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Study of the Internal Male Genitalia of the American Species and Their Bearing Upon Taxonomy

BY

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REPRINTED FROM

Annals of the Entomological Society of America,

Vol. XXII, No. 1.

Columbus, Ohio,

March, 1929.

NEW GENERA AND SUBGENERA FROM THE GENUS DELTOCEPHALUS.

A Study of the Internal Male Genitalia of the American Species and Their Bearing Upon Taxonomy.*

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Some two years ago the senior author constructed and published a key to the North American species of Deltocephalus,† using external characters in an attempt to form a working basis for this group. During this study several problems in taxonomy and relationship presented themselves and had to remain unsolved for the time without an examination and detailed comparative study of internal characters. The present treatment, discussion and figures, is an attempt to throw more light upon these relationships by presenting the structures and data which will assist in solving some of these problems and establishing certain taxonomic relationships among these species.

On the basis of characters used in the previous treatment the genus was divided into a number of subgenera. For this division, wing, head and external genital characters were used. One of the problems in mind in the present study and treatment was a critical study of these divisions which were made formerly. It would seem from the evidence at hand that this division into groups was correct as far as they were established, but that still others should be set off because of certain unique characters, or groups of characters.

Another phase of the generic problem has also entered this discussion, that is the relationship of long established genera which are closely related to the genus *Deltocephalus* as it was formerly recognized, to the different subgenera as set off recently by the senior author. It is apparent from previous and present study that certain genera like *Thamnotettix*, *Euscelis*, *Lontura*, and others of this general group are more

*Contribution No. 94 from the Department of Zoology and Entomology, Ohio State University.

†Ohio State University Bulletin, Vol. 11, No. 13, January 15, 1926.

closely related to certain of these subgenera than some of the subgenera are to each other, especially the extreme groups. It seems logical therefore to term these groups genera in the future and they are thus treated in the following discussion. Also two new genera and two subgenera are established. For many years species that could not be disposed of otherwise were placed in the genus *Deltocephalus* and it is time that these were separated into their proper groups.

There remains little doubt concerning the question of where to place the species recently known as *Thamnotettix nigrifrons* Forbes which was separated from its apparent close relatives because of the absence of a second cross vein in the wing. This small group of *Thamnotettix* belongs with the subgroup carrying the *Deltocephalus* name and containing such species as *vanduzei*, *balli* and *fuscinervosus*. Furthermore, certain *Thamnotettix* species, like *inornatus*, are undoubtedly closely related to the *Laevicephalus* group, while several species of *Euscelis* and *Lonatura* are closely related to species of the *Amplicephalus* group.

Genus **Flexamius** De Long.

(Plates I, II and III).

The genus *Flexamius* was erected by the senior author and this division was based largely upon the character presented by the reflexed costal veins of the first pair of wings. Several rather distinct subgroups were noticed in this subgenus showing diverse types of genitalia which were illustrated previously. In the former treatment these were placed together since external structures alone were considered of necessity. As might be expected when establishing a group chiefly upon a wing character, great diversity is found in the structure of the internal genitalia throughout this group upon examination of these structures. In several cases this is so marked that doubt arises concerning the placing of certain of these species in the same subgenus and even their probable separation into more diverse grouping. At the same time this condition may be due to a loss of or our inability to locate intermediate forms.

The styles probably show less variation than the other internal structures, but in most cases these show specific differences. The terminal processes exhibit the greatest specific

variations regarding size, length and curvature. In some species a spine-like process is present on the anterior lateral corner. The articulation with the connectives also presents slight specific differences. In a lateral view the lateral dorsal folding of the styles is rather prominent in most species. *Abbreviatus* and *surculus*, with their wide blunt apices with angled margins, are quite different from the more pointed apices of the other species of the group as regards the styles.

The oedagus varies greatly throughout the group, especially as regards the terminal processes and is probably the best internal character for specific separation as well as showing those species which are more closely related. The body of the oedagus may be long or short, rather even in width throughout its length or tapering from anterior to posterior ends. The terminal processes may be two in number, same size and type, three in number different size and type, and either single or bifurcate.

From this study some of the more interesting relationships might be pointed out, as well as some of the unique and striking differences. The study would indicate that there have been certain developments in different directions from a generalized type, and these groups which have developed in different ways seem to contain certain species more closely related to each other than to the other species.

Pectinatus appears to be of this generalized type. The oedagus is simple in form and devoid of terminal processes. *Abbreviatus* appears to be rather closely related to *pectinatus*, the oedagus being of the same type but somewhat heavier. The styles of this species on the other hand with the wide blunt apices are different and unique for the group with the exception of *surculus*. It is doubtful where this latter species should be placed, but it shows evidence of being closely related to *abbreviatus*. The styles and bifurcate anterior processes of the oedagus of *surculus* are of the same general type, although the bifurcate terminal processes are similar to those of the *albidus* group.

Four of the species examined, *pictus*, *pyrops*, *sandersi* and *visendus*, each have a pair of terminal processes on the oedagus and are different in this respect from the other species discussed here. *Pyrops* and *pictus* are very similar in view of the pair of tapering terminal processes on each, and their anterior

dorsal processes of the oedagus. *Pyrops* seems to be only an extreme form of this type of oedagus structure. The styles are different in shape and are proportionately larger in the case of *pyrops*. The pygofers of pictus in the region just dorsal to the plates are drawn out into long, triangular, pointed structures which overlap. The other two species examined with two terminal processes, *sandersi* and *visendus*, are quite similar in structure and have been confused because of their external resemblance. The terminal processes of the oedagus are of the same general type and armed with barbed processes, but are distinct. In *visendus* these processes are much longer and broader. The styles are almost identical. The anterior processes of the oedagus are distinct, being hooked or bent at right angles in the case of *sandersi* and straight in *visendus*. One of the best specific characters is found in the pygofers since in *visendus* the edges are serrated and overlap in the region just dorsal to the plates, which condition is not found in *sandersi*.

Specimens of *stylatus* have not been available for dissection, but the styles are so long in this species that they are visible without dissecting. They are long, black and conspicuous, exceeding the blunt plates. This character as shown in Ohio State University Bulletin, Vol. II, No. 13, Plate IX, 5b, is an excellent one for external use.

Inflatus, *flexulosus* and *areolatus* show another diversion in having three terminal processes on the oedagus. In *flexulosus* the three processes are short and of the same type and size, while in *inflatus* two are of the same size and type, lateral in position and resembling somewhat the two processed species, but the third is of different type and much longer. The extreme of the three terminal processed character is apparently reached in *areolatus*, where one process is longer and appears heavily clothed with coarse pubescence, while the shorter two are smooth. The styles are very similar to the other species like *sandersi*. In *slossoni* and *albidus* the pair of bifurcate terminal processes of the oedagus shows some similarity, but not necessarily close relationship since other characters are quite different. In *slossoni* the body of the oedagus attains its greatest width in the middle while in *albidus* the oeadgus is wide at the ends and narrow in the middle. The anterior processes of the oedagus in *albidus* are distinct, their caudal

extremities being expanded into wide bulb-like structures. The styles are different specifically. Furthermore in *slossoni* the terminal fourth of the oedagus curves ventrally and anteriorly, terminating in a rather sharp point. This condition is unique among those species of *Flexamius* examined. A sharp spine-like process which is also unique is found on the ventral side of the oedagus posterior to the articulation with the connectives. In view of these characters and the wing condition a new subgenus is described here and *slossoni* is placed as the type of this group.

Subgenus **Secopennis** nov.

(Plates II and III).

Head produced and flat as in *Flexamius*. Elytra broad and flaring venation somewhat similar to *Flexamius* with the reflexed costal veins present but with posterior margin of elytra sloping obliquely from the claval vein and slightly concavely rounded to the costal margin forming a produced portion on the costal margin which is rounded at the apex. The inner apical cells are very short as seen in the figure of this venation which is given in the monograph of Deltocephalus Plate IV for *slossoni*. This species is designated as the type of this subgenus.

The species is so different from the *Flexamius* group that it has seemed advisable with further study to place it in a separate subgenus.

Subgenus **Palus** nov.

(Plate IV).

Elytra with a definite but small appendix, central ante-apical cell constricted at center but not divided, outer ante-apical cell quite small, sometimes almost obsolete, two or three costal veins slightly reflexed. Vertex somewhat variable in length and degree of angle. Margin of vetex not sharply defined as in *Flexamius*. The external genital characters of the four known species of this group are very similar in both the males and females.

All of these species live on sedges or coarse grasses of the fresh water marshes and all occur in northern habitats.

Type of subgenus *delector*.

The males of only one species have been available in sufficient numbers for dissection.

In *delector* the only species of this apparently diverse group which was available or sufficiently abundant for dissection,

these structures show still further differences. In general form the styles are not greatly different from the generalized type. The oedagus from a lateral view is narrow at the base soon enlarging abruptly dorsally at the top of which a pair of long spine-like processes extend ventrally one either side to the ventral side of the oedagus. Although heavily chitinized on only the ventral side, the oedagus is thickened to the posterior end, tapering slightly to a bluntly pointed tip. A slight spur extends dorsally near the tip. In dorsal view the oedagus is slightly constricted on the central half, the most unique portion being the apex, which is enlarged, with a pair of diverse pointed tips, a pair of barb like spines extending anteriorly at the anterior point of enlargement. This group is apparently quite different from the preceding ones mentioned if we may judge from this species which externally resembles very closely the others which are placed here.

Genus **Alapus** nov.

(Plates II and III).

Vertex similar to *Flexamius* but more strongly produced, usually almost twice as long as width between eyes. Elytra with several cross veins in clavus and middle anteapical cell usually divided into three or more cells. Male pygophers with flapper like structures attached to posterior margin inside of genital chamber and extending forward when in normal position.

Fraternus and *mendosus*, which differ markedly from the *Flexamius* group in the characters mentioned above, as well as the strikingly different external genital characters, are placed in this genus. *Fraternus* is designated as the type.

The internal genitalia although very similar in these two forms seems to give slight specific differences.

Mendosus and *fraternus* have been commonly confused and if species, they are undoubtedly very closely related. The oedagus, although similar and variable in both species, seems to be distinct. It is rather short and comparatively broad, not tapering, terminating very bluntly. At about the middle a pair of wing-like processes are given off which from a side view are continuous dorsally. From a ventral view the oedagus appears to rest on a bifurcate structure which is attached to the wing-like structures anteriorly, apparently without a direct connection. The two processes of this bifurcate structure are

directed posteriorly curving inward, extending as far as the anal ring, to which they are usually attached by the surrounding membrane. These processes present the only constant specific differences, in *mendosus* they are heavier and broader than in *fraternus*, but not as long. From a side view the processes in *mendosus* make an abrupt bend dorsally at about the middle, while in *fraternus* they curve or slope gradually. The styles of these two species are different from the other species of the subgenus, but they are very similar to each other. A considerable amount of variation especially in regard to the width and curvature of the terminal processes and their apices was found among the specimens of these two species examined. In *mendosus* the styles extend beyond the plates.

A pair of structures are present in each of these two species which have not been found elsewhere in the group. They are long tapering, flapper-like structures appearing netted and attached to the posterior part of the pygofers near the median line. From this point of attachment the free end extends anteriorly more than half the length of the pygofer. Occasionally they are found extending posteriorly outside the genital chamber. The external characters of the plates which might be used to separate these species have already been mentioned previously by the senior author. After studying a number of specimens of *mendosus* and *fraternus*, the only constant internal structures found are the oedagi, which are similar except for the bifurcate structures. The processes of these seem to be constant specific characters at least for the material studied.

These two species or species in the making should probably be given generic or subgeneric ranking, since internal and external structures both would indicate a rather distinct type of insect. They are therefore referred to a separate group as indicated here.

Genus **Latalus** nov.

(Plates II and III).

Vertex angularly produced, but usually not greatly longer than width between eyes. Reflexed arcs of front not visible from above Elytra with short veinlets meeting costa at about right angles but differs from *Flexamius* in having no reflexed veinlets to costa. Elytra usually short just covering abdomen. Type of genus *sayi*.

The senior author has mentioned previously that this group is quite different from the species of *Flexamius* and it has seemed advisable to separate it because of further evidence obtained during this study.

Four species of this group are found in sufficient numbers so that specimens were obtained for a study of internal characters.

In external structures and general appearance *misellus, ocellaris* and *sayi* appear very closely related externally. The plates, pygofers and valves would indicate close relationship. An examination of the internal characters shows a great difference in structures. The oedagus is quite variable. In *misellus* the oedagus in ventral view appears very short, but a lateral view shows it to be long but directed dorsally and anteriorly. A pair of spine-like structures are found near the base of the terminal portion, while the dorsal portion is pointed. There are no anterior dorsal processes. The oedagus of *sayi* is very broad at the base, with two short lateral dorsal processes. The central portion is constricted and the terminal portion again broadened into two wing-like structures from between which a pair of long slender processes arise extending ventrally and anteriorly. In *ocellaris* the oedagus is comparatively narrow, the base being expanded and triangular in shape. Four terminal processes are visible, two of these are long and slender, directed anteriorly, two others are short and hair-like, directed posteriorly. The dorsal process of the oedagus seems most closely related to *sayi*.

Configuratus is apparently related to the *sayi-ocellaris* group, the oedagus being of the same general type. The oedagus of *configuratus* is broad at the base and the terminal one-fifth is split. In lateral view it shows similarity in its makeup to these other species. The styles are similar to *ocellaris* and *sayi*.

Genus **Polyamius** De Long.

(Plates IV and IX).

This subgenus was also erected by using primarily a wing character in the form of the cross veins of the clavus, as an important character. In this group we find a great similarity of external genitalia. The group thus seems to contain species

rather closely related to each other if we may judge from the similarity of internal genital characters as well as the external structures, and if the species examined are typical of the remaining unexamined and unavailable species.

The styles of the species throughout the group show great similarity, although specific in practically all of the species. The general shape and form, however, is very similar except in regard to minor details. In *obtectus* for instance the styles have very long anterior inner processes. In species like *arundineus* and *apicatus* these are of average length, while in species like *inimicus* and *texanus* these processes are very short.

The oedagus displays characters which are more varied and characteristic for the species of this group. What might be designated as a generalized type is represented by four of the species which were examined, namely, *apicatus*, *compactus*, *caperatus*, and *interruptus*. These four species have oedagi which are very similar. From a ventral view the oedagus in each of these species is enlarged at the middle, tapering anteriorly rather rapidly to an apex which is bluntly rounded, and posteriorly rather gradually to a bluntly pointed apex. In lateral view in each case the oedagus is enlarged in the central half and bears an anterior dorsal process extending slightly posteriorly and connected with the anal ring by a membraneous structure. The posterior end of the oedagus is narrowed and curves dorsally. There is a specific difference shown in this character as the size and comparative length of this portion is characteristic for each species examined. *Caperatus* and *interruptus* exhibit the longer terminal portions, while *apicatus* and *compactus* display the shorter terminal processes.

From this generalized type the other species examined might easily have developed but along diverse lines. *Obtectus* for instance, which resembles *compactus* so closely in external appearance, might easily have developed from this type. In lateral view the oedagus is strikingly similar, but is tapered more gradually to the posterior end. In ventral view the oedagus is seen to be broader and more broadly rounded posteriorly, bearing a U-shaped notch at the apex.

The *weedi*, *texanus*, *micarius* group might also have arisen from a generalized form of this kind and since they resemble *interruptus* very strongly superficially this probably indicates the source or stem of such a development. The oedagus of

weedi in ventral view is not greatly different from *interruptus* except that it shows a bifurcate condition at the apex. In lateral view it is similar in that the terminal portion is narrowed, curved dorsally and even curves anteriorly in this particular case. It is quite different, however, since there is no anterior dorsal process, and since it is provided with an additional ventral posterior portion formed by the apparent division of the posterior half.

Texanus resembles *weedi* so closely in regard to color, size and form that they cannot be separated without examining the external genital characters. Upon examining the internal structures we find *texanus* is unique among these species especially in regard to the oedagus. From a ventral view the oedagus appears broader for a longer distance from the base, then narrows abruptly to a slender bifurcate apex. In a lateral view the oedagus appears entirely different from *weedi* but has the same number of parts which differ proportionately. The dorsal process is short and straight, flattened above. The ventral portion is longer and heavier, bent at right angles and extending dorsally with a bifurcate apex.

Micarius may have arisen independently of these two species, but it shows some similarity both externally and internally. The oedagus is not enlarged at the middle laterally, but is of about a uniform size and is slightly constricted near the apex. At the base is a short dorsal process and on the connective is found a pair of short dorsal spines. From a ventral view the oedagus is broad, slightly wider at the middle with a pair of teeth-like structures, one either side of a central rounded notch. *Micarius* apparently has come from this generalized type and is still very close to it in many respects.

The most common species of the genus *inimicus*, is very similar in the structure of the internal genitalia to the four species mentioned first. The oedagus in ventral view is long and broad with a broadly rounded apex. In lateral view it is broad at the base with a rather long dorsal process extending slightly anteriorly. The posterior half of the oedagus is narrowed, curved upward and terminates in a rather pointed apex.

Another species, *montanus*, described elsewhere as new, is known only from Montana and superficially resembles *inimicus* very closely. The internal genitalia also show similarity.

The styles are decidedly longer and more narrowed, with a different apex as shown by the figures, Plate IX. The lateral view of the oedagus also shows distinct differences. In *montanus* the oedagus is longer and more narrowed than *inimicus* and although similar as regards the general structure, it is distinct. The apical portion of the pygofer also is entirely different in the two species.

Arundineus shows more divergence than any of the other species, but the oedagus in lateral view shows some similarity to the generalized form. The dorsal process is present and in addition there are two dorso-lateral processes which extend posteriorly. The body of the oedagus gradually narrows to a slender pointed apex. In ventral view the oedagus appears somewhat complicated and confused. The body is broad at the base, but rapidly narrows, then slightly enlarges again just before the bifurcate apex. The dorsal process is broad and blunt at the apex. The dorso-lateral processes arise not far from the base and extend posteriorly, curving inwardly. The tips are pointed and each one is notched on the outer edge, giving it a barbed appearance.

Genus **Hebecephalus** De Long.

(Plates VI and VIII).

A head character was used as a basis for establishing this group. The vertex is usually bluntly angled and the front margin of the vertex is usually quite thick and bluntly angled with the front. The internal male characters indicate a rather close relationship of the species examined.

Three species have been available in sufficient numbers for an examination of the internal male structures. The styles are of the same general type although quite diverse specifically. In *signatifrons* there is a very deep indented portion near the tip forming a rather narrow sharply curved terminal portion. *Vinculatus* is definitely constricted at about half its length and is slightly indented at the tip. The apex is turned backward, prolonged, tapered and sharply angled. *Cruciatus* is only slightly curved at the apex because of a broad shallow notch. The oedagi are quite different in form also. In lateral view the oedagi of *vinculatus* and *cruciatus* are more similar, but in ventral view *vinculatus* shows more similarity to *signatifrons*.

In lateral view the oedagus of *cruciatus* is enlarged at the base, while *vinculatus* is scarcely larger in size basally. Both of these species have a basal spur directed dorsally and apically. In *signatifrons* the basal spur is directed dorsally and slightly anteriorly. The apical portion is longer than in either of the other species and is armed with two reflex spine-like structures at the tip which are quite long. In ventral view the oedagus of *signatifrons* is narrowed medially and the apical lateral spine-like processes are very conspicuous. The dorsal processes are conspicuous at the sides of the oedagus at the base. *Vinculatus* differs from *signatifrons* in having the lateral terminal processes much shorter and the oedagus not greatly widened at the base. *Cruciatus*, although widened at the base, does not bear lateral processes.

These characters are good specifically and yet tend to show a rather close relationship between these species examined.

Genus **Laevicephalus** De Long.

(Plates V, VI and VIII).

This group was established on the basis of a vertex which is angularly produced and with a flat discal portion. The vertex may be sharply, acutely or rather bluntly angled. This group is closely related to the species of *Thamnotettix* of the *inornatus* group and the wing venation is quite similar to the species of that group except for the two cross veins in the discal portion.

This genus contains a number of species which are very similar in appearance and with external genital characters quite similar in many instances although these external characters are usually specific and sufficient in most cases to separate them. There is a decided absence of color markings throughout this group. In view of these facts it is frequently considered that certain of these species are more closely related to each other than seems to be indicated by an examination of the internal genital structures. The type of head and other similar external structures are usually good characters to show relationships also.

When we examine the internal male structures we find on first examination what appears to be quite diverse structures, but after making a thorough study of these it is evident that certain relationships exist among these species.

An examination of the styles shows a great variation as represented by the different species. Most of these species have styles which might be placed in one of two general classes. The first group might be designated as a type with the terminal end usually squarely cut and blunt. The species of the second group have the terminal ends pointed and frequently an incised or indented portion which helps to form the terminal curved spur.

In the first group *acus* and *sylvestris* show close relationship having styles that are very similar. The base of each is broad and the terminal portion narrowed. Others of this group which show this character are *melsheimerii*, *debilis*, *spicatus*, *collinus*, *cinerosus* and *unicoloratus*. *Melshemerii* and *debilis* have very similar styles with a constricted portion just before the blunt apex. *Unicoloratus*, although narrow at the base, is not greatly different from *acus* and *sylvestris*. *Spicatus*, *collinus* and *cinerosus*, although appearing similar because of their narrow basal portions, are each quite different from the others and unique when studied in detail. *Cinerosus* is slightly constricted near the apex and the basal portion is greatly curved and thus folded, which causes it to appear narrow. *Collinus* is broadened at the base and the basal portion appears the most narrowed because of the curved condition.

In the second group there is a great variation in the type of styles, especially in regard to indentation or constriction near the apex. *Striatus* is only slightly constricted near the apex, but the inner basal angle is greatly produced into a long narrow process extending to the connectives. *Abdominalis* has a style which is long and narrow and tapered to a pointed apex. The basal portion is tapered off on one side, but is prolonged on the other and folded back upon itself in such a way as to appear broad. *Auratus* is rather unique also since it is broad basally and apically and is constricted at the middle. The apical portion is pointed and is broadly curved to another pointed lateral portion. Another species which has a unique style is *littoralis*. It is as broad as long and the apical portion is abruptly narrowed to form a pointed apex. The outer basal portion is broad and greatly produced laterally. The generalized type of style is found in the case of *cicatrix*, *orbiculus*, *bimaculatus*, *subrutilus*, and *flavovirens*. *Cicatrix* and *orbiculus* show the rather deep indented apical portion with a curved,

sharply pointed apex. The basal portion is broad and the central portion constricted. *Subrutilus* and *bimaculatus* show a less indented condition near the apex. The broad basal condition is found in *subrutilus*, but in *bimaculatus* the basal portion is narrowed and rather pointed. The style of *parvulus* is gradually narrowed apically and is not indented. *Pascuellus* is of the same general type as regards the style, although only slightly indented apically and bluntly pointed.

These structures present good specific characters for the separation of these species in practically every case as contrasted with those subgenera where the styles are almost identical. These structures are therefore valuable for evidence of specificity and for the separation of species which are superficially so similar that they have been confused for many years.

The oedagi are even more diverse in character and more valuable in showing relationships and in forming evidence for specificity. If one should glance at the oedagi of these species as shown in either lateral or ventral view, he probably would see very little similarity between different species represented in this subgenus. A careful study of these species, however, shows rather definite similarities in structure.

The most simple type of oedagus and probably the most generalized type is found in *spicatus* and *debilis*. The latter species shows a small dorsal spur-like structure at the basal end, which character is quite common to the species of this genus. This structure is absent in *spicatus*. With slight modification it is easy to note the similarity between this type of oedagus and the type we see represented in a number of closely related species such as *orbiculus*, *subrutilus*, *melshemeri*, *parvulus*, *acus*, *sylvestris*, *unicoloratus* and *littoralis*. If we compare these in lateral view, Plate VIII, it is easy to make a relative comparison of these oedagi. *Orbiculus* and *subrutilus* are very similar to *debilis*, except that the dorsal spur is rather long in both cases and a pair of long lateral processes are found at the end of the apical portion of the oedagus in *subrutilus*, *melshemeri* and *parvulus* show further modifications. *Melshemeri* possesses a broad basal portion and the apical structure is rather long and slender. In *parvulus* the basal portion is missing and the dorsal process is much longer and directed apically. *Acus* and *sylvestris* are very closely related to each other and both show a further development of the oedagus especially in

length. The oedagus is extremely long and narrow, somewhat bent and slightly hooked at the apex. The most pronounced difference in the character of the oedagus in these two species is the distinctly longer dorsal spur in the case of *sylvestris*. *Unicoloratus* is not greatly different from *acus* and *sylvestris* and shows a rather close relationship to these species. The oedagus has a short spur at the base and a minute spine on the ventral side not far from the apex. The oedagus of *littoralis* is shorter and broader with a rather large spur extending dorsally.

Another group of three species, although distinct and differing considerably from each other, show a further development in the oedagus. Each of these has a pair or more of terminal processes and the oedagus in each case is strongly curved or looped basally so that the terminal portion of the oedagus extends almost dorsally. In *abdominalis* the oedagus is not enlarged and both basally and apically extends strongly dorsally with a pair of distinct apical processes. *Cicatrix* is enlarged basally with a short anterior dorsal process and a long apical dorsal process. The latter is set with two proximal pairs of anterior apical spine-like processes. If *flavovirens* is a "*Deltocephalus*" it probably is most closely related to this group. The oedagus of this species is somewhat similar to the former two. It is also enlarged basally and has a pair of terminal processes. There is some question too regarding the relative position of *bimaculatus*, which may not belong to this subgenus. The oedagus does not show strong similarity to any other of these species, but is probably most closely related to forms like *debilis* and *cicatrix*. *Collinus* and *cinerosus* are two species which have oedagi of a different type. They are similar only in view of the fact that they each have an oedagus with a pair of short basal processes and with a pair of terminal processes. They probably are not closely related. *Collinus* has an enlarged basal portion with a dorsal process, a pair of short lateral processes are found at the apex. In *cinerosus* the basal portion is not enlarged, but is directed dorsally then curves and extends apically and possesses a pair of rather long lateral processes near the apex which are directed backwards.

Two other species, *striatus* and *pascuellus*, have oedagi which are different from any others of the group. In *striatus* the oedagus seems to be turned upside down in lateral view with an anterior process extending ventrally in this case and the

oedagus is directed anteriorly and curves ventrally. In ventral view it is short and very broad. *Pascuellus* has an oedagus which curves back upon itself so that the apical half extends anteriorly. The most unique oedagus of the group is probably found in *auratus*. In this case the oedagus has a central portion with the dorsal terminal part enlarged. From the base a pair of long curved processes extend, on either side, past the apex of the terminal process of the central portion. Although superficially this species resembles *subrutilus* very closely and they have been placed under the same name for many years, there is no similarity of the structures of their oedagi.

The style-oedagus connectives show very good characters also, but it is not necessary to go into a detailed discussion of these. It might be advisable to simply point out the more important types and differences. Certain forms like *bimaculatus*, *parvulus*, *unicoloratus* and *collinus* have very short connectives. On the other hand species like *striatus* and *debilis* may have very long connectives. A comparison of the ventral view of these structures as seen in Plate VIII, will give a good idea of their variation among the different species.

Genus **Amplicephalus** De Long.

(Plates VII and VIII).

This genus was established chiefly upon the basis of the broad head character and three species have been placed in the genus to date. Two of these, *osborni* and *simplex*, have been available in sufficient numbers for dissection and a study of the genitalia. One of these, *osborni*, is a member of the freshwater marsh association, and the other, *simplex*, lives in the salt marsh association upon *Spartina patens*. The styles of these two species differ considerably. In *simplex* the style is broadest at the base and tapers to the apex, while in *osborni* the broadest portion is at the middle and the apical portion is comparatively longer. The oedagi are quite similar especially in lateral view, where the chief differences seem to be the shape of the terminal portion and the position and direction of the basal dorsal spur. In dorsal view the oedagus of *simplex* is much longer and tapered to a bifurcate tip. In *osborni* the tip is not greatly narrowed and a rather deep concavity is between the outer apices.

This group shows some similarity to both *Laevicephalus* and *Deltocephalus* species and is apparently closely related to certain groups now included in the genus *Euscelis*.

Genus **Deltocephalus** Burmeister.

(Plates VII and VIII).

In view of the fact that *pulicarius* was formerly chosen as the type of the genus it has been necessary to give this group the name of the original genus. This type was chosen by Oshanin and not by Van Duzee, as previously stated by the senior author. The vertex is short, bluntly angled and with disc sloping or convexly rounding from pronotum to the front. Margin of vertex usually very thick. The head character is again the one upon which emphasis was placed in establishing the group. The external genitalia are very similar, however, in the species throughout this group.

The examination of the external structures of the species of this subgenus would lead one to believe that these species are very closely related. In fact in a few cases there has been some question as to the specificity of certain forms. An examination of the internal genitalia has led to the same general conclusion, namely, that these species are a group of very closely related forms, although the internal characters indicate sufficient differences in structure to separate them quite easily.

An examination and study of the styles shows two rather distinct types to which most of the species belong. In one of these groups we might place *balli*, *minutus*, *vanduzei*, *pulicarius* and *castoreus*. These all contain relatively long sharp pointed terminal processes, although their relative width, the angular incision at the base of this process and the basal processes differ considerably. Of this group *pulicarius* and *castoreus* are quite similar, both lacking the deep curvature on the basal portion and the long pieces which articulate with the connectives; *balli* and *vanduzei* are of this later type. *Minutus* presents a somewhat different type with no indication of an articulation process, the basal portion curving from the outer lateral angle to the inner margin. *Flavicostatus* is quite similar to *minutus* in its general structure, but has a very peculiar and different process produced on its inner basal portion as an articulation process. One other species, *nigriventer*, possesses an extremely

long process and the shape of the style in general is entirely different from any other species that has been examined. A second group of species, including *nigrifrons*, *fuscinervosus*, *sonorus* and *marinus*, have rather short terminal processes. Otherwise they are somewhat variable especially in regard to slight differences in the basal structures. *Fuscinervosus* shows the greatest difference in the terminal process, since it is broader and more decidedly curved laterally. *Comesus*, a species described elsewhere, seems entirely different from these other species just considered and has a style which is gradually tapered to a blunt, rounded terminal portion.

An examination of the oedagi in side view shows that with the exception of two or three species the members of this subgenus are very similar in general type. This general type of oedagus is seen especially in *balli*, *pulicarius*, *comesus*, *sonorus*, *castoreus*, *vanduzei*, *nigrifrons* and *fuscinervosus*. Each of these oedagi has an anterior dorsal process directed slightly caudally although the curvature or comparative length of the apical portion may vary slightly. A few species like *minutus* and *nigriventer* have this process directed almost anteriorly. *Nigriventer* presents other differences also in the body of the oedagus especially the anterior ventral portion. The oedagus of *marinus* has the anterior dorsal process, but the body of the oedagus is broad and heavy, appearing inflated and does not have the apical dorsally curved portion characteristic of these other species. *Flavicostatus* is also somewhat different, although it undoubtedly shows its relationship to this group. The apical portion of the oedagus is proportionately heavier, longer and directed more decidedly dorsally and slightly anteriorly. Specimens examined from various portions of South, Central, and North America would indicate that the North American forms, especially north of Mexico, are probably different as Mr. Van Duzee previously suggested and should be properly called *flavicosta*. The oedagus, as the accompanying figures, Plate VIII, will indicate, is more narrowed than, and is somewhat different in shape from *flavicostatus*.

In ventral view the oedagi show some specific and in a few cases unique, differences. *Marinus*, in view of the deeply cleft broad terminal portion, is entirely different from all the others. Species like *balli*, *nigrifrons*, *vanduzei*, *fuscinervosus*, *pulicarius*, *sonorus*, *minutus*, *castoreus* and *comesus* have oedagi

that are quite similar in ventral view. But the comparative length or widened portions of these structures are apparently specific as in the case of *balli*, for instance, which is decidedly widened a little from the base, or *nigrifrons*, which is decidedly longer, as well as forms like *fuscinervosus* and *comesus*, which are apically enlarged or have apical processes. *Nigriventer* with its basal processes and pointed apex and *flavicostatus* with its broad rounded base and tapered apex are easily distinguished from the other species. In this group the connectives present a group of good characters also. Those of *flavicostatus* are unique, also different types are found in each of such species as *minutus*, *nigriventer*, *marinus* and *vanduzei*.

There seems to be no question concerning the relationship between this group and certain species which have been included in the genus *Thamnotettix*. *Th. nigrifrons* and closely related forms have presented for some time a question upon generic status concerning which authorities have disagreed. The wing venation character upon which these were separated into different genera apparently must be superceded by the genital character in such cases which is apparently a better index to relationship. With *pulicarius* as the type of the genus *Deltocephalus* there is only one disposition to make in the case of *nigrifrons* and that is to place it in the same genus because of its great similarity.

The following new species have been described during this study:

Flexamius surculus n. sp.

(Plates I and III).

Resembling *abbreviatus* very closely in form and appearance but with internal genitalia of the male and external genitalia of both sexes distinct. Length 3–3½ mm.

Vertex bluntly angled, almost one third longer at middle than width between eyes. Elytra short, scarcely covering abdomen.

Color: Very similar to *abbreviatus* and other closely related forms. Vertex with the dark brown circular mark around apex, the lines above margin of vertex, the transverse dashes on the disc and the longitudinal markings at the base present. Elytra varying in intensity of color but usually with a spot along outer claval vein, basal portion of the discal cell and a large spot on outer apical cell dark brown. Infuscation of veins on apical portion of elytra rather heavy.

Genitalia: Female last ventral segment with the posterior margin produced to form an angular lobe either side of the central two-thirds

which is rather deeply emarginate either side of a slightly produced central portion, heavily embrowned and composed of four teeth, two outer teeth sharp, narrow and more produced than the inner pair which are broader and more bluntly rounded. The outer teeth are separated from the inner pair by rather deep rounded notches. The inner pair are separated from each other by a rather broad V-shaped notch. Male valve broad, triangular. Plates exceeding valve by about its length, gradually tapering to about two-thirds their length where they are abruptly emarginate and narrowed to form the apical portions which are blunt and rounded to their inner margins. Pygophers greatly exceeding plates.

Described from a series of thirty-three specimens collected at Brownsville, Texas, by Prof. Herbert Osborn, in 1909, and now in his collection. These have been considered as variable specimens of *abbreviatus* until the present study has revealed them as a distinct species by means of the unique internal genitalia.

Latalus ocellaris var. **sobrinus** n. var.

Resembling *ocellaris* in form and appearance but more robust, broader and with different female segment. Length 3½–4 mm. Vertex about as long as width between eyes, bluntly angled. Elytra short and broad.

Color: Similar to *ocellaris* but more conspicuously marked. The pair of triangular spots near apex of vertex and the larger areas just back of these dark brown. Pronotum dark with five pale logitudinal lines. Elytra conspicuously mottled with brown and white. Commissural line bordered with white, clavus with cells heavily infuscated on inner margins. Base of wing, discal cell and apical and anteapical cells dark brown. Veins on central portion of wing broadly milk-white.

Genitalia: Female segment comparatively long, posterior margin gradually produced from lateral angles to form two short rounded teeth separated by a rounded or V-shaped notch. Posterior margin of segment black bordered. Male not known.

Described from six female specimens collected at Slave Lake, Alberta, Canada, August 14, 15 and 17, 1924, by O. Bryant, who forwarded these to the senior author. Other specimens have been examined from northern New York State.

Although *ocellaris* is reported for North America, all the specimens examined agree exactly with the above description and are different from European material at hand. European specimens of this species have a long produced tooth slightly bifurcate at the middle on the female segment. There are no intermediate forms and the North American type is described here and is in all probability a separate species.

Polyamius aestuarium n. sp.

In general appearance resembling *arundineus* and allied species but the coloration of wings and face gives it the appearance of a species of *Scaphoideus*. Length 4 mm.

Vertex slightly wider between eyes than length at middle, flat or slightly depressed on disc. Pronotum slightly longer than vertex, more than twice as wide as long. Elytra exceeding abdomen, central anteapical cell constricted and divided, the anterior cell twice as long as posterior.

Color: Pale yellow, a pair of oblique orange bands extending from the margin of the vertex to the central posterior portion of the disc. Pronotum with a large orange spot along anterior margin extending between the eyes, and a large round spot on central portion of pronotum behind either eye. Basal angles of scutellum orange. Elytra orange yellow, veins milk-white and heavily infuscated at certain places. A large spot on the costal margin at about its middle, discal, central anteapical and apical cells fuscous. Face black above, extending obliquely beneath the eyes. Clypeus and lorae yellow.

Genitalia: Female last ventral segment rather short on lateral margins, then produced to form a broad trilobate posterior margin, only a slight notch is found either side of central lobe but the coloration causes it to appear decidedly trilobate. Lateral portions of underlying segment produced beyond last ventral segment at either side.

Described from a single female specimen taken at Carolina Beach, Wilmington, N. C., June 24, 1928, by the senior author. This was collected from the tidal salt marsh area and is so named.

The question of placing this species is somewhat in doubt, but it is placed in *Polyamius* because it resembles so closely species of this group and because the female genital segment is almost exactly like the majority of the species of this genus.

Polyamius montanus, n. sp.

(Plates IV and IX).

Resembling *inimicus* in form and appearance but shorter with more bluntly angled head, slightly different coloration and genitalia distinct. Length 3½ mm.

Vertex about one-fourth wider between eyes than length at middle. Pronotum slightly longer than vertex. Elytra shorter and broader than *inimicus* with anteapical cell constricted and divided. Claval area with only a few cross veins.

Color: Vertex with a pair of small round black spots just above apex and a pair of large round ones about half way between these and either eye. A pair of small round black spots on anterior margin of pronotum. Black spots on basal angles of scutellum showing through

the pronotum. Veins of elytra slightly infuscated. Reflexed arcs of face not seen from above on vertex.

Genitalia: Female last ventral segment rather short, side margins very short then gradually produced and rounded to posterior margin which is slightly indented either side of a central broad slightly produced tooth. Underlying membranes conspicuous beyond short lateral margins. Male valve broad and only slightly produced. Plates as broad as valve at base, gradually, concavely tapered to acutely pointed tips.

Described from a series of two female and ten male specimens collected July 12, 1927, by Dr. Walter Carter at Bozeman, Montana. Two males, one of which is designated as the type, are in the collection of the senior author. The others which have been examined in the National Museum collection are designated as paratypes. A series of specimens collected by Dr. Martha Shackleford, at Friday Harbor, Washington, during the summer of 1928, are undoubtedly the same species.

Laevicephalus cicatrix, n. sp.

(Plates V and VIII).

Resembling *striatus* in form and appearance but with head slightly more angled and genitalia distinct. Length 3½-4 mm.

Vertex bluntly angled, a little wider between eyes than length at middle. Pronotum shorter than vertex, very short behind the eyes. Elytra slightly longer than abdomen, outer anteapical cell very short.

Color: In coloration resembling a well marked specimen of *striatus*. Face with nine pairs of brownish arcs, the ventral pairs paler. Vertex with a pair of converging curved lines extending from ocelli to either side of apex, and a median line extending two thirds of the way from base to apex, brown. Veins of elytra heavily infuscated. Ovipositor black or dark brown.

Genitalia: Female last ventral segment rather long, roundingly produced from either side to central third which is rather abruptly roundingly emarginate either side of a slightly produced central lobe which is slightly notched at center. Base of emargination either side, with a black spot. Male valve more than twice as broad as long, bluntly rounded. Plates about twice longer than valve, convexly rounded to rather broadly rounded apices. Male internal genitalia distinct as indicated.

Described from a series of eight female and seven male specimens collected at Slave Lake, Alberta, Canada, August 14 to 17, 1924, by Mr. O. Bryant and forwarded to the senior author for identification.

Laevicephalus orbiculus, n. sp.

(Plates V and VIII).

Size and coloration of *debilis* and resembling it very much. Head more bluntly angled and genitalia distinct. Length 3½ mm.

Vertex very bluntly angled, slightly wider between eyes than length at middle. Pronotum shorter than vertex and more than twice as wide as long, lateral margins very short. Elytra short and broad, flaring.

Color: Vertex, pronotum and scutellum straw yellow, slightly tinted with green, elytra dark green, veins yellowish. Ocelli black. Dorsal portion of abdomen mostly black.

Genitalia: Female last ventral segment rather long, lateral angles produced and prominent, between which the posterior margin is concavely rounded about one-third the distance to the base at the center of which a slight notch forms a pair of slightly produced rounded black teeth. Male valve rather broadly rounded. Male plates broad, gradually tapering to blunt rounded tips, a black spot about the middle of each plate. Pygofers scarcely longer than plates. Male internal genitalia distinct.

Described from thirteen female and eight male specimens collected at Mammoth Hot Springs, Wyoming, July 9, 1909, by Professor Herbert Osborn and now in his collection.

This species can best be separated from *debilis* by the male and female genital characters. The male of *debilis* has plates which are more convexly rounded and greatly exceeded by long pygofers. The female segment of that species does not have prominent angles on the last ventral segment.

Laevicephalus subrutilus, n. sp.

(Plates V and VIII).

Resembling *auratus* in form and coloration, but more yellowish with vertex more produced and angled. Male plates more narrowed and produced, internal genitalia greatly different. Length 3 to 3½ mm.

Vertex bluntly angled, as wide between eyes as length at middle and one-fourth longer than pronotum. Pronotum broad and very short at lateral margins. Elytra when of the brachypterous type exposing the last two dorsal segments. Usually this type of wing is present in the female specimens.

Color: A rather uniform orange yellow without definite markings. The toothed portion of the female segment is black margined. As contrasted with *auratus* it shows more yellow and less of the bright, distinct orange color.

Genitalia: Female last ventral segment rather long, lateral angles produced and broadly sloping to central excavated portion, at the

base of which is found a rather broad, produced tooth which is black margined and appears slightly incised at middle. Male valve bluntly angled, male plates rather long, gradually tapering to rounded apices. In *auratus*, with which this species has been confused, the plates are much broader and shorter.

Described from a series of six female and two male specimens all collected at Dickinson, N. D., by Prof. Herbert Osborn. Type in Osborn collection. This species has been confused for many years with *auratus*, which it resembles very much superficially. The shorter, blunt head character, the more orange coloration, the external and internal genital characters as described and figured will easily separate these two species.

Deltocephalus comesus, n. sp.

(Plates VII and VIII).

Resembling *balli* in size and coloration, slightly more robust and with distinct male genitalia. Length 3–3½ mm.

Vertex broadly bluntly angled, almost rounded, slightly more than half as long on middle as width between the eyes. Pronotum longer than vertex and more than twice as broad as long. Elytra with middle anteapical cell constricted and divided.

Color varying from yellow to light brown with definite markings more or less distinct. Vertex with four black spots varying in size just above margin and a transverse dash either side behind the ocellus extending from eye almost to outer spot. Vertex pronotum and basal angles of scutellum more or less mottled with orange.

Genitalia: Female last ventral segment with prominent lateral angles, broadly angularly excavated halfway to base. Central third heavily embrowned. Male valve broadly convexly rounded, plates short, exceeding valve by about its length, gradually tapering to blunt broadly rounded apices. Male internal genital structures distinct as illustrated.

Described from five female and three male specimens from Brownsville, Texas, June 23, 1908, and one female specimen from Arizona. Type in collection of senior author.

EXPLANATION OF PLATES.

PLATE I.

Ventral and lateral view of internal genitalia in situ.
Genus *Flexamius*.

PLATE II.

Ventral and lateral view of internal genitalia in situ.
Genus *Alapus*, Genus *Latalus* and Subgenus *Secopennis*.

PLATE III.

Comparative view of styles (top) and oedagi from ventral and lateral views of species of genera in Plates I and II.

PLATE IV.

Ventral and lateral view of internal genitalia in situ.
Genus *Palus* and *Polyamius*.

PLATE V.

Ventral and lateral view of internal genitalia in situ.
Genus *Laevicephalus*.

PLATE VI.

Ventral and lateral view of internal genitalia in situ.
Genus *Laevicephalus* and *Hebecephalus* (lower right).

PLATE VII.

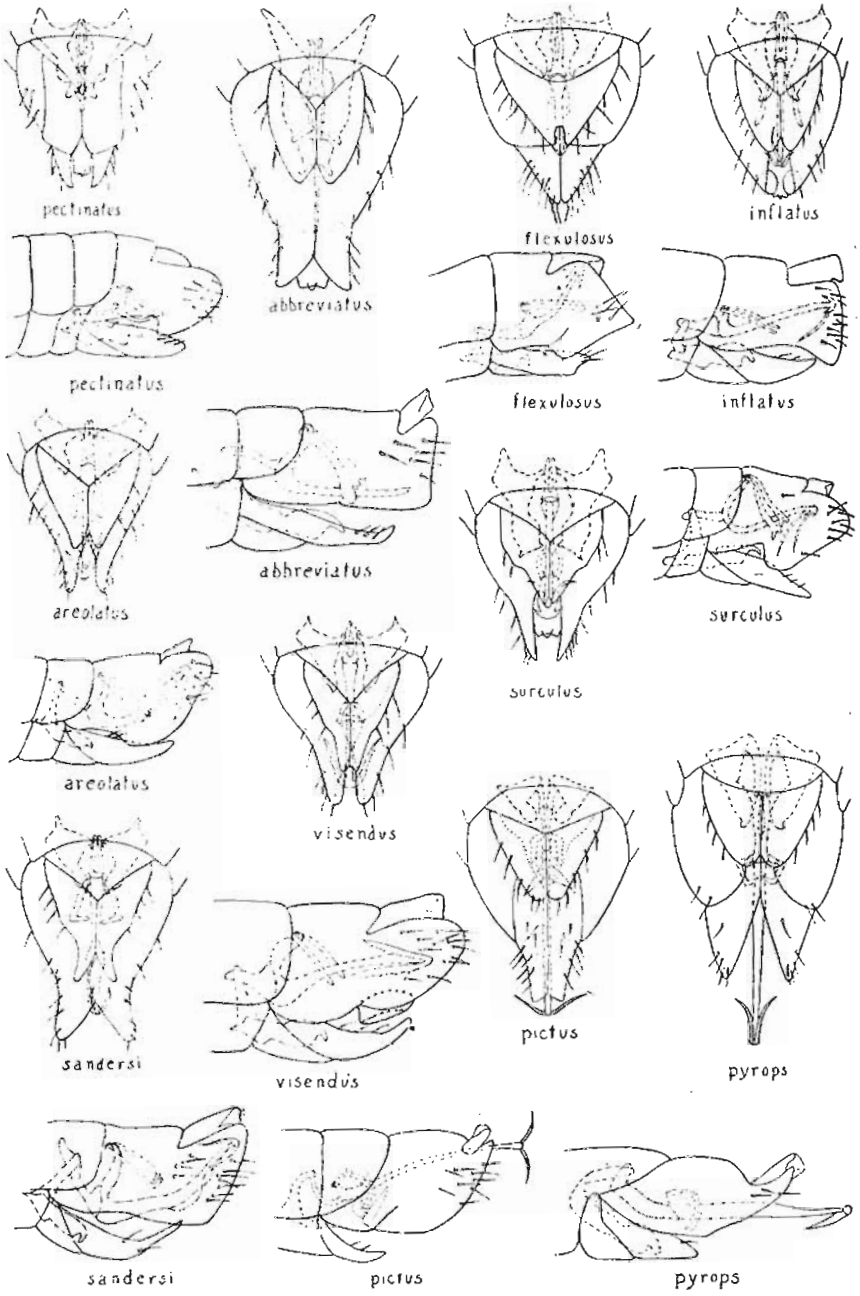
Ventral and lateral view of internal genitalia in situ.
Genus *Amplicephalus* (top) and *Deltocephalus*.

PLATE VIII.

Comparative view of oedagi, ventral aspect (top) and lateral (lower) of Genera *Laevicephalus*, *Hebecephalus*, *Amplicephalus* and *Deltocephalus*.

PLATE IX.

Comparative view of oedagi ventral and lateral aspects (top) and styles (middle) of Genera *Palus* and *Polyamius*. Ventral view of styles (lower) of Genera *Laevicephalus*, *Hebecephalus*, *Amplicephalus* and *Deltocephalus*.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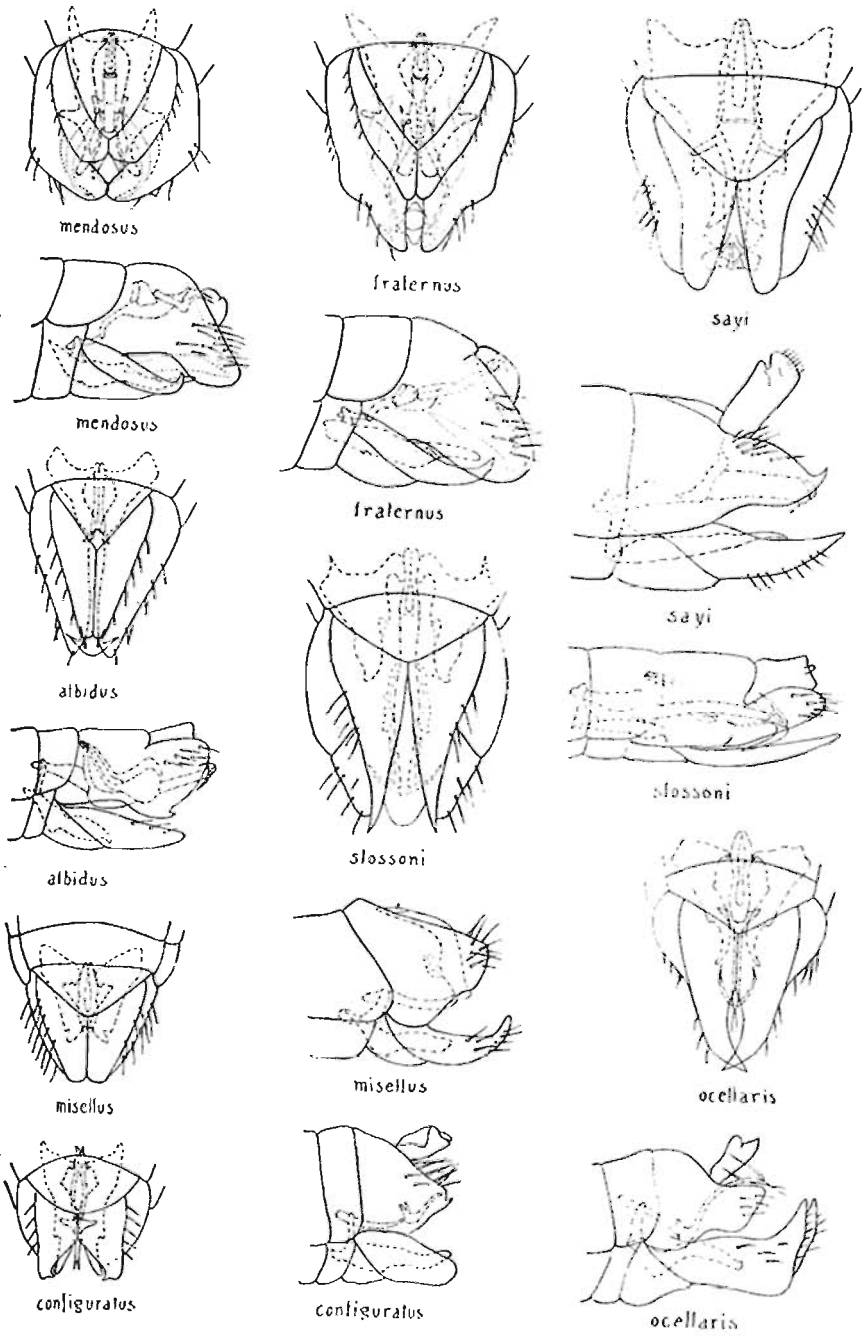
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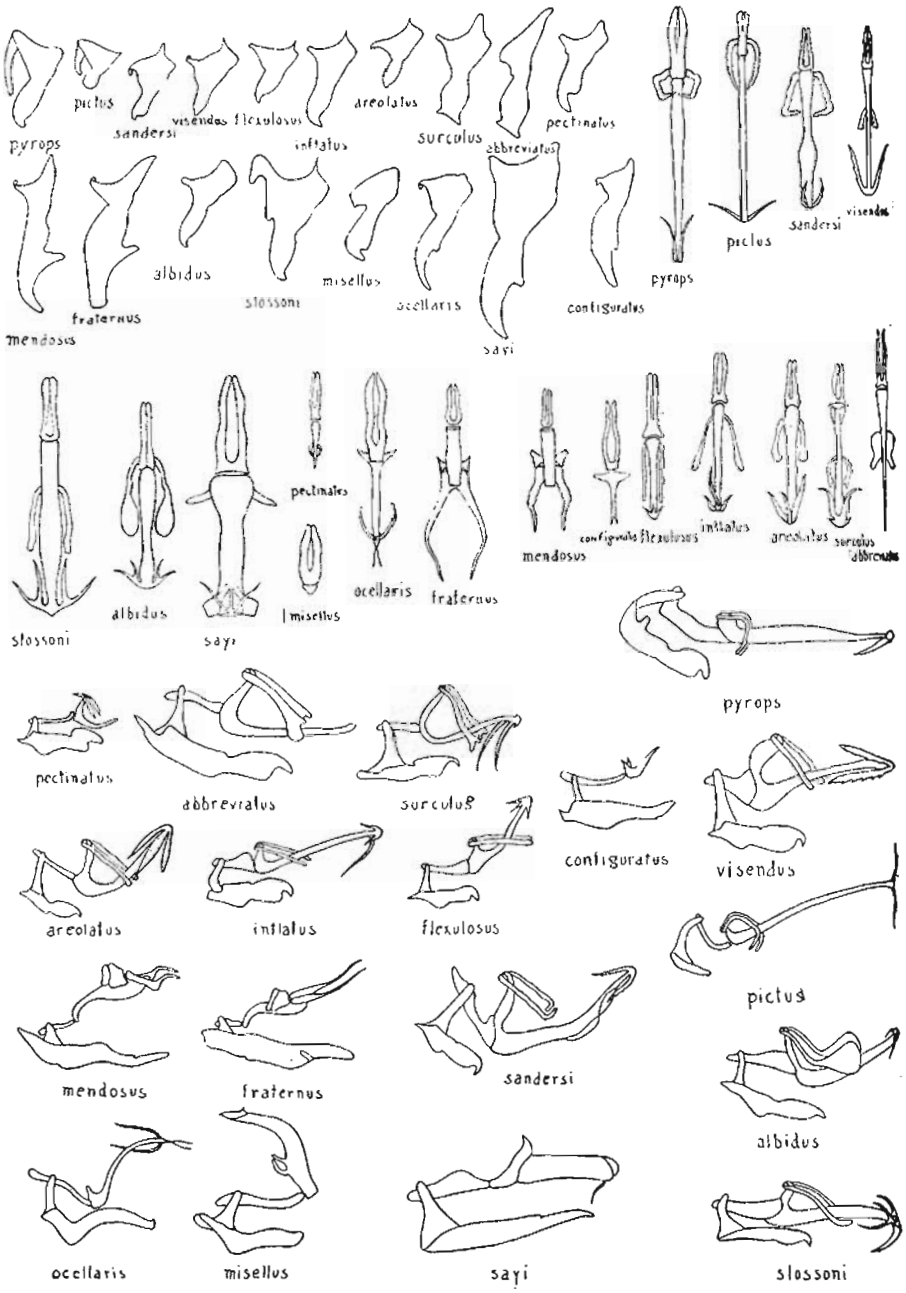
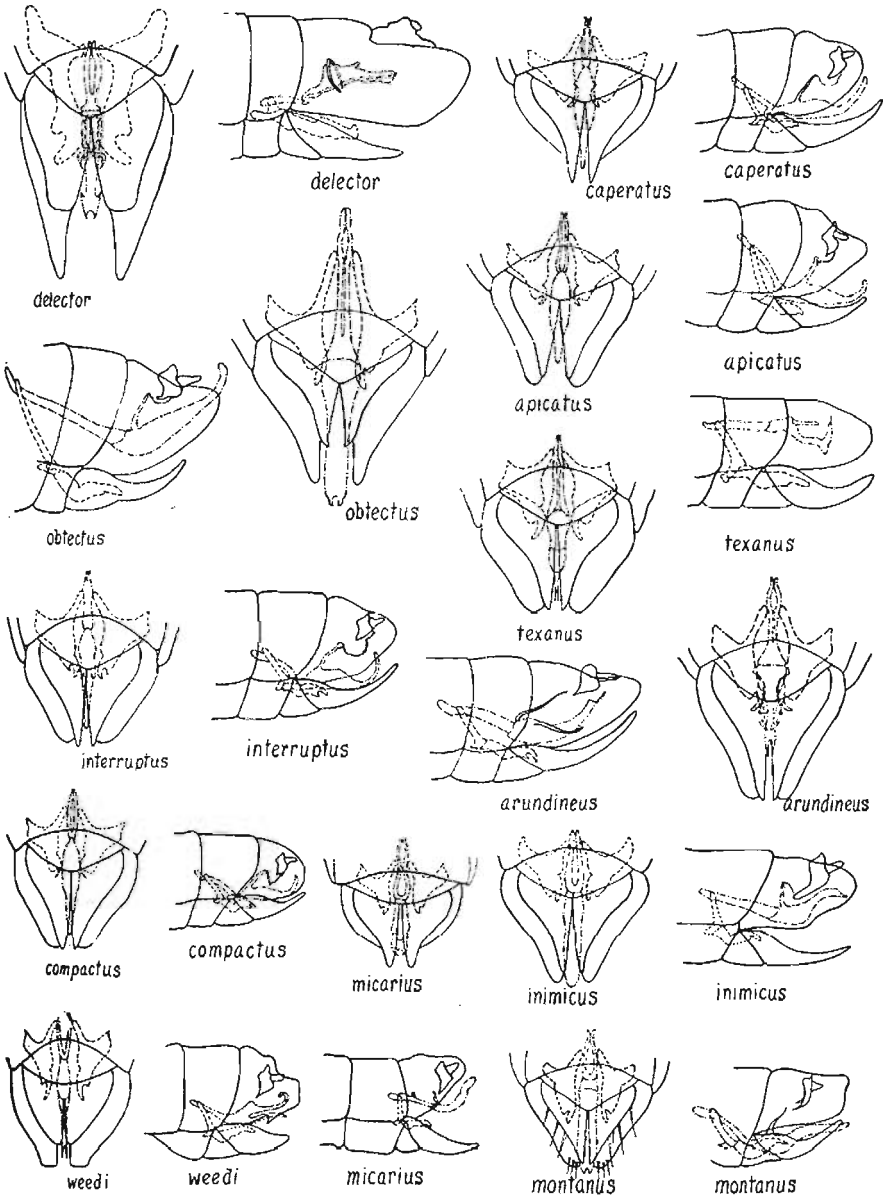
Genera of Deltocephalus
Delong and Sleesman

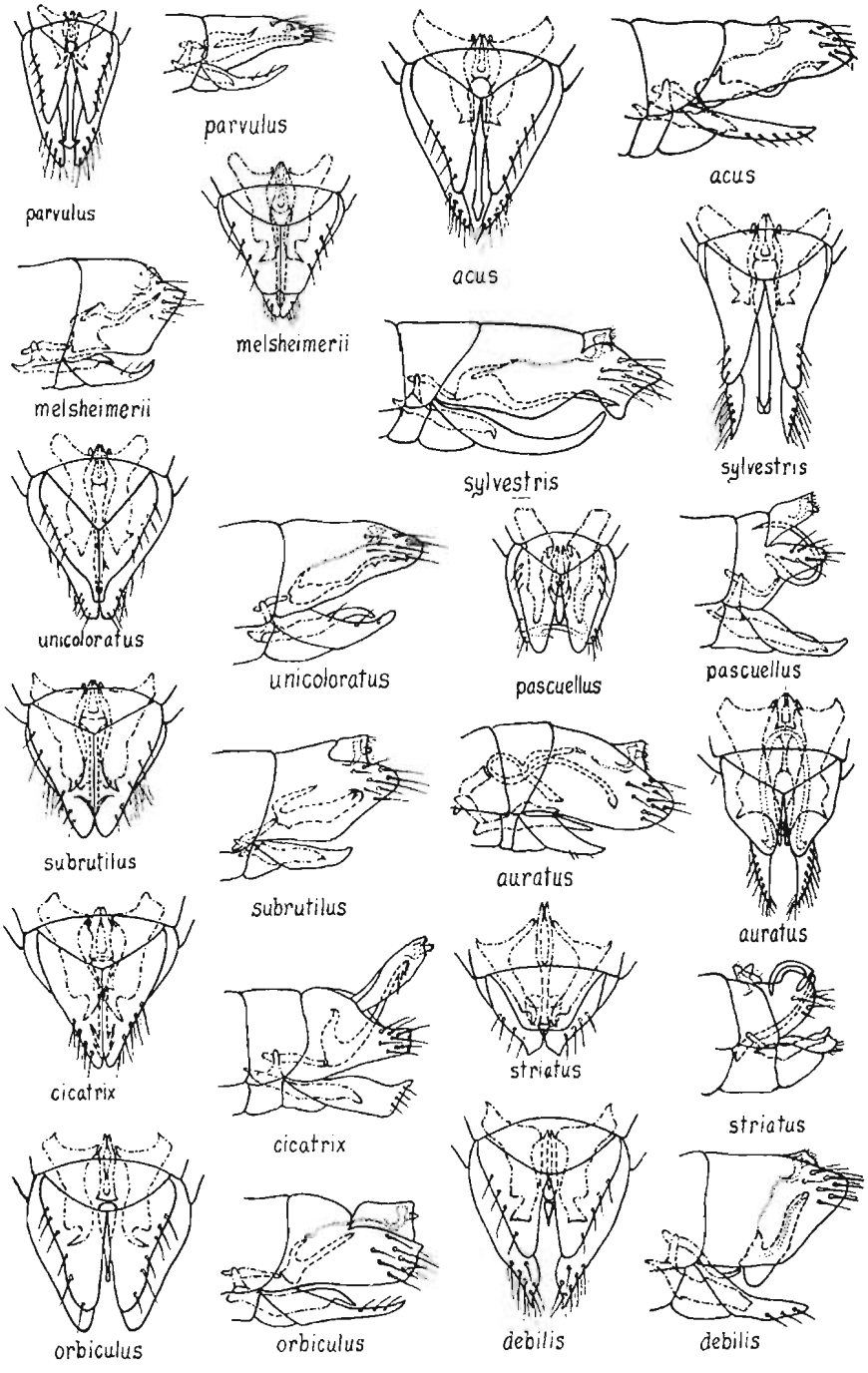
PLATE III



Genera of Deltocephalus
Delong and Sleesman

PLATE IV

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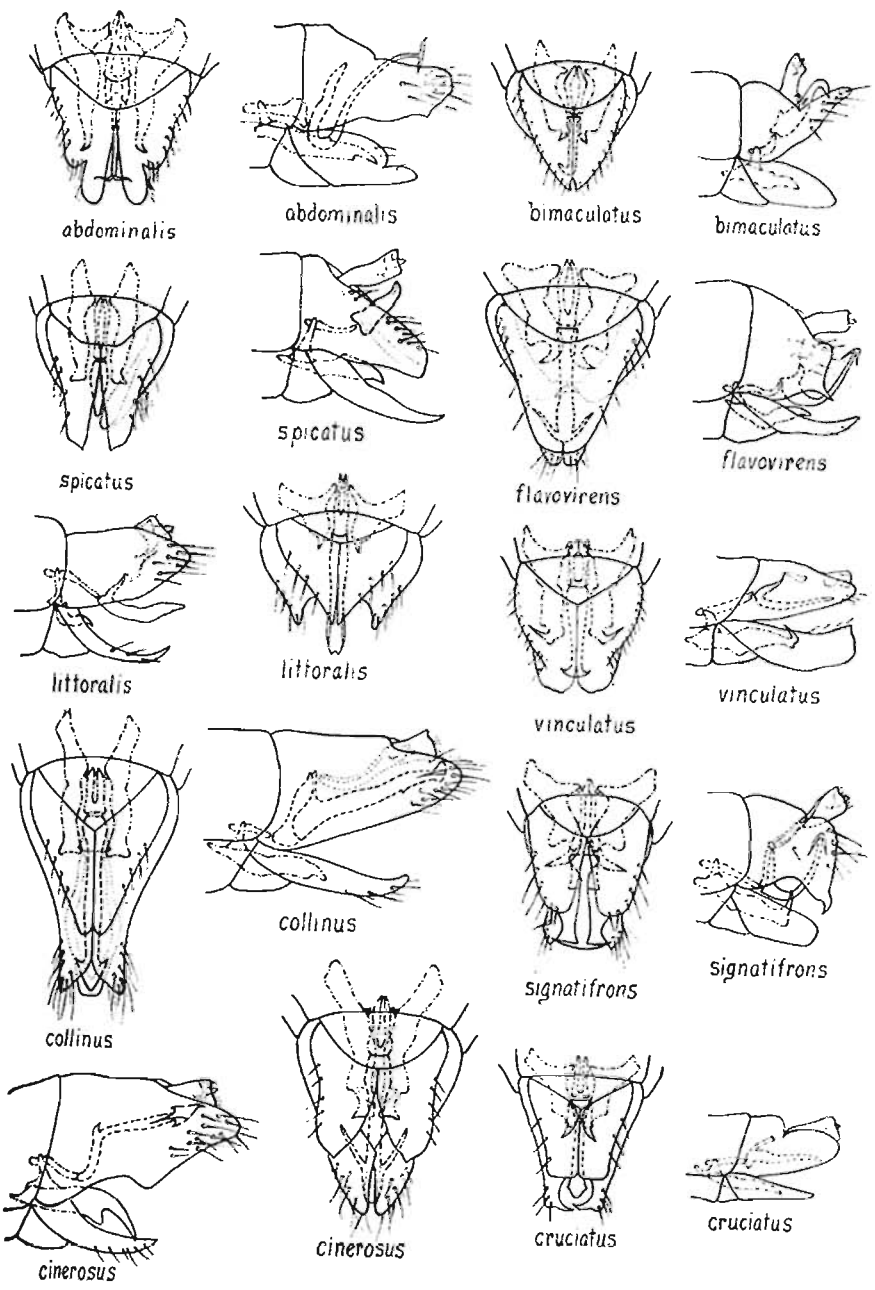
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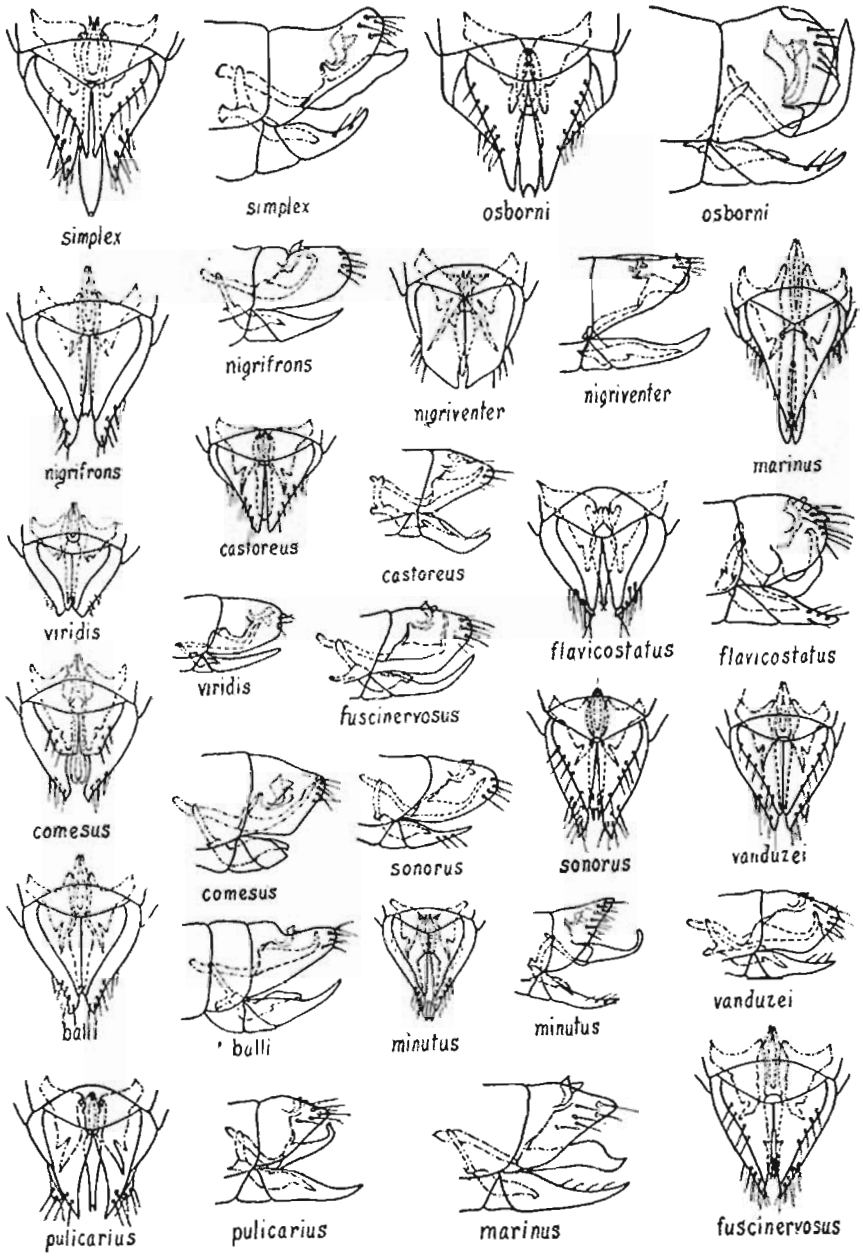
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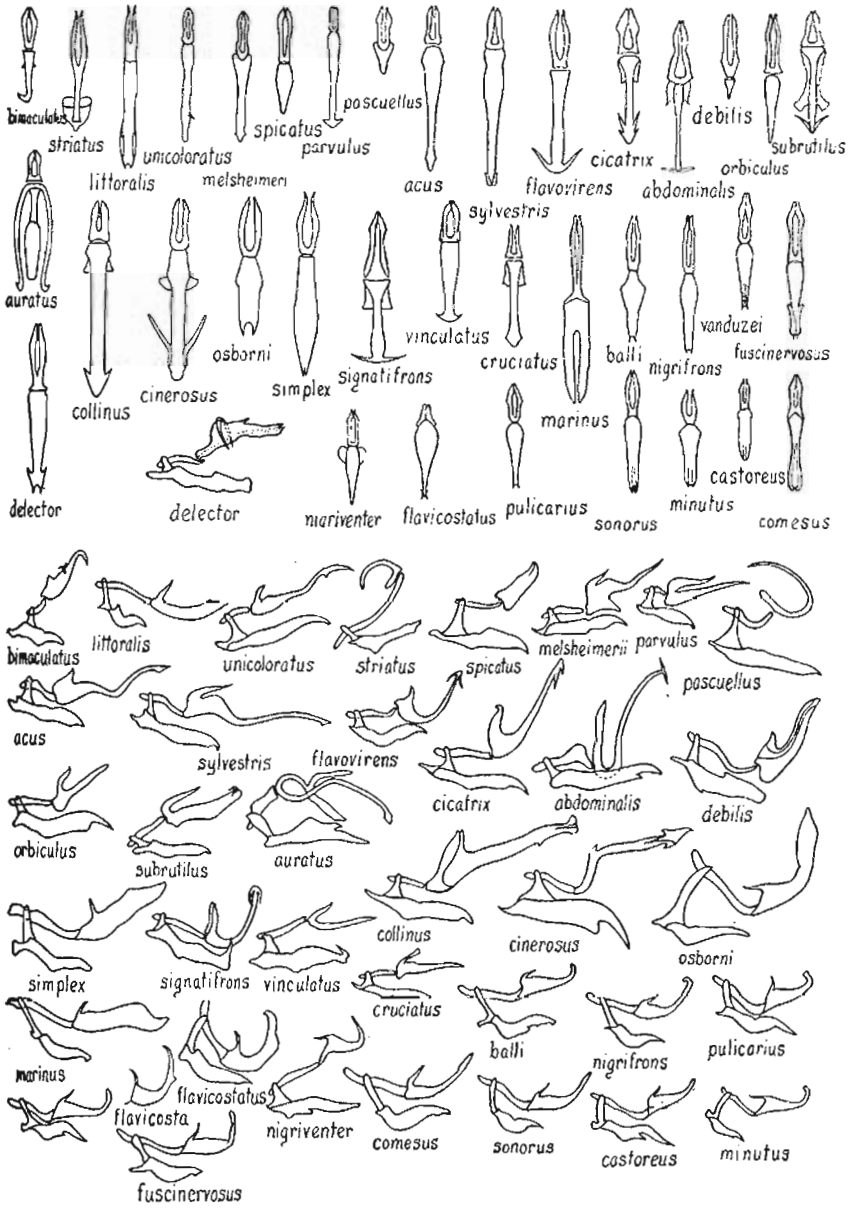
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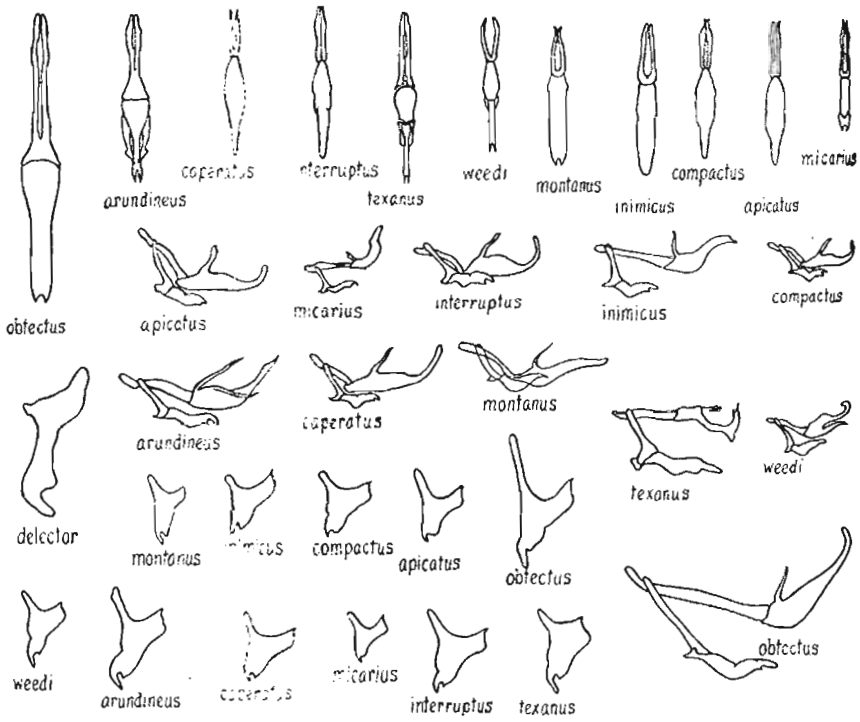
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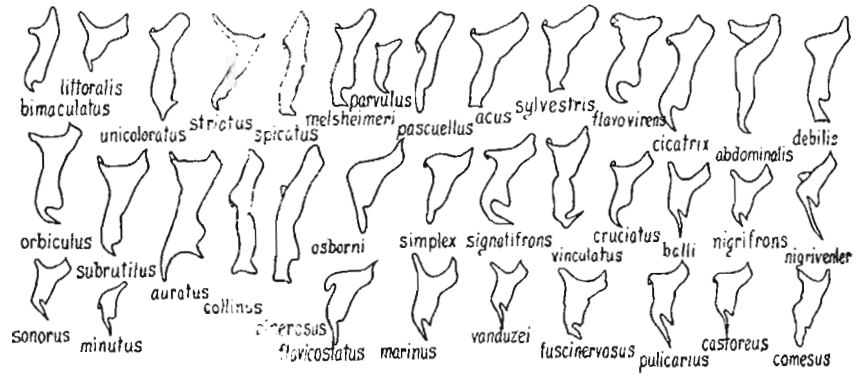
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fuscinervosus
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castoreus
comesus