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Comparative Morphology of the External Male Genitalia of Gymnetis (Coleoptera: Scarabaeidae)

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With best regards to
Dr Goodrich.

Comparative Morphology of the External Male Genitalia of Gymnetis (Coleoptera: Scarabaeidae)

(TITLE)

BY

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INTRODUCTION AND HISTORICAL BACKGROUND

The object of this study is to elucidate the intra- and inter- specific variation in the male genitalia of ten species of Gymnetis, and to compare these with eight species of the closely related genus Cotinis.

Copulatory organs have been frequently used in the discrimination of closely related species in many families of Coleoptera, and very notably in the Scarabaeidae, but taxonomists have used these anatomical structures much less frequently in arranging species in higher categories. Sharp and Muir (1912) were the first authors to review the structure of the male genital tube throughout the order Coleoptera and suspected its significance as an important taxonomic tool, not only for the discrimination of different species of beetles, but also potentially useful in tracing out the phylogeny of various groups. Snodgrass (1957) valued these organs for the identification of insect species as being equal to that of "finger prints" for the identification of human individuals. Tanner (1927) made a study of the genitalia of female Coleoptera and concluded on the basis of these structures that

Scarabaeoidea were the most highly specialized and most recently evolved of the Coleoptera. The study of genitalic structures has now been proved to be of considerable value to taxonomists when combined with data derived through other lines of investigation.

Comparative studies of male genitalia have already been made in some groups of Coleoptera. Nakane (1953) explained the taxonomic importance of the male genitalia in Japanese Lepturinae (Cerambycidae). Ehara (1954) made comparisons of the male genitalia in Cerambycid beetles. Watson (1956) studied the phylogeny of the Coccinellinae using male genitalia in addition to other morphological characteristics. Genitalic characteristics have been frequently used in species segregation in the Scarabaeidae, although only rarely have these characteristics been used in higher classification.

A survey of the literature reveals that relatively little work has been done with the genitalia of the Cetoniinae. Early taxonomists' work on the Gymnetini: Gory and Percheron (1833); Burmeister (1842; Bates (1889); Schaffer (1905); and Casey (1915) described the external morphological characters but completely omitted genital structures. Goodrich (1965, 1966) was the first to study male (and female) genitalia in the Gymetini. In his revisions of the genera Balsameda and Cotinis he used genitalic characters together with external morphology to group as well as to distinguish different species.

METHODS OF INVESTIGATION

Thirty-five male specimens of ten species of Gymnetis and forty-two specimens of eight species of Cotinis were identified and dissected for their genitalia. Specimens were identified by referring to Bates (1889), Goodrich (1965) and Schaeffer (1905). Terminology used in describing genitalic structures is that of Sharp and Muir (1912) and Goodrich (1965, 1966).

Specimens for dissection were placed in a humidifying chamber for seventy-two hours or more to relax them for gross dissection. After relaxation genitalia were removed through the pygidium and placed in ten per cent KOH solution at room temperature for twenty-four hours. Genitalia were then transferred to boiled water and cleaned of attached soft tissues. The internal sacs were forcibly everted with jeweler's forceps exposing the inner surface of the sac with its sclerotized parts. The genitalia were then placed in glycerine and stored in microvials attached to the specimen pins. Dissected genitalia were studied with a binocular dissecting micorscope with magnification ranging from 10x to 40x. An ocular micrometer scale was used for making precise measurements of different parts of the genitalia. In making drawings, the outlines of the genitalia were drawn using a camera lucida. These drawings were then transferred to drawing paper by using

a fluorescent light table, and then completed freehand. Sclerotized areas are shown by stippling, pubescence by fine lines and membranous areas by clear areas.

The specimens used in the study were borrowed from the collections of the Illinois Natural History Survey, Urbana, Illinois, and from the personal collection of Dr. M. A. Goodrich.

RESULTS

Comparative study of the genitalia in the ten different species of Gymnetis and eight different species of Cotinis revealed a great amount of variation in their structures. These variations are conspicuous not only between the two genera but are also considerable between different species of the same genus and may show some small variations within the same species.

Of the various parts examined, the internal sac exhibited the greatest diversity in structure. The size and distribution of areas of sclerotization varied and the variation in armature of these areas ranged from a single tiny tooth to many heavily sclerotized stout teeth. Most species are quite homogeneous in these characteristics, hence these structures could be very useful in determining the taxonomic status of the species.

A second part of the genital structure which showed

considerable degree of variation were the lateral lobes which differed in their arrangement, degree of sclerolization and presence or absence of teeth at their distal angles. This was particularly true among the Gymnetis species.

DIAGNOSTIC DESCRIPTION OF GYMNETIS SPECIES STUDIED

GYMNETIS SALLEI Schaum

A stout bodied species, dull black above, with sides irregularly straw yellow, the head always pale except at the apex of the clypeus where there is usually a small black spot. Occurs in Louisiana, Mexico (Cardona, Orizaba, Jalapa) and Guatemala (Escuintla).

Diagnostic Description of the Genitalia:

Basal piece a heavily sclerotized arched structure (3.5 - 4.0 mm long). Lateral lobes (3.0 - 3.3 mm long) more heavily sclerotized than the basal piece; distal ends of the lateral lobes divergent, bearing pointed teeth at their latero-apical angles; small tooth-like structures are also present on the inner angles of the lateral lobes (Fig. 2). Internal sac, when everted, pubescent on the distal half and bearing two sclerotized

areas (1.3 - 1.5 mm long), each sclerotized area bearing many small bristles and a single large stout tooth (0.72 - 0.75 mm long) (Fig. 1).

GYMNETIS PUNCTATA Blanchard

Color ranging from pale brown to smoky brown on upper surface, under surface including legs polished black. Many prominent punctures on pronotum and elytra which are more concentrated on the lateral sides. Pygidium opaque black but in some species light brown. Found in Mexico (Jalapa, Durango, and Jalisco).

Diagnostic Description of the Genitalia:

Basal piece one and a half times longer than lateral lobes (7.0 mm long). Lateral lobes (4.5 mm long) more sclerotized at the basal half than near the apical ends, joined at their basal ends but slightly diverging near the apices (Fig. 3). Internal sac, when everted, with pubescent at the distal part and a single elongated sclerotized area (3.2 mm long) bearing two long teeth (1.2 - 1.3 mm long) (Fig. 4). In some specimens, the sclerotized area is shortened, the teeth are reduced in size and may be doubled in number thus arranged in pairs

(Figs. 6,7,8). In one specimen there was only a single tooth on the internal sac (Fig. 5).

GYMNETIS CINEREA Gory and Percheron

Color greyish brown above, legs and under surface polished black. Prothorax with two distinct punctures on posterior half; elytra with scattered fine punctures, but far fewer than in punctata. Found in Mexico (Monterey in Nueva Leon, Villa Lerdo in Durango, and Aguascalientes).

Diagnostic Description of the Genitalia:

Basal piece (3.4 - 3.6 mm long) somewhat less sclerotized than in punctata, longer in length than lateral lobes; lateral lobes (2.2 - 2.4 mm long) joined near the basal piece but becoming slightly divergent toward their apices (Fig. 9); the basal half of the lateral lobes more sclerotized than the apical halves. Internal sac, when everted, pubescent on the distal half; bearing armature in the form of an elevated pigmented area (2.2 mm long) in the middle of the sac which bears two long thin teeth (0.92 mm long each) (Fig. 10).

GYMNETIS ARGENTEOLA Bates

Body narrowly oblong, opaque greenish above, under surface including legs silvery cobalt in color, tarsi black. Prothorax and elytra with many more punctures than in cinerea and punctata. Pygidium silvery yellow in color. Found in Mexico (Pinos Altos in Chihuahua) and Arizona (Cochise County).

Diagnostic Description of the Genitalia:

Basal piece (5.1 mm long) lightly sclerotized as in cinerea but with darker margins, double the length of the lateral lobes. Lateral lobes (2.5 mm long) heavily sclerotized with closely approximating basal halves and diverging apical halves, bearing pointed teeth on the outer margins of their latero-apical angles (Fig. 11), lateral lobes directed downward at their apices when seen in the lateral position in contrast to other species of Gymnetis where the apical ends of lateral lobes are almost straight. Internal sac when everted consists of a relatively unpigmented tube except for the pale yellow pubescent portion and two closely placed unnoticeable pigmented areas (0.1 mm long), each one bearing a small conical tooth (0.35 - 0.40 mm long) (Fig. 12).

GYMNETIS CRETACEA Leconte

Head with elevated sides, not seen in any other Gymnetis species. Shining black upper surface; lateral margins of prothorax white; elytra with two white transverse maculae midway between bases and the apices. Ventral abdominal segment with lateral white spots on each side near the elytra margin; pygidium with two large white spots. Anterior tibiae distinctly tridentate A larger species than other Gymnetis (23 - 25 mm long).

Diagnostic Description of the Genitalia:

Basal piece (4.2 - 4.4 mm long) one and a half times longer than lateral lobes and more sclerotized near its union with the lateral lobes than at the proximal end; lateral lobes (3.2 - 3.4 mm long), almost parallel, running parallel to each other except slightly divergent at their heavily sclerotized apical ends; a ridge like latero-apical process present pointing upward and outward (Fig. 13). Internal sac larger than any other Gymnetis species but without armature except for a very small dark brown ridge like structure bearing two fine spines (Fig. 14).

GYMNETIS LOBICULATA Casey

Color dark, brownish grey on the upper surface, under surface including legs shining black; prothorax

and elytra without any punctures in contrast to other similar looking species; pygidium opaque black in color. Found near Jalapa in Mexico.

Diagnostic Description of the Genitalia:

Basal piece one and a half times longer than the lateral lobes and lightly sclerotized as in G. cretacea with proximal end splitting into a fork like structure, the two ends of the fork joining the basal part of the lateral lobes (Fig. 15). Lateral lobes joined at their base but quite divergent at their distal ends as in G. argenteola and G. sallei, each bearing a sharp pointed tooth at their latero-apical angle, and a unique hook like structure on the ventral surface of the basal ends of lateral lobes (Fig. 14). Internal sac with two darkly pigmented areas, (1.5 mm long) one on each side, each bearing many minute bristles and a single stout pointed tooth (0.5 mm long) as seen in G. sallei (Fig. 16).

GYMNETIS CINCTA Bates

Head with two elongated white spots, color dark brown on upper surface with light yellow margins on prothorax and elytra; under surface including legs shining black except the femora which bear white patches;

each abdominal segment with white patches on the latero-ventral sides. Pygidium light yellow with an elongated black spot in the middle. Found in Mexico.

Diagnostic Description of the Genitalia:

Basal piece approximately the same length as lateral lobes (2.5 mm long), more heavily sclerotized near its proximal end especially laterally. Lateral lobes (2.4 mm long) more sclerotized near their basal ends, and very lightly sclerotized at their apices, a feature very much in contrast to other species of Gymnetis. They run parallel to each other, joined together at their basal and apical ends, but quite apart in the middle forming a loop like structure (Fig. 17). Lateral lobes bear teeth on their latero-apical angles which point backward. Internal sac with very little pubescence and no armature except two lightly pigmented spots near its proximal end (Fig. 18).

GYMNETIS LAETULA Casey

Externally much like argenteola but smaller in size. Upper surface smokey brown, under surface including legs silvery blue and tarsi black; pygidium dark brown with white spots. Many irregular punctures on pronotum and elytra. Found in Arizona (Nogales).

Diagnostic Description of the Genitalia:

Basal piece (3.9 mm long) three times longer than lateral lobes, almost transparent, with no pigmentation on the distal end but very slight pigmentation near the proximal end. Lateral lobes (1.6 mm long) joined at their basal ends, but gradually diverge from each other when approaching their apical ends forming a V-shaped structure (Fig. 19), more sclerotized near the apical ends but with no teeth at their latero-apical angles. Internal sac, (3.8 mm long) when everted, quite different from the other species of Gymnetis, with a crescent-shaped sclerotized area at the distal margin bearing a single darkly pigmented tooth (0.5 mm long) (Fig. 20).

GYMNETIS Sp. A.

Color above dark olive, under surface including legs shinging maroon, a part of prothorax with a green metallic sheen and a few white spots. Elytra with several irregularly scattered punctures. Pygidium opaque olive. Found in Guatemala.

Diagnostic Description of the Genitalia:

Basal piece (3.2 - 3.5 mm long) one and a half times longer than lateral lobes and more sclerotized at the proximal end than at the distal end. Lateral lobes (2.2 - 2.4 mm long) stout heavily sclerotized structures bearing darkly pigmented teeth on both sides of their latero-apical angles (Fig. 21). Internal sac with pale yellow pubescence and a small sclerotized area in the middle (0.3 mm long), bearing many small blunt teeth arranged in three parallel rows (Fig. 22).

GYMNETIS Sp. B.

Upper surface pale brown in color, lower surface including legs shining black. Several irregularly scattered punctures on the head, on the elytra the punctures are concentrated on the inner longitudinal margins of the elytra. Pygidium black with a large yellow spot in the middle.

Diagnostic Description of the Genitalia:

Basal piece (4.4 - 4.7 mm long) a little more than double the length of lateral lobes, lightly sclerotized on the distal end. Lateral lobes (1.9 - 2.1 mm long) joined with each other in the middle but separated on

both the ends, moderately sclerotized at the basal end but very lightly sclerotized near the distal ends forming a transparent margin (Fig. 23). Internal sac with yellow pubescence and a single large sclerotized area (1.6 mm long) bearing two thin teeth (0.6 - 0.7 mm long) in the middle and three small teeth located on the lateral margin of the sclerotized area (Fig. 24).

DIAGNOSTIC DESCRIPTION OF COTINIS SPECIES STUDIED

COTINIS MUTABILIS Gory and Percheron

Color highly variable, ranging from jet black to opaque green on the upper surface. Shining metallic green on the lower surface including legs. Clypeal horn well developed with a distinct ridge on the dorsal side. Frontal process long and well developed, usually free and expanding at the apex. Pronotum and elytra smooth with very fine indistinct punctures. Pygidium shining green with transverse strigulations. Occurs in southwestern United States (Texas, New Mexico and California) and south into Mexico, Central America and northern South America.

Diagnostic Description of the Genitalia:

Basal piece (5.8 mm long) more sclerotized at its union with lateral lobes than at the base and is almost one and a half times longer in length than the lateral lobes. Lateral lobes (4.1 mm long) somewhat more sclerotized and separated at their apical end but comparatively less sclerotized and fused together the rest of their length, possessing small teeth at their latero-apical angle which are pointed outward and backward toward base (Fig. 25). Internal sac with a large elongated darkly pigmented sclerotized area (1.7 mm long) bearing two long and stout teeth (1.6 mm long each) (Fig. 26).

COTINIS LATICORNIS Bates

Color green, mixed with brown on the sides and posterior part of the elytra; under surface shining metallic green, legs with light brown hairs. Clypeal horn short with a tridentate apex. Well developed frontal process with a dull point apex instead of expanded one as seen in Mutabilis. Punctate pronotum and elytra smooth with indistinct punctures; pygidium shining green like under surface. Found in West Central Mexico (from Sonora and Durango Mexico and Michoacan States).

Diagnostic Description of the Genitalia:

Basal piece one and a half times longer than lateral lobes (6.5 mm long) and is more sclerotized at its union with lateral lobes than at the distal end. Lateral lobes (4.2 mm long) darkly but evenly sclerotized throughout their length, slightly separated at their apical end but joined together at rest of their length, distinct teeth present on the latero-apical angles (Fig. 27). Internal sac with a large dark sclerotized area (1.6 mm long) possessing a single stout tooth (1.9 mm long) (Fig. 28).

COTINIS LEBASI Gory and Percheron

Color green, yellow or reddish brown on the pronotum and elytra, legs and under surface shining bronze to metallic red. Two dark spots at the posterior margin of the elytra. Clypeal horn, in contrast to mutabilis is small and triangular in shape. Frontal process with an expanded or sometimes pointed apex, but fused to head for most of its length. Distinctively smooth and opaque pygidium. Occur in Central America and northern South America (from Honduras South to Columbia).

Diagnostic Description of the Genitalia:

Basal piece (5.2 mm long) a heavily sclerotized

arched structure. Lateral lobes (3.8 mm long) attached to the distal end of basal piece and are more sclerotized at their basal end than at the apical end, their basal halves fused to each other, and apical halves separate but closely approximating to each other, possessing a ridge-like process which forms teeth at the latero-apical angle (Fig. 29). Internal sac finely pubescent with a dark sclerotized area (2.0 mm long) bearing two long thin teeth (1.6 mm long each) (Fig. 30).

COTINIS SUBVIOLACEA Gory and Percheron

Color variable, ranging from deep plum to shining brassy green above, with a similar coloration on the under surface. Reduced clypeal horn but a long frontal process usually with a free pointed apex. Elytra smooth without any longitudinal costae or punctures. Pygidium brownish black with transverse strigulations. Occur in Eastern Mexico.

Diagnostic Description of the Genitalia:

Basal piece (5.8 mm long) a moderately sclerotized structure, one and a half times longer than lateral lobes. Lateral lobes (3.8 mm long) more sclerotized at the basal

end than at the apical end, separated at their apical ends but fused together throughout rest of their length (Fig. 31), and possessing ridge like teeth at their latero-apical angle. Internal sac with a small and very lightly pigmented sclerotized area (0.3 mm long) bearing a single tiny tooth (0.2 mm long)(Fig. 32).

COTINIS FUSCOPICEA Goodrich

Color polished brownish-black above, legs and under surface shining dark brown. Clypeal horn triangular and more strongly developed than subviolacea. Long pointed frontal process with a free apex. Pronotum and elytra with very fine punctures. Pygidium brownish black with transverse strigulations. Occurs in Temax, Yucatan, and Mexico.

Diagnostic Description of the Gentalia:

Basal piece (5.8 mm long) one and a half times longer than lateral lobes. Lateral lobes (4.2 mm long) more sclerotized at their basal end than at the apical end, fused at the basal end and separated for the rest of their length but very closely approximating each other, possess teeth at their latero-apical angle (Fig. 33).

Internal sac with an elongated sclerotized area (1.1 mm long) bearing a single darkly pigmented tooth (0.8 mm long) (Fig. 34). On some specimens few additional smaller teeth have also been reported.

COTINIS NITIDA Linne

Pronotum green with tawny lateral borders, elytra green with tawny borders on both lateral and posterior sides. Clypeal horn well developed, with reduced or no ridge between clypeus and clypeal horn as seen in mutabilis. Frontal process free and well developed as in mutabilis. Pronotum and elytra with indistinct punctures. Pygidium bicolored, with basal green and tawny apical portion. Occurs in the United States east of the hundreth meridian.

Diagnostic Description of the Genitalia:

Basal piece (6.5 mm long) a moderately sclerotized arched structure of the usual form. Lateral lobes (3.9 mm long) heavily but evenly sclerotized, with completely fused basal ends and slightly separated apical ends; ridge-like process present on the latero-apical angles which project into small teeth (Fig. 35).

Internal sac with an elongated sclerotized area (1.6 mm long) bearing a single stout tooth (1.2 mm long) (Fig. 36).

COTINIS PAUPERULA Burmeister

Color ranging from blue-green to light brown above, legs and under surface metallic shining green. Moderately developed clypeal horn with a pointed apex. Frontal process reduced to a narrow longitudinal carina. Pronotum finely punctate. Elytra distinctly punctate and striated, the punctuations concentrated on the posterior part. Pygidium opaque brown with transverse strigulations. Occurs in Southwestern Mexico (from States of Colima and Michoacan south into Oaxaca).

Diagnostic Description of the Genitalia:

Basal piece (4.5 mm long), lateral lobes (3.2 mm long) more heavily sclerotized at the basal end than at the apical end, fused completely at the basal end but slightly separated the rest of their length with small ridge-like processes at their latero-apical angles (Fig. 37). Internal sac with fine pubescence but without any sclerotized area or armature (Fig. 38).

COTINIS ANTONII Duges

Color shining black with brownish reflections on upper surface, similar coloration on legs and under surface. Reduced clypeal horn. Frontal process fused to head. Pronotum finely punctate, elytra distinctly punctate and striate. Pygidium finely strigulate and shining with two depressions on each side. Occurs in Central Mexico, States of Guanajuato and Zacatecas.

Diagnostic Description of the Genitalia:

Basal piece relatively long for Cotinis (4.5 mm long), and moderately sclerotized. Lateral lobes (2.6 mm long) flattened and more heavily sclerotized at their basal end than at their apical end, slightly separated throughout their length but closely parallel to each other without any ridge or teeth at their latero-apical angle (Fig. 39). Internal sac with pubescence on the lower half and a very small lightly sclerotized area (0.6 mm long) bearing two slender teeth (0.4 - 0.5 mm long) (Fig. 40).

DISCUSSION

A great deal of variation is observed in the structure of certain parts of the genitalia in different species of Gymnetis. These variations in the genitalia, while great in some structures, are still not a radical departure from the basic type for gymnetine scarabs. Hence it was possible to homologize these structures and to determine a possible relationship between the different species.

With regard to the variation of the major parts of the external genitalia, the following general conditions may be made. The least variation is seen in the basal piece which appears similar in almost all the species studied except in size and the degree of sclerotization. The lateral lobes appear much more diversified in their structure, varying in shape, in position with respect to each other, degree of sclerotization, and presence or absence of teeth at their distal angles. The greatest variations are seen in the chitinous armature of the internal sac, which ranges from a small sclerotized area with a single tiny tooth to one, or sometimes two large elongated sclerotized areas, with one or more distinct teeth. In two of the species studied no chitinous armature is seen on the internal sac.

Differences in the structure of lateral lobes although not as great as those seen in the armature of the internal sac, were considered to be most important in indicating relationships because of the uniformity of these structures within each species. Further it is felt that related species show greater similarity of the structure of the hard parts of the aedeagus (basal piece and lateral lobes).

In studying the similarities among the Gymnetis species on the basis of lateral lobes, it is noted that the lateral lobes in G. sallei are similar to those of G. argenteola (Figs. 2, 11). In both of these species the lateral lobes are joined at the basal end, but gradually diverge from each other and become quite apart at their latero-apical angles. However G. sallei possesses teeth on the inner side of the lateral lobes which are not seen in G. argenteola. In G. argenteola on the other hand, the lateral lobes are characterized by their shape, in that, they curve downward at their apices (Fig. 12).

The lateral lobes of G. lobiculata appear somewhat similar to those of G. sallei and G. argenteola with their diverging apical halves and joined basal ends and the presence of teeth at their latero-apical angles. However the latero-apical teeth are reduced and in

addition they also possess a hook like structure on the ventral surface of the base, which is not seen in any other species of Gymnetis studied (Fig. 16).

The similarity in basic structure and arrangement of the lateral lobes in the above three species is indicative of their relationship. This idea is strengthened by the fact that all these species possess two areas of sclerotization on the internal sac (Figs. 1, 12, 16). Gymnetis sallei seems to be more closely related to G. lobiculata in that in both these species the sclerotized areas are larger, widely separated, and bear a single stout tooth on each, whereas in G. argenteola the sclerotized areas are very small, quite close to each other, and bear a single tiny tooth (Fig. 12).

The lateral lobes of G. cinerea are quite similar to those of G. punctata. In both of these species the lateral lobes are not quite joined with each other, although they are approximate at the basal end and are slightly apart at their apices (Figs. 3, 9). Further, the lack of teeth at the distal angles of their lateral lobes and the lack of sclerotization near the apical ends in both these species is quite suggestive of their relationship. A similar situation is seen in Gymnetis Sp. B , which appears very much like punctata externally,

and resembles the above two species in the absence of teeth at the distal angles of lateral lobes and lack of sclerotization at the apical ends. But the lateral lobes in this species are joined in the middle and are slightly apart at both the ends (Fig. 23).

Similarity in the above three species is also seen in the armature of the internal sac. All three species possess a single elongated sclerotized area in the middle of the internal sac, bearing at least two long teeth, although the number of teeth varies within some specimens.

An interesting example of variation within a species is observed in G. punctata in which the internal sac varies in armature in different specimens. The area of sclerotization is similar but the number of teeth and their degree of sclerotization varies. In one specimen there was only one stout tooth on the internal sac (Fig. 5), whereas in other specimens the number of teeth varied from two to four (Figs. 4, 6, 7, 8).

The lateral lobes of G. cincta, G. laetula, G. cretacea and G. Sp. A all have distinctive structures and arrangement of their own and hence do not seem to show any particular similarity to each other or to any other species of Gymnetis studied. But the internal sac in G. cincta and G. cretacae are similar in the sense

that both these species do not possess any kind of armature on the internal sac, except that G. cincta has two very lightly pigmented areas near the basal end of the sac and G. cretacea has brown pubescence and a few dark brown spots scattered on the internal sac (Figs. 14, 18).

Gymnetis laetula has a single area of sclerotization but it is on the distal margin of the sac bearing a single short tooth which is quite different from the other species of Gymnetis seen (Fig. 20).

Study of the related genus Cotinis, on the other hand, shows it to be a much more homogenous group with regard to the structure of the lateral lobes and basal piece. The lateral lobes in all Cotinis species studied were fused at the basal end, gradually diverging and slightly separated at the apical end, a condition similar to Gymnetis cretacea. The exceptions were noted in Cotinis laticornis and Cotinis subviolacae in which the two lateral lobes are completely fused with each other throughout their length and slightly separated near the apical end (Figs. 27, 31).

In all the Cotinis species studied, the internal sac possesses a condition similar to G. laetula, G. punctata, G. cinerea, G. Sp. A and G. Sp. B, but contrasting to other species of Gymnetis which possessed two areas of sclerotization on the internal sac.

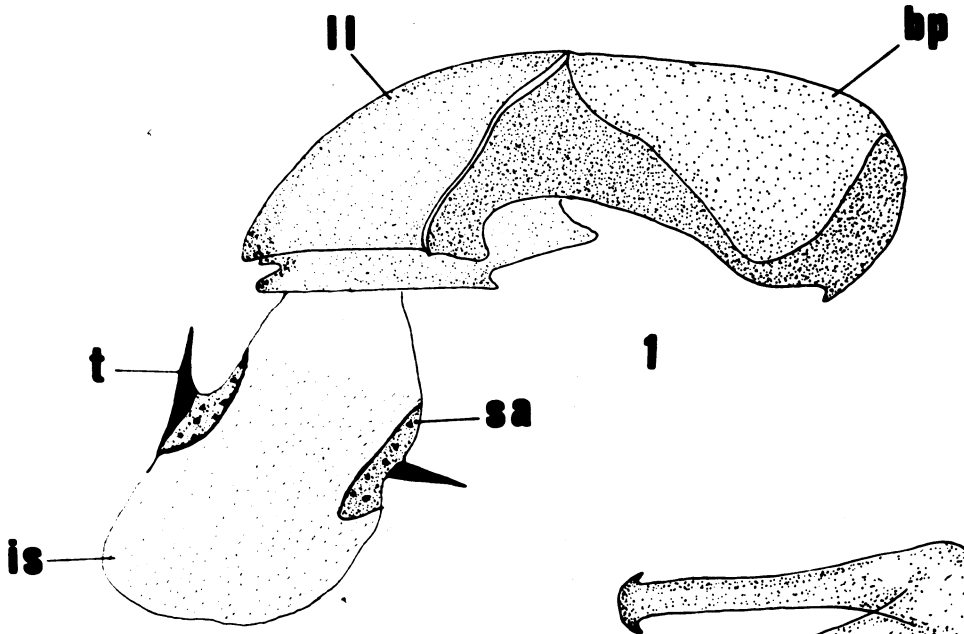
The above described great variations in the genitalic structure of the species of Gymnetis studied reveal a lack of homogeneity in the genus which suggests that subdivision of the genus may be necessary. Furthermore, the lack of congruence between groupings of species arrived at by earlier study of external characteristics with those groupings based on genitalic similarities, indicate clearly the need for utilization of both types of characteristics in any such reorganization.

Fig. 1. *Gymnetis sallei*. Lateral view of male genitalia with internal sac everted. Abbreviations: bp, basal piece; ll, lateral lobes; is, internal sac; t. teeth; sa, sclerotized area.

Fig. 2. *Gymnetis sallei*. Dorso-lateral view of lateral lobes.

Fig. 3. *Gymnetis punctata*. Dorso-lateral view of lateral lobes.

Fig. 4. *Gymnetis punctata*. Lateral view of male genitalia with internal sac everted.



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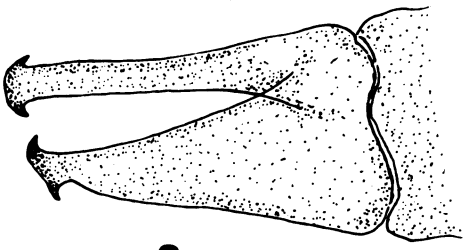

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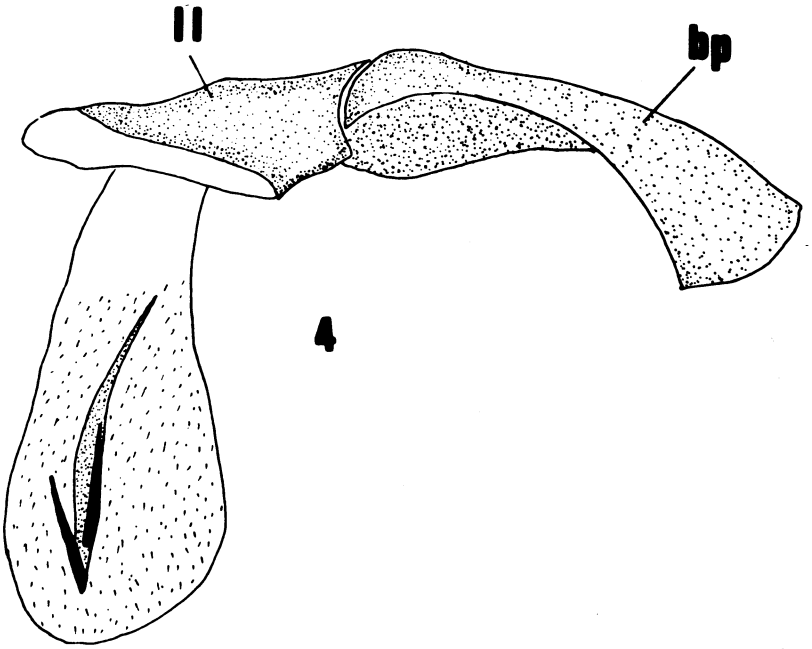

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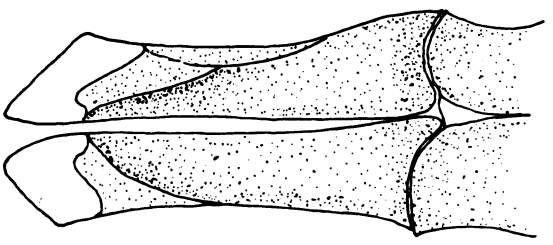

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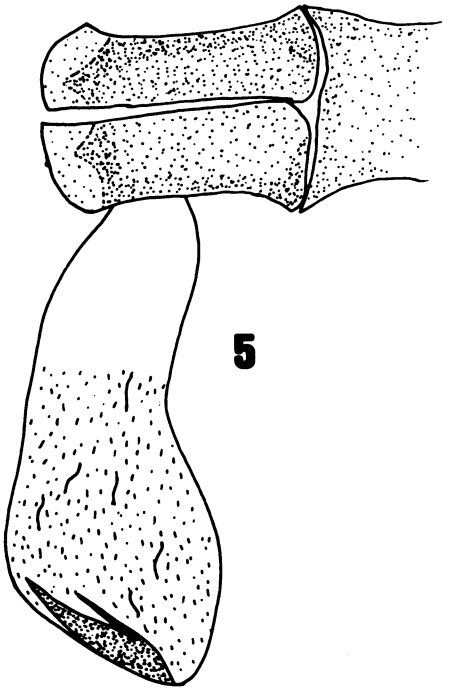
Figs. 5,6,7,8. Gymnetis punctata. Internal sacs showing sclerotized areas and varying number of teeth.



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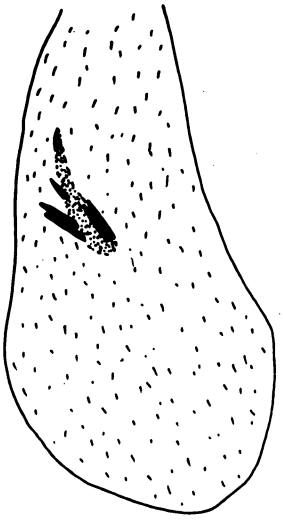

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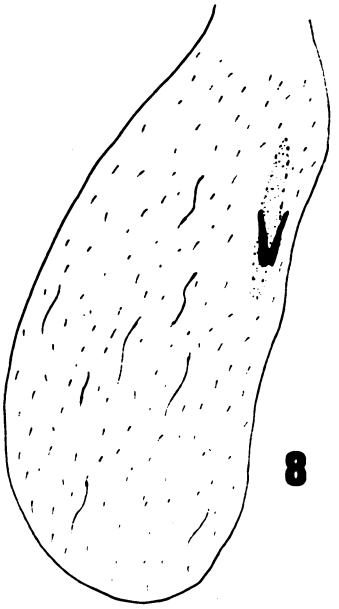

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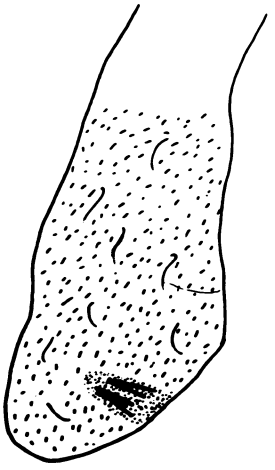

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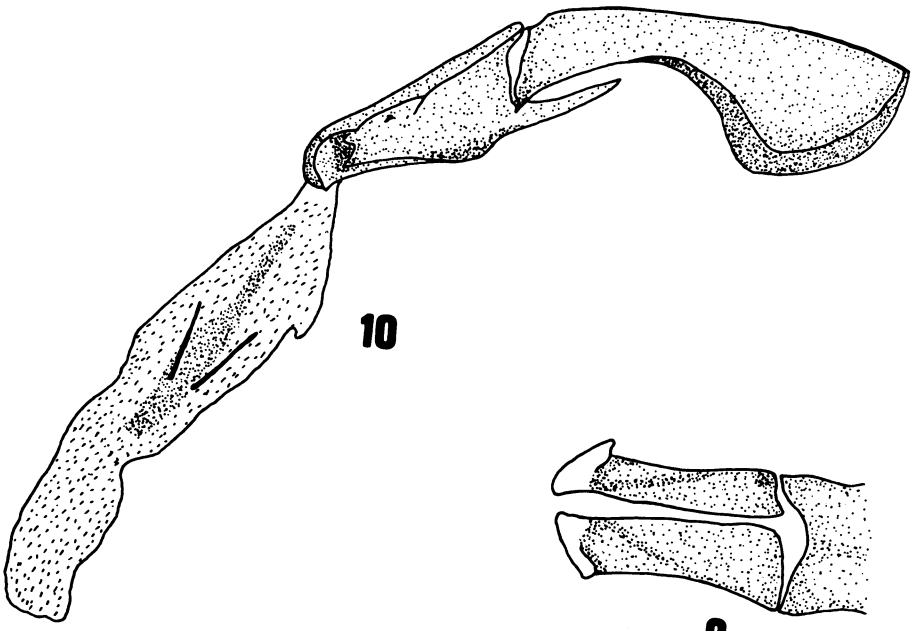
Fig. 9. Gymnetis cinerea. Dorso-lateral view of lateral lobes.

Fig. 10. Gymnetis cinerea. Lateral view of male genitalia with internal sac everted.

Fig. 11. Gymnetis argenteola. Dorso-lateral view of lateral lobes.

Fig. 12. Gymnetis argenteola. Lateral view of male genitalia with internal sac everted.



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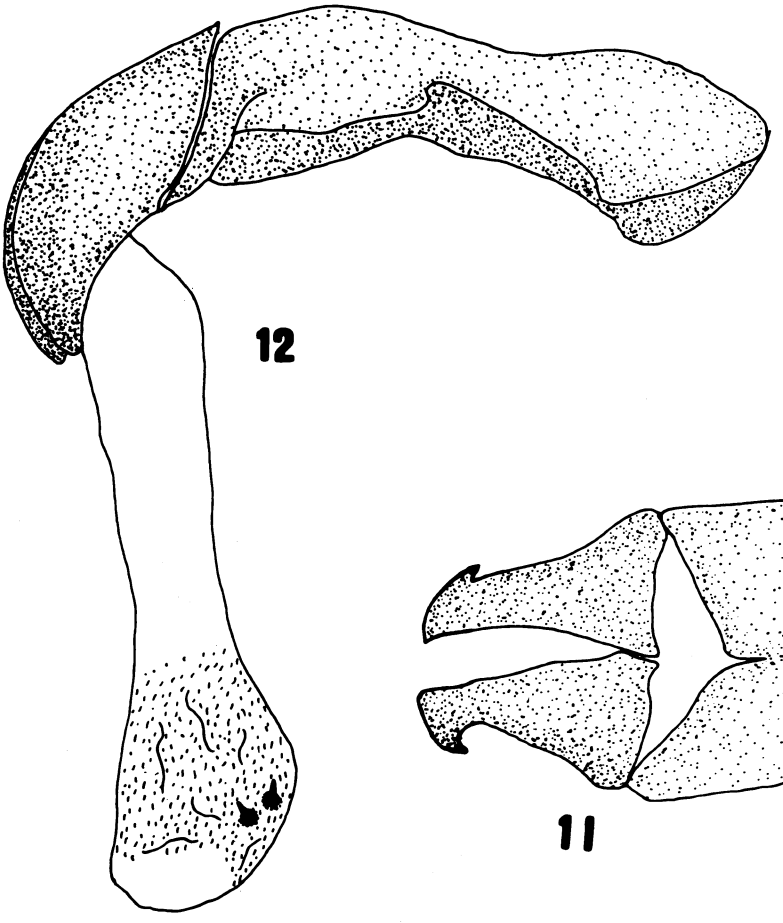

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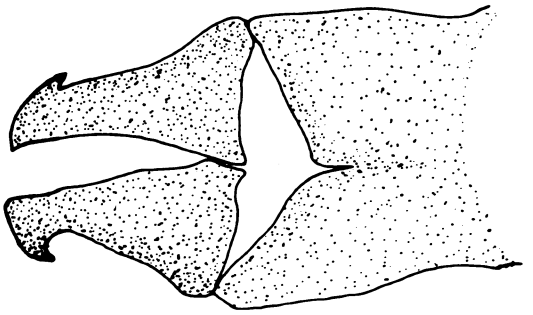

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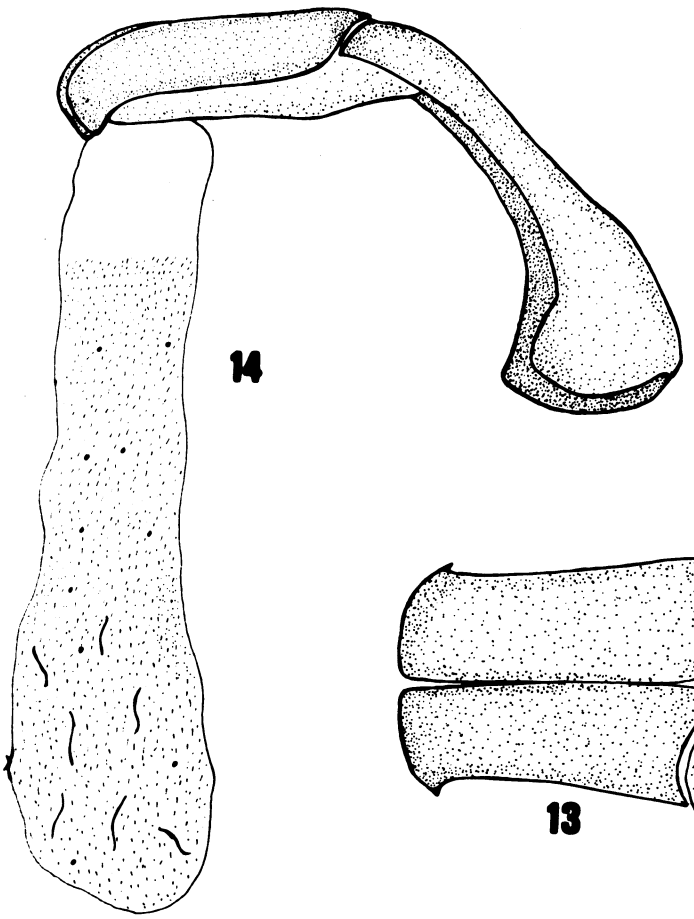
Fig. 13. Gymnetis cretacea. Dorso lateral view of lateral lobes.

Fig. 14. Gymnetis cretacea. Lateral view of male genitalia with internal sac everted.

Fig. 15. Gymnetis lobiculata. Dorso lateral view of lateral lobes.

Fig. 16. Gymnetis lobiculata. Lateral view of male genitalia with internal sac everted.



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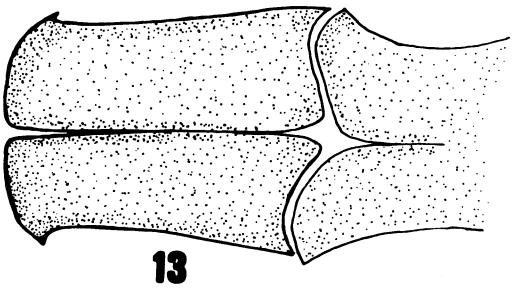

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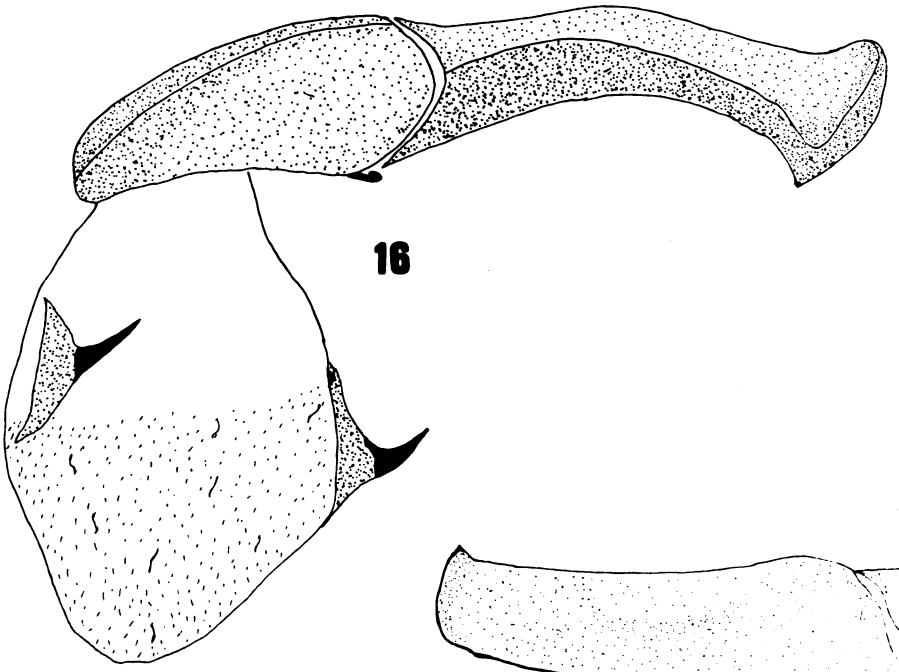

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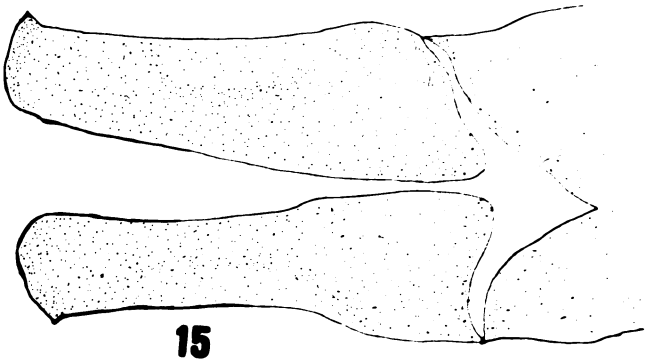

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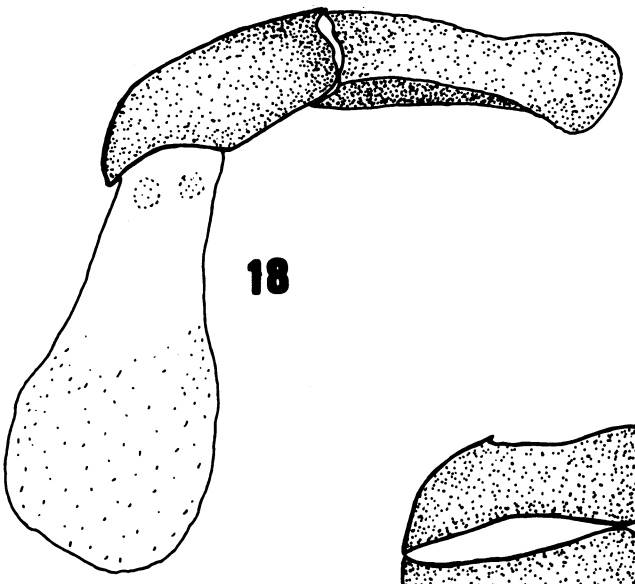
Fig. 17. Gymnetis cincta. Dorso lateral view of lateral lobes.

Fig. 18. Gymnetis cincta. Lateral view of male genitalia with internal sac everted.

Fig. 19. Gymnetis laetula. Dorso lateral view of lateral lobes.

Fig. 20. Gymnetis laetula. Lateral view of male genitalia with internal sac everted.



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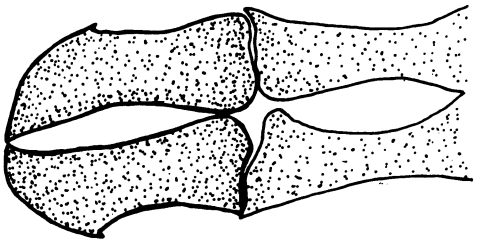

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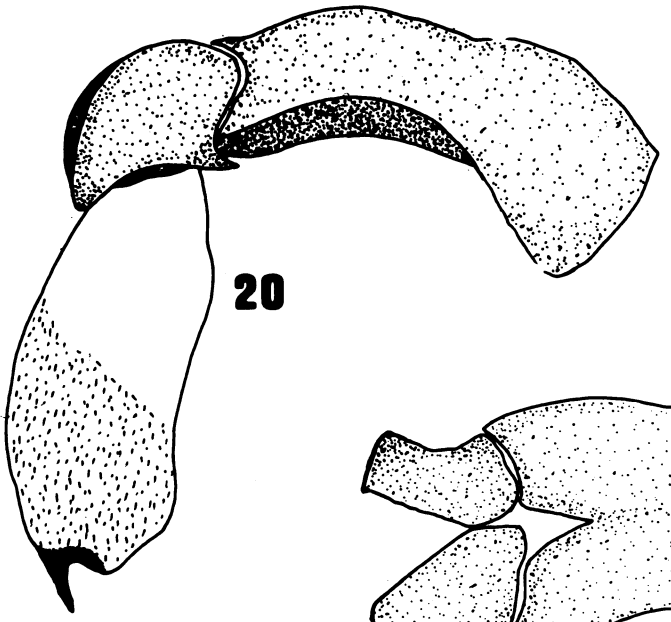

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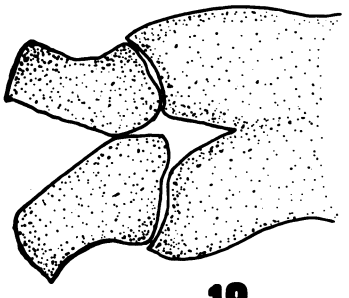

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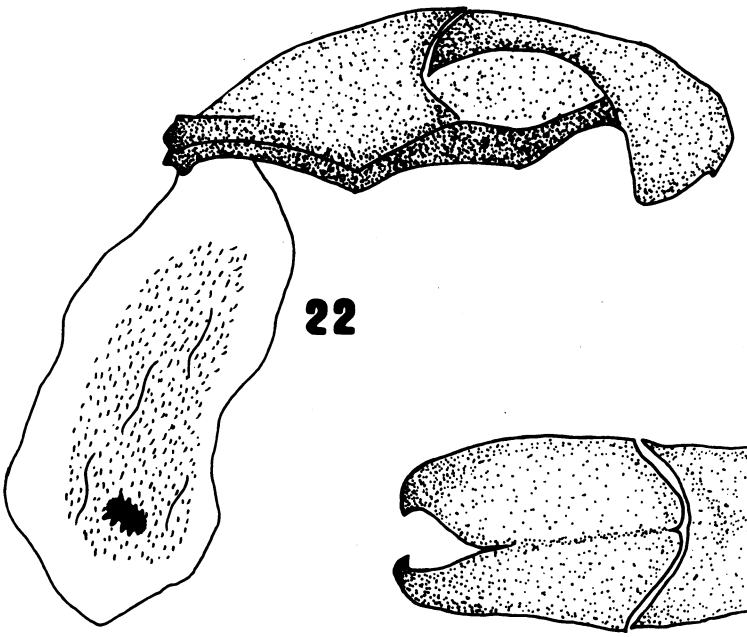
Fig. 21. Gymnetis Sp. A. Dorso lateral view of lateral lobes.

Fig. 22. Gymnetis Sp. A. Lateral view of male genitalia with internal sac everted.

Fig. 23. Gymnetis Sp. B. Dorso lateral view of lateral lobes.

Fig. 24. Gymnetis Sp. B. Lateral view of male genitalia with internal sac everted.



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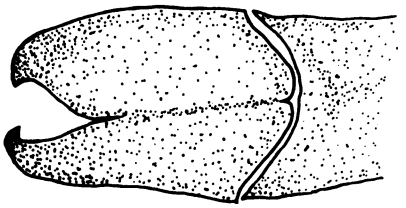

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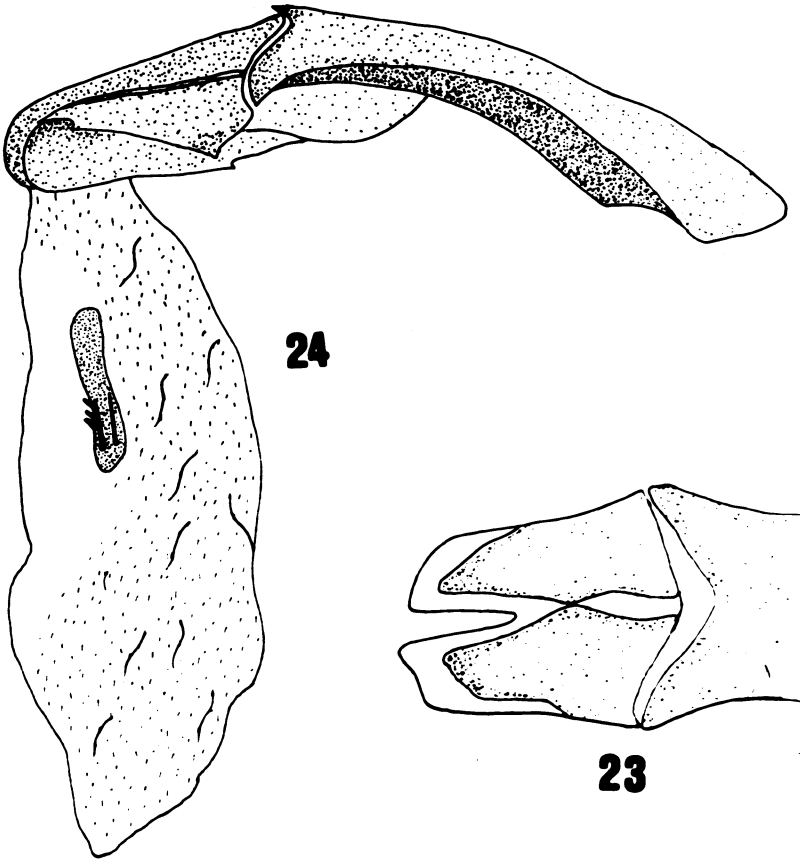

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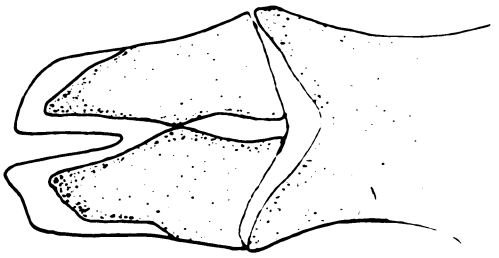

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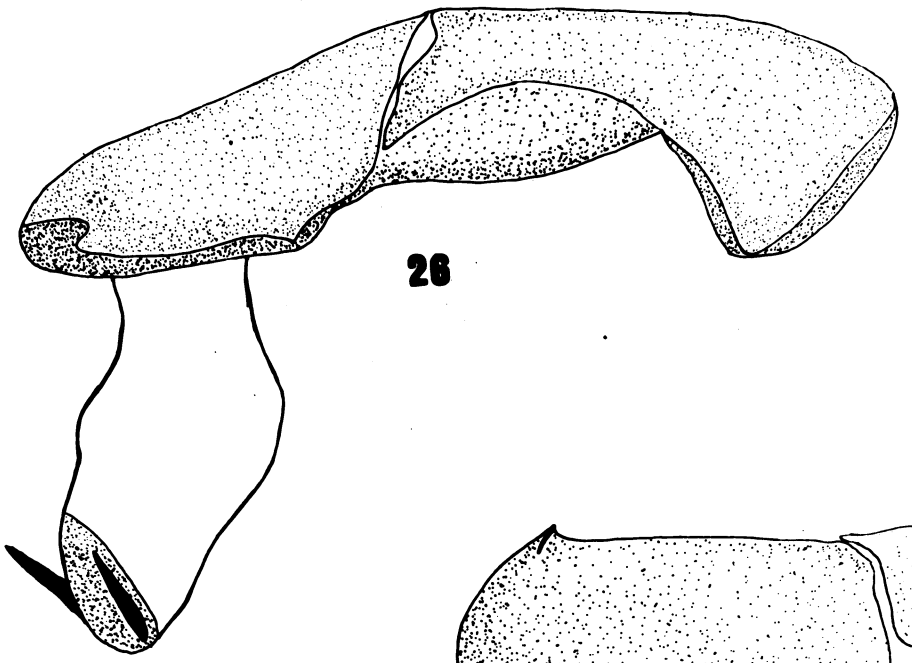
Fig. 25. Cotinis mutabilis. Dorso lateral view of lateral lobes.

Fig. 26. Cotinis mutabilis. Lateral view of male genitalia with internal sac everted.

Fig. 27. Cotinis laticornis. Dorso lateral view of lateral lobes.

Fig. 28. Cotinis laticornis. Lateral view of male genitalia with internal sac everted.



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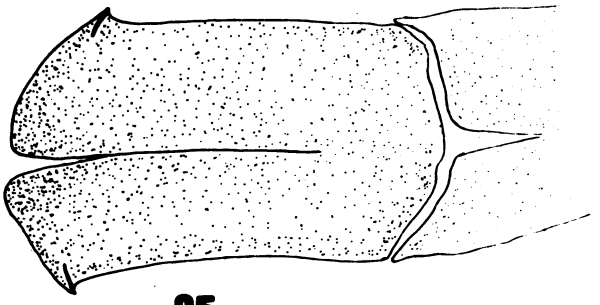

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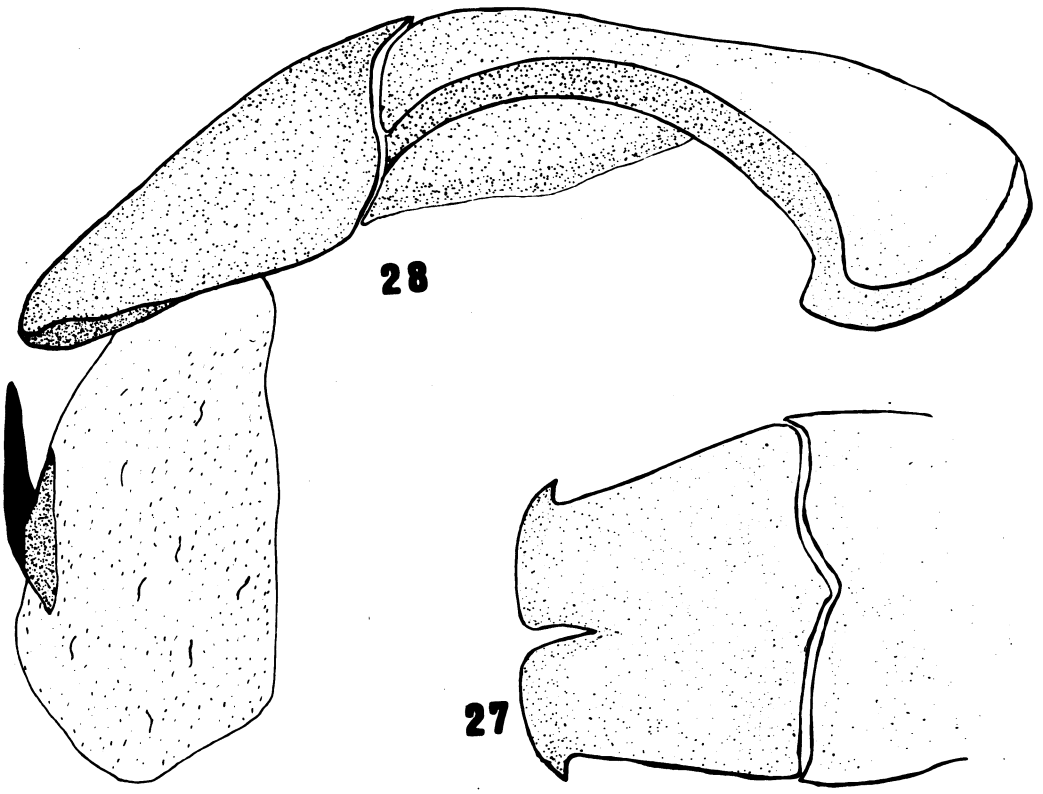

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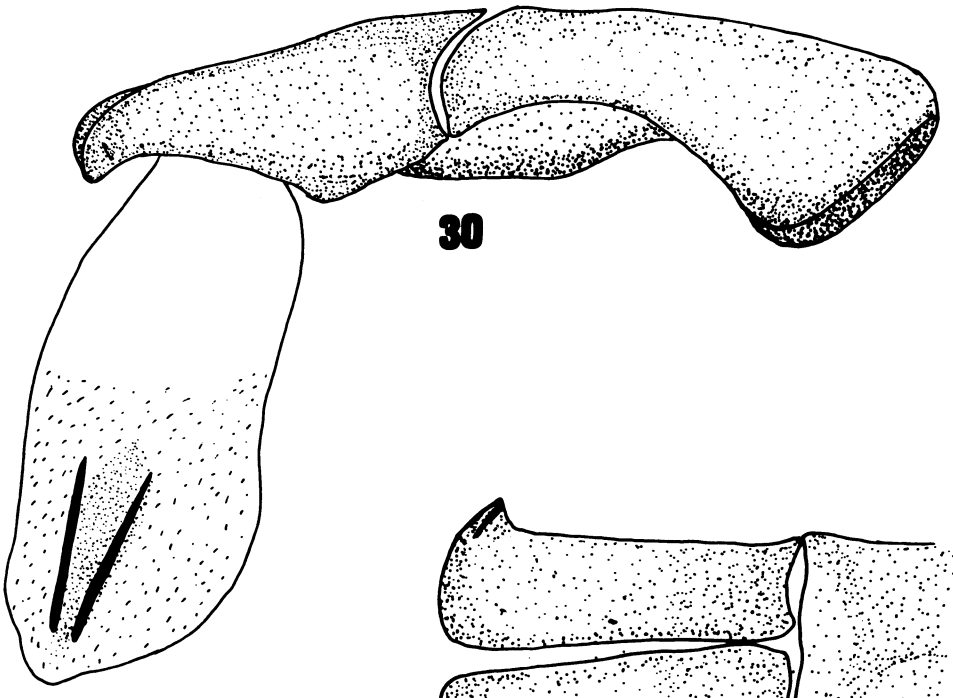
Fig. 29. Cotinis lebasi. Dorso lateral view of lateral lobes.

Fig. 30. Cotinis lebasi. Lateral view of male genitalia with internal sac everted.

Fig. 31. Cotinis subviolacea. Dorso lateral view of lateral lobes.

Fig. 32. Cotinis subviolacea. Lateral view of male genitalia with internal sac everted.



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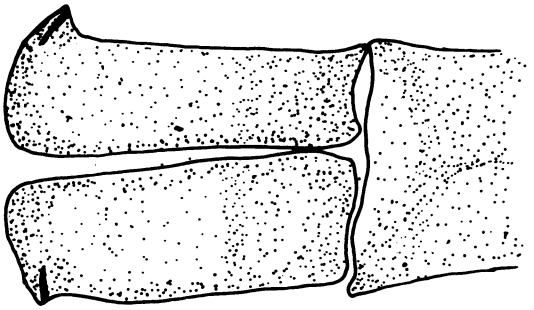

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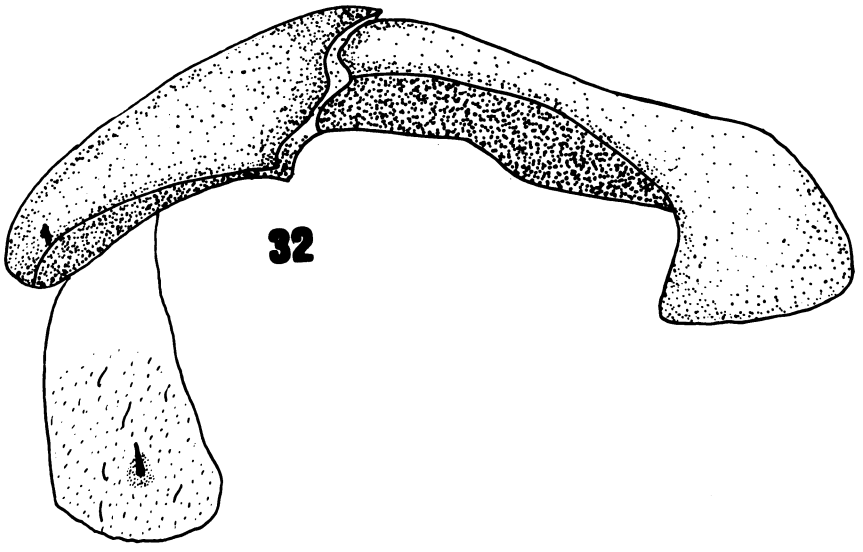

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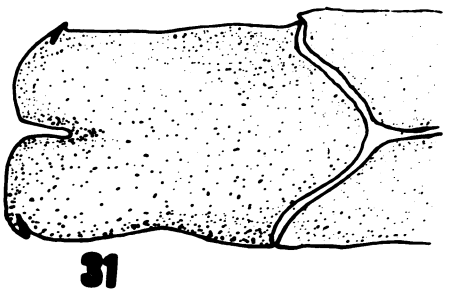

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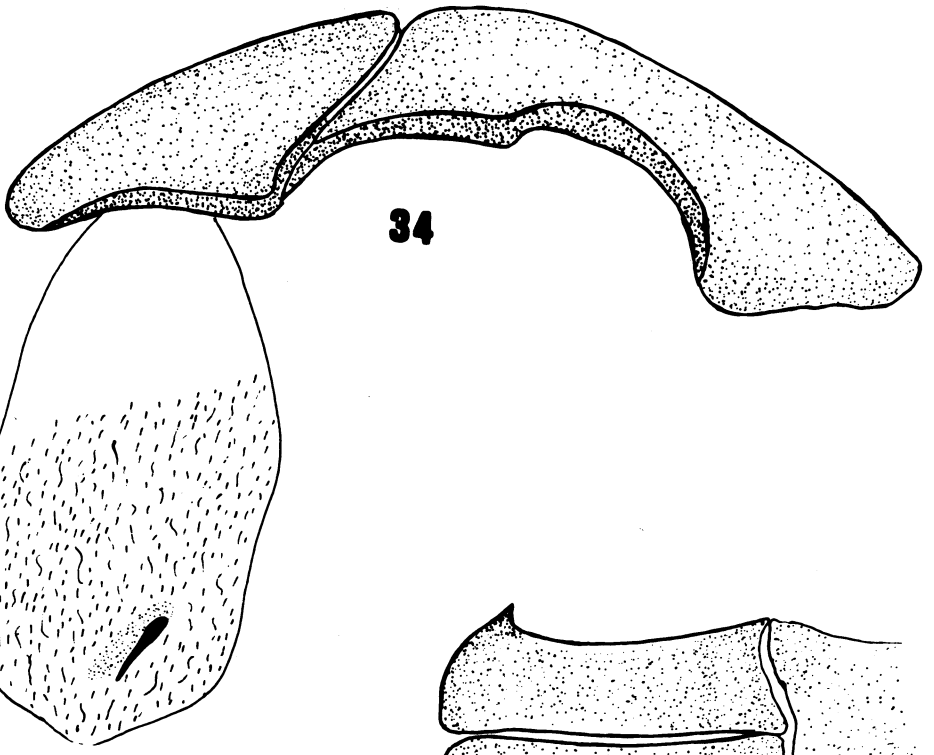
Fig. 33. Cotinis fuscopicea. Dorso lateral view of lateral lobes.

Fig. 34. Cotinis fuscopicea. Lateral view of male genitalia with internal sac everted.

Fig. 35. Cotinis nitida. Dorsal lateral view of lateral lobes.

Fig. 36. Cotinis nitida. Lateral view of male genitalia with internal sac everted.



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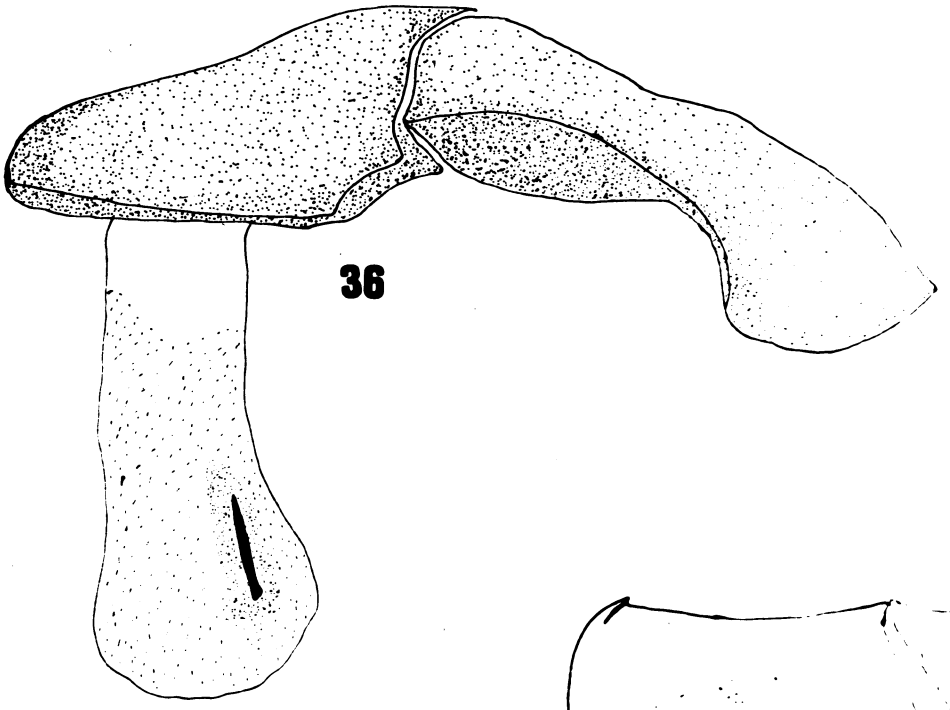

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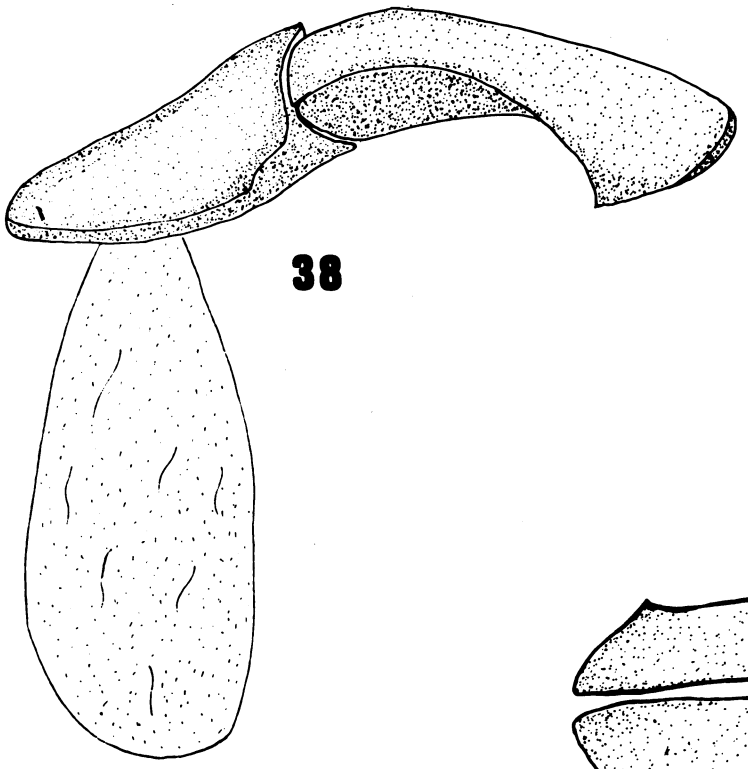
Fig. 37. Cotinis pauperula. Dorso lateral view of lateral lobes.

Fig. 38. Cotinis pauperula. Lateral view of male genitalia with internal sac everted.

Fig. 39. Cotinis antonii. Dorso lateral view of lateral lobes.

Fig. 40. Cotinis antonii. Lateral view of male genitalia with internal sac everted.



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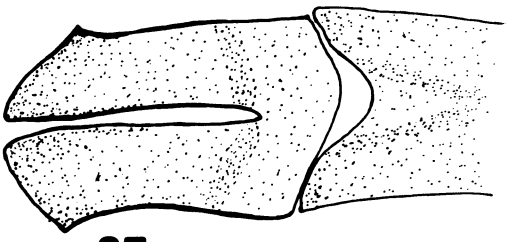

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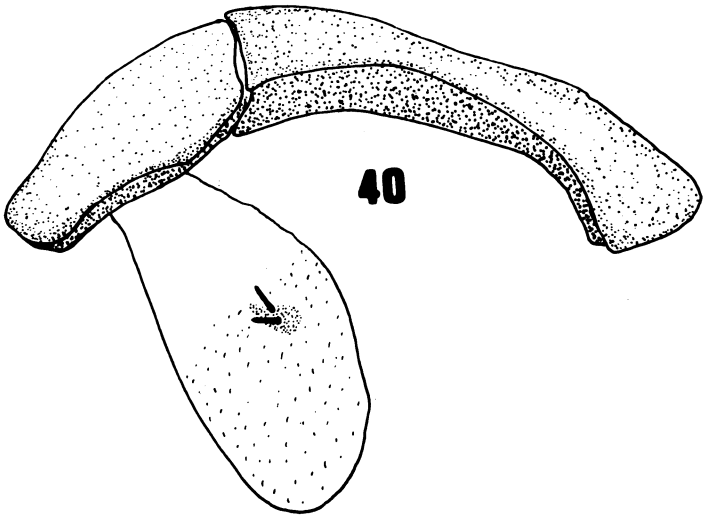

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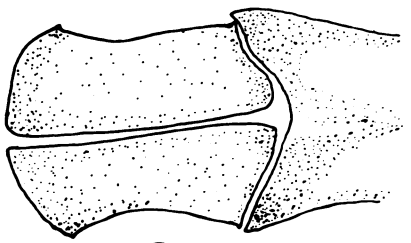

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REFERENCES CITED

Bates, H. W. 1889. Pectinicornia and Lamellicornia. In: Biologia Centrali-Americana, Insecta, Coleoptera, Vol. 2 (2): 432 p.

Burmeister, H. C. 1842. Handbuch der Entomologie. Band 3. Berlin. 826 p.

Casey, T. L. 1915. A review of the American species of Rutelinae, Dynastinae and Cetoniinae. Mem. (Coleop.) 6: 1-394.

Ehara, S. 1954. Comparative anatomy of male genitalia in some cerambycid beetles. J. Fac. Sci. Hakkaido University, Sapporo (Zool) 12: 61-115.

Goodrich, M. A. 1965. A revision of the genus Cotinis (Coleoptera: Scarabaeidae). Ann. Ent. Soc. Amer. Vol. 59 (3): 550-568.

1966. A redescription of and revision of the genus Balsameda Thomson (Coleoptera: Scarabaeidae). Can. Ent. Vol. 97 (3): 298-302.

Gory, H. L., and A. R. Percheron. 1833. Monographie des Cetoines et genres voisins, formant, dans les familles naturelles de Latreille, la division des Scarabees Melitophiles. Paris. 410 p.

Nakane, T. 1953. The male genitalia and their taxonomic importance in the japanese Lepturinae. (Coleop. Cerambycidae), Sci. Reps. Saikyo. Univ. Kyoto (Nat. Sci.) 1:189-192.

Sharp, D., and F. Muir. 1912. The comparative anatomy of the male genital tube in Coleoptera. Trans. Entomol. Soc. London 1912: 477-642.

Snodgrass, R. E. 1957. A revised interpretation of the exterior reproductive organs of male insects. Smithsonian Misc. Coll. Washington 135 (6): 1-66.

Tanner, V. M. 1927. A preliminary study of the genitalia of female Coleoptera. Trans. Amer. Entomol. Soc. 53: 5-50.

Watson, W. Y. 1956. A study of the phylogeny of the genera of the tribe Coccinellini. (Coleop.), Contr. Roy. Ont. Mus. Toronto (Zool) 42: 1-52.

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