. Russell, Lowndes.

Some years the moths are noticed as early as the middle of July, but when they appear so early they are very few.—[J. N. Gilmore, Sumter.

In the month of May usually; occasionally the first of June.—[J. S. Hausberger, Bibb.

They have been seen in January.—[J. A. Callaway, Montgomery.

Latter part of July and first of August.—[H. Tutwiler, Hale.

They are here to be found among rotten wood, and under pieces of wood and bark, any time during the fall, winter, and spring. They commence gathering to the cotton-fields in the month of July; not many in June.—[J. C. Matthews, Dale.

The moths are seen frequently on warm nights in January, February, and March.—[P. D. Bowles, Conecuh.

Frequently in spring.—[J. W. Du Bose, Montgomery.

About the first of July.—[George W. Thagard, Crenshaw.

Last of May; in our opinion these moths are from chrysalis that have wintered here under ground.—[Knox, Minge, and Evans, Hale.

The moths make their appearance the latter part of June.—[A. D. Edwards, Macon.

Moths have been noticed in this locality on warm evenings in January.—[D. Lee, Lowndes.

Sometimes in May, but most generally in June.—[I. D. Driesbach, Baldwin.

In May or June.—[C. M. Howard, Autauga.

July generally; sometimes the latter part of June a few have been seen.—[J. R. Rogers, Bullock.

It is thought by many in early spring, but as far as I know the moth taken for the cotton-worm may or may not be the genuine.—[C. C. Howard, Autauga.

The moth is to be found in this locality during the entire season. In the winter it is concealed under the bark of dead trees, in old barns, or under the roofs of old buildings. During warm spells in the winter they will come out from their covering, and may be seen flying about of nights around the lamps and frequently remain in the rooms of houses occupied.—[R. S. Williams, Montgomery.

The moths can be found during the winter in places where suitable shelter can be found, such as the bark of trees, hay-stacks, barns, &c. Several days warm weather decoys them out, even in mid-winter.—[P. T. Graves, Lowndes.

Sometimes seen in the winter months, if mild, protected by trash and rubbish, and in the spring, especially if a warm, cloudy day; at night, around lights, are seen the identical moths.—[John D. Johnston, Sumter.

In 1860.—[I. F. Culver, Bullock.

About 20th June.—[James M. Harrington, Monroe.

From the last of June to the middle of July; sometimes even earlier than this.—[H. C. Brown, Wilcox.

About the last of May.—[H. A. Stolenwerek, Perry.

In 1874 I saw plenty of moths in January; they were housed, however, under the hull of an old pine; the hull being torn from the heart of the tree and leaving cracks, the moths had taken shelter. I put fire to the tree and quite a swarm came out. I presume all that were not burned perished from cold or were devoured by birds. The moths have been seen as early as May in the cotton-fields, but generally late in June or July; were seen the present year in July.—[H. Hawkins, Barbour.

I have never noticed the moth, otherwise than they may be turned from their abiding place during any month of winter or spring in plowing.—[A. Jay, Conecuh.

Moths make their appearance in July in this locality.—[R. B. Dunlap, Greene.

Have never had any reliable evidence of moths migrating in an experience of thirty-five years. I have seen them in sufficient numbers to attract attention during warm days of February and March, and am satisfied they had come out from their winter quarters. * * * In this manner many of them perish, and no large number left to propagate in the early summer, and hence no great destruction to the cotton that season. Greatest loss after cold, hard winter.—[J. D. Driesbach, Baldwin.

The moths may be seen here any warm evening in winter. We have often seen them around the lamp in the coldest night of winter, warmed into action, doubtless, by the hot fire sin the chimneys, and come down from the attic of the dwelling, where wasps and such insects hibernate. They are swarming out now. March 15, 1879.—[Dr. John Peurifoy, Montgomery.

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ARKANSAS.

July and later.—[Norborne Young, Columbia.
June 1.—[E. T. Dale, Miller.

FLORIDA.

Generally July; sometimes last of June.—[John Bradford, Leon.
In June.—[John B. Carrin, Taylor.
Last of June, or in July.—[J. M. McGehee, Santa Rosa.
I have seen the moth in February, but not in the cotton-fields. Have observed them in the fields the latter part of May.—[R. Gamble, Leon.

GEORGIA.

Early part of June.—[D. P. Luke, Berrien.
June and July.—[A. J. Cheves, Macon.
July and August; mostly in August; they make their web in the cotton-leaves.—[E. M. Thompson, Jackson.
The first moths seen here about July 10.—[M. Kemp, Marion.
June 20 and 1st of July.—[Timothy Fussell, Coffee.
About the middle of August.—[William Jones, Clarke.
This year on or about the 28th of August.—[S. P. Odom, Dooly.
Have seen them in dead of winter alive.—[William A. Harris, Worth.

LOUISIANA.

About the middle of July.—[H. B. Shaw, Concordia.
The moths are noticed here generally in June and July for the first; some persons say they see them earlier; some even contend that they are to be found in winter in tearing down hay or fodder stacks or pulling the bark from old trees. There are so many moths or small butterflies which look so like the moth which produces the army-worm, that our common people would never be able to tell the difference. When they become numerous, they may be observed flying about the cotton plants late in the evening or into rooms where there is a light, and then any one knows them.—[Douglas M. Hamilton, West Feliciana.
The first moths are noticed in March, April, and May.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

It would be a hard statement to make as to the time when the moth makes its first appearance. From the fact of there being so varied a tribe of moths, many people are misled, mistaking others for the real cotton-worm. I have known them here in July.—[John C. Russell, Madison.
I have seen the moth in this county in every month of the year.—[J. Culbertson, Rankin.
They usually appear from the 1st to the 15th of August; sometimes earlier.—[Dr. E. H. Anderson.
In May rarely; June seldom; July generally.—[D. L. Phares, Wilkinson.
About May 10; some say by the 1st.—[J. W. Burch, Jefferson.
About the 20th of July, in limited numbers.—[C. F. Sherriod, Lowndes.
A few in June; generally in July.—[R. Clarke, Chickasaw.
Generally in June.—[C. Welch, Covington.
From the1st to the 20th of June.—[I. G. G. Garrett, Claiborne.
Any time of warm days in February, but do not deposit eggs until the last of June or first of July.—[W. Spillman, Clarke.
Perfect insects, closely resembling that of the cotton-worm, were captured in May; and the eggs obtained by dissection of the moth exactly corresponded with description in Agricultural Report, 1873, of egg cotton caterpillar.—[G. W. Smith-Vaniz, Madison.
About the 15th or 20th of July.—[George V. Webb, Amite.

NORTH CAROLINA.

About the first of September.—[F. I. Smith, Halifax.
From the 15th to the 30th of August.—J. Evans, Cumberland.

SOUTH CAROLINA.

Sometimes as early as the middle of June; generally about the 1st of July.—[James W. Grace, Colleton.
This year (1879) they were first noticed the 10th of August. Last year about the 25th of August; some years as early as the 15th of July.—[James C. Brown, Barnwell.

TENNESSEE.

August 10.—[A. W. Hunt, Perry.

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TEXAS.

Once as early as the 20th of June, and again on the 26th of June.—[J. W. Jackson, Titus.

June. Plenty of them now, this the 25th day of June.—[Natt Holman, Fayette.

The first moth is generally seen in May. In 1867 the worm made its appearance in April, before the cotton was chopped. (Season extremely wet.) Nearly every year following they made their appearance from the 20th of May to the 10th of June. If the season should be dry it takes about three months from the time the first worm is seen till the cotton is destroyed; but if a wet season, about two and a half months. I notify every one on my farm when to look for worms in the spring, and have obtained the above results. The worm when first appearing is green; the second crop is green, neither doing any damage; but the third has most black-back worms and soon destroys the crop. It is just three weeks between each successive brood of worms. After the brood becomes numerous enough to destroy the crops there is a continuous laying and hatching of eggs until everything is eaten up, then all the imperfect worms die. When the cotton is eaten up on the Brazos, 150 miles south of me, before we have worms to hurt us, we begin at once to get ready to poison, as the moths when hatched out cover the whole face of this county. They come in upon us, as it were, in a day and lay our cotton full of eggs. The eggs are a light blue or dark green when first laid, and approach to a gray color the nearer they approach hatching. The eggs are not laid in clusters, but each egg separate. The young worm feeds on the under side of the leaf. While young, and when old enough to pass to chrysalis, it will web on anything that is convenient, but generally on the cotton if there is leaf enough, and always on the upper side of the leaf. The chrysalis does not pass the winter alive. Some farmers think the chrysalis enters the ground till spring, and then the fly comes out. They believe this from the fact that they plow up many chrysalides during the spring when breaking land. I have found the moth in midwinter housed in old rotten trees. I had numbers of them caught and know them to be the veritable cotton-fly. I have hatched out great numbers of them. They never fold their wings as do some moths, but present rather a *triangular* shape and always light with their head down or soon turn their head down if they light otherwise.—[W. T. Hill, Walker.

The moths are scarcely ever seen until the first brood of worms have gone through the first two stages of their life. I have heard some farmers say they had seen the fly about the middle of June. Now, the time of first appearance of the worm varies each year.—[J. M. Glasco, Upshur.

Very seldom as early as June. The larger number generally appears from July to September.—[A. Schroeter, Burnet.

From the 10th of June to the 1st of July.—[S. B. Tackaberry, Polk.

July 1 to 10.—[W. Barnes, Cherokee.

Early in July.—[O. H. P. Garrett, Washington.

About the 10th of June.—[P. S. Watts, Harden.

July.—[R. Wipprecht, Comal.

About July.—[P. S. Clarke, Waller.

The latter part of May or first of June, but not in great numbers.—[J. H. Krancher, Austin.

Some years late in June, but not often before the 1st of July, and sometimes not until late in August, which was the case this year, 1878.—[A. Underwood, Brazoria.

They are noticed in the spring.—[S. Harbert, Colorado.

QUESTION 5 *a.*—*Date when the first worms have been noticed in past years.*

ALABAMA.

On uplands, 1873, July 1; on uplands, 1874, July 15; on swamp, 1874, July 15. On uplands, 1875, none; on swamp, 1875, June 11 On uplands, 1876, August 14; on swamp, 1876, July 12. On uplands, 1877, July 26; on swamp, 1877, May 31. On uplands, 1878, August 27; on swamp, 1878, June.—[J. H. Smith and J. F. Calhoun, Dallas.

The worm made its first appearance in this locality in 1874, the 31st day of July, but not in sufficient numbers to do any material injury to the crop at that time, but had destroyed it by the last day of August. I am not in possession of any reliable dates for other years since, but as a rule they have come later each year.—[J. N. Gilmore, Sumter.

May 12.—[J. A. Callaway, Montgomery.

During the summer of 1873 the first worms were noticed in July, about the first of that month.—[R. F. Henry, Pickens.

Dates of appearance of caterpillar in my own crop may be given as follows, viz: Marengo County, Canebrake: 1869, August 15; 1870, late in September; 1871, late in August; 1872, June 16; 1873, July 16; 1874, July 8; 1875, late in July; 1876, about

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August 1. Montgomery County, Warrin: 1877, July 25; 1878, July 8.—[J. W. DuBose, Montgomery.

In the last of July and 1st of August.—[John D. Johnston, Sumter.

In 1840, September; 1870, August; 1872 and 1873, July; 1878, August.—[I. F. Culver, Union Springs, Bullock County.

Early in May, 1868, I found several worms in different localities, that were growing. Except that year, the earliest seen was the last day of June.—[P. T. Graves, Lowndes.

We cannot give correct dates as to the various years. They usually appear in the month of August of the years in which they do most damage.—[J. S. Hausberger, Bibb.

A few in June.—[H. A. Stolenwerck, Perry.

From the 10th to the 13th of June.—[Knox, Minge, and Evans, Hale.

About the 1st of July.—[James M. Harrington, Monroe.

The latter part of June the worms have been noticed.—[A. D. Edwards, Macon.

Worms were seen in 1873 in May: this year in August.—[H. Hawkins, Barbour.

I have seen a well-developed caterpillar eating the cotton when I was putting it to a stand in May, but the appearance then was no indication that they destroyed the crop any earlier than usual; did not propagate to do any harm until the season of the year usual, from June on.—[A. Jay, Jayvilla, Conecuh.

Have seen worms in July.—[B. B. Dunlap, Green.

July 13.—[J. R. Rogers, Bullock.

Late in May or early in June.—[C. C. Howard, Autauga.

I cannot give the particular dates, but know that when they put in their appearance early that the crop will become destructive. In 1873 I saw them as early as the 20th of May.—[R. S. Williams, Montgomery.

In October, 1824; in September, 1825; the 20th of August, 1846. There have been so many worm years since 1835 I do not remember the dates of but a few. Of late years the worms appear in small numbers about the 15th of July.—[D. Lee, Lowndes.

Generally between the 1st and 10th of July.—[M. W. Hand, Forkland, Green.

About the 20th of July.—[George W. Thagard, Crenshaw.

Sometimes as early as May, but generally not before the 15th of July.—[I. D. Driesbach, Baldwin.

The 17th of May, 1874.—[P. D. Bowles, Conecuh.

The 20th of July, when most fatal; some years not till the 2d or 3d of August.—[J. C. Matthews, Dale.

About the 15th of June.—[C. M. Howard, Autauga.

Appeared in the picnic lands this year (1878) about the 28th of July. Can't say as to previous years.—[R. H. Powell, Bullock.

From the 10th of August to last day of the month; occasionally as early as the 1st of July.—[H. C. Brown, Wilcox.

In 1869, August 15; in 1872, June 16; in 1878, July 8.—[J. W. DuBose, Montgomery.

The first appearance of the worms is difficult to ascertain, from the fact that they are so few at first, and scattered over so large an area of cotton-fields. The negroes, who mostly cultivate these fields, say that the first worms appear sooner than we imagine (say some time in May). Our own observation is, that the eggs of the moth are deposited when the cotton begins to bloom; and this is later in some years than others. The average time is the first week in June, on the earliest cotton-stalks. And it may be that the moth is attracted to the cotton-fields by a double purpose: The first and most important, perhaps, is the propagation of her species; the second, to suck the cotton-blooms—for we often see them in the bloom, "as busy as a bee."—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

The first worm appears about two weeks after the first moth.—[Norborne Young, Columbia.

The 10th of July.—[T. S. Edwards, Pope.

June 21.—[E. T. Dale, Miller.

FLORIDA.

For the last twelve years we never pass June without some one finding the worms. Some years, as you know, they will eat out the crop, and others, like the present, little or no damage will be done.—[John Bradford, Leon.

About the 1st of July is the earliest they have ever been seen in this county.—[John B. Carrin, Taylor.

Previous to the introduction of new improved seeds, they were observed about the middle of August. Referring to an old journal which I kept, I discovered a few August 11, 1841. The winter of 1841 was cold and in 1842, there was no damage to the crop by caterpillar. The winter of 1842 was milder and drier, the first frost, November 10, killing the cotton, which was then green. July 15, 1843, I found a caterpillar; the crops of this year were destroyed.—[R. Gamble, Leon.

First caterpillars reported in Leon County in 1869, May 12; 1872, June 29; 1873, May 24; 1874, July 2; 1875, June 24; 1877, June 19; 1878, June 15.—[Robert Gamble, Leon.

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GEORGIA.

The worms first made their appearance in September, 1804, then not again until late in September of 1825; then September 5, 1840; September 19, 1843; August 18, 1846, August 26 increasing largely; September 14 fields almost stripped; by the 19th the fields were completely stripped; August 20, 1847, August 18, 1852. These two years no harm done. I stopped planting in 1865 and have kept no notes since.—[William Jones, Clark.

Middle of June.—[D. P. Luke, Berrien.

In 1843 they appeared about the 1st of September.—[S. P. Odom, Dooly.

From August 10 to September 1.—[M. Kemp, Marion.

Last of May on my place; have heard of them in other localities sooner.—[William A. Harris, Worth.

Never earlier than the latter part of June.—[A. J. Cheves, Macon.

The first worms were discovered in last of August and first of September during the worm years.—[E. M. Thompson, Jackson.

LOUISIANA.

I have had my neighbors tell me that they found the genuine army worm on the young cotton-plants when working them the first time scraping and chopping out, but I cannot say that I have seen any so early myself. These persons were reliable, and I have governed myself in planting by what they reported to me.—[Douglas M. Hamilton, West Feliciana.

In 1866, '67, and '73 I have noticed them early in June.—[Dr. I. U. Ball, West Feliciana.

The first worms are found about the last of July.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Generally in June or July.—[Daniel Cohen, Wilkinson.

They are remarkably regular in their habits.—[C. F. Sherriod, Lowndes.

About the first week in July.—[J. Culbertson, Rankin.

I think there is a pretty good brood hatched out in May and early in June that would destroy the crop, but for the plowing that shakes them off the stalks and they are covered up by the earth.—[I. W. Burke, Jefferson.

In July.—[Kenneth Clark, Chickasaw.

The month of July worms have been found in past years. This year I have seen fields eaten clean in July.—[John C. Russell, Madison.

This year the worms were found eating cotton as early as the 15th of July before any moths were observed.—[Dr. E. H. Anderson, Madison.

May, June, July, August.—[D. L. Phares, Wilkinson.

In 1866 and 1867 I discovered the matured worms on the 13th of June; the flies came out in eight days after the chrysalis was formed. My field was stripped of its leaves the first week in August; made about half a crop. —[I. G. G. Garrett, Claiborne.

First in 1846, 8th of July; other years at various times up to the 15th of August.—[George V. Webb, Amite.

NORTH CAROLINA.

Not sooner than September 8.—[F. I. Smith, Halifax.

From the 1st to the 15th of September.—J. Evans, Cumberland.

TENNESSEE.

August 13.—[A. W. Hunt, M. D., Perry.

SOUTH CAROLINA.

From June 15 to July 1, though sometimes they have not been observed till August 1, yet have done great injury.—[James W. Grace, Colleton.

The first worms are seen or noticed from three to five days after the moth.—[James C. Brown, Barnwell.

TEXAS.

The earliest that I have ever known the cotton-worm to appear was in 1867, about the 20th of July; that year was remarkable for the late freeze in March and the year of abundance of rain, during the summer months. They did not, however, eat of the cotton-leaves until about the 1st of September; they appeared in small quantities, perforated the leaves in places, made it look rather bad, but it continued to form and make until entirely eaten off, which it took the third generation to do; the result was a fair crop was realized.—[O. H. P. Garrett, Washington.

From the 10th of June to the 1st of July.—[S. B. Tackaberry, Polk.

From July 1 to October 1.—[W. Barnes, Cherokee.

A few in June.—[A. Schroeter, Barnes.

June and July the fly first makes its appearance.—[H. J. H. Brensing, Bowie.

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I cannot give the exact date, but believe in 1866 they came about the 1st of August; 1873 about July 15; 1875, a few appeared in September; 1877 they came in numbers about August 20.—[J. M. Glasco, Upshur.

About the 20th of June, sometimes earlier.—[P. S. Watts, Hardin.

Latter part of July and August.—[P. S. Clarke, Waller.

July.—[R. Wipprecht, Comal.

In 1866 they made their appearance in immense numbers on the 29th of August, making a clean sweep in about three or four days. Very destructive in 1872 on the 15th of August. In small numbers 1873, July 1. In 1875 appeared the 8th of May; 1876, 1st of June; 1877, July 5 in considerable numbers. They generally reappear till first part of October and disappear entirely with the advent of cold nights and rains. —[J. H. Krancher, Austin.

In August.—[C. B. Richardson, Rusk.

Latter part of June and July.—[Natt. Holman, Fayette.

On the 13th of July and again on the 18th of July.—[J. W. Jackson, Titus.

QUESTION 5 *b*.—*Date when the last worms have been seen in past years, or were noticed the present year.*

ALABAMA.

The worm the past year disappeared about the last days of September. If the worms are not sufficiently numerous to destroy the crop before they mature, they all spin that are not destroyed. If it is not fully grown, it dies if the cotton gives out.—[J. N. Gilmore, Sumter.

Worms are found until frost destroys the foliage, unless by their numbers the foliage is entirely consumed earlier. This has occurred several years. But few worms met the frost this year.—[P. T. Graves, Lowndes.

I have seen them as late as October 16 in 1877. There were few as late as October 1 the past year, 1878.—[R. W. Russell, Loundes.

September and first part of October.—[I. F. Culver, Bullock.

Usually in September; in 1878 in October.—[J. H. Smith, J. F. Calhoun, Dallas.

They usually continue until the cotton-leaves are all consumed, unless frost should kill them.—[J. L. Hausberger, Bibb.

October and November.—[J. A. Callaway, Montgomery.

About the 15th of September.—[H. C. Brown, Wilcox.

In October in 1877.—[J. W. Du Bose, Montgomery.

The worms remain generally till frost, about October 15 or November 1.—[A. D. Edwards, Macon.

Have seen worms till frost.—[R. B. Dunlap, Greene.

They seem to pass out of existence when the cotton-fields are swept over, in or about September.—[A. Jay, Conecuh.

September.—[J. R. Rogers, Bullock.

Last I saw this year were in October.—[C. C. Howard, Autauga.

The last worms are generally seen until the cotton-leaf is entirely destroyed. I think when the nights become cool, as they do in October, that this stops the hatching of the eggs.—[R. S. Williams, Montgomery.

Frost has often come before they had destroyed all of the cotton-plant foliage. They generally stay until they eat up all of the cotton foliage.—[John D. Johnston, Sumter.

The last worms noticed this season were in October.—[R. F. Henry, Pickens.

Sometimes until frost. The present year they are still at work, but not in this particular locality, as they had eaten up the crop by the 1st of September.—[H. A. Stolenwerck, Parry.

About the 10th day of October, all over the county.—[D. P. Bowles, Conecuh.

The 1st of October.—[Knox, Minge, and Evans, Hale.

Have seen them this year as late as the 15th of October.—[James M. Harrington, Monroe.

September 15.—[George W. Thagard, Crenshaw.

About the 15th of October, and often until frost if the cotton will furnish them food.—[I. D. Driesbach, Baldwin.

The 28th of July, 1878.—[R. H. Powell, Bullock.

About the last of October; in 1844 they were caught by a frost, and those which were then at work were killed *dead*.—[D. Lee, Lowndes.

They stay until frost if there is any cotton-leaf to feed on. Most of them die or go into the ground before frost. They do not travel from field to field, as some think.—[J. C. Matthews, Dale.

On or about frost.—[C. M. Howard, Autauga.

From the 1st to the 15th of October; this year a little later.—[M. W. Hand, Greene.

After the cotton ceases to grow and after a frost.—[H. Tutwiler, Hale.

The worms last year (1878) appeared comparatively late, and they came to stay.

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Having appeared first in the prairies, as usual, they spread to the sandy land on the Tallapoosa River and did considerable damage, and disappeared in the cool weather in the first weeks of October.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

September 30 about the average, though sometimes as late as frost.—[E. T. Dale, Miller.

In 1875 they remained until frost.—[T. S. Edwards, Pope.

Until frost.—[Norborne Young, Columbia.

FLORIDA.

Have known them to come "in force" and eat out the crop the last of September.—[John Bradford, Leon.

Very few are seen the last of August and first of September.—[J. M. McGehee, Santa Rosa.

About the first of November.—[John B. Carrin, Taylor.

Often remaining on the fields after frosts as caterpillars; are in the fields at this time, September 29.—[R. Gamble, Leon.

GEORGIA.

Past years the 25th of October.—[Timothy Fussell, Coffee.

October; have seen none the present year.—[M. Kemp, Marion.

They disappear at the first frost, say, October 15.—[S. P. Odom, Dooly.

At the appearance of frost.—[D. P. Luke, Berrian.

In October, even after a slight frost—if late cotton young and succulent.—[William A. Harris, Worth.

Their last appearance is governed by the appearance of heavy frost, which varies from last of October to latter part of November.—[A. J. Cheves, Macon.

In 1869 and 1874 from the 20th to the 30th of September.—[E. M. Thompson, Jackson.

LOUISIANA.

Sometimes the last worms are seen soon after they have eaten out the cotton-fields in August, September, or October, as the case may be. Again, they eat the cotton very slowly, and continue to eat it until cold weather comes to kill both worm and cotton.—[Douglas M. Hamilton, West Feliciana.

I have seen them as late as the middle of October.—[Dr. I. U. Ball, West Feliciana.

Worms are seen sometimes until frost.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

The last crop of worms were just coming out the 12th of October, when we had our first slight frost. They began to disappear very soon, and I could find no chrysalides. They did not fold in the leaf as the preceding crop did.—[C. F. Sherriod, Lowndes.

A few now (November 3) after ice and frost; plenty of chrysalides hanging to the skeleton of the dead leaves. I kill them every day as I walk through my fields.—[J. W. Burch, Jefferson.

They can be found as long as there are any green cotton-leaves; that is, till frost.—[J. Culbertson, Rankin.

July, August, September, when food has been consumed or rendered unfit for their use; otherwise October, November, and even as late as December.—[D. L. Phares, Wilkinson.

Worms are here in October if there is any living foliage on the plant, and they stay till it is cleaned out by them or frost, which is often late as November.—[John C. Russell, Madison.

They are rarely observed here after October, unless the frost is late, when the last brood may be found in November.—[Dr. E. H. Anderson, Madison.

The last worms seen this year was about September 10. Some years they are seen till October 15.—[C. Welch, Covington.

October.—[Kenneth Clarke, Chickasaw.

They were in some fields this year after the first frost, on the 7th of October.—[I. G. G. Garrett, Claiborne.

They were in my cotton-field this year until the latter part of October.—[W. Spillman, Clark.

In past years the last have been seen about the 20th of October, when frost was that late, usually at frost.—[George V. Webb, Amite.

NORTH CAROLINA.

About September 15.—[F. I. Smith, Halifax.

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SOUTH CAROLINA.

None have ever been seen after a severe frost.—[James W. Grace, Colleton.

The last worms are seen at frost. There will be some spots green enough to sustain a few until the frosts end them.—[James C. Brown, Barnwell.

TENNESSEE.

Last worms were observed last year October 21. Frost occurred soon after, which was the latest frost in my memory.—[A. W. Hunt, Perry.

TEXAS.

The last worms are seen when the cotton-fields are stripped and the worms starve to death, or they disappear after a heavy frost.—[J. M, Glasco. Upshur.

About the middle of September, generally; this year as late as the 25th of September.—[P. S. Watts, Harden.

Worms now at work, November 3, and will work till frost.—[W. Barnes, Cherokee.

The worm continues to generate until frost. The cotton begins to leaf in a few weeks after the first destruction; then the worm comes again, but not in much force—[O. H. P. Garrett, Washington.

Generally during the second and third weeks in September, but this year as late as the second week in October.—[S. B. Tackaberry, Polk.

October.—[R. Wipprecht, Comal.

In past years the end of October; the present year there are none.—[A. Schroeter, Burnett.

They generally last as long as leaves and young bulbs last.—[C. B. Richardson, Rusk.

Seen from July until November.—[Stephen Harbert, Colorado.

In 1867 they remained (third brood) until the 6th of October, it being a late, pleasant fall, and no frost until this date, which froze them out.—[J. W. Jackson, Titus.

In October none seen yet, but reported south of me, or rather this county.—[Natt. Holman, Fayette.

QUESTION 5 *c.—Number of broods or generations of the worms generally produced.*

ALABAMA.

When the worm comes, say the middle of July, there is generally three broods produced before they destroy the crop, but if they come late in the season the first brood generally destroys the entire cotton-leaf.—[J. N. Gilmore, Sumter.

In 1868 there were three distinct reproductions; since then the generations have been blended; that is, the insects were in every stage, until the fields were completely denuded. This blending of generations is caused by the time occupied by the moth in depositing her eggs, from four to six days, the first hatching that much in advance.—[P. T. Graves, Lowndes.

From three to four.—[I. F. Culver, Bullock.

Three to four.—[J. S. Hausberger, Bibb.

Three.—[J. A. Callaway, Montgomery.

Generally two or three; in this latitude seldom more than two; farther south three.—[H. Tutwiler, Hale.

We think the third generation will eat out the field.—[Andrew Jay, Conecuh.

Three, is the general opinion.—[J. R. Rogers, Bullock.

Should say three.—[C. C. Howard, Autauga.

Depends on the time of the appearance of the first crop. Usually they are in distinct crops, there being twenty-one days between each generation. The third crop generally becomes numerous enough to eat the leaves of the entire sections in a few days. The scattering or first crop are *invariably green*. The second are *mixed*, some green without the black stripes. The third are all striped, and at the least touch of the plant will spring as though shocked with electricity.—[R. S. Williams, Montgomery.

Those who have paid the greatest attention to them state that it requires three crops to destroy the crop of cotton; but I have seen them from July 20, continuously until the crop was destroyed, say about August 25.—[R. W. Russell, Lowndes.

About three, sometimes four.—[John D. Johnston, Sumter.

Three and four.—[J. H. Smith, J. F. Calhoun, Dallas.

By common consent, three.—[R. H. Powell, Bullock.

First general brood about the 10th of August; second brood first of September; third and most destructive brood (the appalling and "sweep all" brood) from the 20th to the 25th of September. New broods come about every twenty days.—[I. D. Driesbach, Baldwin.

There are two crops of the worms.—[A. D. Edwards, Macon.

Some farmers believe a fly, resembling a small butterfly, lays eggs upon the cotton-

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leaf; the eggs are hatched by the heat of the sun, and make worms; these worms web in the cotton-leaves and make a second fly, and so on the to third fly, and this third brood destroys the cotton crop. My own opinion differs. I think the eggs that are seen on the under side of the leaf make lice.—[George W. Thagard, Crenshaw.

Three broods, I think, are always produced during the season before the crop is materially damaged.—[H. Hawkins, Barbour.

Two broods of worms in a season.—[R. B. Dunlap, Greene.

The prevailing opinion has been that there were three broods, though for the past two years that opinion has been changed, under the impression that there are enough of them preserved from the preceding year to destroy the crop whenever the weather is propitious.—[H. A. Stolenwerck, Perry.

I have never seen but three distinct broods. If they come early they disappear early.—[J. W. Du Bose, Montgomery.

Three broods: first, large green; second, light striped; third, black and *devourers*.—[James M. Harrington, Monroe.

About three broods.—[H. C. Brown, Wilcox.

Always three.—[P. D. Bowles, Conecuh.

Three generations: the first very few; second, numerous; third, multiplied millions, and will eat the field out in three days, whether one acre or 1,000 acres; the growth of the worm is rapid, as he will be full grown in three days.—[J. C. Matthews, Dale.

Three.—[C. M. Howard, Autauga.

Three.—[Knox, Minge, and Evans, Hale.

About three.—D. Lee, Lowndes.

Generally two, sometimes as many as three.—[M. W. Hand, Greene.

ARKANSAS.

About three; it generally takes the third to ruin the crop.—[Norborne Young, Columbia.

Generally three.—[E. T. Dale, Miller.

FLORIDA.

In former years, when they appeared, we expected three broods; the third was the one to eat out the crop. Later years they do not seem to follow *rules*. Sometimes will appear in small force and continue to increase and eat for several weeks until all is eaten out. Again, they will sweep everything in three or four days.—[J. Bradford, Leon.

Three.—[John B. Carrin, Taylor.

I am not certain of more than two, though there may be more.—[J. M. McGehee, Santa Rosa.

The third brood is generally supposed to sweep the field, but there is at least one brood preceding these, not noticed in consequence of paucity of number.—[R. Gamble, Leon.

GEORGIA.

In the writer's opinion, the moths hibernate in decaying, sappy parts of woods, thick grass, and other places where materials are soft, spongy, or good non-conductors of heat with crevices that enable them to hide from wind and cold; that as soon as the weather is warm enough they emerge in the spring, but are so few in number that they are not observable until they have passed through perhaps half a dozen generations; then the third broods are generally sufficient to eat up all the tender leaves.—[A. J. Cheves, Macon.

About two.—[D. P. Luke, Berrien.

Generally two; sometimes three.—[William Jones, Clarke.

Three broods; the first does not do much damage; it is the second brood that does.—[T. Fussell, Coffee.

This depends upon the time the moths make their appearance, as they will produce a new crop every four weeks, if the weather is favorable.—[M. Kemp, Marion.

As many as three.—[William A. Harris, Worth.

LOUISIANA.

Three.—[H. B. Shaw, Concordia.

I cannot answer this question accurately or even satisfactorily, to you or myself. I believe there are no regular number, but these are governed by the time when they first appear and the rapidity with which they increase and destroy the cotton crop; with this last event the last crop perishes.—[Douglas M. Hamilton, West Feliciana.

There are generally three broods, or generations, of the worms produced.—[Dr. I. U. Ball, West Feliciana.

There are about three generations in one season produced.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

I think about three. The first is very small in number and does so little damage that few people discover it. The year 1869 was remarkable for the (apparent at least)

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number of generations; the first being survivors of the preceding year, or immigrants; second, caterpillars matured in my cage, imago, July 6; third matured August 2; fourth, September 1; fifth, October 1 to 15; and, lastly, the progeny of these last, none of which, so far as I could discover, passed beyond the pupa stage. Even some of the fifth generation, after completing the last transformation, were so weakened from cold, drought, or other causes that they could not burst the pupa cases, in which I found the moth dead and dry.—[D. L. Phares, Wilkenson.

Three broods of worms produced, and that has been generally enough to clean the cotton-crop of everthing that a cotton-worm could live on.—[John C. Russell, Madison.

I think they kept up a continual stream of generation.—[Daniel Cohen, Wilkinson.

About three.—[C. F. Sherriod, Lowndes.

Usually two or three, sometimes four and five.—[Dr. E. H. Anderson, Madison.

Three or four.—[Kenneth Clark, Chickasaw.

Three, I think.—[J. W. Burch, Jefferson.

Three.—[C. Welch, Covington.

From three to five. I have noticed four or five broods when they failed to strip the field of its leaves; the birds, the ichneumon, and other insects, held them in check.—[I. G. G. Garrett, Claiborne.

Three, and if a late autumn, or frost, four.—[W. Spillman, Clark.

Three.—[George V. Webb, Amite.

NORTH CAROLINA.

Only one.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Three when destructive.—[James W. Grace, Colleton.

From three to five, according to favorable circumstances or time of first appearance.—[James C. Brown, Barnwell.

TENNESSEE.

Five or six are the generations sometimes produced; my own observations would say generally not more than two, barely three.—[A. W. Hunt, M.D., Perry.

TEXAS.

There are about three broods, depending mostly on the time of their appearance. I will, as far as my knowledge goes, give the course they take. First, a few ragged leaves on the cotton indicates the presence of the worm. On examination a few patches of worms may be found; the first generally are as green as the cotton-leaf. In about ten or twelve days they wind up in leaves and remain about four days, when a dusky brown moth is hatched. She soon commences to deposit her eggs, which are said to hatch in three or four days. This new brood takes their course and prepares for the next brood, which cleans up everything.—[J. M. Glasco, Upshur.

Three; under circumstances favorable to them, four.—[A. Schroeter, Burnet.

It is difficult to say how many broods there are, but the fourth finds but little to feed on, and so dies.—[P. S. Clarke, Waller.

Two broods each year.—[R. Wipprecht, Comal.

Generally three; this year four.—S. B. Tackaberry, Polk.

Generally two, occasionally three.—[W. Barnes, Cherokee.

From two to four broods, though but one brood is to be feared; that is the second.—[O. H. P. Garrett, Washington.

Three and four.—[P. S. Watts, Hardin.

Three broods.—[H. J. H. Brensing, Miller.

Generally three broods.—[J. H. Krancher, Austin.

Two, and sometimes three.—[C. B. Richardson, Rusk.

In their early history the crop was never eaten up until the third generation appeared, about three weeks being the time, or six weeks elapsing from the appearance of the first to the third appearance. This, however, has changed, and from their first appearance they go on increasing until the whole vast foliage is alive with them and eaten up, and all fields of hundreds of acres look as though a fire had run over them, and the worm then falls off, covering the ground, sometimes one or two inches deep. They attempt to crawl off, but soon die, producing a most disagreeable odor.—[A. Underwood, Brazoria.

Three broods a season.—[Stephen Harbert, Colorado.

Three distinctive crops or broods of them, being six weeks from the time you see the first crop of them until they are in force enough to eat up the cotton.—[Natt Holman, Fayette.

In favorable seasons we have sometimes as many as three, but often two are sufficient to destroy the crop, and leave the third set of moths nothing to deposit their eggs upon, and evening and morning the air is darkened with their rising to take their flight.—[J. W. Jackson, Titus.

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QUESTION 5 *d.—In what other situations besides the folded cotton-leaves have you known the worms to spin?*

ALABAMA.

In more ways than I can enumerate, perhaps. On anything they can get to when ready to web up. A weed or corn-stalk will answer very well.—[R. W. Russell, Lowndes.

In the leaves of bushes and weeds; in fact, they web up in almost any green shrub or weed that is in their way.—[J. L. Hausberger, Bibb.

We have known them to spin in the leaves of peach, apple, oak, and hickory trees, and also in leaves of weeds and blades of grass.—[J. A. Callaway, Montgomery.

Weeds, grass, and brush.—[H. Tutwiler, Hale.

When the cotton-leaves are exhausted they will web themselves up in the leaves of the hog-weed, or any other weed of proper size which grows on the hedge-rows convenient.—[Dr. John Peurifoy, Montgomery.

(The worms have eaten most of the leaves and young buds of the plants in my field and are on the move. They may be seen moving through the grass, potato-vines, &c., and upon the trunks of pine trees, seldom, however, higher than five or six feet from the ground, as they jump off or fall back after climbing a short time. I do not see that they have begun to eat anything else than the cotton.) Most of the worms of the past week or ten days have webbed up in the cotton-leaves, and the chrysalides hang many from the denuded leaf-skeletons. They are scarcely covered at all, the leaf-blades in which they were wrapped having been eaten away, and they hang almost free in air. The present brood of worms I find webbing up in the leaves of various plants: the following I have noticed: sweet-potato, *Cassia obtusifolia* and *Occidentalis*, *Physalis lanceolata*, *Solanam Carolinense*, sassafras, *Pharbitis nil*, *Ipomœa tamnifolia*, *Sida spinosa*, *Ambrosia artemisiæfolia*, *Xanthana stromarium*, *Euphorbia maculata*, *Amarantus spinosus*, *Quercus aquatica* (small trees), sweet gum (small), watermelon, *Passiflora incarnata*, and young mulberries; the latter seems a favorite. Nearly all the leaves of half a dozen young mulberry plants are rolled up by the worms. A few worms of the present brood I have found webbed up in the cracks of the bark of old field-pines standing in the field. Most that I have seen have been on east, north, and west sides. Have seen none on south sides of the trees. The greater part of the present brood, however, are webbing up in any leaves that they encounter, grass leaves excepted. The webs made by the present brood of worms are simply the leaf rolled once and bound together by the silk. In the case of those worms webbing in the crevices of pine-bark, a thin gauze of the silk was all that protected them; through this web the worm can easily be seen. Thus far I see no tendency on the part of the worms to make a denser cocoon than those of the preceding brood. I have noticed the moths occasionally fly up from a mass of sweet-potato vines among which *Cassia obtusifolia* and *C. occidentalis* were growing. Perhaps the glands on the leaf-stalks of those two species may have offered some attraction, though I have not seen any moth upon the plants.—[E. A. Smith, Tuscaloosa.

When numerous enough to destroy the crop they will spin in any leaf when there are no cotton-leaves left.—[H. A. Stolenwerck, Perry.

They will spin upon anything.—[James M. Harrington, Monroe.

I have seen them webbed up in the leaves of the mulberry and cocklebur.—[R. H. Powell, Bullock.

They will web up in the green leaves of weeds or bushes when most convenient, but I have never known them to spin on anything dry, except the open cotton-boll.—[D. Lee, Lowndes.

They are not confined to a folded leaf, but the eggs may be found upon open leaves.—[J. C. Matthews, Dale.

On almost any kind of weed or bush that happens to be near the field.—[M. W. Hand, Greene.

On the old cotton-stalks, limbs of trees (on the ground), bark, stumps, and old logs, all on the ground.—[P. D. Bowles, Conecuh.

I have never seen the worm spin except in cotton-leaves.—[J. W. Du Bose, Montgomery.

They have been known to web upon any object, on oak leaves, in stumps, or on common weeds, &c.—[A. D. Edwards, Macon.

The worm must find something in which to web up or perish; it will use anything green or soft enough in which to fold itself up, called spinning.—[H. Hawkins, Barbour.

As soon as the third crop is grown, or by the time all the cotton-leaves are consumed and the worms crawl off onto any green weed and spin. I have seen the weeds covered with the worms and not a leaf eaten, but all used by the worm in which to fold himself.—[H. Hawkins, Barbour.

In various kinds; the red-oak leaf, potato-vine leaf, cocklebur leaf. As before said, I don't think such amounts to anything, but I am not positive about it; at least there is no late growth of cotton eaten; hence I conclude the chrysalis found on these leaves don't produce the fly. The caterpillar fly is seen all along in the latter months. In making molasses now (November 26, 1878), they get into your juice.—[A. Jay, Conecuh.

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Have never seen a cotton-worm in any other place than the cotton-field.—[R. B. Dunlap, Greene.

On smart-weed, pea-vines, and almost every kind of vegetation.—[J. R. Rogers, Bullock.

In the leaves of weeds.—[C. C. Howard, Autauga.

The worms in force consume all the leaves, even those already used as wrappers by other worms, are then forced to web on grass, weeds, bushes, or cloth if placed near the field. The distance traveled in quest of a webbing-place will not exceed 30 yards.—[P. T. Graves, Lowndes.

The worm spins on the leaf of any plant that may chance to be convenient.—[J. N. Gilmore, Sumter.

After the leaf is exhausted they will web in the weeds and bushes round the field.—[R. S. Williams, Montgomery.

None other.—[John D. Johnston, Sumter.

Have never known them spin in any other situation than the leaf of the cotton-plant.—[R. F. Henry, Pickens.

After the leaf is exhausted they will web in the weeds and bushes near the field.—[R. S. Williams, Montgomery.

On the forest leaves and weeds, and any other place they could get, after having passed through the cotton-field and eaten all the cotton-leaves up.—[I. F. Culver, Bullock.

Leaves of various weeds.—[J. H. Smith, J. F. Calhoun, Dallas.

When the cotton-leaf has been swept off and the brood is ready to "go to its fathers" or into the chrysalis state, they will *wrap* themselves up in the leaf of the "cocklebur," or any other leaf that is large enough to envelop them. They spin not, neither do they toil, but eat, eat, eat, until they empty our pockets. Banquo's ghost was not more appalling than the first caterpillar is to the planter.—[I. D. Dreisbach, Baldwin.

They fold up in anything that will bend sufficient for the business. I have often found them on paper or old cloth or any substance they can find; this is when they are very numerous, having eaten all the cotton-leaves and leaving nothing on the cotton-stalk to afford shelter.—[H. C. Brown, Wilcox.

After the leaves of the cotton are devoured the worm will spin itself up upon green vegetation of almost any kind. They are often seen in the fence-corners webbing up to protect themselves from the sun. I have seen them in the cracks of the fencing and upon dead timber securely webbed.—[C. M. Howard, Autauga.

Various weeds.—[Knox, Minge, and Evans, Hale.

ARKANSAS.

Have seen them spin from bushes, weeds, and ends of cotton-stalks, though not very often.—[E. T. Dale, Miller.

I have seen the web on different kinds of weeds.—[T. S. Edwards, Pope.

Can't say that I have known them to spin on anything else.—[Norborne Young, Columbia.

FLORIDA.

I have never known the boll-worm to spin on the cotton leaf. I am sure they go into the ground. I have dug them out of the ground in October and always close to the stalk, rarely even four or five inches from it.—[J. M. McGehee, Santa Rosa.

In any weeds or grass that may be near, particularly the rag-weed, which is tender, pliant, and easily folded.—[John Bradford, Leon.

The worm when it leaves the fields, as it sometimes does as early as September, always webs itself in any green leaf which presents itself in the shrubbery along the fence rows or in the weeds or even the grasses there growing, and the miller emerging from the chrysalis goes off into the forest, leaving the cotton-fields which are sometimes only partly stripped, and not returning to them, though they often become green again with new leaves.—[R. Gamble, Leon.

GEORGIA.

No other leaves.—[D. P. Luke, Berrien.

None.—[A. J. Cheves, Macon.

On bark, fence-rails, in fact on grass.—[W. A. Harris, Worth.

They invariably web in the cotton; generally in the top leaves.—[S. P. Odom, Dooly.

The worm will spin on the small limbs of cotton, on bushes and palmetto fans. Sometimes they get in the wood and in the jambs of the fences. I have seen thirty or forty hanging by the end of one palmetto leaf or fan as it is called.—[Timothy Fussell, Coffee.

The worms will spin on any kind of soft leaves in the field, as gum, brier, &c.—[William Jones, Clarke.

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The usual mode is to spin in the top of the cotton from limb to limb, and make a perfect network like the spider.—[M. Kemp, Marion.

I have noticed the worms weave their webs in peach and apple trees and other trees.—[E. M. Thompson, Jackson.

LOUISIANA.

In almost any kind of a leaf large enough to hold them, that is after the cottonleaves are destroyed. This year I have noticed four or five worms wrapped up in one pear-sprout leaf.—[H. B. Shaw, Concordia.

While there is any cotton left to subsist on, the worm eats it until fully grown; then doubles itself up in a cotton-leaf and turns to a black pointed affair, which we call a *cocoon* or chrysalis. From this emerges in due time a moth, or fly, which proceeds to lay eggs on the cotton-leaves which hatch in due time into cotton-worms who go the same round. But the cotton-plant is their sole food and place of breeding as long as any of it exists. The last crop spin their cocoons, or web up, after they have exhausted all the cotton, upon any weeds or bushes they come to. They emerge from these as moths, as before, and may be started up from weeds and bushes by thousands, but they breed and increase no more during that season, so far as I am informed.—[Douglas M. Hamilton, West Feliciana.

The cotton-worm will roll up in anything that is green.—[John A. Maryman, East Feliciana.

I have known it to spin on the blades of sugar-cane, on the leaves of cocklebur and other weeds.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

I have often found the chrysalides enfolded in the meshes of open cotton-bolls, and this is common with the last brood which finds no leaves to web up in.—[J. Culbertson, Rankin.

In the leaves of the cocklebur and Jamestown weed.—[J. W. Burch, Jefferson.

On sundry weeds. Sometimes vast numbers of chrysalides are seen on a single weed; as many as twenty, thirty, and even more have been counted on a twig less than two feet long. This occurs only when the cotton-leaves have been destroyed and the caterpillars have wandered in search of suitable leaves, till, I suppose, finding themselves about to change to chrysalides or forced to spin, they fasten on any convenient place or anything from which they may hang above the ground.—[D. L. Phares, Wilkinson.

They will spin on almost any kind of plant besides cotton and sometimes hang by a single thread on cotton already stripped.—[Daniel Cohen, Wilkinson.

I have seen this year the worm spun up in the hogweed, grass growing on the ditches running through the cotton-fields. It was their only chance, though, to spin in that or die.—[John C. Russell, Madison.

The first brood folds the leaf invariably so long as there are leaves. When the plant is bare, attaches its chrysalis to the naked fibers of the leaf and sometimes to the twigs of the plant.—[Dr. E. H. Anderson, Madison.

On the leaves of grass, weeds, and almost every kind of bush in reach, unless it is the long-leaved pine.—[C. Welch, Covington.

No other.—[Kenneth Clarke, Chickasaw.

In the leaves of any weeds or bushes I have found the crysalides under boards and fence-rails.—[I. G. G. Garrett, Claiborne.

Only on young sassafras and persimmons when growing in fields of young cotton, and probably only then when blown or shaken off the cotton.—[W. Spillman, Clarke.

In every kind of leaf they could find, and often in grass blades.—[George V. Webb, Amite.

NORTH CAROLINA.

No other.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

I have never known them to spin in any other place except when the fields have been eaten out, and then have seen a few wound up in oak-leaves by the side of the fields.—[James W. Grace, Colleton.

If the cotton-leaves are all eaten and there be a leaf near of any weed, they will get on that and fold it over; otherwise they seem to be lost, and perish without going into chrysalis.—[James C. Brown, Barnwell.

TENNESSEE.

I have never known cotton-worms to spin in other situations than the cotton-leaves My attention has frequently been called to other situations in which it was said they had spun. The few of such cases which have been examined by me proved the spinner to belong to another family.—[A. W. Hunt, M. D., Perry.

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TEXAS.

They web upon any leaf they can find; have found them on leaves of potatoes (sweet), peas (field), cockle, on what is known as the hog-weed; have found them in locks of cotton on the stalk; have found them in the cotton-seed in the gin-house. After all leaves are gone one can see them hanging by slender threads, but strong, to the limbs of cotton-stalks.—[P. S. Clarke, Waller.

They will fold almost any kind of leaf, as we call it, to web up in. A large number of them perish while in a webbed state and a large number come forth a full-fledged butterfly. They do not spin any other way but in a folded leaf.—[O. K. P. Garrett, Washington.

I have known them webbed in various other plants; they do not confine themselves to cotton alone to web in.—[P. S. Watts, Hardin.

When the leaves are consumed they spin a slight cocoon and suspend from the stem of a leaf or branch of the cotton.—[J. M. Glasco, Upshur.

In any kind of leaf they can find after the cotton-leaf is destroyed.—[S. B. Tackaberry, Polk.

In no other.—[H. J. H. Brensing, Bowie.

I never saw them anywhere else.—[W. Barnes, Cherokee.

None.—[R. Wipprecht, Comal.

They spin on all plants adjacent to the cotton field, on the weeds or grass at the edge of the field or between the rows.—[J. H. Krancher, Austin.

Never on anything but the cotton leaf or stalk.—[C. B. Richardson, Rusk.

I have seen them on the careless and other weeds; in fact, they will web on most anything after they have eaten up the cotton.—[S. Harbert, Colorado.

On the naked cotton-limb, weeds, and grass after the leaves were devoured.—[J. W. Jackson, Titus.

No other.—[Natt. Holman, Fayette.

Most unquestionably, and beyond all reasonable doubt, they burrow in the ground at or near the precise spot where they lower themselves after leaving their leafy covering by a delicate web from the cotton-bush to the earth, because they are there traced and unearthed.—[William J. Jones, Galveston.

After the process of wrapping themselves in their own meshes is complete they free themselves from their leafy covering, showing a perfect cocoon, and suspend themselves, in their effort to reach the ground, by a tiny thread. When they reach the earth, they work or bore themselves below its surface with wonderful rapidity far enough to evade all ordinary casualties and to be thoroughly hid from view. There they remain till some are disturbed by the plow, while the remainder are content to hibernate till their natural instinct prompts them to take wing and seek for their special, if not only food, the cotton-leaf. The fact that they appear at one time late and another season early, or are more numerous at one period or place than another, or in some seasons not coming forth at all, may be due to local causes yet remaining to be discovered. The best word the most enlightened planter can yet say of this fitfulness of instinct is that it is a profound mystery in nature. If the growth of the cotton-plant were such as to allow us to fallow our lands in the fall, we might destroy a vast number of these cocoons. This occasionally happens where a crop has met with an early disaster, as in my own crop here the last year, a field of 300 acres of cotton being destroyed by a cyclone on the 15th of September, and consequently perhaps very few worms appearing this year very late in the season and doing no sensible damage. We have had no frost as yet (November 23); the cotton is nearly in full foliage, many blooms and some few young bolls from the second growth showing themselves, but no appearance of the worm. It was this second growth of cotton upon which the moth tarried this season.—[William J. Jones, Virginia Point.

QUESTION 5 *e*.—*Have you ever known the chrysalis to survive a frost or to be found in sound and healthy condition in winter?*

ALABAMA.

I never have known the chrysalis to live through winter. I do not believe the worm lives more than ten days in the chrysalis state. I examined quite a number of them last September, when they had spun on weeds after the cotton had been eaten, and never was able to find anything in the web after ten days; they had all matured and come out.—[I. N. Gilmore, Sumter.

I have not. Many farmers think differently. The chrysalis of the cut-worm is mistaken for the cotton-worm. My observation has been that a chrysalis placed on the ground invariably perishes, by sunshine or moisture, provided ants leave it long enough to succumb to those influences.—[P. T. Graves, Lowndes.

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Have plowed up in the spring what appears, to unskilled observers, to be identical with the chrysalis of the cotton-worm.—[J. H. Smith, J. F. Calhoun, Dallas.

I never have, though I am of the opinion that they do hide away somewhere, and that they survive mild winters.—[I. F. Culver, Bullock.

No.—[John D. Johnston, Sumter.

Have not.—[J. L. Hausberger, Bibb.

Never.—[J. A. Callaway, Montgomery.

I now (November 29) send a small box of chrysalides, which may be of advantage in determining the manner and habits of spinning after all the leaves of the cotton-plant have been eaten up and nothing left except weeds or grass on the edges of the field or on ditches. The chrysalis has been known to live all winter, and also in the moth state. I have known the chrysalis to survive a frost; I have, in a few instances, seen the chrysalis turned up with the furrow when preparing land in early spring, which had certainly been thus preserved under or in the ground all winter. Col. Eli S. Shorter, of Eufaula, whose land joins mine, imprisoned a chrysalis thus found, by placing it in a glass jar, and it came out a caterpillar moth. I have seen many of the moths in mild weather in the winters of 1873 and 1874, and I am confident that both the moth and the chrysalis survive the winter, the winter being mild.—[H. Hawkins, Barbour.

Never. I have no idea that they exist in a chrysalis state in winter; but, as before said, in the fly state.—[Andrew Jay, Conecuh.

Have never known a chrysalis to survive the winter.—[R. B. Dunlap, Greene.

I have never noticed them but a very short time after webbing up; generally in about three weeks they hatch, and I never knew what became of them; there are so many insects that resemble the moth that it is hard to distinguish them.—[H. C. Brown, Wilcox.

I think most of them are destroyed by frost, but I do not think they all are. When they have protection from cold, they survive the winter here.—[J. C. Matthews, Dale.

Never. The moth comes out at the usual time or the chrysalis dies. I do not know the number of days—I believe not exceeding ten—till the moth emerges from its thin shell.—[D. Lee, Lowndes.

I have not known the chrysalis to survive the frost or be found in a sound and healthy condition in winter, though others believe otherwise.—[A. D. Edwards, Macon.

In this locality the moth comes forth before cold weather, and I do not remember to have seen a chrysalis alive after a freeze.—[M. W. Hand, Greene.

Yes. This last winter, in preparing the land for planting, we plowed them up, and to all appearances they were as lively and vigorous as when first webbed up on the stalk. Have put them in open-mouthed bottles in a warm room and they would come out a moth in a few days.—[H. A. Stolenwerck, Perry.

Have not, though I have never noticed particularly.—[R. H. Powell, Bullock.

I think not; they become torpid under the influence of cold and rarely survive a killing frost.—[C. M. Howard, Autauga.

Never have.—[James M. Harrington, Monroe.

Never have.—[I. D. Driesbach, Baldwin.

Dr. N. A. Lee says that he has often seen them during the cold weather in January and February when he had plowing done in the field where cotton had been planted the year previous, and this after frost, and they in a healthy condition.—[P. D. Bowles, Conecuh.

Yes, all times of winter under the ground.—[Knox, Minge, and Evans, Hale.

I never did.—[J. W. Du Bose, Montgomery.

Have not.—[C. C. Howard, Autauga.

This, perhaps, is the most important question asked, and if it could be answered *with certainty*, would do more to determine where the next annual generation comes from than anything else. I have found chrysalides during the early spring months in fresh-plowed land that I *believed* to be the *cotton-worm*. Have seen the webbed chrysalis in the leaves after frost. Do not think that *late* in the season they are developed into moths. If they do survive the winter, I think it is by being accidentally covered by the loose earth. The black lands south of this are very favorable for this, as they are soft and porous, and after rains large numbers of them would evidently be covered. The chrysalis has a vermicular motion; are pointed at each end. May they not have the power of penetrating the earth?—[R. T. Williams, Montgomery.

This could hardly be answered satisfactorily, from the fact that there are so many other insects that in the chrysalis look so much like them. Some think they have found them in the winter, but I can't say whether to believe so or not, but rather incline to the opinion that they remain here in the moth state.—[R. W. Russell, Lowndes.

Except in cotton that had been put up in a house.—[R. F. Henry, Pickens.

The colored people tell us that they plow them up frequently this spring, and they are all alive, and will, no doubt, hatch moths at the proper time. A gentleman of our acquaintance experimented on one last spring, and it hatched out a moth in the

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first week in May. An intelligent colored man, of long experience with the cotton-worm, informs us that the chrysalides that are plowed up in the spring are those which fail to hatch in the fall, in consequence of the lateness of the season and the supervention of cold weather; that they ultimately fall on the ground and hide themselves by boring into it.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

The chrysalides remain in the ground, in cotton-stalks, in corn-stalks, about old stumps and trees, in woods adjacent to cotton-fields, through the winter. This I know from personal observation and from other persons who have made careful examinations.—[E. T. Dale, Miller.

I have never noticed one after the weather gets cold.—[T. S. Edwards, Pope.

Yes; have found them healthy in January, taken out of the ground and cotton-stalks.—[E. T. Dale, Miller.

Can't say that I have.—[Norborne Young, Columbia.

FLORIDA.

The chrysalis as such never remains, but going through the natural mutations the moth leaves the vicinity of the fields.—[R. Gamble, Leon.

I have seen thousands of bales of cotton destroyed in Montgomery and Lowndes Counties, Alabama, but have never seen the chrysalis of the worm in any form.—[J. M McGehee, Santa Rosa.

NOTE.—It is maintained by some planters that the chrysalides of the *Aletia argillacea* is often plowed up in the spring. As a planter of fifty years' experience, I have failed to find such chrysalides. I have repeatedly requested those who claimed to have seen them either to subject them to proof by incubation or to furnish me with them, and I would do so in order to set the matter at rest. Up to this date no realization of this theory has been arrived at.—[Robert Gamble, Leon.

GEORGIA.

I have collected a number of chrysalides and hung them in a northern exposure, where they survived a temperature of 12° Fahr. After this I left home, and watched them no longer.—[William Jones, Clarke.

Another correspondent (Putnam County) writes: "During the winter of 1874-'75, I found a number of chrysalides in a sound, healthy state, after we had had several frosts and freezes; but they were protected by the bark on dead trees or stumps about the field, and I think that this is rather the exception than the rule."

I have, but generally in a protected spot.—[William A. Harris, Worth.

I have not.—[M. Kemp, Marion.

No.—[D. P. Luke, Berrien.

I have not known the chrysalis to survive a frost or found healthy in winter.—[T. Fussell, Coffee.

I never have. The chrysalis wings and migrates before frost. The larva and chrysalis found on the stalk after frost perishes before migration.—[S. P. Odom, Dooly.

I never see any appearance of life in the chrysalis after frost and cold weather sets in.—[E. M. Thompson, Jackson.

LOUISIANA.

No.—[H. B. Shaw, Corcordia.

I have heard of the chrysalis being plowed up in the spring, and also of the moths being found in sheltered places during winter—in hay and fodder stacks, outbuildings, under the bark of old logs and stumps—but I cannot say that I have ever seen anything of the sort.—[Douglas M. Hamilton, West Feliciana.

I have known the chrysalis to survive winters, having plowed them up in February in a live condition.—[Dr. I. U. Ball, West Feliciana.

I have found the chrysalis when plowing in the month of February the year preceding the destruction of the cotton. They were really so thick in the ground that I was very much discouraged. But after breaking the ground up completely there came a rain that lasted three days and nights; then the ground freze and destroyed the worms in the chrysalis form, and to my surprise we had a good crop year.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

My observation and experience has led me to conclude the *Anomis* is native and does hibernate in some form; that cultivation in July and August under certain conditions of season, such as plowing the land before the surface-soil is in good state for plowing, produces an artificial state of heat and moisture which is the most favorable for the hatching of eggs. The egg must survive the winter protected in the ground.—[E. H. Anderson, Madison.

Often.—[J. W. Burch, Jefferson.

I never have.—[Kenneth Clark, Chickasaw.

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Have hunted for them after frost, but found none.—[C. F. Sherriod, Lowndes.

No.—[C. Welch, Covington.

Yes; but I am not certain later than December. One season I supposed from appearances that I had some around in January, February, and March; but when warm weather came they manifested no signs of vitality, and on close inspection I found them dead. They may have perished in January for aught I know. How long after December they survived I am unable to state.—[D. L. Phares, Wilkinson.

Know nothing as to the winter quarters of this insect.—[John C. Russel, Madison.

I have found hundreds of chrysalides while ginning cotton as late as January, still living.—[J. Culbertson, Rankin.

Found them all dead this year after the first killing frost.—[W. Spillman, Clark.

I have known them to hatch out of chrysalis after frost, but they have never remained but a few days after frost; they soon die, but doubtless deposit their eggs before they die, and the eggs hatch the next year.—[George V. Webb, Amite.

At the close of last season I had a number of the cotton-worms in chrysalis state, but they were destroyed by the severe freeze about Christmas.—[G. W. Smith-Vaniz, Madison.

NORTH CAROLINA.

No.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Never.—[James W. Grace, Colleton.

We have never known, nor have I heard of any one else ever finding the chrysalis after frosts or during the winter.—[James C. Brown, Barnwell.

TENNESSEE.

I have never known the chrysalis to survive even a slight frost, frosts so light as to have been unfelt by any except rarely sensitive plants.—[A. W. Hunt, M. D., Perry.

TEXAS.

They in some way become buried under the soil, and are preserved throughout the winter. Many of them are plowed up in the winter, and are in a sound state; believe they can be kept safely in the seed. Could not the chrysalis have been brought here in 1834, in the boat-load of seed that came that year from New Orleans?—[P. S. Clarke, Waller.

I have never found a sound or perfect living chrysalis after a severe frost, with cold enough to form ice.—[J. M. Glasco, Upshur.

I do not think they survive a freeze in a chrysalis state. I do not think they are to be found in a healthy condition in winter. I am inclined to the opinion that the moth is migratory; for instance, some seasons we failed to have the worm for more than one year in succession; then again it was upon us. The question, Where has it been all the while, asleep for two or more years? Hardly.—[O. H. P. Garrett, Washington.

Not after a severe frost.—[H. J. H. Brensing, Bowie.

I have not.—[P. S. Watts, Hardin.

No.—[R. Wipprecht, Comal.

I have found the chrysalides in apparently healthy condition during winter in seed cotton, where it had gotten by picking, and in hay.—[A. Schroeter, Burnet.

Yes.—[S. B. Tackaberry, Polk.

Never.—[W. Barnes, Cherokee.

They will, and do survive the frost in the ground, and have been found in winter occasionally.—[J. H. Krancher, Austin.

Never.—[C. B. Richardson, Rusk.

I think I have.—[S. Harbert, Colorado.

No, never.—[J. W. Jackson, Titus.

Not of the cotton-miller; they always come out, and thousands die if the cotton is leafless.—[Natt. Holman, Fayette.

QUESTION 5 *f*.—*Have you ever found the moth hibernating or flying during mild winter weather?*

ALABAMA.

Often.—[P. T. Graves, Lowndes.

Yes; have found them in trash, under old logs and brush.—[John D. Johnston, Sumter.

I never have seen a moth here in winter at any time.—[J. N. Gilmore, Sumter.

I never did.—[I. F. Culver, Bullock.

Often in winter when the sun shines warm the moth flies out.—[J. S. Hausberger, Bibb.

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Yes.—[J. A. Callaway, Montgomery.

In fact I looked everywhere except on the roofs of houses; moreover several fields were just plowed, and I had again occasion to convince myself that there are no pupæ of *Aletia* in the ground. I have to repeat here that I feel more than ever convinced that *Aletia* does not hibernate in these more northern portions of the cotton-belt.—[E. A. Schwarz, Eufaula.

Frequently. The late winter, 1878–'79, has been unusually cold, yet moths have been seen flying from the bark of old trees on the first appearance of mild weather.—[H. Tutwiler, Hale.

They are frequently seen of warm, pleasant evenings in winter, and sometimes come to the lamps at night and get their wings singed like other candle flies.—[Dr. John Peurifoy, Montgomery.

In plowing in the spring and breaking up crusty earth, where clods rise before the plow, these flies are sometimes seen thus turned out, or at least flies which we regard as the caterpillar fly, and in removing old heaps where logs or limbs or trash have been piled, in such places the fly is sometimes turned out in the early spring.—[Andrew Jay, Conecuh.

That the moth lives through the winter admits of no doubt whatever in our climate, provided the winter is a mild one. If it is mild I can find moths any month. The moth has instinct enough to find comfortable quarters. The idea that they are brought here by the south wind certainly cannot hold good. If they should only come by this means, would they not come every year alike, or nearly so?—[H Hawkins, Barbour.

Have never seen a moth in winter.—[R. B. Dunlap, Greene.

We have just passed some good frosts, yet the fly is seen daily in manufacturing molasses, November 26, 1878.—[Andrew Jay, Conecuh.

Have seen moths at that time which quite resembled the cotton-worm moth. But cannot say reliably that it was.—[C. C. Howard, Autauga.

I don't think I have, for the reason that the moth is an exceedingly shy insect, never seen flying about in day time except when molested.—[R. W. Russell, Lowndes.

No.—[R. F. Henry, Pickens.

Frequently.—[J H. Smith, J. F. Calhoun, Dallas.

The moth has been securely wintered in dead logs and in hollow trees. The fall of deadened timber often discloses their presence in quantity when opened or bark falls off. They have been found in mild winters flying out in the open air, and seen as late as February in their hiding places.—[C. M. Howard, Autauga.

Yes; they travel in warm seasons of winter; generally hide themselves under the bark of dead pine trees, where the bark becomes loose upon dead pines.—[J. C. Mathews, Dale.

All times in mild winter around fodder-stacks and barns. In our opinion it is only the moth that comes out from the chrysalis which has lived here underground through winter that damages the crop.—[Knox, Minge, and Evans, Hale.

I think I have found it on the walls of a dwelling and about a lamp in mild weather. [J. W. Du Bose, Montgomery.

This is a well-known fact, and is answered above, yes.—[P. D. Bowles, Conecuh.

Yes; they are very common in mild winter weather.—[H. A. Stolenwerck, Perry.

Yes.—[J. R. Rogers, Bullock.

Since last writing we have had two or three heavy white frosts, viz, on the nights of the 22d, 23d, and 26th October. On the morning of the 23d three moths came from the chrysalides which I have under a glass shade, on a shelf on my porch, exposed to the weather. The moths were benumbed with cold and apparently dead, but they all revived after being brought into a warm room. I turned them loose next day while it was warm and pleasant. Last night the thermometer stood outdoors at 60° Fahr., and on visiting my baited trees I found several of the cotton-moths there. They seem to lie up during the cold spells and to come out when the weather moderates.—[E. A. Smith.]

I judge by the scarcity of the cotton-moths since cold weather that they are not able to stand the cold, and have either been killed or forced to seek secure quarters. I have found none yet in bark of trees or elsewhere. Some of the chrysalides of the last brood are still rolled in the leaves in the cotton-field, but a few which I examined some days ago seem to have died. These chrysalides are slightly shriveled up, and some of them are certainly decaying, if I may judge by the smell when they are opened.—[E. A. Smith, Tuscaloosa.

I have often seen the moth flying during mild winter weather that resembles the cotton-moth; we call them here candle-flies, and find them about old houses and barns.—[H. C. Brown, Wilcox.

Frequently about my gin-house and barn.—[M. W. Hand, Greene.

I have.—[James M. Harrington, Monroe.

I have not.—[R. H. Powell, Bullock.

I have.—[I. D. Driesbach, Baldwin.

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Frequently, especially over the roof of the gin-houses late in the evening.—[D. Lee, Lowndes.

I think I have seen the moth flying during mild winter weather.—[A. D. Edwards, Macon.

ARKANSAS.

I have seen what I took to be the cotton-moth in mild winters.—[Norborne Young, Columbia.

No.—[E. T. Dale, Miller.

I have not.—[T. S. Edwards, Pope.

FLORIDA.

No.—[J. Bradford, Leon.

Often.—[J. M. McGehee, Santa Rosa.

Not earlier than February, and one solitary fly, ragged and worn, and on one occasion only. The insect does not hibernate, but continues to carry on the process of nature during the year, the intervals between successive generations being possibly longer during winter.—[R. Gamble, Leon.

GEORGIA.

A grassy field accidentally took fire in January, 1876. As the old pines with partly decayed sap would catch fire the moths were observed to escape from their hiding places in large numbers.—[A. J. Cheves, Macon.

I have not.—[M. Kemp, Marion.

I think I have seen moth flying about during the mild winter months of warm winters, but could not say that they were the moth above matured.—[E. M. Thompson, Jackson.

Have never found the moth flying in winter.—[T. Fussell, Coffee.

Have on several occasions.—[William A. Harris, Worth.

I never have.—[S. P. Odom, Dooly.

I have not.—[D. P. Luke, Berrien.

I do not belive they do.—[William Jones, Clarke.

I carefully searched the stems without finding any eggs of the moth. An examination of the woods, logs, and brushwood yielded no chrysalides of the cotton-worm. From the appearance of the chrysalides on the plants it must be conceded that the last worms do not quit the plant nor prepare themselves for winter in any way. In my opinion the chrysalides which do not yield the moth and are retarded by the severity of the weather cannot conceal themselves in any way in the ground, and must probably perish from the cold or in the process of removing the dead plants to prepare for a fresh crop of cotton.—[A. R. Grote.

LOUISIANA.

Never. There is a moth seen on mild days, flying about the sheds and gins, but it is not the cotton-moth.—[H. B. Shaw, Concordia.

I have never seen the moths flying during mild winter weather.—[John A. Maryman, East Feliciana.

I have never seen the moth during the winter.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

Never later than December. I have been assured that large numbers of *Aletia* were seen in the Black River region in Louisiana flitting about in warm evenings in the winter of 1866–'67 and 1867–'68, and also in the southwest part of this county. Although so assured by intelligent, close observers, well acquainted with this insect, I do not feel entirely certain; I think it probable, however, that some survive the winter here in the lowlands.—[D. L. Phares, Wilkinson.

The moth usually flies in the evening, between sunset and dark, and at that hour I have seen thousands of them sporting of a mild evening in winter.—[J. Culbertson, Rankin.

I am satisfied they are with us all winter.—[J. W. Burch, Jefferson.

No.—[Dr. E. H. Anderson, Madison.

I have not.—[C. Welch, Covington.

Never.—[Kenneth Clark, Chickasaw.

I have never seen a live moth later than the 15th of November.—[I. G. G. Garrett, Claiborne.

Often in warm days about old out-buildings.—[W. Spillman, Clarke.

Never.—[George V. Webb, Amite.

NORTH CAROLINA.

No.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Never.—[James W. Grace, Colleton.

I have not found the moth hibernating, but I have heard others say that they have.

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It goes under the thick bark of dead trees, and where large pieces of the sapwood of dead pine-trees are partially separated from the heart but still fast to the tree, make good winter quarters for them.—[James C. Brown, Barnwell.

TENNESSEE.

I found the moth both flying and hibernating last winter, which, however, was the mildest winter in my memory.—[A. W. Hunt, M. D., Perry.

TEXAS.

I have never found the moth after very cold weather, and have never seen the moth outside the cotton-field. I do not believe they hibernate in this portion of the country, though I have found one farmer who said he found them plenty in March at an old cotton-gin. If they remained in the moth state all winter they would commence earlier on the cotton; if in the chrysalis state, so soon as they become moths in the spring their work would begin, and we would have them every year, instead of only occasionally, as we do now.—[J. M. Glasco, Gilmer.

No.—[A. Schroeter, Double Horn.

The uncontradicted history of the advent of the moth establishes the fact that they first show themselves in the lower latitudes, on or bordering the coast-line, and then spread rapidly in the interior, reaching very nearly to the parallel 31°; that they may be said to be coetaneous in their movements. This wide belt of territory, perhaps fully one hundred miles, which the moth compasses in so short a time, which, considering its delicate structure and clumsiness of flight, would make it next to impossible for it to traverse in so brief a time, must, therefore, refute the theory of its migration from any distant locality. This leaves but little doubt that the moth springs each season from the field of their last year's operations, and the point left most in doubt is their prolonged preservation.—[William J. Jones, Galveston.

Yes.—[S. B. Tackaberry, Polk.

No.—[W. Barnes, Cherokee.

I tell you the moth cannot winter; its life is too short and too tender; the slightest cold will kill it.—[P. S. Clarke, Waller.

No.—[R. Wipprecht, Comal.

Have never seen the cotton-moth hibernating or flying during mild winter weather, but have seen other moths doing so.—[O. H. P. Garrett, Washington.

The moth has been noticed to fly in very mild winter weather. I have seen one occasionally in January, during unusual mild weather, and so have others.—[J. H. Krancher, Austin.

Never.—[C. B. Richardson, Rusk.

Have not.—[A. Underwood, Brazoria.

Yes.—[S. Harbert, Colorado.

I have seen them flying after frost, and have often found them under bark of trees (dead), logs, and trash when winter set in. Some were living and some had perished.—[J. W. Jackson, Titus.

Seen them in the middle of winter, on calm, warm days, flying around drifts and logs, trash, &c.—[Natt. Holman, Fayette.

QUESTION 5 *g.—How late in the spring has the moth been found alive?*

ALABAMA.

I never have seen a moth in the spring.—[J. N. Gilmore, Sumter.

January.—[J. A. Callaway, Montgomery.

All the spring.—[H. Tutwiler, Hale.

Our opinion, formed from our observation, is that the cotton-moth has become acclimated and naturalized to the climate of this section, and may be seen at all seasons of the year. Few it may be comparatively, but still they are here.—[Dr. John Peurifoy, Montgomery.

Cannot answer. Have dug up the chrysalis in July on a muddy ditch bank.—[H. A. Stolenwerck, Perry.

Have seen them as early as March.—[James M. Harrington, Monroe.

May.—[I. D. Dreisbach, Baldwin.

Last of February and first of March. One strong proof that they hibernate here is that the chrysalis has been plowed up, put in a bottle, and when hatched out proved to be the genuine cotton-fly.—[Knox, Minge, and Evans, Hale.

The last of May.—[H. C. Brown, Wilcox.

During entire winter and until warm weather.—[C. M. Howard, Autauga.

At any time, late or early. But very few cotton planters look for them until about

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midsummer, because it has never been known to do any harm in the spring.—[D. Lee, Lowndes.

I think it safe to say each and every month.—[P. D. Bowles, Conecuh.

They are here always, in this warm climate; they can survive winter; this is their native home.—[J. C. Matthews, Dale.

As late as April, if I remember correctly.—[H. Hawkins, Barbour.

I suppose about May is as soon as they are commonly seen; the fly must have deposited the egg for that worm in April.—[Andrew Jay, Conecuh.

Any time after first noticed, and the later the greater probability of finding it.—[C. C. Howard, Autauga.

On the 8th of April, 1868, I had an old barn taken down and found hundreds of the moths under the roof, active and capable of flying vigorously. That year, in my judgment, the moths that hibernated here propagated successfully.—[P. T. Graves, Lowndes.

I have seen the moth in winter and early spring. I do not think I have ever seen one later than April, from what I thought to be the previous year's crop.—[R. T. Williams, Montgomery.

Have noticed them as late as the first of May, flying around lights on a damp, warm evening, and some springs in great numbers.—[John D, Johnston, Sumter.

Have never seen them.—[I. F. Culver, Bullock.

I have never seen one in spring.—[R. W. Russell, Lowndes.

GEORGIA.

I never saw the moth in the spring; the moth is a night insect, and the first appearance of the worm is the eggs under the leaves.—[William Jones, Clarke.

May 15.—[M. Kemp, Marion.

Never saw the moth in spring.—[Timothy Fussell, Coffee.

I have never seen nor heard of them in spring.—[S. P. Odom, Dooly.

Have found them in July not hatched.—[William A. Harris, Worth.

During the whole spring.—[E. M. Thompson, Jackson.

LOUISIANA.

Never saw a moth in spring.—[H. B. Shaw, Concordia.

The chrysalis can be found all through the spring.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

I have already stated that I have seen the moth in every month of the year, but this is exceptional, and when it occurs it does not follow that the worms will be abundant. That seems to depend on the hygrometric condition of the season from June 20 till September.—[J. Culbertson, Rankin.

I think you could see them any month by close observation.—[I. W. Burch, Jefferson.

I have never seen them in the spring.—[Dr. E. H. Anderson, Madison.

I do not know that it is ever found alive at all in early spring.—[C. Welch, Covington.

I am not sure that I ever saw it alive in any of its stages at any time from last of December till latter part of May.—[D. L. Phares, Wilkinson.

I think they pass the winter in the chrysalis state, but very few escape destruction by the birds, the ichneumon, and other insects in summer. The flies come out in about eight days after the chrysalis is formed; later in the season it is sometimes two or three weeks before the fly comes out.—[I. G. G. Garrett, Claiborne.

The last crop of one year; at least some of them live until time to lay eggs the next year.—[W. Spillman, Clarke.

I have never seen them in the spring, and never until July 8 and on to September.—[George V. Webb, Amite.

NORTH CAROLINA.

I never saw one in spring.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

From June to November; have never seen it earlier than June nor later than November, though Dr. Reese declares he has seen the moth out in mild weather in winter and believes it hibernates in that condition, becoming torpid on the advent of cold weather; this, however, is contrary to our observation and we believe is a mistake.—[James W. Grace, Colleton.

This cannot be answered. If alive at any time in the spring, it has been in that vicinity all winter. This is certain, for the moth would deposit its eggs on the first and nearest cotton-plant it found and then die. It only lives as a seed-bearer.—[James C. Brown, Barnwell.

TENNESSEE.

The moth has doubtless been found alive and doing well as late as May, though I do not speak from my own experience.—[A. W. Hunt, M. D., Perry.

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TEXAS.

Have never seen them in spring alive.—[O. H. P. Garrett, Washington.
I do not believe they are ever seen in spring.—[J. M. Glasco, Upshur.
Never saw one in spring.—[R. Wipprecht, Comal.
Not until its appearance in midsummer or fall.—[W. Barnes, Cherokee.
Never saw or heard of any.—[C. B. Richardson, Rusk.
Have never observed it before June.—[A. Underwood, Brazoria.
They have been seen here all this winter.—[Stephen Har.ert, Colorado.
During the entire spring the moth may be seen.—[Natt. Holman, Fayette.
I have never seen one after severe winter set in.—[J. W. Jackson, Titus.

QUESTION 6.—*Are any birds, quadrupeds, or reptiles known to attack the insect in your locality?*

ALABAMA.

Domestic fowls and the *poor dogs* of the freedmen eat them voraciously. It is to be hoped the government will not resort to the latter for their destruction. Give us the *worms rather*. Have never seen birds of any kind eating them, though am not prepared to say they do not.—[M. W. Hand, Greene.

Birds, chickens, turkeys, and hogs.—[A. D. Edwards, Macon.

The leather winged bat feeds on the moth or fly. Hogs, turkeys, and chickens feed on the worm and chrysalis, and I presume all insectivorous birds also do. Poultry near houses thin them out greatly.—[R. H. Powell, Bullock.

All insectivorous birds. Hogs root for and feed on the chrysalis.—[Knox, Minge, and Evans, Hale.

Domestic fowls, dogs, and some birds, especially the bee-martin.—[C. M. Howard, Autauga.

The wild turkey has been known to feed upon them in the field near the swamps; also the hog—when they leave the field and get out so that the hogs can have access to them—will feed upon them.—[P. D. Bowles, Conecuh.

Poultry will pick the worms from the stalks; at least that is my observation.—[J. W. Du Bose, Montgomery.

All insectivorous birds, chickens, and turkeys, and hogs.—[J. R. Rogers, Bullock.

Birds, as in the case of other insects.—[C. C. Howard, Autauga.

I have seen birds, domestic fowls, and pigs eating them.—[I. F. Culver, Bullock.

Birds.—[J. H. Smith, J. F. Calhoun, Dallas.

Nothing except hogs. They will eat all they can get, and if allowed to remain in the cotton-field will almost entirely destroy the plant in their efforts to get the worms.—[R. F. Henry, Pickens.

All domestic fowls that are carnivorous eat the worm. All carnivorous birds eat them. The wild turkey is particularly fond of them. Hogs eat them greedily.—[J. N. Gilmore, Sumter.

Nearly all birds and hogs. Cotton planted near farm-houses has been greatly protected by the fowls eating them.—[John D. Johnston, Sumter.

Yes; all insectivorous birds attack the worm.—[R. W. Russell, Lowndes.

Birds, chickens, turkeys, all feed on the worms. Hogs will feed and fatten on them.—[R. S. Williams, Montgomery.

All insectivorous birds feed on the moth, chrysalis, and worm; this includes domestic fowls of all kinds, except pigeons. Cats, dogs, and hogs greedily eat the worms and chrysalis. Many insects feed on them; among them a sprightly black beetle, either to deposit eggs in the shell of the chrysalis or to suck out the juices, destroys thousands.—[P. T. Graves, Lowndes.

When hogs can get to them they destroy them with great avidity. Chickens, turkeys, and almost all kinds of fowls are very eager after them in this locality. I am not sure that the smaller birds feed upon them, but I think they do.—[J. S. Hausberger, Bibb.

Yes.—[J. A. Callaway, Montgomery.

I know that poultry does, particularly turkeys.—[H. Tutwiler, Hale.

Birds.—[James M. Harrington, Monroe.

A great many birds and poultry.—[J. C. Brown, Wilcox.

Swine, chickens, turkeys, geese, and ducks.—[J. C. Matthews, Dale.

The impression is that almost all birds will feed upon the worms. Immediately around the cabins where there are poultry and turkeys the cotton will not be destroyed.—[H. A. Stolenwerck, Perry.

Domestic fowls and hogs.—[D. Lee, Lowndes.

Domestic fowls, birds, dogs, hogs, and coons eat them.—[R. B. Dunlap, Greene.

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All insectivorous birds prey more or less upon the worm. No quadrupeds or reptiles to my knowledge.—[I. D. Driesbach, Baldwin.

There are various fowls and birds (no quadrupeds or reptiles known to me) which feed upon the caterpillar. Turkeys eat them greedily, and a cotton-field near a dwelling has been preserved by the turkeys. Chickens also eat them, but their height prevents them from destroying them as effectually as the turkeys. Blackbirds, bee-martins, and other small birds feed on them.—[Andrew Jay, Conecuh.

All birds that would attack the moth, hogs, and dogs eat the worms. Ants kill them if they find them on the ground. No birds seem to prey on the worm.—[H. Hawkins, Barbour.

All the birds feed upon the moths, and barn-yard fowls, even the geese, eat the worms with great gusto. And in this connection, it occurs to us that henneries might be built at proper distances and made a paying institution, for we have noticed that all around the barn-yard the cotton is saved from the worm, continues to grow, and develops a full crop for several acres, or as far out as the hens feed, while the balance is completely riddled, and the loss oftentimes one-half of the crop. This proposition would be laughed at if named here, while the planters pay $1 25 per acre for Paris green, and if the season be rainy the poison fails and the result is a great loss.—[Dr. John Peurifoy, Montgomery.

Mr. Donovan is always able to keep the worms in check by the following simple and cheap method: he drives his large flock of turkeys into the field, and if the plants are too high, a boy brings the worms down by knocking at the plants with a stick. This is repeated every day, and this remedy has proved so far invariably a success. Of course it can only be applied in small fields which are near the house and when the cotton-plants are not of large size. According to Mr. Donovan, the chickens are very fond, too, of the cotton-worms, but of course cannot reach as high as the turkeys. Of other birds feeding upon the cotton-worms, Mr. Donovan mentioned the "yellow-jackets," which he often observed in his cotton-field; and he sometimes saw them pulling the chrysalides of *Aletia* from their webs and eating the contents.—[E. A. Schwarz, Eufaula.

ARKANSAS.

Mocking-birds, bluebirds, and yellow-billed cuckoo.—[Norborne Young, Columbia.

Do not know of any bird, quadruped, or reptile that eats the worms.—[E. T. Dale, Miller.

I do not know of any.—[T. S. Edwards, Pope.

FLORIDA.

Blackbirds, swine, and sunshine.—[J. M. McGehee, Santa Rosa.

Birds and fowls.—[John B. Carrin, Taylor.

Birds, chickens, turkeys, and geese eat them.—[F. M. Meekin, Alachua.

The loggerhead and bee-martin.—[John Bradford, Leon.

GEORGIA.

The hog madly devours them when permitted in the cotton-fields. Also the common fowls. Chickens are very destructive to them, especially the guinea chicken, which travels further from the dwelling than the common fowl.—[S. P. Odom, Dooly.

The partridges prey upon them, and hogs turned into the field when they are numerous have been known to eat them.—[M. Kemp, Marion.

I know of none.—[A. J. Cheeves, Macon.

Turkeys, blackbirds, and chickens.—[D. P. Luke, Berrien.

Birds, fowls, and hogs.—[Timothy Fussell, Coffee.

The birds destroy some, but not in appreciable numbers.—[William Jones, Clarke.

LOUISIANA.

All birds, particularly the crow-blackbirds.—[H. B. Shaw, Concordia.

Many kinds of fowls and birds prey upon the worms, after they have attained some size, and perhaps even prey upon the eggs before they are hatched. When the worms are numerous the fowls and birds gather to the cotton-fields, and remain there daily feeding on them. I know of no animals who do this, except of the feathered kind.—[D. M. Hamilton, West Feliciana.

The common fowls will sometimes eat them.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

A great many sparrows and other small birds appear about the same time, and before and after, but whether to devour them or other insects I know not. I do not believe anything destroys them to any great extent.—[K. Clarke, Chickasaw.

Having occasion to move my fowls during the summer to a location near the cotton-field, my chickens took to the field and ate so many worms that they did not care for other kind of food, and seemed to do well on them. Turkeys and guinea-fowls are very fond of them.—[C. F. Sherriod, Lowndes.

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Black and blue birds, and some species of the sparrow and a green lizard, are often found on the plant, apparently in quest of them.—[Dr. E. H. Anderson, Madison.

Ducks, geese, chickens, most small birds, and especially turkeys, wild and tame.—[C. Welch, Covington.

I have seen birds eating the worms, not with much of a relish as to lead me to suppose they intended to destroy them.—[John C. Russel, Madison.

All kinds of birds, particularly the summer sparrow, also turkeys and chickens.—[I. W. Burch, Jefferson.

It is alleged by the most reliable observers that a number do so. Being near-sighted I cannot swear to seeing anything of the kind.—[D. L. Phares, Madison.

I have not observed any wild bird feeding on the worms. I have noticed small pigs and some large hogs feeding on them; and our domestic turkeys are the greatest enemies of that worm.—[George V. Webb, Amite.

The blue-bird, mocking-bird, and martin feed on them, the martin on the moth, the others on both moth and worm. Chickens and turkeys also feed on them. They both soon learn to find the chrysalis. I have often seen chickens jumping up for them. A few years ago I called to see a friend in an adjoining county who had a large plantation, and found his cotton stripped of its leaves, except a ten-acre field near his house. On inquiry he told me that his turkeys had kept the worms from injuring that field. It was then the time of the third crop of worms.—[W. Spillman, Clark.

NORTH CAROLINA.

None.—[J. Evans, Cumberland.

Birds will sometimes feed on them.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

None.—[James W. Grace, Colleton.

Black-birds and turkeys eat them.—[P. S. Felder, Orangeburgh.

Cotton-fields in the vicinity of such swamps where wild turkeys are found, suffer less damage from caterpillars, because the turkeys will destroy them. There is no bird except this that seems to eat them; this may be because there is so much else they prefer at this time of the year.—[James C. Brown, Barnwell.

TENNESSEE.

The lady-bird and bee-martin doubtless destroy a great many of the moths, and it is asserted that a small sap-sucker bird destroys the larva and eggs.—[A. W. Hunt, Perry.

TEXAS.

It is said that a little gray bird occasionally preys upon the insect.—[A. Schroeter, Burnet.

Hogs are said to feed on them when hungry, but I know of no bird or fowl that feeds on them. I have chickens, guineas, and turkeys, running in the field where the worms were numerous, but have never seen them feeding on them.—[J. M. Glasco, Upshur.

Yes; birds, ants, and pigs.—[Samuel Davis, Hunt.

Mocking-birds.—[R. Wipprecht, Comal.

The insects are destroyed, more or less, by the little martin or swallow.—[O. H. P. Garrett, Washington.

Occasionally turkeys feed on them, but to no great degree.—[W. Barnes, Cherokee.

Turkeys, chickens, and some small birds.—[P. S. Watts, Hardin.

None are known.—[H. J. H. Brensing, Bowie.

English sparrows and swine.—[P. S. Clarke, Waller.

There are no natural enemies to the cotton-worm that will benefit the farmer.—[W. T. Hill, Walker.

There are numerous enemies of the insect; all the small birds here destroy the same. The land turtles, toads, lizards, eat; chickens, turkeys, ducks, partridges, prairie chickens destroy immense numbers.—[J. H. Krancher, Austin.

There are many birds and insects that eat the worms, but none enough to stop their destruction.—[S. Harbert, Colorado.

I saved a small lot of cotton near the residence by feeding the turkeys in it, and they destroyed the worms so as to save the cotton from much injury. In 1846 and 1847, after stripping the cotton of leaves and small bolls, the worms crawled by millions through the fence in the road, and my hogs promenaded the road eating them.—[C. B. Richardson, Rusk.

Birds and domestic fowls are said to feed upon them to a limited extent, but not to diminish their number apparently, and soon tire of them.—[A. Underwood, Brazoria.

A small species of brown or black bird prey upon the worms more or less, but they soon become so numerous that the birds cannot affect them. Chickens, turkeys, and hogs are fond of the worm.—[O. H. P. Garrett, Washington.

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QUESTION 6 *a.—Are any predaceous insects or parasites known to prey upon it, either in the egg, larva, or chrysalis state?*

ALABAMA.

There is a parasite that deposits a grub that destroys it in the chrysalis state. This fact was found out by bottling a chrysalis, which hatched a parasite resembling a fly somewhat smaller than a house-fly.—[James M. Harrington, Monroe.

We know of none.—[H. A. Stolenwerck, Perry.

I think not.—[I. D. Driesbach, Baldwin.

The common little red ant is the only insect known to attack it.—[H. C. Brown, Wilcox.

Ants.—[Knox, Minge, and Evans, Hale.

It is believed that the common black ants prey upon the egg. I know of none interfering with the worm or chrysalis.—[C. M. Howard, Autauga.

I know of none.—[D. Lee, Lowndes.

I know of no insect that preys upon it.—[A. D. Edwards, Macon.

Ants are numerous at times, and seem to feed on them.—[Andrew Jay, Conecuh.

I have seen the ants at work on the egg and larva.—[I. F. Culver, Bullock.

I do not think that the eggs are fed upon.—[P. T. Graves, Lowndes.

Yes; the ichneumon fly in the chrysalis state and ants in the eggs and larva.—[J. A. Callaway, Montgomery.

But the eggs are so much more numerous than the ants that the eggs are not missed.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

Carabid beetles, more especially the *Cicindelidae*, destroy both eggs and larva.—[E. T. Dale, Miller.

There are none.—[T. S. Edwards, Pope.

The small red ant.—[Norborne Young, Columbia.

FLORIDA.

A large, black wasp will eat the larva and worm. And there is an insect commonly called the musquito-hawk (I do not know its technical name); it is long-bodied, has two sets of membranous wings, a large head, and a long continuation of the abdominal portion of the body; there are many sizes and colors; they live on insects and on each other. I have frequently seen them catch the moth of the cotton caterpillar. These musquito-hawks are very numerous here, of many varieties, varying in size from an inch to $2\frac{1}{2}$ or 3 inches in length of body, and I think it does more to prevent the development of the cotton caterpillar than all the rest of its enemies.—[F. M. Meekin, Alachua.

We only know through the entomologist that there is an ichneumon-fly that lays its eggs in the caterpillar.—[R. Gamble, Leon.

GEORGIA.

The ant preys upon the egg and worm to a certain extent.—[William A. Harris, Worth.

None, that I ever heard of.—[M. Kemp, Marion.

None, to effect its progress.—[Timothy Fussel, Coffee.

One species of the ichneumon.—[William Jones, Clarke.

Enemies, the most numerous of which were pupae of *Pimpla conquisitor*. There were also a number of *Tachina* larva noticed.—[A. R. Grote.

LOUISIANA.

Never saw any.—[H. B. Shaw, Concordia.

Many kinds of insects prey upon the army worm while in the shape of eggs, and afterward while in the form of worms. Ants of many kinds are found preying on them in good weather, but not in bad, and this is one reason given why the worm increases so much faster in rainy, wet weather than in dry and fair weather. The cotton-fields have many enemies of the worm out in fair weather devouring eggs and worms, but rain and wet drive these enemies back to their retreats, and then the worm breeds without let or hinderance.—[D. M. Hamilton, West Feliciana.

I know of nothing that preys upon it in any form.—[John A. Maryman, East Feliciana.

The chinch-bug is known to be one of its enemies, but of late years the ant has proved to be the greatest enemy, both to the egg and larva. I entertain the belief that they will ultimately destroy the worm if it should prove to be indigenous rather than of foreign origin.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

Yes; have often found the worm with its juices sucked out; have seen a small louse at work on a dead worm; also am satisfied there is an insect that deposits its egg either

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in the worm before he webs up in the chrysalis state; the larva hatches and feeds upon it.—[J. W. Burch, Jefferson.

None known.—[John C. Russel, Madison.

I have seen a green chinch sucking the juices of the cotton-worm; cannot say that the worm was injured by the act.—[J. Culbertson, Rankin.

I know of none.—[C. Welch, Covington.

In 1870 I gathered 180 chrysalides on the 16th of November. I put them up, some in earth and some in cotton-seed; the following February the ichneumon flies commenced coming out of them instead of the caterpillar flies. I failed to get a caterpillar fly out of the lot. This year I gathered 100 on the 1st of November and put them up as they were webbed up in the leaves; ten days after I found all except four destroyed by very small insects.—[I. G. G. Garrett, Claiborne.

There is an insect, the name of which I cannot give, that pierces with its back into the worm and the worm expires; but this is of no consequence, the number of worms being billions and the bugs few comparatively.—[George V. Webb, Amite.

Many are said to do so, of which I cannot testify, but for the following I can: 1. Soldier-bugs pierce the caterpillars, suck their juices, and then destroy them. (See illustration plate Rural Carolinian, August, 1870, p. 683). The soldier-bug presents his lance, moves deliberately and steadily along till the caterpillar is impaled. Then come smaller soldier-bugs, sometimes quite a number, and join in the feast. 2. Certain ichneumon-flies deposit their eggs in them, when the chrysalis turns out the ichneumon-fly instead of the *Aletia*.

3. Another soft, small parasite fosters on the chrysalis. There is another fly which is probably an enemy of the *Aletia*, but too sly to be caught. The boll-worm and moth I do not give, nor a species of social caterpillar which I have not seen on the cotton-plant for many years, nor several spiders which infest it, nor the cut-worms, &c.—[D. L. Phares, Madison.

I have never seen the worm attacked by any other insect than the grass-worm, and then only when brought in contact. I find the lady-bird and ichneumon fly and other insects frequenting the plant among the worms.—[Dr. E. H. Anderson, Madison.

In my report on the cotton-infesting insects made last autumn, in the portion in which mention is made of insect enemies of the *Aletia*, one is referred to and obscurely figured on paper. I find that my son had drawn it separately and distinctly, and it proved to be a *Coccinella* or *Hippodama*. We are both of the opinion it is the larva of *Coccinella novemnotata*, so abundant on the cotton-plant.—[D. L. Phares, Wilkinson.

NORTH CAROLINA.

None.—[J. Evans, Cumberland.

No.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

None.—[James W. Grace, Colleton.

The common ant maintains an equilibrium when it is not too wet. The ant will destroy the eggs unless the rainy weather keeps it in its retreat. This is the reason that a dry season is never a caterpillar one.—[James C. Brown, Barnwell.

TENNESSEE.

The family, in its different phases, are preyed upon by ants, the ichneumon, the *Megacephala Carolina*, and perhaps several other insects. Their destruction by enemies must be greater than is at present supposed. This is one field in which the labor of entomologists might be profitably employed.—[A. W. Hunt, Perry.

TEXAS.

The little black ant will devour the eggs, as they do the lice that sometimes get on the plant while young.—[P. S. Watts, Hardin.

Some species of the ant will prey upon the egg.—[O. H. P. Garrett, Washington.

There are several species of beetle that prey on them, but as they live on the ground and the cotton-worm on the plant, they get but few. The devil's coach-horse, *Reduvius novenarius*, the ichneumon-fly, and a few other insects prey on the worm, but not to any perceptible diminution of them.—[W. Barnes, Cherokee.

None are known.—[H. J. H. Brensing, Bowie.

Ants.—[P. S. Clarke, Waller.

I believe there is a parasite that sometimes attacks the larva; this I infer from finding the larva nearly dead, dead, and decaying. I gave it but little attention at the time, for I was thoroughly disheartened by their ravages.—[J. M. Glasco, Upshur.

Ants; no parasites observed.—[Samuel Davis, Hunt.

Ants prey upon the egg, larva, and chrysalis.—[S. B. Tackaberry, Polk.

Nothing but the small ant.—[S. Harbert, Colorado.

In dry weather the little ants that are to be found everywhere prey upon them;

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when they get knocked off on the ground and the sun drives them up the stalk for protection, they attack the chrysalides, &c.—[Natt. Holman, Fayette.

None that I have any knowledge of.—[J. W. Jackson, Titus.

Numberless insects destroy it, viz, wasps, lady-bugs, (destroy the egg), devil's horse or alligator fly, spiders, the rear or devil's horses, (*Mantidae*), and several varieties of field bugs are its most active enemies; also several varieties of metallic-green large bugs, sometimes called Spanish flies and ants.—[J. H. Krancher, Austin.

QUESTION 7.—*What has been the result of the efforts to allure and destroy the moths, and what methods have proved most satisfactory? Give your estimate of the relative value for this purpose of poisoned sugar, molasses, and vinegar, and fires.*

ALABAMA.

All the vegetable poisons, as china, Jerusalem oak, Jamestown weed, &c., have been tried and failed. Lamps and pine-knot fires were only partially successful. No gins or traps have been used that we know of. In fact, nothing has been successfully used but Paris green (Royal's patent). The Texas "worm destroyer" was successful at first; last year it failed, and the planters who used it here think it has been counterfeited or in some way deteriorated. The fact we think is that they did not make it strong enough. Great care must be observed not to put too much of either this or Paris green on the cotton, for they all contain arsenic, which will certainly parch up the leaves and injure the cotton. We have no experience in molasses, vinegar, and fires; they are all too slow for this emergency.—[Dr. John Peurifoy, Montgomery.

I have seen fires used at night and drugs used to poison, but don't believe it ever did any good, for the worms finally eat up all the cotton.—[I. F. Culver, Bullock.

Efforts have been made to allure and destroy the moths years ago by lights and poisoned sugar, and molasses and vinegar. While they destroyed large quantities of the insects, it did not seem to affect the numbers of worms to any extent, and do not consider that means of any practical value.—[John D. Johnston, Sumter.

The Paris green is the only remedy tried in this locality for the destruction of the worms, and that with but little success.—[J. S. Hausberger, Bibb.

Nothing yet satisfactory.—[A. D. Edwards, Macon.

The results of the efforts to allure and destroy the moths have generally proved unsatisfactory; poisoned molasses is supposed to be the best method.—[J. A. Callaway, Montgomery.

Some years ago the planters (many of them) used tin plates made for the purpose, on which were placed vinegar sweetened with sugar or molasses. Fires were also made on stands in the field to attract the fly. But as they have been generally abandoned, I suppose the results were not satisfactory.—[H. Tutwiler, Hale.

All the suggestions published in newspapers have been tried by the farmers of this county by building fires at night and then going with brush in hand through the cotton, also stake fires with pans of water; all failed to do any perceptible good.—[P. D. Bowles, Conecuh.

The ravages of cotton insects in this country have been considerable, but no experiments have been made to check or destroy them.—[J. W. Elliott, Marshall.

Efforts made to destroy moths have all proved failures; none of them worth a cent.—[M. W. Hand, Greene.

There have been several experiments made with lighted torches, but nothing yet discovered that proved a success.—[H. C. Brown, Wilcox.

But little has been accomplished; much money has been wasted in efforts to poison them.—[J. C. Matthews, Dale.

The moth will be attracted by sugar and molasses. Fires are more attractive and destructive.—[R. H. Powell, Bullock.

I have no experience; have made no efforts to allure or destroy except when they first appear, which is generally in a small space. What I have done, then, was simply to get a number of hands and pick them off and kill them, and I am led to believe if there were no neighboring fields to supply the crop of flies adjacent they can thus be set back one generation or be, say six weeks, later in their destruction. All cannot thus be killed, of course.—[Andrew Jay, Conecuh.

Have tried fire and sulphur without good effect.—[James M. Harrington, Monroe.

Lights at night and sweetened baits have been used, but with such unsatisfactory results as to be abandoned.—[Charles M. Howard, Autauga.

None.—[Knox, Minge, and Evans, Hale.

Honey, sugar, sirups, and sorghum sirup are the sweets used. Fires at night have been resorted to for the destruction of the moths. Coal-oil has been experimented with. The difficulties met with in using it are: 1st. Want of a suitable means of throwing the mixture of water and oil upon the plants; 2d. The danger of killing the

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plant when the proportion of coal-oil is too great; 3d. The mixing of the oil and water.—[E. A. Smith, Tuscaloosa.

No efforts have been made to destroy the moth. Fires will attract them.—[H. A. Stolenwerck, Perry.

I have known little success to follow the efforts to destroy the moths.—[D. Lee, Lowndes.

Paris green was used some years past for the cotton-worm.—[George W. Thagard, Crenshaw.

Every effort to destroy the moth by allurement or traps are consummate failures. I have experimented in trying to decoy, and have known others to try fires, traps, and lamps at night, and every effort was worthless and a loss of time. Vinegar, molasses, &c., on plates, or otherwise, worth nothing.—[H. Hawkins, Barbour.

No method has been even hopeful for decoying the moth. If a concerted effort could be made with lights, sweetened water, and poison, success is possible, yet where one plantation is guarded and another not, the moths from the unguarded field will be in sufficient numbers to bring destruction in a few days.—[P. T. Graves, Lowndes.

The different methods have been tried to destroy the moth, but all have failed.—[J. N. Gilmore, Sumter.

Fires or lights at night attract them.—[C. C. Howard, Autauga.

But little value is attached to this method of destruction. It has only been tried on a limited scale. Poisons, torches, &c., have been used with but little success.—[R. W. Russell, Lowndes.

All methods of alluring the moth by fires or sweetened substances have proved futile. Many are indeed destroyed, but sufficient remain to do their destructive work.—[R. S. Williams, Montgomery.

As everywhere in Alabama and Mississippi, nothing is done at present for the destruction of *Aletia*. It is very troublesome to find a contrivance which has been in use for some years.—[E. A. Schwarz, Barbour.

I spent one day and a half in hunting up a lantern which was used here three or four years ago. The manufacturer of this lantern, which I sent to the department per express, sold, in 1873 or '74, 100 at 75 cents apiece. The pan at the bottom of this lamp is filled with molasses. There is, of course, a chimney belonging to it, which the express company refused to send on with the lantern. However, this chimney is not peculiar. From information received from several farmers, I learned that these lanterns were very effective and were discarded, partly owing to the fact that the worms have not been destructive in the past few years, and partly because only a few of the planters used them. The Rev. C. R. Dudley, of Canton, Miss., has invented and patented, in 1872 or '73, a lantern for the destruction of *Aletia*, and about 50 of his lanterns were sold in Canton at about $1 apiece. I did not succeed in getting one of these lanterns, and the manufacturer of them, Mr. Snyder, in Canton, was unable to give me a description. Mr. Dudley has taken back all lanterns not sold, and has removed to Saint Louis, Mo., where letters will reach him care of Dr. Rob. Faris. These lanterns consisted of a kerosene lamp with a parabolic refractor, and a sticky substance was smeared on a pan surrounding the lamp.—[E. A. Schwarz, Barbour.

ARKANSAS.

There have been no remedies used to destroy it in this county, except a patent some one made in the shape of a funnel with a light placed in it. I think fires would be preferable to anything else, as the moth is attracted by light, and would be consumed.—[T. S. Edwards, Pope.

No experiments.—[Norborne Young, Columbia.

Some experiments made with fires show that the fires, while they attract the moths, destroy but few, and fields in which fires have been kept have suffered more than those adjacent in which there were no fires.—[E. T. Dale, Miller.

FLORIDA.

Little or no effort has been made. My opinion is that something could be done with poisoned molasses and fires or lamps. A few nights ago I placed a cup 3 inches in diameter with a little molasses in it at a distance from lights and cotton-plants, and found 6 moths in it the next morning, all of them cotton caterpillar moths. A year or two ago I divided an overripe watermelon and placed it in a similar position, and by eight o'clock at night there were 50 or 75 moths feeding on it. Watermelons could be easily grown with cotton and made to serve a good purpose.—[John Bradford, Leon.

No remedies ever tried in this county.—[John B. Carrin, Taylor.

Have no experience in destroying moths; think that fires or rather torches at night, established plentifully over the field, would be most destructive, as the moth seeks the torch. I further believe that the field-hands ought to be instructed to watch or observe the plant closely when hoeing, and destroy all the worms found. Intelligent and faithful hands might prevent the destructive increase by this timely prevention.—[F. M. Meekin, Alachua.

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GEORGIA.

Many futile and unsuccessful efforts have been made, such as poisoning and building, but all proved to be a failure.—[S. P. Odom, Dooly.

Have never tried any remedies to destroy them. I think fires at night would destroy the moth.—[Timothy Fussell, Coffee.

I do not believe any of the methods of destruction mentioned would do any good.—[William Jones, Clarke.

They seldom appear in our neighborhood in such numbers as to do much damage, but when they do come it seems as if any attempt to destroy them could not but be futile; certainly nothing has yet been done that is at all adequate.—[A. J. Cheves, Macon.

We have tried Paris green and arsenic alone, with some success.—[William A. Harris, Worth.

The most satisfactory effort is the night-lamp. Paris green does its work well, but it is dangerous. Fires built all over the field at night is, in my opinion, the best way to destroy them.—[M. Kemp, Marion.

None has ever been used in this county.—[D. P. Luke, Berrien.

There has been little attention paid to the destruction of this moth, because we do not consider them as hurtful as in other sections.—[E. M. Thompson, Jackson.

LOUISIANA.

I know of nothing but Paris green being used of late years. Lamps, fires, and some substance beneath the fire have been used, but abandoned, as it generally turned out that enough moths escaped after being attracted by the fire to entirely destroy the cotton where the fire was used. It might be advantageous to concentrate by this means the worms on certain portions of the cotton, and then destroy them by Paris green at much less cost. Think they are attracted more by the light as all other moths are.—[H. B. Shaw, Concordia.

No good has resulted from the efforts to allure and destroy the moths; no actual benefit from poisoned sugar, molasses, and vinegar, and fires.—[Dr. I. U. Ball, West Feliciana.

I have never tried any plan to destroy the moths, but have heard of many. No plan will avail unless it is general, for the reason that one planter who neglects to destroy the moths on his place, would cause enough to be produced in his fields to eat up the whole neighborhood. No doubt thousands could be destroyed by logs piled up and fired in the fields at night, or by fires built on platforms of pine, or other inflammable materials, or by large lamps or other contrivances. The moths are attracted great distances at night by lights, and many injurious ways might be planned to attract and destroy them.—[D. M. Hamilton, West Feliciana.

All efforts to destroy the moths have been useless.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

For a number of years nothing in my part of the country has been done to destroy them. Some attempts were at one time made, but did not prove satisfactory, and have all been abandoned. Like every other misfortune, we have made up our minds to submit to it.—[K. Clarke, Chickasaw.

Without general concert of action, I think individual effort would be useless.—[C. F. Sherriod, Lowndes.

No efforts have been made here to destroy them, except to pick off and destroy the worm and chrysalis, all of which proved futile.—[C. Welch, Covington.

Building fires at night has been practiced by some; the results I am unable to give. I know of no poisoned sugar, &c., having been tried.—[William T. Lewis, Winston.

Few or no remedies have been used in my locality. Some years since, light wood-fires and plates filled with molasses and vinegar were used with partial success. Lanterns of several kinds have been used, all with some success, in destroying the moth.—[Dr. E. H. Anderson, Madison.

The people of this county do not dread the cotton-worm, and but little has been done for its prevention or destruction.—[J. Culbertson, Rankin.

I think fires, where general, are most satisfactory.—[Daniel Cohen, Wilkinson.

Nothing very satisfactory.—[D. L. Phares, Wilkinson.

Small fires at night destroy great numbers; do not know anything about the molasses, &c.—[W. Spillman, Clarke.

Every effort to destroy them has been a failure. The greatest destruction of the moth has been accomplished by placing lights in the fields at night; the moth flies into it and is destroyed; fires are far the least expensive, and as much better than poison as they are cheaper.—[George V. Webb, Amite.

Perfectly satisfactory to my mind when fully carried out. I saved my crop in 1874 by a system of lanterns, pans, coal-tar, molasses and vinegar. I used a post six feet high and a sheet-iron pan, eighteen by twelve, on top of post, a block of wood in the pan for the lantern to set in; pan filled with molasses or coal-tar: light the lantern

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and you will catch every moth on an acre. Molasses and vinegar attracts better than anything used in conjunction with a bright lantern; one-half of a star candle that will burn three hours is sufficient, as the moth flies early after dark. Did not use anything this year; yellow fever absorbed everything here.—[J. W. Burch, Jefferson.

NORTH CAROLINA.

The worms are so few and rare in this section that no effort has been made to destroy them.—[F. I. Smith, Halifax.

No remedies have ever been used in this county.—[J. Evans, Cumberland.

SOUTH CAROLINA.

I believe one of these plans as good as another, and all of them useless.—[James W. Grace, Colleton.

We cannot give you any information as to remedies or methods of destruction. The worm has never threatened us with such damage as has been experienced in more southern localities, and nearer the coast, and have, therefore, never had to resort to anything of the kind. I have not heard of any farmer in this county who ever tried any experiment. When one had a flock of turkeys or many fowls, he would turn them on the cotton infested with the worm with good results.—[James C. Brown, Barnwell.

TENNESSEE.

This is another field in which the entomologist can, as I believe, be profitably and successfully employed. Success will, perhaps, be achieved when the entomologist combines as his assistant practical knowledge so common among planters and scientific attainments in entomology, or, rather, natural history. Poisoned sugar, as ordinarily used, is of little value; molasses and vinegar are useless; fires, unless used by all planters, decidedly hurtful.—[A. W. Hunt, Perry.

TEXAS.

I know nothing of poisoning, as it has never been tried in this locality. Fires have been tried, but without any effect. One man in this neighborhood tried lamps surrounded by small tin plates, smeared with molasses. If he ever caught any I never heard of it. Many people went to see the result of his experiments, but nothing came of it. Half an hour after sunset the moth may be seen flitting about among the cotton-plants, scarcely ever seen above the tops of the plants, depositing eggs on the under side of the leaves mostly; if not disturbed, never appearing during the day.—[J. M. Glascoe, Upshur.

None have been used except fires.—[H. J. H. Brensing, Bowie.

So far no remedies of any kind have been applied.—[A. Schroeter, Burnet.

A field upon which the worms had made their appearance was promptly sprinkled with the arsenite of soda, prepared at Lodi, New Jersey, and not a worm was to be found and the plant itself had sustained no perceptible injury. It was the only crop in the neighborhood that was not eaten up.—[William J. Jones, Galveston.

I know of none tried.—[W. Barnes, Cherokee.

I know one man that built large fires around his field and destroyed a great many; this is the only remedy tried within my knowledge.—[P. S. Watts, Hardin.

Molasses, with burning lamps, has proved most satisfactory. Unless everybody uses this remedy it is hurtful to those who do, as it attracts the moths of the unilluminated fields.—[R. Wipprecht, Comal.

Poisoned sugar, molasses, and vinegar, used in day-time, and fires or lights placed so that the moth falls into a vessel of gummy matter, have been found efficacious for their destruction, but has never proved wholly so, probably owing to the fact that they are not used early enough or not long enough.—[S. B. Tackaberry, Polk.

Remedies used here have been Paris green mixed with flour, put on by means of a sifter when the cotton is damp. Arsenic dissolved in water is also used; both have proved effectual. The arsenic has proved the most satisfactory and cheapest; judgment has to be exercised or the cotton will be killed with the worm.—[O. H. P. Garrett, Washington.

Nothing attempted in that way in this section.—[A. Underwood, Brazoria.

I have tried making lights all over the farm, with no success. The moth would pass about the cotton seeming not to see it till disturbed. I do not think anything in the way of destroying moths will answer, as they will fly long distances (at night) from other sections of the State, and fill your field with eggs in a couple of days. Have never used sweetened poisons.—[W. T. Hill, Walker.

In 1846 and '47 some planters made pine fires on scaffolds in the field, and had some hands catching the worms, and in 1864 I put 20 hands on three acres to killing the worms, but neither had any good results.—[C. B. Richardson, Rusk.

But few efforts have been made to destroy the moths, farmers of late years chiefly relying on poisoning the worms. However, the idea is gaining foothold that it is better to try and destroy the moth, and thereby prevent the appearance of the worm

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in destructive numbers. The best mode seems to be to set up lights in the field above or in front of some sweet adhesive substance. Moths appear to be attracted by all sweet substances. I have seen them attracted in thousands, after the first brood had webbed up, by dried peaches that were dried on boards in the sun, and had been covered at night with boards, the moths collecting in thousands under the covering of the dry peaches, hundreds being killed by a lamp in a short time. A mouse made a nest with the dead moths the same night.—[J. H. Krancher, Austin.

I am satisfied that this moth does not come here to toil, neither to spin, nor to hunt sweet-scented flowers, nor boards nor trees nor any other thing besmeared with sweetened substances, but to lay its eggs, nothing more, then lie down and die.—[P. S. Clarke, Waller.

Watermelons cut open and spread around with arsenic sprinkled on them will kill the moth.—[Natt. Holman, Fayette.

I have tried to allure the moth with fire, both lamp and torch, also molasses and vinegar, with but little effect. The only one that promises to be a safe remedy is a preparation of arsenic manufactured at Galveston, Tex. It is applied by sprinkling liquid like Paris green, known as the "Texas cotton-worm destroyer."—[J. W. Jackson, Titus.

I used with full effect the arsenite of soda combined with a little vinegar and molasses. I did not use any intoxicating liquids as I was fully satisfied that every moth imbibing the poisoned sweet was instantly killed, none of the dead appearing at any appreciable distance from the pans.—[William J. Jones, Galveston.

QUESTION 7 *a.—Are the moths most attracted to sweetened substances when smeared onto trees, boards, &c., or when contained in vessels in or near which lamps may be lighted?*

ALABAMA.

Have always noticed that while making molasses at night, unless some protection is used, the evaporator will be frequently choked with the moth, either attracted by the odor of the cooking sirup or by the light, or both.—[R. F. Henry, Pickens.

Attracted to vessels when near lights, and great numbers are destroyed by the lights.—[John D. Johnson, Sumter.

I think it would make but little difference wherever it was placed.—[R. W. Russell, Lowndes.

I do not know that they are attracted by saccharine substances.—[R. S. Williams, Montgomery.

They are often seen in great numbers under apple trees where the apples have fallen and were rotting on the ground; also under peach trees where the peaches have fallen.—[H. Tutwiler, Hale.

On trees, boards, &c.—[J. A. Calaway, Montgomery.

Of the attraction of molasses or any other preparation on trees where lamps or fires are lighted we have no experience. They are all certainly too slow for this emergency, when the Lord Almighty only knows how many eggs one moth will lay.—[Dr. John Peurifoy, Montgomery.

I do not know; lights do not attract them much, though sometimes one may be seen flying around the lamp.—[D. Lee, Lowndes.

We have tried fires.—[Knox, Minge, Evans, and Hale.

I know that the wine-press will attract them by thousands in the night two or three miles from the cotton-field. I have noticed the tubs left under the press at night would have two or three hundred moths in next morning; no lights near the wine-press; this the 1st of September. Never heard of any one trying any of the articles named.—[P. D. Bowles, Conecuh.

I have never tried sweetened substances, &c.; but I see they are readily attracted to newly pulled fodder.—[James M. Harrington, Monroe.

Have no knowledge on this question. We noticed this year that the moths were more numerous under the persimmon trees when the fruit was ripe and fallen on the ground. They collected in large numbers under the trees, I suppose sucking the sweet of the persimmon.—[H. A. Stolenwerck, Perry.

Never heard of sweetened substances being used.—[H. C. Brown, Wilcox.

I do not think they are.—[J. C. Matthews, Dale.

The moth is often found feeding under apple and peach trees, where decayed fruit is plentiful; also later in the season under persimmon trees.—[C. M. Howard, Autauga.

As yet I have not been fortunate in getting a solution by which the moths are readily killed. I tried corrosive sublimate and arsenious acid, with rum, molasses, and water in various proportions. The solutions I have smeared upon pine trees standing in the field, upon little shelves set up at places in the field, and upon a dish placed upon a stump. To one pine tree in particular the moths seemed to be attracted most strongly.

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The shelves attracted very few comparatively. I have used for poisons, arsenious acid, corrosive sublimate, strychnia, and potassium cyanide; these I have mixed in varying proportions with rum and sweetened water. The bait appears attractive enough, and I see the moths partaking of it, and yet no dead moths are visible next morning. The proportion of rum which I have mixed with these poisons has been sometimes one-half, and from that down. Of the poisons named above the potassium cyanide is perhaps most easily soluble in the liquids used. Smearing the sweetened liquids upon the trunks of trees is, according to my experience, the best way of exposing them. I have not seen many moths around the dishes set up on shelves and on stumps. The arsenious acid, strychnia, and corrosive sublimate I dissolved to saturation in the sweetened liquids; sweetened water and vinegar I have also found to be one of the most attractive baits.—[E. A. Smith, Tuscaloosa.

The moths are attracted by light.—[A. D. Edwards, Macon.

Moths are attracted by nothing at night but the lights, which they go into as soon as they can reach it.—[M. W. Hand, Greene.

I have no experiments to aid me in answering the inquiry. They seem to be greatly attracted (that is the fly) to places where we make molasses; will get into the evaporator, if it contains partially boiled juice, all night in immense quantities unless covered. Also get into the molasses troughs. Lights are attractive to the fly.—[Andrew Jay, Conecuh.

Moths are not attracted by any sweet substance or device in this county.—[H. Hawkins, Barbour.

Failures. I think none of them of the least value. They are impracticable.—[C. C. Howard, Autauga.

Sweetened substances, such as honey-water molasses-water, or, best of all, fruit juices, placed in closely-sheltered places, in shallow vessels, attracts most. But I hold the opinion that the moth only seeks juices after the egg-laying period is past to supply the wastes of vitality, *i. e.*, in old age.—[P. T. Graves, Lowndes.

I do not believe the moth is attracted by any sweetened substances whatever; if they get to it I think it is accidental.—[J. N. Gilmore, Sumter.

ARKANSAS.

Molasses and other sticky substances will catch many moths when near lamps or candles, but not otherwise.—[E. T. Dale, Miller.

There has been nothing of the kind tried here.—[T. S. Edwards, Pope.

FLORIDA.

They are not attracted by any bait of any kind, nor has any known benefit been attained by the use of any lights.—[R. Gamble, Leon.

GEORGIA.

I cannot say I think they are drawn there by the light of the lamps.—[M. Kemp, Marion.

We have never tried sweetened substances.—[Timothy Fussell, Coffee.

They have no disposition for anything of the kind. They appear to recognize the fact that they have a mission to fill, and they go forward and do it.—[S. P. Odom, Dooly.

Never tested; can't say; no attention is paid until the worm is on us; then they go to work to destroy it. They live on careless, hoping it will appear no more.—[William A. Harris, Worth.

LOUISIANA.

I have no knowledge of moths being fond of sugar, molasses, or other sweets, and was not aware of any such plan of catching them.—[D. M. Hamilton, West Feliciana.

I have never known the moths to be attracted to anything but lights.—[Dr. I. U. Ball, West Feliciana.

I do not think they eat anything sweet. They will fly around a light at night, as any other fly will do.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

Lamps lighted are a greater attraction to the moths than sweetened water.—[C. F. Sherriod, Lowndes.

Nothing known.—[D. L. Phares, Wilkinson.

I always thought that the moth was attracted by the light, and not by any sweetened substances near it.—[John C. Russell, Madison.

The light reflected from any fluid placed near a lamp or light, or even starlight or moonlight, would prove more attractive than if spread on boards, trees, &c. The light seems to be the attraction.—[Dr. E. H. Anderson, Madison.

I do not believe that sweetened substances will attract them at all.—[George V. Webb, Amite.

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NORTH CAROLINA.

Never has been tried.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

As all moths, these are attracted by a light to a certain extent, but we do not believe that any kind of food will be found to attract them at all. When they are found around vessels or boards or trees smeared with molasses or vinegar, we believe their presence is simply a coincidence and not the result of a search for food.—[James W. Grace, Colleton.

TENNESSEE.

Perhaps the moths are most attracted to sweetened substances when near lights; but, as I have said, the lights are harmful.—[A. W. Hunt, M. D., Perry.

TEXAS.

The moths are attracted most by lamps in the night, set on posts or stumps. Place the lamps or lights, as may be, in a flat tin pan with some kerosene oil in it, enough to destroy the moth; by that means it can be caught. Smearing sweet substances on trees, boards, &c., will not effect the destruction of the moth much.—[O. H. P. Garret, Claiborne.

When in vessels near lighted lamps.—[R. Wipprecht, Comal.

I have found halves of melons left on tables all night covered with the moth in the morning, but not killed.—[W. Barnes, Cherokee.

Are mostly attracted by fruit, such as peaches, figs, and melons.—[T. B. Tackaberry, Polk.

The lamp-light business is a failure. That is the plan I adopted ten years ago and abandoned it.—[W. T. Hill, Walker.

Many moths have been caught with molasses and water, but it did not appear to diminish their numbers.—[C. B. Richardson, Rusk.

Yes. I have now, in my cotton, lamps placed with water and kerosene oil in them, for the purpose of catching the moth, and would state that I am succeeding finely, catching thousands, &c.—[Natt Holman, Fayette.

In vessels near where lamps or torches have been lighted.—[J. W. Jackson, Titus.

I have placed the poisoned sweets with lighted lamps in many localities in my cotton fields, and have found dead millers in the pans and around the lamps, but not in any great numbers; none were found about the boards smeared with poisoned molasses.—[William J. Jones, Galveston.

QUESTION 7 *b*.—*Are any flowers known to be attractive to the moth? If so, specify them and their season of blooming.*

ALABAMA.

I am not aware that any flower is especially attractive to the moth except the pea flower. I have seen the moth in the pea-field (the speckled cow-pea), but never saw it eating or sucking the flower.—[H. Hawkins, Barbour.

I think the blossom of the pea. The moths go much in adjoining corn-fields.—[C. C. Howard, Autauga.

I think not.—[P. T. Graves, Lowndes.

I don't think the fly cares for any flower.—[R. W. Russell, Lowndes.

I know of no flower that has any attraction for the moth.—[J. N. Gilmore, Sumter.

I know of none.—[R. S. Williams, Montgomery.

We do not know.—[J. A. Calaway, Montgomery.

I have often seen them about the field-pea as if sucking something from the upper end of the stem to which the pea is attached, but I have never seen them notice the bloom or any other flower. The cotton-moth is very destructive to fruit of all kinds. We cannot have any peaches, grapes, apples, or figs late in the season on account of them; they suck the juice and ruin the fruit.—[D. Lee, Lowndes.

No.—[M. W. Hand, Greene.

No.—[A. D. Edwards, Macon.

I know of none.—[C. M. Howard, Autauga.

None.—[H. C. Brown, Wilcox.

Don't know.—[P. D. Bowles, Conecuh.

None that I know of.—[J. C. Matthews, Dale.

Do not know of any.—[H. A. Stolenwerck, Perry.

Have never known any.—[James M. Harrington, Monroe.

There are no flowers known to me which are attractive to the moth.—[Andrew Jay, Conecuh.

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ARKANSAS.

Don't know any.—[Norborne Young, Columbia
I do not know of any.—[E. T. Dale, Miller.

FLORIDA.

I have frequently seen them feed on the cotton flower.—[John Bradford, Leon.
It is not known that the moth is attracted by any flower other than cotton.—[R. Gamble, Leon.

GEORGIA.

Do not think flowers attract the moths.—[Timothy Fussell, Coffee.
None.—[S. P. Odom, Dooly.
No flowers attract them.—[E. M. Thompson, Jackson.
None that I know of.—[M. Kemp, Marion.
Do not know of any.—[William A. Harris, Worth.
I have been satisfied, from testing, the secretion from the glands on midrib of leaf is sweet. I find that the honey-bee has discovered the same. They seem to habitually neglect the cotton-bloom and go to the glands at base of open bloom and of young bolls from which the blooms have just fallen, and occasionally the glands of unopened blooms. The older bolls they neglect. Two or three species of wasps do the same. This seems to indicate that the glands of the blooms and of younger bolls are most active in secreting, and it may be that so soon as the cotton-plant blossoms in spring it is capable of furnishing sustenance to the *Aletia* moth.—[J. E. Willett, Macon.

LOUISIANA.

I am not aware of the moth being attracted by any kind of blossom or flower.—[D. M. Hamilton, West Feliciana.
I know of none.—[Dr. I. U. Ball, West Feliciana.
There is no flower known to be attractive to the moth; not even the cotton-flower.—[John A. Maryman, East Feliciana.

MISSISSIPPI.

I have never seen one on a flower; have seen large quantities on pea vines; they did not seem to feed, only resorted there for cover during the day.—[C. F. Sherriod, Lowndes.
No.—[C. Welch, Covington.
None.—[Dr. E. H. Anderson, Madison.
No flowers are known to attract the moth.—[John C. Russell, Madison
None.—[J. W. Burch, Jefferson.
None.—[George V. Webb, Amite.

SOUTH CAROLINA.

None.—[James W. Grace, Colleton.

TENNESSEE.

I have no knowledge of the attractiveness of any flower to the moth, though doubtless if due diligence was used some flower might be found which possesses attractive qualities to the moth.—[A. W. Hunt, M. D., Perry.

TEXAS.

I do not think any flower attracts the moth; it is bent on the cotton-leaf for a suitable place to deposit its eggs, while the bloom has no attraction.—[O. H. P. Garrett, Washington.
None known.—[W. Barnes, Cherokee.
No.—[R. Wipprecht.
None.—[P. S. Watts, Hardin.
If they feed on any flower it must be that of cotton. I think they never quit the field unless carried by winds.—[J. M. Glasco, Upshur.
Have never known them to feed from any flowers. They are fond of fruit, and will collect at night in great numbers on dried peaches. They attack very ripe apples and peaches on the trees, and entirely ruin some of the fruit.—[W. T. Hill, Walker.
None.—[A. Underwood, Brazoria.
So far I have not noticed them on any other but cotton-blooms. Some years ago, when Paris green was first employed for the destruction of the worm, large numbers of moths were noticed after the first brood; but few worms appeared at the second brood, however, the inference being that large numbers of the moths had been killed by poisoned cotton-flowers, having been found dead.—[J. H. Krancher, Austin.
None that I ever heard of.—[C. B. Richardson, Rusk.
None that I have ever heard of.—[Natt Holman, Fayette.
In addition to the cotton-plant and cow-pea there is the sweet-potato vine (green

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till heavy frost), besides the honey-dew to be found upon the leaves of many forest trees throughout the entire cotton-belt.—[William J. Jones, Galveston.

I have noticed the moth closely, and have never seen them attracted by any flowers.—[J. W. Jackson, Titus.

QUESTION 7c.—*What do you know of your own observation of the influence of jute grown near or with the cotton?*

ALABAMA.

I am unacquainted entirely with the growth of jute. While I have never experimented with a vine to any general benefit, yet, from casual observation, I think cotton planted with corn, say in alternate rows, would be more likely to escape being destroyed. This idea grew out of seeing some stalks of cotton come up from cotton-seed used for manuring corn and allowed to mature, which retained its leaves and made late cotton when the fields around were eaten clean.—[Andrew Jay, Conecuh.

I know nothing; never saw it growing.—[I. F. Culver, Bullock.

Nothing.—[R. F. Henry, Pickens.

We do not suppose that there is a stalk of jute in this beat. In fact it is a plant we never saw, and know nothing about it.—[Dr. John Peurifoy, Montgomery.

Nothing.—[J. A. Callaway, Montgomery.

No jute grown in this county.—[P. D. Bowles, Conecuh.

It has never been tried that I know of—[J. C. Matthews, Dale.

Nothing.—[C. M. Howard, Autauga.

Nothing.—[I. D. Driesbach, Baldwin.

Nothing.—[James M. Harrington, Monroe.

No jute grown here.—[H. C. Brown, Wilcox.

Have no knowledge about it.—[H. A. Stolenwerck, Perry.

Jute is not cultivated here.—[R. H. Powell, Bullock.

None; no jute ever grown in this locality.—[Knox, Minge, and Evans, Hale.

I never saw jute grown with or near cotton.—[D. Lee, Lowndes.

Nothing.—[M. W. Hand, Greene.

Nothing.—[H. Hawkins, Barbour.

Nothing.—[C. C. Howard, Autauga.

No jute grown in the county.—[T. S. Edwards, Macon.

I do not know.—[E. T. Dale, Millers.

No jute growing here.—[Norborne Young, Columbia.

I have grown cotton and jute side by side with no good results. To test the matter I one year planted alternate rows of cotton and jute. The caterpillars eat the cotton clean and *webbed up on the jute.*—[John Bradford, Leon.

No jute ever grown here.—[John B. Carrin, Taylor.

GEORGIA.

Nothing.—[M. Kemp, Marion.

None whatever.—[S. P. Odom, Dooly.

Nothing known of jute.—[E. M. Thompson, Jackson.

Nothing.—[D. P. Luke, Berrien.

Never saw a stock of jute in my life.—[William A. Harris, Worth.

Nothing.—[Timothy Fussell, Coffee.

LOUISIANA.

Nothing.—[H. B. Shaw, Concordia.

Have no personal knowledge as to the planting of jute near cotton to keep away the army worm. Have heard of something of the kind, but placed no confidence in what was said about it. Have also heard something about the castor-oil plant and Jamestown weed having the same effect when planted about or through the cotton-fields.—[D. M. Hamilton, West Feliciana.

I know nothing about the jute growing among the cotton.—[John A. Maryman, East Feliciana.

I have no knowledge.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

In 1877 I planted jute within 30 feet of a cotton-field. Worms did not eat up the cotton until late in the season, but I can't say it was the jute that delayed them; hardly think it was, as they would have as little regard for jute as for any other weed.—[J. W. Burch, Jefferson.

Nothing.—[Dr. E. H. Anderson, Madison.

I know of none.—[William T. Lewis, Winston.

Nothing.—[C. Welch, Covington.

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Never have seen jute near cotton and cannot say.—[John C. Russell, Madison.
Nothing.—[D.L. Phares, Wilkinson.
It has as yet not been tried here.—[George V. Webb, Amite.

SOUTH CAROLINA.

We have never planted or seen planted the jute, so of our own knowledge know nothing of its effects; although we have seen an essay wherein it was stated that a field around which a row of jute was planted in Texas was not touched by the worm during a destructive worm season and when the cotton all around was destroyed.—[James W. Grace, Colleton.

TENNESSEE.

I know nothing of the influence of jute grown in the vicinity of the cotton-field.—[A. W. Hunt. M. D., Perry.

TEXAS.

Several years ago the Agricultural Department furnished packages of jute-seed to farmers with the request they would plant with a view to its effect on the cotton-worm; but few tried it, and they expressed the opinion that if a sufficient breadth be planted it might arrest their progress while traveling.—[J. M. Glasco, Upshur.
Jute has never been grown here.—[Samuel Davis, Hunt.
Nothing. I planted jute near a cotton-field, but only a few seed came up.—[P. S. Watts, Hardin.
Have never tried the effect of jute grown near cotton.—[O. H. P. Garrett, Washington.
Nothing.—[S. B. Tackaberry, Polk.
Nothing.—[W. Barnes, Cherokee.
Nothing.—[P. S. Clarke, Waller.
No influence.—[R. Wipprecht, Comal.
Have no experience. It is said though that hemp planted around cotton-fields will to some extent prevent the approach of the moth; jute being an analogous plant may have the same effect.—[J. H. Krancher, Austin.
Know nothing of the influences of jute, but have seen many other similar notions tried and fail.—[W. T. Hill, Walker.
Never heard of any being planted.—[C. B. Richardson, Rusk.
None whatever.—[J. W. Jackson, Titus.
Never have grown any or seen any growing.—[Natt. Holman, Fayette.

QUESTION 7*d*.—*Has any effort been made to destroy the moth in its winter-quarters?*

ALABAMA.

No.—[R. F. Henry, Pickens.
None.—[I. F. Culver, Bullock.
None.—[R. S. Williams, Montgomery.
I do not believe the moth has any "winter-quarters." Have never seen a moth in winter.—[J. N. Gilmore, Sumter.
None. The opinion is held, I think correctly, that the moths that spend the winter fail to find cotton-plants upon which to deposit their eggs, and consequently fail to propagate, so any effort to destroy them would be wasted.—[P. T. Graves, Lowndes.
No.—[J. A. Calaway, Montgomery.
The moth's winter-quarters are in shuck-pens, fodder-lofts, attics, hollow trees, under pine bark, in rotten wood, &c., perfectly inaccessible to man.—[Dr. John Peurifoy, Montgomery.
Not that I am aware of.—[J. D. Driesbach, Baldwin.
None.—[Knox, Mingo, and Evans, Macon.
None.—[James M. Harrington, Monroe.
None.—[R. H. Powell, Bullock.
None that I know of.—[H. A. Stolenwerck, Perry.
None.—[C. M. Howard, Autauga.
None.—[M. W. Hand, Greene.
No effort made.—[H. C. Brown, Wilcox.
None.—[J. W. Du Bose, Montgomery.
Think not; never heard of any one attempting to do so in winter.—[P. D. Bowles, Conecuh.
None.—[J. C. Matthews, Dale.
Not within my knowledge.—[C. C. Howard, Autauga.
I know of no effort to destroy the moth.—[R. W. Russell, Lowndes.
I have never heard of any. Any such effort would be altogether impracticable.

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The moths are too much scattered. They lie up in the roofs of all the houses on the farm; under the boards or shingles; under the loose bark of dead trees, either on the farm or in the woods. I guess that I shall winter a dozen or two in my dwelling-house next winter. There are more than that number in my house to-day, and as they are daily emerging from the chrysalides the number I suppose will increase. The trouble would be to get at them.—[D. Lee, Lowndes.

None that I know of. This would be hard to do. Pine timber in our clearings after the sap turns is very valuable for rails and posts, and would be entirely destroyed by fires in destroying the moths in fields near.—[H. Hawkins, Barbour.

ARKANSAS.

The burning of all cotton and corn stalks or other trash found on the ground has shown that ground so treated was least attacked.—[E. T. Dale, Miller.

None.—[Norborne Young, Columbia.

None that I know of.—[T. S. Edwards, Pope.

FLORIDA.

None.—[John Bradford, Leon.

These winter-quarters are not supposed to be known.—[Robert Gamble, Leon.

GEORGIA.

No effort made to destroy the moth in winter-quarters.—[E. M. Thompson, Jackson.

None.—[D. P. Luke, Berrien.

Never here.—[William A. Harris, Worth.

I do not believe the moth has any "winter-quarters," but remains in the chrysalis during the winter.—[William Jones, Clarke.

No effort has been made to destroy the moth in winter-quarters.—[Timothy Fussell, Coffee.

Nothing in this locality.—[M. Kemp, Marion.

It is not here in its winter-quarters.—[S. P. Odom, Dooly.

LOUISIANA.

No.—[H. B. Shaw, Concordia.

No effort has been made to destroy the moth in its winter-quarters that I know of.—[John A. Maryman, East Feliciana.

I know of none.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

None. Its winter-quarters are not known.—[George V. Webb, Amite.

It never having been found where the moth winters, no efforts have been made to destroy them there.—[John C. Russel, Madison.

No effort made.—[Dr. E. H. Anderson, Madison.

No.—[J. W. Burch, Jefferson.

No.—[D. L. Phares, Wilkinson.

No.—[C. Welch, Covington.

None that I know of.—[William S. Lewis, Winston

TENNESSEE.

No effort has been made to destroy the moth in its winter-quarters, nor do I think any such effort would be likely to prove very successful.—[A. W. Hunt, Perry.

NORTH CAROLINA.

None.—[F. I. Smith, Halifax.

TEXAS.

None.—[S. B. Tackaberry, Polk.

No.—[W. Barnes, Cherokee.

Nothing has been done to destroy them; it is very doubtful about their remaining here all winter. From the coast counties a more complete statement may be obtained.—[J. M. Glasco, Upshur.

None.—[P. S. Watts, Hardin.

Has never been found there to my knowledge.—[P. S. Clarke, Waller.

Burning the old cotton-stalks.—[H. J. H. Brensing, Bowie.

No.—[R. Wipprecht.

None that I know of.—[O. H. P. Garret, Washington.

No.—[J. H. Krancher, Austin.

None have been so found.—[C. B. Richardson, Rusk.

None; as the thing would be impossible from the great abundance of timber in Western Texas, and the great distance between farms.—[W. T. Hill, Walker.

None that I know of. My impression is that its winter-quarters would be as hard to find as a remedy to effectually destroy the caterpillar.—[J. W. Jackson, Titus.

None whatever.—[Natt. Holman, Fayette.

None.—[A. Underwood, Brazoria.

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QUESTION 7*e.*—*Have any systematic and organized attempts been made to gather and destroy the chrysalides, or to facilitate their collection and destruction by furnishing inviting material for the worms to spin up in?*

ALABAMA.

None. The first generation find cotton-leaves enough to web up in. The next are forced to find webbing places on grass, weeds, or bushes. To capture the first chrysalis is impracticable, for the reason that each plant would have to be *overlooked*, and to attempt to gather up the second generation would be useless when the damage is done.—[P. T. Graves, Lowndes.

I never have known an effort made to destroy tho chrysalides in any way whatever.—[J. N. Gilmore, Sumter.

None.—[I. F. Culver, Bullock.

None.—[R. S. Williams, Montgomery.

No.—[R. F. Henry, Pickens.

None.—[J. A. Callaway, Montgomery.

No attempts have ever been made to destroy the chrysalides.—[Dr. John Peurifoy, Montgomery,

None.—[H. A. Stolenwerck, Perry.

None.—[Knox, Minge, and Evans, Hale.

None.—[J. C. Matthews, Dale.

Not in my knowledge.—[J. W. Du Bose, Montgomery.

No organized efforts have been made in the destruction inquired about.—[A. D. Edwards, Macon.

Nothing of the kind has come under my observation.—[I. D. Driesbach, Baldwin.

None that I know of.—[James M. Harrington, Monroe.

None.—[R. H. Powell, Bullock.

None.—[M. W. Hand, Greene.

I have not heard of any.—[D. Lee, Lowndes.

There has been none.—[H. C. Brown, Wilcox.

Don't know of any.—[P. D. Bowles, Conecuh.

None. The worms can be as easily taken, *i. e.* caught, as the chrysalides, and I doubt not that the cotton suits him to a T to spin up in.—[C. C. Howard, Autauga.

There has been no such effort made to destroy the chrysalis as contained in this question.—[R. W. Russell, Lowndes.

Nothing.—[P. T. Graves, Lowndes.

None; and this cannot be accomplished so as to prevent the destruction of the cotton crop, for the reason that the first, second, and third crops of worms are hatched when there is an abundant foliage of cotton, and no contrivance could induce the worm to leave the cotton-leaf to spin. It is on the leaf at maturity, and at this point commences immediately to spin. After this third crop is out they destroy all the leaf and foliage and have nothing in which to spin except weed or grass near the field, and not finding this they soon die. Better keep supply out of their way than furnish them.—[H. Hawkins, Barbour.

None.—[J. R. Rogers, Bullock.

ARKANSAS.

Nothing.—[Norborne Young, Columbia.

None.—[E. T. Dale, Miller.

Nothing of the kind has been attempted.—[T. S. Edwards, Pope.

FLORIDA.

None.—[John Bradford, Leon.

None.—[R. Gamble, Leon.

GEORGIA.

No organized effort has been made to destroy the chrysalis or to furnish inviting material for the worms to spin up in—[T. Fussell, Coffee.

None in this county.—[D. P. Luke, Berrien.

Nothing of the kind has ever been done here.—[William A. Harris, Worth.

Nothing done to destroy them.—[E. M. Thompson, Jackson.

None in this locality.—[M. Kemp, Marion.

LOUISIANA.

None.—[H. B. Shaw, Concordia.

Have never heard of any attempts to destroy the insect until it is feared that it may do injury to the growing plants—say during summer and fall, while it is breeding rapidly, and eating rapidly also.—[D. M. Hamilton, West Feliciana.

It would be useless to try to furnish the worm anything to spin up in, as they are too numerous.—[John A. Maryman, East Feliciana.

I have heard of none.—[Dr. I. U. Ball, West Feliciana.

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MISSISSIPPI.

There was some little effort made a few years ago, but was given up in dispair.—[J. W. Burch, Jefferson.

None that I know of.—[W. T. Lewis, Winston.

No effort beyond that of winter plowing.—[Dr. E. H. Anderson, Madison.

No.—[D. L. Phares, Wilkinson.

No.—[C. Welch, Covington.

No efforts to destroy chrysalides, or any material for the worm to spin up in.—[John C. Russel, Madison.

No, and never will be with success; the numbers are too great. They will only feed and spin in cotton while there is a leaf on it.—[George V. Webb, Amite.

NORTH CAROLINA.

None.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

Experiments various and numerous were made years since upon this subject, and continued until experience proved them all worthless.—[James W. Grace, Colleton.

TENNESSEE.

No effort has been made in this State to destroy the chrysalides.—[A. W. Hunt, M. D., Perry.

TEXAS.

None.—[Natt. Holman, Fayette.

None.—[S. B. Tackaberry, Polk.

None.—[W. Barnes, Cherokee.

None.—[P. S. Watts, Hardin.

No.—[P. S. Clarke, Waller.

No.—[R. Wipprecht, Comal.

There have been no organized attempts to destroy the chrysalides or facilitate their collection and destruction by furnishing inviting material for the worms to spin up in.—[O. H. P. Garrett, Washington.

None.—[J. H. Krancher, Austin.

None.—[W. T. Hill, Walker.

None; they only web up on cotton.—[C. B. Richardson, Rusk.

None.—[A. Underwood, Brazoria.

There has been nothing of the kind done.—[S. Harbert, Colorado.

None in this locality; but I believe it can be done to such an extent that the remainder would be harmless to the plant.—[J. W. Jackson, Titus.

QUESTION 7*f*.—*What has been done toward destroying the eggs?*

ALABAMA.

Nothing has ever been done to destroy the eggs, and I presume never will be. They are deposited in little squares on the under side of the cotton-leaf.—[H. Hawkins, Barbour.

Nothing.—[J. R. Rogers, Bullock.

Nothing, as far as I know. It takes a good eye to find them, and I think nothing but gas or spray would reach them.—[C. C. Howard, Autauga.

Nothing. They are very small, barely visible to the natural eye placed singly, the moth rarely ever placing more than one on the under side of the leaf. Other moths use the same leaf, and often five or six eggs are found on a leaf.—[P. T. Graves, Lowndes.

Nothing so far as known.—[R. W. Russell, Lowndes.

Nothing has been done in this section.—[John D. Johnston, Sumter.

Nothing.—[I. F. Culver, Bullock.

Nothing.—[R. F. Henry, Pickens.

I never have known an effort made to destroy the eggs of the moth.—[J. N. Gilmore, Sumter.

Nothing.—[R. S. Williams, Montgomery.

Nothing.—[J. A. Callaway, Montgomery.

Nothing. A succession of hot, dry days will scorch or dry up the eggs and prevent them from hatching.—[J. D. Driesbach, Baldwin.

Nothing.—[J. M. Du Bose, Montgomery.

Nothing.—[M. W. Hand, Greene.

Nothing.—[H. C. Brown, Wilcox.

Satisfied nothing.—[P. D. Bowles, Conecuh.

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Nothing.—[J. C. Matthews, Dale.
Nothing.—[C. M. Howard, Autauga.
Nothing.—[James M. Harrington, Monroe.
Nothing.—[H. A. Stolenwerck, Perry.
Nothing; the eggs cannot be destroyed by man.—[D. Lee, Lowndes.
Nothing.—[Knox, Minge, and Evans, Hale.
Nothing has been done toward destroying the eggs.—[A. D. Edwards, Macon.

ARKANSAS.

Topping the cotton and burning the tops has been tried in a few instances, but not sufficiently to mark any decided effect except in the fields so treated.—[E. T. Dale, Miller.
Nothing whatever.—[T. S. Edwards, Pope.
Nothing.—[Norborne Young, Columbia.

FLORIDA.

Nothing; it strikes me it would be a difficult job.—[John Bradford, Leon.
Nothing; the eggs are deposited singly, the moth depositing her burden of some hundred and fifty or more eggs over the space of many acres; they are placed under the leaf and are very minute.—[R. Gamble, Leon.

GEORGIA.

Nothing in this county.—[D. P. Luke, Berrien.
Nothing whatever.—[William A. Harris, Worth.
Nothing, except to destroy the moths before the eggs are deposited.—[M. Kemp, Marion.
Nothing at all.—[S. P. Odom, Dooley.
Nothing at all.—[E. M. Thompson, Jackson.
Nothing has ever been done to destroy the eggs.—[Timothy Fussell, Coffee.

LOUISIANA.

Nothing.—[H. B. Shaw, Concordia.
Nothing has been done toward destroying the eggs.—[John A. Maryman, East Feliciana.
Nothing.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

No effort to destroy the egg.—[John C. Russel, Madison.
Nothing.—Dr. E. H. Anderson, Madison.
Nothing.—[J. W. Burch, Jefferson.
Nothing that I know of.—[William T. Lewis, Winston.
Nothing.—[C. Welch, Covington.
Nothing.—[D. L. Phares, Wilkinson.
Nothing.—[George V. Webb, Amite.

NORTH CAROLINA

Nothing.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

All efforts abandoned as useless.—[James W. Grace, Colleton.

TENNESSEE.

Nothing has been done to destroy the eggs, except as an experiment. I have been informed of a wonderful success in the prevention of the ravages of the whole class of noxious cotton-insects by a friend, who on one occasion mulched the seed with a mulch whose principal ingredient was milk of sulphur, vulgarly so called, and on another occasion of sowing sulphur with the seed.—[A. W. Hunt, M. D., Perry.

TEXAS.

Nothing.—[P. S. Clarke, Waller.
Nothing.—[R. Wipprecht, Comal.
Nothing.—[P. S. Watts, Hardin.
Nothing.—[S. B. Tackaberry, Polk.
Nothing.—[W. Barnes, Cherokee.
Nothing has been done to destroy the eggs; they are too numerous.—[O. H. P. Garrett, Washington.
Their destruction seems to be impossible, the number being too immense and distributed over too great a space.—[J. H. Krancher, Austin.
Nothing.—[W. T. Hill, Walker.

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Nothing.—[C. B. Richardson, Rusk.
Nothing.—[A. Underwood, Brazoria.
Nothing.—[S. Harbert, Colorado.
None. My observation is that they deposit their eggs early in the night, and that they hatch in a few hours.—[Natt Holman, Fayette.
None in this locality. The destruction of the chrysalides would be much easier and more effectual.—[J. W. Jackson, Titus.

QUESTION 7*g*.—*Has anything been found more generally useful and applicable, or cheaper, than the use of the Paris green mixture to destroy the worms?*

ALABAMA.

Among planters a general doubt prevails as to the value of Paris green. That it will kill the worms that eat it is not doubted, but to distribute it on all parts of the foliage is practically impossible. That, with heavy rains cleaning the leaves for a fresh raid of worms, with a renewal of the fight at a time when cotton-picking claims all the labor of the farm, has caused many planters to doubt the value of poison.—[P. T. Graves, Lowndes.
Arsenic is cheaper than Paris green, but some think it not so efficacious. I think, if dissolved, arsenic will answer all the purposes providing it is not raining too much, in which event you will have to use it otherwise, say, in flour or lime or ashes.—[R. W. Russell, Lowndes.
Nothing that I know of.—[John D. Johnston, Sumter.
Nothing that I have ever used.—[R. S. Williams, Montgomery.
Nothing.—[J. A. Callaway, Montgomery.
Some have used arsenic dissolved in boiling water as cheaper than Paris green.—[H. Tutwiler, Hale.
Molasses. Have used 75 pounds of Paris green on 85 acres of cotton this year, at a cost of $42.50, with very little benefit, as the caterpillars eat it up (clean) by the 17th of September. I commenced three weeks, or one crop, too late. Destroy the moth in time and you are comparatively safe. But all your neighbors must join you in this. Yet much good can be accomplished by Paris green if taken in time.—[I. D. Driesbach, Baldwin.
After considerable experience with Paris green, *i. e.*, six years' use of it, I am disposed to think cotton does not yield fruit—that is fresh fruit—after that poison is applied to it. It is too great a stimulant, and too apt to be absorbed by the growing plant. The present cost of Paris green is 20 cents per acre. I have used the "Texas worm-destroyer" with all the advantage claimed for Paris green, and with none of its bad effects. This is an arsenious preparation, the cost of which is about 25 to 35 cents per acre.—[J. W. Du Bose, Montgomery.
Nothing has been found superior to Paris green for the destruction of the worm.—[A. D. Edwards, Macon.
Arsenic, which is cheaper than Paris green because it takes so much less.—[J. R. Rogers, Bullock.
I have no experience with Paris green, and can say nothing of it from personal knowledge, and certainly know of nothing better, unless it might be found in a gang of a hundred or two hundred turkeys turned into a field and confined to the worm-infested cotton.—[A. Jay, Conecuh.
Nothing has ever been used in this county more generally useful or applicable than the Paris green mixture to destroy worms, and it is far cheaper than would be any plans to destroy the eggs or the moth. I have several times used the Paris green and other preparations; found Paris green cheapest and best.—[H. Hawkins, Barbour.
Paris green or arsenic is used when any attempt is made to destroy them.—[C. C. Howard, Autauga.
Paris green has been used to a very limited extent here, and in several instances it has killed the cotton-plant.—[J. N. Gilmore, Sumter.
No.—[R. F. Henry, Pickens.
Nothing; and that is a humbug. If you can poison the atmosphere so as to kill the moth and nothing else, then talk about poisoning.—[J. C. Matthews, Dale.
There has not.—[H. C. Brown, Wilcox.
Paris green will destroy them when all other remedies fail; nothing surer or cheaper.—[P. D. Bowles, Conecuh.
Nothing more certain to kill than Paris green. White arsenic is cheaper and very sure if the weather is favorable.—[D. Lee, Lowndes.
Nothing that I know of; and Paris green is a failure as far as practical results are concerned.—[M. W. Hand, Greene.

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I think the Texas worm-destroyer better.—[James M. Harrington, Monroe.
Nothing.—[H. A. Stolenwerck, Perry.
Arsenic.—[R. H. Powell, Bullock.
No.—[Knox, Minge, and Evans, Hale.
Nothing.—[C. M. Howard, Autauga.

Mr. Donavan claims to be the first who ever applied Paris green for the destruction of the cotton-worms. This was in 1871 or '72, in a separate field of about one acre. He applied the poison in the month of August, early in the morning before the dew was dried, distributing large quantities of it with the hand over the plants until he was satisfied that every leaf was covered. The success was complete, and one application of the poison was sufficient to prevent the worms from becoming injurious.—[E. A. Schwarz, Eufaula.

The "Texas anti-worm prescription" is cheaper than Paris green, but it is too weak, and one and a half measures to forty gallons of water are required to kill the worms. It is, we suppose, arsenic in a soluble state. It is well known here that arsenic, if too freely applied, will injure the cotton, either by itself or in combination with other poisonous substances; and the only advantage which the Texas poison has is that it can be applied when the dew is not on the cotton; and to protect the farm both Royall's patent and Texas destroyer had better be on hand, and plenty of it.—[Dr. John Peurifoy, Montgomery.

ARKANSAS.

No kind of poison used here.—[T. S. Edwards, Pope.
Don't know. Paris green not used here.—[Norborne Young, Columbia.

FLORIDA.

Nothing that I have heard of.—[John Bradford, Leon.
Have heard kerosene oil much vaunted.—[R. Gamble, Leon.

GEORGIA.

Paris green and all such poisoning is a humbug.—[S. P. Odom, Dooly.
Never used.—[E. M. Thompson, Jackson.
We think the lamp is cheaper and safer.—[M. Kemp, Marion.
No poisons have ever been tried in this county.—[D. P. Luke, Berrien.
Nothing that I have ever seen or heard of.—[William A. Harris, Worth.
No experience in Paris-green mixture.—[William Jones, Clarke.
Neither Paris green nor any other poison has ever been used in Coffee County.—[Timothy Fussell, Coffee.

LOUISIANA.

Nothing.—[H. B. Shaw, Concordia.

Paris green is the poison which has been always used here to destroy the worms, so far as my observation has gone. A preparation called the "Texas cotton-worm killer," or destroyer, has also been extensively advertised, and, perhaps, may have been a good deal used in other sections, but I have never seen it tried, personally. I have seen, many times, where the Paris green has been used with great success. The most successful plan was by the solution of so many pounds of poison to so many gallons of water, and then applied by men riding on horses or mules between the rows of cotton and sprinkling the solution well on the plants as they went. It is a slow process, and requires time and patience to do it well, but when done as well as it should be, and begun and repeated at the proper times it destroys the worms utterly and completely. In fact, in many places where this mixture or the Texas poison have been often used and their mode of application well understood, the cotton-worm has ceased to be the dread and terror it once was. There is a plan of applying the Paris green by mixing it with flour in certain proportions and sifting it from a box carried on the end of a pole, and this carried by a man who rides on horseback over the fields and dusts the preparation over the cotton-plants within his route. I never liked this mode of application as well as the first-mentioned.—[D. M. Hamilton, West Feliciana.

Nothing has been found to destroy them but Paris green.—[John A. Maryman, East Feliciana.

The Paris-green mixture will destroy the cotton-worm, but at the same time will destroy the fructification of the cotton-plant.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

In mid-day, when the sun is very hot, if the cotton-stalk is jarred by a brush being passed over it, large quantities of the worm will be dislodged and fall to the ground. I have seen them die in five minutes when it was *very* warm. Large quantities of them could be destroyed by tying brush at intervals on a rope that would drag in between the rows. Let it be carried by two men and brush out four rows at a time.—[C. F. Sherriod, Lowndes.

Neither Paris green nor any other poison has been tried to any extent.—[C. Welch, Covington.

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The prejudice against poisonous remedies is too strong to get any of them introduced for experiment.—Dr. E. H. Anderson, Madison.

Nothing that I have heard of or known.—[William T. Lewis, Winston.

My preference is for the pan and lantern invented by J. G. Garrett, Port Gibson, Miss.; cheaper and less dangerous.—[J. W. Burch, Jefferson.

Perhaps not.—[D. L. Phares, Wilkinson.

My insect-destroyers are more useful. If used in time they attract and catch, with or without a light, the caterpillar and boll-worm flies, and prevent the ravages of both the caterpillar and boll-worm.—[J. G. G. Garrett, Port Gibson.

No; but the Paris green is a dead failure.—[George V. Webb, Amite.

SOUTH CAROLINA.

Nothing.—[James W. Grace, Colleton.

TENNESSEE.

To my knowledge nothing has been found more useful than Paris green to destroy the insect in question. I am of opinion, from experiments which I have made, that an inestimable benefit would accrue were an organized, general, and energetic battle made on this line against the insect enemies of the cotton-plant. I am sure it would end in their extermination if its use could be made general for three years.—[A. W. Hunt, Perry.

TEXAS.

Arsenious acid is cheaper, but the Paris green is the best preparation, to be used with flour (a small portion powdered rosin, 25 pounds of flour to one of Paris green). Ashes can be used in lieu of flour, or any other article that will act as a vehicle.—[P. S. Clarke, Chickasaw.

Solution of arsenic.—[R. Wipprecht, Comal.

Nothing.—[S. B. Tackaberry, Polk.

Nothing.—[W. Barnes, Cherokee.

Nothing has been brought into use here cheaper than arsenic; Paris green next.—[O. H. P. Garrett, Washington.

A great many cheap poisons have been used, but none have given satisfaction. I use only Paris green.—[W. T. Hill, Walker.

Not in this county.—[P. S. Watts, Hardin.

Arsenic in solution, mixed at the rate of about a quarter pound to forty gallons of water and applied in the form of a shower, either by a fountain pump or similar contrivance, appears to be the cheapest; but as it has to be applied three, four, or five times, it is very tedious. Paris green is the most dangerous to man.—[J. H. Krancher, Austin.

None.—[C. B. Richardson, Rusk.

Arsenic in liquid form more generally useful, effective, cheaper, and more easily applied.—[A. Underwood, Brazoria.

I do not think there is anything cheaper than Paris green that is so sure a remedy.—[S. Harbert, Colorado.

Yes; the Texas cotton-worm destroyer, put up in Galveston, Tex.—[J. W. Jackson, Titus.

Arsenic in its raw state, dissolved in boiling water, is better and cheaper; applied by being thrown on the plant with pumps. I would state that I saved my crop in 1877 by its use.—[Natt. Holman, Fayette.

QUESTION 7 *h.—Have you known of any injurious effects following the use of this poison, either to the plant, to man, or to animals?*

ALABAMA.

Yes; to plant, man, and animals.—[J. A. Callaway, Montgomery.

The dangers of Paris green are well known here. Stock of all kinds will be killed by it, if suffered to eat the cotton poisoned. Any sore or abrasion of the skin will inflame, and if applied too freely to the cotton it is sure to parch the leaves and injure the plant.—[Dr. John Peurifoy, Montgomery.

None to man or beast, but some little to cotton where the mixture was too strong; one tablespoonful of Paris green to one gallon of water, cotton to be sprinkled at the commencement or advent of a new crop of worms.—[I. D. Driesbach, Baldwin.

I have not.—[H. C. Brown, Wilcox.

I have injured crops of cotton in this, that after being poisoned with Paris green they matured no more fruit. My laborers have been made ill by using it on cotton. I have known cows and horses killed by eating the cotton on which it had been deposited.—[J. W. Du Bose, Montgomery.

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Yes; it will kill anything that gets to the leaf and eats it; it washes off by rain and is carried off into the streams of water, and some stock have died from drinking the water.—[J. C. Matthews, Dale.

It will kill the leaves if applied too strong. Have known no serious injury to man or animal.—[H. A. Stolenwerck, Perry.

It injures the plant.—[James M. Harrington, Monroe.

Have heard of cows eating the cotton-leaves after the Paris green had been sprinkled upon it, and that it killed some of them.—[P. D. Bowles, Conecuh.

I have known of none; but once I observed that the applications of Paris green seemingly dwarfed the growth of the common field-pea, grown upon the same soil the following year.—[C. M. Howard, Autauga.

Yes; the plant frequently ceases to fruit; field-hands have been injured sometimes severely, and stock killed.—[M. W. Hand, Greene.

Yes; two heavy an application destroys the plant, and if not carefully handled injurious to man and beast.—[Knox, Minge, and Evans, Hale.

The plant is injured by too copious an application of Paris green. I have known no injuries from its use, to man or animal.—[A. D. Edwards, Macon.

It stops the plant from bearing, and if too strong kills the plant. I have heard of horses and cows having been killed by drinking out of vessels in which poison had been mixed. With care there is no danger to man or beast.—[D. Lee, Lowndes.

If used too freely arsenic will kill the plant.—[R. H. Powell, Bullock.

I have never known any injuries to man or beast, but when applied too strong it hurts or burns the cotton and perhaps prevents it making any fruit more than to mature what it has.—[H. Hawkins, Barbour.

I saw a field where Paris green had been applied, and the cotton was as lifeless and as unproductive as it possibly would have been if every leaf had been eaten off by the worm.—[Andrew Jay, Conecuh.

Yes; on all of them.—[J. R. Rogers, Bullock.

I have heard of local poisoning.—[C. C. Howard, Autauga.

The young bolls of cotton show the effects of poison where the atoms fall upon them; some partially rot. Arsenic in solution produces a caustic blight on the leaves when not greatly reduced. Some few animals have been killed by eating Paris green and flour mixed. Less damge has resulted than was feared.—[P. T. Barnes, Lowndes.

If too much poison is put on the plant it will injure it; say of arsenic 1 pound to the acre in 30 gallons of water dissolved, will kill the worms and not injure the cotton. I have known no injury to man or beast from the use of it.—[R. W. Russell, Lowndes.

If used injudiciously it will destroy the plant. Have seen the hands from carelessness poisoned with it. Have known it to kill stock.—[R. S. Williams, Montgomery.

I am satisfied that the poison injures the cotton-plant; that it appears to close up the pores of the leaf, and the cotton stops fruiting.—[I. F. Culver, Bullock.

None in my experience.—[John D. Johnston, Sumter.

Injurious to plant when put on too strong, and to men and animals if saturated with solution in applying.—[J. H. Smith and J. F. Calhoun, Dallas.

I have known it to kill the cotton-plant. I never have known it to injure animals of any kind.—[J. N. Gilmore, Sumter.

ARKANSAS.

Have known of the plant being killed.—[E. T. Dale, Miller.

No.—[T. S. Edwards, Pope.

FLORIDA.

None whatever.—[John Bradford, Leon.

No.—[R. Gamble, Leon.

GEORGIA.

I have heard it said that it is very injurious to cattle.—[S. P. Odom, Dooly.

Not of my own knowledge. Some of my neighbors say that it destroys the birds that will do as much good in destroying the worm as the Paris green.—[M. Kemp, Marion.

None.—[T. Fussell, Coffee.

Have heard of injuries to the plant in Dougherty County, but none to man or beast. —[D. P. Luke, Berrien.

Yes; it has killed some stock that got in cotton-fields where used.—[William A. Harris, Worth.

LOUISIANA.

Yes; if too strong will kill the plant. If the mules are galled or have old sores, will make them very hard to heal; same with the men who handle it. If any ordinary care is taken, no bad effects result from the use of it.—[H. B. Shaw, Concordia.

Have heard of persons being injured by this poison, but, of course, as it is a poison it should be used with proper caution or injury will happen. Have never heard of any

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injury to plants except to the cotton-plant itself when the poison was put on too strong. —[D. M. Hamilton, West Feliciana.

I have never known any person or animal to be injured by the use of it, but if made too strong it will kill the plant.—[John A. Maryman, East Feliciana.

Paris green, in my experience, has always been used with care, and no injurious effects from its use have followed.—[Dr. I. U. Ball, West Feliciana.

MISSISSIPPI.

No; it has been used here to a very limited extent only.—[D. L. Phares, Wilkinson,

No.—[C. Welch, Covington.

None.—[William T. Lewis, Winston.

Paris green has never been tried here.—[C. F. Sherriod, Lowndes.

Have heard of cattle being killed by eating poisoned leaves. No Paris green used in our county.—[J. W. Burch, Jefferson.

None.—[John C. Russel, Madison.

When used too freely it kills the leaves; have heard of no other bad effects.—[W. Spillman, Clarke.

I have had instances of cotton pickers affected with disease similar to "painters' colic," but no damage to animals.—[George V. Webb, Amite.

NORTH CAROLINA.

Never has been used here.—[F. I. Smith, Halifax.

SOUTH CAROLINA.

None, except when carelessly used and inhaled; have seen the nostrils, mouth, and sometimes the throat inflamed and even sore among those who sprinkled it over the plant.—[James W. Grace, Colleton.

TENNESSEE.

I know of no injurious effects following the use of Paris green to the plant, to man, or to animals, but do not doubt that if incautiously used injury might result therefrom, especially to man.—[A. W. Hunt, M. D., Perry.

TEXAS.

A gentleman last year tried Paris green, using it at night; his face was full of the powder. After returning home his condition was such that I told him he was poisoned, when the above was admitted; there were no serious results. Those assisting were not affected. If too strong, it will kill the plant.—[S. P. Clarke, Waller.

No.—[W. Barnes, Cherokee.

Have never heard of any.—[R. Wipprecht, Comal.

I have known injurious effects to follow the use of poison on the plant, on myself.—[O. H. P. Garrett, Washington.

No.—[P. S. Watts, Hardin.

Sometimes destroys the plant.—[S. B. Tackaberry, Polk.

When Paris green is pure it will not hurt the cotton; some is adulterated with crude arsenic, which makes it burn the cotton. I have known it to make sores on men from carelessness in using, but would soon be well again. Have known of no stock being injured.—[W. T. Hill, Walker.

No injurious effects following the application of arsenious solutions to man or animal; of Paris green several cases are known. A strong solution of arsenic or Paris green has frequently injured the plant; in some instances the plants have lost all their leaves and fruit.—[J. H. Krancher, Austin.

Death of a few animals that eat the cotton after it was applied.—[Natt Holman, Fayette.

None, to plant or man; have heard of cattle getting into the fields and being injured and some killed by eating the cotton.—[C. B. Richardson, Rusk.

If used too strong, injures the plant. Seldom injures men or animals externally.—[A. Underwood, Brazoria.

I have used it, and never found any injurious effect upon any thing, either man or beast.—[S. Harbert, Colorado.

No; nothing serious; some slight poisoning to man and beast. The people (farmers) are afraid of Paris green, and would rather see their crop destroyed than risk using it.—[J. W. Jackson, Titus.

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QUESTION 7 *i*.—*State what you consider the best and most effective method of destroying them in your section.*

ALABAMA.

It is contended by some farmers here that if the cotton could be topped just at the time the eggs were first deposited it would more effectually destroy them than the application of any medicated substances. The moth always deposits its eggs in the tender buds of the cotton first.—[J. N. Gilmore, Sumter.

Cannot answer, as everything has failed that has been tried in this section. I consider nothing that has been used throughout this section has resulted in good in either saving the crop or destroying the pest.—[John D. Johnston, Sumter.

Paris green carefully applied.—[Dr. John Peurifoy, Montgomery.

ROYALL'S RECEIPT.—*Formula*: 18 pounds flour, 1 pound Paris green, 1 pound pulverized gum arabic, 2 pounds rosin; cost of material, $1.25 per acre; application, 50 cents per acre.—[J. A. Callaway, Montgomery.

Paris green and arsenic.—[H. A. Stolenwerck, Perry.

Paris green diluted with water.—[H. C. Brown, Wilcox.

The best and most effective means to destroy the worm has been the use of Paris green, applied in a solution of water, and sprinkled or thrown on the plant by a small brush or broom. It is said now that the Texas preparation is the best and most economical way to use Paris green.—[H. Hawkins, Barbour.

Arsenic and Paris green. One man saved seven acres by picking off and killing when they first made their appearance. He went over the ground a number of times.—[J. R. Rogers, Bullock.

Should use arsenic, as being much cheaper.—[C. C. Howard, Autauga.

The best method of destroying is Paris green. Say 1 pound of Paris green to 30 or 40 gallons of water, in which you mix 5 or more pounds of flour; with this sprinkle the cotton. But I would prefer arsenic, it being so much cheaper, and will ordinarily answer all the purposes.—[R. W. Russell, Lowndes.

Paris green, properly applied.—[R. S. Williams, Montgomery.

Paris green.—[Knox, Minge, and Evans, Hale.

We use nothing.—[I. F. Culver, Bullock.

I consider every method resorted to so far as a failure. Paris green was thought to be an effectual remedy, but those who were credulous enough to try it have abandoned the use of it as wholly impracticable.—[M. W. Hand, Greene.

The application of Paris green mixed with flour and rosin.—[A. D. Edwards, Macon.

Sprinkling poisoned water or flour on the plant.—[J. W. DuBose, Montgomery.

Nothing has yet been discovered that is worth a cent.—[J. C. Matthews, Dale.

Paris green and arsenic mixed with water, and sprinkled over the field regularly, while the worms are at work.—[D. Lee, Lowndes.

Paris green has been used more effectually in this section. One pound of Paris green or arsenic to two hundred and fifty or three hundred gallons of water, and distributed with a watering-pot.—[R. H. Powell, Bullock.

The Texas remedy.—[James M. Harrington, Monroe.

Paris green in solution or powder.—[C. M. Howard, Autauga.

Paris green is the only effective method of destroying them in this country, and most or nearly all farmers have abandoned Paris green and concluded to let the worm do its work unmolested.—[P. D. Bowles, Conecuh.

I think the best mode to protect your crop from their ravages is to catch the moth with molasses. This can be done by placing a tin plate to every half acre of cotton, and covering the bottom of the plate with molasses. The plate should be secured to a stake, and placed above the top of the cotton. This should be done about the 1st of July; molasses renewed every other day. Every female moth produces about four hundred worms. Destroy the first and second broods of moths, and your chances for a good crop are increased a hundred fold. Paris green the next best, but either will fail unless the practice is general.—[I. D. Driesbach, Baldwin.

It is believed early and fast cultivation is one of the best remedies for insect injuries, and also to keep all the weeds and grass out, and plant to the middle or last of July.—[George W. Thagard, Crenshaw.

ARKANSAS.

I think fires would be the most effective.—[T. S. Edwards, Macon.

Top the cotton and kill all the worms possible; then gather all trash, stalks, &c., and burn the same each year. Hand-killing is the only effective method I know of.—[E. T. Dale, Miller.

FLORIDA.

Paris green 1 pound, flour 20 pounds, sprinkled early while the dew is on the cotton and applied as soon as the worms appear in force. Three weeks ago I saved a small

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lot of late cotton in this way. The worms have just appeared again, and I could drive them off again (or rather kill them), but think the lot will be benefited by allowing them to strip the foliage, which is so dense that all the lower fruit is rotting.—[J. Bradford, Leon.

Hogs turned into the cotton-fields in August will be the cheapest and best method of destroying them.—[J. M. McGehee, Santa Rosa.

Destruction of all undergrowth shrubbery.—[R. Gamble, Leon.

GEORGIA.

I think that topping the cotton the last of July or first of August, and taking the tops so cut off in sacks or baskets out of the field, especially after a spell of cloudy weather, as the eggs are deposited in the top buds, where the young worm can have the tender foliage to feed on.—[Timothy Fussell, Coffee.

Have found nothing better than Paris green, or a good large flock of tame turkeys.—[William A. Harris, Worth.

Lamps or bonfires built on stumps or scaffolds in the cotton-field just as dusk sets in.—[M. Kemp, Marion.

I am one of those that view it as an impossibility.—[S. P. Odom, Dooly.

I know of no possible way of destroying them.—[William Jones, Clarke.

LOUISIANA.

Paris green.—[H. B. Shaw, Concordia.

Paris green is the best and most effective method of destroying them.—[John A. Maryman, East Feliciana.

SOUTH CAROLINA.

One pound of Paris green, worth about 25 cents, 20 pounds of flour $1, applied three times, making a total of $3.75 per acre.—[James W. Grace, Colleton.

MISSISSIPPI.

Fires, vessels of poisoned sirups, and Paris green. The last is mixed, 1 pound with 30 pounds of wheat flour, and sprinkled on the plant while the leaves are wet with dew. If dried before rain falls, it proves effectual; if not, the poison is worth little.—[D. L. Phares, Wilkinson.

Light and some sticky substance that will retain them when caught.—[J. W. Burch, Jefferson.

Let it be ascertained when, where, and how this insect hibernates; then the most effective method for their destruction ought to be found.—[John C. Russell, Madison.

No means of forming an opinion.—[C. Welch, Covington.

Quit raising cotton.—[W. Spillman, Clarke.

Lights in the cotton-fields on stumps and boards elevated to the top of the cotton.—[George V. Webb, Amite.

TENNESSEE.

Paris green I regard most successful in destroying the insect in question *if generally used*. Lighted fires of next importance *if generally used*, though, as I have said, harm results from its partial use. Of next importance I regard the natural enemies of the insect. Except for these enemies the growing of cotton would long since have been abandoned. The value of their assistance cannot be overestimated.—[A. W. Hunt, M. D., Perry.

TEXAS.

If the weather should prove to be dry after the worms make their appearance, the Paris green in a solution is best; but if it continues wet, then the powder is best. This is my experience.—[S. Harbert, Colorado.

Paris green, 1 pound to 25 pounds of flour, and a small portion of rosin. The rains will wash off the poison, and it will have to be applied after each beating rain; it should be used wherever the worms are first seen. Destroy if possible this first crop.—[P. S. Clarke, Waller.

Solution of arsenic.—[R. Wipprecht, Comal.

Any preparation of arsenic applied in solution.—[S. B. Tackaberry, Polk.

There has been no trial of any method.—[W. Barnes, Cherokee.

A solution of arsenic and water is considered equal to Paris green, if properly applied, and by far the most expeditious.—[O. H. P. Garrett, Washington.

The best and most effective mode is doubtless the application of Paris green and flour—1 pound of Paris green to 20 or 30 pounds of flour. It is also the most expensive, but at the same time one application is generally sufficient. People, however, seem to discard the extensive use of poisons, and appear inclined to pay more attention to the destruction of the moth.—[J. H. Krancher, Austin.

I poison my cotton altogether with machinery drawn by two horses. The machine consists of the fore part of a wagon, with a platform made sufficient to hold a tank

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of water, containing 120 gallons and 4 pounds of Paris green. This will poison three acres. In this tank is placed a 3-inch force-pump for forcing the spray continuously; on the pump place 4 feet of 1-inch hose, with nozzle 1¼ inches in diameter, with 50 small holes in it. One man drives and pumps, and another stands on rear of platform and guides the hose back and forth (in a semicircle) over the cotton, carrying seven rows in large cotton and nine rows in small cotton about as fast as the horses can walk. By having the water hauled to keep the machine at work all day, between 20 and 30 acres can be poisoned. Two men, without any assistance, can poison 12 or 15 acres per day. Should the weather be showery I use 9 pounds flour to the 120 gallons of water, made into starch. This holds the Paris green till frost if there are not too many heavy rains. I use no adhesive substance if the weather is dry.—[W. T. Hill, Walker.

Paris green is considered best by those who have tried it.—[C. B. Richardson, Rusk.

All attempts, so far, I regard as doubtful experiments, as no general favorable results have as yet been demonstrated.—[A. Underwood, Brazoria.

The cotton caterpillar makes its appearance in this part of the country in July or August; when it appears in July it destroys three-fourths of the crop, but when it comes in August it only cuts the crop short about one-third. This was the case before the farmers began to use poison; but now they have a correct compound by the use of which they can destroy the caterpillar without danger to themselves or their stock, *i. e.*, 1 ounce of arsenic, 2 gallons of molasses to 40 gallons of water for one acre of cotton, the molasses only being used to make the poison adhere to the leaves. The plan of poisoning was not generally adopted here for some time, from the fact that the colored people were afraid of it, but when they witnessed the good effect of its use among the white people they tried it, and there can now be found in all their cabins the hand-sprinkler and poison ready for use. In proof of the good effect of the poison, I will mention one instance. One farmer cultivated 40 acres, and sent to market 22 bales averaging 500 pounds lint cotton per bale. He had used the poison in the way mentioned; his neighbor did not use poisons, and from 68 acres only raised 6 bales, and part of that was "frost" cotton. The land was cultivated in the same way, and the seed was the same.—[Samuel H. Waldie, Belmont.

Destroy the first crop of chrysalides and they will do you no serious damage.—[J. W. Jackson, Titus.

By using poison pretty freely. Some use Paris green and some arsenic.—[Natt. Holman, Fayette.

QUESTION 7*j*.—*State the cost per acre of protecting a crop by the best means employed.*

ALABAMA.

With molasses, about 50 cents per acre; with Paris green, from 50 cents to $2 per acre.—[I. D. Driesbach, Baldwin.

With Paris green, about $2 per acre.—[H. C. Brown, Wilcox.

As much or more than the crop is worth.—[M. W. Hand, Greene.

One dollar per acre.—[Knox, Minge, and Evans, Hale.

Perhaps $3 per acre is about the average cost.—[D. Lee, Lowndes.

Five dollars per acre.—[James M. Harrington, Monroe.

Not less than $1 per acre, and this cannot always be done. If the remedy is applied and it rains before it dries on the plant, the labor is lost, and should it rain for several days, it will be too late to apply the remedy again; then the crop is gone.—[H. Hawkins, Barbour.

From $1 to $2. Often more injury is done than good by the use of arsenic and Paris green.—[J. R. Rogers, Bullock.

Varies with cost of Paris green from $1 to $2 per acre. I think it impossible to apply it so as to kill the worms and not injure to some extent the plants.—[R. S. Williams, Montgomery.

To poison with Paris green it will cost from 35 to 50 cents per acre; with arsenic, not more than ten cents per acre. This is for each application. Sometimes we have to apply two or three times, depending on showers.—[R. W. Russell, Lowndes.

The cost of Paris green is $1.25 per acre.—[Dr. John Peurifoy, Montgomery.

From 25 to 50 cents per acre.—[C. M. Howard, Autauga.

The cost of the mixture (Paris green, flour, and rosin) about $2.50 per acre.—[A. D. Edwards, Macon.

Paris green undoubtedly the best and also a sure remedy. Two pounds per acre cost $1, and 50 cents for application, making cost per acre $1.50. This in ordinary cotton, at night, very rough weed, would, of course, take more water and longer to sprinkle it over. The above is the amount applied by Dr. R. A. Lee, and which effectively destroyed *all* the worms.—[P. D. Bowles, Conecuh.

Generally speaking, the poisons for an acre will cost (two or three applications allowed)

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about 75 cents. The labor and the flour or other materials are also additional.—[J. W. Du Bose, Montgomery.

From 20 cents to $1; much cheaper in solution.—[H. A. Stollenwerck, Perry.

No such thing as protection. This Paris green is costly, dangerous, and worthless.—[J. C. Matthews, Dale.

The cost would be very small for securing logs to make fires; in fact so little as to be almost nominal.—[T. S. Edwards, Pope.

Not more than $5 per acre.—[E. T. Dale, Miller.

FLORIDA.

From $1 to $1.50 per acre.—[John Bradford, Leon.

GEORGIA.

I have never tried it, as I have never been visited by the worms but once (in 1836), and then too late to have any damage done. It is my opinion, though, that it could be used at a cost of 10 cents per acre.—[M. Kemp, Marion.

More than the crop is worth.—[S. P. Odom, Dooly.

Can't say; arsenic is cheap; not a great amount; but of so little moment never tried to know.—[William A. Harris, Worth.

LOUISIANA.

About $4.50 per acre.—[H. B. Shaw, Concordia.

I cannot state the cost of the poison by wholesale and the rate required per acre; there are large drug-houses in New Orleans which keep and advertise all these articles with prices per quantity and of material per acre.—[D. M. Hamilton, West Feliciana.

MISSISSIPPI.

The cost is trifling: one post, six feet, 3 cents; one pan, 50 cents; one lantern, 25 cents; one quart of molasses, 10 cents; one pound star candles, 15 cents; total, $1.03. The articles at wholesale at half rates. The poorest fermenting molasses, at 18 cents per gallon, is the best. An acre can be protected for 75 cents.—[J. W. Burch, Jefferson.

No means of forming an opinion.—[C. Welch, Covington.

Probably $3.—[D. L. Phares, Wilkinson.

It will cost but little to use the lights, and that is the only protection I believe there is, and that is only partial.—[George V. Webb, Amite.

SOUTH CAROLINA.

Cost, $3.75 per acre.—[James W. Grace, Colleton.

TENNESSEE.

Cost per acre of protecting a crop of cotton by the use of Paris green by any of the present imperfect means of application, $10. Of course this might be reduced by better methods of application to at least $3. Cost of the next best method if generally used, lighted fires, $7 per acre or even a little less.—[A. W. Hunt, M. D., Perry.

TEXAS.

Not less than $5.—[S. B. Tackaberry, Polk.

Suppose the cost per acre to protect against worms would be $1 to $1.50, it would have to be gone over two or three times.—[O. H. P. Garrett, Washington.

About $1 per acre.—[P. S. Clark, Waller.

Cost 25 cents per acre.—[R. Wipprecht, Comal.

The price varies of course with the market price of material, flour and Paris green being cheaper the present year. The cost changes also in proportion to the size of the plant; on a small or low growth the cost is less. On an average 30 pounds of flour and 1 or 1¼ pounds of Paris green is sufficient for an acre, which at the present time would amount to $1.25 to $1.50, besides the cost of applying the same at about 10 cents per acre.—[J. H. Krancher, Austin.

The cost other than labor, with arsenic, is very little, say 4 cents an acre for each application. The poison is sometimes applied from three to eight times. Some contend that in this way they know it to prove a perfect success.—[A. Underwood, Brazoria.

Paris green in solution will cost from $1 to $1.50 per acre; in a powder will cost from $1.50 to $2 per acre. A good force-pump is best for the solution, and a very fine wire or brass sifter for the powder is what I have used, and find them very effectual. The sifter must be finer than the finest flour-sifter.—[S. Harbert, Colorado.

The preparation of arsenic above referred to can be furnished to farmers at a cost of 25 cents per acre.—[J. W. Jackson, Titus.

If the lamp and pan project works, which in my opinion is the best, being less labor, less dangerous, and at a cost of not more than 15 cents per acre.—[Natt Holman, Fayette.

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OTHER INSECTS.

ALABAMA.

From 1825 to 1832 the cotton crop was cut off very much by an infection called "the rot." The bolls which were not matured became diseased and sour and were quite offensive. The cause was unknown. Since 1832 and 1833 there has been very little complaint of that infection. From 1835 to 1853 or 1854, the lice were a pest to the young plants in May and June. They were the worst on light lands. If the plants were thin the lice would badly injure the stand. There were no known means of destroying them. The best plan was to let the grass grow with the cotton in the drill until hot weather, when they would soon disappear. The boll-worm has, I doubt not, destroyed more cotton in Alabama than the *Aletia argillacea*. It is the offspring of a moth. There are three kinds. The most numerous is of a dirty, yellowish color, and has an owl-shaped head. It deposits its egg or eggs on the upper buds of the plants. The larvae are very small at first. They commence in the small forms first and bite them a little. The sign is not larger than the dot of an *i* in small type; but it will destroy the form, which dies within five or six days. The bite or sting is poisonous to the form or young boll. I have pierced the form with pins more deeply, and it did not hurt it at all. As the worm grows it eats into the young bolls, and almost eats out the inside. It never eats the leaves. When its task is almost done it bores into a boll nearly matured, scoops a bed and changes to a chrysalis. It never spins.—[D. Lee, Lowndes.

We have an insect, which we denominate "rust," that I regard equally and I may say more destructive to cotton than the caterpillar. I have no doubt but our ignorance has given it the wrong name. For a few years back (some years worse than others) it has infested the crop, and it is very destructive when moist. It seems to cause the growth to cease, and then the stalk and leaves in some instances entirely disappear from the ground, save possibly a little of the main stem, and this after the cotton is full of squares and small bolls. If not thus disposed of, the leaves seem dead, bolls disappear unless matured, in which case they will prematurely open, and possibly such stalks will have remaining life enough to put out, and, if not too late, mature more or less bolls. To all appearances this insect is what we have been in the habit of calling "lice" on cotton when the plant is about to be put to a stand; but at the stage of attack here the leaves are, of course, grown, and the lice, or whatever it be, are as thick as any one could conceive, or as thick as lice ever were seen on the small plant in the spring. When in this condition it is easily observable by the complexion of the leaf, which becomes darker-colored and has a deposit on the top resembling what we call honey-dew on forest flowers. When a field gets in this condition it is ruined. The caterpillar would be twice welcomed over it. There is but little known of it. I think, however, dry seasons are more conducive to its spread, and when the lice are found by the hundreds on one leaf; heavy rains seem to relieve the cotton some.—[Andrew Jay, Conecuh.

I would mention the "*boll worm*," which bores into the boll and destroys each lobe pierced, and many think the boll-worm is more destructive upon an average than the caterpillar, for the reason that it attacks the cotton more or less every year. I have counted frequently as many on some stalks as 25 bolls destroyed by the boll-worm. In 1847 there was no caterpillar; but the boll-worm, from written memoranda furnished me by Hon. A. C. Mitchell, of Glenville, Ala. (this county), very nearly destroyed the crops, being equally as destructive as the caterpillar the previous year. The caterpillar and the boll-worm are the great enemies of cotton. To hasten the maturity of the crop, hoping to have as much fruit matured as possible before the caterpillar attacks the cotton crop, has been one of the great incentives to the use of commercial fertilizers.—[H. Hawkins, Barbour.

In 1875 there was an insect made its appearance on the cotton crops in this locality, piercing the very smallest squares and destroying them. In 1876 it caused the failure of the crop; in 1877 they did no damage; in 1878 they have damaged the crop, in our opinion, more than the caterpillar. The first year or two that it made its appearance it was confined to a certain character of land, but in 1878 it was general. A good many planters in this locality dread it as much as they do the caterpillar.—[Knox, Minge, and Evans, Hale.

The boll-worm does also great injury. The same means that will destroy the moth of the caterpillar will, I think, destroy the moth of the boll-worm.—[H. A. Stolenwerck, Perry.

The lice in the spring frequently retard the growth of the cotton, and sometimes injure or destroy the stand. These and the boll-worm, which is frequently very injurious, are the only insects in addition to the cotton caterpillar from which the crop suffers.—[A. D. Edwards, Macon.

The boll-worm destroys the grown or half-grown bolls, but does not feed on the foliage or the stalk.—[J. W. Du Bose, Montgomery.

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There is a small worm that generally comes in advance of the regular caterpillar, that bores into the forms before the bloom comes out, and it has been my opinion that the damage caused by these is as heavy as any caused by the caterpillar. The said worms are called by some farmers the pierce-worm or boll-worm, as they seem to attack the bolls while young, causing them to fall off. I have observed as many as one-half dozen squares or forms on one stalk that had fallen off from attacks of these worms.—[H. C. Brown, Wilcox.

I will here remark that there are several kinds of moths which wrap up in the cotton-leaf, and the chrysalis looks not unlike the chrysalis of the genuine *cotton eater*, or *Aletia argillacea*, but he is "another fellow" entirely, and of different habits and appearance; some of them white and black spotted and various colors. But one kind of moth produced the genuine *cotton dragon*, and the cotton caterpillar (*Aletia argillacea*) and boll-worm are the only insects (lice excepted) which are destructive to the cotton-plant in this vicinity or the Southern States.—[I. D. Driesbach, Baldwin.

Wet weather seems favorable to the boll-worm, which bores into the boll, generally does most damage on damp, rich land, and bores the boll while young and tender. Bud-worms injure cotton while very young, in cool, wet weather, generally last of April and through May. Lice come on cotton in June and first of July; grasshoppers generally in April and May.—[George W. Thagard, Crenshaw.

I believe the boll-worm has done a great deal more damage in the aggregate than the cotton-worm. The latter stripped my cotton of foliage about the 1st of October this year, and I think without any damage. If the cotton was very rank, the leaves eaten off at that time would increase the maturing and opening.—[C. C. Howard, Autauga.

ARKANSAS.

Cotton has been remarkably healthy, and I have not seen or heard of a "boll-worm" at any time in the county, nor any other worm or insect injuring the crop, except a few crops occasionally injured in the spring by "cotton-lice." It is not common for boll-worms to be found this far north. South of 34° is the section where they are found, and 32° and 33° is their home; consequently I have no report to make in regard to them, as the last I saw was over twenty years ago in Middle Georgia.—[T. W. Cochran, Fulton.

We sometimes have foliage of the plant and the shuck from around the boll eaten off by a kind of caterpillar or *grass-worm*. When it preys upon the smaller growth (on poor land) it may injure it to some extent; but it is an advantage to the larger or more luxuriant plants, giving better air and sun to the boll, thus insuring better maturity and earlier opening.—[Alfred A. Turner, Bradley.

The other insect most destructive to cotton is the boll-worm, and I have as yet not been able to make any observations upon it that are satisfactory or learn from others anything reliable. The boll-worms appear every year. The moth or fly deposits an egg inside the young boll by means of an ovipositor. The larva destroys the boll which falls off. Parties tell me of different kinds of insects; some speak of a moth and some of a fly. I am inclined to think there are two insects, a fly besides the regular boll-worm moth.—[E. T. Dale, Miller.

The boll-worm is the only insect that has injured the cotton in this county. I am, therefore, not prepared to give any information about any other insect. And but for the serious damage this year to crops, no one could have noticed the boll-worm; but if we should have a very severe winter and a late cold spring, with no south winds, it may be several years before we are troubled with them again.—[T. S. Edwards, Pope.

FLORIDA.

The cotton-plant has other enemies in Florida. Among them is the *red bug*. Sometimes this bug is very injurious. It multiplies very rapidly, will live through the winter, unless the cold is very severe, and endure until the cotton is ready for it, that is, when the bolls are matured and commence to open. It subsists by sucking the seed. This action stains and otherwise damages the lint. This bug is more destructive in new land, and has not troubled this section seriously within ten or twelve years. Then there is what is called the *green bug*. This insect does its mischief by sucking the limbs and branches of the plant, which causes them to die or wither. There is also the *black bug*, which sucks the bolls before they are opened, and damages the cotton somewhat like the red bug. The red bug and black bug will also suck oranges and ruin them. Last season I noticed them covered with this black bug. The oranges would fall and on examination were found without juice and worthless. I have seen neither of the above-mentioned insects this season.—[F. M. Meekin, Alachua.

The ordinary cut-worm in the spring, and of late years a large hairy worm, injure our stands of cotton. Grasshoppers, too, are quite a pest sometimes.—[John Bradford, Leon.

GEORGIA.

There is nothing that is so destructive as the cotton-worm. There are other insects that attack cotton in early spring. 1st, a worm called the cut-worm, that cuts it off

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when it is first up, which destroys the plant entirely. I have known fields to have to be plowed up and planted over, as those worms had destroyed it after a good stand was up. They are not apt to last many weeks before they pass to something else. They are worst in cold, wet springs. The cut-worm hides under about an inch of the loose earth on the surface of the ground during the day, and only works at night. 2d, we have a yellow insect called a cricket that attacks cotton. Some springs, generally in the month of May, they will climb up the plant and cut 1 to 3 inches of the top, causing the plant to become scrubby and flat. These crickets burrow in the ground to the depth of 10 to 15 inches and raise their young at the bottom of their burrows; one will have 20 or 30 young, and they carry parts of the tender cotton into their burrows for their young to feed on until they are able to gain their own livelihood.—[Timothy Fussell, Coffee.

I have never known any very great damage done to the cotton crop in this section by any insects until two years ago, when some crops were destroyed by the grasshopper; and also the year previous to that, 1874, some plantations in this part of the country were visited by what we call a caterpillar from the woods in the month of September, which ate all the leaves off of the stocks, but did not injure the fruit; in fact, it was an advantage to the farmer in that respect; his cotton matured at an earlier period.—[H. W. Hammett, Cobb.

The *aphis* or cotton-louse injures the cotton more or less early in the season. In past years there was a red bug, which made its appearance in Florida and came as far north as McIntosh County, Georgia. This insect did considerable damage. Have heard nothing of it lately.—[William Jones, Clarke.

We have what is called the cotton-louse that attacks the cotton the last of May or first of June and injures it badly. It seems to be under the leaves and sucks the plant until it stops its growth entirely for some time. Hot weather after a while drives it away and the plant grows rapidly. Some say that it is not damaged by the louse, but I think differently.—[E. M. Thompson, Jackson.

I herewith inclose another insect that is very destructive to cotton, in box marked B. They are called here the stinging worm, and their sting is very painful. They web up and transform into a different shaped worm. They remain here during winter, being so securely housed.—[S. P. Odom, Dooly.

Among the new insects I have found on the cotton is *Citheronia regalis*, which feeds on the leaves in August and September. It feeds besides on persimmons and sweet gum, the hickories and walnuts. Its occurrence on cotton-weed excites no alarm. to which plant it is not as injurious as the double-hooded hyperclunia.—[A. R. Grote, Savannah.

The only worm that troubles us in this county is the army worm. They only eat the leaves and destroy the grass. Millions are now in the cotton-fields and hay-fields, but do but little damage to the cotton, and in some instances are a benefit by eating the leaves from large rank cotton, causing the sun to shine in and open it where otherwise the cotton would rot and not open.—[R. H. Springer, Carroll.

There is no other worm except the caterpillar that affects the cotton after it has been chopped and worked out. The cut-worm very often does serious injury to the crop in the way of injuring the stand in spring when the cotton first comes up.—[D. P. Luke, Berrien.

The boll-worm does us more damage, upon the whole, than the cotton-worm. The previous entomologist of the Department has the fly, the worm, and the work, accurately described.—[A. J. Cheves, Macon.

General inquiry in regard to injury of cotton-plant in my section by small insect, and request to send you sample of same, is hereby acknowledged. The injury commenced, as stated in my report, in small patches around trees and stumps on fresh land, particularly on lands which had been in continuous cultivation in cotton from five to seven years, and about the last week in July. At first I did not attach much importance to it, considering it only small patches of crust, but in two or three weeks it spread over a number of acres on my farm, totally ruining the cotton infected. My neighbors reported the same thing, in the same way. We had never had anything of the kind before. The insect is very small, hardly discernible by the eye without a glass. The foliage is the part attacked, which falls off and leaves the stalk. Their ravages seemed worse during the excessive hot weather; rather checked up after a rain. They lasted from four to five weeks, which was about the last week in August. Since then the foliage has grown out, and in some instances a fair crop of half-grown fruit. The season is too short, however, for it to mature.—[Henry W. Dean, Floyd.

LOUISIANA.

When the cotton-plant is small it is sometimes affected with small insects which we call "cotton-lice," and which are found on the under side of the leaves. They cause the leaves to draw up and have a puckered appearance. This we call "possum-ears." If very numerous they cause the stalks infested to become sickly and sometimes to die. Next comes a worm which preys on the cotton after it has grown to be five or six inches high which we call the "cut-worm." It burrows in the ground at the roots of the

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cotton-plant, and at night cuts the stalk partially or altogether through, causing its utter destruction, or making a puny and deformed plant of it. Next we have a worm called the "boll-worm" or "bore-worm," which bores a hole into the boll after it has become partially or wholly grown, and causes it to perish altogether or to become hard and imperfect and fail to mature and open. Some seasons the cotton-plant is injured by grasshoppers, but their injuries are not deemed very great. The cotton-plant sometimes dies of rust, but this is considered a disease of the plant caused by something present in the soil which poisons the plant, or some elements lacking in the soil to nourish the plant properly.—[D. M. Hamilton, West Feliciana.

MISSISSIPPI.

The boll-worm is comparatively small, resembling the silk-worm in its early stages. Its attacks are made within the calyx and about the base of the boll, which it perforates, and when first forming are tender; it wholly devours it or causes it to drop off. The light effectually disposes of the moth that deposits this egg. The greasy rot is caused by the puncture of the boll by a bug or something. It looks like a greasy spot about the size of a three-cent silver piece with a little dot or puncture in the center. The diseased boll when broken open often contains a small variety of insects sometimes in the different stages of their transformations. This disease first made its appearance in 1810 and lasted for about ten years, occasionally to such an extent as almost to cause the abandonment of the culture of cotton, a contingency prevented by the introduction of the Tennessee green seed which was exempt from the disease or less affected than the black seed variety. It reappeared in 1852, more or less then to date (see Wailes, 1854). In my opinion cotton is subject to as many ailments as human flesh is heir to, but will say this: that it has the most wonderfully recuperative powers of any plant I ever saw, and I never despair of a cotton crop until attacked by worms, for if you give it half a chance it will come out in this latitude, 31° 45′.—[J. W. Burch, Jefferson.

The boll-worm visited the crops here early in July (during which month we had repeated rains), and has continued its ravages up to the present period. The opinion of the planters, as generally expressed to me, as well as my own, is that it has done more damage this year than the *anomis* will do, though many fields are now stripped of their leaves by the latter. Many say the worms have cut the crop short one-half, others again one-third. The grass-worm appeared likewise in July, but only in small areas, and though found eating the leaf and young boll, to a partial extent, did no appreciable damage. The leaf has been covered with the aphis or louse, throughout the season, but has done no noticeable damage. I have found occasionally a single large worm, resembling, but larger than the boll-worm, stripping individual stalks of cotton. No other insects have proved injurious.—[E. H. Anderson, Madison.

There are two kinds of worms, both very destructive: the boll-worm, which pierces the small squares first and is not larger than a pin-point, but grows two or three inches long, and eats all the green bolls; and the leaf-worm, that eats all the leaves, leaving nothing but the branches or stems.—[Kenneth Clarke, Chickasaw.

The boll-worm often destroys many of the growing bolls. But as every stalk produces many more forms than it can mature and the bolls attacked are quickly replaced, the damage is not often great.—[J. Culbertson, Rankin.

Lice are sometimes very injurious in the spring; and in the season of production the "blare-worm," a small worm that perforates the "square" about the time of blooming and causes the "square" to stand blared open and to drop off; and the boll-worm, so well known and often described, often does great damage.—[C. Welch, Covington.

The plant-louse, *Aphis*, is very destructive on the young cotton-plant, especially if the weather be cool, so that the plant cannot grow vigorously. I have taken some pains to investigate its habits. If you desire it I will furnish you with what I know relative to it. Do not know of anything that will counteract its work. It sucks all the sap out of the plant. Some suppose the ants eat them. This, however, is not the case; they protect them, and only eat the nectar they discharge.—[W. Spillman, Clarke.

NORTH CAROLINA.

The common grub, garden, or "colored" worm is very destructive to cotton in this locality, especially on light soils highly manured. They cut the young plant off, during the night, an inch or so above the ground, and pull the leaves into the hole they burrow in the earth. Plowing the ground during cold weather is the only remedy ever used, and not an efficient one at all. The plant is also attacked in early spring in low, damp places, by a small insect or louse known among us as the "blue-bug." It sucks the plant just above ground, as many as a dozen being frequently found on one plant. Cotton-plants are also troubled in the months of June and July, during damp, cool weather, by the plant-louse. They seldom destroy, but do seriously retard the growth of the plant.—[J. Evans, Cumberland.

During the past three seasons the common cabbage-worm or cut-worm has been very destructive to young cotton, cutting it down just as it is coming up, injuring and often

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destroying the stand so much as to require replanting. They were very destructive the present season and are increasing yearly. They never do any damage on land that was lying out or in small grain the previous year. They are specially destructive on land that has been planted a series of years in cotton. Possibly they may prove a blessing to us, for if they continue to increase they will force us into a rotation of crops. All birds and poultry seek and devour them greedily. I think the remedy is in the protection of the birds, and ceasing to plant the same land in cotton two years in succession. The rapid increase is perhaps to be attributed to the unusually mild winters for the last two years.—[John Robinson, Wayne.

The cut-worm will occasionally cut young cotton when the weather is cool and wet, but does very little damage.—[F. I. Smith, Halifax.

TENNESSEE.

Though to a very limited extent, some years the boll-worm has been found. We do not like even to guess whether the boll-worm can reproduce itself in this latitude (locality) or not. But however much our theory may be rejected as to its production, we venture a few words. The moth deposits its egg in the young fruit (or form) when in bloom. The boll grows to maturity, the egg is hatched, producing a worm which feeds upon the inside of the boll until the appointed time, then cuts its way out, which process completely destroys the boll. Sometimes decay takes place before the worm cuts its way out. It is a mistaken idea that the worm cuts into the boll, "*Worms cut their way out.*" There is a moth that stings other young fruit here (we believe same as cotton-moth), such as pease, beans, &c., when in bloom, and perhaps when the fruit is gathered and dried for winter the worm finds its way out. We only guess why we are not troubled with the cotton-worm. Our cotton is not in bloom at the particular time the miller lays its eggs. We are aware the above suggestion will be subject to strong criticism, nevertheless they are our convictions from experience and observation.—[E. W. Cunningham, Henderson.

There is a kind of lice that injures the cotton here to some small extent.—[L. Dodson, McMinn.

SOUTH CAROLINA.

The cotton-worm or cotton-caterpillar is the only insect which has been known to damage the plant to any considerable extent in this county (Barnwell). On some farms the "stands" have been injured by the cut-worm, which is the same as that which cuts down cabbage and other vegetables, and is not peculiar to cotton. This trouble is occasional—of late cool springs. Lice or *Aphis* are often seen on the young plant, but seldom injure it. There is no boll-worm yet in any part of the county.—[James C. Brown, Barnwell.

TEXAS.

The boll-worm (*Heliothis*) has done more damage this year than the *Noctua xylina*. They appeared early in June, and the third crop is still at work. The crop of this county is cut off at least one-third. A field of sixty acres planted by my brother-in-law that with no casualty would have made forty-five bales, will barely make fifteen, while some fields are entirely untouched. The egg is laid on the involucel during the night, hatches in from six to ten days, and commences feeding on the parenchyma of the calyx, and as soon as they have got strength they eat through into the inclosed flower-bud, or into the boll, if laid after the bloom. They destroy one or more of the divisions in the boll, and all that are punctured before blooming or while quite young fall off. In the field mentioned above we found many stalks six to seven feet high without a single boll. Instead of webbing up on the cotton-plant, this worm descends into the ground, where it makes a cocoon and is enabled to withstand the severity of our winters, and thus makes its appearance as soon as the weather becomes warm in the spring. I have often plowed out the chrysalides, and examined to see if they were alive, finding them so. The fly, or moth, is hardly half as large as that of the former insect. There are some other insects injurious to the cotton-plant, and I do not know that any effort has been made for their extermination, or if any means could be adopted successfully.—[Walter Barnes, Cherokee.

The boll-worm fly deposits its egg on the young squares just before they bloom, about the last of July or first of August. The fly deposits its eggs at twilight and moonlight nights. I cannot say what kind of a moth it is, but my neighbor, an intelligent planter, says it is a yellow fly, smaller than the army-worm fly. I have never seen the boll-worm eat anything but the young bolls and squares before blossoming. They pierce the blossom and eat or suck the juice, which causes them to drop off. Some seasons they are more numerous than others. I have never heard of any means being taken by any farmer to destroy or prevent their depredations, but they take their presence as a matter of course.—[C. B. Richardson, Rusk.

We have the old-time enemy, the boll-worm that punctures the squares and bolls. I am certain the larva of this insect falls to the ground and hides itself there to perfect its being. There is another insect that we call the "boll-weevil" or "ball-cur-

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culio," that punctures the boll and causes it to commence rotting from a very small black speck. This rot continues throughout the whole boll, sometimes leaving one lobe. It is a small black beetle about one-sixteenth of an inch long. I once had a fine crop destroyed by this insect when my near neighbor suffered very little. My cotton being older, was suited better for its work. There was a great quantity of cotton destroyed in Texas this year, when rot had credit of doing it. I know of no remedy against this insect.—[W. T. Hill, Walker.

There is what we call the boll-worm, that bores a small hole in the little pod while in a state of formation; it does its work in the night; it will be hard to destroy. Thirty-five years ago there was a web-worm came on the cotton in May, and literally killed it, except the stem; however it would sprout out again and make a crop. That was in certain localities. This worm has entirely disappeared. I have lived in Texas forty years next month; have made thirty-nine crops. My experience is the worm will be hard to overcome; he is a fixture upon us, and the surest remedy against him is to plant early and cultivate well; in so doing a reasonable crop can be frequently realized. If all the farmers would combine and place lamps on posts in flat tin pans with kerosene in them the moth could be more effectually destroyed than any other way I see.—[O. H. P. Garrett, Washington.

The boll-worm, (*Heliothis*) has done more injury to the cotton-plant than any other insect this year. Unlike the army worm, they hibernate in the country, and commence their depredations as soon as the young bloom buds make their appearance. Some years they do a great deal of damage; it is said by some farmers that fifty per cent. of the crop is lost on account of the boll-worm. It seems the moth deposits the egg in the last bloom bud. When hatched it eats out the pistil of the unexpanded flower, (it is now called sharp-shooter,) then descends the branch, eating up all on his way, and by the time it gets to the last one perhaps it is grown and ready to go into the chrysalis state. There are birds and poultry that feed on the larva when it can be got at. The plant-louse is somewhat injurious to the young cotton-plant; hot weather soon drives it away.—[J. M. Glasco, Upshur.

The cut-worm, boll-worm, grasshopper, and lice are all more or less injurious to the cotton-plant.—[S. B. Tackaberry, Polk.

In 1877 the boll-worm appeared in Clay County, and some fields were about half eaten up, while others were not touched.—[William Tanner, Clay.

The boll-worm is some years quite destructive, though I hear of none this year.—[Samuel Davis, Hunt.

When the young plant first makes its appearance above the ground the cut-worm, which attacks all young plants, will destroy a few plants here and there. Later in the spring, when the plant has taken on some five or six or more leaves, the web-worm almost every year will eat and web upon some of the most vigorous stalks. The injury inflicted by these insects is not much dreaded, as their evil tendencies may be corrected, and they soon disappear as spring advances. The next and last enemy of the cotton-plant is the boll-worm, which only penetrates the young boll when in its most delicate and tender state, and is sometimes more destructive than the army worm. There are some points of resemblance between the two, but their tastes and habits, although both only prey on cotton, are totally different. They are represented as having appeared in several counties of the interior. They are rarely seen on or near the coast, evidently preferring a higher latitude.—[W. J. Jones, Galveston.

This insect, though not so numerous nor so regular in its visitations, is far more formidable in its ravages than the leaf-worm, since there is no way of saturating the cotton-boll with poison to destroy them. A very intelligent planter in Falls County, on the Brazos River, in this State, is well satisfied that he has found the miller or mother moth of this worm, and has discovered a sure, simple, and inexpensive method for its destruction, and at the same time increasing the yield of the staple. He says the egg is deposited by a moth of a lighter color, of larger size, and much heavier body than that of the army worm; that it invariably deposits its eggs on the very top bud of the cotton-plant; that as the worm increases in size he travels down the stalk, taking every boll as he goes, rapidly penetrating the same in its young and succulent state, very few worms completing the destruction of the entire fruit of the plant. The worm attaining its full growth is larger than the army worm, and is more destructive to the product of the plant. This gentleman, with some of his neighbors, watched closely the progress of this insect, and very satisfactory results were obtained. Experiments were made upon three different plantations with the same results. They all checked the march by topping the cotton (removing the bud) when the moth first made its appearance, and whether the egg was only in deposit or the young worm at work, the result was the same, as both perished upon the ground, and the worm never made an effort to reascend the stalk. The topping of cotton has been practiced many years by some of our most intelligent planters, but with a different purpose, the stripping of the top being supposed to increase the fruiting and to hasten the opening of the pods of cotton.—[William J. Jones, Galveston.

The boll-worm is very injurious to cotton in August and September by boring in the

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bloom and the young bolls, causing them to fall off. They are more or less on the cotton every year. The first crop of bolls that are formed in July generally escape their ravages, but the top squares and bollst hat come in August are liable to their attacks.—[C. B. Richardson, Rusk.

The cotton has two more dreadful enemies; the first consists of a small bee or fly that bores into the square or rather the formation of the bloom, and causes it to wither and fall off. Some years they are very destructive. The second is the boll-worm that penetrates the young boll in its tender state, causing it to fall and sometimes rot on the plant. This pest is caused by a small fly or bee that deposits its eggs on the boll, and I think is the same chap that bores in the square; the only way to catch or destroy him is by the lamp; you cannot do anything with him with poison, as he only preys on the boll, &c.—[Nat. Holman, Fayette.

There is one other insect that has destroyed more cotton in this locality within the four years than all other insects combined. It is known here as the boll-worm, the moth of which is larger and darker than the cotton-moth, which deposits its eggs by piercing the form or square at the base of the bulb that makes the bloom. The egg hatches in a few days, and the larva devours the young boll before it fairly blooms. Then it crawls upon the limb to another boll, bores in, and eats out the contents; then to another, and so on until all, or nearly all, that is upon the stalk is destroyed. The habit of the moth is nearly that of the cotton-moth, but the worm does not resemble that of the cotton-worm in any respect. It does not feed upon anything but the cotton-boll. Its numbers are increasing so rapidly and its destruction so great, it is becoming a terror to the cotton planter in this locality. If you know anything of this worm and can point out some means of destroying it you will have the gratitude of the cotton planters in this county and probably throughout the cotton belt.—[J. W. Jackson, Titus.

The plant is injured to some extent by aphides or leaf-louse, which appear every year in large numbers on the lower side of the leaves; they do the most injury in spring, when the plant is small and tender. *The web-worm*, which only injures the plant in spring when the plant is small, and appears mostly in large and destructive numbers during the prevalence of cold and dry weather, the plant then making little or no progress in growth; the worm is a small insect about one inch in length, green with black dots, spins the leaf together, and destroys the substance between the leaf ribs, causing the young plant to wither and die. The boll-worm, which attacks the grown fruit before its opening, boring into it and destroying the lint, has been very destructive the past summer. Several varieties of grasshoppers, the green grasshopper appearing in summer, has been observed the past summer in large and destructive numbers in some fields.—[J. H. Kranchor, Austin.

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APPPENDIX III.

LIST OF CORRESPONDENTS.

The following list contains the names and addresses of those gentlemen not regularly employed in the investigation who have assisted in its prosecution either by answers to the circular-letter or by other correspondence. They are arranged alphabetically under the subheads of their respective States, and the States themselves are also alphabetically arranged:

ALABAMA.

Names of correspondents.	Town.	County.
H. C. Brown	Camden	Wilcox.
P. D. Bowles	Evergreen	Conecuh.
I. F. Culver	Union Springs	Bullock.
J. F. Calhoun	Minter	Dallas.
J. A. Callaway	Snowdoun	Montgomery.
W. M. Douglas	Huntsville	Madison.
John Witherspoon Du Bose	Pike Road	Montgomery.
R. B. Dunlap	Boligee	Greene.
I. D. Driesbach	Tensaw	Baldwin.
A. D. Edwards	Tuskegee	Macon.
P. T Graves	Burkville	Lowndes.
H. Hawkins	Hawkinsville	Barbour.
J. N. Gilmore	Gaston	Sumter.
R. F. Henry	Columbus	Mississippi. For Pickens County, Alabama.
C. C. Howard	Ataugaville	Autauga.
James M. Harrington	Newtown Academy	Monroe.
J. S. Hausberger	Tionus	Bibb.
M. W. Hand	Fortland	Greene.
Charles M. Howard	Mulberry	Autauga.
John D. Johnston, M. D	Sumterville	Sumter.
Andrew Jay	Jayville	Conecuh.
Knox, Minge and Evans	Faunsdale	Hale.
David Lee	Mount Willing	Lowndes.
J. C. Matthews	Crittenden Mills	Dale.
R. H. Powell	Union Springs	Bullock.
Dr. John Peurifoy	Mount Meigs	Montgomery.
J. R. Rogers	Union Springs	Bullock.
R. W. Russell	Lowndesborough	Lowndes.
H. A. Stolenwerck	Uniontown	Perry.
J. H. Smith	Minter	Dallas.
H. Tutwiler	Green Spring	Hale.
George W. Thagard	Rutledge	Crenshaw.
Robert S. Williams	Mount Meigs	Montgomery.

ARKANSAS.

Names of correspondents.	Town.	County.
S. W. Cochran	Union	Fulton.
E. T. Dale	Texarkana	Miller.
O. L. Dodd	Mountain Home	Baxter.
T. S. Edwards	Gum Log	Pope.
T. W. Quinn	Prattsville	Grant.
L. N. Rhodes	Wittsburgh	Cross.
J. W. Ransom	Jonesborough	Craighead.
Alfred A. Turner	Hermitage	Bradley.
John T. Wickham	Boydsville	Clay.
G. Whittington	Mount Ida	Montgomery.
Norborne Young	Magnolia	Columbia.

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FLORIDA.

Names of correspondents.	Town.	County.
J. Bradford	Tallahassee.	Leon.
John B. Carrin	Deadmen's Bay	Taylor.
Robert Gamble	Tallahassee	Leon.
John M. McGehee	Milton	Santa Rosa.
F. M. Meekin	Morrison's Mills	Alachua.
W. E. Woodruff	New Berlin	Duval.

GEORGIA.

Names of correspondents.	Town.	County.
James R. Brown	Canton	Cherokee.
A. J. Cheves	Montezuma	Macon.
Timothy Fussel	Kirkland	Coffee.
George P. Harrison	Savannah	Chatham.
H. M. Hammett	Marietta	Cobb.
W. A. Harris	Isabella	Worth.
William Jones	Athens	Clark.
William J. Johnson	Spring Place	Murray.
Morgan Kemp	Buena Vista	Marion.
M. D. Langsford	Ringgold	Catoosa.
D. P. Luke	Nashville	Berrien.
S. P. Odom	Drayton	Dooly.
R. H. Springer	Whitesburg	Carroll.
E. M. Thompson	Jefferson	Jackson.
John T. Wingfield	Washington	Wilkes.

LOUISIANA.

Names of correspondents.	Town.	County.
I. U. Ball, M. D	Bayou Sara	West Feliciana.
Douglass M. Hamilton	Saint Francisville	West Feliciana.
John A. Maryman		East Feliciana.
C. B. Richardson	Henderson	East Carroll.
H. B. Shaw	Lake Saint John	Concordia.
G. W. Thomas	Cypre-mort	Saint Mary's.

MISSISSIPPI.

Names of correspondents.	Town.	County.
E. H. Anderson, M. D	Kirkwood	Madison.
J. W. Burch	Fayette	Jefferson.
S. Culbertson	Brandon	Rankin.
Kenneth Clarke	Okolona	Chickasaw.
Daniel Cohen	Ashwood Station	Wilkinson.
I. G. G. Garrett	Port Gibson	Claiborne.
William T. Lewis	Louisville	Winston.
D. L. Phares, M. D	Woodville	Wilkinson.
John C. Russell	Kirkwood	Madison.
C. F. Sherriod	Columbus	Lowndes.
Samuel Scott	Canton	Madison.
W. Spillman	Enterprise	Clark.
George V. Webb	Liberty	Amite.
C. Welch	Station Creek	Covington.

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NORTH CAROLINA.

Names of correspondents.	Town.	County.
S. W. Blalock	Bakersville	Mitchell.
James M. Barnett	Roxborough	Person.
J. D. Click	Oak Forest	Iredell.
J. W. Cooper	Murphey	Cherokee.
W. G. Curtis	Smithville	Brunswick.
D. D. Davies	Cullowhee	Jackson.
J. J. Erwin	Morganton	Burke.
J. Evans	Fayetteville	Cumberland.
H. M. Houston	Monroe	Union.
W. H. Hartgrove	Garden Creek	Haywood.
Joseph Livingston	Hendersonville	Henderson.
T. H. Lassiter	Gatesville	Gates.
Thomas Long	Huntsville	Yadkin.
M. McKay	Lillington	Harnett.
T. L. Rawley	Ruffin	Rockingham.
John Robinson	Goldsborough	Wayne.
F. I. Smith	Scotland Neck	Halifax.
Jasper Stone	Pin Hook	Gaston.
R. T. Weaver	Saint John	Hertford.

SOUTH CAROLINA.

Names of correspondents.	Town.	County.
James C. Brown	Millettville	Barnwell.
Paul S. Felder	Orangeburgh	Orangeburgh.
James W. Grace	Walterborough	Colleton.

TENNESSEE.

Names of correspondents.	Town.	County.
N. Y. Cavit	Paris	Henry.
E. W. Cunningham	Lexington	Henderson.
L. Dodson	Athens	McMinn.
W. C. Emmert	Vanderbilt	Unicoi.
A. Gardner	Dresden	Weakley.
L. C. Hall	Gainsborough	Jackson.
A. W. Hunt, M. D	Denson's Landing	Perry.
John F. Hauser	Gruetli	Grundy.
J. M. Hammer	Sevierville	Sevier.
H. W. Hart	Pikeville	Bledsoe.
J. P. Hooke	Maryville	Blount.
D. W. Holman	Fayetteville	Lincoln.
J. S. Lindsay	Jacksborough	Campbell.
Ephraim Link	Greeneville	Greene.
Robert McNeilly	Charlotte	Dickson.
Thomas J. Mason	Loudon	Loudon.
John McMillan	Decaturville	Decatur.
J. S. Thomason	Glenloch	Monroe.
Miles F. West	Walnut Shade	Macon.
J. K. P. Wallace	Andersonville	Anderson.
George W. Walker	Springfield	Robertson.

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TEXAS.

Names of correspondents.	Town.	County.
H. J. H. Brensing	Texarkana, Miller County, Arkansas.	For Bowie County, Texas.
Walter Barnes	Larissa	Cherokee.
P. S. Clarke	Hempstead	Waller.
Samuel Davis	Greenville	Hunt.
O. H. P. Garrett	Brenham	Washington.
J. M. Glasco	Gilmer	Upshur.
W. T. Hill	Waverly	Walker.
Stephen Harbert	Alleyton	Colorado.
Natt. Holman	Fayetteville	Fayette.
W. R. Hayes	Aransas	Bee.
J. W. Jackson	Mount Pleasant	Titus.
J. H. Kranchor	Millheim	Austin.
I. F. P. Kruise	Fort McKavett	Menard.
Pryor Lea	Goliad	Goliad.
James O. Gaffney	San Patricio	San Patricio.
C. B. Richardson	Henderson	Rusk.
A. Shroeter	Double Horn	Burnet.
John Speir	Blanco	Blanco.
S. B. Tackaberry	Moscow	Polk.
Wm. Tanner	Cambridge	Clay.
A. Turpo	Eagle Pass	Maverick.
A. Underwood	Columbia	Brazoria.
P. S. Watts	Hardin	Hardin.
R. Wipprecht	New Braunfels	Comal.

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