

a newly hatched larva and an unhatched egg taken together for comparison.

Figure 4 of the plate is a photograph from life of the adult *Benacus*. It was taken while clinging to a white board in an aquarium, head downward (the photo print accidentally mounted in the opposite position for the plate). As is well known, the adult flies freely from pond to pond, coming with *Belostoma* to electric lights in cities and towns. It lays its eggs upon a dry stem several inches above the surface of the water.

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### Studies in Certain Cicada Species.

By JOHN B. SMITH and JOHN A. GROSSBECK.

Plates III, IV, V.

This study originated in the desire of the senior author to prepare for his annual report an account of the periodical *Cicada*, a brood of which was due to appear in New Jersey, in 1906, and incidentally, to call attention to the other species that occurred within the limits of the State. Messrs. Davis and Joutel had just published their notes in ENTOMOLOGICAL NEWS, Vol. XVII, page 237, and the junior author was assigned to the task of separating out our material which was fortunately quite rich, and to making such drawings and sketches as might be required to bring out the interesting features:—ovipositor, stridulating apparatus and the like. It was easy to separate the bulk of our material into the species recognized by Davis and Joutel, the more as Mr. Davis had used some of it in his work; but there remained a puzzling residue, part of which was eliminated when Prof. Osborn published his description of *Cicada fulvula* in ENTOMOLOGICAL NEWS, Vol. XVII, page 322. None of the recent authors had seemed quite satisfied with the identification of *pruinosa* Say, and our own efforts to fit the specimens usually listed under that name to the description were hardly more satisfactory. But we found among our puzzles a very few examples that did fit, perfectly: the description as it stood might have been made from any one of them. But this left the common form nameless, unless some of the terms cited as synonyms of *tibicen* might really prove to be this form. The idea of including our study in the annual re-

port was now abandoned and additional material sought for. As usual, the collections proved poor in the common species, but from the Academy of Natural Sciences of Philadelphia, the Brooklyn Institute Museum, the American Museum of Natural History, the Children's Museum of Brooklyn, the U. S. National Museum at Washington, and from Messrs. W. T. Davis and E. Daecke we obtained series that enabled us to separate our species very nicely.

It became necessary now to determine the form to which Linné's term should be applied, and here another surprise was in store for us. The description of course fitted almost any *Cicada*; and the only pointer given by Linné himself was the reference to Merian's Surinam, pl. 49, where we found a fair figure of a species totally different in appearance from what we had been calling *tibicen*. Running down the literature to ascertain *how* the species came to be identified with our American type, we found that it rests upon a casual statement of Stal. The whole matter is interesting enough to warrant detail and both authors have been over some of the volumes to make sure of the facts.

On the occasion of a recent visit to Washington, Mr. O. Heideman was good enough to show me the *Cicada* material from Central and South America, and there is nowhere any specimen that could be mistaken for our so-called *tibicen*, while there are several of a type resembling Madame Merian's figure and among which I feel very confident the true *tibicen* may be identified. Mr. Heideman also showed me the works of Mr. Distant, and called my attention to the fact that in the "Biologia" *tibicen* was included only on the authority of Stal and not from any material identified with that species.

*C. tibicen* was described by Linné in the Syst. Nat. ed., X, p. 426, in the most general terms; the Merian figure already cited was referred to, and "Habitat in America" was added for locality. In 1767, in the 12th edition of the same work, Vol. I, pt. 2, the description and reference were repeated and nothing was added to modify the original statement as to locality.

In 1775, Fabricius in the Syst. Ent., 679, places the *Cicada*

*tibicen* of Linné in *Tettigonia*, cites Merian's *Ins. of Surinam* as before, and also Brown's *Jamaica*, pl. 43, f. 15. This figure which has been examined by Mr. Grossbeck may or may not be a species of the forms we have called *tibicen*, but it certainly does not seem to be the species figured by Madame Merian.

In 1778, De Geer, in his *Insects*, III, 212, pl. 32 (not 22 as usually cited), figures his *lyricen*. He cites *tibicen* Linn. as the same species, and credits Mme. Merian with the name *lyricen* or "lierman." He adds to his diagnosis the statement that the species is found in America "septentrionale" as well as "meridionale" and gives a detailed description of his material from New Jersey and Pennsylvania both as larva and adult, including the singing and egg-laying habits of the adult. There is no doubt that De Geer had a North American insect before him and there is no reasonable doubt that this was the exact form that Prof. Osborn has so recently described as *C. fulvula*. The figure is excellent and the description is accurate in all details. There can be no reasonable doubt as to the identity of *lyricen* De G.

In 1790, Olivier in the *Enc. Meth.*, 749, refers to *tibicen* Linn., cites *lyricen* De Geer as a synonym, and quotes Merian as to the habits of the species and the damage done in coffee plantations.

As a new species he describes *C. opercularis* from the Isle of Java and cites Stoll, pl. 13, A and B, for a representation of the species. This figure of Stoll is utterly unlike anything that I know from North America, and is certainly incapable of being twisted into a resemblance to our "tibicen" or even the *tibicen* of Linné.

In 1794, Fabricius in the *Ent. Syst.*, IV, 18, again refers to *tibicen*, as before, but adds the reference to De Geer, giving America meridionale as the habitat. On p. 19 he describes *Tettigonia variegata*, habitat in Carolina, just after *septendecim*, and says of it that it is of the size and build of the preceding, i. e., *septendecim*. There is nothing in this, and nothing in the subsequent description that refers to any resemblance or relation to *tibicen*.

In 1803, Fabricius in the *Syst. Rhyng.*, p. 35, cites *tibicen*

as before, and again gives America meridionale as the habitat. To this is added, in the Academy copy, in Say's handwriting, "St. Paulo, Brasilia, Germar," indicating that some effort has been made to identify this with a South American form.

At p. 37. *variegata* is again described, placed as before and recorded from Carolina.

In 1825, Say described his *pruinosa*, knowing of the Fabrician and Linnæan species; but what forms he identified with the names I have no means of knowing.

In 1830, Germar gives in Thon's Archiv., II, p. 40 et seq., a descriptive list of Cicadids in which he refers to *variegata* Fabr., describes it at some length, and cites Roesel's Ins., pl. XXV, f. 5, as representative of the species.

Roesel's figure, unfortunately, tells nothing. It is not well drawn for identification and may be meant for any one of half a dozen or more species. It is said to be an "Indian" variety, but this may mean American as used.

Germar also refers to *opercularis* Oliv., gives Java as the habitat, and then adds that he believes it to be a variety of *variegata* in spite of the difference in locality. He cites Stoll's figure as usual and there is at least one important hint in this, because Stoll's figure does resemble *septendecim* in general build, and the Fabrician comparative reference is therefore in so far confirmed.

Walker's work in 1857 adds little to our knowledge, but he makes *lyricen* De G., *pruinosa* Say and *mannifera* Linn. synonyms of *tibicen*, while recording *opercularis* as a species unknown to him.

In 1869, Stal in his Hemiptera Fabriciana, II, 6, cites the *tibicen* of Linné, gives all the Fabrician references, adds as an additional synonym *opercularis* Oliv., gives America meridionalis as habitat and then comments:—this species inhabits boreal America.

Since that time matters have remained much as Stal left them. In 1841, Dr. Harris described *canicularis* in "Insects Injurious to Vegetation," p. 175, but Fitch disposes of that species in his Third Report in 1856. He says *pruinosa* is *tibicen* with the mealy powder not rubbed off, and *canicularis* is only a

small *pruinosa*. He quite correctly calls attention to the variation in the opercular plates and says they are not good bases for specific separation.

In 1892, Uhler in the Trans. Md. Acad. Sci., p. 149, makes *canicularis* a good species, but cites under *tibicen*, the names *lyricen*, *variegata*, *opercularis* and *pruinosa* as synonyms. He states that according to Germar the true *tibicen* is the common form figured by Stoll, and that Olivier's species having been described from that figure must be a synonym.

The most recent list of species is by McGillivray in the Can. Ent., XXXIII, p. 74, in which Uhler is followed as to *tibicen*, without original study of the problem.

The conclusions drawn from this study of the literature are that *C. tibicen* L. is not a North American species at all; but that, based on Merian's figure, it is a common Central and South American species. What we have called *tibicen* is an undescribed species. *C. opercularis* Oliv. is a Javan form for which there is absolutely no evidence that warrants us in identifying it with any American species. *C. variegata* Fabr. is an ally of *septendecim* which has not yet been identified in collections. *Lyricen* De G. has been redescribed as *C. fulvula*. De Geer's belief that he had the same form as Linné is based on nothing better than a general similarity.

The notes on structure and the specific descriptions are by the junior author, though all points have been verified by both authors.

It seems strange that such large and common insects should have received so little careful attention. In most of the collections seen by us there were from two to five, and in one instance nine, species under the name *tibicen*. It would have been difficult to definitely separate the species in any one collection without additional material, and so from a number of sources something over two hundred and fifty specimens taken at many points in the eastern United States and a few from the western and southwestern portions were gathered together.

Having established the identity of Say's *pruinosa* and reached the conclusion that *tibicen* did not occur in North America at all, the description and figure of *lyricen* left no

doubt as to the species intended and consequently *C. fulvula* Osborn falls into synonymy. *Canicularis* Harris is sufficiently well characterized to enable the species to be recognized with certainty. Having thus disposed of or identified all the published names we are free to name all other forms that are specifically distinct from them.

*Cicada linnei* is proposed for the species which has so long been known as *tibicen*.

*Cicada sayi* is proposed for the form hitherto erroneously known as *pruinosa*.

*Cicada davisi*, so called in honor of Mr. Wm. T. Davis, whose article induced the present critical study, is proposed for a very distinct little species which has been confused with *canicularis*.

*Cicada similaris* is proposed for a Floridan species, close to *lyricen* in general appearance, but widely variant in genitalic structure.

There are other species under our observation from the U. S. N. M. collection, which will eventually have to be named; but which we do not describe, partly because of the scant material at hand and principally because they are quite without the scope set for this study. The genitalia of one of these species from Mexico is figured, pl. III, f. 7 and 8, to illustrate the amount of variation displayed by members of the *tibicen* group.

There is considerable difference between species in a number of structural details, but most of them are subject to some variation. These differences may be used to good advantage for the separation of species, though in a few cases the variation is so great as to leave almost no definite line of demarcation between closely allied species when only one character is used. For the purposes of specific separation no structures are of more importance than the male genitalia, which in the Cicadids are large, strongly chitinized and easily examined. They are absolutely constant in form, however subtle certain processes may be, and are always to be relied upon. The uncus shows the greatest diversity of form. In the usual type it is broad above, with parallel lateral margins, and from the side is narrow, slightly constricted a short distance from the base, and

there tapered evenly to the apex. From the side it may appear pointed as in *canicularis*, pl. III, fig. 5; or capitate as in *marginata*, fig. 1; or subapically dilated as in *davisi*, fig. 4. In *similaris*, fig. 9, it has two spinelike processes on the under side, which together show as one from the side. An extreme form from Mexico (sp. indet.) is represented in figures 7 and 8, where it takes the form of a pair of curved horns. The large side pieces also show some difference in shape, though less than in the uncus.

The opercula afford good characters. Usually they vary but little, the single instance of great variability being in *canicularis*, which merges into the opposite extreme of *linnei*. Even the color of these structures is of some importance.

The first and second abdominal segments below are intimately united and appear almost as one, the first bordering the anterior margin of the second. Taken together they differ considerably in the various species, the greatest variability in any one species again showing in *canicularis*. The figures of *linnei* and *canicularis*, pl. IV, figures 7 and 8, though drawn to one scale, represent large and small specimens, respectively—the average size of each species—with size eliminated, the difference is not as great as at first appears; consequently, the amount of variation needed to bring the two forms together is not really so great. The last ventral abdominal segment, used by Davis and Joutel in their separation of *linnei* (*tibicen*), *canicularis* and *sayi* (*pruinosa*), are also of value.

The thoracic sclerites offer practically no differences in shape within generic limits. We have lettered these sclerites (pl. IV, fig. 1), using *pruinosa* for this purpose, but the result is not entirely satisfactory and some changes may have to be made. The prosternum lying between the front coxæ is hidden beneath the lower part of the head. The mesosternum is a large, broadly pentagonal sclerite, just anterior to and partly between the second pair of coxæ. In the prothorax, the large lateral pieces, immediately posterior to and at the sides of the front coxæ, are an inflexure of the pronotum. The two small sclerites posterior to it represent the propleural sclerites—the proepisternum and the proepimeron. Both pleural pieces of the

mesothorax occupy their proper places and are very little modified. The association of the names with sclerites is somewhat doubtful in the metathorax, and the notes here given are to induce observation. Dr. Sharp, in the Cambridge Natural History, speaks of the opercula as enlargements of the metepimera, and we have so designated them.

In the structure of the female we merely show the ovipositors of a few species—*marginata*, *linnei* and *septendecim*. The differences between them are not great; in *marginata* the basal portions are proportionately much larger than in *linnei*, which is taken as the type form, and the apical portions correspondingly shorter; in *septendecim* the structure is much as in *linnei*, but the entire organ is proportionately shorter. One of the side pieces of the tip of the ovipositor of *septendecim* is figured, highly magnified to show the hooks by which the splint is pulled out from the slit made in the twig.

***Cloada pruinosa* Say.**

Length—♂, 33 mm., to tip of wing 49 mm.; ♀, 30 mm., to tip of wing 48 mm.—Head black, anterior margin on each side of clypeus and posterior margin between ocelli and compound eyes green; center of upper portion of clypeus with an elliptical green spot. Pronotum largely green, with two broad black marks beginning at anterior margin and becoming attenuated posteriorly where they join, inclosing a green, somewhat diamond-shaped spot; two other marks originate back of eyes and curve posteriorly toward the center; posterior and lateral margins wholly green. Mesonotum green, with black marks distributed as follows: On each side of center, beginning at anterior margin, is a broad mark which becomes slightly narrower and rounded posteriorly and ends before middle; a second mark narrowly separated from the first begins broadly at anterior margin, becomes greatly attenuated and sometimes divides as it proceeds posteriorly, then broadens abruptly and terminates just before the posterior margin; a third near the lateral margin begins as before and joins the second mark posteriorly; in center of posterior portion of mesonotum is a large mark, rounded posteriorly and extending in a point between the two central marks of the anterior portion. Abdomen above black, base of first segment with a white, heavily pruinose lateral dash, which encroaches to some extent upon the second segment; a similar but longer and broader lateral dash extends along the base of the third segment and a spot of the same color is on each side of the eighth segment. In the female the dash of the second segment differs from that of the male in not becoming



attenuated dorsally, but in being squarely truncated; the spot on the seventh segment also extends on to the following segment—that which ensheaths the ovipositor—and is apparent from above. Beneath the abdomen is pruinose on pleura and sides of sternum, the central portion shining black. The opercula are as broad as long, excluding the extension beyond the coxal cavity, and overlap slightly in the center.

*Habitat*.—Anglesca. September 8th; Cape May County, September 20th, and Bayside, October 21st,—all in New Jersey.

This is the most invariable of the species before us, as far as can be judged from the eight examples (7 ♂ and 1 ♀) studied. The thoracic markings are well defined and illustrate the type of maculation of this group. The abdominal ornamentation also is identical in all specimens of one sex.

***Cicada sayi* nov. sp.**

Length.—♂, 30-35 mm., to tip of wings 45-53 mm.; ♀, 28-34 mm., to tip of wings 43-51 mm.—Head black, except for a small green spot just inside the compound eyes; upper portion of clypeus usually all black. Pronotum green, with two marks, sometimes broken, which begin broadly on anterior margin, become narrow and join posteriorly, forming a distinct V; lateral and posterior margins usually black, sometimes with a green spot on each side of the center of the latter, which may broaden or lengthen or, rarely, involve the whole margin save for a small central and lateral mark. Mesonotum black, with a fulvous background showing more or less plainly and the maculation always partaking of the general pattern described for *pruinosa*. Abdomen black, with a large white pruinose spot on each side of the first segment. Beneath, the entire body excluding the legs, heavily pruinose. The opercula are very large, longer than broad and overlap considerably in the center. The genitalia are similar to that figured for *C. fulvula*; the uncus dilated and truncated apically.

*Habitat*.—Ranges from New York southward to Alabama, and westward to the Mississippi River; in the vicinity of New York and New Jersey from mid-July to early October; Kentucky, May; Mississippi, early April. The dates for the Southern States are suggestive.

This is undoubtedly the most common form in the eastern United States, and probably occurs from Canada to the Gulf of Mexico east of the Mississippi, though we have no specimens outside the range given above. It is the most robust species occurring in New Jersey.

***Cicada lyricea* De Geer = *fulvula* Osborn.**

Fifteen specimens of each sex, which agree in the main with Professor Osborn's description, are before us. With this number of individuals the range of variation is considerably beyond that given in his diagnosis. The pronotum in some is all black, except for a broad central line and the mesonotum in such is also black, with narrow fulvous lines indicating the usual pattern. In other examples fulvous is the predominating color, the black maculation being reduced; but the posterior and lateral borders of the pronotum are always black, except for a small spot which is sometimes present near the head. Green occasionally replaces the fulvous and, rarely, both are present on the same insect, the fulvous occupying the lateral portions of the mesothorax, the green the remainder of the background. The narrow pruinose line at the base of the abdomen is more often than not separated into two lateral linear spots and is rarely absent. Beneath, the black polished center with lateral pruinose borders holds true in all specimens. The opercula are as broad as long and vary in shape posteriorly from rounded or elliptical as described, to the more usual shape for this form, of a sub-quadrangle as shown in the figure. They are of a uniform pale brown color, quite different from the creamy yellow color, with black shadings, of most of the allied species. The genitalia are of the more usual form; the uncus much dilated and truncated apically.

*Habitat*.—New York to Florida and westward to Indiana; New York—Long Island and Staten Island, July to September; New Jersey—Normanock, July; Newfoundland, July 28; Paterson, July 14; Newark, July 27; New Brunswick, Farmingdale, August 12; Mentone, Alabama, August 10; Georgiana and Archer, Florida, July.

***Cicada similis* nov. sp.**

Length: ♂ 35 mm., to tip of wings 50 mm.

This species is very close to *C. lyricea*, but the great difference in the genitalia (pl. III, fig. 9) separates it at once from that species. The clasp or side piece is not very characteristic, but the uncus is curiously shaped like the head of a snake with expanded jaws, and from above the lower "jaw" is deeply

cleft, dividing it into two lateral spines. The present form differs further by the lateral border of the pronotum being largely green, which may, however, occur in *lyricen* by the enlargement of the green spot near the head, and by the slightly longer opercula which extend to the end of the third abdominal segment, the border of which is also more strongly reflexed. Otherwise it comes within the range of variation displayed by *lyricen*.

Type: One male from Fernandina, Florida, collection U. S. National Museum.

This may be the species which Professor Osborn regarded as the possible male of his *fulvula*, since he speaks of the opercula having "a distinct reflexed border," while in the true *fulvula* they are not more strongly reflexed than in other species.

***Cicada canicularis* Harris.**

Length.—♂, 27-30 mm., to tip of wings 40-44 mm.; ♀, 26-27 mm., to tip of wings, 39-45 mm. The head and thoracic markings are much like those described for *pruinosa*, but the extreme lateral mark of the mesothorax rarely joins the sublateral one posteriorly. As a rule but little variation is shown, though in a few specimens the two central anterior marks combine, forming one large spot and each of the two lateral marks join in a like manner. The posterior and lateral margins of the prothorax are green, as in the entire background of the thorax, —and rarely, in heavily marked examples, there is a tendency for the anterior portion to become black. Abdomen above black, with small linear pruinose spots on the first segment in a few of the males only. Beneath, the center is highly polished black, with broad white pruinose borders. In the specimen from which the figure was made the pruinose border was removed, which shows the major portion of the pleura also black. The opercula in typical specimens are considerably broader than long and are usually dark brown or blackish, though variations run toward larger opercula which are also lighter in color. The uncus of the genitalia is slender when viewed from the side, tapers apically and is slightly swollen in the center.

*Habitat*.—From Nova Scotia and Lake St. George, Quebec, westward to Wisconsin and Iowa and southward to Washington, D. C.; mid-August to mid-October.

This form probably occurs throughout the northern United States east of the Mississippi River.

**Cicada linnei** nov. sp.

Length.—♀, 31-34 mm., to tip of wings 45-50 mm., ♂, 29-33 mm., to tip of wings 44-48 mm.

This species has been regarded as the *tibicen* of Linnaeus. Typical specimens are widely different from specimens typical of *cunicularis*, but occasional examples occur which are almost intermediate and are difficult to place correctly. In the large number of both species before us, however, the few such forms compared with the large number which are recognized at a glance leaves small room for doubt as to there being two species. *Linnei* differs from *cunicularis* chiefly as follows: By the greater size of the individuals and the more prominent eyes; by the thoracic markings, the component parts of the pattern of which are not so closely set as in *cunicularis*, thus showing a greater amount of the green background; by the comparatively larger size of the basal spots of the abdomen of the male (there are none in the female); in the greater comparative length of the second abdominal segment of the male, and in the longer opercula, which are usually as long as broad and almost always light in color. The genitalia are like *cunicularis*.

There are a few male examples in the series before us which lack the pruinose spots at base of the abdomen, but these seem to have been in alcohol, which causes the disappearance of such spots.

*Habitat*.—This has probably the same range as *cunicularis*; specimens before us show its occurrence from Boston, Massachusetts, westward to Michigan and Illinois, and southward to Tennessee and Black Mountains, North Carolina, early August to mid-September.

**Cicada davisi** nov. sp.

Length.—♂ and ♀ 29-31 mm., to tip of wings 42-45 mm.—Head black, anterior margin between the eyes and clypeus and a spot in the center of the clypeus green. Pronotum including posterior and lateral margins green except for a single pair of black marks which begin at the anterior margin immediately behind the eyes, become suddenly broad, then taper posteriorly, but do not join as usually do the corresponding marks in *cunicularis*; the dilation also begins much farther from the anterior margin, which in *cunicularis* is so close as to be separated only by a narrow line of green; the space between the pronotal sulcus and the posterior margin is much longer than in *cunicularis*. The mesonotum has markings similar to *cunicularis*, but the median posterior spot is much shorter, leaving a broad space of green; the two lateral pairs of marks are fused together. The abdomen is black, without white spots at the base. Beneath it is

pale yellowish, probably pruinose in fresh specimens, with a narrow black portion in the center and the pleura also are sometimes black. The opercula are about as broad as long, rather convex and uniformly pale yellowish in color. The uncus of the genitalia is stout and dilated subapically.

Types: ♂ and ♀, in the collection of the New Jersey Experiment Station; co-types in U. S. N. M., and Acad. Nat. Sci., Philadelphia.

Described from five males and three females; Anglesea, N. J., August 25th; Paterson, N. J., September 4th; Miami, Florida, August 13th, Georgiana, Florida.

This is a very distinct species hitherto confused with *canicularis*. It may be separated at once from that species by the greater width of that portion of the pronotum posterior to the transverse sulcus, by the shape of the black marks on the anterior portion of the pronotum and by the comparatively narrow black central portion on the under side of the abdomen.

***Cicada marginata* Say.**

This, the remaining species of *Cicada*—using the term within generic limits—in New Jersey, is so distinct from anything else that a detailed description of it at this time is unnecessary. It may be recognized by its large size, averaging over 40 mm. to tip of abdomen, and over 60 mm. to tip of wings, and its exceedingly robust form. The thoracic markings illustrate the general type of maculation, and the body above as well as below is largely pruinose. The opercula of the male are broader than long, pale green covered with white, pruinose and the anal abdominal segment below is considerably broader than long. The male genitalia are chunky, with the uncus knobbed at the apex.

It occurs commonly in the southern portions of New Jersey, more rarely northernwardly, and is recorded from New York to the Gulf States and as far west as Utah.

Plate III, figures 7 and 8, illustrate the genitalia of a Mexican species of *Cicada*, which we have not attempted to identify and present merely to show the variation of the structure in the genus. The specimens were sent from the U. S. N. M., with the *tibicen*, and were labelled *C. opercularis* Oliv., which, of

course, they are not. It probably represents a new species.

In Plate 1, figure 10, we figure the genitalia of *Tibicen noraboracensis* Emmons, a distinct and well-marked species and not a synonym of *rimosa*, as Uhler contends. It may, however, prove to be the same as *T. canadensis* Prov., upon further study. The specimen was taken in the Catskill Mountains, July 6th, by Mr. R. F. Pearsall and kindly given us.

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