

THE GENUS *Chlorotettix*—A STUDY OF THE  
INTERNAL MALE GENITALIA. INCLUDING THE  
DESCRIPTION OF A NEW SPECIES.\*

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The species of *Chlorotettix* with the exception of size are very similar in appearance. As a rule the color is a uniform green or yellow and although somewhat variable within the species, there are very few color markings throughout the group to distinguish these forms. The only possible basis for distinguishing them has been by means of external genital characters such as the last ventral segment of the female and the plates of the male. Certain workers have expressed doubt regarding the specificity of these external characters preferring to believe that in many cases these were variations in the genital segment. This study of the internal structures of the male was undertaken largely to determine if possible, to what extent the external characters could be used as specific characters and in an attempt to correlate external structures with internal. In some cases the internal structures are even exposed beyond the external and can thus be used easily in systematic work.

Another angle of this problem might also be mentioned which has stimulated interest in an examination of internal structures. Ecological studies have brought to light specimens in the field collected in different habitats and belonging to different species which resemble each other so closely morphologically and in general appearance that they were previously classed as a single species. The internal structures have been used to separate these and the examination made as a result of field studies. In studying these species of *Chlorotettix* both internal and external structures have been found to vary with the species. Special study has been made of the oedagus and styles as internal structures and the valve, plates, and pygofers as external structures. There is a great diversity

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in the structure of the internal genitalia of the males throughout the group. This is so marked that in some cases it would seem that certain species might not even belong to the same genus because of the decided differences exhibited in these structures.

The styles probably show the least variation when internal structures are considered, although a comparison of these in the accompanying plate (XXXVIII), will show specific differences. In general contour they vary from a triangular type like *lusorius* and *necopinus* to the much elongated type represented by *vacunus* and *limosus*. The articulation with the connectives may appear short or prolonged. The apex of the style shows variation both in direction, curvature, and relative length of the terminal process when present (Plate XXXIX.) In general the species are somewhat similar while certain species can be grouped together because of styles which resemble each other very closely. *Viridius* with its wide blunt apex, *necopinus* tapering suddenly to a point, and divergens curving back upon itself are exceptional variations and unique types in the genus in respect to the styles. In a side view of the styles as seen in plate XXXIX, the lateral dorsal folding of the styles is quite pronounced in several species while in others it is entirely lacking. More variation occurs in the oedagus than in the styles (Plate XXXVIII.) The greatest variation in this structure is found in the width of the body of the oedagus, in the width and length of the terminal portion, and in the number and type of the apical processes.

The body of the oedagus may taper from anterior to posterior ends or visa versa, while in some cases it may attain its greatest width at the middle. On the other hand such species as *spatulatus* show a splitting of the greater part of the oedagus into long terminal processes which may be two or four in number, short or long, or which may diverge at definite but varying angles according to the species. In lateral view the anterior dorsal process is present in most species, but is lacking in *vacunus*. This process may extend anteriorly or posteriorly and seems to be a part of the main body of the oedagus in most cases. In lateral view there is also great variation among the species in regard to comparative width in the anterior, central, and posterior portions.

Considering external characters, the valve may be short or long and the posterior margin may be rounded or triangularly produced. The male plates vary decidedly in length and may be short and broad, or long and narrow. The outer margins may taper gradually to the tips or may be convexly or concavely rounded. The apices may be broadly rounded or sharply pointed and proximal or divergent.

Other external characters, the structures on the pygofers of the male have not previously been used to any extent in work with *Cicadellidæ*. There are constant specific variations in most of the species examined. With few exceptions one or more spines are present on the ventral posterior margin of the pygofer. The angle in which it is directed or the degree of curvature is distinctive in each specific case. In a few species the spines are dorsally situated and the pygofers divided into lobes. In addition the general shape of the pygofer in many cases whether rounded, squarely cut, shallowly notched, or otherwise, is an excellent specific character.

In order not to treat this subject in an entirely superficial way it might be well to enter into a more specific discussion of related or unique species and make a comparison of the internal structures of those species studied which are probably representatives of the other species of the genus.

It has been possible by studying these structures to divide the genus into groups of species which have similar types of internal genitalia and apparently are more closely related to each other than to other species of the genus. Probably the most striking example of this similarity is in the case of the round-headed spatulate group including *spatulatus*, *rugicollis* and *limosus*. These species are very large in size and can be distinguished from all the other species of *Chlorotettix* in regard to male genitalia by the four equal, long slender processes at the distal end of the oedagus. *Minimus* also has four terminal processes but they are arranged differently and are unequal in length. In this species the oedagus is cleft further toward the base and the needle-like, shorter processes are different from those of *spatulatus* showing more similarity to *tunicatus* and *capensis*, as is also the case with the styles. The longer very slender and curved processes are peculiar to the oedagus of *minimus*. *Spatulatus* and *rugicollis* appear to be almost identical by an examination of their internal structures.

It might be possible, judging it upon this basis, that *rugicollis* is only a color variety of *spatulatus*, but other factors probably indicate specific ranking. The spines on the pygofer are arranged differently in the two cases and the habitats in the two species are entirely different. *Spatulatus* occurs in fresh water marshes and is commonly found in the *Scirpus-Juncus-Sabbatia* association, while *rugicollis* inhabits the short grasses of the southern pine forests where adult and immature stages have been found in abundance. In this connection it might be stated that *limosus* is a species not previously described which has always been placed under the name of *spatulatus* but which is very different. *Limosus* occurs on tall grasses found associated with the *Sphagnum tamarak* bog, a distinct habitat from that of *spatulatus*. In respect to internal structures also, *limosus* is distinct. The styles are greatly elongated and the four terminal processes of the oedagus are much longer than in any other species. The styles are so long that their apices are conspicuous as black spine-like processes either side of the plates near their tips.

*Balli* and *suturalis* are rather closely related to the former group. In the case of *balli*, we find a species with a spatulate process as in the previous group, while the head is decidedly produced and the body is much narrower. The internal male structures disclose a style similar to *spatulatus*, while the oedagus has two bifurcate terminal processes which are very slender and curve outwardly and dorsally, which is quite different from this species. The proximal part of the oedagus bends posteriorly and is unique among these species. The bifurcate terminal processes of the oedagus of *suturalis* appear wide and blade-like from the lateral view curving outward and dorsally. The style although similar to the aforementioned species has a broader and more strongly curved terminal process.

Of the remaining species studied, *galbanatus*, *capensis* and *tunicatus* show the greatest similarity. In lateral view *capensis* and *tunicatus* are very similar, although the oedagus in *capensis* is slightly larger. The styles, however, differ considerably in the posterior processes. *Galbanatus* and *capensis* have similar styles, but the oedagus and connective in *galbanatus* are much heavier at their junction than in the latter species. *Viridius* resembles somewhat *tunicatus* and *capensis* but is much smaller in size. The terminal part of the oedagus is

comparatively much shorter. The styles although distinct are of the same type as the species just mentioned.

The styles of *tergatus* also resemble in a general way those of *capensis* but lack the prominent angles on the lateral edge as seen from the ventral view. The oedagus in lateral view is narrower anteriorly and projects forward while the posterior portion is heavier and recurved anteriorly.

Unicolor shows some resemblance to this same group. The styles are similar to *capensis*. The oedagus is also similar in side view but in ventral view the body is proportionately wider. The terminal processes of the oedagus are four in number, two of which are very short. The longer pair form at least one-fourth the total length of the oedagus.

*Lusorius* is rather distinct, resembling this group only slightly. The ventral view of the oedagus is similar but in lateral view the oedagus is different from any other examined in the group. The styles are distinctive, lacking the terminal process usually present and appearing notched when seen from the ventral side.

In *productus* the oedagus lacks the terminal processes of most of the other species of this group. With this exception the general contour of the oedagus is similar to *tunicatus*. The styles are quite similar to others of this group but in lateral view each bears a peculiar terminal process curved ventrally.

In a study of this type one would naturally expect to find certain species with internal structures entirely different from any other members of the genus and from the groups which show marked similarities. This could be expected because of our method of establishing a genus from a few species and adding new forms to it from time to time. These are added because of similar external characters which might have come about by parallel development regardless of origin.

Such diverse characters were found in the case of *vacunus*, *divergens*, *necopinus*, and *viridius*. In *vacunus* the oedagus shows no anterior process while a terminal process is formed by a deep notch. In ventral view it is greatly enlarged just before a short terminal process which is normal in size. The styles are only slightly curved, but are narrowed and elongated with rather blunt tips. In *divergens* the oedagus is extremely short, comparatively enlarged at the base and Y-shaped or bifurcate at the apex. In a lateral view the dorsal process

is not proportionately in keeping with the other species while the terminal portion recurves. The posterior third of the styles is bent sharply, obliquely back so that the curved tips are brought together. This unique bending of the styles is not found elsewhere in those species of *Chlorotettix* examined.

The oedagus of *necopinus* is also unique. In ventral view it widens from the connectives to the distal end which is quite broad, each lateral posterior portion being armed with two spines. The shorter pair point inward and are somewhat ventrally directed while the longer pair equalling the oedagus in length are directed dorsally. The styles also are distinct but show more similarity to the styles of other species. The chief difference in *necopinus* is the lack of a curved or prolonged terminal process.

The oedagus of *viridius*, especially in the lateral view, is similar to *lusorius* and the *tunicatus* group. There are several minor differences which distinguish it specifically. The styles, however, probably show less resemblance to other species than any in the group. They widen to form broad flat ends which are heavily chitinized, forming two ridges.

If we may judge from published work, very little attention has previously been given to the structure of the pygofer and the arrangement of spines upon them as external characters for specific recognition. The accompanying figures illustrate these specific characters very clearly and it will not be necessary to describe them in detail. The normal condition is for the pygofer to bear one or more large heavy spines, but a few species that have been studied lack these structures entirely although they have other characteristic markings upon the pygofer. For example *suturalis* bears a peculiar brush of short bristles on the inner edge of the lower posterior lobe; the rounded pygofer of *necopinus* has numerous scattered short bristles and bears a notch on the anterior ventral margin; the pygofer of *rugicollis* and *spatulatus* each have a slight but distinct bulge on the ventral margin; while the pygofer of *vividus* are almost squarely cut posteriorly. The most prevalent condition among the species of the genus is the bearing of a single spine on the pygofer. Of this group, *capensis*, *tunicatus*, and *galbanatus* are very similar, each with a single spine on the posterior ventral edge. In *capensis* the spine is curved downward toward the ventral side; in *tunicatus* it is

directed posteriorly; while in *galbanatus* it bends outward and upward along the posterior edge of the sloping pygofer. *Minimus* also bears a spine on the ventral edge which extends dorsally in the genital chamber and is serrated at the tip. In *divergens* the spine is long, nearly straight, situated on the ventral posterior portion and is directed dorsally and posteriorly, extending half its length beyond the posterior margin of the pygofer. The long blade-like spine of *tergatus* is on the ventral posterior margin also, but is ventrally directed, doubly curved, and unique in structure among these species. *Productus* bears a short, ventral curved spine, high up on the posterior edge while the dorsal edge shows a peculiar thickening. *Balli* might also be placed with the former, since it has a spine-like chitinization on the median posterior edge of the pygofer.

Three species have been placed in the group bearing two spines on the pygofer. In *lusorius* the ventral lobes of the pygofers are armed with two long, heavy dorsally directed spines. *Vacunus* bears two long spines, one of which is on the ventral posterior edge, curved sharply upwards, then gradually posteriorly to meet the oedagus; the other arises on the dorsal edge and extends downward through the genital chamber. The third species, *unicolor*, has a large ventral, rounded lobe with two short but distinct spines on the posterior margin. In *viridius* the pygofer is divided by a suture, the anterior part bearing several small bristle-like spines dorsally and one long ventral posterior spine which follows the posterior edge of the pygofers. *Limosus* is distinct in possessing a short process bearing five heavy spines on the posterior ventral lobe of the pygofer.

From the practical standpoint, the variations found on the pygofers in the several species are probably the best for use in identification in addition to those already used such as the plates and valve of the male and the last ventral segment of the female. In a few cases the styles protrude beyond the plates and are thus external characters, or the posterior portion of the genital chamber may be open so that the oedagus is frequently visible either as it protrudes or is seen in its internal position. In such cases these can be used as constant characters but are probably not needed in most cases for specific identification.

The value of this study, in all probability lies in demonstrating that internal structures are specific for the species of this genus and in verifying external characters now used for identification by the internal structures. Moreover it probably adds further evidence regarding the inter-relationship of the species of the genus. After a similar study can be made of all the species in many groups, it may be possible to establish more soundly generic affinities, but this cannot be done without a broad and thorough study of many groups.

It has been possible to study only a limited number of these species from the standpoint of internal structures since many are represented by only the type specimens or small type sets and it has seemed inadvisable to mutilate these types for this study.

***Chlorotettix limosus* n. sp.**

Resembling *C. spatulatus* in size and form but with distinct genitalia. Length, 7-8 mm.

Vertex slightly produced in front and appearing broadly rounded, almost three times as wide between eyes as length at middle. Pronotum broad and rather short. Elytra long, exceeding abdomen.

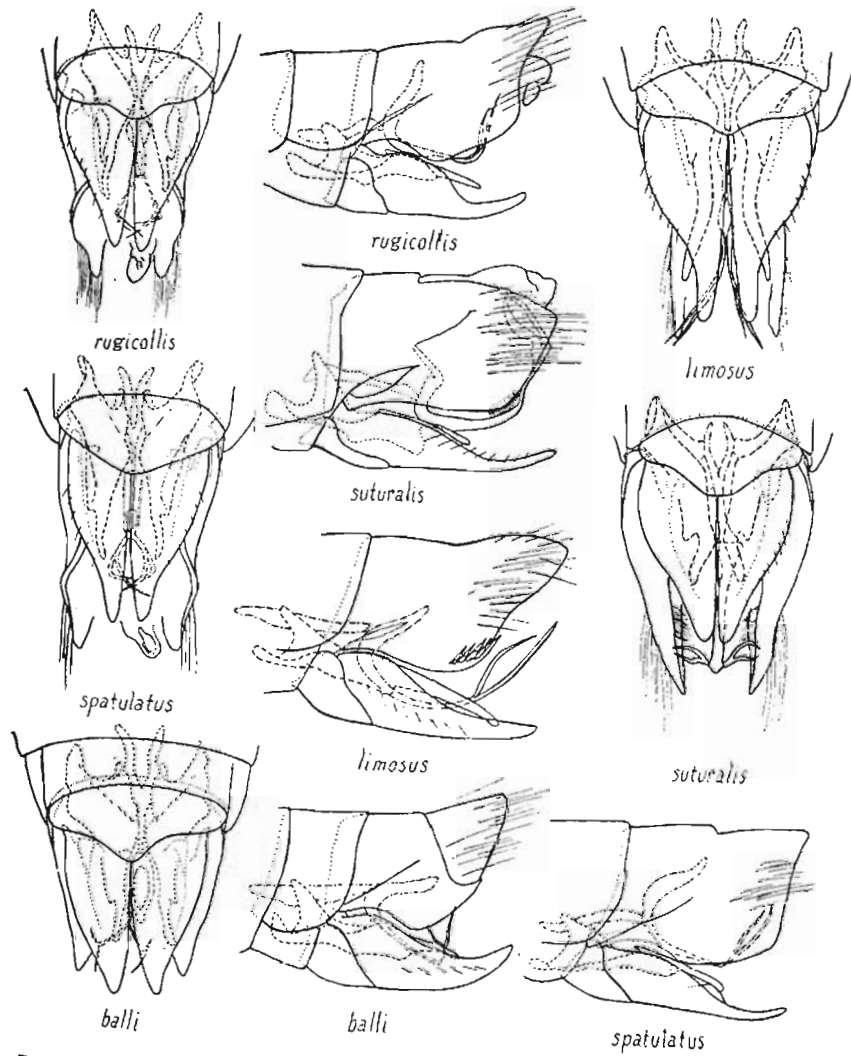
Color: Green washed with yellow, or slightly brownish yellow, without definite color markings.

Genitalia: Female last ventral segment longer than preceding, lateral angles prominent, posterior margin excavated half way to base either side of a prominent spatulate process which is cleft at apex and extends about half the distance of the excavation. Sides of excavation gradually sloping then convexly rounded to spatulate process. Male valve triangular, apex rounded; plates rather long, convexly rounded two-thirds their length then concavely rounded to blunt, rounded apices. Tips of styles prominent either side of plates just before apex.

Described from a series of eight females and four males taken by the senior author and Mrs. DeLong in a small bog in the Pymatuning swamp at Hartstown, Pa., from a sphagnum-tamarack habitat. Also one male from Doubling Gap, Pa., collected by H. B. Kirk.

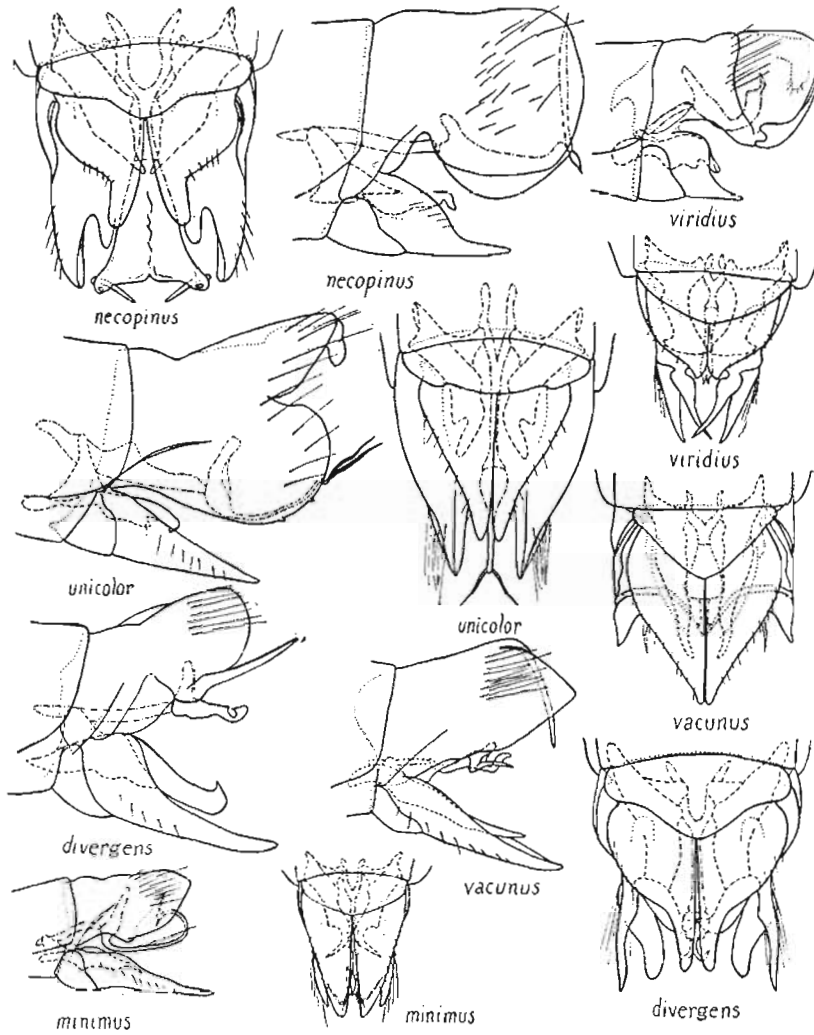
The female of this species was formerly figured by the author as *spatulatus*. Although the female character is a constant and distinct one, it can most easily be separated from *spatulatus* by the black tips of the styles which are visible either side of the male plates near their tips.





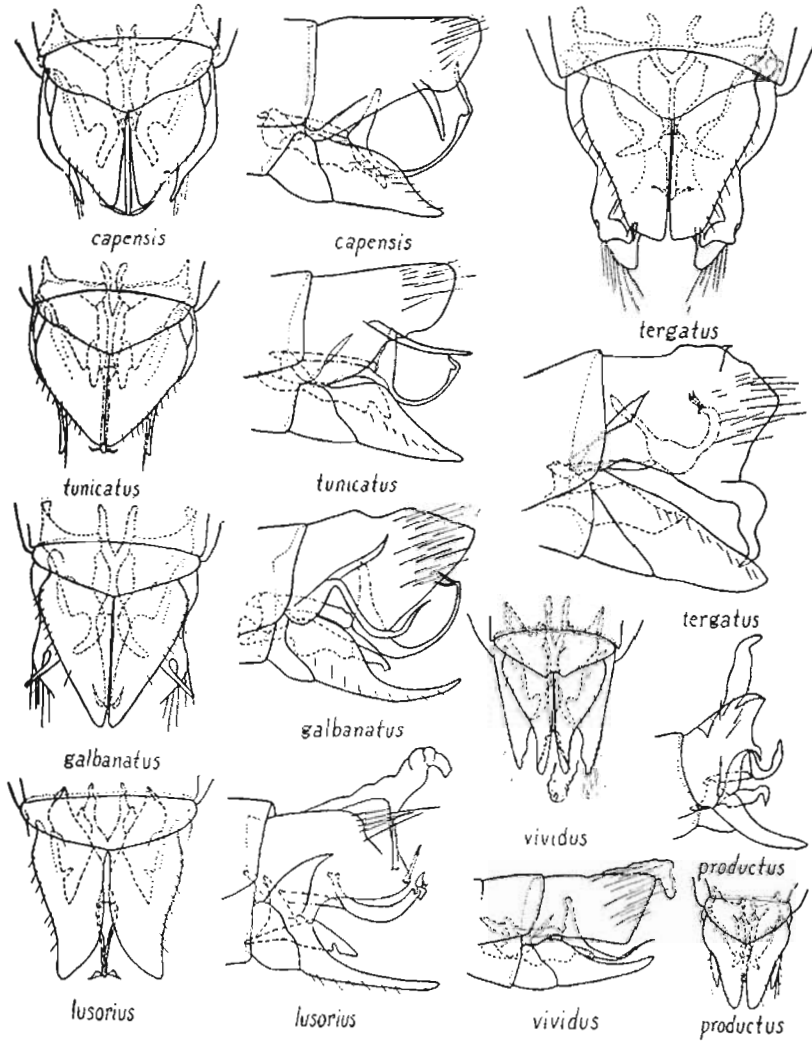
DeLong and Cartwright.

Ventral and lateral views of male genitalia with internal structures represented by broken lines.



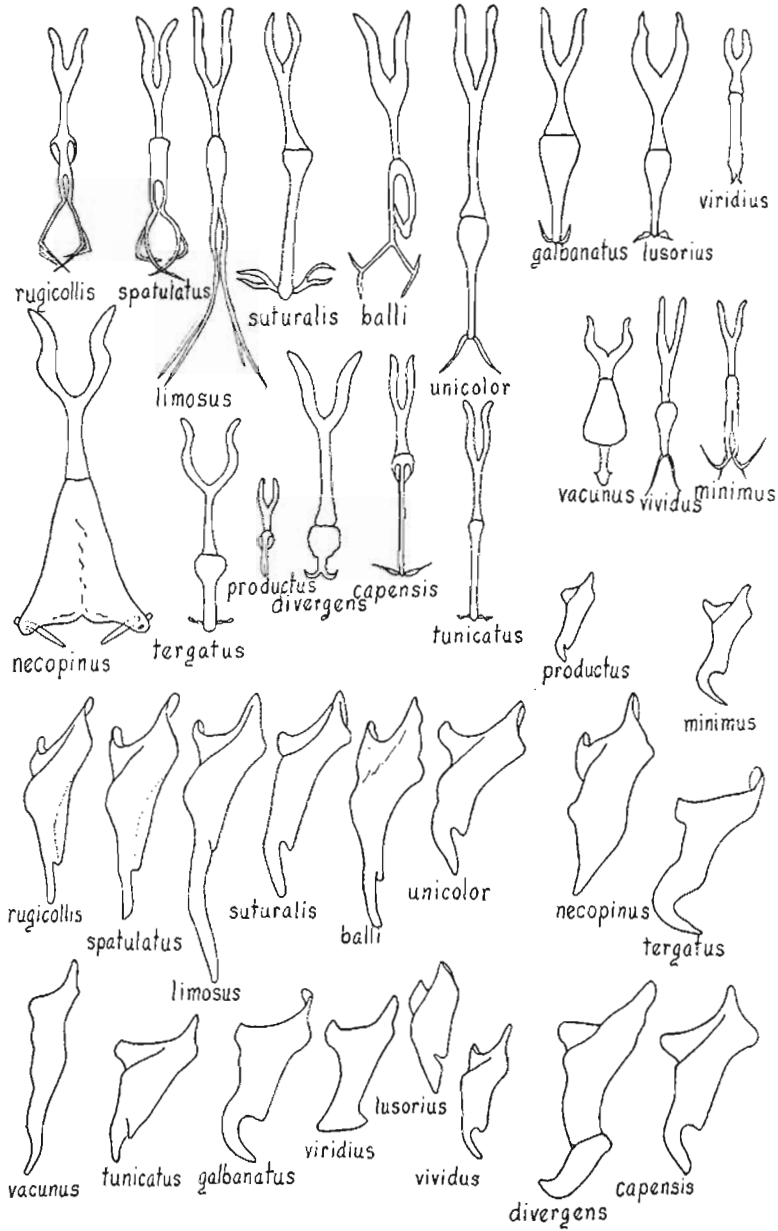
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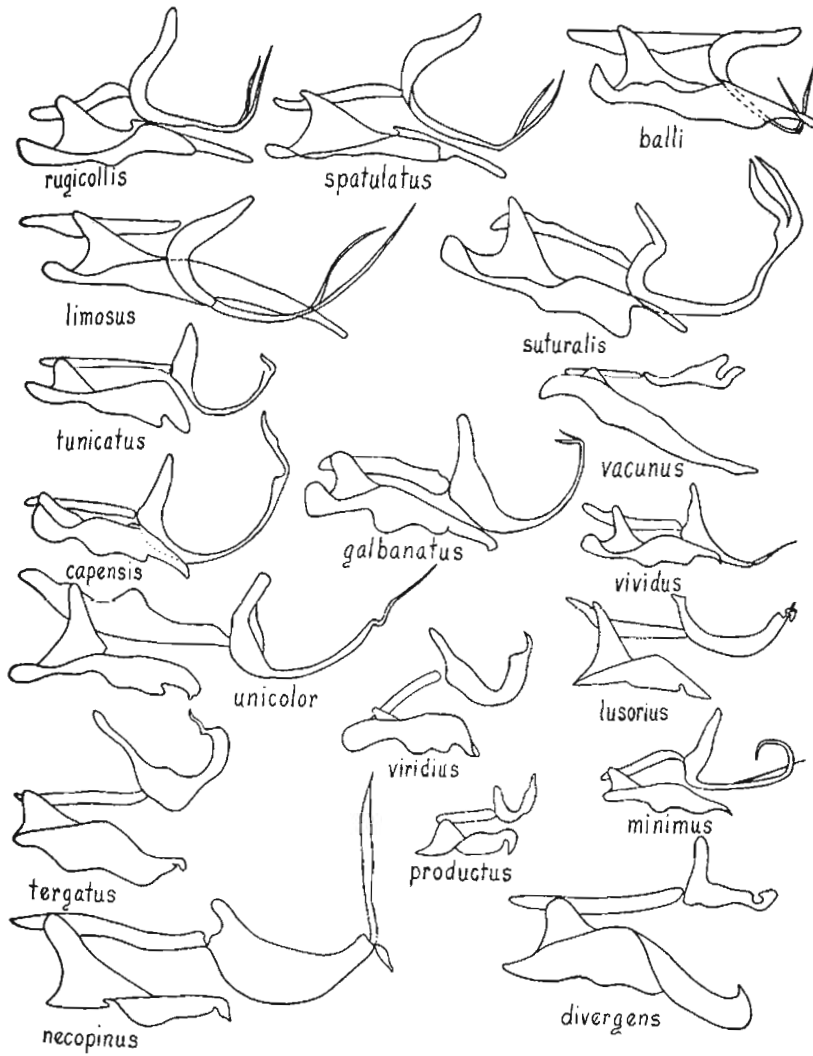
DeLong and Cartwright.

Ventral and lateral views of male genitalia with internal structures represented by broken lines.



DeLong and Cartwright.

Ventral views of the oedagi, above; ventral views styles, below.



DeLong and Cartwright.

Lateral views of the styles, oedagi and connectives.