A MONOGRAPHIC STUDY OF THE NORTH AMERICAN SPECIES OF THE GENUS DELTOCEPHALUS

DISSERTATION

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE GRADUATE SCHOOL OF THE OHIO STATE UNIVERSITY

BY

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AUTOBIOGRAPHY

I, Dwight Moore De Long, was born in Corning, Ohio, April 6, 1892. I received my secondary school education in the public and high schools of Corning and Crooksville, Ohio. My undergraduate training was received at Ohio Wesleyan University, which I attended from 1910 to 1914 and from which I obtained the degree of Bachelor of Science in 1914. While a senior at that institution, I acted in the capacity of Assistant to Dr. E. L. Rice, Professor of Zoology. In the summer of 1914, graduate study was pursued at the Ohio State Lake Laboratory. During the years 1914 to 1918 inclusive, graduate study was continued at Ohio State University while acting in the capacity of Graduate Assistant, Assistant, and Instructor in Zoology and Entomology. Several months of the following year were spent in army service and during this time a course of study in bacteriology was pursued at the Yale Army Laboratory School at New Haven, Connecticut. The last few months I served as technician in the laboratory of the base hospital at Camp Devens. The following three years were spent as Scientific Assistant in the Pennsylvania Department of Agriculture, Bureau of Plant Industry, in charge of the field laboratory at North East where experimental and advisory work was carried on. The year 1921-1922 was spent at Ohio State University in the capacity of Assistant Professor in the Department of Zoology and Entomology. In addition, two summers, 1915 and 1917, were spent at the United States field laboratory, Bureau of Entomology at Clarksville, Tennessee, in the capacity of field assistant, and the summer of 1916 as nursery inspector for the State of Wisconsin. In 1922 I received from the Ohio State University the degree of Doctor of Philosophy.

INTRODUCTION

During the past few years a field and laboratory study of the species of the genus *Deltocephalus* has been undertaken in an attempt to form a working basis for future study, which is the purpose of the present treatment. Although a very careful examination has been made of all available material and all possible characters have been used in an attempt to arrange them phylogenetically according to structural relationships, no claim is made to a final treatment. In order to accomplish this, a detailed study must be made of such genera as *Lonatura, Aconura, Euscelis,* and others closely related to the genus under discussion. So far as possible type material has been examined and synonyms have been removed from specific ranking. A few species listed for North America are not recognized at present in our North American fauna and these have been omitted from the keys, but descriptions or references are included in the systematic portion.

During this study, personal observations have been made of field conditions in many localities in the eastern United States, including Tennessee, Wisconsin, Ohio, Pennsylvania, New York, Virginia, Connecticut, New Jersey, and Florida. In this work a correlation of field records and observations has been made with the laboratory examination of material to determine food habits, adaptations, limitations, and distribution of these insects. The records of the western species have been obtained from other workers.

Sources of Materials and Acknowledgments

This study and treatment has been made possible only by the valuable and willing assistance offered by many workers in this particular field. The work has been completed under the direction of Professor Herbert Osborn who has placed at the author's disposal his private library and personal collection containing a large number of types and several undescribed species in this group. He has also offered very helpful suggestions and criticisms during this study. A large part of the technical work was completed while the author was employed as a member of the Pennsylvania Bureau of Plant Industry under the direction of Professor J. G. Sanders,

to whom the author is greatly indebted for many opportunities and personal favors. From the first he has taken a deep interest in this work, has offered opportunities for field and laboratory study, has assisted with illustrations, has placed at the writer's disposal the apparatus and facilities of the well-equipped laboratories of this Bureau, and has been a constant source of help and encouragement. Dr. E. D. Ball has furnished valuable material consisting of types and many uniques of rare or little known species. In addition he has looked over certain portions of the manuscript and has offered many helpful suggestions and criticisms upon difficult problems encountered. The help and material given by these workers is sincerely appreciated, as is also the material and records received from H. L. Dozier, W. H. Larrimer, Jos. Ouellet, J. McDonnough, E. L. Dickerson, J. N. Knull, A. B. Champlain, H. B. Kirk, E. M. Craighead, G. G. Ainslee, J. S. Hine, H. C. Severin, S. E. Crumb, F. H. Lathrop, F. A. Fenton, W L. McAtee, C. J. Drake, P. B. Lawson, and G. W. Barber.

Assistance has also been given by Dr. E. N. Transeau, Dr. R. C. Osburn, Dr. F. H. Kennedy, and Dr. E. M. Gress.

TECHNIQUE

It is not necessary to describe methods of collecting leafhoppers, but it might be stated that material broken in collecting or poorly preserved either when placed in alcohol or with large insects, especially *Lepidoptera,* is almost worthless and cannot be used for collections. The mounting of specimens should be done in such a way that only a very small portion of the abdomen will be covered with the point. This requires only small points and a little neatness and adds greatly to the value of the specimens.

ILLUSTRATIONS

Two types of illustrations have been used in this study. First, accurate line drawings to illustrate structures and proportions, and second, photomicrographs to show especially the general appearance and color pattern of the species treated in this paper.

For the purpose of making the line drawings accurate an ocular micrometer disc ruled in 0.5 mm. squares was placed on the diaphram of the ocular. By superimposing this scale upon the insect, all of the exact proportions, angles, curvatures, etc., can be transferred almost exactly to co-ordinate paper and the imagina-

tion has very little opportunity to play a part. After the drawings were traced upon drawing board, they were all corrected before inking. The elytral and wing drawings were made by removing the wings, treating them with ten per cent caustic potash, and mounting them on slides. These were then placed on a microscope stage, and by the use of an ocular prism and a projection lantern the wings were projected upon the drawing board where they were accurately traced. These drawings were also corrected before being inked, by studying the slides under the miscroscope.

The photomicrographs were taken with a camera consisting of an ordinary extension bellows and a 32-mm. micro-tessar lens. Artificial light was used for the most part and after a little practice very good results were obtained. In order to obtain a sharp focus the specimen was placed upon a stage fitted with a microscope fine adjustment and after the camera was fastened it was not moved in the focusing. This gave much better results than when attempting to move the ground glass. These photographs were then carefully retouched while the specimen was studied under the binocular.

No internal dissection was performed and the internal organs were not studied. Specimens were treated, however, with a ten per cent solution of caustic potash and were then dissected in order to work out the various body sclerites and the internal genital characters. After being treated with caustic potash until cleared, the insects were removed to distilled water, dissected, and studied. In studying the internal genital character of both male and female, some of the structures were dissected out, dehydrated, and mounted in balsam after drawing in situ and these drawings were then corrected.

BIBLIOGRAPHY

Several recent publications have contained whole pages of references and bibliography included under each species and intermingled with the text. It seems useless to repeat these numerous references in the text especially since Van Duzee's recent catalogue* can be used by those interested in the literature. A brief synonymy has been given under each species and this will help to

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* Catalogue of the Hemiptera North of Mexico. E. P. Van Duzee University of California Publications Tech. Bull. Vol. 2 (1917).

simplify the reference material. Also a general bibliography is included at the end of this paper and the reader's attention is directed to this for a more complete list of references.

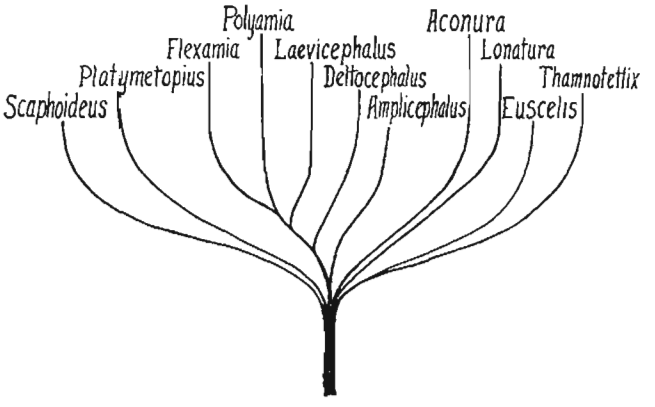
THE GENUS

The genus *Deltocephalus* was established by Burmeister in 1838 and no type was designated. The first species mentioned under the genus description was *pulicarius* which has now been made a logotype by Van Duzee. According to the original description "the vertex is acutely triangular, distinctly margined; width between eyes scarcely equaling length; front broad, convex; vertex flat." The genus was thus named according to the head character. Fieber later in his work on the *Deltocephali* used the character of the two cross nervures between the first and second sectors as a subfamily character. This wing character was used more by later workers, and gradually the head character was disregarded until at the present time the two cross veins of the elytron are used almost exclusively by American workers to designate the species of the genus. Mr. Van Duzee has referred to it as a "trivial and not infrequently variable character," but in spite of this has arranged the species, disregarding largely other characters. The double cross vein character exists in species of *Thamnotettix, Euscelis, Platymetopius, Lonatura, Aconura,* and all other groups allied to and arising from the *Thamnotettix* and *Deltocephalus* stems; therefore it seems necessary to use a combination of characters for the placing of these species. Some so called *Deltocephalus* species have been removed from that genus in this treatment but perhaps others should also be eliminated and this may be done after further study. The excellent work of Osborn and Ball has formed a working basis for the past twenty-five years, but since only one-fourth of the North American species was treated at that time and at present there is no key or illustrations of characters to at least three-fourths of these, a revision has been undertaken. The basis laid down in their work has been largely followed and their type material used in this treatment.

As the genus now stands it is composed of some ninety-five species which form a rather heterogenous group and vary greatly. If the two extremes of the group are thus compared, they have very little in common even though they are connected by a series of intermediate groups. It has therefore been deemed advisable, es-

pecially after consulting older workers in the field, to divide the genus into a number of groups which are here designated as subgenera. Some of these groups and perhaps all deserve generic ranking, but they have not been raised to that status at this time and will serve the same purpose by simplifying the work of identification and bringing together those species which seem to be more closely related.

It is sometimes doubtful whether a species should be placed in *Deltocephalus* or some other closely related group. If we believe in evolutionary development and a natural relationship among all animals, it is useless and absurd to look for hard and fast lines in all cases to separate animals into groups as man has tried to classify them. Indeed our failure to find these outstanding groups



has a tendency to add evidence to the theory that animals have developed gradually along certain lines. It is true that in many cases intermediate forms have entirely disappeared, leaving a group well defined and distinctly outstanding from its nearest relatives. Other species seem to show no decided break in this development so that living forms exhibit relationships with a number of groups. The Genus *Deltocephalus* is of the latter type and contains a series of small groups of species which are closely related and have many things in common. They are also closely related to other so called genera. The subgenus *Flexamia* containing the reflexed veined species approaches the genus *Platymetopius* in its characteristics. Those placed in *Laevicephalus* approach in many respects the true *Thamnotettix* species. Those placed in *Amplice-*

phalus are closely related to the members of the genus *Euscelis*, and the members of the subgenus *Deltocephalus* are very closely related to the *Thamnotettix nigrifrons group*. The species placed in the subgenus *Polyamia* with the reticulate clavus often have abbreviated elytra and resemble the members of *Lonatura* and *Aconura*. No hard and fast lines can be drawn between these genera, and the species must be placed with their closest relatives only after a careful study and then, only by using a combination of characters and general similarities in structure. Such an attempt has been made to place the species treated here.

The members of the *Lonatura*, *Driotura*, and *Aconura* groups which are most easily confused with species of *Deltocephalus* may be easily separated in the short winged forms where the elytra are cut off abruptly with no apparent abbreviation of venation, while in *Deltocephalus* the brachypterous forms show only a shortening of the cells, both apical and anteapical. In the *Aconura* group, in addition to the wing character, the ovipositor of the female is extremely long, greatly exceeding the pygofers.

It is rather unfortunate that *pulicarius* has been made the type as it is not typical of what has always been regarded as *Deltocephalus* and it will not fit the characters of the head as given there. In this respect, *ocellaris*, the second species cited under the original description, is more a typical *Deltocephalus* but the subgenus name must follow the type.

The original characters given mean nothing as the group now stands for the head may vary from at least one-half longer than wide to one-third wider than long, and may be sharply or bluntly angled, or rather broadly rounded, and the disc may be flat or sloping to the front. The elytra may vary from long to short and the venation may be of several different types as shown later. The genitalia, too, are greatly differentiated in the various groups. The two cross-veined character of the wing is quite constant but the other groups as mentioned previously may also have this character.

CONTENTS

EXTERNAL MORPHOLOGY

In the following discussion no attempt has been made to treat the subject of morphology from an exhaustive standpoint or even to show the comparative morphology of different "jassid" types. *Deltocephalus configuratus* has been chosen as an example in order to show in a general way the external structures which are characteristic and many of which are important in identification and classification. Many problems in this phase of the work have arisen during this study which could not possibly be undertaken in the time available; consequently the treatment is limited to a few outstanding structures.

The body is covered by a chitinous exoskeleton composed of numerous sclerites. Some parts are very heavily chitinized and others are almost membranous. This is always the case where the segments articulate. Various types of sculpturing may occur in different species especially upon the head and pronotum. Pubescence is more common upon the apical segments of the abdomen and large spines are found on the legs. Many species have bright color markings, in both nymphal and adult stages, which are frequently retained after boiling in caustic potash or even after preserving in alcohol.

THE HEAD

The head structures of the various groups of *Homoptera* are essentially alike and the parts can be homologized. This has been quite definitely proven by the work of Muir and Kershaw and later by Cogan and Funkhouser. The head in the various groups is quite different in general appearance, but the sclerites are similarly situated and the arrangement and position of the mouth-parts are very similar. The head proper is composed of a number of fixed sclerites fused or very firmly fastened together, while the majority of the mouth-parts and the antennae are movable structures. The mouth-parts in all cases are directed backward and ventrally, extending caudally between the coxae of the fore legs.

The external skeleton of the head or head-capsule is composed of several segments, so fused in the case of the species of *Deltocephalus* and other *Cicadellidae* that definite sutures are not

found to separate these regions. Thus the limitations of these sclerites have been determined by the muscle attachments of the mouth-parts and the invagination of certain sclerites during their embryological development.

The epicranium is composed of the occiput, vertex, frons, and genae and a portion of the clypeus might be included also. (Plate II, Figs. I and II.) The vertex occupies the dorsal region of the head, which is usually rather long and more or less flattened, lying between the large compound eyes. In this genus the proportions of the vertex, of length to width, and the angle with which it meets the front are constant and rather important characters in dividing the genus into definite groups. No suture is found to separate the vertex from the occiput, which region is the most posterior dorsal portion of the head. This region extends downward at the posterior portion of the head and can be observed when the head is removed from the thorax.

The vertex merges anteriorly into the frons or front which, although a separate sclerite and lying in a different plane, is not separated by a definite suture. The vertex may be rather sharply angled with the front, forming a fairly definite margin, or it may slope forward and be rounded to the front, forming in that case a thick, rounded margin.

The ocelli are two in number and are found in all the species of the genus located on the margin between the vertex and the front and rather close to the eyes. In case a sharp margin is found, they are usually on the margin. In the case of the rounded thick margin, the ocelli may be found close to the top of this curved portion and almost in a plane with the vertex or they may be down farther on the curved margin.

The compound eyes are hemispherical or ellipsoid in shape, elongated in the anterior-posterior line of the body, and occupy a large part of the dorso-lateral region of the head. The eye contains about one thousand to twelve hundred facets and the curvature is such that the jassid is able to see in the dorsal, ventral, lateral, and anterior directions without movement of the body. The pronotum is strongly convex anteriorly, fitting into the vertex between the eyes, and it extends backward laterally over the prothoracic segment and obscures some of the sclerites in every case.

The clypeus, as considered at present, is rather hard to define since no definite suture separates it from the front. These regions

are determined entirely by an examination of the interior and by the location of the invaginations of the anterior arms of the tentorium. The lateral margins are developed as two elongated semicircular plates which extend ventrally on each side of the labrum and are separated from it by a definite suture. These portions have been previously called the lorae. They have been considered as the mandibular plates, but Muir and Kershaw have shown that they have no connection with the mandibles.

The labrum or upper lip, although one of the mouth-parts, is not a movable structure and is firmly attached to the lateral and median portions of the clypeus. It is a large plate covering the basal segment of the labrum. It is usually broadest at the point of its attachment to the clypeus and is narrowed and either rounded or truncate on its apical margin.

The genae and maxillary plates are fused to form the portion of the head posterior to the clypeus and lorae. The genae proper would be the region next the eyes. The maxillary plates extend down around the clypeus, surround the labrum, and are slightly fused beneath it at the outer apical margins. They also form the ventral surface of the head and fold in behind it where they form on either side a chitinous plate, which fits against the prothorax.

The frontal sutures extend from the ocelli upon the face to the base of the labrum, passing very close to the eyes. The antennae arise in the narrow portion between this suture and the eye, in front of the ventral rounded portion. They are usually found in depressions or sunken areas and are directed almost ventrally, then curve forward. The general type of antennae is the same throughout the genus, with several minor modifications found in various species. Plate 2, fig. 9 shows the structures and segments of the basal third of the antenna of *D. configuratus*. The basal two joints are very large and the following three joints are somewhat smaller, being gradually reduced in size. The first fifteen segments are more irregular in shape and of various sizes; the remainder of the antenna is composed of similar minute segments and is very setaceous or filamentous in structure. In the antenna noted here there are about fifty segments of which the apical half is composed of segments a little more elongated than the basal ones of the setaceous portion. The tip, for a distance of eight or ten segments, is very slender and apparently unsegmented.

The Mouth Parts

(Plate II, Figs. 12 and 13.)

The labrum or upper lip has been described in connection with the sclerites of the head.

The epipharynx is a short pointed structure which projects from under the apical portion of the labrum and fits into the labial groove at its base. The structure appears to be fused with the labrum but is extended under the labrum and forms the roof of the pharynx.

The labium is the only other portion of the mouth parts which is visible and it is the largest and most conspicuous. In the *Deltocephalus,* as in others of the *Cicadellidae* in general, it is composed of three definite segments which form a beak or proboscis. This is the lower lip and a very small shallow groove is visible on the upper or anterior surface. In view of the fact that the beak is extended ventrally and posteriorly, the groove in reality is ventral when the beak is in normal position. It is a protection and guide for the elongated hair-like mandibular setae and maxillary setae which are contained in the groove, and when feeding the proboscis is pulled down to touch the leaf surface. The apical end is much smaller and chitinized, with a minute opening through which the mandibles and maxillae are thrust into the leaf tissue.

The mandibles are represented by a pair of elongated, very fine mandibular setae which are concealed in the trough of the labium and beneath the epipharynx. The mandible is flattened, with its apical end slightly rounded in *configuratus* and the edge bears about eight blunt saw-like teeth. The proximal end is attached by muscles to the head capsule at the sides of the occipital foramen, according to the work of Cogan.

The maxillae are the other two slender chitinous setae found in the labium and are usually so firmly fastened together that it is hard to separate them with a dissecting needle. This pair of structures forms the sucking tube through which the plant juices are taken into the body. At the apical end these are pointed and, when fastened together, form a rather sharp spear-like tip which is pushed into the leaf tissue. The inner portion of each maxilla is hollowed out, as seen when examined under the microscope and as they fit together form the tube. The maxillae are enlarged at their basal ends where two sets of muscles are found to operate

these structures. The muscles attach them to the maxillary plate and to the occipital region. Their articulation is with the maxillary plates.

THE THORAX

The thorax of *Deltocephalus* is composed of the three segments, pro- meso- and metathorax, which will be discussed separately, but briefly. The thorax shows no extreme modifications or differences, although the sclerites are quite different in shape and general appearance and sometimes two are fused. In the metathorax, especially, certain ones are very hard to designate.

THE PROTHORAX

(Plate II, Figs. 1 and 2.)

The prothorax is small and quite simple in general structure. The pronotum covers the entire dorsal region of the segment, extending down some distance at the sides, and no sutures are present to indicate subdivisions in the jassid. From the dorsal view this sclerite is usually strongly convex anteriorly and concave posteriorly, often being used in descriptive work. The pleuron is composed of two sclerites, a larger epimeron which is posterior to the pleural suture, extending from the pronotum to the coxa, and a smaller anterior episternum which is joined to the narrow posternum. The trochantin is large, somewhat wedge-shaped, and is anterior to the coxa.

THE MESOTHORAX

(Plate II, Figs. 1 and 3.)

The mesothorax is larger and the anterior portion, especially of the notum, projects into the prothorax. The notum is divided into three well defined sclerites. The anterior smaller one is perhaps the pre-scutum, the central large portion the scutum and scutellum, which is a triangular shaped sclerite and important from the standpoint of identification work. It is commonly known as the scutellum. Apparently these notal sclerites are almost completely fused in the jassid and a short transverse groove near the middle is the only suggestion of the possibility of two plates. The third portion is very narrow dorsally, as seen from above, partly covered by the scutellum. The side portions appear much broader.

In the mesopleuron, the pleural suture extending from the base of the wing to the coxal segment is practically straight and divides the pleuron into two very definite portions. The anterior region is known as the episternum and the posterior portion as the epimeron. Each of these is again divided by definite sutures. The episternum is thus separated into two sclerites called anepisternum and katepisternum by Taylor, and Episternum 1 and 2 by Funkhouser. The lower episternal plate joins the sternum and is separated from it by a suture. Between the coxa and the episternum is a narrow elongated segment called the trochantin. In the *Deltocephalus* species the epimeron is rather long and divided by a diagonal suture. The lower portion will then lie along the pleural suture and the upper portion will not touch the suture through its entire length. The mesosternum is composed of a single plate lying between the episternal sclerites.

The Metathorax

(Plate II, Figs. 1 and 4.)

In studying the metathorax some difficulty has been encountered in attempting to determine the coxal segment. In the specimens treated with caustic potash some rather faint sutures are seen in the lower portion of what was later determined to be the coxa, but in the untreated specimens these are not visible. Also if these were considered as sutures separating the coxa, the pleural suture would be very hard to define and it would be very irregular, which is seldom the case in the *Homoptera*. Furthermore, if the coxa were thus considered, it would seem to be very definitely fused with the other sclerites and this again is not true as a rule in the *Homoptera*. By considering the coxa as a very large, well-defined segment, the sclerites will homologize very nicely with those of the *Cicada* and in this way will agree with the work of Taylor who suggests the close similarity of these two groups. For these reasons it has seemed best to consider this whole portion as the coxa and for the time being to disregard the suggested sutures in the basal portion.

In general, the metathorax is quite similar to the mesothorax, but the size and arrangement of the sclerites is quite different. In contrast to the condition found in the *Cicada* and other *Homoptera*, the metathorax, especially the dorsal region, is longer than in the mesothorax.

The anterior portion of the notum is quite large and is designnated as the prescutum. It is entirely covered by and fused on its posterior margin with the mesonotum. The scutum is a large broad sclerite posterior to the prescutum. The scutellum is short and rather narrow and represents the third division of the notum. A very narrow portion, the postscutellum, almost concealed by the scutellum, is the last division and is connected with the membranous portions of the sclerite.

The coxa of the metathorax is apparently very large and extends upon the pleuron for a great distance. Thus only a short pleural suture is found connecting the coxa and the base of the wing. The episternum is in front of the pleural suture and is apparently undivided. The only suggestion of a division is a faint suture running almost perpendicular to the pleural suture. The episternum is fused with a small pointed sclerite, the sternum, which is just before the hind coxa. A small elongated sclerite between the coxa and episternum is undoubtedly the trochantin. The epimeron lies just posterior to the pleural suture and extends down behind the coxa. It is narrow and very much elongated with an abbreviated suture suggesting a possible division.

The Legs

(Plate II, Figs. 5, 6, 7, and 8)

Perhaps the most characteristic and outstanding difference in the legs is their relative length and size. The third pair of legs is twice as long as the fore legs and almost twice as long as the middle pair and proportionately larger. In general structure they are composed of the same number of segments, which are similar in the three pairs. When the insect is walking or in the act of feeding, the fore legs are directed forward and the middle and hind legs are directed backward. The condition of the legs as found in *Deltocephalus configuratus* is typical of all the members of the genus and a comparison of the structures of the three pairs is included here.

The coxa is a thick, rather large segment at the base of the leg. The three pairs are attached respectively to the pro- meso- and metathorax. In all three pairs the coxae are broader and thicker than the other segments of the leg. The fore and middle coxae protrude more from the body and may articulate a little with it. The

hind coxae are greatly enlarged and flattened, and are fused with the metathorax in such a way that no articulation is possible. A portion of these structures next the midventral line are produced ventrally for the reception of the trochanter and the muscles. In this way a sort of groove is formed in which the femur is held, extending forward almost to the eye when the insect is at rest. The articulation of the trochanter is almost transverse in the hind coxa. The faint sutures at the distal end of the third coxa are somewhat confusing but apparently designate a small meral sclerite.

The trochanter is a small curved segment, very weakly fastened to and articulating with the coxa. The segment is curved in such a way as to direct the distal end outward from the midventral line. The fore and middle trochanters are definitely fused with the femora and do not articulate with these segments. The hind trochanter is composed of two pieces at least, partially divided by a faint dorsal suture. They are so firmly fused that they function as a single segment. The femur is more weakly joined than in the other two pairs of legs and there is apparently a slight articulation at this joint.

The femur is rather short and broad in all three pairs of legs and in the last two pairs is decidedly flattened. Since the fore and middle legs are about equal in size and are used about the same in walking and jumping, the femora are quite similar in size, shape, and general appearance. Both are a little longer than the tibia, curved inwardly at the distal end and slightly enlarged to receive the tibia. In each femur a deep groove is found along the inner distal margin for the reception of the tibia when folded, and the flattened ventral portion produced on the inner distal margin aids in forming the groove and supporting the tibia. A row of rather short but heavy spines is on the inner edge in each femur. The hind femur is quite different in general appearance and more flattened than either of the other femora. It gradually broadens from the proximal end and is curved near the distal end. The tibia is very small at the point of articulation with the femur and a groove is present on the inner margin to receive the tibia, which can be folded back against the femur for its entire length. A rather large circular plate is present on the inner ventral side of the distal end of the femur, lying ventrally to the groove as a guide and support for the tibia. This apparently is of great assistance in jumping.

One or more large spines are always found on the outer curved distal end of the femur.

The tibia, like the femur, differs considerably in the different legs. The fore and middle tibia are quite similar and are slightly longer but much narrower than the femora. They are only slightly flattened and nearly uniform throughout except at the proximal end, where they are slightly narrowed to articulate with the femur. Large spines are arranged in definite rows on the lateral margins. The hind tibia are proportionately much more elongated than the others and are at least one-half longer than the femur of the same leg. They are decidedly flattened and narrowed at the proximal end, where a very short fused segment articulates with the femur. The outer margin or edge is armed with two rows of long heavy spines set at rather definite intervals and with small spines between them. The inner margin bears a row of smaller dorsal spines and a ventral row of large ones. A circlet of small spines is found at the distal end of the tibia, surrounding the base of the first tarsal joint. This characteristic of the tibia, the arrangement of the spines, has been used almost entirely as a character for the separation of the leafhoppers as a group. Other families of the *Homoptera* have the rows of spines on the leg quite pronounced. But the *Cercopidae* which are very closely related in many other respects can be separated by this one character as they bear a circlet of large spines at the distal end of the tibia.

The tarsus is composed of three segments. In the fore and middle legs the basal two segments are about equal in length and together are about equal to the third. The tarsus of the hind leg is almost twice as long as the fore and middle tarsi and here the basal segment is equal in length to the last two. All of the tarsal segments are rather small at their proximal end and are expanded toward the distal end where they are obliquely cut off so that each succeeding segment seems to arise from the dorsal region of the previous segment. Thus a lobe usually set with spines on its ventral border is conspicuous, extending backward on the ventral region of each succeeding segment. At the tip of each tarsus are two large chitinous claws which articulate with the distal tarsal segment. They are heavy at the base, narrowed to sharp pointed tips, directed ventrally, and usually divergent.

No characters of the legs have thus far been used to differentiate the groups of the *Cicadellidae* although, in studying over

some genera, certain leg characters have been noted which may prove constant and sufficient for taxonomic work. The characteristics described above are typical of the genus under study at this time and no character has been found of value in classification.

The Wings

(Plates IV, V, and VI.)

The attachment of the wings to the meso- and metathorax has been worked out for various groups of the *Hemiptera* and no further study of this condition has been made. The wings are attached just beneath the anterior portions of the scutellum of the mesonotum and the scutum of the metanotum as shown in plate II, Figs. 1, 3, 4.

Metcalf (1913) has worked out the homologies of the wing veins in the *Cicadellidae* and has come to the conclusion that the costa is missing in the adult wing and is replaced functionally by the subcosta. The radius is two branched, being represented by R2+3 and R4+5 in the adult wing. The medius is two branched, represented by M1+2 and M3+4. The cubitus may be represented by one or two branches. All three anal veins are represented and the third is frequently two-branched.

In this discussion of the wing venation only one of the one hundred American species of *Deltocephalus* was chosen. Since the wing venation within the genus presents some striking differences which will separate many of the species into groups, and since the wing characters have been used for classification previously, it seems best to discuss certain of these variations found in the species under study. The great majority of these differences occur in the elytra, the second pair, or under wings, being very similar in general venation.

For many years it has been customary among those working with *Cicadellidae* to refer to the veins and cells by separate terminology and, in order to make clear the points under discussion, both systems of terminology will be used. The following names have been commonly used: outer and inner branches of first sector for "R" and "M"; second sector for "Cu;" claval suture and claval veins for first, second, and third anals respectively; reflexed costal veins for "R"2+3 and the two cross veins preceding it; apical cells for the row of cells at apex of wing; anteapical cells for the three cells preceding apicals; and cross veins between first and second sectors for the two connecting veins between "M" and "Cu."

So much emphasis has been placed upon some of the wing characters that others have been too frequently overlooked and disregarded. At the present time Van Duzee has included in the Genus *Deltocephalus* all of the species with the two cross veins between the first and second sectors and has transferred to other genera species with only one cross vein. The two cross vein character is usually a good one but we cannot rely upon it absolutely and other characters must be taken into consideration in determining relationships. Practically all of the genera arising from the *Deltocephaloid* and *Thamnotettix* stems contain some species with this double cross-vein, and frequently a specimen is found where two cross-veins occur in one elytron and one only in the other.

The Genus *Deltocephalus* as it now stands can be divided into rather definite groups according to types of wing venation. This division is not made on the basis of one vein but a combination of veins which are usually present. In the Subgenus *Flexamia* we find a condition where the veins from the costal margin are curved or reflexed to the first branch of the medius. Combined with this characteristic is usually a very small outer anteapical cell, although in a few cases it is entirely wanting. In some cases the second and third anal veins are fused for a portion of their length, especially the middle portion, or in some cases the third is almost entirely wanting. The largest group of species having these reflexed veinlets is without an appendix which usually arises from the apex of the first anal vein (claval suture) and extends to the apex of the elytron. One very different condition is seen in the elytron of *slossoni* where no suggestion of an appendix is found and the tip instead of being normally rounded is obliquely cut off or slightly concave from the tip of the clavus (1st anal) to the outer margin, thus forming a rounded, produced portion at the apex of the costal area. The apical cells are crowded forward and are very short. In the smaller group, as in *bilineatus*, the elytron has the appendix, which is usually small. This character combined with others forms a good basis for a grouping of these two types.

In the Subgenus *Polyamia* the clavus (anals 1 and 2) is usually strongly reticulate, the central anteapical cell is constricted and usually divided, and the veinlets from the costal margin to the first branch of the medius are usually very short and often at right angles to it.

Practically all of the species placed in the Subgenus *Hebecephalus* have the outer anteapical cell quite short. The central anteapical cell is very long, strongly constricted at the center and with the apical end greatly enlarged. A definite appendix is combined with this type of wing.

In the Subgenus *Laevicephalus,* the wing condition resembles the preceding very much and in some cases approaches *Thamnotettix* very closely. The two cross veins are almost always found, and the first and third anteapical cells are usually short, the central cell more elongate. The two species placed in the Subgenus *Amplicephalus* have the central anteapical cell constricted and divided, and the first and third anteapicals are rather small.

In several species of the genus a dimorphic condition of the wings is seen which causes a decided difference in the general appearance of the wing in different specimens. The apical cells are frequently very short, in some instances being almost entirely wanting, and the anteapical cells are often very much shortened. There is a marked difference in this respect from the species of *Lonatura* and *Aconura* in which the elytra are squarely cut off at about half their length and there is no similar reduction of cells.

The second pair, or hind wings, shows very few modifications as compared with the elytra. In several of the species of the Subgenus *Flexamia* the wings are greatly reduced in size but show no modifications in the venation. In some cases radius 3 and 5 may be united by a short cross vein or may be fused for a short distance; and where the wing is greatly shortened the medius and cubitus may extend to the marginal vein without branching. In some cases the marginal vein may be very close to the margin of the wing.

By far the most striking condition is found in the underwings of *fraternus* and *mendosus,* where the only remnant of the wing is a minute membranous spur about one-fifth as long as the elytron, with only the subcosta apparently left as an indication of a wing vein. Of the many species of this genus in which the wings have been examined, all show a definite venation and a rather uniform condition, with this exception. These two species live in very similar habitats, on grasses of the prairie and pine forest floor, and apparently the wing is almost lost by reduction. The wing of *slossoni* is somewhat reduced but still shows a similarity in venation to the other members of the genus.

THE ABDOMEN

(Plate III, Figs. 1, 2, 7, and 8.)

The abdomen of this group is very similar to other *Homoptera* and in a general way agrees with the work of Berlese on the *Cicada*, and Funkhouser on the *Membracidae*. From a careful examination of material boiled in KOH it is quite evident that the abdomen is composed of eleven segments, some of which are represented as mere rudiments of chitin. The posterior segments in the male and female specimens are strikingly different, containing what are known as the genital segments. They will be discussed separately after a brief consideration of the anterior portion, which is very similar in the two sexes.

The first segment is represented by only one sclerite, the tergum, which is on the dorsal portion and is pushed tightly against the tergum of the thorax. In some cases it is almost obscured under the thoracic segment. When treated with KOH it appears almost membranous and apparently is not as heavily chitinized as the succeeding segments. The second segment is rather short and is ring-like. The most conspicuous sclerites are the tergum and sternum, the pleura being apparently more or less fused with the pleural sclerites of the following segment, which are large and are strongly pushed forward. If the pleura are separate, they are very small and are crowded medially by the anterior projection of the pleura of the third segment, being hidden almost entirely between the abdomen and thorax when they are in normal position. Segments three to eight inclusive are similar in structure to segment two, ring-like in general shape and extending around the muscles and internal organs. They are each composed of four plates. The first is a tergum which is strongly convex, covering the dorsal portion and extending down on each side to the pleura. The pleural sclerites, one on each side, are quite small as compared with the tergum and are really ventral in position, as is seen in certain other groups of the *Homoptera*. They are rather sharply angled or bent inwardly from the attachment of the tergum. The sternum or ventral plate lies between the pleura and is usually convexly produced. The spiracles are apparently present on the first eight segments of the abdomen and a pair is found in each of these on the extreme anterior portion of the pleura and very close to the sterna. No spiracles could be located on the remaining segments but they may be present.

Each segment is constructed so as to fit into the previous one in more or less of a telescopic manner and the segments taper rapidly to the posterior end. When specimens are boiled in KOH it is evident that the portion between the segments is covered with very thin chitin which entirely disappears during this process leaving only the membranous covering. This condition apparently is necessary for articulation of the segments, each articulating by moving under the previous segment which overlaps it.

Normally the wings and elytra cover, for the most part, the abdomen except in brachypterous forms, and the characters of the abdomen are seldom used, except the genital parts which will be discussed later. In many cases the color markings and striping of the abdomen are characteristic for a certain species and are conspicuous. In the adult they are seldom seen unless the wings are removed, but could be used in many cases for classification. It seems best, however, to use structural characters when possible and color characters which are more easily seen without interfering with various parts and breaking them.

In many species the segments vary in regard to comparative size and, in some cases, to the shape where they overlap. In the female the relative length of the sternal plates of segments six, seven, and eight are sometimes used in taxonomic work. No use is made of the pleura or terga and there are no structures on these segments that are used at the present time.

The Female

(Plate III, Figs. 3, 4, 5, 8, and 11.)

As has been mentioned, the sternum of segment two is rather small and narrow. The sterna of the other segments to and including segment six are of about equal size and normal in structure. The sternum of segment seven, usually known as the last ventral segment, is on the other hand one of the most important structures of the female of the *Deltocephalus* group as well as many allied genera. The posterior margin is modified in the different species so that it may contain deep notches or concave emarginations, or may be variously broken up into lobes. Certain other species may have long characteristic tooth-like structures or definitely produced portions. In practically all the species examined this character is found to be very uniform and constant for any species. In a few

cases the sternum of this segment appears to arise from under the previous sternum and there is apparently only a slight attachment if any to the pleura of segment seven. In other species it is visibly attached to the pleura only by a narrow basal portion. In the majority of the species of the genus it is attached throughout its entire length to the pleura. The posterior margin is often abnormally thickened and heavily chitinized and frequently bears color markings that are still conspicuous after boiling in KOH.

In many species another structure occurs in connection with the sternum of segment seven which cannot be homologized. It has previously been referred to as the underlying membrane, which explains its position. It is usually quite thickened and chitinized and is strongly concave at the middle so that only the rounded lateral lobes are visible, since the whole structure is almost covered by the last ventral segment. This so-called membrane seems to arise from the base of that segment or the base of the sternum and is definitely attached to the pleura. It was at first thought to be the sternum of the next segment which had been pushed forward, but careful study has disproven that hypothesis. It is common in such species as *inimicus, obtectus, apicatus,* and many others.

The sternum of segment eight has been confused with the underlying membrane, since it is often conspicuous as a lobe at the lateral angles of the sternum of segment seven. In all the species examined, it is divided into two widely separated plates, one attached to either side of the pleuron. The enlarged portion of the ovipositor is usually quite rigidly attached between these sclerites. In some species these sternal plates are concealed by the last ventral segment or the underlying membrane. In other cases they are quite prominent and conspicuous at the outer angles. In species like *configuratus* they appear as portions of the underlying membrane and are confusing. This sternum may be represented by large or small plates in different species.

In the case of *configuratus* the ovipositor expands at the base and is held firmly between the two sternal plates of segment eight. Berlese in his work on the *Homoptera* has referred to the ovipositor as a part of the sternum of segment eight, which it seems to be in this genus. Other authors have considered it as a modified appendage.

The ovipositor is composed of three pairs of styles which are

compressed laterally, making them rather broad and flattened (Plate III, Figs. 9 and 10). The outer pair is more chitinized at the tips than the other two pairs and is somewhat hollowed out. The second pair lies in this concavity, as does also the third or ventral pair, which covers the second. The outer pair is the longest and fits tightly, forming a sheath entirely covering the others when not in use. These are broader than the other pairs and their tips are rather bluntly pointed, extending normally beyond the pygofers. From the ventral view they are the only visible structures of the ovipositor.

The second or inner pair of styles is shorter and narrower. The tips are sharply pointed and are somewhat roughened with chitinous ridges. The bases are flattened laterally, but enlarged and rounded dorso-ventrally and the outer edges are margined with a heavy chitinous band. These enlarged portions are incised posteriorly and the first pair of styles are rather loosely attached to the apical portion of the upper lobes. So both of these pairs may be operated by the muscles attached to these enlarged basal discs. Another rather curious modification of the inner pair of styles is the fact that just posterior to the basal enlargements they are fused and rounded dorsally for about one-third the distance to the apex. This portion is more heavily chitinized and forms an inverted trough, open on its ventral surface. In normal position these lie under the dorsal part of the second pair.

The third (ventral) pair is broad, sword-shaped, distinctly curved, and decidedly enlarged at the base. The tips are sharply pointed and at least two heavy chitinous ridges extend lengthwise of these styles. The heavy bases fit in between and attach to the two sternal plates of the eighth segment. Also one of these chitinous ridges curves strongly and attaches to the heavy chitinous ring which extends completely around the base of the pygofers (tergum of segment nine).

The ninth segment is the largest of the whole abdomen and the most conspicuous part. It is apparently composed of one plate, the tergum, which is curved almost completely around the body, extending ventrally to each side of the ovipositor, which fills in the opening between the two margins. In taxonomic work they are usually referred to as the pygofers. This portion is usually strongly inflated laterally and set with spines, especially in the ventral and apical regions.

The tenth and eleventh segments are greatly reduced and only a very small proportion of the chitin is found. In *configuratus*, for example, the tenth segment is represented only by a bifurcate chitinized plate lying on the ventral surface and is enclosed under the dorsal portion of the posterior part of the ninth segment. The remainder is membranous. The eleventh is represented by a very small chitinous ring which is found just posterior to the ninth segment. A similar condition has been found in the *Cicada* by Berlese and in the *Membracidae* by Funkhouser and these authors have been followed in the naming of these small chitinous plates.

The Male

(Plate III, Figs. 2, 12, and 13.)

In this sex the posterior portion of the abdomen is entirely different from that found in the female and the structures in some cases are not homologous with any found in the opposite sex.

The first eight segments are the same or practically so in both sexes and since they have been discussed in one sex the description need not be repeated. There is only one exception that might be mentioned and that is the fact that the sternum of segment seven is not notched or curiously produced as in the female. Also the sternum of segment eight is unmodified. It is given the same name as sternum seven in the female and usually spoken of as the last ventral segment. The posterior margin is usually evenly concavely rounded or truncated and does not differ in appearance from the previous sterna.

The tergum of the ninth segment is rather long and indented behind to expose the anal tube. A slightly indicated suture extending from the dorsal apical region to the basal lateral region seems to separate a somewhat lateral sclerite which might be termed the pleuron. It turns in just below the oedagus and is dorsal to the plates and styles. This may be the portion spoken of as the lateral valve by Funkhouser. It is quite doubtful if this is a separate sclerite, and together with the dorsal region is usually called the pygofer. It is often very pubescent, especially on the apical region and may be margined with one or more heavy chitinous spines. The sternum of the ninth segment is usually a somewhat triangular or rounded produced plate, attached to the tergum by only a narrow margin and is called the valve. A pair of structures, which are frequently broad and often strongly produced and pointed,

appear to arise from and are apparently fused with the valve. Their general appearance would suggest that they are a portion of this sternal plate and their paired condition would suggest a modified appendage; however no attempt is made here to homologize these structures, as it seems necessary to trace these out very carefully before we can fully understand their origin.

The tenth and eleventh segments are represented by much larger structures than in the female and form a covering and support for the anal tube. These are often exposed and are not covered by the tergum of the ninth segment. The tenth segment is especially large and conspicuous, but only a small amount of chitinous structure is found. The eleventh is usually much smaller and telescoped within the tenth, it being also represented by a small chitinized ring.

The Internal Genital Structures

(Plate III, Figs. 12 and 13)

Very little work has been done on the internal structures of the male genitalia of *Cicadellidae,* especially in North America. Dr. Lawson has worked out a few species in most of the North American genera but no genus has been thoroughly worked to date. A detailed study has been undertaken on the Genus *Deltocephalus* in an attempt to correlate internal and external characters, but it will take some time to complete this study. The work of Dr. Lawson has given us an excellent basis for future work. The internal structures have been shown in plate III, figures 12, 13, and the parts can be seen by reference to this plate.

Practically all of these structures are found in the genital chamber and are not really internal organs. This chamber is formed by the ventral genital plates and the dorsal pygofers. The internal structures are composed of three parts, the styles, the oedagus, and the structures connecting these two, spoken of as style-oedagus connectives by Lawson. All of these structures are apparently modified appendages and arise from the ninth segment. The homologies have not been worked out and no definite statement can be made, but from a careful study by several workers this conclusion has been reached.

The styles are paired and usually appear as a dorsal part of the plates, since they lie upon and are fastened to them, but they

often project beyond the plates posteriorly. In the species examined in this genus these are variously curved or modified and often bear prominent chitinized teeth. There is usually more specific variation in the posterior end, where they may be more pointed or rounded and with a different condition of the chitinized ridges or teeth. These are apparently paired appendages arising from the base of the ninth segment although in some cases they extend farther anteriorly in the abdomen. It is thought that these are used as claspers, and observations made upon copulating "jassids" would seem to indicate this. A chitinous plate at the base usually connects these two styles and often appears as a pair of plates only slightly joined, and also connects the styles to the oedagus. These structures are known as the style-oedagus connectives. There are usually medial processes on the styles to which the connectives are attached. In *configuratus* they are found just at the base of the valve.

The oedagus is posterior to and sometimes dorsal to this connective and usually joined to it by the anterior extremity. It is also chitinous in structure, apparently functioning as the penis sheath and is attached to the membrane of the genital chamber. In the different species various shapes and structures are noticed which are, however, quite constant within each species. The anterior end is usually enlarged and often has thick processes protruding from it. The posterior end is frequently extended dorsally and may be bifurcate or sometimes swollen and enlarged or with additional processes. It is often visible from the posterior view, especially where the plates and styles are bent down ventrally and where the genital chamber is more open.

The use of the genital characters in taxonomic work is very important. In fact in many cases in the Genus *Deltocephalus* as well as in allied genera certain species can only be, or sometimes can more easily be, separated by the male characters. For this work the external characters have been sufficient in most cases for this separation. The last ventral segment, the valve (sternum of segment nine), the plates ,the pygofers (tergum of ninth segment), and occasionally the styles have been used. In species like *stylatus*, for instance, where the styles are extremely long and conspicuous, greatly exceeding the plates, the character is an excellent one from external appearance. The shape and size of the plates, the character of the apices, and often the shape of the valve, or its com-

parative length with the plates, are good and constant characters. Also the comparative length of plates and pygofers in many cases will readily separate certain species. All of these characters are normally exposed and are accessible for taxonomic work. The internal characters have not been used for this work, because it necessitates the breaking off of the abdomen and consequently the mutilation of a specimen where these are used. When a unique is known for a certain species it seems absurd to take off this portion for dissection. Where possible, however, these characters should undoubtedly be examined to verify the external character. The styles, connectives, and oedagus all show excellent variations which are constant with any species but are distinct within the genus. In many genera, however, they are of the same general type.

In the genus under discussion, then, the male characters, both external and internal, are important in classification and they are far better for specific determination than any other characters, with the possible exception of the female characters which are used in some cases.

SYSTEMATIC

Key to Subgenera of Deltocephalus

1. Elytra with apical costal veinlets distinctly reflexed and usually broadly bordered with dark markings, or with the two outer apical veinlets short and nearly right angled with costa. Head usually flat, well produced, and angled.....2

   Elytra without reflexed apical costal veinlets or short, right angled costal veinlets. Vertex less produced, often with disc sloping and margin rounding to front.....3

2. Vertex more than twice as long as width between eyes, a furrow beneath the margin and the front strongly convex.....*Acurhinus*

   Vertex less than twice as long as width between eyes, front less convex.....*Flexamia*

3. Form often stout but not unusually broad, vertex sometimes bluntly produced but not greatly wider than length at middle.....4

   Form very broad and robust, vertex strongly rounded or very broadly, bluntly angled, width between eyes greatly exceeding width at middle.....*Amplicephalus*

4. Vertex bluntly angularly produced, clavus strongly reticulate veined and with central anteapical cell constricted and usually divided.....*Polyamia*

   Clavus often with one or two reticulate veins, not strongly reticulate.....5

5. Head usually distinctly angled, side margins sometimes rounding to apex and more definitely margined with front, disc flat or slightly concave, ocelli slightly more distant from and just before upper margin of the eyes and on a level with the disc 6

   Head roundingly produced or bluntly angled, disc convex or sloping from pronotum and rounded to front, or with margin very thick. Ocelli close to eyes at about their middle and distinctly below the level of disc of vertex. Central anteapical cell usually divided.....*Deltocephalus*

6. Elytra not longer than abdomen, without true appendix, or if long with central anteapical cell strongly constricted at middle, enlarged at either end and produced much beyond the other anteapical cells (except in *vinculatus*). Veins heavily margined with brown or black.....*Hebecephalus*

Central anteapical cell of elytron usually extending a little beyond adjoining anteapical cells but not greatly enlarged at either end nor strongly constricted at center. Species usually green or yellow unicolorous, occasionally with dark markings; elytral veins seldom fuscous margined..... *Lacvicephalus*

SUBGENUS ACURHINUS

"Head strongly produced ,the vertex with sides nearly straight, subacute, apex acute, slightly concave above, frons reaching close to eyes, antennal pits touching eyes, and ocelli very close to eye border. A decided furrow beneath the margin between vertex and front and the front strongly convex. Costa with strongly reflexed veinlets next the outer anteapical which is much reduced."

This is the original description of the group by Professor Osborn. Type species *maculatus* Osb. from Guatemala.

Only one species from United States is placed in this genus.

Deltocephalus pyrops Crumb

(Plate VII, Figs. 1, 1a, 1b; Plate XX, Fig. 1)

Crumb, Ann. Ent. Soc. Amer., VIII, p. 191, 1915.
Platymetopius pyrops Van Duzee, Cat. Hemip. N. A. p. 635, 1917.
Acurhinus pyrops Osborn, Ohio Jour. Sci., XX, p. 159, 1920.

With an extremely long produced vertex but in general appearance resembling the reflexed group with similar wing venation and the same general type of genital characters. Length 3.5 to 4 mm.

Vertex more than twice as long as basal width between eyes, acutely angled, tip slightly rounded, the apical fourth slightly concaved, the median impressed line extending from base to this concave portion. Pronotum less than half as long as vertex and twice broader than long, scutellum proportionately large. Elytra almost reaching tip of abdomen.

Color: Vertex, pronotum, and scutellum yellowish; vertex with a black spot either side of apex connected with a curved brownish band enclosing a pale spot on apex; two interrupted brownish bands before eyes, one anterior and one posterior to ocelli. Lateral portions of pronotum darker. Eyes and ocelli red. Elytra pale yellow or white, nervures margined with fuscous, coloration very similar to *pictus*. Face pale yellow, the upper margin with black reflexed arcs in the form of large teeth-like areas.

Genitalia: Female last ventral segment more than twice as long as preceding, lateral margins obliquely sloping to produced lateral angles, between which the posterior margin gradually slopes to the middle third, which is squarely excavated one-fourth the distance to the base and bears a broad, short, black tooth. Male valve obtusely triangular, more than twice as long as preceding segment. Plates short and broad, exceeding valve by its length, lateral margins convexly rounded to broad, blunt, slightly divergent tips. Pygofers exceeding plates by more than their length.

There is some question about the relationship of this species to the members of the *reflexus* group but it appears to be by an examination of both nymphal and adult forms a species with an extreme development of the head structure. The elytra are certainly very similar to *reflexus* in structure and the genitalia are

very similar in form to those of the *reflexus* group. Considering these factors as a group it seems best to place it here.

The species is quite widely distributed and abundant when its habitat is located. It occurs in Tennesseee, Mississippi (Dozier), Ohio (Osborn and De Long), Pennsylvania (Knull), Maryland (Sanders), Virginia (De Long), and North Carolina (Osborn and Metcalf).

In the original description Crumb reports this species as occurring on *Aristida gracilis* and it has been found by the author to occur in great abundance in a meadow habitat where isolated patches of this plant were present with other very short vegetation, and it was surrounded by extensive areas of *Andropogon virginicus.* Other species occurring on the *Aristida* society were *Lonatura catalina, Deltocephalus pictus,* and *Xerophloea viridis.*

The number of generations and detailed life cycle are not known, although nymphs have been taken in great abundance in Ohio during the last of June and the first of September.

Type locality Clarksville, Tennessee. Type in Crumb collection. Type examined, also specimens from localities mentioned above.

SUBGENUS FLEXAMIA

Vertex strongly produced, pointed, disc flattened or slightly depressed, acutely and sharply angled with the front. Face elongated. Elytra with apical costal veinlets reflexed or very short and right angled. Inner claval veins often partially coalescing. With or without elytral appendix.

Type of subgenus *reflexus* Osborn and Ball.

The species belonging to this subgenus are usually conspicuously marked by the broad white reflexed veins which are dark margined. Although differing somewhat in general appearance, the species of *sayi-ocellaris* group are included in this subgenus because of their close relationship to the reflexus group.

Key to Species of Flexamia*

1. Elytra without a definite appendix.....2
   Elytra with a definite membraneous appendix although usually rather small.....25
2. Vertex strongly produced and angled; elytra with two outer apical veinlets strongly reflexed to costa, white, margined with dark.....3
   Vertex proportionately shorter, not much longer on middle than width between eyes; elytra without reflexed veinlets to costa, but with short veinlets meeting almost at right angles.....21

* Not including *productus*, see description, page 43.

3. Size less than 5 mm., some shade of brown, yellow, or white....4
Size more than 5 mm., lemon yellow marked with brown stripes, female segment evenly angularly excavated....*grammicus*

4. Elytra normally rounded on apical margin....5
Elytra obliquely sloping or slightly concavely rounded from tip of clavus to costa, forming a roundingly pointed apex on costa. Female segment incised so as to form four rather broadly rounded lobes....*slossoni*

5. Vertex at least one-half longer on middle than basal width between eyes....6
Vertex usually not more than one-third longer on middle than width between eyes....8

6. Bright yellow without cross markings on vertex and with a round black spot on center of each elytron. Female segment emarginate either side of a produced, slightly notched, broad, central tooth....*areolatus*
Brownish to dark fuscous, vertex marked with at least two broken black cross bands. Female segment excavated with central produced teeth. Known from Florida only....7

7. Size larger, usually 3.5 mm. or more; female segment deeply concave either side of a pair of sharp median teeth, separated by a deep incision. Male plates elongate..*fraternus*
Size smaller, usually not exceeding 3.25 mm. Female segment convexly, rather abruptly excavated, with a slight tooth either side of a median incision. Male plates more transverse, almost semicircular at tips....*mendosus*

8. Vertex decidedly longer than width between eyes....9
Vertex broad, only slightly longer than basal width between eyes or as broad as long....19

9. Female segment with posterior margin produced at middle into a broad obtusely rounded tooth or lobe often slightly incised at middle....10
Female segment with central portion of posterior margin possessing two or more blunt teeth formed by a median incision or emargination....17

10. Male plates elongated, usually two-thirds or more as long as pygofers, apices variously modified....11
Male plates usually short and somewhat convexly rounded, exceeded more than their length by pygofers or with ventral keel of pygofers separating them at tips....16

11. Apices of male plates simple, rounded or evenly produced, not notched nor produced on one side only....12
Apices of male plates notched and bifurcated or with one side only produced to form the tip....14

12. Male plates abruptly narrowed at about two-thirds their length and produced into strongly divergent pointed tips. Pygofers exceeding plates by one-half their length. Lateral angles of female segment rounded off, lobe strongly produced at center. ....*sandersi*
Male plates gradually sloping, not abruptly narrowed and not diverging at apices....13

13. Male plates rather narrow, almost as long as pygofers, tip slightly rounded. Female segment with very shallow emarginations between the lateral angles and the median obtuse tooth....*reflexus*
Male plates a little broader, more bluntly rounded at apex, pygofers exceeding plates by almost one-half their length. Female segment with prominent lateral margins and a rather deep narrow concavity either side of median lobe....*impulsans*

14. Size larger, about 4 mm. Male plates broad, tips bifurcate forming two prominent pointed teeth at apex of each plate. Pygofers narrow, exceeding plates by about one-half their length....*atlanticus*
Size smaller, not more than 3.5 mm. in length. Male plates with only outer lobe produced, inner lobe rounded off to inner margin....15

15. Male plates abruptly narrowed about two-thirds their length and tapering to a minute rounded tooth on outer apical margin. Pygofers about one-fourth longer than plates. Female segment with lateral angles rounded off, median lobe somewhat pointed ....*visendus*

Male plates slightly concavely and gradually narrowed to apices. Tips almost one-half as broad as basal width. Outer rounded teeth prominent, inner margins slightly divergent, not produced. Pygofers a little longer than plates. Female segment with prominent angles and strongly produced median lobe.....*gramineus*

16. Male plates seemingly fused at base, prominent ventral keel separating their tips and fitting into a broad rounded notch between them, one-third distance to base...*flexulosus*

Male plates short, no ventral keel on pygofers separting plates. Female segment with a slight median notch and a black mark and indentation at either side of ovipositor .....*pictus*

17. Posterior margin of female segment with four central teeth equal in length, the outer pair usually pointed and the inner pair more rounded. Male plates broad, forming broad obliquely sloping tips.....*pectinatus*

Female segment with only two definite equal teeth, male plates small, convexly rounded..18

18. Teeth of female segment formed by deep median incision, broad at apex and either truncated or slightly concave.....*abbreviatus*

Teeth either side of ovipositor separated by a rather deep concavity, black bordered and deeply incised at middle.....*curvatus*

19. Color yellowish to fuscous, never milky white, longitudinal markings if present on vertex and pronotum very pale fuscous.....20

Color milky white or slightly yellowish, marked with blackish or dark brown longitudinal stripes on base of vertex, pronotum, and scutellum.....*albidus*

20. Size large, 4.5 mm.; female segment with central obtuse lobe incised at middle and bearing a conspicuous black tooth at middle of each side. Male plates truncate and divergent at tips, inner margins of pygofers with a long black style-like process .....*stylatus*

Size usually smaller, female segment without conspicuous black teeth on margins of central lobe. Male plates convexly rounded to rounding apices, no visible styles on pygofers .....*inflatus*

21. Size large and rather broad, length 4 mm. or more; female segment with a pair of elongate black spines at middle.....*configuratus*

Size smaller, not exceeding 3.5 mm. in length, usually some shade of brown.....22

22. Vertex slightly broader between eyes than length at middle, female segment produced into a long usually bifid tooth, male plates long, tips sharp pointed and curved .....*ocellaris*

Vertex as long or longer than width between eyes; genitalia differing.....23

23. Female segment roundingly concave at middle, male plates rather long, outer borders curved to pointed inner margins.....*sayi*

Female segment either produced at center or forming a broad truncated central tooth....24

24. Female segment roundingly produced or slightly notched either side of a central rounded portion. Male plates rather short and broad, tips blunt and rounded.....*misellus*

Female segment with a deep rounded notch either side of a broad, square, truncated, central tooth. Male plates divergent at tips.....*latidens*

25. Vertex sharply angled, margins straight, a little longer at middle than width between eyes. Vertex, pronotum, and scutellum crossed by two longitudinal black and brown stripes .....*delector*

Vertex usually broader between eyes than length at middle, sides more convexly rounded, tip blunt.....26

26. Vertex, pronotum, and scutellum crossed by two longitudinal brownish stripes bordered with black on inner and outer margins on the vertex.....27

Vertex whitish or yellowish unmarked, tip rather blunt and slightly rounded.....28

27. Vertex almost as long as wide, disc flat, not sloping to front, elytra long and flaring. Female segment with somewhat pointed lateral angles, posterior margin sloping to a rather abrupt notch at center.....*marginatus*

Vertex wider than long, anterior third strongly sloping to front, elytra appressed at tips. Female segment gently sloping from lateral angles and slightly notched at center ..... *bilineatus*

28. Vertex ivory white washed with yellow, elytra grayish or whitish, veins heavily fuscous margined. Male plates sloping at tips and rounded on inner and outer margins ..... *luteocephalus*

Vertex, pronotum, and elytra buff or yellow, with a few dark markings in apical cells, Male plates almost truncated at tips..... *paludosus*

Deltocephalus areolatus Ball.

(Plate VII, Figs. 4, 4a, 4b; Plate XX, Fig. 2)

Ball, Can. Ent. XXXI, p. 188, 1899.

An olive green species with a black spot on middle and another on tip of each elytron, and a strongly produced vertex. Length 3.5 to 4 mm.

Vertex strongly acutely angled, tip rounded, more than one-half longer on the middle than width between eyes, and at least one-half longer than pronotum which is more than twice as wide as long with very short lateral margins. Elytra as long as abdomen, flaring, venation rather obscure.

Color: Vertex yellowish olive, the crescent marks at tip inclosing a white spot; pronotum yellowish olive, unicolorous or sometimes paler on anterior half. Elytra pale olive to bright yellow, a large black or fuscous blotch between sectors and behind first cross nervure, the outer apical margin and anterior borders of the broad, white, reflexed veins, fuscous. Face and venter black.

Genitalia: Female last ventral segment more than twice as long as preceding, lateral margins strongly narrowing posteriorly to bluntly produced lateral angles, posterior margin between these angularly excavated one-fourth the distance to the base, either side of a rounding, medially notched tooth one-fourth the width of segment and equaling lateral angles in length. Male valve triangular, apex acutely produced, four times as long as preceding segment. Plates more than twice as long as valve, gradually narrowed to bluntly pointed, divergent apices. Pygofers one-fourth longer than plates.

This species is quite distinctly marked and easily recognized. The known distribution is along the Atlantic coast from New York to South Carolina, along the Gulf coast in Mississippi (Dozier), in the Mississippi valley, in Kansas and Missouri, and southwest in Arizona. Apparently its normal range is southern and it has worked northward along the Atlantic coast.

Osborn and Metcalf have reported it as living on *Arogrostes pectinacea* from which it was taken abundantly. It has been collected by the author on a *Panicum* type of plant which grows abundantly on the sandy coastal areas along the Atlantic ocean.

Type localities Arizona and College Pk., Md. Type in Ball collection. Type examined, also specimens from Va., Md., Kan., Mo., N. Y., Miss., and N. C.

Deltocephalus fraternus Ball.

(Plate VII, Figs. 3, 3a, 3b; Plate XX, Fig. 4)

Ball, Can. Ent., XLIII, p. 201, 1911.

Form and general shape of *reflexus*, vertex pale with black quadrate spots, elytra shorter

than abdomen. Length 3.5 to 4 mm.

Vertex flat, produced, not quite twice as long as width between eyes, and nearly twice as long as the transverse pronotum which is strongly convex anteriorly. Elytra shorter than abdomen, apices more narrowed and less flaring than in *reflexus*. Central anteapical cell divided into two or more cells.

Color: White to gray tinged with yellow, vertex with reflexed arcs from front, black converging spots bordering white apex; a triangular spot at anterior end of impressed line, a pair of quadrate spots between ocelli and a pair at base between eyes, dark fuscous or black. Pronotum with several irregular fuscous spots forming six more or less distinct longitudinal bands. Elytra grayish, veins heavily margined with fuscous. Face usually black with pale arcs, sometimes pale below. Venter fuscous.

Genitalia: Female last ventral segment one-half longer than preceding, lateral angles strongly produced and tips rounded, posterior margin slightly concave between bases of lateral projections and a pair of sharp median teeth which are separated by a narrow median slit half way to base. Disc of segment shining black. Male valve as long as wide, triangular tip acutely pointed. Plates narrow, elongate, appearing as ridges along valve, tips blunt terminating between pygofers which are strongly inflated and exceed plates by one-fourth their length.

There is a great variation in the posterior margin of the female segment. Often the concavity is notched, sinuated, or bears numerous teeth. The general form, however, is the same.

This species seems to have a more northern distribution than *mendosus* and is found on grasses in open pineland throughout the northern and central part of Florida. It was not found in the typical everglade or prairie regions where *mendosus* occurs so abundantly.

Type localities Jacksonville, St. Petersburg, and Sanford, Florida. Type in Ball collection. All specimens examined, including type were from Florida.

Deltocephalus mendosus Ball.

(Plate VII, Figs. 2, 2a, 2b; Plate XX, Fig. 7)

Ball, Can. Ent., XLIII, p. 202, 1911.

Resembling *fraternus* in form and general appearance, but smaller and with different genital characters. Length 2.5 to 3.25 mm.

Vertex a little shorter proportionately than in *fraternus*, at least two-thirds longer than width at base in female and about one-half longer than basal width in male, almost twice as long as transverse pronotum. Elytra very similar to *fraternus;* somewhat narrowed apically, shorter than abdomen in female. Central anteapical cell often constricted but not divided and often broken up into two or more cells.

Color: Grayish to tawny, markings as in *fraternus* but often paler. Whole insect, often almost black. Elytra usually with pale nervures dark margined, especially on apical half, and dark spots on clavus, disc, and third apical cell. Face dark above with pale arcs shading to fuscous below.

Genitalia: Female last ventral segment one-half longer than preceding, lateral angles produced, posterior margin with median fifth abruptly excavated and bearing a median incision, side lobes to lateral angles convexly rounded, often sinuate or notched. Male valve a little shorter than broad, tip acutely angled, plates broader than in *fraternus*, strongly rounded

and together almost semicircular behind, not exceeding valve as much as in *fraternus*. Pygofers strongly inflated and exceeding plates by about two-fifths their length.

The male described here was taken in abundance with great numbers of females which correspond with the type of the species. The male described by Crumb as *mendosus* is apparently a dimorphic form of *fraternus* and was taken, in company with typical females of *fraternus*, by the author at Orlando, Florida. Furthermore *mendosus* does not occur in that region.

Although the two species are quite variable, from field studies and collecting observations in Florida and a laboratory study of a large series of specimens the two forms seem to be specific. *Mendosus* is a common form on the prairies at La Belle, Florida, and on small prairie grasses found in the everglade regions. *Fraternus* occurs on grasses of the pine woodlands in a more northern area and has not been taken south of St. Petersburg. Although the two species were both abundant they were not collected at the same localities since the records for distribution of *mendosus* conform rather definitely to the former everglade region.

Type locality Estero, Florida. Type in Ball collection. Type, material, and specimens from many localities in southern Florida have been examined.

Deltocephalus sandersi Osborn.

(Plate VIII, Figs. 1, 1a, 1b; Plate XXI, Fig. 4)

Osborn, Proc. Dav. Acad. Sci., X, p. 164, 1907.

Resembling *reflexus* in color and general appearance but readily distinguished by the male genital characters Length 3.5 mm.

Vertex more pointed than in *reflexus*, about one-third longer than width between eyes, and more than one-third longer than pronotum which is truncate behind. Elytra rather broad and flaring, veins coalescing for some distance on median portion of clavus.

Color: Yellowish gray, vertex with the pale tip enclosed in a darker circular or quadrate dark ring, the margins with pale fuscous lines to ocelli, the transverse band and basal oblique marks as in *reflexus*. Elytra dull yellowish gray, nervures usually paler, the apical margin and costal reflexed veins heavily bordered with dark fuscous.

Genitalia: Female last ventral segment at least one-half longer than preceding, lateral angles gradually rounded to the median third of posterior margin which is strongly produced into a broad tooth slightly incised at middle and black either side. Male valve triangular, twice as long as preceding segment; plates one-third longer than valve, broad at base, narrowed rapidly two-thirds their length, then abruptly concaved to strongly divergent, acutely pointed apices; about two-thirds as long as pygofers.

An examination of a great number of specimens has shown this species to be confused with *visendus* and *reflexus* in records already published. *D. sandersi* apparently is the common eastern coast form while *visendus* and *reflexus* are only occasionally found. It

is common in Connecticut, Pennsylvania, Ohio, and Tennessee, and the Mississippi valley states to the Gulf in Mississippi (Dozier). The distribution may be even greater but no further records are available.

In Tennessee this species was taken abundantly upon *Andropogon virginicus* over large areas. No data has been collected in regard to the life history.

Type localities Ch. Bridge, Va., and Monticello, Ga. Type in Osborn collection. Type examined.

Deltocephalus reflexus Osborn and Ball.

(Plate VIII, Figs. 2, 2a, 2b; Plate XXI, Fig. 6)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 203, 1897.

One of the most common of the reflexed group, pale cinereous with dark markings, vertex strongly produced and angled. Length 4 to 4.5 mm.

Vertex about one-fourth longer on middle than width between eyes and one-fourth longer than pronotum, tip blunt. Pronotum short, almost truncate behind, lateral margins very short. Elytra flaring, costal veinlets strongly reflexed, veins of clavus coalescing through the median third of their length.

Color: Pale cinerous above, tip of vertex often ivory white enclosed in fuscous triangle or between crescent marks; marginal lines before ocelli; transverse dashes before eyes and oblique marks on base fuscous. Pronotum dull white with faint indications of longitudinal stripes. Elytra pale fuscous, nervures margined with fuscous, spots on clavus and one on disc conspicuous, reflexed veins and apical margin broadly bordered with fuscous.

Genitalia: Female last ventral segment about one-half longer than preceding, lateral angles broadly roundingly angled, central third roundingly broadly produced into a tooth which is notched at center, a large black spot either side of notch. Male valve obtusely triangular, longer than preceding segment; plates long, rather narrow, concavely attenuately pointed, equaling pygofers in length, tips slightly divergent.

This species is one of the most abundant and widely distributed of the reflex veined group. It has been somewhat confused with other forms but is quite distinct when its specific characters are known. It has been reported as occurring in Iowa, Kansas, Wisconsin, Colorado, Tennessee, and North Carolina, and specimens have been examined from Mississippi (Dozier). It no doubt is abundant in the states of the Mississippi valley but it is doubtful if its range is extended beyond this area. According to Osborn and Ball "this species occurs well distributed over the prairies but has not been found on the field of *Andropogon scoparius*." Apparently there are two seasonal generations.

Type localities Ames, Iowa, and Colorado. Cotypes in Osborn and Ball collections. Types examined and specimens from Minn. (De Long), Kansas (Larrimer), Tenn. (De Long), and Mississippi (Dozier).

Deltocephalus imputans Osborn and Ball.

(Plate VIII, Figs. 6, 6a, 6b; Plate XXI, Fig. 1)

Osborn and Ball, Proc. Dav. Acad. Sci., VII ,p. 75, 1898

In form resembling *reflexus* with head a little broader, a distinct creamy yellow color with spots at apex of vertex, and reflexed veins only with color marking. Length 3.5 to 4 mm.

Vertex about one-third longer on middle than width between eyes, almost one-half longer than pronotum. Elytra rather short, reaching tip of abdomen, flaring, veins on clavus almost parallel.

Color: Creamy yellow tinged with olive, vertex with median impressed line and a spot either side of pale apex, black. Reflexed veins of elytra broadly white, margined anteriorly with fuscous. Outer apical cell with the posterior margin fuscous. Face black, venter somewhat infuscated.

Genitalia: Female last ventral segment half longer than preceding, lateral angles produced and acutely angled, emarginate from these either side of a central broadly produced lobe which is angular and somewhat incised at center either side of which is a black spot. Male valve traingular, more than twice as long as preceding segment, constricted either side of produced apex; plates exceeding valve by about its length, gradually narrowed from base to rounded divergent tips, exceeded by pygofers more than one-third their length.

Records of the distribution of this species are very few and it is only known from Iowa, Kansas, and Wisconsin. The specimens cited from Tennessee will not agree with the types. It is found on *Muhlenbergia* growing in a sheltered but not shaded situation, (Osborn and Ball). It seems to be a two-brooded insect.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined.

Deltocephalus atlanticus n. sp.

(Plate VIII, Figs. 3, 3a, 3b; Plate XXI, Fig. 2)

In general appearance and coloration most closely resembling *visendus* but longer, more darkly colored and with distinct genital characters. Length 4 to 4.5 mm.

Vertex almost one-third longer on middle than width between eyes at base, and more than one-third longer than pronotum, which is very broad and transverse. Elytra long and flaring, extending to or slightly beyond tip of abdomen. Claval venation as in *reflexus*.

Color: Pale cinereous, vertex washed with yellowish, a black longitudinal spot either side of apex and an interrupted transverse band just before anterior margin of eyes, fuscous. Pronotum with indications of longitudinal banding. Elytra gray to cinereous, nervures heavily margined with fuscous, especially on posterior half. Black spot on outer clavus and discal cell. Reflexed veins heavily black margined. Face and below very black with pale areas on clypeus, genae and lorae. Venter dark fuscous.

Genitalia: Female last ventral segment more than twice as long as preceding, lateral angles strongly sloping inward and in reality forming produced lobes of the posterior margin, between these the posterior margin is angularly excavated either side of a broad, strongly produced median lobe, the sides of which are somewhat sinuated and the apex distinctly notched. Male valve triangularly produced, two-thirds as long as wide. Plates broad at base, gradually narrowed two-thirds their length, then concavely rounded to broad tips, each of which is bifurcate, forming two teeth, and the plates are slightly divergent at apex.

Described from one male from Egg Harbor, N. J., July 9, kindly sent by Mr. Dickerson, one male from Lakehurst, N. J.,

loaned by Dr. Ball, and four female specimens from Mr. Olson, collected at Woods Hole, Mass., July 15-August 16, 1917, and Lakehurst, N. J., July 4, 1909, labeled *D. reflexus*. A series of specimens were examined from Egg Harbor. One specimen was retained and Mr. Dickerson reports the others were destroyed later. The male specimen is the type but it is quite certain the females are the corresponding sex of the same species.

Type in author's collection.

Deltocephalus visendus Crumb.

(Plate VIII, Figs. 4, 4a, 4b; Plate XXI, Fig. 5)

Crumb, Ann. Ent. Soc. Amer., VIII, p. 189, 1915.

In general appearance and coloration resembling *reflexus* and *sandorsi*, but distinguished from them by the male genitalia. Length 3.5 to 4.2 mm.

Vertex almost one-third longer on middle than basal width between eyes and one-third longer than transverse pronotum. Tip of vertex blunt and somewhat rounded. Elytra very similar to *reflexus*, the claval veins coalescing on median third.

Color: Pale cinereous, vertex with white tip margined each side by a black spot, an orange line along margin on each side to red ocelli. The transverse dashes before eyes and the longitudinal lines on pronotum sometimes fuscous. Elytra dull cinereous; a spot on clavus, one just back of first cross nervure and the margins of reflexed veins, black or dark fuscous. Face black above, brownish below.

Genitalia: Female last ventral segment almost twice as long as preceding, lateral angles produced and rounded off, the posterior margin with median third broadly angularly produced, entirely black and slightly incised at middle. About the middle on each side a blunt spur somewhat as in *stylatus*. Male valve triangular, three times as long as last ventral segment, plates twice as long as valve, wide at base, gradually narrowed two-thirds their length, then abruptly narrowed to form rather blunt parallel tips. The other half of tip is more produced and rounded and slightly excavated on the inner margin. The plates are exceeded by pygofers by one-third their length.

In distribution this species is almost entirely southern, occurring in Georgia, Florida, and the Gulf states to the Mississippi. It has been recorded for Kansas (Lawson) and occasionally is found along the Atlantic coast as far north as Virginia or New Jersey.

In Florida it is abundant on short grasses in open pinelands.

Type locality Jacksonville, Florida. Type in Crumb collection. Type examined also specimens from Florida, Mississippi, and New Jersey.

Deltocephalus gramineus n. sp.

(Plate VIII, Figs. 5, 5a, 5b)

In general appearance resembling *visendus* but with male plates broader apically and female segment distinct. Length 3.5 to 4 mm.

Vertex about one-fourth longer than width between eyes, at least one-third longer than pronotum, which is short and rather broad. Elytra a little shorter than abdomen in female, reaching tip of abdomen in male.

Color: Dull brownish yellow, the characteristic markings of the *reflexus* group rather faint, ocelli reddish, parenthesis markings at tip and transverse dashes pale brownish. Elytra with fuscous spots on clavus and discal cell and with reflexed veins distinctly bordered with brown. Face pale below, above darker with pale arcs.

Genitalia: Female last ventral segment almost twice as long as preceding. Posterior margin with lateral angles produced, slightly emarginate either side of a median produced lobe which is slightly notched at middle and again either side forming four short rather blunt and slightly rounded teeth. Median portion darker. Male valve broadly triangular with rounded apex. Plates exceeding valve by more than twice its length, concavely narrowed to slightly divergent apices which have rounded inner lobes and rather narrow produced outer tips. Apical portion more than one-third width at base. Plates slightly exceeded by pygofers.

Described from a pair of specimens, one from Douglas County and one from Ottawa County, Kansas. The male is designated as the type. It is differentiated from *visendus* by the character of the male plates which are much broader apically.

Type localities Douglas and Ottawa counties, Kansas. Type in author's collection.

Deltocephalus flexulosus Ball.

(Plate IX, Figs. 7, 7a, 7b; Plate XXI, Fig. 3)

Ball, Can. Ent., XXXI, p. 189, 1899.

General appearance of *reflexus* with vertex in female a little shorter and with elytra narrower and less flaring. Genital characters distinct. Length 3.5 to 4 mm.

Vertex one-fourth longer than width between eyes and one-fourth longer than pronotum which is narrower than head, including eyes. Vertex rather blunt and rounded in female, more pointed in male. Elytra in female as long as in male, exceeding abdomen, not inclined to be flaring.

Color: Light cinereous washed with yellow and with fuscous markings. Vertex with a quadrate border around apex, marginal and transverse dashes and basal marks, fuscous; longitudinal markings on pronotum and veins of elytra fuscous margined. A spot on outer clavus, one just behind anterior cross vein, the anterior borders of the reflexed veins and the apical margin, fuscous. Face black above, pale yellow below. Venter pale cinereous.

Genitalia: Female last ventral segment resembling *abbreviatus*, more than twice as long as preceding, lateral margins narrowed posteriorly, lateral angles produced, posterior margin excavated between these either side of a broad wedge-shaped median tooth extending beyond the lateral angles. The apex sometimes notched in the middle and with a smaller one either side. Male valve short, broadly obtusely triangular, plates exceeding valve almost twice its length, outer margins sloping, tips rounded, notched one-third the distance to base along median line to make room for sharp ventral keel of pygofers. Pygofers exceeding plates by one-half their length.

Described from Colorado and Kansas and has since been taken in North Dakota (Osborn) and South Dakota (Severin). These are the only known records at present for its distribution and practically nothing is known regarding the food plant or life history.

Type localities Ft. Collins, Windsor, Estes Park, Denver, and Holly, Colorado, and Western Kansas. Type in Ball collection.

Type and specimens from Bismark, N. D. (Osborn) and Brookings, S. D. (Severin) were examined.

Deltocephalus pictus Osborn.

(Plate IX, Figs. 3, 3a, 3b; Plate XXII, Fig. 1)

Osborn, Proc. Dav. Acad. Sci., X, p. 165, 1907.

D. funabulus Crumb, Ann. Ent. Soc. Amer., VIII, p. 189, 1915.

Similar to *reflexus* in general form but usually with more intensive color markings and distinct genital characters. Length 3 mm.

Vertex about one-fifth longer than width between eyes, tip blunt and rounded. Pronotum short, transverse, a little more than half as long as vertex. Elytra not quite as long as abdomen with strongly reflexed veins.

Color: Pale gray, vertex with a black circle at tip enclosing a pale spot; the orange line on margin, one or sometimes two interrupted bands before eyes and spots at base, fuscous. Pronotum with prominent longitudinal bands. Elytra gray or whitish, veins pale, usually heavily bordered with fuscous or black. The central apical cell is often entirely black or brown.

Genitalia: Female last ventral segment almost two and one-half times as long as preceding, lateral margins sloping from half their length to an almost truncate posterior margin. The central third is broadly roundingly produced and two small incisions form a minute tooth on apex either side of a median rounded lobe. Male valve rather narrow, obtusely triangular, plates exceeding valve by one and one-half times its length, slightly convexly rounded to blunt apices. Pygofers more than twice as long as plates, gradually tapering.

The male genital characters will readily separate this species from all closely allied to it. The dark markings on the elytra too are quite conspicuous.

At present time the species is known to occur in New York (Osborn), Pennsylvania (Sanders), Kansas (Crumb and Beamer), Mississippi (Dozier), Virginia, District of Columbia, and Maryland (Sanders), Tennessee (Crumb and De Long), and Ohio (De Long).

It occurs on *Aristida ologantha* in Kansas and on *Aristida gracilis* in Tennessee according to Crumb. Apparently there are other closely related food plants but all specimens taken have been from small grasses in dry meadows. Many immature specimens have been taken by the author but no data has been obtained on the life history.

Type locality Staten Is., N. Y. Type in Osborn collection. Type examined and specimens from states mentioned above.

Deltocephalus pectinatus Osborn and Ball.

(Plate IX, Figs. 1, 1a, 1b; Plate XXI, Fig. 8)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 205, 1897.

In general appearance resembling *reflexus* but with shorter vertex and often much shorter wings. Genital characters distinct. Length 3.5 to 4 mm.

Vertex one-fourth longer than basal width between eyes, tip blunt, almost pointed. Pronotum very short and broad, truncated behind. Elytra short, not flaring, often exposing last dorsal segment, especially in the female, veins on clavus not coalescing.

Color: Pale cinereous to gray, vertex with a circular ring at apex; interrupted transverse band before eyes and blotch on base at each side fuscous; marginal lines orange. Elytra dirty white, nervures pale, margined with fuscous. Apical and discal cells most heavily marked. Face dark above shading to pale below, marked with white arcs.

Genitalia: Female last ventral segment twice as long as preceding, the lateral margins narrowed posteriorly, lateral angles produced and rounded, posterior margin slightly concaved, with four black comb-like teeth occupying the central third. The inner two are rounded and close together, and separated by a notch from the outer pointed ones. Male valve triangularly produced, twice the length of the preceding segment. Plates twice as long as valve, slightly narrowing, almost parallel margined, then broadly rounded to blunt almost truncate tips. Pygofers one-fourth longer than plates, ventral keel exposed between plates near tip.

This distinct and interesting species is quite widely distributed over the prairie section of the upper Mississippi valley. It is known to occur in Iowa, Kansas, Nebraska, Wisconsin, and South Dakota and it may occur in other states where collecting has not been done and records are incomplete. It appears to feed abundantly upon *Bouteloa hirsuta* and *B. curtipendula* in a mixed association on the prairie and if restricted to one plant it is probably a restriction of egg deposition (Osborn and Ball).

The life history is apparently very similar to that of *reflexus*, having two seasonal generations.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined, also specimens from Madison, Wis. (De Long), Brookings, S. D. (Severin) and Long Pine, Neb. (Pierce).

Deltocephalus abbreviatus Osborn and Ball.

(Plate IX, Figs. 4, 4a, 4b; Plate XXI, Fig. 7)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 206, 1897.

Resembling *pectinatus* but smaller, with short elytra. Length 3 to 3.25 mm.

Vertex at least a third longer on middle than basal width between the eyes, roundingly pointed, more than twice as long as pronotum, which is very short, truncate behind and very broad. Elytra variable in length.

Color: Pale cinereous, markings as in *reflexus*, the white tip enclosed in a quadrate ring; marginal, transverse and basal dashes prominent, fuscous. Transverse band before eyes almost complete. Pronotum irregularly marked. Elytra with almost all the veins dark margined. Reflexed veins and apical margin more heavily marked. Entire face infuscated, marked with pale arcs.

Genitalia: Female last ventral segment more than twice longer than preceding; lateral angles prominent, posterior margin excavated either side of the central fourth, which is abruptly produced one-third the length of the segment, truncated, incised at middle and slightly arcuate either side forming four more or less distinct teeth. Male valve triangularly produced, four times as long as last ventral segment; plates exceeding valve by one and one-half times its length, convexly rounded from base and slightly rounded from inner margin near tip to bluntly pointed apices. Pygofers narrow, greatly exceeding plates.

This species is easily distinguished from those closely allied to it by the small size, short wings, and the genital characters which are distinct.

As other species of this group, it is limited to the prairie regions of the Mississippi valley, and known to occur in Iowa, Kansas, Colorado, Nebraska, North Dakota (Osborn) and South Dakota (Severin). A record is also at hand from Plano, Texas (Tucker).

According to Osborn and Ball it occurs in company with *pectinatus* on *Bouteloa hirsuta* and was found abundantly in high gravelly pasture where the sides and tops of the knolls were covered with this grass.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined and many specimens from the states previously mentioned.

Deltocephalus curvatus n. sp.

(Plate IX, Figs. 2, 2a, 2b; Plate XXI, Fig. 9)

Size and form of *abbreviatus*, but much lighter in color and with distinct genital characters. Length 3 to 3.25 mm.

Vertex rather short, one-fifth longer than basal width, one-third longer than pronotum. Elytra short as in *abbreviatus*, exposing almost entire last dorsal segment in the female.

Color: Pale straw yellow, the elongate spot either side of apex joined posteriorly, a transverse dash each side between anterior margins of eyes and an oblique dash each side near base, almost parallel with inner margin of eye, pale fuscous, very faint orange line extends from apex to ocelli. Pronotum longitudinally striped with six faint fuscous bands. Elytra pale, nervures margined with fuscous, a darker spot on outer clavus and discal cell. Face faintly fuscous above with pale arcs, below pale.

Genitalia: Female last ventral segment more than twice longer than preceding, lateral angles prominent, posterior margin shallowly excavated either side of a pair of produced points rounded on apex, between which is a rather deep excavation and a median incision with a minute tooth either side. The whole median excavated portion is broadly black margined.

Described from a series of female specimens collected in Clay County and Delphos, Kansas, the former by Professor J. H. Schaffner and labeled August 1, 1906, the latter by Professor Herbert Osborn. No intermediate forms between this and *abbreviatus* can be found although both were taken at the same place and time.

Type in author's collection.

Deltocephalus stylatus Ball.

(Plate IX, Figs. 5, 5a, 5b; Plate XX. Fig. 5)

Ball, Can. Ent., XXXI, p. 190, 1899.

One of the largest of the *reflexus* group with a broad head, and coloration similar to *pectinatus*. Length 4.5 mm.

Vertex slightly longer than its basal width, about one-fourth longer than pronotum. Front and clypeus proportionately broad. Elytra usually longer than abdomen, flaring at tip, venation as in *inflatus*.

Color: Pale cinereous, vertex yellowish with the black crescents either side of apex, the pale lines along margin to ocelli, transverse band on either side before the eyes and a spot in the middle of either side at base, fuscous. Elytra pale, marked as in *flexulosus*, the nervures pale, margined with fuscous; the outer clavus with a dark spot either side of cross nervure, and a spot either side of first cross nervure of the disc.

Genitalia: Female last ventral segment more than two and one-half times the length of preceding, lateral angles slightly produced and well rounded, posterior margin produced on the middle third into an obtusely triangular tooth, bifid at the apex and bearing a small lateral tooth at about the middle of either side. Male valve equilaterally triangular, plates extending beyond the valve scarcely its length, roundingly divergent at the apex where they are half as wide as at the base, their tips truncated or slightly roundingly emarginate. Pygofers inflated, greatly exceeding plates, their inner margins extending into a pair of narrow, curved, black style-like processes.

The only definite records for this species are from Iowa and Nebraska. The specimens from Tennessee and Wisconsin are not typical of this species. No definite food plant is known at this time but according to Ball it occurs on prairie grasses.

Type locality Little Rock, Iowa. Type in Ball collection. Type and specimens from Springview Bridge, Nebraska were examined.

Deltocephalus inflatus Osborn and Ball

(Plate IX, Figs. 6, 6a, 6b; Plate XX, Fig. 8)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 202, 1897.

In form somewhat resembling *albidus* with vertex proportionately broader than most of the related species and distinct genital characters. Length 3 to 4.5 mm.

Vertex almost as wide between eyes as length at middle ,pronotum short and broad, transverse. Elytra rather broad and flaring, usually exceeding abdomen, claval veins not fused or joined by cross nervures.

Color: Dirty yellow to pale fuscous, faintly or distinctly marked; vertex with crescent dashes either side of apex, marginal line, transverse bars before eyes and oblique marks on base, fuscous. Longitudinal markings on pronotum and scutellum. Elytra with claval veins, those on the disc and on apical portion of elytra bordered with fuscous. Face above usually dusky with pale arcs.

Genitalia: Female last ventral segment more than twice as long as preceding segment, lateral angles slightly produced and rounded, a slight rounded indentation between these either side of a central broad produced portion, which is notched at center, bearing a black spot and slight tooth on the sloped sides. Male valve obtusely triangular, twice as long as preceding segment, plates twice as long as valve, gradually convexly rounded to appressed, roundingly pointed apices. Plates sometimes notched at apex by the sharp edge of pygofers. Pygofers enlarged, inflated last tergite much enlarged.

This species is easily recognized and is widely distributed through the eastern United States. It is found from Colorado, Iowa, Kansas, and Wisconsin eastward to the Atlantic coast through Ohio, Pennsylvania, New York, New Jersey and south along the coast to Florida.

Although abundant the food plant has not been determined. It occurs on tall grasses in low meadows and grasses surrounding lagoons. Nothing definite is known regarding the life history.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes and specimens from all states mentioned above, examined.

Deltocephalus albidus Osborn and Ball

(Plate VII, Figs. 5, 5a, 5b; Plate XX, Fig. 9)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 201, 1897.

A large milky white species with conspicuous brown or black markings on vertex and pronotum, and the elytra marked as in all the reflexed species. Length 4.25 mm.

Vertex a little longer on middle than width between eyes, tip rounded, a little longer than pronotum which is more than twice as broad as long. Scutellum comparatively large, elytra broadly rounded and flaring.

Color: Milky white, sometimes slightly yellowish; a triangular margin enclosing pale spot at tip of vertex, a slightly curved transverse band before eyes, four or six longitudinal lines across pronotum, the inner pair rising on the base of vertex and extending across scutellum on to elytra, black or dark brown. Elytra with claval and apical margins, anterior borders of reflexed veins and spots on clavus and disc brown or black. Face pale, unmarked.

Genitalia: Female last ventral segment more than twice as long as preceding, posterior margin divided into three lobes by two angular excavations one-third the distance to base. The central lobe is almost as broad as the combined width of the other two, incised at middle with a slight blunt tooth either side. Male valve triangular, acutely angled, more than twice as long as preceding segment. Plates twice as long as valve, gradually tapering to blunt, convexly rounded apices, slightly exceeded by pygofers.

Described from Iowa, this species has since been taken in South Dakota (Severin), Nebraska, Kansas (Lawson), and Missouri. Apparently the exact food plant has not been determined since Osborn and Ball report a rich variety of native grasses where it occurred abundantly. The species apparently has two generations although very little data is present regarding the second one.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined.

Deltocephalus slossoni Ball.

(Plate VII, Figs. 6, 6a, 6b; Plate XX, Fig. 6)

Ball, Proc. Biol. Soc. Wash., XVIII, p. 119, 1905.

In general appearance and coloration resembling *grammicus* but without a bright yellow tint. Elytra obliquely truncated and slightly concave posteriorly. Length 4 to 4.25 mm.

Vertex acutely angled, the apex blunt, one-fourth longer on middle than width between the eyes, one-half longer than pronotum which is broad and transverse. Scutellum proportionately large. Elytra not quite covering abdomen in either sex, from the apex of clavus the elytra are obliquely truncated and slightly concavely rounded to the produced and rounded costal margin. Anteapical cells very small. Vertex and front acutely angled.

Color: Pale creamy yellow, vertex with the crescent spots at apex, dashes along margin and interrupted band before eyes fuscous. The six stripes, the central pair arising on basal half of vertex, extend across pronotum on to elytra, the inner pair parallel crossing the scutellum, the outer pairs converging and meeting the inner pair at apex of clavus. Most of the veins on corium are white, narrowly margined with fuscous, the reflexed veins broadly light, narrowly margined with fuscous anteriorly, the enclosed cells tinged with tawny. Face pale, the upper half, a spot on clypeus and a minute one at outer edge of each lora, black. The black above in the form of about five bands all interrupted in middle except the upper one.

Genitalia: Female last ventral segment five times as long as preceding, almost as long as combined length of the other abdominal segments. Posterior margin divided into three nearly equal lobate parts by two curved incisions extending two-thirds the distance to base. The outer lobes slightly obliquely rounding away from the inner one, which is bluntly rounded and distinctly incised at middle. Male valve triangular, three times as long as preceding segment. Plates exceeding valve by twice its length, gradually narrowed to long acutely pointed, attenuated tips, which reach the tips of the blunt, bulbous pygofers.

For several years this species has been known by a single female specimen. A large series was recently collected by the author and Mr. J. N. Knull in the Florida everglades and the above description of the male genitalia is the first published description.

The species is found quite abundantly on the prairie vegetation at the margins of sawgrass areas in the everglades or in small stretches of prairie between pineland. It was taken from *Disticslis spicata* (L) Greene, both as nymphs and adults at Paradise Key, Miami, and in the Gulf on Sanibel Is., Florida. The habitat in which it occurs is no doubt submerged during a part of the year although quite dry in the first week of April when collecting was done.

Type locality Biscayne Bay, Florida. Type in Ball collection. Type examined, also specimens from many Florida everglade localities.

Deltocephalus grammicus Ball.

(Plate VII, Figs. 7, 7a; Plate XX, Fig. 3)

Ball, Can. Ent., XXXII, p. 204, 1900.

In general form closely resembling *albidus*, but larger and with beautiful markings, lemon yellow marked with brown stripes. Length 5.25 mm.

Vertex about one-fifth longer than width between eyes, flat, roundingly right angled, one-fifth longer than pronotum which is quite broad. Face very narrow, acutely angled with vertex. Elytra long, flaring, with strongly reflexed costal veins. Claval veins coalescing for some distance on the middle.

Color: Vertex white, washed with yellow, a crescent mark on either side of apex, a short dash along margin before ocelli and a transverse band between ocelli interrupted at middle, fuscous. A pair of dark brown bands arising on basal third continue across pronotum and scutellum. Pronotum with two additional lines behind each eye. The four central lines continue on to elytra, the two on each side converging and uniting before tip of clavus, where they terminate. Three other bands paler in color occur on each elytron, interrupted by pale yellow veins. Face yellow, a narrow black line just beneath margin of the vertex. Below pale yellow.

Genitalia: Female last ventral segment one-half longer than preceding, lateral angles produced and rounded, posterior margin angularly excavated one-third the distance to the base, the margins of the excavation near the center slightly toothed and marked with black.

This beautiful species is known only from the type specimens and the male has never been described. It has been collected in Colorado and Nebraska but no other records are at hand and no data in regard to food plant or habitat.

Type localities Sneyder and Julesburg, Colorado, and Kimball, Nebraska. Type in Ball collection. Type examined.

Deltocephalus configuratus Uhler.

(Plate X, Figs. 6, 6a, 6b; Plate XXII, Fig. 2)

Uhler, Bul. U. S. Geol. Geog. Surv., IV, p. 511, 1879.

A large species with bluntly angled head, more closely related to the *sayi* group. It is closely related to two European species but can be distinguished quite readily by the genital characters. Length 4 to 4.5 mm.

Vertex flat, bluntly angled, slightly wider between eyes than length at middle, and one-fourth longer than pronotum which appears short and very broad. The elytra are broad and broadly rounded at apex without any evidence of a distinct appendix.

Color: Dirty white to gray or dull green; vertex with a white cross and the margin pale, the coloration pale fuscous to orange. Pronotum with coloration forming longitudinal bands, sometimes indistinct. Elytra dirty gray, nervures paler, faintly margined with fuscous in some areas. Face pale fuscous, marked with pale arcs, venter buff, last ventral segment of female black on central half.

Genitalia: Female last ventral segment longer than preceding. Lateral angles produced and rounded, between these the posterior margin is concavely rounded either side of a rather long pointed median tooth which is usually bifid. Male valve short, broadly rounded. Plates twice as long as valve, gradually sloping along outer margins. Inner margins suddenly diverging at two-thirds their length and rounded to outer blunt apices.

In general form and specific characters it resembles closely the European types of *Deltocephalus* and is seemingly more closely related to one or two European species such as *calceolatus* than to any in North America.

It has a northern range in North America, occurring in Canada, and from Maine to Colorado, Wyoming and Montana across northern United States. In some states where mountains occur, it extends much farther southward both in the Alleghenies and the Rockies.

In Pennsylvania the species has been collected abundantly at State College by Professor Sanders from *Poa compressa* on high ridges during June and July but could not be found in adult or immature form during the first week of September.

Type locality Milk River Region, North Montana. Type in United States National Museum, Washington, D. C. Type speci-

mens examined; also specimens from many northern states and Canada.

Deltocephalus ocellaris (Fallen).

(Plate XI, Figs. 2, 2a, 2b; Plate XXIII, Fig. 2)

Cicada ocellaris Fallen, Hemip. Sues. Cicad., p. 33, 1826.

In size and form closely resembling the common *sayi* but with color markings and genitalia distinct. Length 3 to 3.5 mm.

Vertex bluntly angled, a little broader at base between eyes than length at middle. Pronotum more than twice as broad as long. Elytra rather short and broad, in female not reaching tip of abdomen.

Color: Dull yellow to cinereous marked with brown and fuscous. Four fuscous quadrants formed by a light cross more or less conspicuous on vertex. Pronotum irregularly marked with fuscous. Elytra pale cinereous, the nervures pale or whitish, irregularly, sometimes heavily margined with fuscous. Face yellowish marked with heavy dark arcs. Venter fuscous, segments often pale margined.

Genitalia: Female last ventral segment almost one-half longer than preceding, posterior margin with rounded but quite prominent angles, the central third produced to form a triangular tooth, often bifid and produced at apex. Male valve at least four times as long as preceding segment, triangularly produced and with blunt apex. Plates exceeding valve by twice its length, combined width at base narrower than valve and gradually tapered to actuely pointed, tooth-like apices which converge and often overlap at tip.

A species common to both Europe and North America. In distribution it is quite northern and has been taken in Canada, Colorado, Lake Placid, N. Y. (Van Duzee), Cranberry Lake, N. Y. (Osborn), Kansas (K. U. Coll), and in Colorado. It is no doubt more widely distributed throughout northern states. It is reported by Edwards as very abundant on grasses, but a definite food plant has never been designated.

Type locality Stockholm, Sweden. Type probably in Stockholm Museum.

Deltocephalus sayi (Fitch).

(Plate XI, Figs. 1, 1a, 1b; Plate XXIII, Fig. 4)

Amblycephalus sayi Fitch, Homop. N. Y. St. Cab., p. 61, 1851.

A common meadow species with sharply angled head and usually conspicuous by two transverse light bands across the elytra. This combined with the distinct genital character will readily separate it from the other closely related species. Length 3.5 mm.

Vertex quite sharply angled, longer on middle than width between the eyes, and slightly longer than pronotum which is more than twice as wide as long. Elytra broad and rather short, often not covering abdomen.

Color: The vertex is pale yellowish with the four fuscous spots arranged in two somewhat concentric rows about the apex. The anterior ones are triangular and the posterior pair are somewhat irregular. Pronotum pale, irregularly marked with fuscous. Scutellum with a fuscous spot in each basal angle. Elytra dull cinereous to dark brown, interrupted by two pale transverse bands, one at base and another across elytra just back of middle. The nervures in these bands are usually milk white and are not margined with fuscous as in other parts of the elytra. Face cinereous with numerous pale arcs. Venter dark in color.

Genitalia: Last ventral segment of female a little longer than preceding, lateral angles broadly rounded to posterior margin which is shallowly concavely and often sinuately rounded. Male valve twice as long as preceding segment, broad at base, triangular. Apex blunt, almost truncate. Plates exceeding valve by one and one-half times its length. Outer margins slightly concavely narrowed to near the apices where they are suddenly convexly rounded to the inner blunt apices.

One of the most common species throughout northeastern United States extending west to the Dakotas and Colorado, south on the Alleghenies to North Carolina and Tennessee and northward into Canada.

It is a meadow and pasture species occurring more frequently in moist areas on blue grass. According to the records of Osborn and Ball there are three distinct broods during the summer.

Type locality New York. Type in State Collection, Albany, N. Y. A large number of specimens examined from northern and eastern localities.

Deltocephalus misellus Ball.

(Plate XI, Figs. 4, 4a, 4b; Plate XXIII, Fig. 7)

Ball, Can. Ent., XXXI, p. 191, 1899.

Very closely resembling *sayi* in general appearance, but slightly smaller, without banded elytra and with distinct genital characters. Length 2.75 to 3 mm.

Vertex more bluntly angled than in *sayi*, length equal to width between eyes, slightly longer than pronotum, which is twice wider than long. Elytra broad and short, broadly rounded behind, shorter than abdomen in female and longer than abdomen in male.

Color: Pale cinereous, the vertex pale with the four brownish fuscous spots separated by a white cross, and often two other irregular blotches near the base. Pronotum irregularly marked with fuscous. Elytra pale cinereous, the nervures pale, irregularly margined with fuscous. Face fuscous with numerous pale arcs; below fuscous.

Genitalia: Female last ventral segment one-half longer than preceding, the middle half of posterior margin convexly rounded either side of which it is shallowly concave to the lateral angles. Male valve one-half longer than preceding segment, obtusely triangular. Plates not twice longer than valve, broad at base, gradually narrowed to apices, which are pointed and slightly divergent or broadly bluntly rounded.

In range this species is even more restricted to northern areas than in *sayi*. It has been found in Maine, New Hampshire, New York, Connecticut, Pennsylvania, Wisconsin, Minnesota, Utah, and Colorado and is reported from Missouri but this record is doubtful. It seems to occur only on the high elevations in northern Pennsylvania and is found in grassy areas especially in woodland and moist places.

Type localities Estes Pk, Pinewood, Steamboat Springs, and Marshall's Pass, Colorado. Type in Ball collection. Type examined and specimens from practically every state mentioned previously.

Deltocephalus misellus var. occidentalis n. var.

Resembling typical *misellus* in size, form, and coloration, but with different genital characters. Length 3 mm.

Vertex a little longer than basal width, a little longer than pronotum. Elytra shorter than female abdomen, rather short and broad, well rounded at apex.

Color: Pale yellowish with the fuscous markings on head. Elytra with whitish nervures, margined with dark fuscous.

Genitalia: Female last ventral segment one-half longer than preceding. Posterior margin with lateral angles rounded and a somewhat rounded notch either side of a broad, rather short median lobe, which is black margined and slightly indented at middle.

The female character is distinct from *misellus* and may prove to be specific.

Described from two female specimens collected and sent for study by Professor F. H. Lathrop. These were taken from grassland at top of St. Mary's Peak, Oregon, August 15, 1917.

Deltocephalus latidens Sanders and De Long.

(Plate X, Figs. 7, 7a, 7b; Plate XXIII, Fig. 1)

Sanders and De Long, Ann. Ent. Soc. Amer., XII, p. 234, 1919.

Closely resembling *misellus* but slightly longer and more robust, with more produced vertex and distinct genitalia. Length 3 mm.

Vertex a little longer than width between the eyes. Pronotum short, more than twice as broad as long. Elytra a little more than twice as long as broad, broadly rounded posteriorly, slightly shorter than abdomen.

Color: Buff irregularly marked with pale orange and fuscous. Vertex with traces of the four quadrants found in *misellus*, usually appearing as a broken broad transverse band between anterior margins of eyes, and two indistinct triangular spots approaching apex, pale orange. Pronotum irregularly marked with orange in the form of six longitudinal bands. Elytra darker, veins pale, occasionally margined with fuscous in claval and apical areas, cells pale orange. Face brown with traces of about eight pale arcs. Beneath yellow, heavily marked with brown.

Genitalia: Female last ventral segment more than twice as long as preceding, posterior margin deeply, roundingly incised near lateral margins two-thirds distance to base, leaving a broad central truncated tooth one-half the width of entire segment produced beyond the lateral angles which appear as long narrow spatulate processes. Male valve broadly triangular, more than twice as broad as long. Plates two and one-half times longer than valve, strongly divergent from their inner edges at about the middle to bluntly rounded tips.

In general appearance it resembles so closely *misellus* that these species were placed together at first, but a careful examination of the characters later revealed this striking character.

The only known records for this species are from northern Wisconsin and were secured from the type specimens. The species was abundant in the same association with *misellus* in meadows where a variety of grasses were swept.

Type localities Trout Lake, Amery, and St. Croix Falls, Wisconsin. Type in Sanders and De Long collection.

Deltocephalus delector Sanders and De Long.

(Plate X, Figs. 1, 1a, 1b; Plate XXII, Fig. 4)

Sanders and De Long, Anns. Ent. Soc. Amer., XII, p. 223, 1919.

D. *productus* Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 77, 1898.

Coloration and general appearance of *bilineatus* and *marginatus* but with more sharply angled head and distinct genital characters. Length 3 to 3.5 mm.

Vertex well produced and sharply angled, apex pointed, as long as pronotum, about one-fourth longer on middle than width between the eyes. Pronotum strongly arcuate in front, about twice as wide as long. Elytra moderately long, well rounded posteriorly, central anteapical cell strongly constricted at middle.

Color: Vertex creamy white with two broad tawny bands extending from base to apex, where they converge and form two black triangular spots, one either side of white tip, and extend over margin. Behind these in each band a "V" shaped black spot inclined inwardly. A narrow black curved line extends from eye around ocellus on margin toward apex. Pronotum whitish with four longitudinal tawny bands, one behind either eye, and the central two are the extensions of the bands on the vertex which continue across scutellum. Elytra tawny with costal, sutural and apical margins and veins white. A spot in inner apical cell, reflexed veinlets and posterior white margin black bordered. Face pale with dark markings. Beneath pale yellow.

Genitalia: Female last ventral segment about as long as preceding, lateral angles produced but somewhat rounded, posterior margin sinuately sloping to form broad shallow median notch slightly indented at center, either side of which is a large round black spot. Male valve short and broad with nearly truncate apex. Plates three times length of valve, gradually sloping to broad truncated apices; inner apical third black, white margined.

The female is described here for the first time.

For a number of years this species has been cited as *D. productus Walker* but will not answer the description any better than others of the *reflexus group*. Also since the species has been taken only rarely and in such small numbers it seems only probable that a more common species must have been captured at the time of Walker's description.

Specimens have been captured in Maine (Osborn), New Hampshire (Weed), Ohio (Sanders), New York (Osborn), and more abundantly in Pennsylvania (Sanders and De Long).

The food plant is not definitely known but the species is abundant on the herbaceous growth in open woodland areas of the climax forest type. It occurs in an association of short grasses, violets, etc., where the principal species of plants are *Sanicula canadensis* and *Luzula campestris,* and the secondary species are *Viola blanda, Prenanthes aetissima, Tiarella cordifolia,* and *Geranium maculatum.* It was collected in the same association with *Phlepsius particolor* and *incisus, Chlorotettix lusorius* and *balli.*

Type locality Pt. Matilda, Pa. Type in Sanders and De Long collection. Type and specimens examined from localities mentioned previously.

Deltocephalus productus (Walker).

Jassus productus, Walker, List. Homop. III, p. 891, 1851.

The following is the original description: "Palo yellow, head and chest flat, slightly streaked with buff; head conical; crown a little longer than broad, concave along the hind border, with a very slender, longitudinal ridge, with a pale red stripe on each side and two black dots on the fore border; underneath black with slender, slightly curved yellow bands on each side, and with a yellow dot in the disk; shield convex in front, almost straight along the hind border, scutcheon small with a straight suture across the middle; breast almost buff; abdomen buff, partly pitchy; back toward the tip, yellow with brown streaks on each side; valves of the oviduct with buff dots; legs buff, with brown marks; fore wings buff, paler along the fore border, with some white marks on the border toward the tips; veins partly bordered with brown; two brown spots on each disk, and one at the tip; hind wings colorless. Length of body 1½ lines; of the wings 2½ lines."

At the present time this species cannot be definitely placed, for the description will fit any one of a number of closely related species.

An attempt was made by Professor J. G. Sanders and the author to obtain the exact identity of this species. In order to accomplish this, specimens of many of the closely related eastern species were sent to Dr. Distant, before his death, for comparison at the British Museum. He replied that time was not available for this work and the species has stood as a "nomen nudum."

During January, 1924, Dr. T. J. Naude made comparisons for the author at the British Museum and has forwarded a camera lucida drawing of the female genitalia. Dr. Naude states, "Superficially it appears to me identical with specimens of *sandersi* and *pictus*." He furthermore states that the posterior angle of the last segment in *productus* is sharper than in either of these species. Dr. Naude did not have specimens of *visendus* for comparison and it is the only species resembling *pictus* and *sandersi* that is found in Florida, according to known records. Furthermore it differs from these two species essentially in the characters as stated by Dr. Naude. It is therefore quite probable that future work will show *productus* to be the species now known as *visendus*.

Type locality St. John's Bluff, Florida. Type in British Museum.

Deltocephalus marginatus De Long.

(Plate X, Fig. 2, 2a; Plate XXII, Fig. 5)

De Long, Ohio Jour. Sci. 18, p. 228, 1918.

Resembling *bilineatus* in form and coloration, but with vertex flat and more produced, paler in coloration and with elytra longer and more flaring. Length 4 mm.

Vertex bluntly produced, flat, as long at middle as width between eyes. As long as pronotum. Elytra long, rather narrow, inclined to be flaring in all specimens examined.

Color: Creamy white with orange, testaceous and fuscous markings. Vertex white with two pale testaceous bands arising near apex and extending across pronotum to middle of scutellum where they end in two black spots on the disc. Each is bordered interiorly on the vertex by a fuscous line broken into spots which converge at the apex, and partially bordered exteriorly by fuscous spots. A black transverse band extends across the margin of the vertex and recurves on to vertex at each end along the eyes. Pronotum with four longitudinal testaceous bands. Elytra pale testaceous almost orange, nervures white, heavily margined with fuscous along claval margin and on apical portion. The reflexed veinlets, posterior margin, and inner apical cell heavily marked. Face and beneath pale yellow.

Genitalia: Female, last ventral segment longer than preceding lateral angles produced, well angled, posterior margin sloping to a rather broad, shallow "U" shaped notch slightly incised at center. On each side of the notch is a large oval black spot. The male is not known.

In many respects this species is very close to *bilineatus* and it may be possible that the male will present a good specific character in the genitalia. However the more produced vertex and the long flaring elytra will readily separate this species from both sexes of *bilineatus*.

A number of specimens were collected in Wisconsin (Sanders and De Long) in swamp and marsh areas and were found in a habitat of tall sedges and swamp grasses. It has since been found in North Dakota and one specimen at hand from Orono, Maine (Osborn) is typical. These records although scattered indicate a northern range and it will no doubt be found at intermediate points.

Type locality Amery, Wisconsin. Type in author's collection.

Deltocephalus bilineatus Gillette and Baker.

(Plate X, Figs. 4, 4a, 4b; Plate XXII, Fig. 6)

Gillette and Baker, Hemip. Colo., p. 85, 1895.

With two fuscous bands across head and pronotum, margined with darker brown on anterior portion of vertex. Length 3.2 to 4 mm.

Vertex blunt, conical, rounded and sloping to front, a little wider between eyes than length at middle. Pronotum longer than vertex. Elytra rather long, well rounded posteriorly, distinctly overlapping at apex.

Color: Dull white to gray with fuscous markings. Vertex with a pale fuscous stripe either side of apex extending across vertex, pronotum, and on to scutellum. This is margined on the anterior portion of vertex on both inner and outer edges with dark brown, varied in intensity. The median impressed line and a line on margin between eyes brown. Pronotum with an additional fuscous stripe behind each eye. Scutellum with a pair of spots on disc, basal angles and apical third brown. Elytra pale gray, nervures pale, heavily margined with fuscous. The elytra appear to be banded by pale interruptions on clavus, extending across anterior portion to costa and a pale band across anterior portion of antcapical cells. Face yellow, sutures faintly darker. Beneath yellowish, marked with fuscous.

Genitalia: Female last ventral segment more than one-half longer than preceding; lateral angles produced and rounding, posterior margin concavely rounded to a central "V" shaped notch, either side of which is a large black spot. Male valve triangular, as long as last ventral segment. Plates exceeding valve by twice its length, broad at base, gradually sloping to broadly rounded ,almost truncated tips, half as broad as at base. The inner apical half dark fuscous.

This species was described from Colorado and has since been reported for Iowa. A single male specimen from Orono, Maine (Osborn) is exactly like the Colorado specimens. According to Osborn and Ball, the Iowa specimens were taken in July from the undergrowth in a woody pasture in the habitat with *Scaphoideus jucundus*. Nothing further has been reported regarding its food plant.

Type locality Steamboat Springs, Colorado. Type in Agr. College collection, Ft. Collins, Colorado. Colorado specimens examined (Ball collection).

Deltocephalus luteocephalus Sanders and De Long.

(Plate X, Figs. 5, 5a, 5b; Plate XXII, Fig. 2)

Sanders and De Long, Ann. Ent. Soc. Amer., X, p. 84, 1917.

Closely related to *paludosus* but with elytra much more distinctly marked and with genital characters distinct. Length 3.5 to 4 mm.

Vertex convexly produced, pointed, a little wider between eyes than length at middle. Pronotum slightly longer than vertex, with distinct side margins and slightly indented posterior margin. Elytra long and rather narrow, distinctly exceeding abdomen, venation distinct, costal nervures reflexed. Face rather broad, front convex.

Color: Vertex white to pale yellow, ocelli orange red and a median black suture on basal two-thirds. Anterior margin of pronotum ivory white, darker posteriorly. Scutellum yellow. Face immaculate, pale yellow, antennal pits black. Elytra smoky subhyaline, claval, discal, and apical cells darker. Costal reflexed veins and apical margin heavily bordered with fuscous. Nervures conspicuously pale, narrowly margined with fuscous. Beneath pale.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles produced and angled, posterior margin slightly concavely excavated to a broad median "U" shaped notch which has a slight incision at the center. A black spot either side of notch. Male valve as long as preceding segment, broadly rounded. Plates large, exceeding valve by twice its length, gradually narrowed to bluntly rounded apices, each with a large brown spot near tip. Pygofers greatly exceeding plates.

Very few records for distribution are available at this time. In addition to the type specimens (Wisconsin) the only other known was taken at Brookings, S. D. in July (Severin). The Wisconsin specimens were taken from swamp vegetation. No specific food plant is known and nothing regarding the life history.

Type locality Madison, Wisconsin. Type in Sanders and De Long collection. Type and specimens from Brookings, S. D. (Severin) examined.

Deltocephalus paludosus Ball.

(Plate X, Figs. 3, 3a, 3b; Plate XXII, Fig. 7)

Ball, Can. Ent. XXXI, p. 307, 1899.

Although having very slight color markings, it is closely related structurally to *luteocephalus* and belongs to the *bilineatus* group. Length 3.5 to 4 mm.

Vertex bluntly angled, the margins rounded, apex subconical, a little wider between eyes than length at middle, shorter than pronotum which is strongly convex anteriorly and twice wider than long. Elytra longer than abdomen in female, decidedly longer in the male, costal veins reflexed.

Color: Female pale lemon yellow,the eyes darker, spots in apicals cells fuscous and often a spot in anal cell and a fuscous line around the apex. Male greenish yellow, the face and vertex sometimes orange, eyes and a spot in each apical cell fuscous. Beneath yellow, sometimes washed with orange.

Genitalia: Female last ventral segment a little longer than preceding, lateral angles produced, between which the posterior margin is gently sloping to a median triangular notch either side of which is a broad black spot. Male valve triangular, apex rounded, one-half longer than last ventral segment. Plates as broad at base as last ventral segment, gradually narrowed to broad, almost truncate, apices. The apices of plates are slightly concaved between outer and inner margins and bear a fuscous spot on the inner tip and a black spot before this on either side.

A large number of specimens have been taken in Colorado at different localities but it has not been reported from any other state. According to Dr. Ball the food plant is *Carex* sp. but nothing further has been learned concerning the habitat or life history.

Type locality Ft. Collins, Colorado. Type in Ball collection. Type examined.

SUBGENUS POLYAMIA

Vertex rather short, bluntly angled, disc slightly convex or sloping forward, and thickly, rather bluntly angled with front. Elytra with outer clavus strongly reticulate veined, central anteapical cell constricted and divided.

Type of subgenus *weedi* Van Duzee.

The species belonging to this group usually have a strongly reticulate outer clavus and are conspicuously marked with black or fuscous. The genital characters are quite similar and the underlying membrane is frequently present in the female.

Key to Species of Polyamia*

1. Less than 4 mm. in length 2
   Length 4 mm. or more 13
2. Vertex more pointed, bluntly angled, disc more flattened, length on middle usually equaling or more than width between eyes 3
   Vertex more bluntly angled, disc more sloping, usually wider between eyes than length at middle 7
3. Female segment rounded off at lateral margins exposing underlying plates, produced at middle into a central blunt tooth. Male plates very narrow, short, and blunt. . *micarius*
   Female segment not produced into a central tooth, male plates broader and longer 4
4. Rather large and robust, female segment convexly rounded and rather narrow exposing large lobes of underlying membrane; male plates rather long, concavely rounded to acute tips ..... *interruptus*

* Not including *D. limicolus* and *fusconotatus* described since this manuscript was completed. Descriptions of these are appended at end of systematic portion.

Shorter and more narrowed; female segment not exposing underlying membrane if present 5

5. Female segment almost truncate or slightly concave, not forming conspicuous lobes..... 6
Female segment twice roundingly excavated, forming three rather large almost equal lobes; male plates very long, concavely tapering to black tips. Vertex and elytra conspicuously colored ..... *arundineus*

6. Posterior margin of female segment evenly, shallowly, concavely rounded and brown bordered. Male plates short and broad, each as broad as long, convexly rounded to blunt tips..... *weedi*
Posterior margin truncated, broadly and strongly keeled on median third and slightly notched at middle. Male plates rather long, concavely produced to blunt tips... *texanus*

7. Elytra with veins usually heavily margined with dark fuscous or brown. If uniform greenish, with elytra decidedly infuscated..... 8
Elytra yellowish subhyaline, veins rather conspicuous but not margined with brown or fuscous 12

8. Vertex bluntly pointed, uniform bright green, elytral nervures infuscated. Female segment trilobate with distinct notches between lobes. Male plates short and narrow, concavely rounded to blunt tips..... *viridis*
Not uniform green, or with dark markings in form of spots or bands on vertex..... 9

9. Vertex blunt with an interrupted dark band between anterior margins of the eyes and a row of spots above margin. Elytra grayish, veins fuscous margined..... 10
Vertex yellowish, usually unmarked, elytra uniformly dark brown to apical cells, which are light yellow. Female segment strongly convex, side margins of underlying membrane conspicuous ..... *apicatus*

10. Length 3 mm. or more; elytra usually longer than abdomen, female segment seemingly abruptly produced from preceding segment and convexly rounded, exposing side plates. Male plates short, concavely narrow and bluntly pointed..... *obtectus*
Length usually less than 2.75 mm., short and compact, elytra usually as short as abdomen 11

11. Length about 2.75 mm., female segment strongly convexly rounded, side plates of underlying membrane rounded. Male plates long, tapering, not exceeding pygofers.. *compactus*
Length less than 2.75 mm., female segment sloping on sides to almost truncated, posterior margin, which is produced into three minute pointed lobes. Visible portions of side plates more angled. Male plates very long and with narrow tips which exceed pygofers ..... *satur*

12. Vertex with a pair of black spots at tip running over onto face and a pair of black dashes between anterior margin of eyes. Female segment strongly convexly rounded, exposing side plates. Male plates long, concavely narrowed and bluntly pointed ..... *caperatus*
Vertex appearing rounded, with a row of five black spots above margin and a heavy black band below. Elytra very short, exposing last three dorsal segments. Female segment with a square blunt tooth in concavity. Male plates long, concavely pointed, tips black..... *decisus*

13. Grayish to white, with a pair of black spots on vertex, pronotum and scutellum. Elytra with black spots and veins fuscous margined. Male plates rather short, concavely narrowed to pointed tips..... *inimicus*
Dull uniform smoky brown in color, male plates very long, concavely tapering to pointed tips ..... *funidus*

Deltocephalus micarius Ball.

(Plate XI, Figs. 3, 3a, 3b; Plate XXII, Fig. 9)

Ball, Can. Ent., XLIII, p. 203, 1911.

In general appearance closely resembling *weedi* but larger, with more produced head, longer elytra, and distinct genitalia. Length 3.5 mm.

Vertex right-angled, almost twice as long at apex as against the eye, longer on middle than width between eyes and as long as pronotum, which is strongly arcuate in front and with side margins almost obsolete. Elytra long, often flaring.

Color: Pale brownish yellow, the vertex mottled with orange, with margins and areas on posterior portion light. The reflexed arcs of face, the ocelli, a pair of spots just back of ivory apex and one either side midway to ocellus, black. Pronotum olive with five narrow light longitudinal stripes. Elytra with light nervures margined with brown and fuscous, the cells often washed with dull orange. Face brown with pale arcs.

Genitalia: Female last ventral segment a little longer than preceding, the lateral angles broadly rounded to posterior margin, which is slightly concave either side of a broad median tooth. Lateral lobes prominent at sides of segment. Male valve short, only half the width of preceding segment, plates as wide as valve, as long as last ventral segment, gradually narrowed to rather broad, blunt apices.

This beautifully marked species is distinct and seems to be typically southern in distribution. It has been found in Florida, North Carolina, South Carolina, and Mississippi, and perhaps will not be found farther north. It has been collected by the author in the Florida prairies and more abundantly in the dry areas where the water was receding in the everglades. It was taken abundantly as nymph and adult in the same habitat with *D. slossoni* at Paradise Key from a thick growth of *Distichlis spicata, Dichromena floridensis, and Rynchospora divergens.* It also occurs in some places on grasses in pineland but is not so abundant.

Type localities Seven Oaks and Sanford, Florida. Type in Ball collection. Type examined, also specimens from Florida, Mississippi, Georgia, North Carolina, and South Carolina.

Deltocephalus interruptus De Long.

(Plate XI, Figs. 6, 6a, 6b; Plate XXIII, Fig. 5)

De Long, Tenn. St. Bd. Ent. Bul., 17, p. 51, 1916.

In general appearance and coloration closely resembling *weedi* but larger, more robust, with darker markings and distinct genital characters. Length 3.5 to 3.7 mm.

Vertex broadly but rather sharply angled, slightly longer at middle than basal width between eyes. Pronotum longer than vertex and twice wider than long. Broader than entire width of head. Elytra broad, exceeding abdomen in length.

Color: Dull yellowish to brownish testaceous with black and fuscous markings. Vertex with two large spots at apex, sometimes joined with reflexed coloration of the face, a smaller spot either side between these and eyes, and an irregular transverse band, broadest at middle, between anterior margins of eyes, black or dark brown. Face black, with traces of a median line and six pairs of arcs, light. Pronotum with some dark brown spots on anterior portion and six more or less conspicuous brown longitudinal bands. Elytra testaceous, nervures white, heavily and irregularly bordered with fuscous.

Genitalia: Female last ventral segment strongly convexly produced on median two-thirds from near its base, rounded lateral lobes conspicuous at sides and produced beyond last ventral segment. Male valve rather short and narrow, almost transverse, slightly angled at middle. Plates more than twice as long as valve, strongly concavely narrowed to long acute apices. Pygofers inflated at either side.

Although rather recently described from Tennessee this species is quite widely distributed and apparently has been confused with *weedi* which it resembles very closely in general appearance and coloration. It has been found extending almost to the Gulf coast, also along the Atlantic from North Carolina to Massachusetts and Connecticut and specimens have been examined from Cranberry Lake, N. Y. (Osborn), Pa., Ohio, Md., D. C., and Virginia and it will no doubt be found in other localities.

It is found on tall bunch grasses along stream margins in southern Pennsylvania and a few specimens have been taken from short grasses in the hemlock forests of northern Pennsylvania. The life history has not been worked out to date.

Type locality Colliersville, Tennessee. Type in author's collection.

Deltocephalus weedi Van Duzee.

(Plate XI, Figs. 5, 5a, 5b; Plate XXIII, Fig. 6)

Van Duzee, Trans. Am. Ent. Soc., XIX, p. 306, 1892.

A common grass species, variously mottled and with a bluntly produced vertex. Length 3 mm.

Vertex bluntly angled, as long as width between eyes at base, shorter than pronotum which is twice as wide as long. Elytra rather broad and covering abdomen.

Color: Dull dirty yellow marked with black and fuscous. Vertex with four large black spots, the central two triangular, just above vertex, and an irregular brown band between anterior margins of the eyes, also some vague markings at the base. Pronotum marked with irregular brownish areas and with faint indications of longitudinal bands. Scutellum with a large brown spot in each basal angle and at apex. Elytra pale brown, nervures white, heavily irrorate with fuscous; cells usually dark in color. Face brown with traces of several pale arcs. Beneath dark, last ventral segment lighter, posterior margin dark.

Genitalia: Female last ventral segment a little longer than preceding, lateral angles produced, between which the posterior margin is rather evenly and strongly concaved. Male valve lying in concavity of last ventral segment, posterior margin almost straight, slightly angled at middle. Plates short and broad, about one-third longer than valve, triangular, apices bluntly angled.

This is one of the most common of the southern pasture and meadow species. It has a rather widely known distribution and is found throughout the southeastern United States. It occurs along the coast from Florida to Connecticut, and from the Gulf to the Great Lakes and westward beyond the Mississippi valley, having been found commonly in Kansas and Iowa.

In Florida it was collected abundantly both as nymph and adult from *Cenchrus gracillimus* Nash, in young stands of *Pinus palustris*. In other localities it has been collected from grasses in meadow habitats and apparently has a variety of food plants.

Nothing definite is known regarding its life cycle but from field observations it apparently has two or more generations.

Type locality "Mississippi." Type in Agr. College collection, Ames, Iowa. Specimens examined from almost every state in the eastern United States.

Deltocephalus texanus n. sp.

(Plate XI, Figs. 7, 7a, 7b; Plate XXIII, Fig. 3)

In general appearance resembling *weedi* and *obtectus*, somewhat intermediate in form and with distinct genital characters. Length 2.5 to 3 mm.

Vertex bluntly pointed, a little longer on middle than width between eyes at base but shorter than pronotum, which is twice wider than long. Elytra rather short, just covering the abdomen in female, distinctly longer than abdomen in male. Clavus strongly recticulate, central anteapical cell constricted and divided.

Color: Dirty white to gray washed with yellow and marked with fuscous. Color pattern very similar to *obtectus*. Vertex with reflexed arcs from front, four spots between ocelli above margin, an interrupted band between anterior margins of eyes (often rather faint), and oblique dashes on base, fuscous. Pronotum with indefinite longitudinal banding, a series of dark spots just back of anterior margin. Scutellum with four spots along anterior margin, the outer pair the darker. Elytra pale gray, nervures light, fuscous margined. Claval, discal, and apical areas darkest. Face fuscous with pale arcs. Clypeus, lorae, and genae pale with fuscous markings.

Genitalia: Female last ventral segment twice as long as preceding, side margins sloping inward to almost truncate posterior margin, which is broadly shallowly notched at middle and brown margined. Segment strongly and broadly keeled, forming a ventrally produced portion extending from posterior margin to base of segment. Male valve obtusely angled, twice wider than long. Plates one and one-half times longer than valve, concavely narrowed to rather blunt tips. Pygofers conspicuous at sides. A brown elongate spot at base of each plate.

Described from a series of twenty specimens from Brownsville, Texas, collected by Professor Herbert Osborn.

Type in Osborn collection.

Deltocephalus obtectus Osborn and Ball.

(Plate XII, Figs. 1, 1a, 1b; Plate XXIII, Fig. 9)

Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 78, 1898.

Closely resembling *weedi* in form and coloration but lighter in color, and genitalia distinct. Length 3 to 3.5 mm.

Vertex bluntly angled, almost one-fourth wider between eyes than length at middle. Pronotum one-fourth longer than vertex and not quite twice as wide as long. Elytra rather narrow, exceeding the abdomen in length.

Color: Dirty white or grayish, marked with black and fuscous. Vertex with reflexed arcs of face, a pair of spots just back of apex, another either side midway to eye, an irregular interrupted band, broadest at middle, between anterior margins of the eyes, and an indefinite spot either side behind this, black or fuscous. Pronotum with black spots on anterior margin and disc irregularly marked with olive. Scutellum with a large black spot in each basal angle. Elytra with nervures broadly whitish, the cells darker and the nervures margined with fuscous.

Genitalia: Female last ventral segment seemingly arising abruptly from the preceding segment, not touching the pleural pieces and produced more than twice its length to an almost

truncated posterior margin. Underlying membrane having long lateral plates with rounded outer margins, the central portion of membrane covered by the last ventral segment. Male valve large, triangular, more than twice length of preceding segment, plates longer than valve, broad at base, concavely and strongly narrowed to produced, attenuated tips which are much shorter than pygofers.

It is rather widely distributed over the eastern United States having been collected from Florida to Maine and westward to Iowa, Kansas, and Missouri. It occurs on rather dry, well-drained pasture areas, apparently feeding on blue grass in the North and Professor Osborn reports it from Bermuda grass in the South. Both nymphs and adults have been taken abundantly on these short pasture grasses.

The last instar nymphs and adults were collected in late June and again in August in northern Pennsylvania and it seems quite certain that two generations are found at this locality. No detailed life history work has been done.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes and specimens from a great variety of localities examined.

Deltocephalus compactus Osborn and Ball.

(Plate XII, Figs. 3, 3a, 3b; Plate XXIII, Fig. 8)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 217, 1897.

Very similar to *obtectus* in form and coloration, but vertex shorter, elytra much shorter and with distinct genital characters. Length 2.75 mm.

Vertex bluntly angled, one-fourth broader between eyes than length at middle. Pronotum a little longer than vertex, twice wider than long, scutellum quite small. Elytra short and broad, not covering tip of abdomen in female, longer than abdomen in male.

Color: Vertex yellowish, marked very similarly to *obtectus* with the recurved arcs of face, the four spots behind margin and the broken transverse band between anterior margins of eyes, fuscous. Pronotum irregularly marked with brown. Elytra gray to fuscous, the nervures broadly white, cells heavily margined with fuscous.

Genitalia: Female last ventral segment very short at lateral margins, then strongly roundingly produced on median two-thirds, forming a slightly three lobed posterior margin. Underlying membrane deeply circularly emarginate behind, visible only as acute lateral angles at the sides of the last ventral segment. Male valve about as long as last ventral segment, rounded posteriorly, plates broad at base, rapidly concavely narrowing and produced, almost three times length of valve to long attenuated tips which exceed the pygofers.

From the locality records at hand this species would seem to have a rather wide distribution. It has been reported from Washington and from New York. It occurs in the Atlantic coastal states from New York to Georgia and has been found in the Gulf states, the Mississippi and Ohio valleys and as far north as Wisconsin. In Iowa and Kansas it is reported as a prairie species occurring on

Sporobolus hookeri and probably having two seasonal generations. It has been collected in Wisconsin, Tennessee, and Pennsylvania in a dry, prairie type of habitat.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes and specimens examined from many localities.

Deltocephalus satur Ball.

(Plate XII, Figs. 2, 2a, 2b; Plate XXIV, Figs. 1, 2)

Ball, Can. Ent., XXXI, p. 309, 1899.

In general appearance and coloration resembling *compactus* but smaller with a shorter vertex and distinct genitalia. Length 2 to 2.5 mm.

Vertex as wide as long, sides of head somewhat rounded to obtuse apex. Pronotum longer than vertex and twice as wide as long. In macropterous form elytra a little longer than abdomen in both sexes. Venation as in *compactus*, clavus reticulate. In brachypterous form elytra short, obliquely truncate, exposing the ultimate and most of the penultimate dorsal segments, apical cells minute.

Color: Vertex brownish, a broad pale band between ocelli, including a pair of triangular spots next apex and a small one close to each ocellus, posterior margin pale forming a somewhat interrupted dark band across between anterior margins of the eyes. Pronotum olive brown with a submarginal row of fuscous spots. Scutellum with basal spots fuscous. Elytra with nervures white, irregularly narrowly margined with fuscous. A spot on the center of costa, the inner anteapical cell and the second apical, fuscous or black.

Genitalia: Female last ventral segment about as long as preceding, lateral margins very short, then sloping to posterior margin, which is slightly emarginate and bearing a short broad median tooth at apex. The second membrane is visible at the sides as acutely angled lateral lobes. Male valve short, broadly rounded, plates broad at base, concavely, attenuately pointed, two and one-half times longer than valve, equalling the pygofers.

In general appearance, especially the macropterous forms, this species cannot be distinguished from *compactus* but the genitalia will readily separate it.

Specimens have been examined from Colorado (Ball), Texas (Osborn), and South Dakota (Severin) and no other records for distribution are known. The food plant and habitat data have not been reported if known at the present time.

Type locality Holly, Colorado. Type in Ball collection. Type and specimens from Ft. Pierre, S. D. (Severin) and Brownsville, Texas (Osborn) have been examined.

Deltocephalus apicatus Osborn.

(Plate XI, Figs. 8, 8a, 8b; Plate XXII, Fig. 8)

Osborn, Can. Ent., XXXII, p. 285, 1900.

Closely related to *obtectus* structurally but very different in coloration. Head, pronotum, and tip of elytra yellowish, the remainder of elytra reddish brown. Length 3 mm.

Vertex bluntly angled, as long on middle as width between the eyes. Pronotum a little longer than vertex, more than twice as wide as long. Elytra rather long, covering tip of abdomen or often short with apical areoles abbreviated.

Color: Vertex, face, and anterior portion of pronotum yellow, often the face is slightly darker and marked with faint pale arcs. Posterior portion of pronotum shading to brown. Scutellum and elytra to apical transverse veins, reddish brown, the nervures yellowish, apical cells yellowish hyaline. Beneath sordid yellow, sometimes marked with fuscous.

Genitalia: Female last ventral segment very short at each side, then abruptly produced and semicircularly rounded, margin bisinuate and with a brown spot either side of middle, giving it a trilobate appearance. Underlying membrane deeply concavely rounded as in *compactus*, the only visible portion being the outer rounded lateral angles, which are exposed by the last ventral segment. Male valve longer than preceding segment, angularly produced and rounded, plates more than twice as long as valve, broad at base, concavely rounded to narrow tips, produced almost to length of pygofers.

As a rule the coloration alone will easily separate this species from those closely allied.

It is found over a rather large area including the Atlantic coastal states from Maine to North Carolina, westward to Wisconsin and south to Tennessee and Mississippi. Although not definitely reported from all intervening states it will no doubt be found when sufficient collecting is done.

It has been taken abundantly on Presque Isle at Erie, Pennsylvania and was found both as nymph and adult on *Panicum villosissimum* which occurs in isolated patches on the sand plain. During the day the heat here is intense and the species may be limited in its northern range to this type of habitat. Nymphs of the last three instars and a great number of adults were found on August 25. In addition to this generation there may be an earlier one in June as in the case of closely related species.

Type localities, Hyattsville, Md., and Woodstock, Vt. Type in Osborn collection. Type examined, also specimens from many localities in the eastern United States.

Deltocephalus apicatus var. **alboneura** De Long.

Deltocephalus alboneura De L., Ohio Jour. Sci., XVIII, 7, p. 237, 1918.

Differing from typical *apicatus* by a more pointed vertex and distinct coloration. Length 2 to 2.5 mm.

Vertex more strongly produced, at least one-fourth longer on middle than width between eyes and more sharply angled. Body more narrowed and elongate than in *apicatus*. Elytra in female exceeding abdomen. In male very short, exposing the three large posterior segments and the anal tube. Apical cells very minute, anteapicals decidedly shortened.

Color: Vertex pale yellow with ocelli and four quadrate spots above margin black. A pair of transverse dashes between anterior margins of eyes and a pair of oblique dashes either side, behind these, black or dark fuscous. Pronotum black with five yellowish longitudinal stripes. Scutellum and elytra black. Veins pale yellow. Face yellowish, with a few dusky markings. Venter black or dark fuscous.

Genitalia: Female segment agreeing with typical *apicatus*. Male plates slightly more pointed.

Although previously given specific rank it seems best to in-

clude this as a varietal form of *apicatus* in spite of the more produced head character. It is known from Tennessee and Mississippi and the specimens from these localities agree very well.

Deltocephalus viridis Osborn.

(Plate XIII, Figs. 8, 8a, 8b; Plate XXIV, Fig. 4)

Osborn, Ohio Jour. Sci., XX, p. 164, 1920.

A light green species with bluntly angled vertex, and many small cross veinlets in elytra. Length 2.5 to 3 mm.

Vertex about one-fifth wider than long, bluntly angled. Pronotum shorter than vertex, and more than twice as wide as long. Elytra in brachypterous form exposing only two last dorsal segments. Apical and discal cells decidedly shortened. In macropterous forms the elytra exceed the abdomen and are normal *Deltocephalus* in venation.

Color: Light green, vertex marked with faint dusky areas, especially just above margin. Elytra greenish, nervures bordered with fuscous.

Genitalia: Female last ventral segment one-half longer than preceding, side margins short, concavely rounded to trilobate, posterior margin formed by a notch either side of middle. The lobes of underlying membrane are exposed at either side. Male valve short, scarcely angled. Plates rather broad at base, concavely narrowed to narrow blunt acuminate tips. Exceeded in length by pygofers.

In genital and other structural characters this species shows decided relationship to the reticulate clavus group and perhaps is most closely related to *apicatus*.

Known only by specimens of the type series collected in Texas by Professor Herbert Osborn. According to the original description they were taken from a dense turf of fine grass growing at the bottom of the resaca at Brownsville.

Type locality Brownsville, Texas. Type in Osborn collection which has been examined.

Deltocephalus caperatus Ball.

(Plate XII, Figs. 5, 5a, 5b; Plate XXIV, Fig. 3)

Ball, Can. Ent., XXXII, p. 343, 1900.

Deltocephalus vinnulus, Crumb, Ann. Ent. Soc. Amer., VIII, p. 192, 1915.

In form resembling *weedi* but with a somewhat yellowish coloration with black markings on the vertex. Length 3 mm.

Vertex bluntly angled, about as long on middle as basal width between the eyes. Pronotum longer than vertex, the lateral margins rounded. Scutellum rather large. Elytra rather broad and well rounded at apex. Venation strong, outer clavus with very few reticulate veins.

Color: Vertex pale yellow, black markings from front extending on to vertex and forming a triangular spot on either side of apex, and a broken black band extending transversely across between anterior margins of eyes forms a white cross on the anterior portion; posterior part pale yellow. Pronotum and scutellum olive, without conspicuous markings. Elytra olive subhyaline, veins whitish, sometimes narrowly fuscous margined. Face black above with light arcs, lighter below. A dark band along the apex of the front and a stripe on the clypeus.

Genitalia: Female last ventral segment twice as long as preceding, lateral margins strongly emarginate from the base, lateral angles rounded to posterior margin which is bisinu-

ate, forming three lobes, the central one the smallest. A membrane as in *compactus* is visible at the lateral margins of the last ventral segment. Male valve triangular, rather narrow. Plates almost twice longer than valve, concavely narrowed and produced to gradually tapering acutely angled apices. Pygofers broadly visible on either side.

This species was described from female specimens from Colorado, Nebraska, and Iowa. By a comparison of typical specimens of *vinnulus* Crumb it is evident that the two so-called species are not distinct unless the male of *caperatus* should present some different character. The coloration and female genitalia are exactly the same in the different specimens. Adding the records for this species it would greatly extend the range of *caperatus* for it has been taken in Tennessee, Mississippi, Virginia, Pennsylvania, Connecticut, Maryland, District of Columbia, and in Florida and perhaps it will be found in many other states when thorough collecting has been done. In Tennessee and Ohio it has been taken in great abundance from *Andropogon virginicus* where a pure stand will often occur over large areas. In Virginia it was collected in a similar habitat but where the pine had invaded, leaving only small areas of Andropogon.

Type localities Ray, Colorado, Stratton, Nebraska, and Ames, Iowa. Type in Ball collection. Type examined and many specimens from various localities.

Deltocephalus decisus n. sp.

(Plate XII, Figs. 4, 4a, 4b; Plate XXIV, Fig. 5)

A rather short, broad, robust species with elytra not covering abdomen, a row of black spots on margin of vertex and distinct genital characters. Length 2.5 mm.

Vertex as long at middle as width between eyes, sides convexly rounded, very blunt and almost rounded at apex. Pronotum as long as vertex, very broad and transverse. Elytra short, exposing entire last two dorsal segments, apical cells extremely short, central anteapical cells constricted and usually divided.

Color: Straw yellow, vertex with a large transverse spot just above apex, sometimes divided into two separate spots, an elongated one either side along margin midway to eye and a smaller one next each eye, black. Margin milky white between this row of spots and a heavy black band at base of front extending between the eyes. Face fuscous with faint indication of pale arcs. Elytra brownish-yellow subhyaline, nervures paler. A black spot on last dorsal segment in either sex.

Genitalia: Female last ventral segment more than twice as long as preceding, lateral angles produced and rounded, posterior margin broadly and angularly excavated one-third distance to base and bearing a broad blunt tooth at the apex. Male valve twice longer than last ventral segment, obtusely rounded; plates exceeding valve by almost twice its length, broad at base, concavely narrowed and produced into long blunt processes, blackened on apical half.

Described from a series of specimens collected at La Belle, Florida, April 21, 1921, by the author. This species occurs on the

open prairies on short grasses and was found in a slight depression where there was a thicker mat of vegetation and apparently a moister condition.

Type in author's collection.

Deltocephalus arundineus Crumb.

(Plate XII, Figs. 6, 6a, 6b; Plate XXIV, Fig. 7)

Crumb, Ann. Ent. Soc. Amer., VIII, p. 191, 1915.

In coloration and general appearance it resembles *inimicus* and bears a cruciate band on the elytra similar to *Scaphoideus sanctus*. Length 3.5 mm.

Vertex bluntly produced, almost one-fourth longer on middle than width between eyes. Pronotum longer than vertex, twice as wide as long. Scutellum comparatively large. Elytra rather broad and broadly rounded at apex.

Color: Vertex creamy, with a triangular pair of spots near apex and one each side midway to eyes, black. A pair of large irregular spots forming a somewhat broken band between anterior margins of eyes, fuscous, and a pair of oblique dashes on base. Pronotum fuscous with five somewhat indistinct pale longitudinal bands, and an irregular darker spot behind either eye. Scutellum with a spot at apex and one in each basal angle. Elytra fuscous, nervures whitish, margined with fuscous, three conspicuous dark spots on each elytron. One on middle of clavus, another on middle of costal margin, and one covering outer apical cell. Between the two on costal margin is a large pale area, thus forming a fuscous cross on the posterior half. Face pale fuscous marked with heavy dark arcs.

Genitalia: Female last ventral segment three times as long as preceding, the posterior margin trilobate. The lateral angles are roundingly produced in definite lobes, between which is a broadly rounded somewhat shorter median lobe; each side of this is a distinct rounded notch. Male valve triangular, apex rounded, more than twice as long as preceding segment. Plates long, exceeding valve by more than twice its length, rather rapidly concavely narrowed and produced into long acute tips.

The only known records for this species are Tennessee (Crumb and De Long), Florida (Drake), North Carolina (Sherman), and Mississippi (Dozier). It is found on cane *(Arundinaria tecta)* and apparently its distribution in the Gulf region is controlled by the distribution of this plant. It should be found more widely distributed in the Gulf states than present records indicate.

The nymphs were taken in abundance during early July and again in August and these observations would indicate a two-generation life cycle.

Type locality Clarksville, Tennessee. Type in Crumb collection. Type examined, also specimens from states mentioned previously.

Deltocephalus inimicus (Say).

(Plate XII, Figs. 7, 7a, 7b; Plate XXIV, Fig. 8)

Jassus inimicus Say. Acad. Nat. Sci. Phila., VI, p. 305, 1831.
Jassus 6—punctatus Provancher, Nat. Can., IV, p. 378, 1872.

A grayish yellow species mottled with fuscous. Perhaps the most common *Deltocephalus* throughout North America and easily recognized by a pair of large black spots on vertex, pronotum, and scutellum. Length 4 mm.

Vertex bluntly angled, not strongly produced, more than one-fourth wider between eyes than length at middle. Pronotum one-fourth longer than vertex and twice wider than long. Elytra long, greatly surpassing abdomen.

Color: Dirty dull yellow, vertex with a pair of minute spots at apex and a large round one either side midway to eye, black. Some irregular markings on posterior portion fuscous. Pronotum with two large round black spots on anterior margin of pronotum and two in basal angles of scutellum. Elytra grayish, nervures broadly white, cells margined with fuscous. At times the color is almost faded out but the six black spots are usually present.

Genitalia: Female last ventral segment with lateral portions only visible, preceding segment very short at sides, then produced abruptly to posterior margin which is slightly trilobate. Male valve about two-thirds as long as preceding segment, obtusely angled, plates more than twice as long as valve, concavely narrowed to pointed tips.

This species is the most abundant and widely distributed in North America of all our Deltocephalus species and is able to subsist on a large variety of host plants. For many years it has been reported as occurring in abundance on wheat, alfalfa, timothy, clover, oats, rye, blue grass, and a variety of native grasses in various regions. It is common in the prairie, the meadow, and pasture, and is abundant in swampy and marshy places. Very few of these species are found under such a variety of conditions.

It is common from the Atlantic coast to the Pacific through the northern states and southern Canada and occurs as far south as the Gulf coast in the Mississippi valley. It has been recorded as far south as South Carolina along the Atlantic coast but perhaps is very rare in Florida and it has not been reported for that state at the present time. No records are available for the Southwest.

Two full generations are known and there may be a third or partial third in southern localities. There is no definite data to affirm this supposition.

Type locality "Virginia." Type probably lost. Since this is one of the two or three most common species of the group, thousands of specimens have been examined.

Deltocephalus fumidus Sanders and De Long.

(Plate XII, Figs. 8, 8a, 8b; Plate XXIV, Fig. 9)

Sanders and De Long, Ann. Ent. Soc. Amer., X, p. 86, 1917.

In general form resembling *inimicus* but slightly larger, without the claval cross veins and with a smoky brown iridescent color. Length 4.5 to 5 mm.

Vertex bluntly angled, a little wider between eyes than length at middle. Pronotum twice as wide as long and almost one-half longer than vertex, strongly convex anteriorly, side margins almost obsolete. Elytra long, considerably longer than abdomen.

Color: Smoky brown iridescent, vertex darker at apex, ocelli black encircled with white. Pronotum, scutellum, and elytra pale brown, nervures paler narrowly brown margined. Face smoky shading to lighter on clypeus. Abdomen beneath pale yellowish.

Genitalia: Female last ventral segment longer than preceding posterior margin truncated, slightly sinuated and infuscated either side of middle. Underlying membrane with prominent rounded lobes visible at sides of last ventral segment. Male valve shorter than preceding segment, rather narrow and inserted in the concavity of the last ventral segment; plates long, broad at base and concavely narrowed to pointed apices. A median brown spot on base of each plate.

Although lacking the reticulate veins of the clavus, in other characters this species seems to be allied to *inimicus*. Further study however may prove it to be more closely related to species of *Thamnotettix*. It is known only from Wisconsin at the present time and was collected from pasture grasses on a steep hillside among shrubby growth, along the Wisconsin River. The exact food plant is not known.

Type locality Woodman, Wisconsin. Type in Sanders and De Long collection.

SUBGENUS HEBECEPHALUS

Vertex bluntly angled, disc usually flattened, margin thickened and bluntly angled with front. Elytra usually rather long, central anteapical cell elongated, strongly constricted at middle, enlarged at either end and decidedly produced beyond the other anteapical cells.

Type of subgenus *signatifrons* Van Duzee.

In most species the color patterns are conspicuous and the veins of the elytra are heavily margined with fuscous. The vertex is usually marked with transverse spots. The species placed in this group are for the most part mountain meadow forms.

Key to Species of Hebecephalus

1. Vertex wider than long, bluntly angled or almost rounded..... 2
   Vertex as long as wide, sides convexly rounded, tip slightly conical..... 6

2. Female last ventral segment with a pair of approximate, large black pointed teeth arising from central concavity. Male plates (where known) blunt but elongate..... 3
   Female segment concave or with rounded lobes but without pointed teeth. Male plates short and very bluntly rounded..... 4

3. Length 3 mm. Female segment with lateral angles very strongly produced and rounded, deeply concavely excavated between, with a median lobe incised to form two heavy black teeth. Vertex with a pair of apical dots and two pairs of transverse dashes, brown ..... *callidus*
   Longer, more than 3 mm. Median teeth longer, incision between them deeper and broader at base. Male plates very long, broad, and blunt at tips..... *vinculatus*

4. Female segment with broadly rounded lateral angles, excavations usually on median third and quite abrupt, not evenly concavely rounded..... 5
   Female last ventral segment rather strongly concavely excavated from side margins. Male plates scarcely as long as valve, rounded..... *obesus*

5. Usually more than 3 mm. in length, vertex one-fourth wider than long. Female segment concavely rounded either side of a convexly rounded lobe, forming a rather deep, narrow, abrupt excavation at center. Male plates almost twice as long as valve, broad and almost truncate at tip.....*signatifrons*

Length less than 3 mm. and broader than *signatifrons*. Vertex only slightly wider than long, more sharply angled. Female segment with strongly rounded marginal lobes, median third abruptly rounded and almost truncate. Male plates twice as long as valve, convexly rounded to inner pointed apices.....*scxmaculatus*

6. Size 2.5 mm. or more, vertex marked with three pairs of irregular dark spots or blotches. Female segment almost truncate and sinuate. Male plates wedge shaped, truncate at tip.....*cruciatus*

Size smaller, not over 2 mm. in length, vertex strongly rounded to front and bulbous, two brownish longitudinal bands on vertex; female segment with prominent angles and a short lobe in central concavity.....*blandus*

Deltocephalus callidus Ball.

(Plate XIII ,Figs. 4, 4a; Plate XXV, Fig. 1)

Ball, Can. Ent., XXXI, p. 306, 1899.

Resembling *signatifrons* in general appearance and with similar coloration, but more robust and with distinct genital characters. Length 3 mm.

Vertex bluntly angled, about one-sixth wider between the eyes than the length at middle, a little shorter than pronotum which is twice wider than long and with very short lateral margins. Elytra equaling abdomen in length, rather broad.

Color: Pale creamy white, vertex with a small triangular spot either side of apex, an interrupted bar between anterior margins of the eyes, often with a spur running forward at outer ends, and a spot on either side at base, fuscous. Pronotum irregularly marked, elytra pale, nervures white, margined with fuscous which is somewhat banded. Beneath dark, face dark with pale arcs.

Genitalia: Female last ventral segment one-half longer than preceding. Lateral angles very prominent, acute, abruptly excavated to posterior margin, which is composed of a broad roundingly produced tooth triangularly notched at its apex. The tooth is black and the lateral angles are light in color.

The genital characters will readily separate this species. At present it is known only by the type specimens from Pullman, Washington, so its known distribution is very small. Extensive collecting may show a much wider range.

Type locality Pullman, Washington. Type in Ball collection. Type examined.

Deltocephalus vinculatus Ball.

(Plate XIII, Figs. 6, 6a, 6b; Plate XXV, Fig. 4)

Ball, Can. Ent., XXXI, p. 191, 1891.

Resembling *signatifrons* but broader and with darker and more distinct color markings, elytra with two distinct transverse brown bands. Length 3 to 3.5 mm.

Vertex bluntly produced, scarcely angled, one-fourth wider between eyes than length at middle. Pronotum one-fourth longer than vertex and twice as wide as long, the side margins prominent. The elytra exceeding abdomen and quite broad.

Color: Vertex irregularly marked, fuscous markings usually in form of three irregular transverse dashes on each side of median line. Always with anterior margin, a median stripe and a transverse bar before the middle, light. Pronotum with fuscous markings usually in

form of longitudinal bands. Elytra pale, nervures light, a broad band across the middle and another across apex of clavus and spots on outer apical cells, fuscous. Face and venter dark.

Genitalia: Female last ventral segment a little longer than preceding. Lateral angles produced and rounded, between which the posterior margin is roundingly excavated to a large acutely pointed black tooth which is cleft nearly to its base. The oblique plates are exposed either side of this. Male valve obtusely angled, one-half longer than preceding segment. Plates broad at base, two and one-half times as long as valve, gradually narrowed to bluntly rounded tips two-thirds as broad as base.

Although this species has been reported for widely separated localities, there are no records at present to show intermediate distribution. It occurs in the mountains of Colorado and a large series of specimens in the Osborn collection are from Nain, Labrador (L. M. Turner). It seems to have a distinctly northern distribution working into the United States only on high mountains and is no doubt abundant in many Canadian localities. According to Ball it is a mountain meadow species.

Type locality Ft. Collins, Colorado. Type in Ball collection. Type and specimens previously mentioned were examined.

Deltocephalus signatifrons Van Duzee.

(Plate XIII, Figs. 2, 2a, 2b; Plate XXV, Fig. 2)

Van Duzee, Trans. Am. Ent. Soc., XIX, p. 305, 1892.

A common western species, pale yellow to gray with fuscous markings on vertex and elytra. Length 3 to 3.5 mm.

Vertex bluntly, obtusely angled, almost one-third wider between eyes than length at middle. Pronotum one-third longer than vertex and twice as wide as long, side margins prominent, scutellum small. Elytra quite long, considerably longer than abdomen.

Color: Gray sometimes washed with yellow, vertex with ocelli, a pair of marginal dashes close to apex, a pair of large rectangular spots behind these with a spur extending to margin and a pair of large round ones on base, fuscous. Pronotum mottled, and with traces of five pale longitudinal lines. Elytra gray, nervures pale margined with fuscous, often appearing more or less banded by heavy fuscous markings in the cells. Beneath black.

Genitalia: Female last ventral segment longer than preceding, with lateral angles prominent and broadly rounded. The posterior margin is shallowly concavely rounded between these and a pair of large rounded median lobes, which are separated by a square notch extending almost half way to the base at the bottom of which a broad tooth is slightly produced. Male valve twice as long as preceding segment, bluntly angled. Plates about one-third longer than valve, broad at base, gradually narrowed to very broad, rounded apices.

The species is a western form and specimens have been examined from Colorado, Iowa, Kansas, Nebraska, Montana (Osborn), New Mexico (Ainslie), Wyoming, and Utah. It has also been reported from Tennessee and Maryland. The former citation was a mistake made by the author and the Maryland record is no doubt an error.

According to Osborn and Ball it occurs abundantly in weedy areas along roadsides and apparently lives in the *Setaria-Panicum*

association. From collecting records there seem to be two seasonal generations, the first in May and June, the second in July and August.

Type locality "Colorado." Type in Agr. College collection, Ames, Iowa. Specimens examined from above mentioned localities.

Deltocephalus signatifrons var. **crassus** n. var.

(Plate XIII, Figs. 3, 3a, 3b; Plate XXV, Fig. 3)

Resembling *signatifrons* but more robust with darker coloration in the form of transverse bands, and genitalia a little different.

Vertex bluntly angled, about one-fourth wider between eyes than length at middle. Elytra rather short, broadly rounded at apex, only slightly longer than abdomen.

Color: Vertex pale with the two spots at apex and the two pairs of transverse markings between eyes. Elytra marked similarly to *vinculatus* with two rather definite dark fuscous transverse bands, one before middle and the other across apex.

Genitalia: Female segment more than twice as long as preceding. Posterior margin with the four lobes as in *signatifrons*, formed by the incision at center and concavity each side. In the specimens at hand the lobes are more prominent, the concavity on each side is much deeper, the central incision is deeper, and the median lobes are more pointedly produced and closer together. The last ventral segment is proportionately much longer also. The male plates are slightly longer and more obliquely cut off in this case while in *signatifrons* they are blunt and broadly rounded.

Described from a series of specimens in the collection of Professor Herbert Osborn which he collected at Yellowstone Park, Wyoming. It may be possible that these are specifically different but in order to determine this, more must be known about food plants and habitats in addition to an examination of secondary genital characters.

Deltocephalus sexmaculatus Gillette and Baker.

(Plate XIII, Figs. 5, 5a, 5b; Plate XXV, Fig. 5)

Gillette and Baker, Hemip. Colo., p. 88, 1895.

In general appearance resembling the *signatifrons* group but with different color markings and distinct genital characters. Length 2 to 2.5 mm.

Vertex bluntly angled, a little broader between eyes than length at middle, slightly longer than pronotum, which is broad with short lateral margins. Scutellum very small, elytra longer than abdomen.

Color: Pale creamy white, often washed with yellow. Vertex with six black or fuscous spots, a triangular pair near apex, a triangular spot just back of either ocellus and a large oval spot at base on either side. Pronotum with anterior margin more yellowish, scutellum with a fuscous spot on either side of apex. Elytra with nervures white, rather heavily marked with fuscous. Face black with pale arcs, venter dark.

Genitalia: Female last ventral segment twice as long as preceding, lateral angles rounded to posterior margin, which is abruptly rectangularly excavated on the median third about one-fifth the distance to base. The inner angles each contain a black spot which gives the appearance of a median sunken lobe with a produced broadly rounding one on either side. Male

valve rather narrow, roundingly produced three times the length of preceding segment. Plates exceeding valve by one and one-half times its length, convexly rounded to near tips, then sloping to acute apices.

This species has been collected in a number of localities in Colorado but is not known to occur outside of that state. Nothing has been reported in regard to its food plant, but according to Ball it is a mountain meadow species.

Type locality Leadville, Colorado. Type in Colorado Agr. College collection. Colorado specimens in Ball collection examined.

Deltocephalus obesus Osborn and Ball.

(Plate XIII, Figs. 7, 7a; Plate XXV, Fig. 9)

Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 81, 1898.

In general appearance and coloration resembling *signatifrons* but with shorter vertex and an additional row of black spots above margin. Length 2.25 to 2.75 mm.

Vertex short and broad, about one-fourth wider between eyes than length at middle, tip blunt and rounded; pronotum one-fourth longer than vertex and twice as broad as long. In brachypterous forms the elytra are short, not quite covering the fifth abdominal segment, obliquely truncate from apex of clavus. In macropterous forms the elytra are slightly longer than the abdomen, central anteapical cell is long and divided.

Color: Grayish olive marked with brown. Vertex with four dark spots above margin and in a line between ocelli, a line between anterior margins of eyes, usually interrupted at middle and basal two-thirds, brownish. A pale spot about the middle next each eye and one in each basal corner. Pronotum irregularly marked, usually with fine pale longitudinal stripes. Elytra gray, nervures pale, brown margined, a fuscous spot behind middle of clavus, another behind first cross nervure of corium and a third on costal margin in line with the other two. Face black with pale arcs, venter black.

Genitalia: Female last ventral segment one-half longer than preceding, obliquely sloping on lateral angles, posterior margin somewhat strongly concavely excavated and brown margined. Male valve twice wider than long, rounding exposed part of plates scarcely as long as valve, their tips rounding half the width of valve, side margins nearly straight, oblique, pygofers greatly exceeding plates.

This species was described from specimens from Texas, Arizona, and Mexico and has not been recorded since. There is no record of food plant or any data as to its habitat.

Type material from the collection at Ames, Iowa, has been used for the illustrations.

Type localities Aaron, Texas; Orizaba, Vera Cruz; Mexico; and Arizona. Type in Agr. College collection, Ames, Iowa. Type examined.

Deltocephalus cruciatus Osborn and Ball.

(Plate XIII, Figs. 1, 1a, 1b; Plate XXV, Fig. 7)

Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 77, 1898.

Resembling *signatifrons* in general appearance but smaller and with a more angularly produced head. Length 2.75 to 3 mm.

Vertex bluntly angled, length equaling width between eyes, a little longer than pronotum, which is twice as wide as long and with lateral margins almost obsolete. Elytra long, body in male reaching only to apex of clavus.

Color: Yellowish to gray, the vertex with frontal arcs extending over margin, a pair of triangular spots just back of apex, two irregular oblique spots between ocelli and a pair on each side at base, fuscous. Pronotum usually bearing five pale stripes on a mottled background. Scutellum with four small spots along anterior margin. Elytra whitish, nervures pale, margined with fuscous, a few cells often quite dark. Below brownish, face brown with pale arcs.

Genitalia: Female last ventral segment a little longer than preceding, lateral angles rounded, posterior margin slightly concaved and sinuated. Male valve longer than preceding segment, rounding. Plates exceeding valve by twice its length, broad at base, gradually narrowed to truncate tips, which are one-half as wide as at base.

Described originally from Iowa and has since been collected at Dickinson, Williston, Tower City, and Bismark, North Dakota (Osborn). It is a prairie form but very little is known regarding its habitat and distribution.

Type localities Little Rock and Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined. Also specimens mentioned above.

Deltocephalus blandus Gillette.

(Plate XIII, Figs. 9, 9a; Plate XXV, Fig. 6)

Gillette, Colo. St. Agr. College Exp. Sta., Bul. 43, p. 26, 1898.

A minute gray species with fuscous markings, head produced and somewhat conical. Length 2 to 2.5 mm.

Vertex bluntly produced, somewhat conical, about one-fourth longer on middle than width between the eyes at the base. Considerably longer than pronotum, which is broad and almost transverse with side margins very short. Scutellum minute, elytra about equaling abdomen in length, apical cells very short, appendix wanting.

Color: Whitish to gray, sometimes washed with yellow, vertex with a brown longitudinal band on either side enclosing two elongated white spots so as to form a letter "B," pronotum irregularly marked. Elytra gray, nervures light, rather heavily margined with fuscous. Face fuscous with pale arcs, venter dark.

Genitalia: Female last ventral segment one-half longer than preceding, lateral angles gradually broadly rounded to form large outer lobes of posterior margin. The median third of posterior margin is rather suddenly excavated and bears a small rounded tooth at center. This segment resembles somewhat the last ventral segment of *sexmaculatus*.

Known to occur only in Colorado. In the original description Professor Gillette states that the type specimens were swept from native grasses. Nothing further has been reported concerning this species.

Type localities Ft. Collins and Calhon, Colorado. Type in Colorado Agr. College collection. Colorado specimens examined (Ball collection).

SUBGENUS LAEVICEPHALUS

Vertex varying from a sharply angled and pointed type which is acutely angled with front to a rather bluntly angled type with sides often rounding to apex which is bluntly angled with front. Vertex always decidedly flattened on disc. Elytra sometimes shortened but with venation simple.

Type of subgenus *sylvestris* Osborn and Ball.

Practically all the species belonging to this subgenus are a uniform greenish or yellow with very few dark markings .

Key to Species of Laevicephalus

1. Vertex broader between eyes than length at middle, or if as long with apex roundingly pointed, not sharply angled..... 9
   Vertex longer than basal width between eyes, usually with distinctly angled and pointed vertex, occasionally with tip slightly blunt..... 2

2. Color some shade of green or yellow..... 3
   Color rather uniformly grayish brown with darker longitudinal markings on head, and veins of elytra fuscous margined. Female segment with a pair of divergent teeth either side of central incision. Male plates broad, divergent to blunt tips.....*cinerosus*

3. Size smaller, 3 mm. or less..... 4
   Larger, length 3.5 mm. or more..... 6

4. Vertex only slightly longer than basal width. Female segment not excavated, either incised or produced..... 5
   Vertex distinctly longer than basal width, female segment with broad shallow excavation, male plates short, broad, and almost truncate.....*meinheimerii*

5. Female segment narrowly incised at middle, a round black tooth either side. Male plates convexly rounded .....*minimus*
   Female segment gradually produced, median third truncated; male plates narrower with outer margins almost straight.....*parvulus*

6. Without conspicuous dark markings on vertex..... 7
   Vertex marked with a pair of irregular longitudinal fuscous bands converging toward apex. Female segment strongly produced from side margins and broadly excavated at middle, forming two rather broad rounded lobes.....*convergens*

7. Female segment sinuated with three small lobes at center; male plates tapered to narrow attenuated tips.....*unicoloratus*
   Female segment distinctly produced at center..... 8

8. Female segment with median third abruptly produced and truncated; male plates with tips quite broad, bluntly pointed and divergent.....*sylvestris*
   Female segment with median half gradually produced to a pointed brownish tooth; male plates tapered to narrowly rounded tips.....*acus*

9. Vertex about as wide as long or only slightly wider than long.....10
   Vertex distinctly broader than long, usually at least one-fifth wider, very bluntly angled, almost rounded.....23

10. Length usually 3 mm. or more.....11
    Size smaller, usually not exceeding 2.5 mm. Vertex blunt, often distinctly marked with brown or black. Female segment concave with median rounded tooth, male plates short, valve large.....*cookei*

11. Color greenish to greenish-yellow, usually with definite markings in the form of longitudinal stripes or black dashes. Not bright yellow.....12

Color bright yellow to orange, usually without greenish tint and not marked with black or definite coloration 21

12. Length more than 3 mm. 13
Not exceeding 3 mm. in length, vertex with a brown dash either side of apex. Female segment with a rounded sunken tooth. Male plates rather long and blunt... *monticolus*

13. Greenish to yellow without dark longitudinal bands across vertex and pronotum..... 14
Color greenish, with two rather broad longitudinal brownish bands extending from apex of vertex on to base of scutellum, often only slightly darker..... 19

14. Female segment slightly or strongly convexly rounded, sometimes with median tooth.. 15
Female segment truncated and incised or strongly produced..... 17

15. Concavity of female segment shallow or deeply incised, not bearing a median tooth.... 16
Concavity of female segment bearing a rather broad, blunt tooth, often with three minute projections; male plates strongly incised on outer margins..... *abdominalis*

16. Female segment deeply incised bearing a black margined incision at the base. Male plates broad and rounded at tip..... *pascuellus*
Female segment shallowly concave on median half, a square black spot either side of middle ..... *canadensis*

17. Female segment not forming a definite median tooth. Male plates well rounded at apices 18
Female segment forming a median, rather blunt tooth with a black spot either side at base. Male plates short and pointed at apex..... *littoralis*

18. Female segment with posterior margin gradually produced to a central incision. Male plates short, greatly exceeded by pygofers..... *debilis*
Female segment almost truncated, slightly produced either side of a deep median incision. Male plates rather long, rounded at tips, exceeding pygofers..... *spicatus*

19. Vertex bluntly angled, female segment produced or with sunken tooth..... 20
Vertex scarcely angled, almost rounded, markings pale, female segment truncated or slightly notched at center. Male unknown..... *concinnus*

20. Markings not conspicuous; large, more than 3.5 mm. Female segment concave with rather broad sunken tooth. Male plates rather broadly rounded at apices..... *collinus*
Markings very dark and conspicuous. Elytra also marked with about five rounded spots. Female segment slightly produced and bilobed at center. Male plates rather short and triangular..... *labeculus*

21. Color yellowish, female segment without median tooth..... 22
Color bright orange to yellow, female segment roundingly produced with median incised tooth. Male plates broadly rounded at apices..... *auratus*

22. Length 3 - 3.25 mm.; female segment concave at middle with a visible produced portion midway to either side. Male unknown..... *helvus*
Length 3.5 mm.; female segment slightly sinuately concavely rounded and black margined. Male unknown..... *exectus*

23. Vertex with a pair of large round black spots extending over apex on to front. Female segment produced with a broad rounded tooth at middle..... *bimaculatus*
Vertex with longitudinal stripes but without black spots..... 24

24. Female segment shallowly concavely rounded, male plates truncate, only slightly exceeding rounded valve..... *striatus*
Female segment with one or more teeth, male plates longer..... 25

25. Female with a pair of divergent pointed teeth separated by a rounded median lobe. Vertex with a pair of faint longitundinal brown bands..... *ordinatus*
Female segment with a rather broad, short, sunken tooth at middle, male plates concavely rounded to divergent blunt tips. Elytra short, not covering abdomen ..... *larrimeri*

Deltocephalus cinerosus Van Duzee.

(Plate XVII, Figs. 7, 7a, 7b; Plate XXV, Fig. 8)

Van Duzee, Trans. Amer. Ent. Soc., XIX, p. 305, 1892.

D. cinereus Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 214, 1897.

Form and size of *sylvestris* but with vertex a little shorter, dull cinereous marked with fuscous. Length 3 - 3.5 mm.

Vertex strongly produced and angled, tip blunt, length equaling basal width between eyes. Pronotum as long as vertex, not twice as wide as long. Elytra a little longer than abdomen.

Color: Vertex dark brown with anterior margin, the margin along the eyes and a broad central longitudinal band including black impressed line, dull yellow; a darker broken line forms the anterior boundary of the brownish area. Pronotum irregularly light with fuscous markings. Scutellum with basal angles and apex darker. Elytra cinereous, nervures whitish margined with fuscous. Face light with heavy brown arcs, venter cinereous.

Genitalia: Female last ventral segment about one-half longer than preceding, lateral angles rounded off to posterior margin which gradually slopes to a central pair of broad, bifid teeth between which is a "V" shaped notch. Apices of teeth black. Male valve one-half longer than last ventral segment, apex rounded. Plates exceeding valve by more than its length, outer margins almost straight, inner margins suddenly divergent to rather blunt apices. Greatly exceeded by black pygofers.

This species has been reported from California only, but Professor Osborn reports it as being a common species on native grasses from Bakersfield and Salinas south to San Diego. The known distribution is rather limited to the southern portion of California.

Type locality "California." Type in Agr. College collection, Ames, Iowa. All specimens examined were from southern California.

Deltocephalus minimus Osborn and Ball.

(Plate XIV, Figs. 1, 1a, 1b; Plate XXVI, Fig. 7)

Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 211, 1897.

D. melsheimerii VanDuzee, Cat. Hemip. N. A., p. 647, 1917.

Resembling *parvulus* in size and general appearance. Greenish-yellow, vertex bluntly angled, sides evenly convexed. Length female, 2.75 - 3 mm.; male, 2.5 mm.

Vertex produced and angled but tip broadly blunt, longer on middle than between eyes. In male as wide as long, tip blunter. Pronotum quite small, very convex anteriorly, sides extremely short. Elytra a little longer than abdomen.

Color: Greenish-yellow, vertex, pronotum and scutellum paler, traces of two brownish arcs on each side of vertex extending from apex toward ocellus. Elytra milky hyaline, nervures yellowish, faintly bordered with fuscous especially in male. Face dull brownish, pale arcs almost meeting on median line in female. Venter pale, basal segments dark at middle, ovipositor black.

Genitalia: Female last ventral segment almost twice as long as preceding, posterior margin roundingly produced, narrowly incised at middle with a very small rounded notch either side; median third black-margined. Male valve convexly, roundingly triangular, almost twice as long as last ventral segment; plates more than twice longer, convexly tapering to bluntly pointed tips. A black spot on middle of each.

This minute species seems to be restricted in distribution to the prairie sections of the central states. It has been collected in Iowa, Kansas, Nebraska, South Dakota, Wisconsin, and occasionally a specimen is found as far east as Ohio. According to Osborn and Ball it occurs on prairie grasses in Iowa in a habitat where the principal plants are *Sporobolus heterolepsis* and *Stipa*. The distribution also would indicate a prairie habitat.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined, also specimens from the states mentioned above.

Deltocephalus parvulus Gillette

(Plate XIV, Figs. 3, 3a, 3b; Plate XXVI, Fig. 8)

Gillette, Colo. Agr. Exp. Sta., Bull. 43, p. 23 (1898).

A minute yellowish-green species with produced head and blunt apex, especially in the male. Length, female, 3 mm.; male, 2.5 mm.

Vertex bluntly pointed, in female slightly longer than width between eyes and a little longer than pronotum. In male a little broader between eyes than length at middle and shorter than pronotum, ocelli black. Pronotum twice as wide as long, side margins almost obsolete. Elytra decidedly longer than abdomen, venation simple.

Color: Vertex, pronotum, and scutellum yellowish-green, a rather broad indefinite fuscous stripe either side of apex on vertex extending toward ocellus, broadening on disc and continuing to pronotum, leaving a median paler stripe. Impressed median basal line black. Elytra dull hyaline, nervures yellowish-green. Frons dull brownish, traces of seven pairs of pale arcs, lower portion of the face pale, sutures darkened. Venter pale yellowish-green.

Genitalia: Female last ventral segment one-half longer than preceding, posterior margin roundingly produced, almost truncated on median third. Male valve longer than last ventral segment, triangular, sides sinuate; plates three times longer than valve, outer margins weakly concave, tips bluntly pointed and appressed.

This species is very minute and seems to be restricted to the prairie regions of Colorado, Kansas, and Nebraska where it occurs abundantly on native grasses. It may be more widely distributed but no additional records are available.

Type localities Ft. Collins and Colorado Springs, Colorado. Type in Agr. College collection, Ft. Collins, Colorado. Specimens examined from states mentioned.

Deltocephalus melsheimerii (Fitch).

(Plate XIV, Figs. 2, 2a, 2b; Plate XXVI, Fig. 9)

Amblycephalus melsheimerii Fitch, Homoptera N. Y. St. Cabinet, p. 61, 1851.
D. vicilinus Crumb, Ann. Ent. Soc. Amer., VIII, p. 193, 1915.

Equaling *D. minimus* in size, but vertex more sharply angled and females paler in color. Size, female, 2.75 mm.; male, 2.5 mm.

Vertex strongly produced and sharply angled, distinctly longer than width between eyes, and longer than pronotum. Elytra exceeding abdomen, venation simple.

Color: Female usually rather uniform yellowish, elytra subhyaline, nervures milky white, face with faint arcs. Male head, pronotum, and scutellum brighter yellow; a faint brown arc either side from apex to black ocelli. Elytra subhyaline, nervures milky white, faintly bordered with fuscous throughout. Face pale brown with six or seven pairs of arcs and lower portion of face pale.

Genitalia: Female last ventral segment about equaling preceding, median half of posterior margin with simple, very shallow, black bordered excavation. Male valve almost semicircular, considerably longer than preceding segment; plates broad at base, only slightly narrowed to broadly rounded upturned tips, appearing from below as almost truncate. A median brownish line expanding toward tip of each plate.

The species is widely distributed over the eastern and central states and is abundant on small grasses in pastures and meadows. It has been collected from Maine and Canada to the Gulf coast and is found as far west as Kansas, Iowa, and Colorado. It occurs with *sylvestris* in the *Danthonia* association and has been taken from *Danthonia spicata* and *D. compressa* in many localities. It is found most commonly in rather dry, well-drained fields.

Type locality Albany, New York. Type in State collection, Albany, New York. Type examined, also many specimens from diverse localities as suggested by distribution records above.

Deltocephalus unicoloratus Gillette and Baker.

(Plate XIV, Figs. 4, 4a, 4b; Plate XXVI, Fig. 4)

Deltocephalus unicoloratus Hemip. Colo., p. 89, 1895.
D. oculatus Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 212, 1897.
D. nominatus Sanders and De Long, Pa. Dept. Agr., Tech. Ser. Bul. 1, p. 9, 1920 (n. n. for *oculatus* preoccupied by *D. oculatus* Sahlberg.)

Resembling *D. sylvestris* in size and form but usually pale yellow and with vertex more bluntly angled. Length 3.5 mm.

Vertex slightly longer than width between eyes, apex bluntly angled, a little longer than pronotum. Pronotum twice as wide as long, side margins short but distinct. Elytra distinctly exceeding abdomen, venation simple.

Color: Female usually rather uniform pale dull yellow, male frequently tinted with greenish. Ocelli, impressed line on vertex and eyes, dark, inter-ocellar line from apex to ocelli pale brownish. Elytra subhyaline, nervures yellowish. Face with pale arcs on upper portion, paler below. Venter yellowish.

Genitalia: Female last ventral segment equal in length to preceding, posterior margin with median third slightly produced, dark margined and scarcely trilobate. Male valve triangularly produced, almost twice length of last ventral segment. Plates convex, narrowed to produced, attenuated tips.

An examination of the female type in the national museum has shown that the species which we have designated as *oculatus* for many years should properly be called *unicoloratus* as the type now stands. The type specimen however does not fit the original description as there is no sign of a sunken tooth, nor abnormal specimen.

The species is common on *Andropogon* over a large number of the eastern central states where it is widely distributed. It occurs from Colorado, South Dakota, Kansas, Nebraska, and Iowa to New York, New Hampshire, and Connecticut, extending northward in Wisconsin and Michigan and southward in Pennsylvania and Tennessee to Texas. It seems to prefer a prairie or dry meadow habitat to any other type.

Type locality Pleasant Valley, Colorado. Type in Baker collection U. S. Nat. Museum. Type examined, also specimens from practically all states mentioned above.

Deltocephalus sylvestris Osborn and Ball.

(Plate XIV, Figs. 6, 6a, 6b; Plate XXVI, Fig. 10)

Osborn and Ball, Proc. Ia. Acad. Sci., IV., p. 213, 1897.

A greenish species with sharp head, often bearing two rather conspicuous dark stripes, and with distinct genitalia. Length 3.5 mm.

Vertex distinctly and rather sharply pointed, about one-fourth longer than width between eyes. Pronotum shorter than vertex, almost twice as wide as long, side margins longer than in allied species and rounded. Elytra exceeding abdomen, venation simple. Face gradually narrowed to clypeus.

Color: Dull greenish, tinged with yellow, eyes and ocelli dark, a rather heavy fuscous stripe either side of apex extending obliquely onto disc, then broadening and continuing to pronotum. Pronotum often with fine pale stripes. Elytra whitish or dull hyaline, nervures greenish yellow, often broadly margined with fuscous, especially on apical portion and along sutural line. Face brownish with about six pairs of paler arcs, clypeus and lorae paler, sutures dark. Venter dark with pale areas, ovipositor black.

Genitalia: Female last ventral segment one-half longer than preceding, lateral angles prominent either side of which the posterior margin is slightly excavated, then abruptly produced on median third into a black truncated process almost one-third the length of the segment. Male valve one-half longer than last ventral segment, triangular with rounded apex. Plates twice as long as valve, sides concavely narrowed to bluntly pointed divergent tips.

In general appearance it is easily confused with *D. acus* but the characters are distinct. It is widely distributed throughout the states east of the Rocky Mountains and occurs from Maine and the Great Lakes to the Gulf coast. This species is common in meadows and pastures and apparently has a variety of food plants. It has been taken abundantly by the author from *Danthonia compressa* during August in a dry upland habitat.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes and a great number of specimens from diverse localities have been examined.

Deltocephalus acus Sanders and De Long.

(Plate XIV, Figs. 7, 7a, 7b; Plate XXVI, Fig. 11)

D. acus Sanders and De Long, Pa. Dept. Agr. Tech, Ser. Bul. 1, p. 10, 1920.

Resembling D. sylvestris, but slightly longer and generally paler in color; almost buff with triangularly pointed head. Length, female and male, 4 mm.

Vertex flat, sharply pointed, one-fifth longer on middle than width between eyes, one-fifth longer than pronotum. Pronotum strongly arcuate in front and slightly emarginate behind; lateral margins very short. Elytra distinctly longer than abdomen, almost hyaline, broadly rounded at tips, venation simple.

Color: Pale buff with greenish yellow tinge on head and pronotum. Vertex in well-marked specimens with median impressed line, ocelli and arcuate line from apex toward eye, pale brown. Elytra milky hyaline revealing the dark yellow margined segments; veins paler, faintly bordered with fuscous especially toward apex. Face above sordid yellow with paler arcs; clypeus and genae yellow. General color of venter yellow, except median line and border of abdominal segments which are fuscous.

Genitalia: Female last ventral segment slightly longer than preceding, hind margin with median half produced forming a broad pointed tooth with sinuate sides margined with brown. Male valve triangularly rounded, as long as but narrower than last ventral segment. Plates at base as broad as last ventral segment, twice length of valve, concavely narrowed to round-pointed tips.

Apparently this species has long been confused in identity with *D. sylvestris* and *D. unicoloratus (oculatus)* but it is quite distinct as the illustrations of genital characters will readily show. The distribution too is northern and will follow pretty closely the distribution of *unicoloratus*. It has been collected abundantly in Wisconsin, New York, and northern Pennsylvania, and specimens have been examined from Connecticut also. It is a grass species and is commonly found on coarse grasses in swampy and marshy places. This seems to be its optimum habitat as compared with the *Andropogon* type in *unicoloratus*. It frequently occurs with *Euscelis striolus, Thamnotettix fitchii, Th. melanogaster*, and *Helochora communis* in a swampy habitat with mixed *Juncus, Cyperus* and coarse grasses.

Nymphs in the last three instars and adults were collected on June 29.

Type localities North East, Hartstown, Kane, and Charter Oak, Pennsylvania. Type in Sanders and De Long collection.

Deltocephalus convergens n. sp.

(Plate XIV, Figs. 5, 5a; Plate XXVII, Fig. 4)

In general appearance resembling *parvulus* but much larger and with distinct genitalia. Length 3.75 mm.

Vertex angularly produced and pointed, as long on middle as basal width between eyes, a little longer than pronotum. Elytra long, well exceeding abdomen, central anteapical cell extremely long.

Color: Greenish tinged with yellow. Vertex with median impressed line and ocelli black and an irregular longitudinal band either side, converging at apex, pale fuscous. Pronotum darker green on disc. Elytra greenish subhyaline with nervures paler and conspicuous. Face pale with heavy fuscous arcs. Beneath pale, ovipositor black.

Genitalia: Female last ventral segment longer than preceding, side margins rather short, lateral angles wanting, posterior margin strongly produced and sloping from side margins to form two broadly rounded lobes at apex which are separated by a broad shallow notch. Ovipoistor black, gradually tapering to a narrow apex.

Described from a unique female specimen in excellent condition, collected at Estes Park, Colorado, at an altitude of 8000 feet, August 29, 1920, and received for identification from Professor H. C. Severin.

It seems best to treat this specimen as new at this time as it is distinct from all the allied described species.

Type in author's collection.

Deltocephalus pascuellus (Fall).

(Plate XV, Figs. 1, 1a, 1b; Plate XXVI, Fig. 1)

Cicada pascuellus Fallen, Homip. Suec., Cicad., p. 32, 1826.
Cicada punctipes Zetterstedt., Ins. Lapp., Column 292, 1840.
Deltocephalus fuscosignatus Dahlb., Kong. Vet. Handl. for 1850, p. 195.
Deltocephalus minki Provancher, Pet. Faune Ent. Can., III p. 279, 1889 (cited in error).

A rather robust form with bluntly angled vertex and a black or brown dash either side of apex. Length, female, 3.5 mm.; male, 3 mm.

Vertex as long at middle as width between the eyes, with bluntly rounded tip. Pronotum twice as broad as long, scutellum rather small. Elytra but little longer than abdomen.

Color: Vertex yellowish with a paler band in female along the margin and an oblique dash either side extending toward eye from the apical dashes, pale brown. Pronotum and scutellum yellow. Elytra yellowish-green subhyaline, nervures yellowish. Face dull brown with about seven broken pale arcs, the infra-ocellar line black or brown connecting with brown line or blotch along lower margins of eyes, pale below. Abdomen black beneath, posterior margins of segments yellow. Pleurae yellow with black dots. Pygofers yellow, ovipositor black.

Genitalia: Female last ventral segment a little longer than preceding, lateral angles prominent, hind margin broadly and deeply excavated with sharp, median, black-margined incision. Male valve one-half longer than last ventral segment, triangular with sides sinuate and apex broadly rounded. Plates twice longer than valve, broad at base, outer margins slightly sinuate, narrowed to rounded tips. Each plate with a median impressed longitudinal line.

This species, common in Europe, has apparently been introduced into the United States and has been found in the New England states and in New York, Pennsylvania, and eastern Canada.

Professor Osborn reports it as very abundant in meadows and along roadsides in Maine where it occurs on numerous grasses and suggests that it seems to replace *inimicus* as a pest in this northern locality. Present records show that it is pretty well confined to northern localities, although occasionally found farther southward at high elevations.

Type locality Stockholm, Sweden. Type doubtful, probably in Stockholm Museum.

Deltocephalus canadensis n. sp.

(Plate XVII, Figs. 1, 1a)

In general appearance resembling somewhat *pascuellus* but with different genital characters. Length 4 mm.

Vertex bluntly angled, sides a little convex, a little wider between eyes than length at middle. Length equaling pronotum which is rather broad and truncate behind. Elytra rather long, exceeding abdomen, venation simple.

Color: Dull greenish, vertex, pronotum, and scutellum washed with yellow. Median impressed line and a line either side from apex to eye extending above black ocelli, brownish. Scutellum with a black spot in each basal angle. Elytra dull green, veins lighter, yellowish, heavily infuscated. Face infuscated, marked with pale arcs. Beneath yellow, marked with black, ovipositor black.

Genitalia: Female last ventral segment a little longer than preceding, posterior margin with a rounded lobe extending from lateral angle to a broad, rather shallow median emargination with a slight notch at middle and a rather broad black spot either side. Ovipositor black.

Described from a single female in excellent condition from Nordegg, Alberta, Canada, collected by J. McDunnough, July 29, 1921, and forwarded to me for study by Professor J. G. Sanders. Although the genital characters resemble *paludosus* in general appearance, it is distinct in this and other characters.

Type in Canadian National Collection, Ottawa, Canada.

Deltocephalus abdominalis (Fabricius).

(Plate XVI, Figs. 1, 1a, 1b; Plate XXVII, Fig. 3)

Cercopis abdominalis Fabricius, Syst. Rhyng., p. 98, 1803 (n. n. for *bicolor*.)
Cicada bicolor Fabricius, Ent. Syst., IV, p. 40, 1794.
Cicada balteata Zetterstedt, Ins. Lapp., column 290, 1840.
Aphrodes juvenca Hardy, Proc. Tyneside Field Club, I, p. 425, 1846.
Deltocephalus evansi Ashmead, Harriman Alaska Exped., VIII, p. 132, 1904.

A green robust species common to both Europe and North America and with distinct genital characters to distinguish it from others closely related. Length 3.5 - 4 mm.

Vertex bluntly angled, sides somewhat convexly rounded as in *pascuellus*, a little wider between eyes than length at middle, longer than pronotum which is considerably more than twice as wide as long. Elytra quite broad and short, exceeded by abdomen in female.

Color: Vertex, pronotum, and scutellum greenish, washed with yellow, usually with few dark markings. Elytra dull green, nervures paler. As a rule the upper half of the face is black with pale arcs and the lower half pale with a few dusky markings. This, however, will not always be the case and should not be used as a specific character.

Genitalia: Female last ventral segment longer than preceding, lateral angles prominent, produced and rounded; between these the posterior margin is sinuately concavely rounded to a median blunt tooth which is often three pointed and either side of which is a rounded notch. Male valvo triangular with blunt apex, twice as long as preceding segment. Plates exceeding valve by twice its length, gradually narrowed two-thirds the distance to apex then suddenly notched or incised beyond which the blunt tips are broadly convexly rounded and slightly divergent.

This is a common European species and is found in the extreme northern part of the United States, in Canada, and Alaska. It has been reported for Maine (Osborn), New Hampshire, Labrador, Quebec, and Ontario. Specimens have also been examined from Cranberry Lake, N. Y. (Drake), and Estes Pk., Colo. (Severin). It occurs on coarse grasses and it has been reported as attacking wheat in Maine (Osborn).

The distribution is very similar to *debilis* but does not extend so far south.

The specimens in the United States National Museum described as *Deltocephalus evansi* by Ashmead are alcoholic specimens of this species and the green color has disappeared. As stated in the original description the form is that of *abdominalis* and the two species are identical in their genital characters.

Described from a European locality. Deposition of type doubtful.

Deltocephalus debilis Uhler.

(Plate XVI, Figs. 2, 2a, 2b; Plate XXVII, Fig. 5)

Uhler, Bul. U. S. Geol. Geog. Surv., I, p. 360, 1876.
D. melshcimerii Osborn, Proc. Ia. Acad. Sci, I, p 126, 1892 (cited in error).

A robust greenish species resembling the European *abdominalis* in size and form and often with very similar coloration, but genital characters distinct. Length 4 mm.

Vertex produced and angled, flat, as long as wide at base and as long as pronotum which is twice wider than long. Elytra broad, apices broadly rounded, almost truncate, scarcely covering abdomen in the female.

Color: Quite variable, green or yellow, often marked with black. Vertex uniform yellowish-green, often with a pair of oblique dashes extending toward eyes. Pronotum greenish, often clouded. Scutellum pale green. Elytra yellow to green sometimes entirely black, but usually with traces of black, especially on claval and apical areas. The costal margin is usually greenish. Face variable in color, usually dusky with pale arcs.

Genitalia: Female last ventral segment twice as long as preceding, lateral angles, broadly rounded to posterior margin which is gradually, often strongly produced to a pair of blunt, slightly divergent teeth, one either side of a median incision, posterior margin broadly black. Male valve about as long as preceding segment, bluntly triangular. Plates broad at base, exceeding valve by one and one-third times its length, strongly convexly rounded and somewhat truncated at apex forming inward appressed blunt tips. There is usually a distinct opening between plates at base and they are greatly exceeded in length by pygofers.

The genital characters will readily separate this species from *abdominalis* and another species described here as new which apparently has always gone under the name of *debilis*.

This species was described from Colorado and has been reported from Maine, New Hampshire, New York, Pennsylvania, Virginia, Tennessee, Missouri, Iowa, Kansas, and Ontario. Type specimens in the collection of the National Museum have been examined through the kindness of Mr. W. L. McAtee, and females of *abdominalis* are also found in this series.

This species is found in moist wooded areas or in open moist places on coarse grasses. It is reported by Uhler as occurring on the sides of high mountains in Colorado.

It apparently has a northern distribution in Canada and the northern United States, and is found farther south at high altitudes.

Type locality Colorado. Type in United States National Museum, Washington. Type examined, also specimens from most of the states mentioned above.

Deltocephalus spicatus n. sp.

(Plate XVI, Figs. 3, 3a, 3b; Plate XXVII, Fig. 2)

In general appearance and coloration resembling *debilis* but with vertex more sharply angled and genitalia especially in the male distinct. Length 3 - 3.75 mm.

Vertex more sharply pointed than in *debilis*, about as wide between eyes at base as length at middle, about one-fifth longer than pronotum which is transverse and more than twice as wide as long. Elytra rather long, just exceeding abdomen in female, decidedly exceeding abdomen in male. Central anteapical cell very long, apical cells short.

Color: Greenish yellow, shading to dark green. Vertex, pronotum, and scutellum bright yellow tinged with green. Ocelli dark green or black, disc of pronotum usually darker green. Elytra dull green, nervures paler. Face pale fuscous with lighter arcs, venter buff, with dark markings.

Genitalia: Female last ventral segment one-third longer than penultimate, lateral angles prominent, rounded, posterior margin almost truncate, slightly excavated either side of a pair of scarcely produced but rounded median lobes, formed by a deep median incision one-third distance to base either side of which is a black spot. Male valve obtusely angled, tip rounded, about two-thirds as long as preceding segment. Plates three times longer than valve, gradually narrowed to broadly rounded tips. A rather large round black spot about the middle of each plate. Plates longer than pygofers.

This species has apparently been confused with *debilis* which it closely resembles but they can easily be separated by the short or long male plates and by the truncate or produced female segment and the pointed vertex.

Described from a large series of specimens from Delphos, Kansas, collected by Professor Osborn. Some of the specimens are labeled June 27, 1910.

Type in author's collection.

Deltocephalus littoralis Ball.

(Plate XV, Figs. 3, 3a, 3b: Plate XXVI, Fig. 2)

Ball, Proc. Biol. Soc. Wash., XVIII, p. 120, 1905.

A large robust form resembling *D. collinus* in general appearance. Length, female, 4.4. mm.; male, 3.5 mm.

Vertex strongly produced but very blunt, as long on middle as width between eyes, slightly rounded to front. Pronotum as long as vertex, twice wider than long, side margins very short, posteriorly concave. Elytra shorter than abdomen in brachypterous females and longer in macropterous females, slightly longer than or equaling abdomen in male. Venation usually simple, but often with middle anteapical cell divided by a cross nervure.

Color: Dull green, vertex, pronoutm and scutellum often yellowish green. Ocelli and dyes black, a strongly curved line from either side of apex extending beneath ocelli and two arcs on margin visible from above, fuscous. Usually with two triangular fuscous areas back

of apex. Elytra smoky hyaline, nervures greenish yellow. Front brown, about nine or ten pairs of arcs and median line pale. Lower part of face paler.

Genitalia: Female last ventral segment about twice the length of preceding, lateral margins short, concavely narrowed to strongly produced median third which is abruptly narrowed to a rounded median tooth appearing as a notch. An oval plate either side projecting beyond lateral margins. Male valve about one-third as long as last ventral segment and convexly rounded. Plates quite long, concavely rounded to acutely pointed tips.

The characters are distinct and will readily separate it. The species is distributed along the Atlantic and Gulf coasts having been found recently in Mississippi by Dozier, but taken in the same habitat as found along the Atlantic where it is common from Connecticut to Florida. It is a salt marsh species and has been taken in abundance at Cape Charles, Virginia, from *Distichlis spicata* along the tide water flats. It has also been found in salt marsh with *D. simplex* where almost a pure association of *Spartina patens* occurred, but this apparently was not its true habitat as very few specimens were taken.

Type locality Cape May and Anglesea, New Jersey. Type in Ball collection. Type examined, also specimens from various localities along the Atlantic and Gulf coasts from Rowayton, Connecticut to Florida and Pascagoula, Mississippi.

Deltocephalus collinus Sahlberg.

(Plate XVII, Figs. 3, 3a, 3b; Plate XXVII, Fig. 9)

Boheman, Kong. Vet. Akad. Handl. for 1850, p. 261.
Deltocephalus aridellus Boheman, Kong. Vet. Akad. Handl. for 1850, p. 263.

Another pale greenish species common to both Europe and North America. Both brachypterous and macropterous forms are known. Length 3.5 - 4mm.

Vertex bluntly angled, about as long at middle as width between eyes, a little longer than pronotum which is twice as wide as long and strongly convexly rounded on anterior margin. Scutellum comparatively large, elytra in brachypterous forms leaving the two apical dorsal segments entirely exposed. In macropterous forms the elytra reach to tip of abdomen.

Color: Greenish marked with yellow, vertex olive green with a pale median stripe, one next either eye, and a marginal stripe between vertex coloration and reflexed arcs of front. Pronotum paler on anterior portion and usually longitudinally striped with fuscous. Elytra pale greenish, nervures paler. Face olive-brown with pale arcs and a pale median line.

Genitalia: Female last ventral segment as long as preceding, lateral angles produced and sharply rounded, between these the posterior margin is sinuately then concavely rounded to a broad rather short blunt median tooth. The rounded lobate portions at either side formed by the sinuation are black. Male valve triangular, almost twice as long as preceding segment. Plates exceeding valve by twice its length, broad at base, convexly then concavely rounded to blunt rounded tips.

This is another European species that occurs quite abundantly in limited areas in the United States. It has been reported for Iowa ,Colorado, Kansas, and specimens have been examined from

South Dakota (Severin). Several additional records were obtained from the Osborn collection, Yellowstone Park, Wyoming; Kalispell, Montana; Bismark and Fargo, North Dakota; Brookings, South Dakota; Delphos, Kansas (H. O.) and Springer, N. M. (Ainslie). Osborn and Ball report it as occurring on *Sporobolus* in Iowa.

The adults examined were collected in late June and early July and again in late August and early September. There is a strong probability of two seasonal generations but no definite information is at hand.

Described from a European locality. Type doubtful.

Deltocephalus labeculus n. sp.

(Plate XV, Figs. 5, 5a, 5b; Plate XXVII, Fig. 1)

In general appearance resembling *parvulus* and *convergens* but with more bluntly angled head and usually with numerous fuscous spots on elytra. Length 2.5 - 3 mm.

Vertex bluntly angled, about as long on middle as width between eyes. Pronotum shorter than vertex, anterior border very strongly convex, side margins very short. Elytra exceeding abdomen, narrowly rounded at apex, appendix narrow. Central antepaical cell very long, scarcely constricted, outer anteapical cell very minute, often wanting.

Color: Dirty white to gray, vertex with reflexed arcs from front, two rather broad longitudinal bands converging at apex, dark fuscous. Pronotum with indications of six longitudinal stripes, the central pair a continuation of those on vertex, each of which terminates in a black spot on scutellum. Elytra pale gray, nervures paler, numerous spots rather evenly distributed and a faint border along suture, fuscous. Face dusky with numerous white arcs, beneath pale.

Genitalia: Female last ventral segment about three times as long as preceding, lateral margins broadly rounding to posterior margin which is slightly produced, forming a broad median lobe faintly notched at middle each side of which is a heavy black spot. Small side plates are visible at the margins of last ventral segment. Male valve obtusely angled, almost twice as long as preceding segment. Plates exceeding valve one and one-half times its length, very broad at base, then concavely rounded to blunt tips. Pygofers slightly exceeding plates.

Described from a series of specimens collected by Professor Herbert Osborn at Williston, North Dakota; Yellowstone Park, Wyoming; and Bozeman, Montana, and kindly loaned for study in the preparation of this paper; also a single specimen from Missoula, Montana, was collected by Mr. W. H. Larrimer.

Type in Osborn collection.

Deltocephalus concinnus Sanders and De Long.

(Plate XV, Figs. 8, 8a; Plate XXVIII, Fig. 1)

Sanders and De Long, Ann. Ent. Soc. Amer., X, p. 86, 1917.

A rather blunt headed species, size and form of *striatus* with two parallel brownish stripes on vertex and a long truncated and slightly sinuate genital segment. Length 3.5 mm.

Vertex flat, as long as wide, bluntly angled. Pronotum equaling vertex in length, strongly convex to the broadly rounded humeral angles, posterior margin truncate. Elytra rather long, just exceeding abdomen, tips broadly rounded and slightly flaring.

Color: Testaceous, ocelli black, vertex, pronotum, and scutellum with two broad, parallel brownish stripes, an additional stripe behind each eye on pronotum. Elytra with white nervures. Abdomen pale orange above, venter yellow. Face dusky, a median line and traces of seven pairs of arcs, dull yellow.

Genitalia: Female last ventral segment slightly longer than preceding, almost truncate, sinuated and with median brown spot. Pygofers robust.

The only known specimens are the types from Ladysmith, Wisconsin, where the species was collected from tall, coarse bunch grasses along the higher margins of a sphagnum-tamarack bog.

Type in Sanders and De Long collection.

Deltocephalus concinnus var. incisurus n. var.

(Plate XV, Figs. 9, 9a)

Form and general appearance of *concinnus* but with a different genital character. Length 4.25 mm.

Vertex bluntly angled, a little wider between eyes than length at middle and shorter than pronotum. Elytra rather long and narrow, exceeding abdomen, outer anteapical cell very short.

Color: Buff with darker markings. Vertex uniformly buff. Pronotum with faint indications of longitudinal markings. Elytra washed with orange, nervures paler, on discal area and posterior half, heavily margined with fuscous. Face uniform buff, venter pale with black markings, ovipositor black.

Genitalia: Female last ventral segment about as long as preceding, lateral angles prominently produced, posterior margin shallowly, sinuately excavated to a small median "U" shaped notch surrounded by a black spot. A small notch just inside each lateral angle.

Described from a single female specimen collected by the author at Ladysmith, Wisconsin, August 9, 1916, from grasses on the margin of a tamarack bog. It was collected with *concinnus* and has been placed under that name but after a comparison of the genital characters it has been decided to describe it as a varietal form at least and it can perhaps be raised to specific rank when more material is examined.

Deltocephalus monticolus Gillette and Baker.

(Plate XV, Figs. 7, 7a, 7b; Plate XXVI, Fig. 5)

Gillette and Baker, Hemip. Colorado, p. 88, 1895.

Closely allied to *D. striatus* Linn. with vertex more produced and bluntly angled, yellowish-green with a pair of oblique brown dashes back of apex. Length, female and male 3 mm.

Vertex produced, bluntly angled, a little wider between eyes than length at middle. Pronotum shorter than vertex, twice wider than long, lateral margins almost angled. Elytra decidedly longer than abdomen, venation simple.

Color: Yellowish-green, vertex, pronotum and scutellum deeper yellow, median impressed line on vertex, infra-ocellar line, a pair of narrow curved lines extending from this up over apex and a pair of heavy oblique dashes above apex, brownish. Elytra whitish subhyaline, nervures yellowish. Face dark brown with eight pairs of conspicuous pale arcs, clypeus and lorae paler, sutures dark. Venter, except apical segment, principally black and ovipositor black.

Genitalia: Female last ventral segment equal in length to preceding, posterior margin roundingly produced, median half abruptly, deeply excavated each side of a long, median round-pointed tooth. Lateral angles obsolete. Male valve longer but much narrower than last ventral segment, roundingly produced to sharp-pointed apex. Plates broad at base, almost four times length of valve, convexly rounded then gradually narrowed to pointed appressed tips. Pygofers very long, much exceeding the plates, and with numerous stout bristles.

The characters as described will readily separate this species. It is a grass feeding species and is found in the mountains of Colorado but no records for other states are known.

Type locality Leadville, Colorado. Type in Agr. College collection, Ft. Collins, Colorado. Type and other specimens examined were from Colorado.

Deltocephalus helvus n. sp.

(Plate XVI, Figs. 4, 4a; Plate XXVII, Fig. 8)

In general appearance resembling *auratus*, but slightly larger, more robust, pale yellow in color and with distinct genitalia. Length 3 - 3.25 mm.

Vertex bluntly angled, flat, a little wider between eyes than length at middle. Ocelli close to eyes and above margin. Pronotum as long as vertex and about twice as wide. Elytra in brachyterous forms exposing the last two dorsal segments. In macropterous forms exceeding abdomen.

Color: Straw yellow to dull green without dark marking. Veins of elytra paler. Face pale fuscous with lighter arcs. Ovipositor sometimes black.

Genitalia: Female last ventral segment one-half longer than preceding, in general appearance somewhat transparent and apparently composed of the last ventral segment proper and an underlying membrane which is more or less fused with it. Lateral angles rounded, exposing small portions of side plates. Posterior margin with central third broadly and moderately concave between two narrowly produced and slightly rounded lobes which apparently are portions of an underlying membrane. Margin of segment proper seemingly sinuated and slightly notched at center but almost obscured by fusion.

Described from a series of eighteen female specimens collected at Yellowstone Park, Wyoming, and Dickinson, North Dakota, by Professor Herbert Osborn and kindly loaned for this study.

Type in Osborn collection.

Deltocephalus exectus n. sp.

(Plate XVI, Figs. 7, 7a; Plate XXVII, Fig. 7)

A yellowish species resembling in size and form the eastern *littoralis* but with distinct genital characters. Length 3 - 3.5 mm.

Vertex well produced and bluntly angled, margin thick and rounded to front, a little wider at base between eyes than length at middle, as long as pronotum. Elytra either just covering abdomen or exposing the last two dorsal segments. Face broad, convexly rounded.

Color: Straw yellow to deep golden or greenish yellow without dark markings, veins of elytra paler. Face pale fuscous, arcs lighter.

Genitalia: Female last ventral segment almost twice as long as preceding, lateral angles rounded to posterior margin which is gently sloping either side to a central slightly concave portion. Margin of segment embrowned.

Described from two female specimens in the collection of Dr. E. D. Ball, collected at Little Beaver, Colorado, August 20, 1898, and at Fort Collins, Colorado, August 13, 1900; and a series of female specimens in the collection of Professor Herbert Osborn, collected by him at Bozeman, Montana, labeled Webster No. 7037.

Type in Osborn collection.

Deltocephalus auratus Gillette and Baker.

(Plate XVI, Figs. 5, 5a, 5b; Plate XXVI, Fig. 6)

Gillette and Baker, Hemip. Colorado, p. 85, 1895.

An orange yellow species with vertex almost rounded. Length, female, 3 mm.; male, 3.25 mm.

Vertex very blunt and rounded at apex, variable in length from as wide as long in female to one-fourth wider than length at middle in male. Pronotum twice as wide as long. Elytra considerably longer than abdomen in macropterous forms, but reaching only to penultimate dorsal segment in brachypterous females; venation simple.

Color: Varying from dull yellow to bright orange yellow, margin of vertex and face often deeper orange. Elytra slightly smoky subhyaline, nervures bright orange. Legs and venter same as above, basal segments black on dorsum in males. Face often with paler arcs.

Genitalia: Female last ventral segment slightly longer than preceding, lateral angles obsolete, posterior margin slightly excavated either side of a median, low obtuse black-margined tooth which is very blunt or slightly bifid at apex. Male valve one-half longer than last ventral segment, broad, triangular. Plates almost twice longer than valve, gradually narrowed to broadly rounded tips. A dark spot on inner apex of each, and a large semi-circular hyaline area at base of each, appearing dark.

This species was described from a female of one species and the male of another but since the female is apparently the common *striatus* which is now missing in the type set and as the name has been attached to the male as described it seems best to disregard the female as described by Gillette and Baker and replace it by the female as described by Sanders and De Long which is the female corresponding to the original male.

The range of this species is western only and it is now known to occur in Colorado, Wyoming, Montana, and North Dakota. Professor Osborn reports that at different altitudes a decided difference in color will be found, the more highly colored specimens occurring at higher altitudes. The food plant for this species has not been reported.

Type locality Ft. Collins, Colorado. Type in Baker collection United States National Museum, Washington, D. C. Type examined, also specimens from Yellowstone Park, Wyoming; Dickerson, North Dakota; and Bozeman, Montana (Osborn collection).

Deltocephalus bimaculatus Gillette and Baker.

(Plate XV, Figs. 6, 6a, 6b; Plate XXVIII, Fig. 4

Gillette and Baker, Hemip. Colo., p. 86, 1895.

Easily distinguished from the other green species by the bluntly produced head with two large round black spots, and by the distinct genital characters. Length 4 - 4.5 mm.

Vertex blunt, one-fourth wider between eyes than length at middle, as long as pronotum which is truncated behind and with lateral margins obsolete. Elytra long, rather narrow, exceeding abdomen.

Color: Dull green washed with yellow on vertex, pronotum, and scutellum; vertex with a large round black spot each side of apex on margin and extending onto front, and often an irregular blotch near each ocellus. Pronotum dull olive green, scutellum lighter, washed with yellow. Elytra dull green, nervures paler, often margined with fuscous. Face marked with conspicuous black arcs.

Genitalia: Female last ventral segment one-half longer than preceding, lateral margins narrowed at half their length, and sloping to median half of posterior margin which is slightly concave with a broad rounding median tooth, causing it to appear somewhat trilobate. Male valve as long as last ventral segment, rounded, almost semi-circular; plates twice longer than valve, broad at base and gradually narrowed to rather acute tips which converge and sometimes overlap at apex.

At the present time this species is known only from specimens collected in Colorado where it seems to be quite common and well distributed. According to Baker's record it was taken from *Carex* and *Willow*. Dr. Ball reports that the nymphs are of the *Thamnotettix* type and further study may show this relationship more clearly.

Type locality Estes Park, Colorado. Type in Baker collection, United States National Museum, Washington, D. C. Type and other specimens examined were from Colorado.

Deltocephalus cookei Gillette.

(Plate XV, Figs. 4, 4a, 4b; Plate XXVIII, Fig. 3)

Gillette, Colo. Agr. Exp. Sta., Bul. 43, p. 24, 1898.

In form resembling *striatus* but smaller with more coloration on vertex and distinct genital characters. Length 2.2 - 2.5 mm.

Vertex almost as long as width between eyes, apex very blunt and rounded, shorter than pronotum which is truncate behind. Elytra longer than abdomen, with only a suggestion of the appendix.

Color: Pale yellow to gray, vertex with a line arising either side of apex which extends to eye along margin then to base of vertex. A curved line just inside this either side arises near the disc, curves toward eye then obliquely to base running almost parallel to outer one. In some specimens only spots are present to indicate these markings. Pronotum with faint longitudinal lines. Elytra gray to greenish subhyaline, nervures near base and apex fuscous margined, often with dark blotches on base. Face pale brown with numerous arcs; venter dark brown to black.

Genitalia: Female last ventral segment as long as preceding, lateral angles strongly produced between which the posterior margin is distinctly concave to a broad, blunt median tooth. Male valve one and one-half times as long as preceding, convexly rounded to obtuse blunt apex. Plates exceeding valve by two-thirds its length, as broad as valve at base,

strongly convexly rounded two-thirds their length then suddenly constricted and produced into broad, rather blunt apical teeth.

It is known to occur in Colorado (Gillette) and South Dakota (Severin). It is apparently a grass species but no definite data is at hand regarding food plant or habitat.

Type locality Manhattan, Colorado. Type in Agr. College collection, Ft. Collins, Colorado. Colorado specimens in Ball collection examined, also specimens from Ft. Pierre, South Dakota (Severin).

Deltocephalus striatus (Linneaus).

(Plate XV, Figs. 2, 2a, 2b; Plate XXVI, Fig. 3)

Cicada striata Linneaus, Fauna Suec., Ed. I, p. 642, 1746.
Jassus striatus Herrick-Schaeffer, Deutschl. Ins., p. 130, 10.
Jassus strigatus Germar, Mag. d. Ent., IV, p. 92, 33.
Deltocephalus striatus Flor. Rhny. Livl., II p. 259, 1861.
Deltocephalus affinis Gillette and Baker, Hemip. Colo., p. 84, 1895.
Deltocephalus harrimani Ashmead, Harriman Alaska Exped., VIII, p. 132, 1904.

A very common species, greenish to brownish, marked with fuscous, vertex broadly angled. Length, female, 4 mm.; male, 3.5 mm.

Vertex very blunt and broadly angled, almost one-third broader between eyes than length at middle. Pronotum one-fourth longer than vertex, more than twice as wide as long. Elytra greatly exceeding abdomen, venation simple.

Color: Quite variable, vertex often with definite fuscous spots or blotches, interocellar line pale. Pronotum and scutellum with irregular fuscous markings. Elytra whitish hyaline, nervures greenish-yellow, more or less margined with fuscous. Sometimes very dark and giving a striped appearance to the elytra. Face brownish with pale arcs and paler below. Venter black in the male or marked with black in the female.

Genitalia: Female last ventral segment a little longer than preceding, simple, posterior margin produced, median half shallowly concave, lateral angles rounded. Male valve narrower and slightly longer than last ventral segment, roundingly produced to almost truncated apex. Plates exceeding valve by only one-third their length. Apices obliquely truncated and gently sloping to median line. The large rounded valve almost covering the short plates is characteristic of this species.

The genital characters and especially the unique character of the male, with a large semicircular valve almost covering the short plates will easily distinguish this species.

It is extremely variable in coloration, markings, and general appearance. The color may vary from a pale green or yellow to a dull dark green or brownish green and it may be striped or bear various ornamentation on the head and elytra. The elytra too may be extremely long or scarcely cover the abdomen but there is no variation in the genital characters. It has consequently been described by various authors under different names.

In the United States it has been known for many years as D. *affinis* Gillette and Baker, and specimens from Alaska preserved

in alcohol were described as *D. harrimani* Ashmead. Professor Osborn reported these as "evidently *affinis*" and an examination of the type material in the National Museum has verified this identification.

It is a very common meadow species and occurs on numerous grasses, especially abundant in blue grass habitats. It is abundant throughout the summer.

Described from Europe, perhaps Sweden. Type doubtful.

Deltocephalus ordinatus Ball.

(Plate XVII, Figs. 2, 2a; Plate XXVIII, Fig. 2)

Ball, Can. Ent., XXXI, p. 307, 1899.

Resembling *collinus* and *littoralis* in form but with a broad, blunt vertex and with longitudinal brownish bands on vertex. Length 3.5 - 4 mm.

Vertex bluntly angled, slightly wider between eyes than length at middle, as long as pronotum which is broad and with rounding lateral margins. Elytra in macropterous form exceeding abdomen, in brachypterous form exposing the last two abdominal segments.

Color: Pale straw yellow, with a brownish stripe, often only faintly showing on either side of vertex extending from the apex to the base of scutellum. Pronotum with an additional faint stripe behind each eye. Elytra pale yellowish, subhyaline, with brownish color of abdomen more or less visible. Face pale olive with light arcs, beneath yellow.

Genitalia: Female last ventral segment longer than preceding, lateral angles slightly produced and rounded, posterior margin roundingly excavated for one-third the distance from the lateral angles then produced into a pair of slightly divergent, acutely angular teeth between which is a short, broadly rounded lobe.

Although only one sex is known the character is distinct and unique among the allied species. Very few specimens apparently have been taken and records for distribution are very limited. It was described from Colorado and has since been taken at Bismark N. D. (Osborn). Nothing is known regarding its food plant and life history.

Type localities Marshall's Pass and Ft. Collins, Colorado. Type in Ball collection. Type examined, also specimens from Bismark N. D. (Osborn.)

Deltocephalus larrimeri n. sp.

(Plate XVI, Figs. 6, 6a, 6b; Plate XXVII, Fig. 6)

A large robust species, in general appearance resembling an *Aconura* but most closely related to *collinus*. Genital characters distinct. Length 4 mm.

Vertex bluntly rounded, about one-third wider between eyes than length at middle, not quite as long as pronotum which is strongly concave posteriorly and more than twice as broad as long. Elytra very short in female, almost entirely exposing last two dorsal segments. Cells strongly abbreviated.

Color: Dirty white to a dull gray tinged with green. Vertex whitish with indications of two broad, longitudinal, fuscous stripes. Pronotum and scutellum tinged with green, un-

marked. Elytra dull gray, nervures whitish, abdomen above yellowish. Face pale fuscous with lighter arcs. Beneath dirty white.

Genitalia: Female last ventral segment a little longer than preceding, lateral angles rounded to posterior margin which is almost truncate, the central fifth distinctly and abruptly excavated and bearing a broad, short tooth at its apex. Pygofers very long and slender. Male valve two-thirds as long as basal width, apex rounded, more than twice as long as preceding segment. Plates exceeding valve by one and one-half times its length, broad at base, convexly rounded two-thirds their length then produced into rather broad, blunt, divergent apices. Pygofers broader and longer than plates.

Although the male resembles *collinus* very much and apparently is closely related to it, the male plates are proportionately longer and the produced tips are narrower. The female is designated as the type.

Described from one male and three female specimens from Missoula, Montana, collected August 3, 1916, by Dr. W. H. Larrimer. I take pleasure in dedicating this species to Dr. Larrimer who has collected many interesting species in this group.

Type in author's collection.

SUBGENUS AMPLICEPHALUS

Vertex transverse and broad, width between eyes greatly exceeding length at middle, strongly rounded or very broadly bluntly angled and bluntly angled with front. Form broad and robust. Elytra with central anteapical cell constricted and divided.

Type of subgenus *osborni* Van Duzee.

The members of this subgenus are very closely related to those of the genus *Euscelis* and with further work in the relationships of that group it may be necessary to transfer these species. They seem, however, to show certain *Deltocephaloid* relationships and are cited here as a separate subgenus.

Key to Species of Amplicephalus*

1. Vertex bluntly angled, four prominent black spots above margin, the central pair approximate and triangular. Female segment with rounded tooth between two broad lobes; male plates rather narrow, concavely rounded to pointed tips....*simplex*

Vertex very broad, scarcely angled, female segment with posterior margin almost trilobate, the central lobe shortest; male plates broad, triangular, tips pointed..*osborni*

Deltocephalus simplex Van Duzee.

(Plate XVII, Figs. 4, 4a, 4b; Plate XXVIII, Fig. 5)

Van Duzee, Trans. Am. Ent. Soc., XIX, p. 304, 1892.

Athysanus simplarius. Osborn and Ball, Ohio Nat., II, p. 249, 1902 (n. n. for *simplex* Van D.)

Broad robust species with bluntly angled vertex, greenish with four black spots on anterior margin of vertex. Length 4-5 mm.

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* Not including *D eburneus* described since this manuscript was completed. Description at end of systematic portion, page 95.

Vertex more than one-fourth wider than long, bluntly, broadly angled. Pronotum slightly longer than vertex, more than twice as wide as long, transverse. Elytra exceeding abdomen, broad and broadly rounded at apices.

Color: Pale yellowish green, pale reflexed arcs of front extending onto vertex, a pair of large, triangular approximate spots at apex and a large transverse spot next either ocellus, black. Pronotum unmarked, sometimes olive green. Elytra greenish, nervures conspicuous, yellow. Face pale with brownish arcs, venter pale brown. Ovipositor black.

Genitalia: Female last ventral segment as long as preceding, lateral margins very short, then concavely rounded to produced posterior margin which is slightly concaved and notched either side of a short blunt median tooth. Underlying membrane visible as lateral lobes at sides of last ventral segment. Male valve very short, almost transverse, lying in concavity of last ventral segment. Plates about twice as long as valve, broad at base, strongly concavely rounded and produced to acute tips.

Collecting records show that this species has a rather extended distribution along the Atlantic coast, from Connecticut to lower Virginia. It was collected by the author at Cape Charles, Virginia, in late July very abundantly from *Spartina patens* in a salt marsh. The growth of *Spartina* was very dense and after fruiting the tops had fallen over and made a perfect mat. This was simply teeming with adults and several specimens of *littoralis* were also collected.

Type localities, Canton Marsh, Md., Astoria, L. I., and Hoboken, N. J. Type in Agricultural College collection, Ames, Iowa. Specimens examined from East River, Conn., Keyport, N. J., and Cape Charles, Va.

Deltocephalus osborni Van Duzee.

(Plate XVII, Figs. 5, 5a, 5b; Plate XXVIII, Fig. 6)

Van Duzee, Trans. Am. Ent. Soc., XIX, p. 304, 1892.
Athysanus osborni Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 220, 1897.

Broader than *simplex* with vertex more obtuse, tawny yellow with darker marking. Length 4.5-5 mm.

Vertex one-third broader than long, obtusely angled, shorter than pronotum which is very broad. Elytra three and one-half times as long as broad, slightly longer than abdomen.

Color: Tawny yellow, varied in markings. Vertex usually with four or six dark spots on anterior margin. The middle pair larger and prominent. The two next either ocellus smaller, transverse and often wanting. Often in well marked specimens a tawny interrupted transverse band between eyes and an irregular area on base at either side. Pronotum tawny with traces of five pale longitudinal bands. Elytra grayish yellow, nervures white, often heavily margined with fuscous. Face pale with heavy brownish arcs. In pale specimens markings often indistinct.

Genitalia: Female last ventral segment with lateral margins very short, then suddenly concavely produced to posterior margin which is bisinuate forming three broadly rounding lobes, broadly margined with dark brown. Underlying membrane produced as lateral lobes which extend beyond the last ventral segment. Male valve short and broadly rounded. Plates three times as long as valve, triangular, gradually narrowed to acute tips.

In general appearance this species resembles a number of species now referred to the Genus *Euscelis*. There is some doubt con-

cerning its true relationship and this as well as other species have been hard to place in this arrangement to show their relationship by characters that are most important.

It is quite widely distributed through the Northeastern United States and has been found from Maine to Colorado, Missouri, and Nebraska and extending almost as far south as the Ohio River. It is especially abundant in more northern states.

It occurs on tall grasses and sedges in marshy areas of the *Calamagrostis* meadow where a swamp or lagoon has receded. The definite food plant is not known.

Type locality Lancaster, N. Y. Type in Agricultural College collection, Ames, Iowa. Specimens examined from many localities.

SUBGENUS DELTOCEPHALUS

Vertex rather short, usually roundingly produced or very bluntly angled, disc sloping or convexly rounding from pronotum to front or with margin very thick, scarcely angled with front. Ocelli close to eyes and distinctly below the level of the disc. Venation of elytra simple, central anteapical cell very elongate, constricted and usually divided.

Type of subgenus *pulicarius*. Fallen.

The species placed in this subgenus can usually be recognized by the black coloration on the vertex in the form of spots and bars which extends down along the eyes on the face and by the numerous heavy black bars or arcs on the face. The female genitalia are usually concave and frequently bear a sunken tooth.

Key to Species of Deltocephalus

1. Size small, not exceeding 2.5 mm 2
   Size larger, more than 2.5 mm., often 3 mm. or more 6

2. Vertex, pronotum, and scutellum black or heavily mottled with black 3
   Vertex, pronotum, and scutellum pale, usually yellowish or greenish with a few black spots or pale stripes 4

3. Robust, elytra black or with heavy black bands, always with a milky white transverse band across anterior veins of anteapical cells. Female segment concave with a short blunt tooth at apex ..... *castoreus*
   More slender, elytra whitish subhyaline, sometimes slightly smoky; female segment deeply concave without prominent tooth ..... *gnarus*

4. Color greenish-yellow, vertex frequently with a pair of approximate black spots at apex and an irregular blotch next either eye. Female segment with a prominent tooth at center of concavity and conspicuous lobes of underlying membrane. Male plates triangular, with pointed tips ..... *minutus*
   Usually with a row of spots above vertex margin. Female segment without a median tooth 5

5. Vertex bluntly pointed, a little longer than width between eyes. Female segment almost truncated, with exposed lobes of underlying membrane. Male plates extremely long with narrow, black, pointed tips.....*marinus*

Vertex bluntly rounded, wider than median length. Female segment shallowly concave without membraneous lobes. Male plates shorter, narrower and bluntly pointed.*australis*

6. Dark brown to black with several white spots on vertex, and costal margin of elytra broadly yellow. Female segment almost abruptly produced from preceding segment, posterior margin almost truncate.....*flavicosta*

Usually pale with dark markings, costal margin not broadly yellow. Female segment usually concave or incised..... 7

7. Vertex heavily marked with black, elytra mottled. Female segment slightly produced, narrowly notched and incised at middle. Male plates suddenly curved near apices to inwardly pointed tips.....*nigriventer*

Female segment not incised at middle..... 8

8. Color yellowish, vertex with a pair of very large, round black spots just before eyes. Female segment with a narrow sunken median lobe.....*punctatus*

Vertex with more or smaller markings, female segment without sunken lobe..... 9

9. Vertex with a pair of approximate triangular spots just above apex, often only faintly visible. A broad white band on posterior margin of next to last visible dorsal segment of abdomen in female.....10

Vertex with a row of spots above margin sometimes fused into bands or blotches without white band on dorsal abdominal segment.....11

10. Female segment with long lateral margins, lobes of underlying membrane not visible, posterior margin concave with sunken tooth, male plates short.....*pulicarius*

Female segment with side margins short, sloping to truncate posterior margin, lobes of underlying membrane conspicuous. Male plates longer, abruptly narrowed to tips ..... *chintinomy*

11. Female segment with lobes of underlying membrane conspicuous at side margins of last ventral segment.....12

Underlying membrane, if present, not visible, almost entirely covered by side margins of female segment.....13

12. Form slender, posterior margin of female segment with a rounded lobe either side of a median rounded tooth. Vertex anteriorly with four black spots above margin, the median pair smaller and approximate, posteriorly with paler oblique dashes....*sonorus*

Vertex usually with a dark broken band between anterior margins of eyes and some small spots before it. Female segment rather abruptly excavated, slightly rounded either side of a median tooth.....*balli*

13. Color variable, vertex marked with black band and spots, female segment excavated with a short median tooth at its apex.....*fuscinervosus*

Color variable with a few spots or darkly marked, female segment rather broadly shallowly excavated without median tooth.....*vanduzei*

Deltocephalus castoreus Ball.

(Plate XVIII, Figs. 1, 1a, 1b; Plate XXIX, Fig. 2)

Ball, Can. Ent. XXXI, p. 308, 1899.

Short and robust with blunt vertex, black with three pale subhyaline bands across elytra. Length 2-2.5 mm.

Vertex conical, obtusely angled, two-thirds as long as width between eyes, disc sloping, pronotum almost one-third longer than vertex, side margins extremely short. Elytra rather short and broad, surpassing abdomen in male, not covering abdomen in female.

Color: Vertex shining black, a circle enclosing black tip connected with ocelli by a slender line, and a broad irregular band covering base, pale yellow, leaving a black band before eyes. Pronotum black with a trilobate yellow mark on middle two-thirds of posterior margin.

Scutellum black. Elytra black with three rather irregular pale hyaline transverse bands. One runs from scutellum obliquely across first cross nervure to costa, another transverse one across apex of clavus and a third across apex of elytra. Black beneath.

Genitalia: Female last ventral segment half longer than preceding, lateral angles produced and rounded, posterior margin concave with a small median tooth. Male valve short and broad, obtusely triangular, almost as long as preceding segment, edge membraneous except at tip. Plates broad at base, three times as long as valve, roundingly narrowing to blunt rounded apices which are curved upwards. The plates as long as pygofers.

The coloration may vary in a series of specimens from almost a pure black to a banded appearance as described above. The short robust form will usually distinguish this species very easily.

The only record for distribution which has been reported is for Colorado. Specimens have been examined in the Osborn collection from Yellowstone Park, Wyoming, and Kalispell, Montana, all collected by Professor Osborn.

Type locality Larrimer County, Colorado. Type in Ball collection was examined.

Deltocephalus gnarus Ball.

(Plate XVIII, Figs. 2, 2a, 2b; Plate XXX, Fig. 1)

Ball, Can. Ent., XXXII, p. 345, 1900.

A very minute species resembling *nigriventer* but with vertex, pronotum, and scutellum black, and milky white elytra; genitalia distinct. Length 2.25–2.5 mm.

Vertex blunt, obtusely angled, one-fourth wider between eyes than length at middle, and longer than pronotum. Elytra longer than abdomen, venation weak, outer anteapical cell very small.

Color: Vertex shining black, a spot at apex sometimes connected with a cross back of it and often connected by lines to the circles around ocelli, and a pair of oblique dashes from margin toward disc, light. Pronotum black, a row of submarginal spots and the posterior margin, narrowly light. Scutellum black. Elytra white, subhyaline, veins milky, in the male the disc often smoky. Face black with numerous dashes and pale arcs; venter black.

Genitalia: Female last ventral segment twice as long as preceding, lateral angles broadly rounded to almost truncate posterior margin, central fourth slightly indented bearing a very minute central blunt tooth. Membraneous plates exposed at sides of last ventral segment. Male valve as long as preceding segment, obtusely angled; plates as broad as valve, slightly roundingly narrowed to somewhat acuminate, pointed tips.

This minute black species is undoubtedly a member of the *balli* group but is easily separated from the other species.

The known distribution is quite limited and the species will no doubt be found more widely distributed than present records indicate. It was described from Iowa and recently has been taken in Tennessee by Crumb and in South Dakota by Severin.

Dr. Ball reports this species as occuring on "dog hair" *Juncus* at the margin of a pond. Mr. Crumb reports it from the same food plant and a similar habitat, and the South Dakota specimens from Severin are labeled "Lake Oakwood," June 26. It apparently is

confined to this type of habitat since the food plant upon which it is found occurs only in wet or marshy places. The life cycle is not known but collecting records indicate a two-generation cycle.

Type locality Ames, Iowa. Type in Ball collection. Type examined, also specimens from South Dakota, (Severin).

Deltocephalus minutus Van Duzee

(Plate XVIII, Figs. 5, 5a, 5b; Plate XXX, Fig. 2, 3)

D. minutus Van Duzee, Ent. Amer., VI, p. 96, 1890.
Doratura minuta Osborn and Ball, Proc. Ia. Acad. Sci., IV, p. 220, 1897.
Lonatura minuta Van Duzee, Trans, San Diego Soc. Nat. Hist., p. 54, 1914.

In size, form and coloration resembling *minimus* but with different head and genital characters. Length 2-2.5 mm.

Vertex bluntly angled, a little wider between eyes than length at middle, as long as pronotum. Elytra often short exposing the dorsal surface of pygofers and preceding segment. Apical cells very minute and anteapicals very much shortened. Elytra when normal longer than abdomen, venation simple.

Color: Yellowish green, ocelli and often a pair of approximate spots at apex, black. Pronotum and scutellum yellowish green, unmarked. Elytra subhyaline, dark color of body showing through, veins yellowish. Face shining black, often with paler spots indicating arcs. Venter dull green to black. Ovipositor black.

Genitalia: Female last ventral segment attached to pleuron by only a short basal portion, then rather abruptly produced to posterior margin forming a large rounded lobe either side of a median excavation which bears at its apex a sharp pointed tooth. A lobe of underlying membrane conspicuous at either side. Male valve only slightly obtusely produced, lying in concavity of last ventral segment. Plates rather long, gradually produced to rather blunt tips. Pygofers much longer than plates.

Although this species has been placed in *Lonatura* it shows very definite relations in head, wing, and genital characters to species of the *fuscinervosus-vanduzei* group and it seems best to place it here because of these characters. At present it is known only from the southern portion of California.

Type locality "California." Type in Agricultural College collection, Ames, Iowa. All specimens examined were from California.

Deltocephalus marinus Metcalf and Osborn.

(Plate XVIII, Figs. 3, 3a, 3b; Plate XXIX, Fig. 5)

Metcalf and Osborn, Ann. Ent. Soc. Amer., XIII, p. 110, 1920.

A very small species allied to the *nigrifrons group*, in coloration resembling *sonorus* but much smaller, with more pointed vertex and distinct genital characters. Length 2.25 mm.

Vertex bluntly angled, about one-fifth longer on middle than width between eyes at base. Pronotum almost truncate behind, not quite as long as vertex, side margins almost obsolete. Elytra longer than abdomen.

Color: Pale yellow, vertex with four black spots just above margin, the inner pair largest, in well marked specimens a pair of spots on disc and a pair of elongate oblique ones either side on base, fuscous. Pronotum with six faint longitudinal stripes. Elytra dull white

to olive, veins lighter, margined with fuscous. Face yellowish with several pairs of fuscous arcs.

Genitalia: Female last ventral segment more than twice as long as preceding, lateral margins rapidly narrowed and rounded to posterior margin which is slightly concave. The underlying mebrane conspicuous as lateral lobes at either side. Male valve broadly angled, apex blunt. Plates three times longer than valve, broad at base, concavely rounded to sharp pointed, divergent, upturned black apices.

The habitat of this species as stated in the original description is a grassy mat on the shore between the high and low tide lines and where apparently the insect is submerged during a part of each day. It is probably adapted for some condition of this kind. By recent data collected in Florida by the author it seems that the species is not confined to this condition, for it was found occurring on the prairie grasses at La Belle in the everglade region and several miles from tidal conditions. Also it occurred on short grasses in dry habitats. It was also taken on Sanibel Is. above the high tide line and occurred on dense mats of rather coarse grasses. This would indicate a diverse habit and it may be fitted for living in extreme conditions.

Type locality Wrightville Beach, North Carolina. Type in Osborn and Metcalf collections. Type examined, also specimens from La Belle and Sanibel Is., Florida.

Deltocephalus nigriventer Sanders and De Long.

(Plate XVIII, Figs. 4, 4a, 4b; Plate XXIX, Fig. 3)

Sanders and De Long, Ann. Ent. Soc. Amer., X, p. 85, 1917.

A small robust species, resembling *vanduzei* in general form and coloration on vertex but with genital characters distinct. Length 2.5-2.75 mm.

Vertex obtusely angled, two-thirds as long as width between the eyes, rounded on disc. Pronotum a little longer than vertex, posterior margin truncate. Elytra exceeding abdomen.

Color: Vertex yellowish, a pair of apical spots just back of apex and a broad sinuate band, interrupted at middle between anterior margins of eyes and ocelli, black. Pronotum milky white to yellow, scutellum with spots in basal angles and a median longitudinal stripe, black. Elytra milky gray, subhyaline; clavus irregularly mottled with brown, a large spot on discal cell, one on third anteapical cell and another midway on costal margin, black. Nervures milky white. Face black with several pairs of pale lateral arcs. Venter black, segments pale margined.

Genitalia: Female last ventral segment twice as long as preceding, lateral angles rounded to almost truncate posterior margin which is incised nearly to base, margins of incision almost overlapping, roundingly angled. Male valve scarcely longer than preceding segment, obtusely pointed. Plates large, broadly convex, tapering to rounded, upturned blunt points, margins and dorsal surface with pale hairs.

The small size together with the black bar on vertex, and the black and milk-white spots on the elytra will readily separate it from closely related species.

This species was first recorded for Wisconsin and has since

been taken in New York (Osborn), Quebec (Ouellet), and in South Dakota (Severin). All these records point to a northern distribution.

It occurs in old pastures on short grasses. The food plant is not definitely known but apparently is a grass with a northern distribution.

Type locality Merrillan, Wisconsin. Type in Sanders and De Long collection.

Deltocephalus australis n. sp.

(Plate XIX, Figs. 2, 2a, 2b; Plate XXVIII, Fig. 9)

In general appearance resembling *fuscinervosus* but with elytra shorter, coloration a little different and with genitalia, especially in the male, distinct. Length 2.5 mm.

Vertex obtusely angled, tip blunt and rounded, about one-fifth wider between eyes than length at middle. Pronotum longer than vertex, twice wider than long, lateral margins almost obsolete. Elytra rather short, not much longer than abdomen, outer clavus with one reticulate vein, central arteapical cell constricted and divided. Eye distinctly notched next to basal joint of antenna.

Color: Brownish yellow, vertex with median impressed line brown, a pair of round spots just back of apex and an elongated spot, sometimes divided, just back of ocellus on each side, black. Pronotum and scutellum unmarked. Elytra brownish subhyaline, nervures paler, black color of dorsum showing through. Face black with central stripe and a few arcs pale.

Genitalia: Female last ventral segment longer than preceding, lateral angles rounded to concaved last ventral segment which is narrowly brown bordered. Male valve large, triangular .apex obtusely angled, narrower than last ventral segment and about one-half longer. Plates short and broad, exceeding valve by about its length, tips more than half as wide as at base, broadly rounded. Exceeded by pygofers both laterally and apically.

Described from a series of specimens taken at Miami, Florida, by the author, April 4 and 12, and one specimen from Sanibel Is., Florida, April 28, 1921, and three specimens from Pascagoula, Mississippi, collected August 8, 1921, by H. L. Dozier. This is a strikingly distinct species and was taken at Miami, Florida, on small grasses on the sandy upper beach along the bay. The food plant is not definitely known.

Type in author's collection.

Deltocephalus flavicosta Stal.

(Plate XVIII, Figs. 6, 6a, 6b; Plate XXVIII, Fig. 7)

Stal. Rio. Jan. Hemip., II, p. 53, 1862.
D. flavicostatus Van Duzee, Can. Ent. XXIV, p. 116, 1892.
D. retrorsus Uhler, Proc. Zool. Soc. Lon. for 1895, p. 78.

A dark brown or black species with a few yellowish spots and the costal margins of the elytra broadly yellow. Length 3-3.5 mm.

Vertex rounded, bluntly conical, broader between eyes than length at middle. Pronotum longer than vertex, twice wider than long. Scutellum large. Elytra rather long and narrow.

Color: Dark brown to black, vertex with spots enclosing ocelli, a spot at tip of apex and three arranged concentrically behind this, one against the margin of each eye behind ocellus, and a pair of approximate elongate ones at base, pale. Pronotum with faint traces of pale longitudinal lines. Elytra with veins usually paler, the anterior half of costa broadly yellow and the costal veinlets on posterior portion broadly white. Face black with a few pale arcs. Venter black with pale markings, legs yellow.

Genitalia: Female last ventral segment twice as long as preceding, seemingly arising abruptly from preceding segment, lateral margins at half their length concavely produced to a sinuate posterior margin forming four more or less distinct lobes, the inner pair narrower. Underlying membrane visible only as lateral lobes at sides of segment. Male valve broad, longer than preceding segment, obtusely angled. Plates one and one-half times longer than valve, gradually narrowed to blunt rounded tips.

Through the kindness of Professor Osborn a series of specimens has been examined from Mexico, Brazil, Guatemala, and Bolivia. In the United States it is known to occur in the southwest, the Mississippi valley in Kansas, Missouri, and Iowa, and throughout the eastern United States as far north as New York and Connecticut. The specimens examined show a slight variation in characters and a very different intensity of coloration, but they are certainly all the same species belonging to *flavicosta* Stal.

In the south there are at least two generations and perhaps a second occurs in the northern states. In Florida it occurs on grasses in the open pinelands where it was taken abundantly both as nymph and adult. It apparently has several food plants. Farther north it occurs in meadows and on grasses in open woods.

Deltocephalus punctatus (Osborn and Ball).

(Plate XVIII, Figs. 7, 7a, 7b; Plate XXVIII, Fig. 8)

Athysanus punctatus Osborn and Ball, Proc. Dav. Acad. Sci., VII, p. 94, 1898.
Deltocephalus punctatus Van Duzee, Univ. Calif. Publ. Div. Ent. Tech. Bul., I, p. 249, 1916.

A broad, robust species with obtusely angled head and a pair of large round black spots on vertex, one next each ocellus. Length macropterous form 3.5 mm., brachypterous form 2.5-2.75 mm.

Vertex bluntly angled, almost one-fourth wider between eyes than length at middle. Pronotum about one-fourth longer than vertex, side margins very short, strongly produced anteriorly. Elytra just covering abdomen in macropterous forms and with apical cells distinct. In brachypterous forms elytra reaching only to sixth abdominal segment, apical cells small or wanting.

Color: Pale brownish yellow, vertex with a large round black spot just inside each ocellus and extending over two-thirds the distance between ocelli, often a pair of minute spots before the large ones and just back of apex. Pronotum and scutellum yellowish. Elytra subhyaline, more brownish, nervures a little paler, in some specimens appearing black from abdomen showing through. Face pale testaceous, dark brown to black.

Genitalia: Female last ventral segment twice longer than preceding, the lateral margins narrowed from near base and rounding to posterior margin which is almost truncate, the middle fourth of which is slightly excavated and bears a slightly produced lobe. The lobes of the underlying membrane are visible at the sides of segment. Male valve almost rounded, longer than preceding segment. Plates two and one-half times as long as valve, broad at base, concavely rounded to acute tips. Pygofers inflated at base.

Although not so closely related to this group the species shows definite relationship and has been included here. It was placed by Osborn and Ball as an *Athysanus* and further study may show it to be more closely related to that genus.

This species was described from specimens collected in Iowa and Nebraska, swept from *Sporobolus* and this should no doubt be considered as one of the prairie species. More recently Mr. Van-Duzee has reported this species from California stating that it resembles a pale form of *fuscinervosus*. The genital characters of *punctatus* are quite distinct as accompanying figures will show.

Type localities Little Rock, and Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined.

Deltocephalus pulicarius (Fallen).

(Plate XIX, Figs. 1, 1a, 1b; Plate XXIX, Fig. 1)

Cicada pulicarius Fallen, Hemip. Suec., Cicad. p. 34, 1826.
Jassus pulicarius Flor, Rh. L., II, p. 266, 1861.
D. infumatus Osborn, Me. Agr. Exp. Sta. Bul., 238, p. 118, 1915.

In general appearance recalling *compactus* but with a much blunter rounding head, elytra without claval reticulations, and with distinct genital characters. Length 2.5-3 mm.

Vertex broadly subangulate, one-fourth wider between eyes than length at middle. Pronotum as long as vertex, twice wider than long and side margins short. Elytra in female quite short exposing two apical segments of abdomen, apical cells very short; in male exceeding abdomen in length.

Color: Dull brownish, vertex with a pair of large spots just back of apex and two smaller ones either side toward eyes, brownish. These are often only faintly indicated. Pronotum dull brownish without definite markings. Scutellum with a dark cross on disc. Elytra subhyaline with a few whitish veins, venation somewhat indistinct, abdomen black above, penultimate dorsal segment of female conspicuously banded on posterior half with white. Face black with paler arcs, venter black.

Genitalia: Female last ventral segment a little longer than preceding, posterior border gently sloping from lateral angles to a shallow notch either side of narrow median tooth. Male valve short, rounded, as long as preceding segment; plates almost three times as long as valve, broad at base, gradually narrowed to thick blunt apices.

This species is known to occur in the United States only in Maine where it was collected by Professor Osborn and given the name *infumatus*. He stated in the description that it was probably *pulicarius*. These have been compared with European specimens and cannot be separated from that species. It has a meadow habitat but the food plant is not definitely known.

Type locality Stockholm, Sweden. Type probably in Stockholm Museum.

Deltocephalus chintinomy n. sp.

(Plate XIX, Figs. 4, 4a, 4b; Plate XXIX, Fig. 8)

Resembling very closely the European *pulicarius* in form and general appearance but easily separated by the genital characters. Length 2.75-3.25 mm.

Vertex bluntly rounded, at least one-fourth longer on middle than basal width between eyes. Pronotum transverse, longer than vertex, almost truncate behind. Elytra rather short, scarcely reaching tip of abdomen in female and only slightly surpassing it in male.

Color: Dirty yellow to brown. Vertex with indications of four spots, two at apex and two next ocelli as in *pulicarius*. Elytra brownish with white nervures. Next to last dorsal segment with white band on posterior portion. Face pale with about six pairs of brownish arcs more or less distinct. Venter dark brown to black.

Genitalia: Female last ventral segment about twice as long as preceding, side margins very short, gradually sloping to truncated or slightly produced posterior margin and thus exposing prominent side lobes of underlying membrane. Male valve short, only slightly roundingly produced, plates long, three times length of valve, broad at base, only slightly narrowed to one-third the distance from apex where they are more strongly narrowed to bluntly pointed tips. In general appearance resembling plates of *nigriventer*.

This species resembles very closely *pulicarius* and may be a European form but it cannot be so placed at present.

Described from a series of specimens received for study from Professor F. H. Lathrop collected from grassland at top of Mary's Peak, Oregon, August 5, 1917.

Type in author's collection.

Deltocephalus sonorus Ball.

(Plate XVIII, Figs. 8, 8a, 8b; Plate XXIX, Fig. 7)

Ball, Can. Ent., XXXII, p. 344, 1900.
D. signatifrons De Long, Tenn. St. Bd. Ent., Bul. 17, p. 47, 1916 (cited in error).

In general appearance and coloration resembling *balli* but more slender, with four black spots above vertex margin, and genitalia distinct. Length 3.25 mm.

Vertex obtuse, rounded at apex, one-fourth wider between eyes than length at middle. Pronotum truncate, almost one-third longer than vertex. Elytra rather long and narrow, appendix large, central anteapical cell extremely long.

Color: Vertex pale dirty yellow, with four large black spots on the anterior margin. The inner pair usually quadrate and smaller. Usually a pair of elongate fuscous spots either side at base and a pair on disc. Pronotum pale olive with five yellowish longitudinal stripes. Elytra olive to yellowish, subhyaline, veins pale often margined with fuscous. Face dull yellow to fuscous with pale arcs.

Genitalia: Female last ventral segment one-half longer than preceding, the lateral margins roundingly narrowed forming rounded lateral angles. The posterior margin slightly excavated with a slightly produced, rounded median lobe. Male valve obtusely angled, tip rounded, longer than preceding segment. Plates twice longer than valve, broad at base, gradually narrowed to acute tips. A pair of long attenuate styles almost as long as plates seem to be attached to their apices.

It is longer and more slender than the other species of the group occurring north of Mexico and has been definitely reported for only a few localities in Arizona, Texas, and Florida. The Osborn collection contains material from many localities such as North and South Carolina, Mississippi, New Mexico (Ainslie), and California, all collected by Professor Osborn unless otherwise designated. Records are also at hand for Tennessee (De Long) and

Kansas (Lawson). From this data it can be seen that the species has a very definite southern distribution.

It occurs on a number of grasses and from records of specimens given above it has been swept from *Alfalfa* at Holtville, California and from *Bermuda* grass at Sacaton, Arizona.

Type locality Tuscon, Arizona. Type in Ball collection examined.

Deltocephalus balli Van Duzee.

(Plate XIX, Figs. 5, 5a, 5b; Plate XXIX, Fig. 9)

Van Duzee, Check List. Hemip., p. 71, 1916 (n. n. for *nigrifrons Van D.*)
Deltocephalus nigrigrons Van Duzee, Trans. Amer. Ent. Soc., XXI, p. 293, 1894.

In general appearance resembling *nigrifrons* but with different markings on vertex and distinct genital characters. Length 3-3.5 mm.

Vertex bluntly angled, almost rounded, one-third wider between eyes than length at middle. Pronotum almost one-third longer than vertex, twice wider than long. Elytra much longer than abdomen.

Color: Yellowish to olive, markings variable. Vertex yellow or green, usually four spots above margin of vertex. The inner pair may be large or small and the outer pair are often in the form of a band extending between the anterior margins of the eyes and interrupted in the middle. Basal portion often with faint fuscous spots. Pronotum usually pale on anterior half and darker posteriorly. Scutellum with fuscous or orange spots in basal angles. Elytra smoky or olive subhyaline, nervures paler. Face black with several short pale arcs. Venter black.

Genitalia: Female last ventral segment one-half longer than preceding, lateral margin narrowed from near the base to produced, rounded lateral angles. Posterior margin sinuately sloping to a slightly excavated central portion which bears a minute black tooth at its apex. Membraneous lobes of underlying membrane conspicuous at sides of segment. Male valve obtusely angled, shorter and narrower than last ventral segment. Plates three times longer than valve, broad at base, convexly rounded to blunt tips which equal or surpass pygofers.

In attempting to obtain the type material and original description of this species it has been found that there is no type so designated and the only original description is of the darker forms of *nigrifrons* given by Osborn and Ball (1897). The species then must be based upon these specimens from Iowa. Typical specimens have been examined from Iowa (Osborn and Ball), Wisconsin, Ohio, and Pennsylvania (Sanders and De Long), and it is undoubtedly more widely distributed. This species is abundant in pastures and meadows feeding upon grasses and seems to be distributed throughout the northeastern United States.

Type locality Ames, Iowa. Cotypes in Osborn and Ball collections. Cotypes examined.

Deltocephalus fuscinervosus Van Duzee.

(Plate XIX, Figs. 3, 3a, 3b; Plate XXIX, Fig. 4)

Van Duzee, Bul. Buf. Soc. Nat. Sci., V, p. 207, 1894.

Very close to *balli* in coloration and structural characters from which it can be separated only by the genital characters. Length 2.5-3 mm.

Vertex obtusely angled, a little more pointed at apex than in *vanduzei*, at least one-third wider between the eyes than length at middle. Pronotum longer than vertex, truncate behind. Elytra longer than abdomen.

Color: Vertex yellow, an interrupted band between anterior margin of eyes, a pair of spots at apex and often one next each ocellus and four on basal half between eyes, black. These markings are quite variable. Pronotum with irregular markings on basal half black and posterior half dark brown to black. Basal angles of scutellum and a central line black. Elytra brownish olive, nervures pale, fuscous margined. Face black with a few pale arcs.

Genitalia: Female last ventral segment more than one-half longer than preceding, lateral margins rounded to rather prominent angles, posterior margin gently sloping to a slight notch either side of a small rounded central tooth. Membrane not visible at side margins. Male valve scarcely angled, almost transverse, plates broad at base, convexly rounded to blunt rounded tips, about two and one-half times as long as valve. Pygofers exceeding plates.

As noted in the original description the species is variable in intensity of color markings especially on the vertex. It was described from California and has since been taken over a large part of the western United States from Colorado to the Pacific coast where it occurs in abundance.

Type locality "California." Type in Agricultural College collection, Ames, Iowa. Specimens examined from many western localities.

Deltocephalus vanduzei Gillette and Baker.

(Plate XIX, Figs. 6, 6a, 6b; Plate XXIX, Fig. 6)

Gillette and Baker, Hemip. Colo., p. 90, 1895.
Athysanus artemesiae Gillette and Baker, Hemip. Colo., p. 91, 1895.

In size and form closely resembling *nigrifrons* but with different vertex markings, and genitalia distinct. Length 3 mm.

Vertex obtuse, almost one-third wider between eyes than length at middle, longer than pronotum which is almost truncate behind. Elytra longer than abdomen.

Color: Vertex yellowish, a pair of black spots near apex and a pair of large, irregular spots partially surrounding ocelli and touching eyes. These are sometimes fused in a band before the eyes. Pronotum pale anteriorly, olive posteriorly with indications of longitudinal bands. Scutellum with basal angles and a median line darker. Elytra pale olive, nervures pale, bordered with fuscous. Face black with a few pale arcs.

Genitalia: Female last ventral segment more than twice longer than preceding, lateral margins gradually narrowed to posterior margin which is slightly concave. The underlying membrane is present but not visible and concealed by the segment. Male valve obtusely angled, almost rounded. Plates almost three times as long as valve, gradually sloping to rather blunt tips, exceeded by pygofers.

It is quite probable that this form will prove to be only a variety of *fuscinervosus* which it resembles very closely in coloration and structural characters. At present it is separated only by the slightly concaved female segment which does not bear a tooth but this character may be variable in these two forms. These occur over the same areas of the west from Colorado to the Pacific coast and live in the same habitats.

Type locality Leadville, Colorado. Type in Agricultural College collection, Ft. Collins, Colorado. Specimens examined from Colorado and the pacific Coast.

Since the completion of this manuscript (June, 1922) three species have been described which are appended here.

Deltocephalus limicolus Osborn.

Florida Entomologist, Vol. VI, p. 17, 1922.

Resembling *interruptus* but broader and more robust. Length 3.6-3.75 mm.

Vertex wider than long, obtusely angled. Pronotum as long as vertex. Clavus of elytra with numerous reticulations. Anteapical cells irregularly broken up by cross veinlets.

Color: Vertex white with four dots on anterior margin, two lunate spots midway and two rounded ocellate spots on hind border, fuscous. Pronotum fuscous with five pale stripes. Scutellum with ivory spot on each side. Elytra with veins and veinlets for the most part ivory white, areoles mostly fuscous. Front with pale arcs and a median pale line, lorae yellowish. Venter dark.

Genitalia: Female last ventral segment short, posterior border slightly shallowly excavated. Underlying plates conspicuous at margins. Male valve short, transverse, broadly rounded; plates broad as base narrowing rapidly and terminating in acute, thin ,slightly upturned tips which are shorter than the pygofers.

This is a member of the subgenus Polyamia. It occurs on low growing plants on the tidal flats of the Florida coast.

Deltocephalus fusconotatus Osborn.

Florida Entomologist, Vol. VI, p. 17, 1922.

Resembling *arundineus* in size and general coloration, with distinct genitalia. Length 3.5 mm.

Vertex as long as width between eyes, one-half longer at middle than next the eye. Pronotum as long as vertex, clavus reticulate veined, central anteapical cell divided.

Color: Vertex pale, bordered anteriorly with black except at tip. Pronotum with three spots, two dots on base of scutellum. Elytra marked with a basal spot, a spot anterior and one posterior to the merged veins, a spot on costa near base, another before nodal vein, and the apical cells, fuscous or black. Base of front black, remainder of front, clypeus, lorae and lower part of cheeks, white.

Genitalia: Male valve narrow, rounded behind, plates small, triangular, about one-half the length of pygofers.

Known only from Cameron, Louisiana, the type locality. Type in Osborn collection. This species is closely allied to *arundineus* and is a member of the subgenus Polyamia.

Deltocephalus eburneus De Long.

Jour. N. Y. Ent. Soc. Vol. XXXII, p. 63, 1924.

In general appearance and coloration resembling a *Scaphoideus* of the *sanctus* group, but closely allied to *simplex* and *osborni*. Length 4.5 mm.

Vertex bluntly angled, almost one-fourth wider between eyes than length at middle. Disc flat, rather sharply angled with front. Pronotum almost twice as broad as long, side margins very short. Scutellum large. Elytra long, clavus reticulate, central anteapical cell long, constricted and divided at center, enlarged posteriorly.

Color: Vertex white with four small spots above margin and a blotch on disc either side of middle, pale orange. Pronotum with a median broad stripe and a narrower one either side, brownish. Scutellum pale yellow, basal angles and apex darker. Elytra milky white, a large spot on middle of outer clavus, dark brown; posterior claval cells washed with yellow. Inner anteapical cell, anterior and posterior portions of middle anteapical cell, and outer apical cell pale to dark brown, this pattern forming a cross on the two elytra. Face, clypeus and lorae heavily embrowned, with traces of pale arcs.

Genitalia: Female last ventral segment almost three times as long as preceding. Posterior margin slightly narrower at base than preceding segment, lateral margins slightly rounding to prominent lateral angles, posterior margin shallowly concave.

This species is a member of the subgenus *Amplicephalus*. It is known only from the type locality, Corinth, Mississippi, where it was collected by Dr. C. J. Drake. Type in author's collection.

Three species previously considered as members of *Deltocephalus* have been referred to other genera because of their apparent relationship to these groups. They are listed in the Van Duzee catalogue as members of *Deltocephalus* and may be thus considered by other workers. *D. escalantus* has been referred to the genus *Euscelis*, while *D. concentricus* and *D. flavo-virens* have been referred to *Thamnotettix*. Illustrations of these species are included on plates XVII, XIX, and XXX.

BIOLOGIC

Very little detailed life history work has been carried out for the species in this group, but some valuable observations and records have been obtained by Osborn and Ball, especially during their work in Iowa, and a few other workers have added to this data. At the present time it is safe to say that very little is known of the biology of this genus and there is opportunity for a great amount of careful work. During field studies many records of life history stages have been made and this data, together with available records by others, is included in a graphic table for a comparison of the known life cycles.

WINTERING

The majority of species whose life cycles are known winter in the egg stage. This seems to be the normal condition. Observations have indicated in a few cases a possible hibernation. Such species as *inimicus, sayi,* and *striatus* appear very early in the spring, before there is opportunity for development from the egg. It is quite probable that these winter as both egg and adult. Only a few common species, all recognized as pests from an economic

standpoint, can be placed in this group and it is perhaps the unusual condition. Of the three possibilities or combinations, the egg stage is by far the most common and important as a winter condition. In the case of *D. configuratus*, Osborn and Ball record it as passing the winter as a partially developed nymph, and it is the only species known to have this curious cycle.

Hatching and Appearance in Spring

The specific time of hatching in the spring is variable and as in the case of the bursting of the leaf buds is controlled by the seasonal conditions. As a rule, the overwintering eggs hatch during April or in early May and the development to adults occurs by the first week in June. In some cases a longer time is apparently required for nymphal development and the adults do not appear until three or four weeks later. In case a second seasonal generation is known the eggs are deposited within two or three weeks after the females appear, and they hatch and develop within a month or six weeks. Then the adults appear and continue until November, in many instances.

Mating and Oviposition

In all species observed under field conditions, the males appear a week or more before the females and disappear as much earlier. Thus, from collecting observations, it is often quite easy to determine the time in the adult brood. When either males or females only can be found it is certain to prove that the adults are either just beginning to appear or disappear.

Mating takes place very soon after the females emerge and they begin to deposit eggs usually within a few days. In case of the summer broods the egg deposition seems to extend over a shorter period than in the case of the fall brood where the period of egg deposition often extends over several weeks.

In all of the grass species where habits of egg deposition are known, the eggs are inserted into the leaf tissue or placed on the stem under the leaf sheath. In either case the ovipositor is an important structure. In some species the leaf is cut or split by the ovipositor and the egg pushed entirely under the epidermis or cuticle. In other instances the rounded side or a slight portion of the tip of the cephalic end is exposed. Some of the species ovi-

positing on tall grasses or small grains use the ovipositor merely to insert the eggs under the leaf sheath and fasten them to the stem.

Length of Egg Stage

The only definite record of the length of time from oviposition to hatching of the egg is in the case of *D. inimicus*. Professor Osborn reports the time varying from 10 to 17 days. In the case of several species observed under field conditions, the egg period seemed to average from about ten days to two weeks. For the period of overwintering, the duration of the egg stage varies considerably with different species, for often eggs are deposited much earlier in the fall by some insects. But this overwintering condition can scarcely be compared to the length of egg periods of the summer broods.

By observations made in Iowa it was found that eggs for a given brood are deposited within a limited time and a time may be determined when practically all of a given brood of any species are in the egg stage. This was determined so definitely in the case of *D. configuratus* that practically the whole brood was exterminated by the cutting of the grass and the consequent crushing of the eggs as the grass dried.

Another important consideration in regard to the cutting of the grass is that, as a rule, each species has one definite food plant upon which it deposits eggs and here the nymphs develop. The adults are often found feeding upon numerous plants, but this is seldom the case with immature stages.

The actual process of hatching is very interesting. If the eggs are deposited in a stem or twig all the eggs of a specific oviposition will hatch at about the same time. Just before hatching the egg seems to become slightly larger at the anterior end and it is pushed farther out of the slit in the tissue. Then, as soon as the nymph has emerged, the covering of the embryo dries and projects from the plant tissues in such a way as to be quite noticeable. In the case of all the eggs examined the head end is directed upward or toward the distal end of the plant.

Instars

Very little is known as to the number of instars in the various species. For the few species definitely worked out there are five

known immature stages although Webster* reports only four in the case of *inimicus*. During the nymphal stages the insect resembles in many ways the adult. As a rule the head is a little more sharply pointed, and the abdomen tapers to a more prolonged, pointed condition than in the adult. The genital plates are not developed until mature and the nymphs cannot be separated by these characters. The coloration is usually characteristic of each species, but is more pronounced in the last three instars. As a rule the color pattern of the nymphs is different from that of the adults. The wing pads, too, are not discernible usually until the third instar. The legs and body segments are not essentially different from the adult, but the chitin of the skeleton is much thinner and if the insect is killed the body shrivels very much upon hardening.

Length of Life of Adults

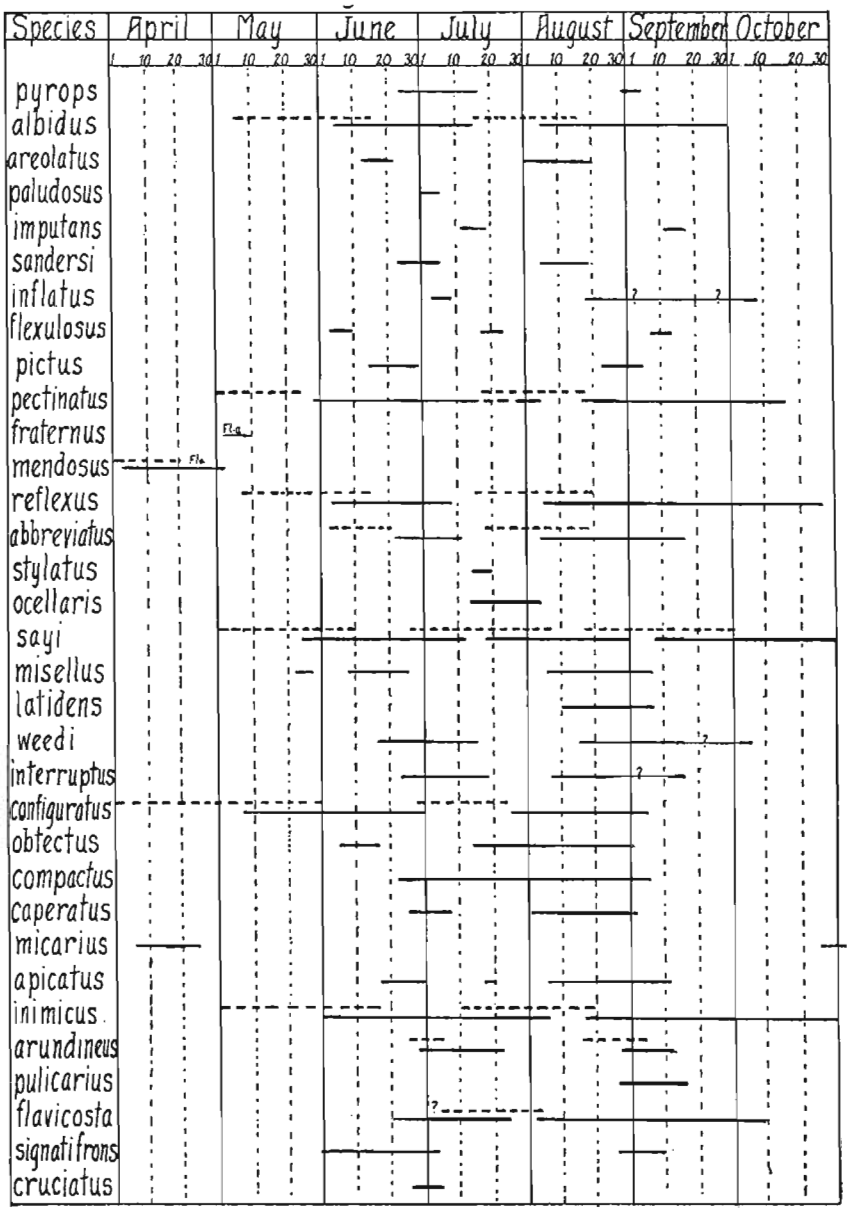
The length of life in the case of any adult will vary with the species and there is great variation within the genus. In the case of most of the species studied it has been found that the adults will disappear before or very soon after the appearance of the nymphs of the following brood. If they do overlap, the adults will practically all be females and the nymphs will be very small and it is quite easy to determine the time of the brood. In general the adults of any one brood will not live over six or eight weeks and the life of an individual is usually shorter. In the case of *inimicus* the generations overlap and adults can be found throughout the entire year, either in the field or in hibernation. *D. striatus* and *D. sayi* are other species where the generations overlap. In the case of *inimicus* it has been found to hibernate in addition to the winter egg stage.

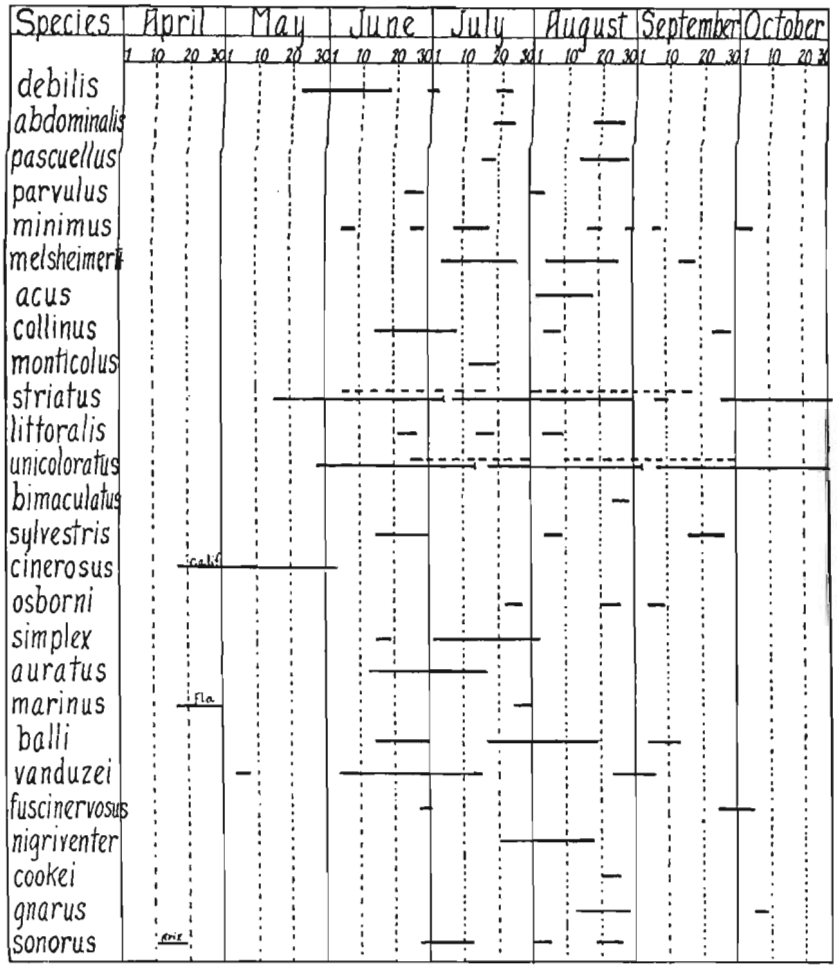
Seasonal Generations

Although the data in regard to this phase of the subject are rather meagre, three different conditions are known. Some species are known to have only one seasonal generation, a very few others perhaps have three, and by far the larger number have two. In many cases where the life cycle has not been worked out, but where extensive collecting has been carried on, the evidence is decidedly

* Webster, Ohio Agr. Exper. Sta. Bul., 68, p. 43, 1896.

in favor of a two-generation cycle. It is interesting to note, too, that with certain species which have specific food plants the cycle is in keeping with the processes of the grass, especially as regards





EXPLANATION OF FIGURES 2 AND 3

Solid lines represent time of occurrence in adult stage. Dotted lines represent time of occurrence in nymphal stages.

fruiting. Records show that some species of *Deltocephalus* have been collected in Florida during every season of the year, but nothing is known concerning the detailed life cycle or the number of generations. A diagrammatic table showing the known data of the various life cycles in graphic form is given in figures 2 and 3.

MIGRATION AND SWARMING

Migration occurs to some extent in the grass feeding species. This is more pronounced in the case of meadow or prairie forms where large stretches of open grass land are found. An interesting factor in this respect is the occurrence of both long- and short-winged forms in many prairie species. The short-winged condition apparently prevents migration, while the long-winged forms are able to migrate. In a few species, only the short-winged condition is known, in others only the long-winged condition, and in several species both short- and long-winged individuals can be found at the same time. One of the most interesting conditions found is a specimen of *fraternus* with one long and one short wing which was taken by the author in Florida. Migration apparently does not occur to such an extent in the woodland species. During the mating season swarming occurs, often at night, where a light may be an added attraction. This has been observed in several species of the *Cicadellidae* and in the case of a few species of *Deltocephalus* where walks and roadways were covered with individuals of a species after such a period of swarming.

HABITS

One of the most characteristic habits of the leafhoppers as their name would indicate is their ability to jump very quickly and when disturbed in the least they usually resort to this method of locomotion. Often the first jump is only a beginning and a series of three or four will follow very rapidly carrying the insect some distance. The species of *Deltocephalus* usually living in grassy areas seldom fly for any distance when disturbed, but merely jump and do not use the wings for distances of a few feet. In many of the other genera, and especially the tree inhabiting forms, the wings are used for longer flights. Quite frequently some of the *Deltocephalus* species will run sidewise over the margin of a leaf or on a blade of grass, but jumping is the method of locomotion usually observed. This is accomplished very easily by the large elongated hind legs. In several of the grass-feeding species, especially the prairie forms, the wings are so reduced that they do not function as organs of locomotion. It is evident that the locomotion in these species is accomplished entirely by the legs. In many other grass feeders where the wings are well developed the insect can fly for several yards.

Interrelation of Species

A rather large group of species is always found living together in a meadow or prairie and species of other genera are usually present. Some of the grass-feeding species of *Draeculacephala, Euscelis, Phlepsius, Thamnotettix,* and *Chlorotettix* live in the same habitats and a definite community or complex usually exists. In addition many other types of insects are present. Several *Cercopidae* and *Fulgoridae* are meadow forms and common species like the grasshopper are abundant. As a rule this association of insects will vary with the type of vegetation. Frequently two or more species of leafhoppers are feeding on the same plant and the eggs will be deposited on the same stems or under the leaf sheaths. Many times the same insect is a parasite to two or more species of these meadow leaf feeders. In this way the whole group is bound together by very definite interrelation. With many different types of grass-feeding insects all striving for their food and preservation, and with parasitic and predaceous insects holding many in check and preventing their rapid multiplication a balance is usually maintained in nature.

Protective Adaptations

As further field studies are carried on each year many interesting facts are revealed in regard to structures, habits, and colorations which are undoubtedly protective to certain species of leafhoppers. In this group of grass-feeding species, where many specimens are frequently found infesting a head of grass, often the insect resembles so closely the seeds and spikelets of its food plant that it is not easily separated by the unaided eye. A detailed study of many species has not been made, but numerous observations have shown this to be the case and a few examples will show this resemblance. The spikelets of *Andropogons* of the middle west are rather sharp pointed and several species of the *reflexus* group which live upon these grasses have a strongly produced, sharply pointed head. *D. sandersi* and its food plant, *Andropogon virginicus,* present an excellent example. Prairie grasses like *Stipa* and *Sporobolus* bear seeds and spikelets similar in appearance to these sharp-headed prairie forms. *Poa pratensis* is the common food plant of many *Deltocephalus* species and especially of the sharp-headed greenish forms, which resemble in many ways the spikelets of the blue grass. On the other hand a good example

of the blunt-headed type is *apicatus* which is very similar to the small rounded seeds of the *Panicums* upon which it lives. If there is any doubt concerning this resemblance, one needs only to make a sweeping, then kill all insects in the net by placing it in a very large cyanide bottle, and after spreading everything in the net on a sheet of white paper, proceed to pick out the leafhoppers. The resemblance will then be observed more easily, for the seeds will frequently be mistaken for leafhoppers because of their similarity in size, shape, or markings.

Coloration is a factor of importance also in protection. The greenish or yellowish color of these grass species is an excellent protection and certain of the black or brown markings are exactly like rusts or discolorations of the grass blades and stems.

Perhaps the most interesting habit is in the case of *marinus*, reported by Metcalf and Osborn, which was found living on vegetation of the tidal flat along the Atlantic coast on plants that were submerged during a portion of each day. It is not known by what means this is accomplished.

ECOLOGY

The relation of plant associations and plant formations to the leafhoppers has received very little treatment by other workers and perhaps a discussion of this subject should not be undertaken here. The data for this treatment is rather meagre and inadequate but it seems advisable to present a brief ecological discussion as a working basis in spite of the mistakes that will no doubt occur. In many cases the food plant has been definitely cited and this data is of value. It seems however that the idea of the association of plants which occur together under the same conditions and in the same type of habitat should replace the idea of the food plant alone as it gives some definite information concerning the part the plant plays in the landscape as a unit. With this idea we can work out more easily the distribution and limitations of many species. A collector who is interested in an insect from the field standpoint thinks of it in terms of the association of plants as seen in the swamp, bog, meadow, prairie, and forest.

Ecology in its broader aspect has come to include so many factors that numerous complications are encountered when one attempts to determine or investigate the specific habitat of a certain insect and the factors which control its distribution. The

changing of plant associations in a succession is a gradual process and all stages or gradations may be found in continuously changing associations. For this reason an insect having a specific food plant which may be controlled by a complex of factors may not occur in one of two associations that appear very similar. As a rule the group of leafhoppers associated in similar areas are quite uniform and the character of the vegetation is a good index to their distribution. We cannot say that there are definite successions of insect associations but there is a definite relationship between the insects and the plant associations.

Comparatively few species in this group have been studied in a detailed way in regard to their habitats, but numerous observations made by several workers have been of service in explaining the factors which control distribution.

Practically all of these species feed upon grasses and they might be grouped according to the type of habitat into prairie, meadow, and swamp forms. Naturally there are many types and gradations in the prairie from the typical western plains to the Florida prairie which is an outgrowth of the everglade; the meadows may include various types of open pastures, the woodland and mountain meadows; and the swamp may vary from a partly submerged vegetation to a marsh with practically no water visible above the soil in which the plants are growing. The salt marsh is also included in this group, where the submergence may be continuous or only occur during a part of each day by the tidal action.

Plains and Prairie Formations

A large number of species belonging to this genus are found on the western plains and prairies and some of them are limited to these areas if we may judge from their known distribution. Such forms as *albidus, imputans, pectinatus, abbreviatus, flexulosus, stylatus, cruciatus, satur, parvulus, collinus,* and *minimus* are limited to a large extent to the region occupied by the western plains. *Imputans* is found on *Muhlenbergia; pectinatus* and *abbreviatus* are associated together in a mixed association of *Bouteloa hirsuta* and *B. curtipendula. Collinus* and *minimus* are found feeding in an association of *Sporobolus* and *Stipa; compactus* and *obtectus* also occur in this plant association but are more widely distributed through the eastern United States and are found in dry upland meadows as well as on similar types of vegetation.

It is quite difficult to separate some portions of the plains and typical prairie regions. The latter however has been shown by Sampson to be a distinct formation with the principal grass *Andropogon furcatus* succeeded by *Andropogon scoparius* as a climax in the intermediate region bordering the plains. A few of the above mentioned species as *minimus, compactus, obtectus, albidus,* and *imputans* are more typical of the prairie region although not entirely limited to that area. Other prairie forms such as *unicoloratus* and *caperatus* occur on *Andropogon* and are found in the deciduous forest area with *sandersi* and other *Andropogon* species. These evidently can live under more diverse conditions or are able to feed upon a greater variety of plants all of which, however, are of the same general type. *Areolatus* is also a prairie type but its distribution is somewhat different from the species already mentioned. It occurs in the southern portion of the Mississippi valley, along the Gulf states and northward along the Atlantic coast. Here prairie plants are distributed along the sandy coastal flats and each species seems to have a specific plant or combination of prairie plants throughout this area. One of the most common species of this group is *reflexus* which is widely distributed over the prairie region and through the southern Mississippi valley and it may be found to have a distribution very similar to *areolatus,* but it has been so often confused with other closely related species that it is impossible at present to give its exact distribution.

Southern Prairie Formation

The Florida prairies are quite different from the western type and a large part of these areas are higher portions of the everglades which are submerged during a few months of the year. At other places small strips of prairie occur between slightly higher pinelands. A third type occurs in the region just north of La Belle, Florida, where for miles a flat area is seen covered with short grasses and with only an occasional clump of cabbage palmettoes to interrupt the horizon. Two species found only in the extreme south, *slossoni* and *micarius,* were taken from an association of *Distichlis spicata, Dichromena floridensis* and *Rynchospora divergens* in the prairie formation of the everglades at Paradise Key, Florida. This prairie is submerged a part of the year but was very dry at the time the species was found. It is adjacent to and intermediate between the saw grass of the everglades and the pine

hammocks. *Mendosus* is extremely abundant on the short grass prairies where submergence seldom takes place and was taken from an association of *Rynchospora divergens* and *Lachnocaulon anceps* on the typical southern prairie formation. *Fraternus* and *visendus* occur in similar habitats and are found in open pinelands on small grasses. Although for the most part a different association of grasses ,a few prairie species are common in the open pineland and it bears the appearance of a mergence of these two types.

Dry Uplands

Another group of interesting species is found on the *Andropogon* association of the Dry Upland Formation. These areas are rather high and well drained; the principal species of grasses are *Andropogon virginicus* and *Aristida gracilis.* Small patches only of the *Aristida* are found scattered here and there where apparently it has been almost crowded out by the advancing *Andropogon. Pyrops* and *pictus* are confined to these small patches of *Aristida* in the southern states and usually *compactus* and *obtectus* are very abundant on the same areas. The *Andropogon* is widely distributed and very abundant, growing in bunches, and it seems to be the food plant of *sandersi, unicoloratus* and *caperatus (vinnulus). Inflatus* has been taken from similar vegetation in Ohio. *Configuratus* is found in northern United States and in Canada on *Poa compressa* on dry upland areas.

Moist Meadow

A large number of species are common in pastures and meadows and several are found under varying conditions. *Sayi, weedi, flavicosta, inimicus,* and *striatus* are the most common and widely distributed and are found on blue grass meadows and pastures but are not restricted to this habitat. They are found also on sandy or dry upland areas. The meadow however appears to be the optimum habitat. Other meadow forms are *misellus, latidens, pulicarius, debilis, abdominalis, nigriventer,* and *pascuellus* but these species seem to have a more northern distribution and are confined to the northern meadows. The exact associations in many cases are not known but their distribution follows largely the northern mesophytic evergreen forest area. *Interruptus* may occur in a wet or dry meadow; the exact association is doubtful. It

is found at times on grass clumps along river banks. *Cinerosus*, also a meadow species, is known only from southern California and apparently is restricted to the Pacific coastal plain.

Oak-Hickory Forest Formation

Danthonia compressa occurs frequently as a pure association forming the ground layer of the Oak-Hickory Forest Formation. In these regions and on this association *D. sylvestris* and *melsheimerii* are very abundant and although frequenting meadows the *Danthonia* is apparently an optimum condition. It is usually a very dry area and resembles somewhat the general prairie type. *Delector* is usually associated with the Oak-Hickory forest but occurs on a different ground layer association where the violet, *Viola blanda* is one of the principal species and is associated with *Sanicula canadensis* and *Luzula campestris*. Many of the blue grass and meadow forms might be included in this formation.

Alpine Meadow Formation

Several of the western species are members of the Alpine or mountain meadow formation according to Ball but no specific data has been worked out by those collecting in that region. Some species which are known to occur in the alpine meadows of Colorado are *signatifrons, vinculatus, sexmaculatus, bimaculatus, monticolus,* and *auratus*. Some of these are found also in meadows of the northern evergreen forest formation in various parts of Canada.

Salt Marsh Formation

Three species are definitely known to live in the Salt Marsh Formation. Two of these are found as a rule upon the *Spartina patens* association in marshes where the tide has very little effect upon the habitat. Especially is this true of *simplex* which no doubt lives upon the *Spartina*, as it was taken abundantly in immature stages from this plant. *Littoralis* which was also taken in the salt marsh was found more abundantly in an association of *Distichlis spicata* where a considerable submergence by the tide was observed. A species which apparently has a very different mode of living in the salt marsh is *marinus* which Metcalf and Osborn report as living on vegetation which is entirely submerged during the high tide. In Florida this species was found several miles from

the coast on low areas of prairie where no tidal action takes place. It may be able to live under somewhat diverse conditions.

THE FRESH WATER MARSH FORMATION

Several species are definitely associated with the fresh water swamp or marsh formation. *Gnarus* is more closely allied with the swamp or lagoon, being found at the margin on an association of "Dog hair" *Juncus*. Some other species are more often found in marshy places. *Osborni* is almost always found in the *Calamogrostis* meadow of the *Cladium-Calamogrostis* association closely following or often merged with the *Scirpus-Typha* association. *Sayi* often occurs in that habitat although primarily a blue grass species. *Acus* has also been taken in marshy areas of the moist meadows from a mixed *Cyperus-Juncus* association along Lake Erie. In addition it was taken from moist meadows in the mountain regions of Pennsylvania.

A few species with exclusively northern or western distribution are apparently limited to marsh formations. *Bilineatus* was described from Colorado as occuring on *Carex*. Dr. Ball reports collecting it from marsh plants in the mountains of Colorado and its known distribution is rather limited only occurring in this mountain habitat, but it would not be surprising if it were found in Canada. Two species closely related morphologically to *bilineatus* and which have similar habitats are *luteocephalus* and *marginatus*. Both occur on an association of coarse grasses and sedges in the marsh formation near fresh water lakes. They have been taken only in the extreme northern parts of the United States and undoubtedly will be found in Canada. *Concinnus* apparently has a very similar distribution and has been found to date only on tall grasses at the margin of a northern sphagnum-tamarack bog.

One interesting species *arundineus* lives entirely on cane *Arundinaria tecta* which occurs on the banks of streams in the southern states. The distribution of this species is apparently limited by the distribution of the plant.

NATURAL ENEMIES

In addition to the relation of the leafhoppers to plant associations and habitats they are associated with a great number of other insects and higher animals, many of which feed upon them.

Two types of natural enemies are known to reduce to a marked degree the number of leafhoppers. These can be considered under two groups. First the predaceous enemies, including the birds, toads, spiders, and predaceous insects, and secondly the parasitic insects, all of which are no doubt important in checking these grass-feeding species.

Toads

The toads and frogs are known to feed upon all sorts of insects and the leafhoppers make up a good percentage of their entire food. The toad is attracted by moving objects and since the leafhoppers are quite active and are frequently found on the lower blades of grass, running or moving sidewise, they are quickly recognized and easily captured by the toad. *Deltocephalus inimicus* has been found as a part of the toad's food more than any other leafhopper of this genus, but records show that many of the other common grass species are captured also. It is quite probable that the toad does not prefer jassid food to many other insects and that the capture of leafhoppers is only accidental, but the fact that they are brought close together in their living conditions and that great numbers are captured is important in the economic balance in nature.

Birds

Published records of the Biological Survey show that the remains of species of *Deltocephalus* have been taken from the stomachs of many kinds of birds, chiefly grass or marsh species. In practically every case where these were found the percentage of stomachs containing them and the percentage of insects in the stomach was so small that the benefit derived from their feeding is undoubtedly very little. It may be possible that the stomachs examined are not representative of the birds as a whole and furthermore at certain times during serious infestations the birds may feed to a greater extent upon "jassid" food, but at present we are inclined to believe that as enemies of leafhoppers their value is practically negligible.

Spiders

Spiders have been previously reported as enemies of many leafhoppers and observations of the last few years have verified that report. In grass land, pasture and open woods especially, spiders have been observed upon many occasions feeding on "jas-

sids" just captured, or frequently only the elytra and legs remained in the web. Perhaps the field spiders which do not construct webs are just as important in killing these insects as are the web spiders for they are very quick and have been observed in the act of jumping and catching them. *Deltocephalus inimicus, sayi,* and *striatus* have all been found in abundance in webs and in the Florida everglades *micarius* and *mendosus* were found many times in the grasp of some of the grass inhabiting spiders. Collecting observations have brought them together in the net in such a way that frequently many of the spiders will attack the leafhoppers before they can be captured in cyanide bottles. In addition to the jumping and web-making spiders certain species are protectively colored and hide under or in the blossoms of flowers and await their prey. The front legs are usually extended and grasp the insect as soon as it approaches. It is not an uncommon experience to slip up to a plant where an attractive leafhopper is apparently feeding and quickly place a bottle over it only to find a large spider withdraw from the under surface of the plant, leaving the dead insect upon which it was feeding. In many specific cases field spiders are known to obtain leafhoppers as about 10 per cent of their food and although they capture beneficial insects also, they undoubtedly are of great benefit in holding in check many of the grass-feeding leafhoppers as well as other pests.

Predaceous and Parasitic Insects

Although several species of *Lygaeidae, Pentatomidae,* and *Nabidae* have been found feeding upon leafhoppers, no specific data is at hand regarding their attacks upon the species of this genus, and no observations of predaceous insects have been made during this study.

The parasitic insects belonging to the three orders *Hymenoptera, Diptera,* and *Strepsiptera* are apparently the most important leafhopper enemies known. In Hawaii they have been used as control measures by actual propogation and in North America they have been observed in various localities in great abundance on many species of *Deltocephalus.*

The largest number of parasitic species known to live on *Deltocephalus* hosts belong to the *Anteoninae (Dryinidae)* and have been discussed in some detail by Fenton (1918). Only a few general statements in regard to the parasites of the species under

discussion will be considered here. A part of the life cycle of the parasite is spent inside the body of the leafhopper. Shortly after hatching, the larva works its way through the wall forming a sac on the abdomen or thorax of the insect. The sac is usually attached between the segments and on some definite region of the leafhopper body for each specific parasite. This sac is frequently very large causing the displacement of the elytra and is consequently conspicuous in many cases where parasitism occurs. When collecting in the field these are usually recognized without the aid of a lens. At length the larva drops to the ground forming a cocoon but the leafhopper, in practically all cases, dies from this injury. It has been found that the number of generations of the parasite will correspond with the number of generations of the host. Thus in *Deltocephalus inimicus* we have two known seasonal generations and Dr. Fenton has found that there are two generations of *Gonatopus erythrodes* which parasitizes it, the generations of the parasite corresponding in season with the generations of the leafhopper.

Eleven American species of *Deltocephalus* have been reported as hosts of *Dryinid* parasites. To this list could be added about twenty additional species which have come under the author's observation. A mere listing of the host species here would mean very little without the determination of the parasites, but the parasitism has been found in every locality where the leafhoppers were found in sufficient abundance for a large amount of material to be obtained. At Kane, Pennsylvania, on top of one of the high Allegheny ridges both *misellus* and *melsheimerii* were found so heavily parasitized that from thirty to forty per cent of the material collected in the net showed the large brown sacs on the abdomen under the elytra. In Florida a large percentage of parasitism was noted on *micarius*. Professor Osborn reports 20 per cent of *sayi* parasitized at Cedar Point, Ohio, during an entire season. From these observations it would seem that these natural enemies are undoubtedly of importance in the checking of infestations of these grass-feeding species.

Although the *Strepsiptera* occur on many of the larger leafhoppers belonging to the *Cicadellinae* they have not been found to date on any of the *Deltocephalus* species (Jassinae). If they are of importance as parasites of the members of this genus, they are still to be worked out and reported.

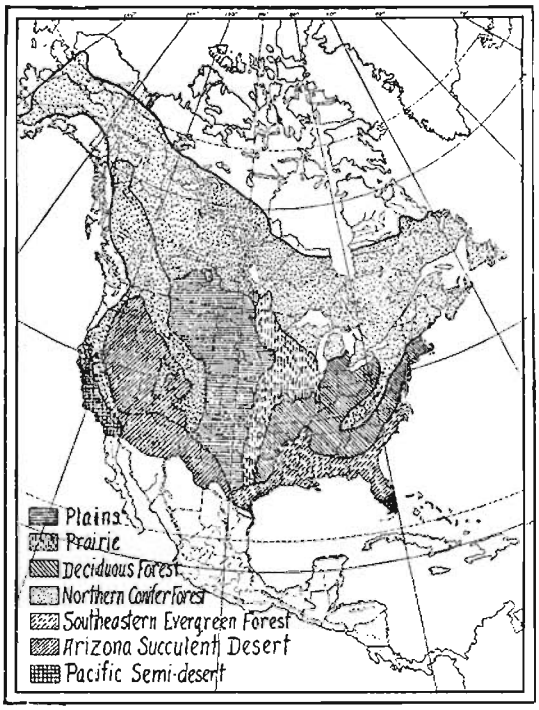
FAUNISTIC

Distribution in North America

It has been customary for all investigators working with animal life to treat the subject of distribution in accordance with the Life Zones as established by Merriam. In view of the fact that all insects under discussion feed entirely upon plants, it seems only proper and advisable to discuss their distribution in terms of plant distribution or Climatic Plant Formations which do not coincide with the Life Zones previously mentioned. The map of Merriam was based on the summation of temperatures and climatological data disregarding the moisture coefficient. Transeau*, and later, Livingston and Shreve, found, while investigating vegetational areas in an attempt to determine the most important factors which controlled and limited certain formations, that the relative temperature is perhaps the least important while the precipitation evaporation ratio is apparently the most important factor, and relative humidity often has a decided bearing upon limitations. Furthermore it was found that two or more zones might have parallel series of temperature conditions, especially where the vegetational areas extended for some distance north and south, but the precipitation and evaporation data coincided very well with the distribution of the principal species of the vegetation. It is only natural to expect an overlapping of these zones in nature and we cannot divide them by hard and fast lines. In some cases the faunal zones and the vegetational areas correspond very nicely and in other instances they are extremely different, in which case the vegetational zone is followed as it explains the natural distribution, for it is surprising how closely the distribution of many insect species conforms with plant areas. For this reason the data already given under the subject of ecology will explain to a large extent the distribution of the North American species. The vegetation areas of North America are shown in an accompanying diagram, Fig. 4.

No personal observations have been made by the author west of the Mississippi River and no discussion of this area can be made. The few general statements are deductions from the collecting records of others, especially Professor Osborn and Dr. Ball, and data from material examined.

* Amer. Nat. XXXIX, p. 875-889.



EXPLANATION OF FIGURE 4

Diagram showing the Vegetation areas of North America, north of Mexico.

The Northern Evergreen Forest area corresponds in a general way to the boreal zone of Merriam and includes the larger part of Canada south of the Hudson Bay, and almost all of Alaska, Maine, and the northern parts of Michigan, Wisconsin, and Minnesota. In the Appalachian mountains it extends southward at high elevations to North Carolina and in the Rocky mountains at elevations of from 6000 to 7000 feet. A number of our *Deltocephalus* species are distributed in North America only in this way. Such examples as *bilineatus ,ocellaris, configuratus, misellus, vinculatus, abdominalis, pascuellus,* and *nigriventer* conform almost exactly to the region occupied by the northern evergreen forest. So far as records go *latidens, fumidus, pulicarius, monticolus, auratus,* and a few minor species would fall within this zone although their known distribution is very limited at the present time. *Ocellaris* and *abdominalis* are typical examples which are known from Alaska and

occur throughout Canada and at high altitudes on the Rocky mountains.

The Deciduous forest covers the larger part of eastern United States east of the Mississippi river with the exception of the broad coastal strip from Long Island to Louisiana and the northern parts of the most northern states. A large spur of this forest area also extends southwest through Missouri and Arkansas into Texas. The species which apparently are allied to this vegetational area feed upon different grasses to some extent and are found in more than one true zone of vegetation and in as many as a half dozen of Merriam's life zones. Such species as *sayi, melsheimerii, sylvestris, acus, apicatus, sandersi, pictus, pyrops,* and *osborni* are very well confined to the deciduous forest area while *unicoloratus, compactus, obtectus,* and *weedi* are found in the plains and prairie regions and the latter three occur in the coastal zone also. Such species as *striatus* and *inimicus* are cosmopolitan and feed to a large extent upon any type of grass as well as some other kinds of vegetation. So the deciduous forest, although having a typical fauna of these species, is perhaps least designated as a vegetational area for limited distribution.

Although quite hard to distinguish the typical plains from the prairie fauna in some cases with present records, this interesting strip of plains vegetation extending from central Texas through Kansas and into Canada together with its rich fauna of species of *Deltocephalus* which are not found in other vegetational areas is strong evidence against the artificial life zones of Merriam, three of which it crosses. Such species as *collinus, flexulosus, grammicus, stylatus, parvulus, satur, pectinatus,* and *abbreviatus* apparently are confined in their distribution almost entirely to the plains or short-grass regions. A broad strip lying just east and extending south from North Dakota to southern Texas is known as the true prairie, a region composed of tall grasses with *Andropogon furcatus* and *A. scoparius* as climax types. In this typical prairie section are found species like *albidus, imputans, minimus,* and *reflexus* which sometimes occur in parts of the plains area. If we should place these in Merriam's Upper Austral zone as would be necessary they would occur eastward through Illinois, Indiana, Ohio, etc., but a study of the distribution of many of these species has shown that they are not so distributed but conform to the grassland region in some cases from Texas to North Dakota with no re-

lation to the Deciduous forest area. Others occur in the center of this region in Kansas, Nebraska, and western Iowa only, just as some of the grasses are distributed.

A few species are distributed along the Atlantic and Gulf coasts on what is sometimes known as the coastal plain and more often as the Southeastern Evergreen Forest Formation which extends from Long Island to Louisiana. By the nature of the formation the salt marsh insects such as *littoralis, simplex,* and *marinus* are always found in this area. Also *micarius, visendus,* and *arundineus* are limited almost entirely to this distribution. Such species as *flavicosta* may occur in the deciduous forest or grassland areas while *areolatus* is common to this evergreen area as well as to a limited portion of the southern prairie section. *Fraternus* is confined to northern Florida (according to known records) which is a portion of the southern evergreen forest area.

In some respects the southern tip of the Florida peninsula is unique in its fauna and three species might be mentioned that are distributed only in the everglade country. They are *slossoni, mendosus,* and *decisus,* the latter described as new in this paper, and might be termed as southern prairie species or perhaps subtropical.

Cinerosus is distributed along the Pacific coastal plain in southern California and apparently is restricted to this area.

DISTRIBUTION IN GENERAL

The species of the Genus *Deltocephalus* are not confined to North America but are distributed over practically the whole world, the large majority of known species occurring in North America and in Europe. At the present time about one hundred species are known from North America while only about two-thirds of that number are found in Europe. The question naturally arises in which country did the genus originate and how did it migrate to the other country? This can be answered only tentatively by the evidence at hand. If we compare the fauna of the two countries we find at least six species that are common to both and there may be others that are designated under different specific names at present in these respective countries. Of these six, *ocellaris, abdominalis, striatus, pascuellus, collinus,* and *pulicarius,* the former three occur in Alaska as well as the United States and Europe, and the latter three are distributed entirely or to a large extent in the Northern Conifer forest area which seems to indicate a possible

northern bridging over by way of Alaska and northern Asia and the common distribution at present may be explained by this northern route. Although very few are specifically alike, it is surprising how many species are so closely related and resemble each other so much superficially that a close examination of characters is necessary to separate them. For example *configuratus* and *calceolatus* resemble each other so closely that they can be separated only by a careful examination of the genital characters. Many other examples of the same kind might be given but the problem would remain whether there was once a common ancestor occurring in both Nearctic and Palaearctic zones from which these two very similar forms arose. We are not able to solve these problems from geological or other evidence but it seems to be the only logical conclusion at present that a common ancestral form existed.

In regard to the origin it is as easy and logical to assume that the distribution has been from North America to Europe as in the opposite direction and the evidence in living material will tend to substantiate the former view. As has already been mentioned there are about one-third more known species in North America than in Europe and within the group there is a greater diversity of minor groups and of species. For instance there is no species in Europe which shows a typical *reflexus* character and none that we place in that immediate group, the closest resemblances being in the *sayi series*. In North America there are at least a dozen or more of these species which are closely related and are placed at one extreme of this genus. The *compactus-obtectus* group, too, seems to be an additional unit which is entirely Nearctic. According to the criteria used for determining the center of dispersal, the evidence presented above would favor North America as the original realm and undoubtedly the Mississippi valley as a center since the largest concentration and greatest diversity of species is found in that area where the plains region, the prairie and the deciduous forest area approach each other quite closely. Professor Osborn has already mentioned this area as a probable center.

If we consider the probability that the arctic circle was at one time subtropical it is quite logical to assume that the genus originated in that region, that the species were later pushed southward in both countries, and that now only those species are found in the original area that are specially adapted and more resistant to adverse conditions; or there is a possibility that our present species

have arisen from a center after having been driven southward by the ice.

PATHS OF MIGRATION

If we consider the Mississippi valley as the center of dispersal, it is easy to point out certain possible paths of migration. The route already suggested is undoubtedly a probable one whether the genus was originally Nearctic or Palaearctic and the species mentioned above as occurring commonly in Alaska are conclusive evidence of such a connection. On the other hand we find very few species of this group occurring in Central or South America but one very common Nearctic form which is abundant in Mexico, Central and South America demonstrates the possibility of a southwestern path of migration by way of Mexico and Central America. Other species which are distributed in the Southwest are *sonorus* and *obesus* and their definite distribution into the Southwest is not known although records of both are at hand from Mexico. Another species not recorded from the United States but which is closely related to *sonorus* is *elimatus* which is known from Mexico and may extend southward. The path of the lower Mississippi valley and the coastal plain seems to connect certain of the east coast species and may be a path of migration for the southeastern United States. It is quite difficult to account for the subtropical fauna of Florida but it seems to bear resemblances to the West Indies' fauna and may have once been connected with that region. *Slossoni* for instance is apparently not closely related to the North American species and resembles some of the Brazilian forms. Also other groups of *Cicadellidae* give evidence of this relationship by their species which are common to the West Indies, Brazil, and southern Florida. A few species have undoubtedly been introduced by way of commerce and some of these may be on our eastern coast unrecognized at present. From known records *pulicarius* might be called a possible introduction. It is known only from Maine, and since other species such as *Allygus mixtus* are evidently of recent introduction it is quite probable *pulicarius* has come into the United States in that way.

ECONOMIC

It is usually customary for any one working on a group of economic insects to state that his particular field is of more import-

ance than any other. No claim of this kind is made regarding this group but it is undoubtedly true that these insects are of much more importance than conceded at present, and the average entomologist does not take sufficient notice of their damage, especially the grass-feeding species. Of course the apple and beet leafhoppers have demanded attention, but very little consideration has been given to the species feeding upon grasses. This is partly due to the type of feeding which is performed by a minute beak supplied with sucking mouthparts which gradually saps the plant of its vitality, while chewing insects, by destroying and consuming portions of the plant, display their damage, and the amount of plant injury can be more easily noticed by ordinary observation.

A band of army worms may attack a portion of a field crop and will immediately be given proper attention; on the other hand, several million leafhoppers can inhabit a pasture field all season, causing a constant drain on the grasses but no attention is paid to them and the cattle are turned in to nibble at whatever survives.

Another reason for the lack of recognition is their relatively small size as compared with the other rather large conspicuous grass pests. It is surprising how many people have never seen a leafhopper although every time they walk across the lawn or through a small grass plot they cause hundreds of them to move from their places of feeding. Even when called to their attention the statement is often forthcoming that these hoppers are so minute that they cannot do damage to anything, little realizing that when present in great numbers they can cause as much or more damage than many of the larger insects where the numbers are fewer. This is undoubtedly the reason that the minute *Empoasca mali* was never connected with the "tip burn" of potatoes and that this was designated as a physiological disease. Also in several cases that have been observed it is the reason why the dying and drying up of the grass is attributed to dry or hot weather and not to the fact that the grass, having lost practically all of its vitality through leafhopper injury, is not able to withstand even slightly unfavorable conditions.

Furthermore, these insects are often overlooked because of their coloration which is greenish or dull yellowish-green and conforms so well to the color of the foliage that they are invisible unless disturbed. Their habits of feeding on the under surface of the grass blades and in many cases close to the ground or within the

head are also reasons why they are less noticed than many other economic species.

Where several species are feeding upon the same plants it is often quite difficult to determine the type of injury by any one group of insects and especially sucking insects where evidence of injury is not easily recognized until an advanced stage has been reached and the affected plants are greatly discolored or in a dying condition. Leafhopper injury upon foliage is usually of the same type. First, a pale spot will appear around the original puncture and the most characteristic recognition seems to be the loss of the chlorophyll, causing the leaf to appear finely speckled or peppered with these minute pale dots. Later these areas turn brownish giving the whole leaf a mottled appearance, and the plant then begins to turn brown in large areas, and gradually shrivels and dies. The blades of tall grasses will often curl lengthwise and turn brown while the short grasses shrivel and die forming dead tufts here and there over large areas.

Practically all of the *Deltocephalus species* where occurring in sufficient numbers to be of economic importance are recognized as pests of cereals, grains, and forage crops of all kinds, becoming numerous and abundant in pasture range and meadow. All grassy areas are attacked by certain species whether they occur in a moist or dry location.

All of the grains are attacked by a few species of *Deltocephalus,* chief among which are *D. inimicus, striatus, sayi, configuratus,* and *sylvestris,* but this group will vary somewhat both in number of individuals and species with the locality, although in the grain regions the species are about the same. Professor Osborn has recorded* numerous observations on the species infesting grain. Mr. W. H. Larrimer, who has been working with cereal and forage crop insects for several years, reports many species as being injurious to wheat in Montana at Missoula and Helena. *D. cruciatus* and *flavo-virens* were found on June 12. He also has many records of the more common forms.

Perhaps the greatest numbers are found on grasses in pastures, especially those which have not been cultivated for several years. Professor Osborn has estimated a million or more to an acre of grassland. This number seems to be too large until personal observations are made, but by walking through the meadow

* Bul. 108. U. S. Dept. Agr. Bur. Ent.

and closely observing the hundreds that hop at every step it does not seem unreasonable to estimate such a number as being present under ordinary conditions. The meadow species will vary considerably with the types of grasses found in the different meadows. *D. inimicus* is common in all grassland and *striatus* is almost as widely distributed. *Sayi* is a common meadow species throughout the northeastern United States. *Configuratus, pascuellus,* and *misellus* are pests of northern meadows and the former may occur in many western states. It seems to be abundant especially in meadows where *Poa compressa* is the common grass. *Sylvestris, melsheimerii,* and *unicoloratus* are also abundant as meadow species in the eastern United States. The latter together with *sandersi* are pests of the *Andropogon virginicus* pasture lands. The plains and prairie species, especially *reflexus* and allied forms, are important on the range lands, or short grass areas of the West. In the southern states *micarius, flavicosta, obtectus,* and *weedi* are especially abundant in meadows and pastures, and in extreme southern areas *fraternus* and *mendosus* are very common.

A number of times attention has been called to golf greens, and observations have shown that in many cases the leafhoppers were actually killing out the grass in spotted areas. Observations were first made on the golf course at Memphis, Tennessee, in 1915, where a large number of species were found to be doing serious injury. Since that time many similar places have been examined in several states and upon a few occasions the author was called in to advise in regard to the control, in order to prevent the dying of the grass. This type of permanent grass area forms an ideal place for the rapid multiplication of these grass species and this is another place where the entomologist must face the leafhopper problem.

Also grasses of lawns and parks are often seriously injured, especially where a new stand of grass is being attempted and upon soils or under conditions which are not optimum to the growth of these grasses.

By far the best control measures known at present are the ordinary farm practices of clean farming and the destruction of crop remnants. Most of these species pass the winter in the egg stage in grass stems or leaves and these are easily destroyed by burning over. By examining burned over areas it is found that leafhoppers are very scarce during the year following the burning.

It is a common practice among the cattle ranchers of Florida to burn over large areas of pasture land as they believe it produces a better stand of young grass. In doing this they almost entirely eliminate the grass leafhopper species. On areas examined which had not been burned over for two years, very few specimens were found, although the grass was luxuriant and indicated in every way ideal collecting grounds. The fence rows and head-lands near cultivated fields also harbor many species and these should be burned or destroyed.

If the farmer does not desire to have the area burned over, he should change his pasture land as often as possible since that practice is one of the best to destroy the leafhoppers. Pastures of long standing are ideal breeding grounds. If possible, then, the same field should not be used for pasture more than two or three consecutive years.

Osborn and Ball found that mowing grass while the second generation was in the egg stage would destroy this brood almost entirely, for when the stems shriveled the eggs were crushed.

Although many other control measures have been used and recommended, these are undoubtedly the best for the grass species and the most practical from the farmer's standpoint, which is the ultimate and important consideration.

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INDEX

INDEX

PLATES

EXPLANATION

PLATE I

Diagram showing characters used in identification

Fig. 1. D. configuratus; entire insect, dorsal view.
Fig. 2. Female genitalia.
Fig. 3. Male genitalia.
Fig. 4. Face.

PLATE I

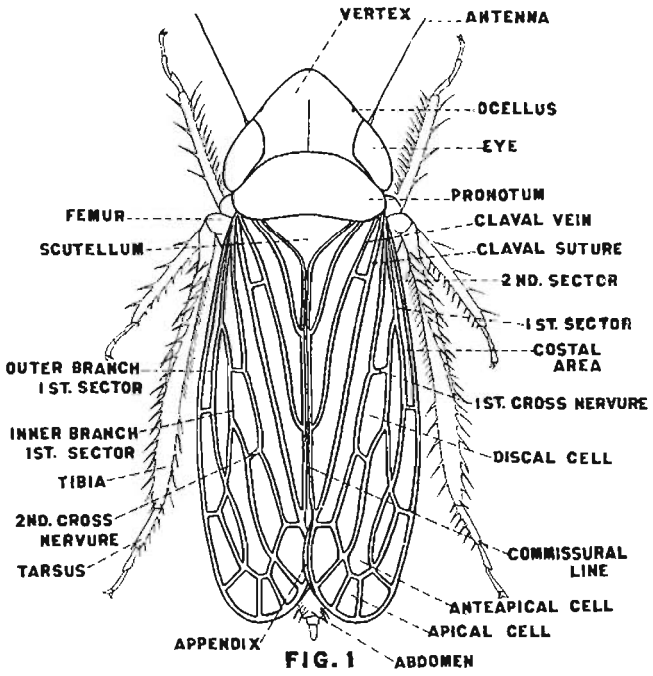


FIG. 1

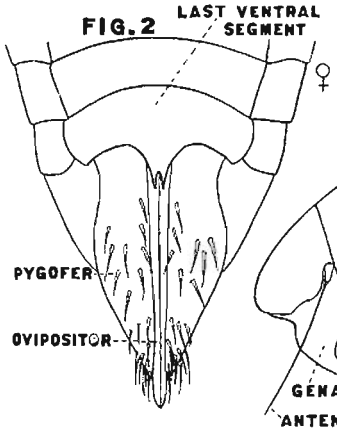


FIG. 2

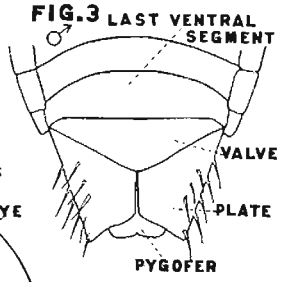


FIG. 3

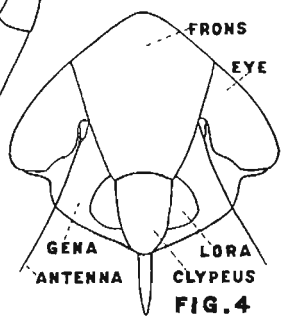


FIG. 4

PLATE II

Fig. 1. Head and Thorax (Side view).
Fig. 2. Prothorax (Side view).
Fig. 3. Mesothorax (Side view).
Fig. 4. Metathorax (Side view).
Fig. 5. Fore leg (ventral view).
Fig. 6. Middle leg (ventral view).
Fig. 7. Hind leg (ventral view).
Fig. 8. Femur-tibia, articulation of hind leg (dorsal view).
Fig. 9. Basal third of antenna.
Fig. 10. Ventral view of thorax (coxae removed).
Fig. 11. Head and Thorax (ventral view).
Fig. 12. Mouth parts as attached to head (ventral-anterior view).
Fig. 13. Mandibular and maxillary setae (magnified).

PLATE II

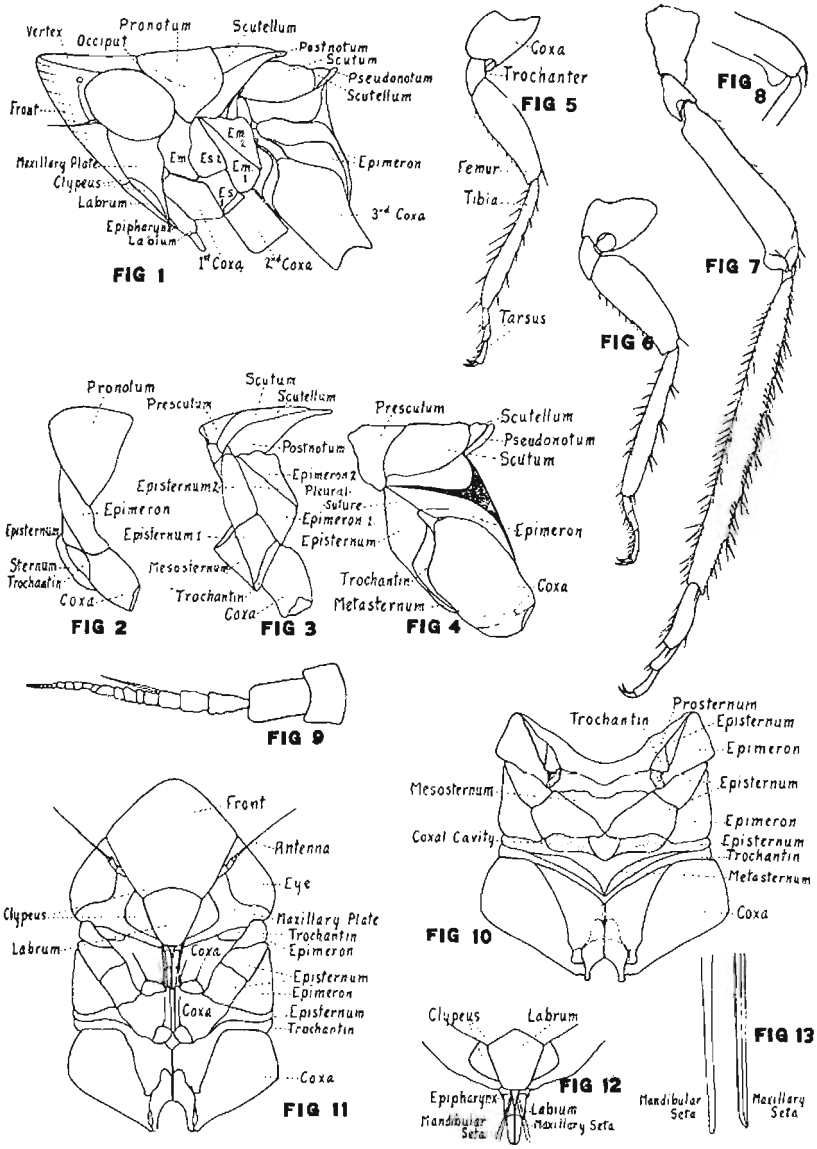
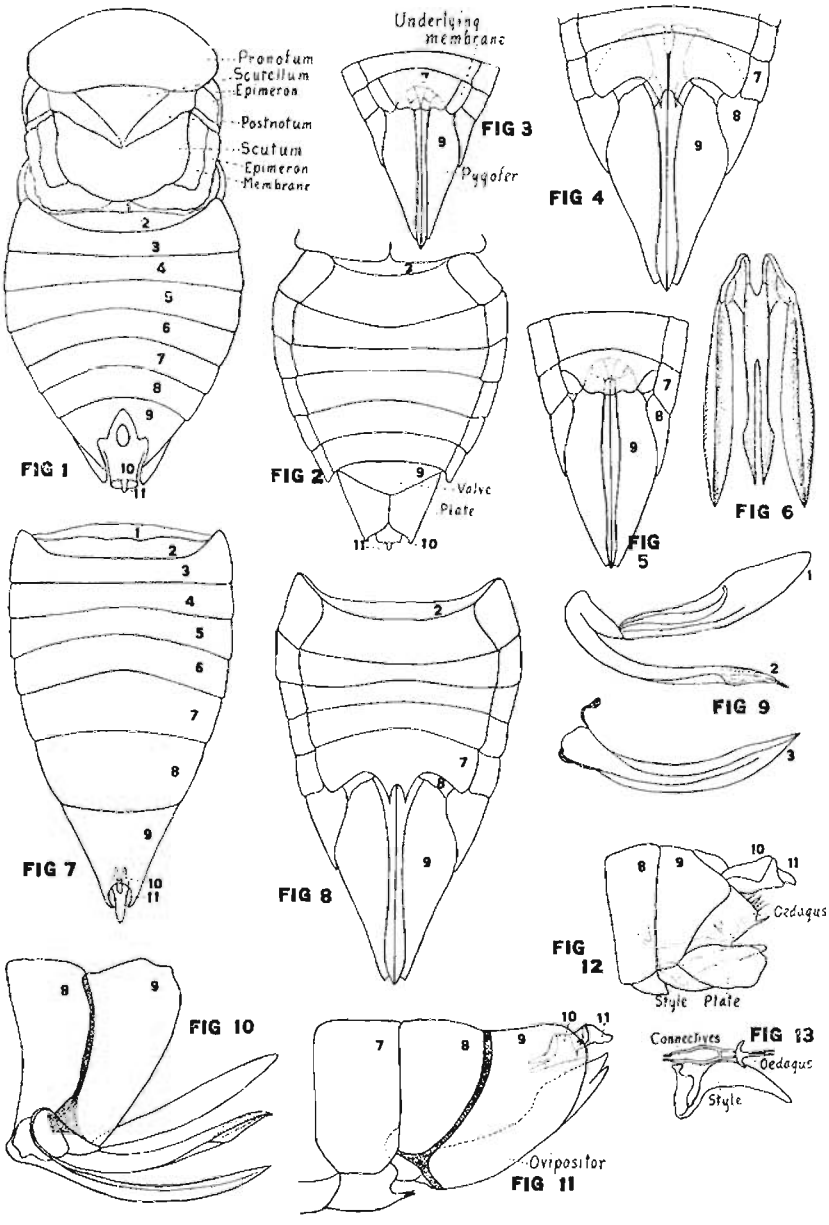

Vertex
Occiput
Pronotum
Scutellum
Postnotum
Scutum
Pseudonotum
Scutellum
Epimeron
3rd Coxa
Front
Maxillary Plate
Clypeus
Labrum
Epipharynx
Labium
1st Coxa
2nd Coxa
Em 2
Em
Est
Em 1
Es
FIG 1
Coxa
Trochanter
FIG 5
Femur
Tibia
Tarsus
FIG 8
FIG 6
FIG 7
Pronotum
Prescutum
Episternum
Epimeron
Episternum 1
Sternum
Trochantin
Coxa
FIG 2
Scutum
Scutellum
Postnotum
Epimeron 2
Pleural Suture
Epimeron 1
Episternum
Mesosternum
Trochantin
Coxa
FIG 3
Prescutum
Scutellum
Pseudonotum
Scutum
Epimeron
Trochantin
Metasternum
Coxa
FIG 4
FIG 9
Front
Antenna
Eye
Clypeus
Maxillary Plate
Trochantin
Epimeron
Labrum
Coxa
Episternum
Epimeron
Coxa
Episternum
Trochantin
Coxa
FIG 11
Trochantin
Prosternum
Episternum
Epimeron
Episternum
Mesosternum
Epimeron
Coxal Cavity
Episternum
Trochantin
Metasternum
Coxa
FIG 10
Clypeus
Labrum
Epipharynx
Labium
Mandibular Seta
Maxillary Seta
FIG 12
Mandibular Seta
Maxillary Seta
FIG 13

PLATE III

Fig. 1. Male thorax and abdomen (dorsal view).
Fig. 2. Male abdomen (ventral view).
Fig. 3. Tip of female *obtectus* abdomen (ventral view).
Fig. 4. Tip of female *configuratus* abdomen (ventral view).
Fig. 5. Tip of female *inimicus* abdomen (ventral view).
Fig. 6. First and second pairs of female styles (ventral view).
Fig. 7. Female abdomen (dorsal view).
Fig. 8. Female abdomen (ventral view).
Fig. 9. Styles of ovipositor (lateral view).
Fig. 10. Tip of abdomen with styles of ovipositor separated (lateral view).
Fig. 11. Tip of female abdomen (lateral view).
Fig. 12. Male abdomen (lateral view).
Fig. 13. Internal genital structures of male (dorsal view).

PLATE III


Pronotum
Scutellum
Epimeron
Postnotum
Scutum
Epimeron
Membrane
FIG 1
Underlying membrane
FIG 3
Pygofer
FIG 4
FIG 2
Valve
Plate
FIG 5
FIG 6
FIG 7
FIG 8
FIG 9
FIG 10
FIG 11
Oedagus
Style
Plate
FIG 12
Connectives
FIG 13
Oedagus
Style

PLATES IV, V, AND VI

Elytra and wings of species of *Deltocephalus* as labeled. In each case the elytron is numbered and the wing is marked with the same number followed by the letter "a."

PLATE IV

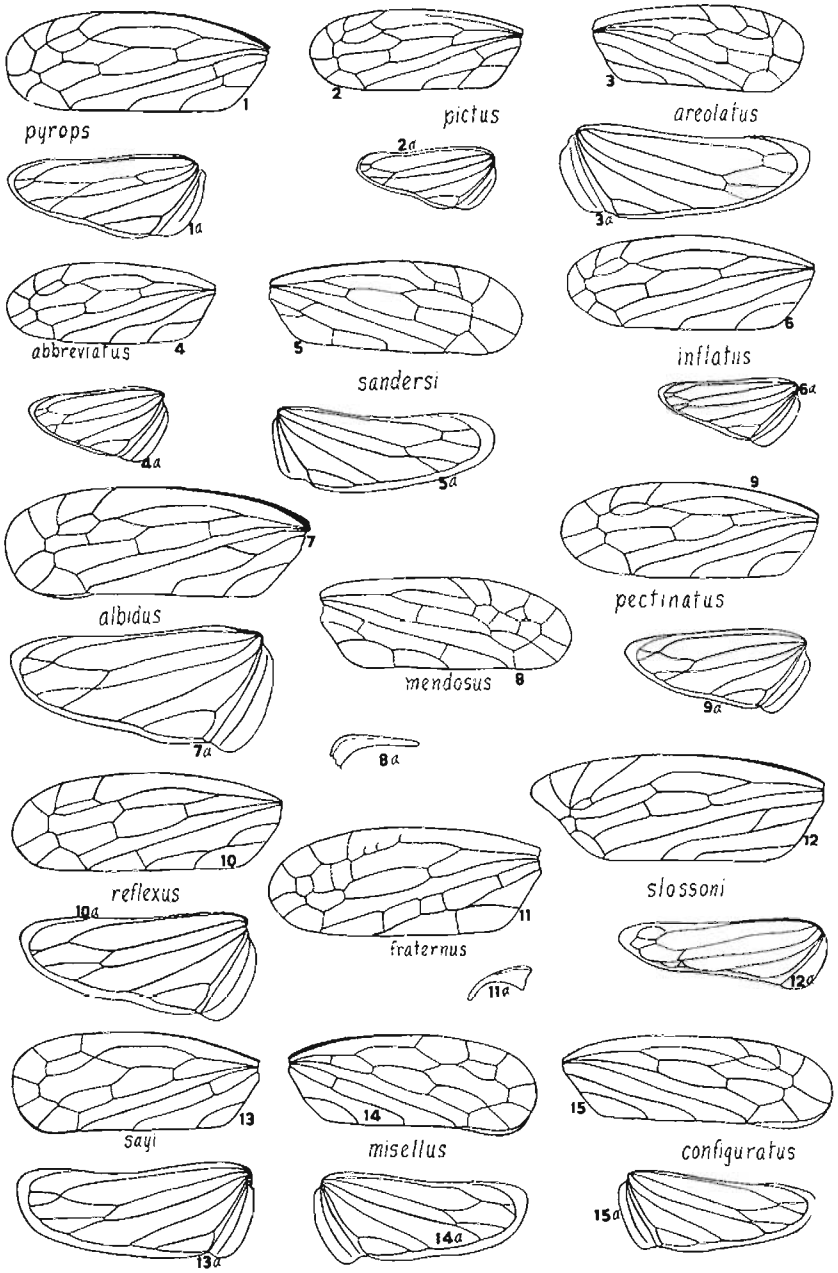

1
pyrops
1a
2
pictus
2a
3
areolatus
3a
abbreviatus
4
4a
5
sandersi
5a
6
inflatus
6a
7
albidus
7a
mendosus
8
8a
9
pectinatus
9a
10
reflexus
10a
11
fraternus
11a
12
slossoni
12a
13
sayi
13a
14
misellus
14a
15
configuratus
15a

PLATE V

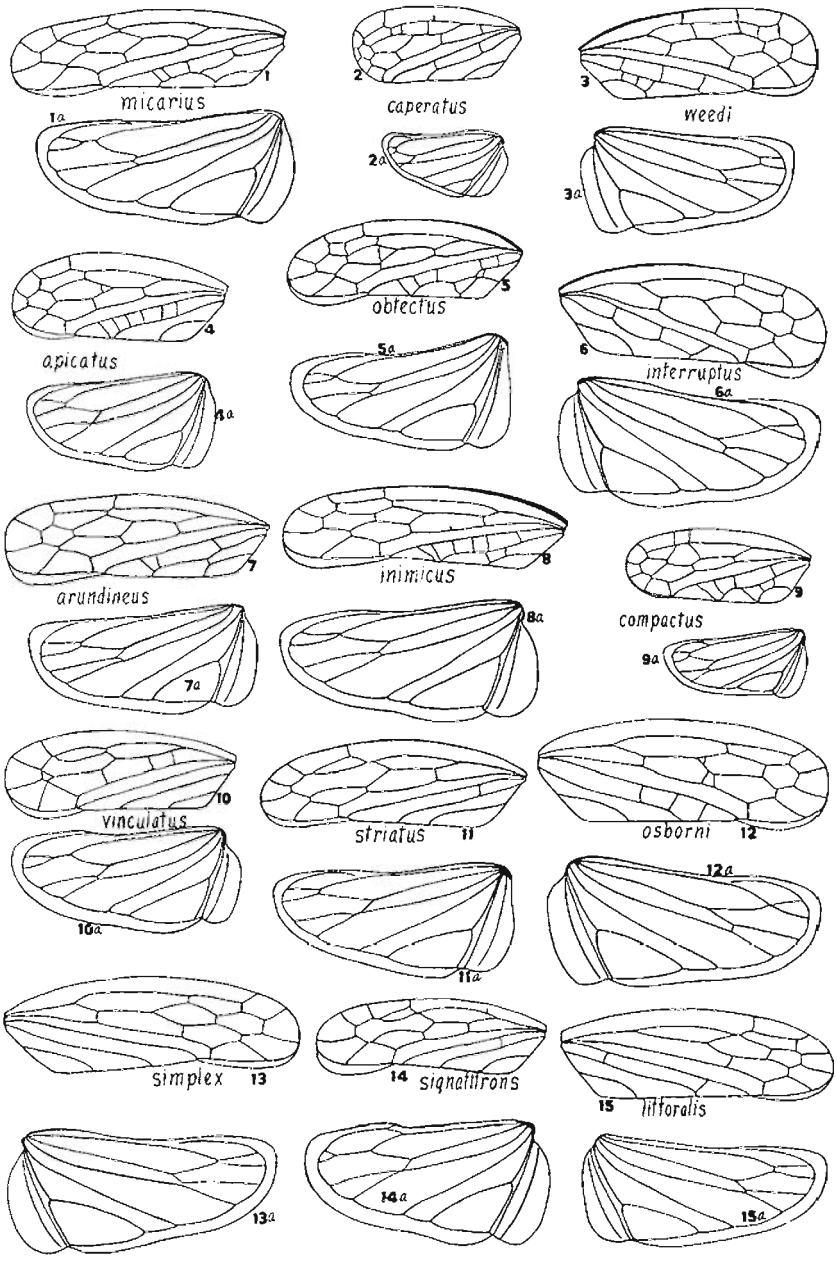

micarius
caperatus
weedi
obtectus
apicatus
interruptus
arundineus
inimicus
compactus
vinculatus
striatus
osborni
simplex
signatifrons
litforalis

PLATE VI

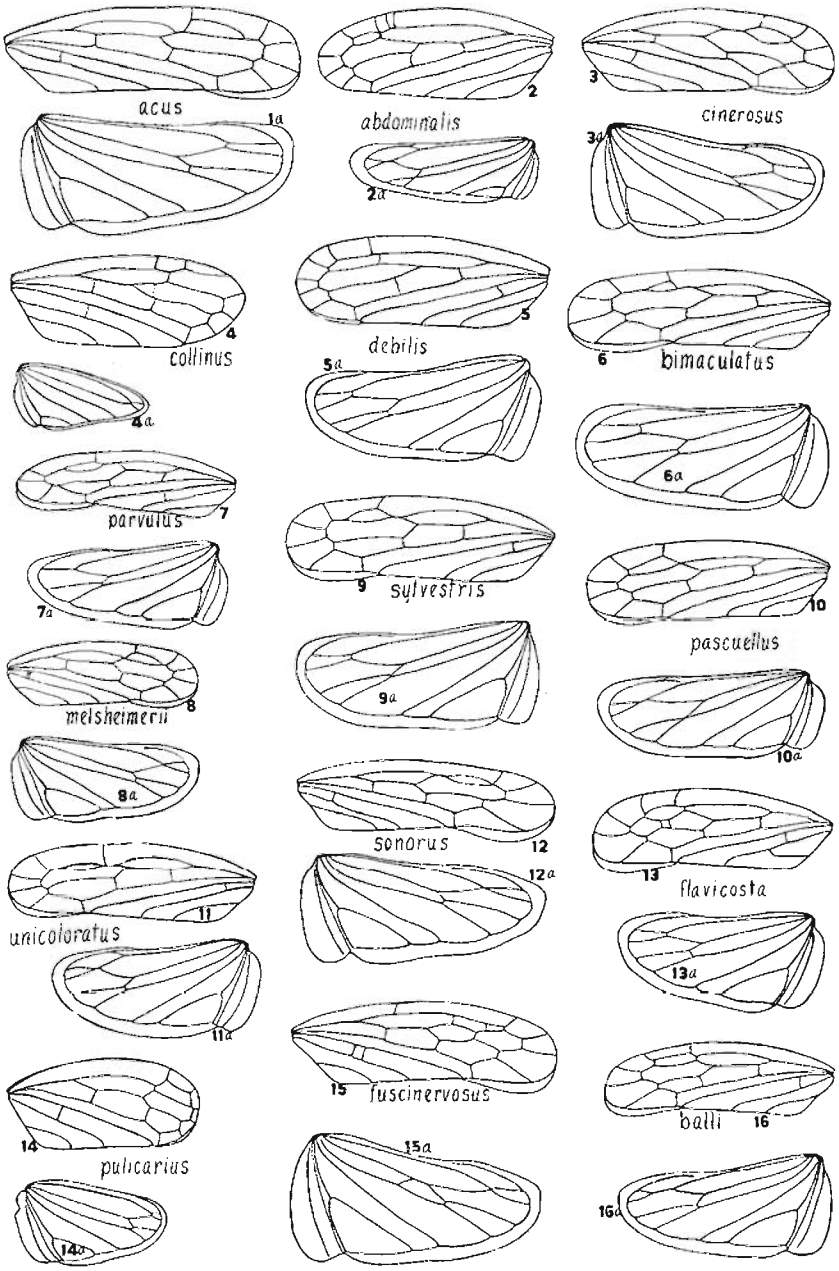

acus
1a
abdominalis
2
2a
3
cinerosus
3a
collinus
4
4a
debilis
5
5a
6
bimaculatus
6a
parvulus
7
7a
melsheimeri
8
8a
sylvestris
9
9a
pascuellus
10
10a
sonorus
12
12a
13
flavicosta
13a
unicoloratus
11
11a
fuscinervosus
15
15a
balli
16
16a
pulicarius
14
14a

PLATE VII

Fig. 1. D. pyrops; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. mendosus; 2a—male genitalia; 2b—female genitalia.
Fig. 3. D. fraternus; 3a—male genitalia; 3b—female genitalia.
Fig. 4. D. areolatus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. albidus; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. slossoni; 6a—male genitalia; 6b—female genitalia.
Fig. 7. D. grammicus; 7a—female genitalia.

PLATE VII

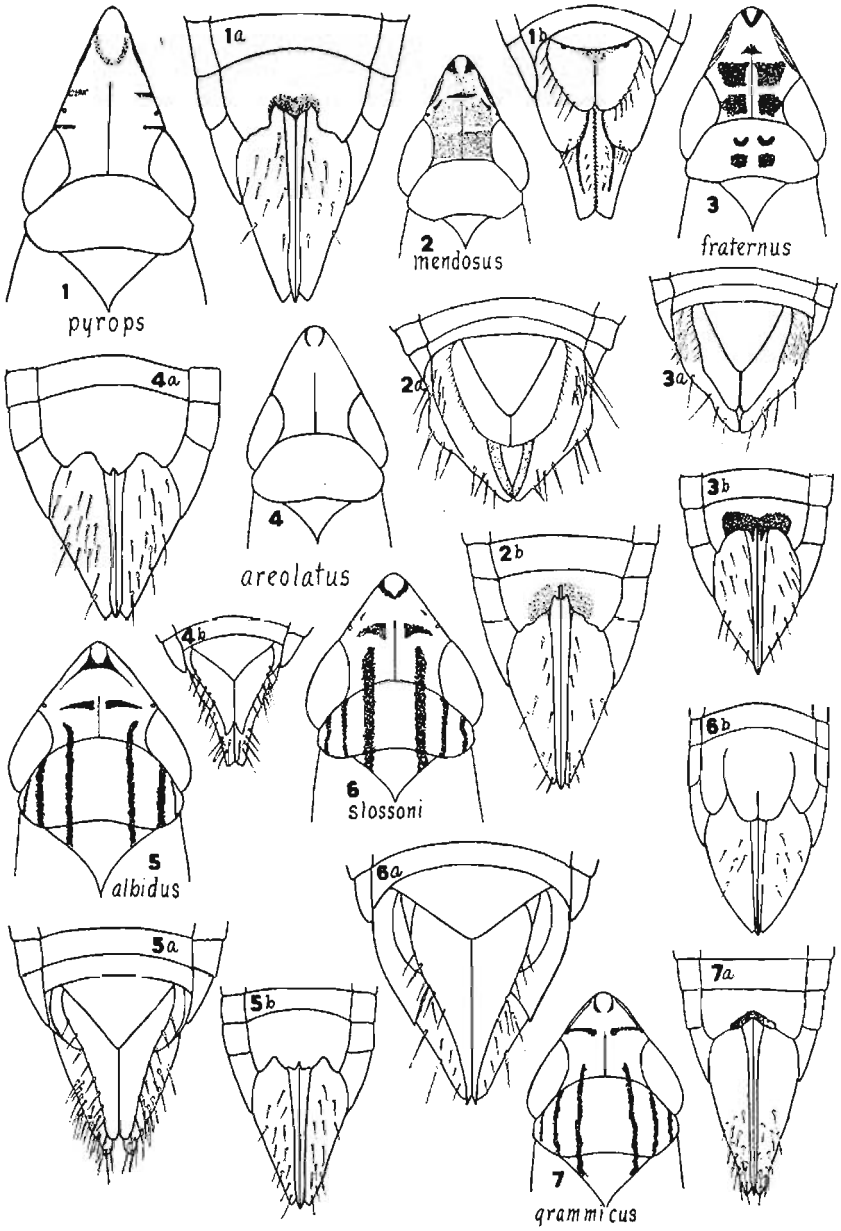

1
pyrops
1a
2
mendosus
1b
3
fraternus
4a
4
areolatus
2a
3a
3b
2b
4b
6
slossoni
6b
5
albidus
6a
5a
5b
7a
7
grammicus

PLATE VIII

Fig. 1. D. sandersi; 1a—male genitalia; 1b—female genitalia.
Fig. 2. D. reflexus; 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. atlanticus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. visendus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. gramineus; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. imputans; 6a—male genitalia; 6b—female genitalia.

PLATE VIII

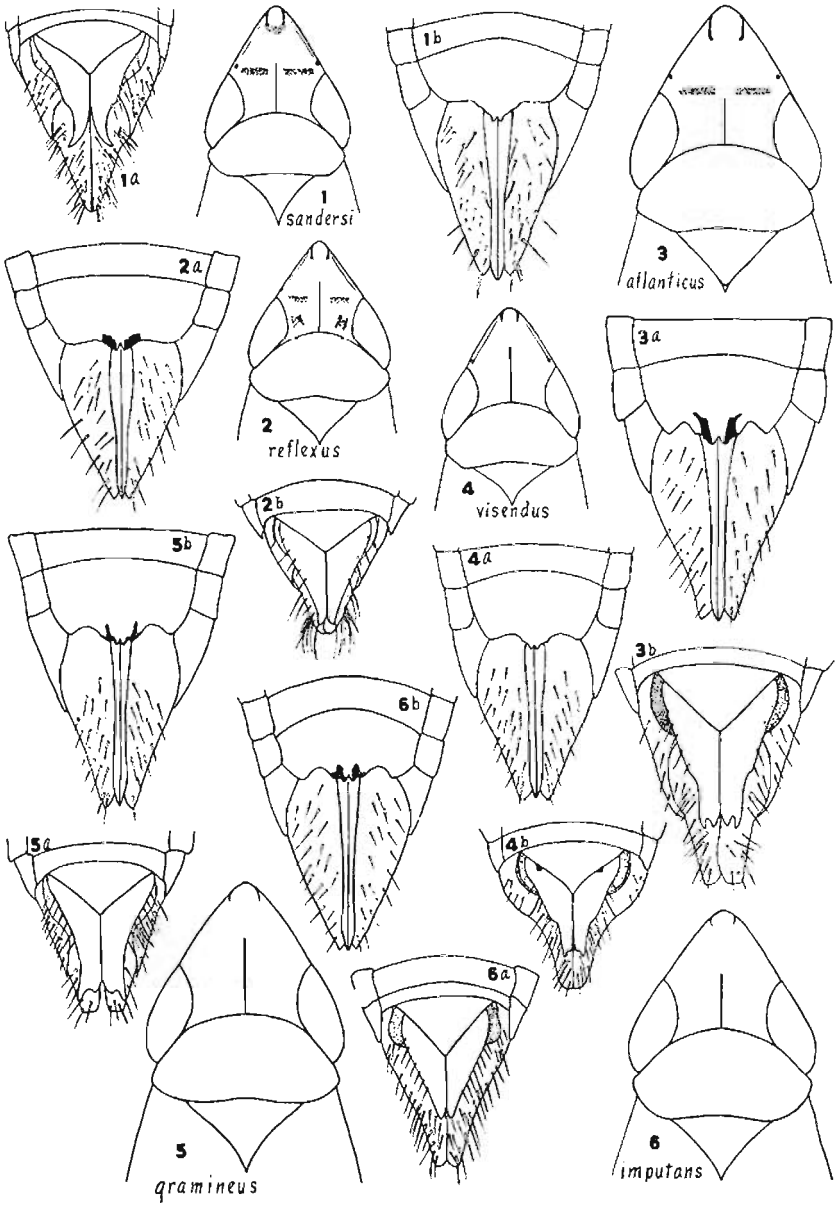

1a
1
sandersi
1b
3
atlanticus
2a
2
reflexus
3a
4
visendus
2b
5b
4a
3b
6b
5a
4b
6a
5
gramineus
6
imputans

PLATE IX

Fig. 1. D. pectinatus; 1a—male genitalia; 1b—female genitalia.
Fig. 2. D. curvatus; 2a—male genitalia; 2b—female genitalia.
Fig. 3. D. pictus; 3a—male genitalia; 3b—female genitalia.
Fig. 4. D. abbreviatus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. stylatus; 5a—female genitalia; 5b—male genitalia.
Fig. 6. D. inflatus; 6a—male genitalia; 6b—female genitalia.
Fig. 7. D. flexulosus; 7a—male genitalia; 7b—female genitalia.

PLATE IX

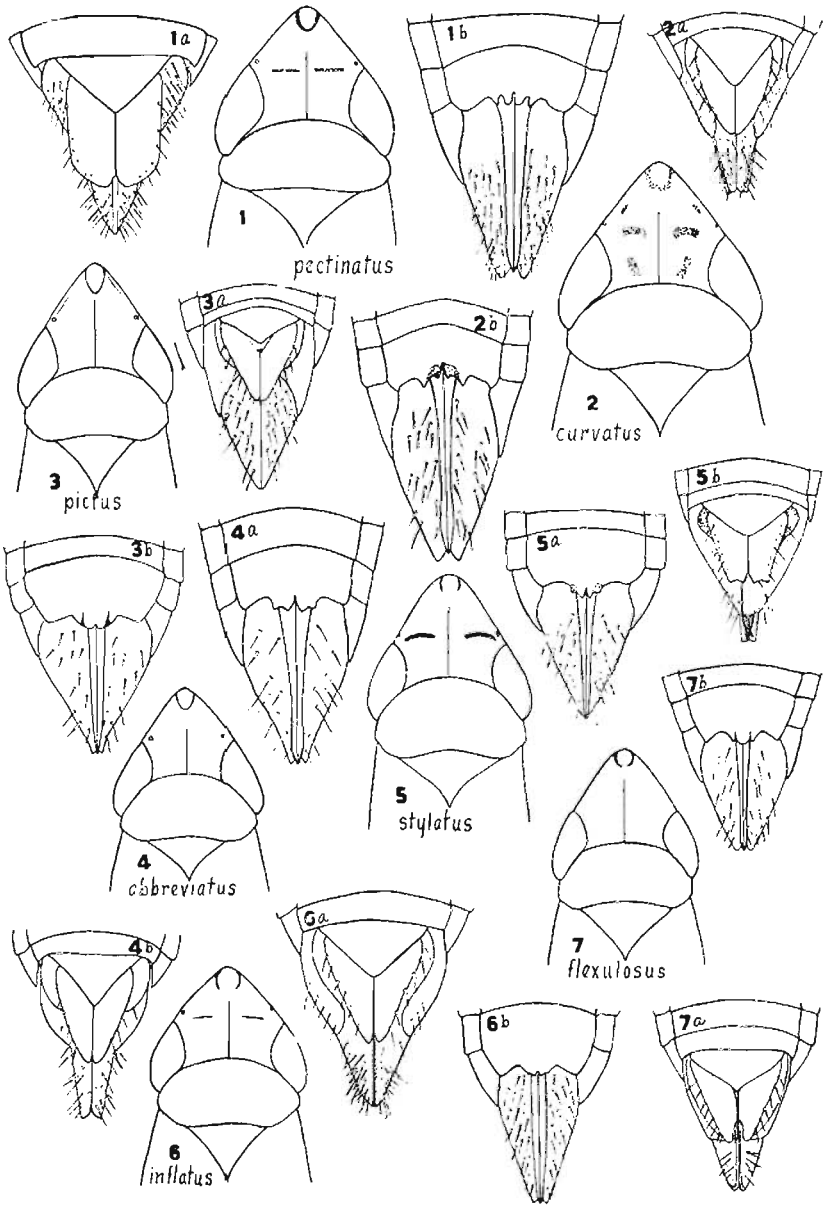

1a
1
pectinatus
1b
2a
2b
2
curvatus
3a
3
pictus
3b
4a
4
abbreviatus
5a
5b
5
stylatus
7b
7
flexulosus
4b
6a
6
inflatus
6b
7a

PLATE X

Fig. 1. D. delector; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. marginatus; 2a—female genitalia.
Fig. 3. D. paludosus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. bilineatus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. luteocephalus; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. configuratus; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. latidens; 7a—female genitalia; 7b—male genitalia.

PLATE X

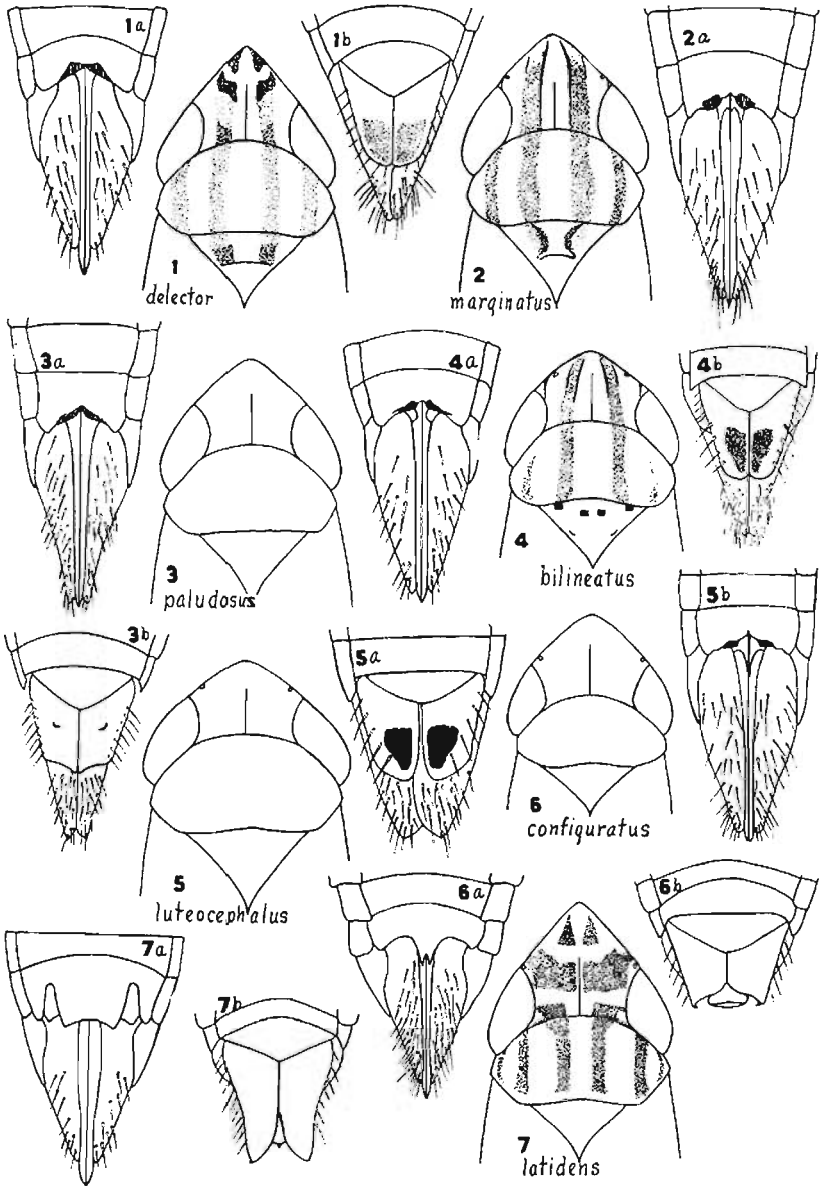

1a
1b
1
delector
2
marginatus
2a
3a
3
paludosus
4a
4
bilineatus
4b
3b
5a
5
luteocephalus
6
configuratus
5b
6a
6b
7a
7b
7
latidens

PLATE XI

Fig. 1. D. sayi; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. ocellaris; 2a—male genitalia; 2b—female genitalia.
Fig. 3. D. micarius; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. misellus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. weedi; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. interruptus; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. texanus; 7a—male genitalia; 7b—female genitalia.
Fig. 8. D. apicatus; 8a—female genitalia; 8b—male genitalia.

PLATE XI

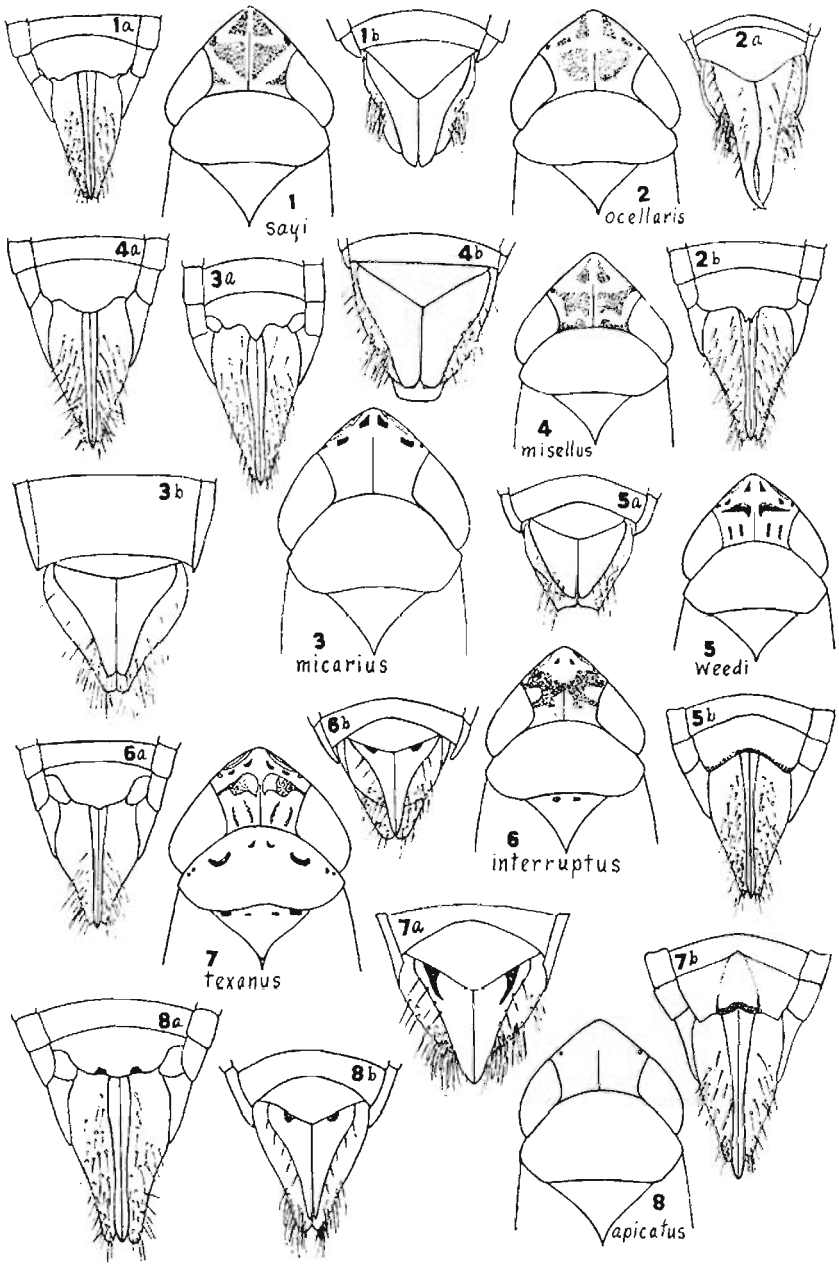

1a
1
sayi
1b
2
ocellaris
2a
4a
3a
4b
4
misellus
2b
3b
3
micarius
5a
5
Weedi
6b
6a
6
interruptus
5b
7
texanus
7a
7b
8a
8b
8
apicatus

PLATE XII

Fig. 1. D. obtectus; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. satur; 2a—male genitalia; 2b—female genitalia.
Fig. 3. D. compactus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. decisus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. caperatus; 5a—female genitalia; 5b—male genitalia.
Fig. 6. D. arundineus; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. inimicus; 7a—female genitalia; 7b—male genitalia.
Fig. 8. D. fumidus; 8a—male genitalia; 8b—female genitalia.

PLATE XII

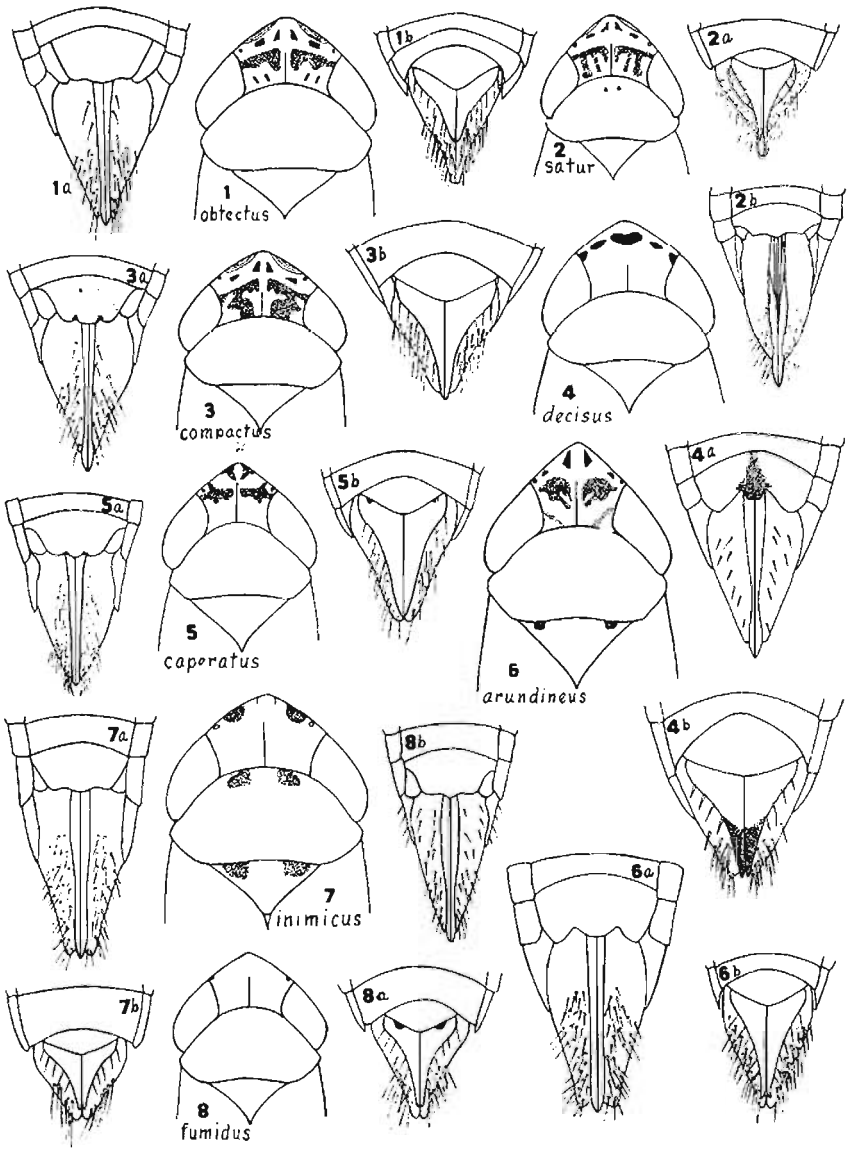

1a
1
obtectus
1b
2
satur
2a
2b
3a
3
compactus
3b
4
decisus
5a
5
caperatus
5b
6
arundineus
4a
7a
7
inimicus
8b
4b
6a
7b
8
fumidus
8a
6b

PLATE XIII

Fig. 1. D. cruciatus; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. signatifrons; 2a—male genitalia; 2b—female genitalia.
Fig. 3. var. crassus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. callidus; 4a—female genitalia.
Fig. 5. D. sexmaculatus; 5a—female genitalia; 5b—male genitalia.
Fig. 6. D. vinculatus; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. obesus; 7a—female genitalia.
Fig. 8. D. viridis; 8a—female genitalia; 8b—male genitalia.
Fig. 9. D. blandus; 9a—female genitalia.

PLATE XIII

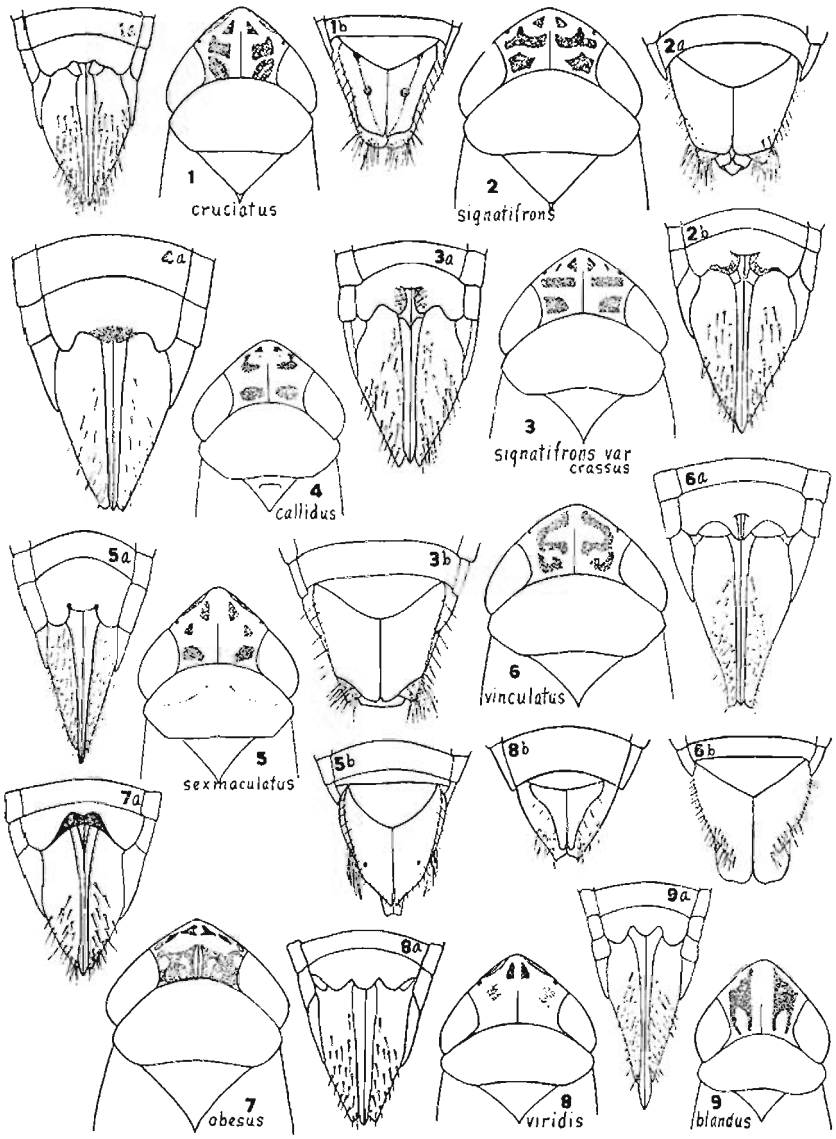

1a
1
cruciatus
1b
2
signatifrons
2a
2b
4a
3a
3
signatifrons var
crassus
4
callidus
6a
5a
3b
6
vinculatus
5
sexmaculatus
5b
8b
6b
7a
9a
8a
7
obesus
8
viridis
9
blandus

PLATE XIV

Fig. 1. D. minimus; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. melsheimerii; 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. parvulus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. unicoloratus; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. convergens; 5a—female genitalia.
Fig. 6. D. sylvestris; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. acus; 7a—male genitalia; 7b—female genitalia.

PLATE XIV

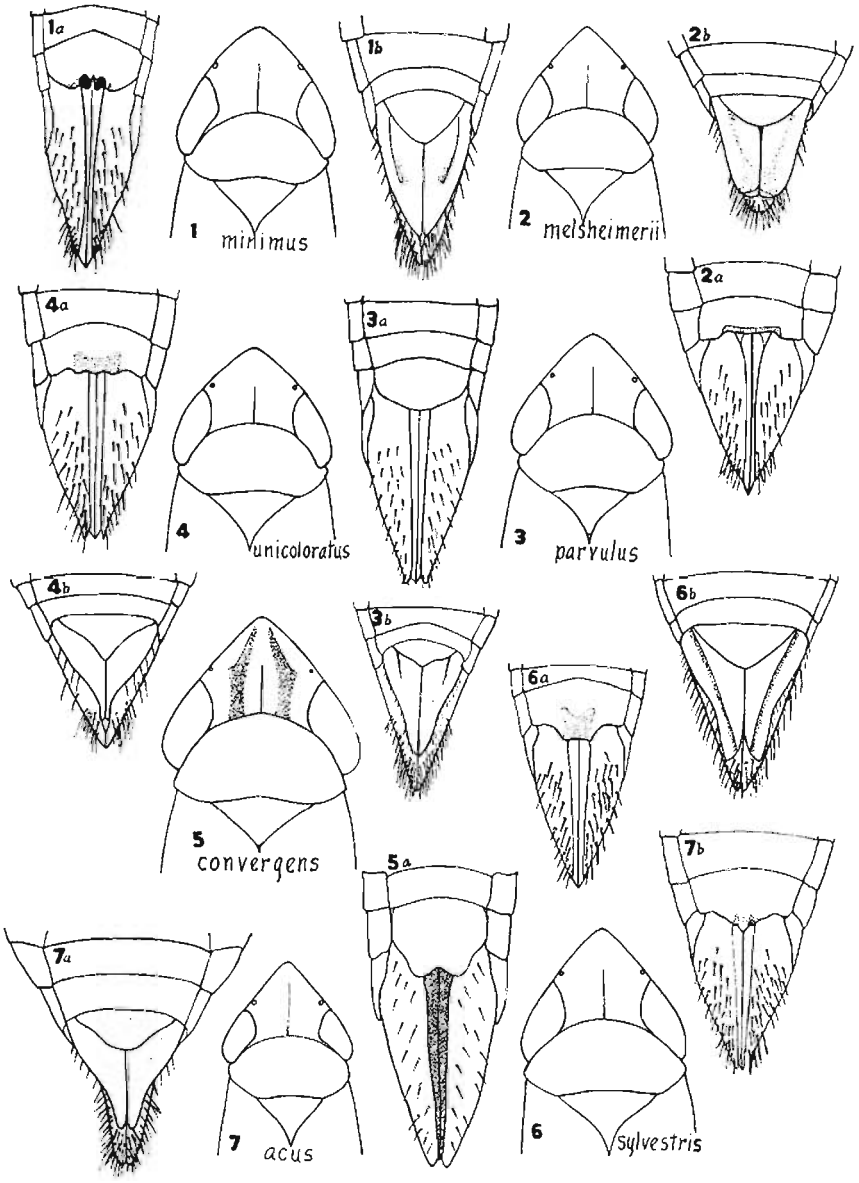

1a
1 minimus
1b
2 melsheimerii
2b
4a
4 unicoloratus
3a
3 parvulus
2a
4b
5 convergens
3b
6a
6b
5a
7b
7a
7 acus
6 sylvestris

PLATE XV

Fig. 1. D. pascuellus; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. striatus; 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. littoralis; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. cookei; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. labeculus; 5a—female genitalia; 5b—male genitalia.
Fig. 6. D. bimaculatus; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. monticolus; 7a—female genitalia; 7b—male genitalia.
Fig. 8. D. concinnus; 8a—female genitalia.
Fig. 9. D. concinnus var. incisurus; 9a—female genitalia.

PLATE XV

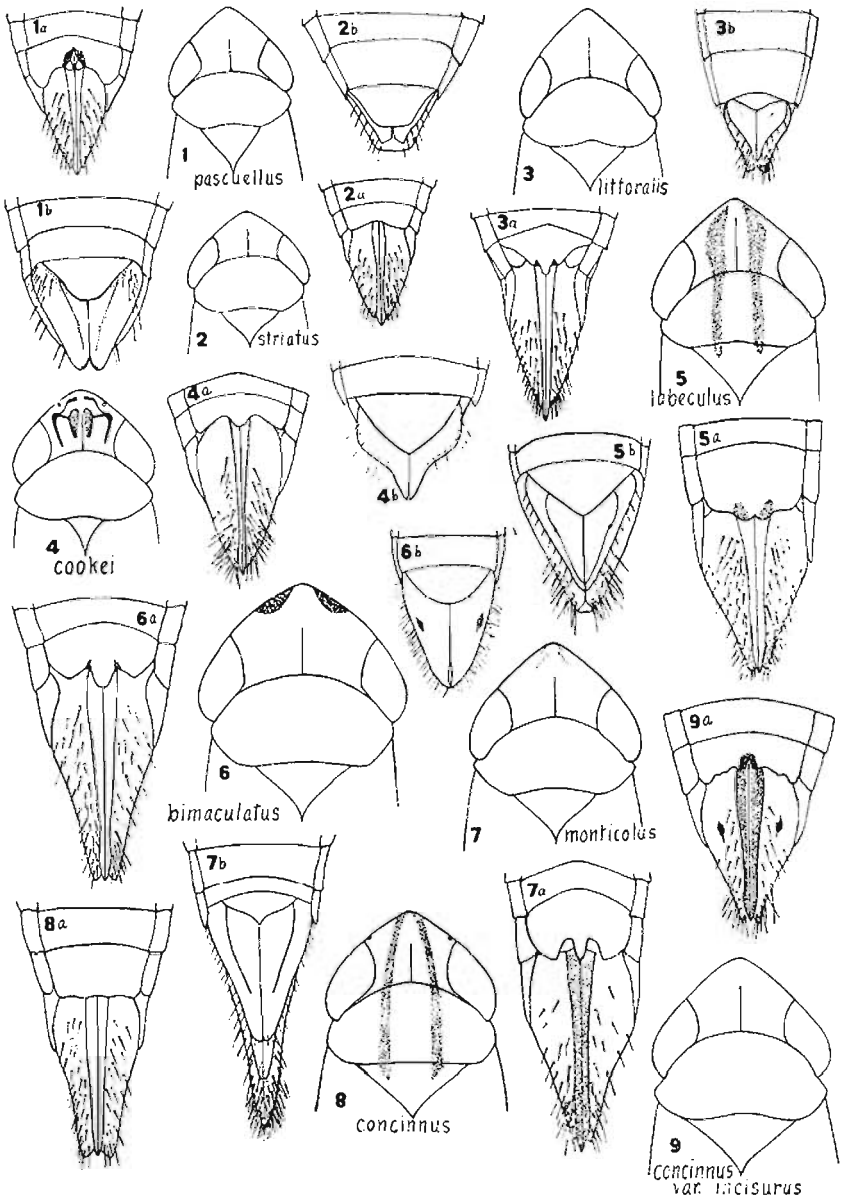

1a
1
pascuellus
2b
3
litforalis
3b
1b
2
striatus
2a
3a
5
labeculus
4a
4b
5b
5a
4
cookei
6b
6a
6
bimaculatus
7
monticolus
9a
7b
8a
8
concinnus
7a
9
concinnus
var. incisurus

PLATE XVI

Fig. 1. D. abdominalis; 1a—male genitalia; 1b—female genitalia.
Fig. 2. D. debilis, 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. spicatus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. helvus; 4a—female genitalia.
Fig. 5. D. auratus; 5a—female genitalia; 5b—male genitalia.
Fig. 6. D. larrimeri; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. exectus; 7a—female genitalia.

PLATE XVI

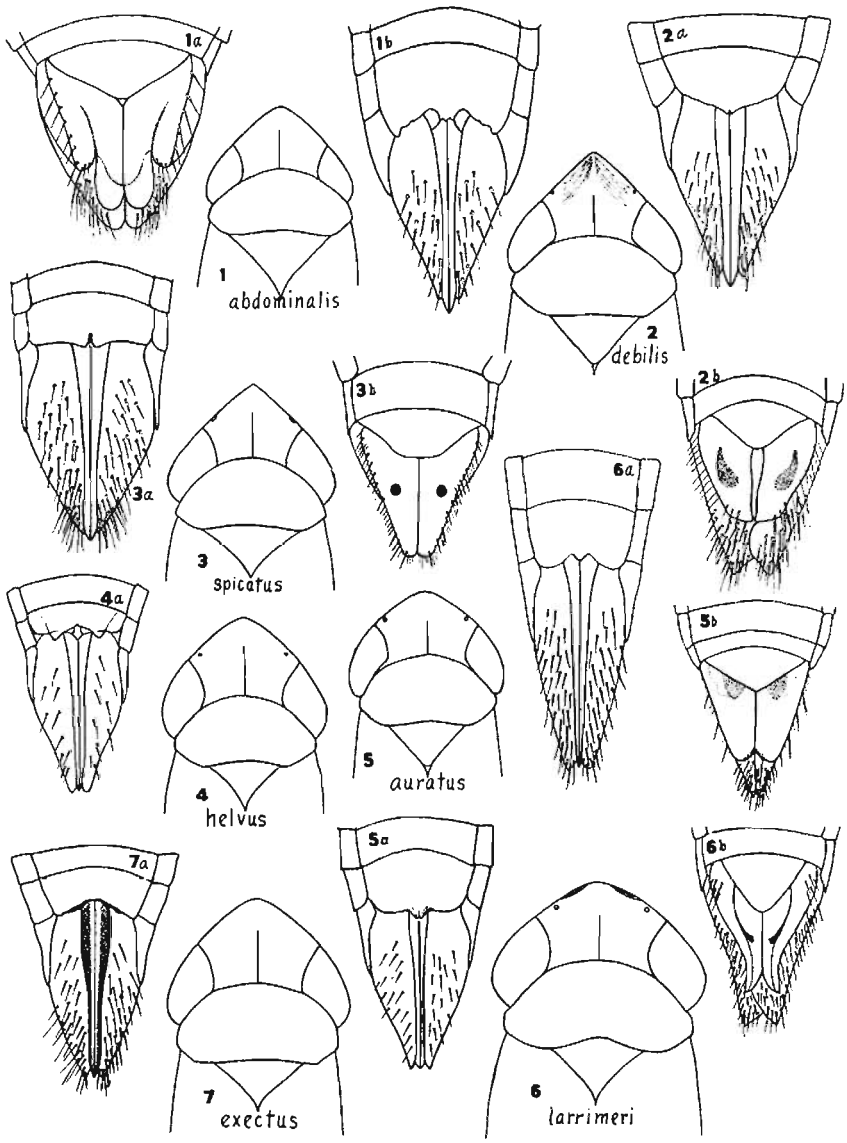

1a
1b
2a
1
abdominalis
2
debilis
3a
3b
2b
6a
3
spicatus
4a
5
auratus
5b
4
helvus
7a
5a
6b
7
exectus
6
larrimeri

PLATE XVII

Fig. 1. D. canadensis; 1a—female genitalia.
Fig. 2. D. ordinatus; 2a—female genitalia.
Fig. 3. D. collinus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. simplex; 4a—male genitalia; 4b—female genitalia.
Fig. 5. D. osborni; 5a—male genitalia; 5b—female genitalia.
Fig. 6. Th. flavo-virens; 6a—female genitalia; 6b—male genitalia.
Fig. 7. D. cinerosus; 7a—male genitalia; 7b—female genitalia.

PLATE XVII

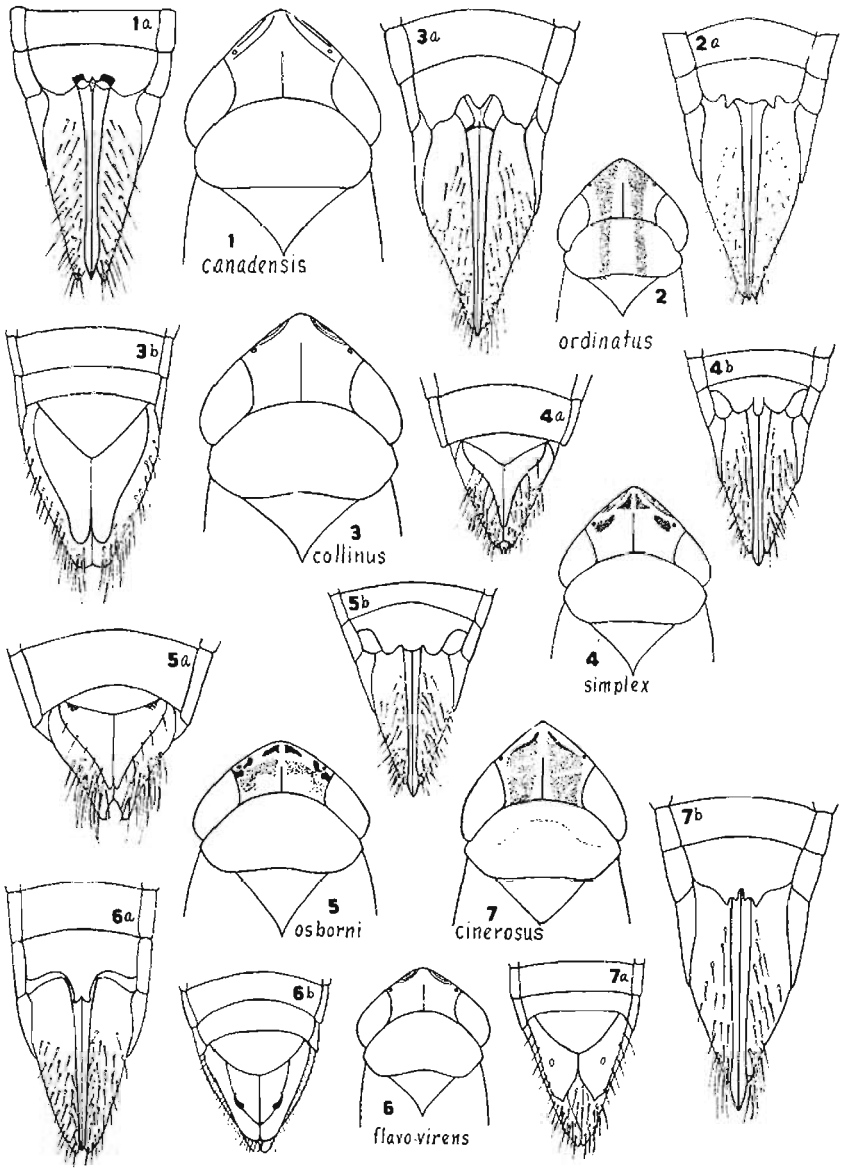

1a
1
canadensis
3a
2a
2
ordinatus
3b
3
collinus
4a
4b
4
simplex
5b
5a
5
osborni
7
cinerosus
7b
6a
6b
6
flavo-virens
7a

PLATE XVIII

Fig. 1. D. castoreus; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. gnarus; 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. marinus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. nigriventer; 4a—female genitalia; 4b—male genitalia.
Fig. 5. minutus; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. flavicosta; 6a—female genitalia; 6b—male genitalia.
Fig. 7 D. punctatus; 7a—male genitalia; 7b—female genitalia.
Fig. 8. D. sonorus; 8a—male genitalia; 8b—female genitalia.

PLATE XVIII

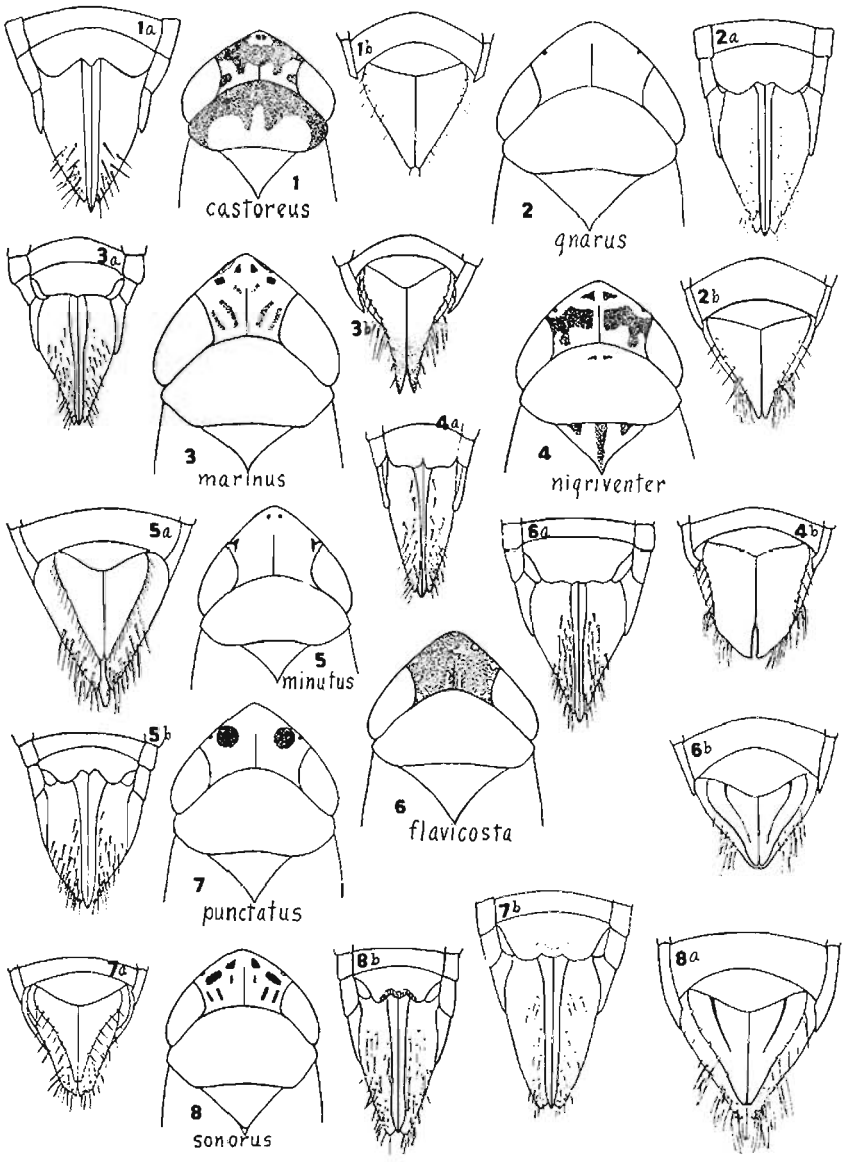

1a
1
castoreus
1b
2
gnarus
2a
3a
3
marinus
3b
4a
4
nigriventer
2b
5a
5
minutus
6a
4b
5b
7
punctatus
6
flavicosta
6b
7a
8
sonorus
8b
7b
8a

PLATE XIX

Fig. 1. D. pulicarius; 1a—female genitalia; 1b—male genitalia.
Fig. 2. D. australis; 2a—female genitalia; 2b—male genitalia.
Fig. 3. D. fuscinervosus; 3a—female genitalia; 3b—male genitalia.
Fig. 4. D. chintinomy; 4a—female genitalia; 4b—male genitalia.
Fig. 5. D. balli; 5a—male genitalia; 5b—female genitalia.
Fig. 6. D. vanduzei; 6a—male genitalia; 6b—female genitalia.
Fig. 7. E. escalantus; 7a—female genitalia.
Fig.8. E. concentricus; 8a—female genitalia; 8b—male genitalia.

PLATE XIX

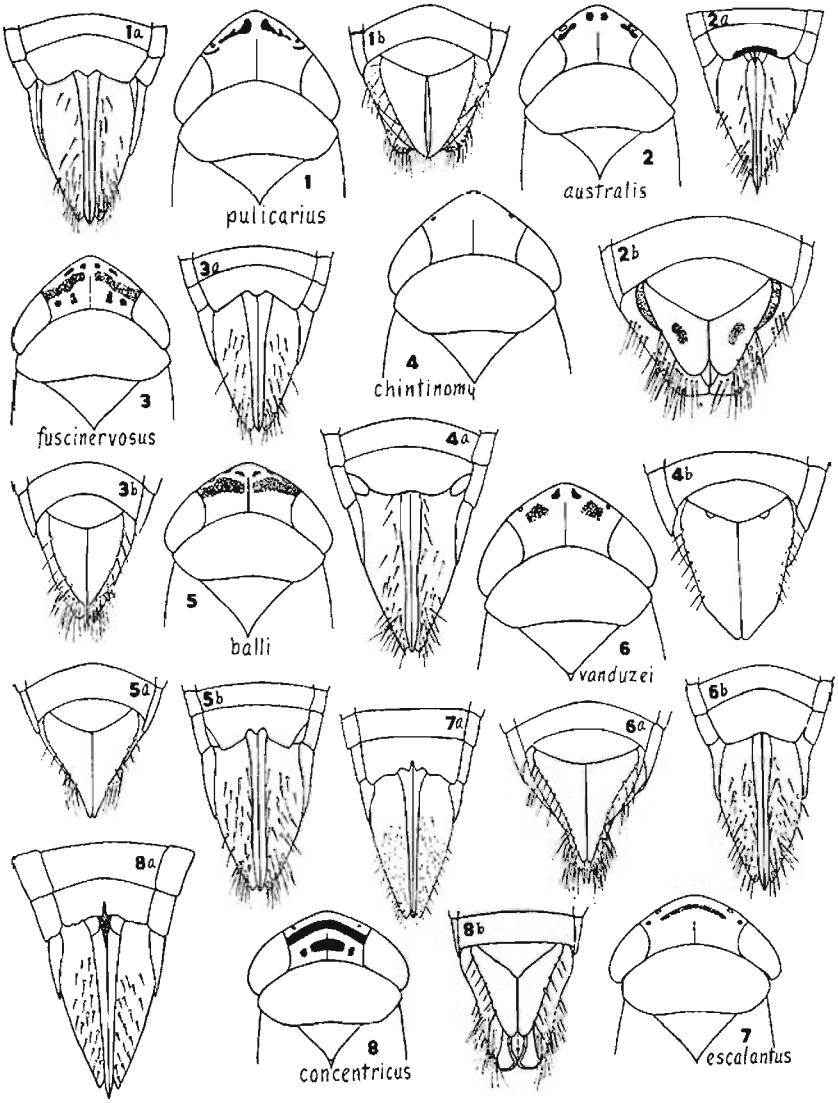
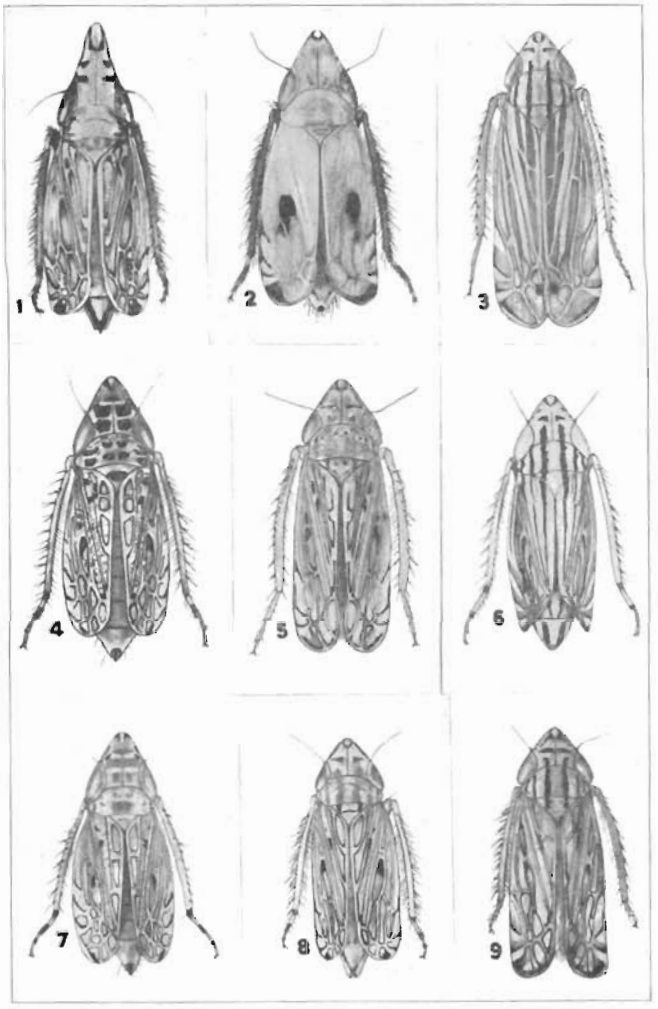
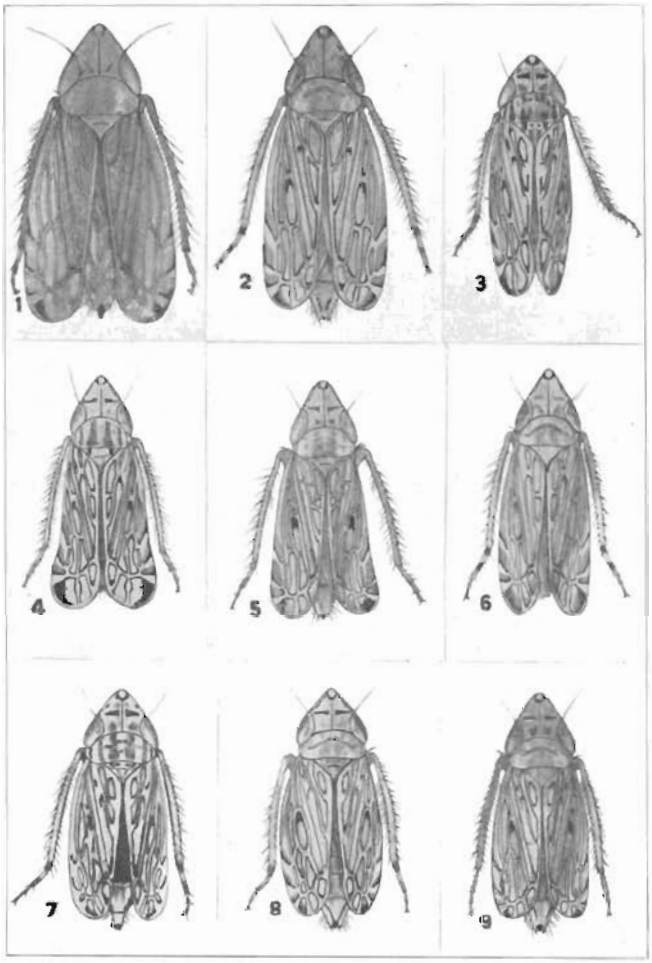

1a
1
pulicarius
1b
2
australis
2a
3a
3
fuscinervosus
4
chintinomy
2b
3b
5
balli
4a
6
vanduzei
4b
5a
5b
7a
6a
6b
8a
8
concentricus
8b
7
escalantus

PLATE XX



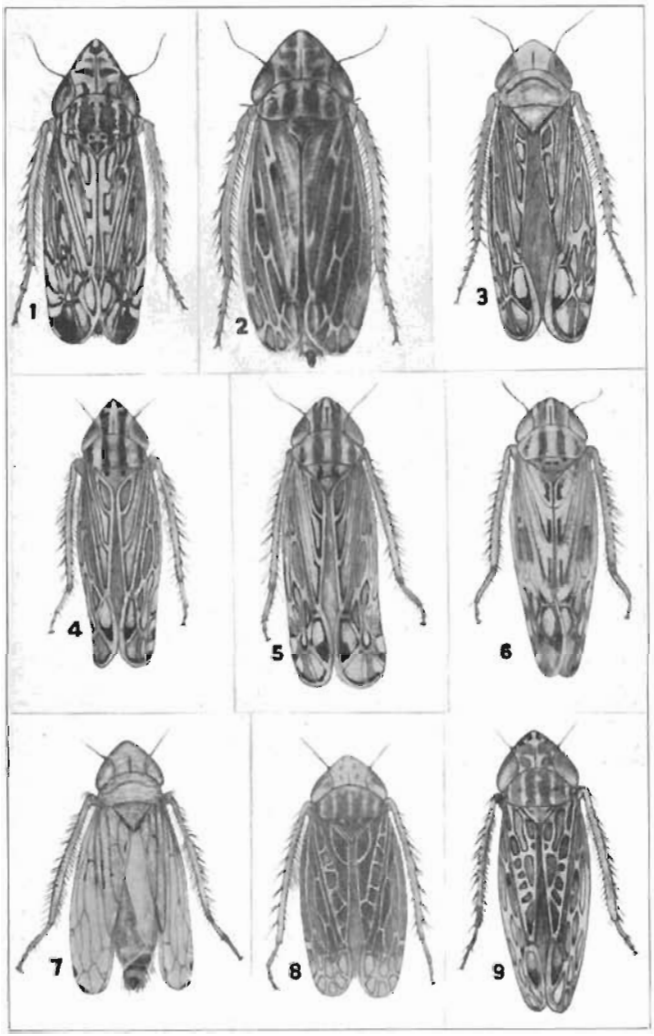
1. D. pyrops Crumb.
2. D. areolatus Ball.
3. D. grammicus Ball.
4. D. fraternus Ball.
5. D. stylatus Ball.
6. D. slossoni Ball.
7. D. mendosus Ball
8. D. inflatus O. & B.
9. D. albidus O.& B.

PLATE XXI



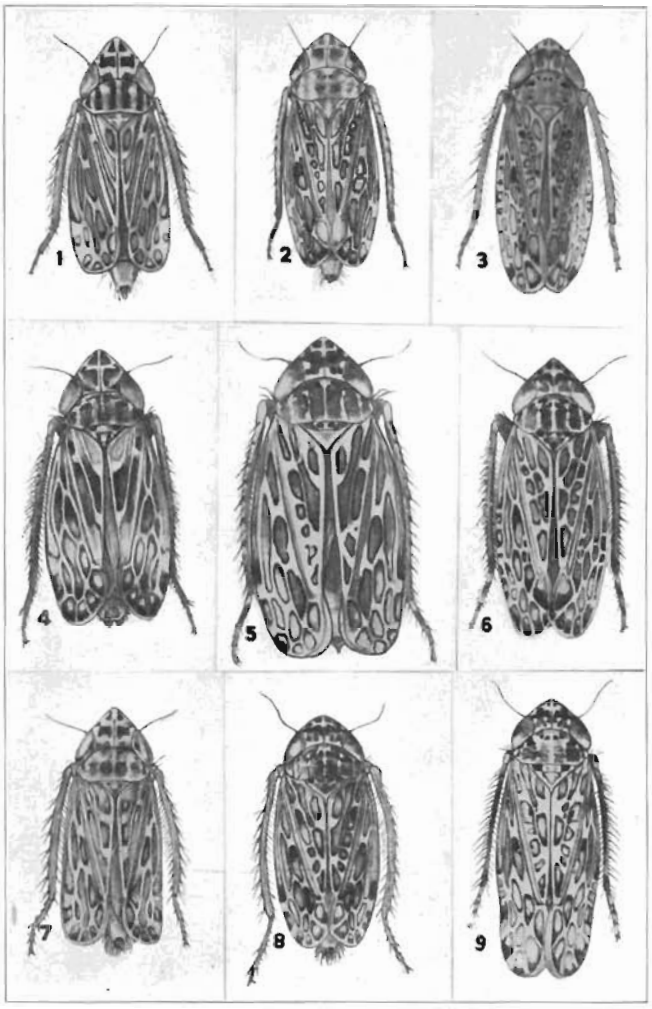
1. D. imputans O. & B.
2. D. atlanticus n. sp. DeL.
3. D. flexulosus Ball.
4. D. sandersi Osb.
5. D. visendus Crumb.
6. D. reflexus O. & B.
7. D. abbreviatus O. & B.
8. D. pectinatus O. & B.
9. D. curvatus n. sp. DeL.

PLATE XXII



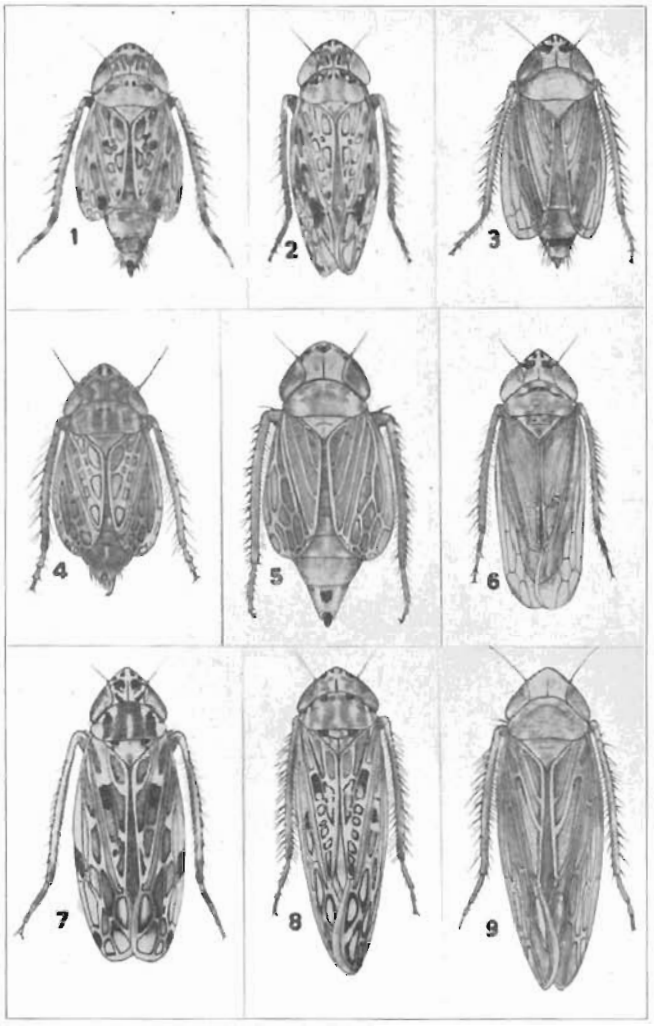
1. D. pictus Osb.
2. D. configuratus Uhl.
3. D. luteocephalus S. & DeL.
4. D. delector S. & DeL.
5. D. marginatus S. & DeL.
6. D. bilineatus G. & B.
7. D. paludosus Ball.
8. D. apicatus Osb.
9. D. micarius Ball.

PLATE XXIII



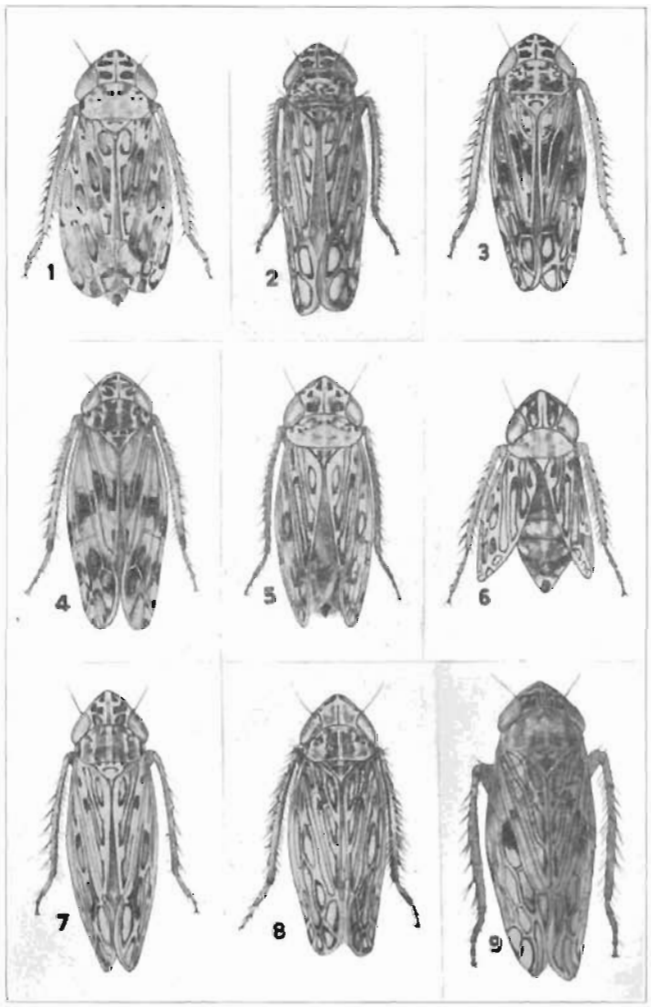
1. D. latidens S. & DeL.
2. D. ocellaris (Fall).
3. D. texanus **n. sp.** DeL.
4. D. sayi (**Fitch**).
5. **D. interruptus** DeL.
6. **D. weedi V. D.**
7. **D. misellus Ball.**
8. D compactus **O.** & B.
9. D. obtectus O. & B.

PLATE XXIV



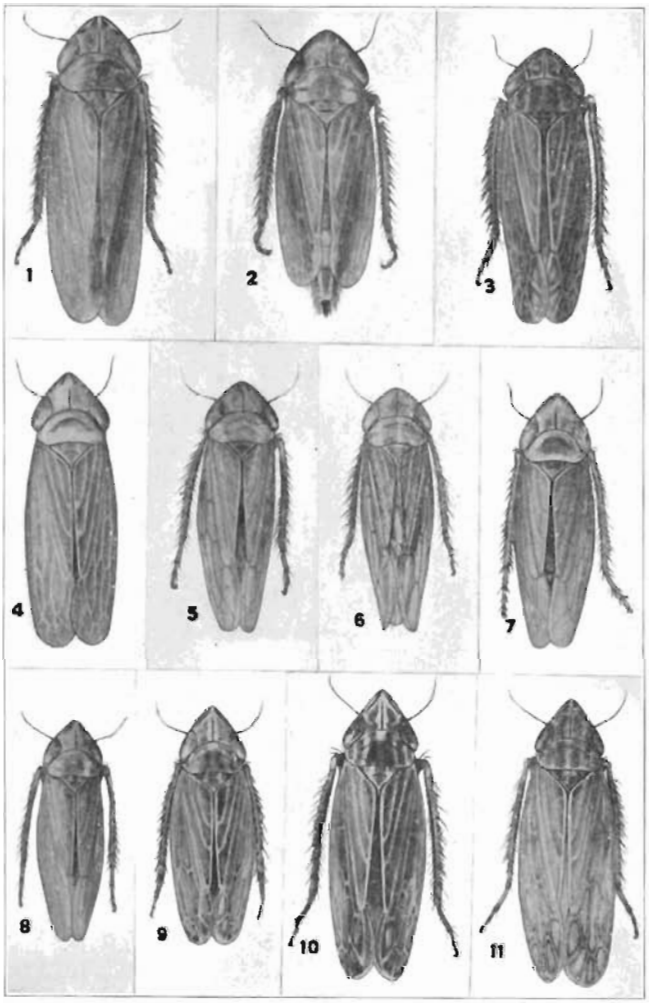
1. D. satur Ball.
2. D. satur Ball.
3. D. caperatus Ball
4. D. viridis Osb.
5. D. decisus n. sp. DeL.
6. D. caperatus Ball.
7. D. arundineus Crumb.
8. D. inimicus (Say).
9. D. fumidus S. & DeL.

PLATE XXV



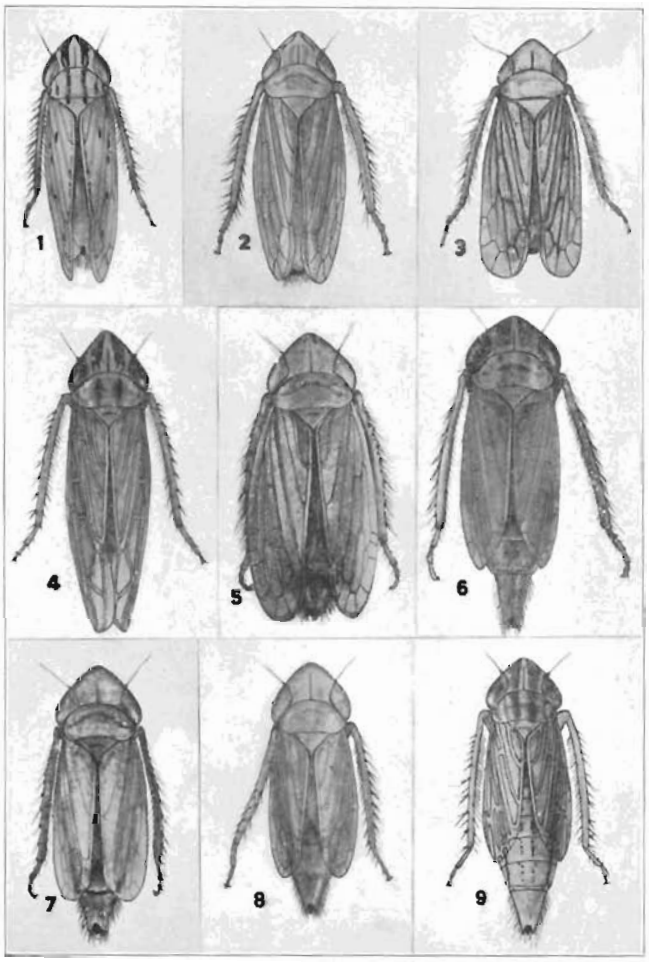
1. D. callidus Ball.
2. D. signatifrons V. D.
3. D. signatifrons var. crassus n. var. DeL.
4. D. vinculatus Ball.
5. D. sexmaculatus G. & B.
6. D. blandus Gill.
7. D. cruciatus O. & B.
8. D. cinerosus V. D.
9. D. obesus O & B.

PLATE XXVI



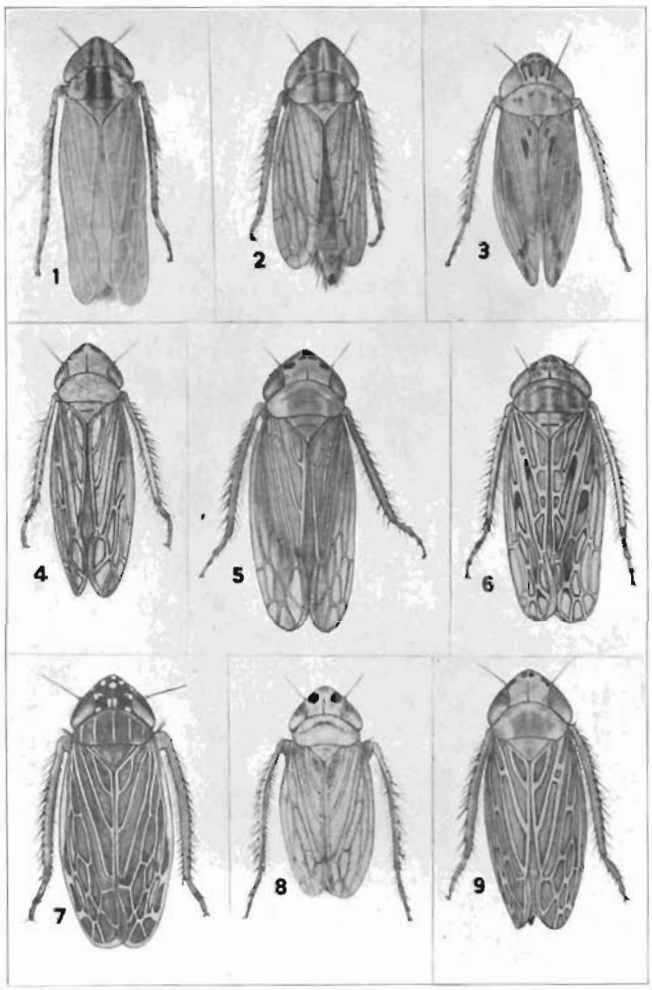
1. D. pascuellus (Fall).
2. D. littoralis Ball.
3. D. striatus (Linn).
4. D. unicoloratus G. & B.
5. D. monticolus G. & B.
6. D. auratus G. & B.
7. D. minimus O. & B.
8. D. parvulus Gill.
9. D. melsheimerii (Fitch).
10. D. sylvestris O. & B.
11. D. acus S. & DeL.

PLATE XXVII



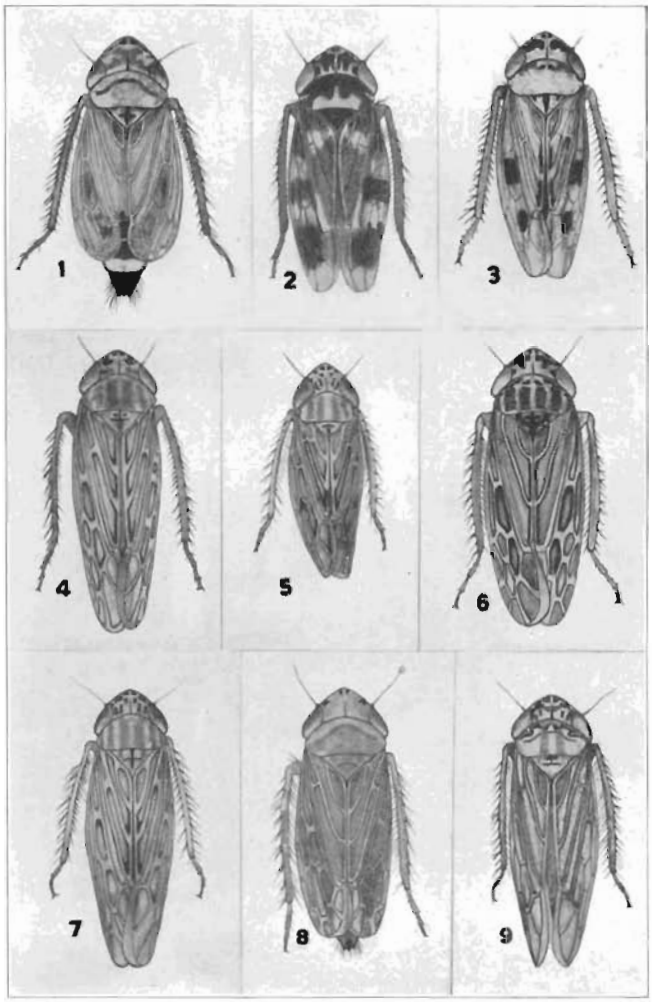
1. D. labeculus n. sp. DeL.
2. D. spicatus n. sp. DeL.
3. D. abdominalis (Fabr.).
4. D. convergens n. sp. DeL.
5. D. debilis Uhl.
6. D. larrimeri n. sp. DeL.
7. D. exectus n. sp. DeL.
8. D. helvus n. sp. DeL.
9. D. collinus Boh.

PLATE XXVIII



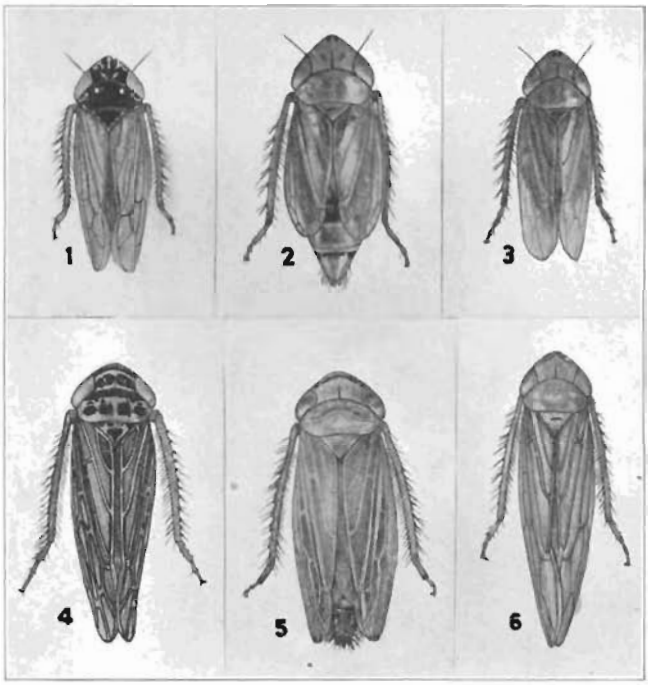
1. D. concinnus S. & DeL.
2. D. ordinatus Ball
3. D. cookei Gill.
4. D. bimaculatus G. & B.
5. D. simplex V. D.
6. D. osborni V. D.
7. D. flavicosta Stal.
8. D. punctatus O. & B.
9. D. australis n. sp. DeL.

PLATE XXIX



1. D. pulicarius (Fall).
2. D. castoreus Ball.
3. D. nigriventer S. & DeL.
4. D. fuscinervosus V. D.
5. D. marinus Met. & Osb.
6. D. vanduzei G. & B.
7. D. sonorus Ball.
8. D. chintinomy n. sp. DeL.
9. D. balli V. D.

PLATE XXX



1. D. gnarus Ball.
2. D. minutus (female) V. D.
3. D. minutus (male) V. D.
4. Th. concentricus G. & B.
5. E. escalantus Ball.
6. Th. flavo-virens G. & B.