66–10,165

ARRINGTON, Jr., Richard, 1934–
COMPARATIVE MORPHOLOGY OF SOME
DRYOPOID BEETLES.

The University of Oklahoma, Ph.D., 1966
Zoology

University Microfilms, Inc., Ann Arbor, Michigan

THE UNIVERSITY OF OKLAHOMA
GRADUATE COLLEGE

COMPARATIVE MORPHOLOGY OF SOME DRYOPOID BEETLES

A DISSERTATION
SUBMITTED TO THE GRADUATE FACULTY
in partial fulfillment of the requirements for the
degree of
DOCTOR OF PHILOSOPHY

BY
RICHARD ARRINGTON, JR.
Norman, Oklahoma
1966

COMPARATIVE MORPHOLOGY OF SOME DRYOPOID BEETLES

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DISSERTATION COMMITTEE

ACKNOWLEDGEMENTS

I wish to express sincere appreciation to Dr. H.P. Brown, my major professor, for his vital contributions to my education and this research. He made many facilities of his personal library and laboratory available to me. My research could not have been done without his guidance and facilities.

I thank the other members of my dissertation committee, Dr. H.P. Clemens, Dr. M.E. Kraynak, and Dr. J.T. Self, for their helpful criticisms of this paper.

The many kindnesses of Mrs. Eilene Belden who assisted in obtaining needed supplies are much appreciated.

Finally, I must thank my wife and children for suffering many inconveniences which made it possible for me to complete this work.

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COMPARATIVE MORPHOLOGY OF SOME DRYOPOID BEETLES

CHAPTER I

INTRODUCTION

The need for basic information concerning both the external and internal morphology of the dryopoid beetles was first mentioned by Hinton (1939b). Noting the need for this knowledge in attempting to classify the beetles of the superfamily Dryopoidea, Hinton wrote:

> The choice of the characters which are used today in analysing the degrees of relationship in classifications which purport to be genuinely phylogenetic appears to be governed largely, if not entirely, by the ease with which they may be examined. Thus it is, that in the classification of various groups, particularly those of sub-ordinal rank, it is the rare exception and not the rule to find any mention whatever of internal characters. It is my belief that no genuinely scientific system can be evolved on the basis of an arbitrarily selected set of readily available external characters.

Again, on the subject of the use of internal anatomy in classification, Hinton (1940b) wrote:

> It is only necessary here to point out that without the use of such characters it is much more difficult and in many cases impossible, to build a system of classification which gives even an approximate picture of the phylogeny of the groups involved.

As a result of the use of internal structures for taxonomy by Hinton the concept of some generic limits has been modified. In addition, the study of internal morphology has in some cases necessitated a careful re-examination of external characteristics.

Aside from Hinton's work, little on the internal morphology of the Dryopoidea has been reported. In the relatively few other cases where internal morphology has been used for taxonomy, the use has been restricted to a description of the male genitalia. However, most investigators have used no internal character of any sort. Undoubtedly, much of the uncertainty which exists in dryopoid systematics, though by no means all, could be resolved by a better knowledge of the complete morphology of the adult and immature stages of these beetles.

With this in mind, I have undertaken to describe and compare the internal and external morphology of the adults of 33 species belonging to 16 genera and 4 families of the Dryopoidea, including 12 new species. I make no claim that my investigation solves the problems of phylogeny within the Dryopoidea. I have not examined immature stages, though a knowledge of the immature stages has an unquestionable value in establishing phylogenetic relationships in Coleoptera. The task of establishing these relationships is an enormous one, which will require thorough investigations by several workers. The purpose of my work is to make a contribution towards the solution of the relationships within the Dryopoidea by studying the morphology of representatives from the four major families.

In choosing the morphological characters to be examined in this investigation, I have tried to include those characters which appear to be of importance in the present system of taxonomy. In giving rather detailed descriptions of characters usually left undescribed by the taxonomist, I have included characters which I assume may be of value in making comparisons with new species which may be described, avoiding, I hope, the necessity of the re-examination and the revision of characters each time a new species may be described.

Review of the Literature

As stated above, very little work has been done on the morphology of beetles of the superfamily Dryopoidea. Dufour's early work (1838) dealing with anatomical research on *Macronychus*, *Stenelmis*, and *Elmis* is one of the first investigations of a morphological nature which involved both internal and external characters in the Dryopoidea. This work is briefly discussed in the part of the text dealing with *Macronychus*.

The publications of the British entomologist, H. E. Hinton, provide the major descriptions of internal morphology. Two of Hinton's papers have been particularly useful in this investigation and laid many of the guidelines followed here. Hinton (1939b) published a work dealing with natural classification of Dryopoidea based partly on their internal anatomy. This amply demonstrated how internal characters could be used in conjunction with external morphology. Hinton's monographic revision of the Mexican elmids (1940b) provides many useful descriptions of their morphology. In addition, most of Hinton's papers since 1938 have included some description of internal as well as external morphology.

Most taxonomic papers include some external morphology, and some have descriptions of male genitalia. They are too numerous for discussion here, but are amply discussed in the text of this work.

Two papers of Sanderson's should also be mentioned here. Sanderson (1938) in his monographic revision of Stenelmis, gives a detailed description of external morphology and male genitalia within that genus and presents a good historical review of the Dryopoidea. Also in his revision of the nearctic Elmidae, Sanderson (1953) provides useful descriptions of external morphological characteristics and a discussion on phylogenetic relationships.

The works singled out above are of obvious importance to any morphological study on dryopoid beetles. But it should be equally apparent that much work remains to be done on the morphology of this group of Coleoptera.

CHAPTER II

MATERIALS AND METHODS

All of the specimens which have been examined in this investigation are from the dryopoid collection of Dr. H. P. Brown of the University of Oklahoma. The specimens were preserved in a solution of 80 per cent ethanol. The collection dates and sites for the respective specimens are included in the text.

For the study of the internal morphology, intact specimens and dissected parts of specimens were examined with the aid of a binocular dissecting microscope and a compound microscope.

In order to make dissections for studying the internal morphology, each specimen was first partially embedded in beeswax. Dissection trays were made by pouring melted beeswax into deep well slides and syracuse watch-glasses and allowing the wax to solidify. A metal spatula, heated in a flame, was used to melt the wax at the point where the specimen was to be embedded. Each specimen was embedded in such a manner that the dorsal surface was left exposed. All dissections were made under water, beginning from the dorsal side by first removing the elytra. The desired structures were removed and placed in labelled vials containing 80 per cent ethanol or permanently mounted on properly labelled slides for study and preservation. In the case of the male genitalia, the structure was either placed in a drop of glycerine for detailed examination under the microscope or permanently mounted on a glass slide in Down's one-step clearing-mounting medium (Barr, 1960).

A camera lucida was used to aid in outlining some of the illustrations. The scale for each illustration represents 0.2 mm.

Dissection tools used here were fashioned from insect pins, microneedles and conchoidal chips of razor blades.

CHAPTER III

RESULTS

Dryopidae (Erichson, 1847)

The history of the taxonomy of the family Dryopidae has been marked by constant changes in the taxa beginning at the family level. The history of the family up to 1938 is reviewed by Sanderson (1938). Since 1938, considerable revisions have occurred in the family Dryopidae and only an exhaustive study of the literature will serve to detail all changes. The major change in this family has resulted from the elevation of the Elminae, formerly a sub-family, to the family level. Presently three genera, Helichus, Dryops, and Pelonomus are known in the United States.

Arnett (1963, p. 471 - 472) includes the following characteristics in his description of the Dryopidae. The body is elongate, oval and convex; 1 - 8 mm long; head deflexed and inserted into the prothorax; antennae 11-segmented (may vary from 8 - 11), clavate, with the second segment ear-like; mandibles curved and denticulate; lacinia acute, internally setiferous, galea lobate and apically tufted; maxillary palpi 4-segmented, labial palpi 3-segmented.

The pronotum is larger than the head, ovate, with laterally arcuate border and broadly emarginate anteriorly; mesocoxal cavities closed behind. The anterior and middle coxae are small, separate, and rounded, while the hind coxae are transverse. Tarsi are filiform with a tarsal formula of 5:5:5, claws are simple and relatively long. There are five visible abdominal sternites.

Hinton (1939b) has called for the use of internal and external characteristics of larvae and adults in characterizing the family. Included in his description are the following: female genitalia without styli; midgut densely set with projecting regenerative crypts, anterior margins never with ceca; six Malpighian tubules always present.

In this investigation the morphology of 8 species belonging to two genera of the Dryopidae is described.

Helichus (Erichson, 1847)

In the early literature the genus Helichus was described under the generic names of Dryops and Parnus. Musgrave (1935) has given an account of the use of the names Dryops and Parnus for Helichus. The following brief discussion is based on his description.

Erichson established the genus Helichus in 1847. For more than 100 years Helichus was confused with Dryops Olivier (Parnus Fabricius). Erichson, in his description of Helichus, which was included in a key to the Dryopini, attempted to separate the two genera on approximate or distant hind coxae. This was an error which was first noted by Sharp who pointed out that the hind coxae are distant in both genera. Sharp placed both in *Dryops* Leach and made *Helichus* a synonym. According to Musgrave;

> The *Dryops* of Leach is the *Helichus* of Erichson and cannot be used because the name was previously used by Olivier. This fact validates *Helichus* Erichson, although the name did not appear until 1847.

Specimens belonging to five species of *Helichus* have been examined. These five species and the collection localities are as follows:

Helichus sp. A (new) - Rio Tula, Mexico (October, 1964). Ten specimens examined, 8 dissected.

H. suturalis - Ocotoxco, Tlaxcala, Mexico (November, 1964). Fourteen specimens examined, 6 dissected.

H. lithophilus - Fairhaven, Ohio (September, 1964). Twelve specimens examined, 5 dissected.

H. basalis - Fairhaven, Ohio (September, 1964). Ten specimens examined, 6 dissected.

Helichus sp. B - Rio Apomila, Mexico (November, 1964). Ten specimens examined, 5 dissected.

External Morphology

The general external characteristics listed below, with minor modifications, are the same as those established for the genus by Erichson (Musgrave, 1935). They are:

1) The form is elongate and compact, tapering posteriorly

to become convex or nearly so.

2) The head is retractile and can be completely withdrawn into the prothorax.

3) The antennae form a pectinate or laminate club beyond the second or third segment; the basal segment is always conical towards the apex and the second segment is expanded and relatively large and ear-shaped.

4) The maxillary palpi are four-segmented, with the terminal segment equalling or slightly exceeding the combined lengths of the other three segments.

5) Labial palpi are short and three-segmented, with the terminal segment equalling the combined lengths of the other two segments; the gula is quadrate with distinct sutures; mentum is transverse and laterally lobed.

6) Mandibles are strong and possess three apical teeth.

7) The prothorax is convex with prominent lateral apical angles.

8) The prosternum possesses a posteriorly-projecting broad process which separates the front coxae and fits into a matching groove in the mesosternum.

9) Tarsi are five-segmented, the terminal segment nearly the combined lengths of the preceding four.

<u>Helichus sp. A (new)</u>. This species, which closely resembles the description given for <u>H</u>. <u>immsi</u> (Hinton, 1937) is 7 - 8 mm long and 2.3 - 2.6 mm across the elytral humeri. The body is densely pubescent dorsally and ventrally, with

hairs at the antero-lateral edges of the prothorax longer and denser than elsewhere on the dorsal body area.

As is the case with all of the species examined here, the head has no visibly distinct impressions, as reported by Hinton (1937) to be present in H. immsi. The antenna is 10-segmented (Fig. 1). The anterior margin of the clypeus is arcuate and smooth, and the labrum is feebly rounded at the ventro-lateral margins and feebly emarginate at the mid-ventral margin (Fig. 6). The ventral margin is fringed with hair and the surface appears granulated. The galea and the lacinia each have a terminal fringe of spinose hairs (Fig. 11). Each mandible possesses a well-defined membraneous prostheca and three apical teeth. The molar region of the mandible is concave (Fig. 13). The labium is as figured (Fig. 18).

The convex pronotum is punctate with punctures separated by 3 - 4 times their diameters (Fig. 23). The prosternum (Fig. 27) is slightly longer than broad (1.7 mm to 1.6 mm). The apical margin is deeply emarginate on each side where it receives the prothoracic legs. The prosternal process is truncate at its apex.

The meso-metasternum (Fig. 32) is deeply grooved between the bases of the middle coxae to receive the prosternal process. The antero-lateral edges are raised to produce sinuses. On each side of the mesosternal groove the lateral margins are darkened and feebly raised.

There is a well-defined median longitudinal line beginning at the base of the prosternal groove and extending the length of the metasternum to the antecoxal process. A feeble notch occurs in the median line of the antecoxal process just between the hind coxae. This notch receives the anteriorly-projecting abdominal process.

The densely pubescent elytra are approximately three times as long as the prothorax, gradually widening to the widest point at the apical third. The base of each elytron (Fig. 34) is feebly arcuate, crenate, and notched in the antero-medial margin where the elytra meet and join the scutellum.

Only the first two striae of each elytron are visible. These striae extend from the base to 4/5 the length of the elytron.

The abdominal sternites are equally pubescent and the apical margin of the fifth sternite appears truncate from a ventral view (Fig 39).

The tibia of each leg is characterized by a fringed tomentum extending from the upper third to the lateral apex and appearing to arise from a very shallow concave channel. The outer margin of the tibia is noticeably crenate and the apex is greatly expanded (Fig. 44).

There is a fringe of tomentum on the inside of the femur of the middle leg which is not found on the femur of the front and hind legs.

Externally, males and females are indistinguishable.

Helichus suturalis. *H. suturalis* is 5 mm long and 2 mm wide across the elytral humeri. The body is not uniformly pubescent, there being less pubescence on the fifth abdominal sternite and in the area of the elytral sutures than on the remainder of the body. The reduced pubescence in the sutural area is set off as a distinct vitta in this area.

The antenna (Fig. 2) bears 8 segments. Hinton (1939b) reports that the number of antennal segments varies from 7 to 8 in this species. The anterior margin of the clypeus, in addition to being arcuate, is also dentiform. The labrum of *H. suturalis* lacks the granulated appearance seen in that of *Helichus* sp. A (Fig. 7). The ventral margin of the labrum is very feebly emarginate but the emargination is accentuated by the emargination in the fringe of hair of the ventral margin. The structure of the maxilla (Fig. 12) is rather like that of *Helichus* sp. A except for the difference in size and a very small difference in the galea.

The labium of *H. suturalis* can be distinguished from that of *Helichus* sp. A on the basis of the lateral lobe of the mentum. In *H. suturalis* the lateral lobes are narrower and more expanded. The apical margin is even in *H. suturalis* but indented in *Helichus* sp. A (Figs. 18 - 19).

The mandibles (Fig. 14) of H. suturalis are morphologically similar to those of Helichus sp. A. The same is true of the pronotum (Fig. 23) except for the absence of the long hairs at the antero-lateral edges. The lateral lobes of the prosternal angles, where they receive the prothoracic legs, are shallow compared with Helichus sp. A (Fig. 28). The lateral margins of the prosternal process are feebly dilated at the base.

The mesosternum and metasternum are shown in Figure 33.

The elytra bear a distinct sutural area which has been referred to above. Each elytron bears seven visible striae. The punctures of the striae are enclosed by irregular rectangular cells (Fig. 35). In other respects the description given for the elytra of Helichus sp. A serves well for the elytra of H. suturalis.

The fifth abdominal sternite, which is less pubescent than the others, is arcuate, and bears a median notch on its posterior margin for receiving the tips of the elytra.

The description of the legs of Helichus sp. A is suitable for H. suturalis with the following exceptions: 1) the expansion of the distal ends of the tibiae is much less conspicuous, and 2) the legs of H. suturalis are, of course, smaller.

The male may be separated from the female on the basis of four external secondary sexual characteristics. The first three of these were first described by Hinton (1937a). They are as follows: 1) A group of approximately fifty fine, pale, testaceous hairs, approximately .25 mm long, on each side of the prosternum in front of the front coxae; 2) a similar group of hairs on each side of the metasternal disk between the middle and hind coxae; and 3) the longest spur of the middle tibia is bent inward at a right angle. A fourth male secondary sexual characteristic which I have observed, is a group of hairs, similar to those described above, on each side of the anterior margin of the clypeus. These hairs extend out and downward in a "whisker-like" fashion.

Helichus lithophilus. This species is 4.5 - 5 mm long and 2 mm wide across the elytral humeri. The body is covered by short uniform pubescence.

The antenna (Fig. 3) is 11-segmented. The anterior of the clypeus is arcuate and even. The labrum is broadly arcuate and without an emargination in the ventral margin (Fig. 8). The maxilla is as in H. suturalis except that the cardo is notched in the apical margin. The mandible of H. lithophilus is basically like that of H. suturalis, but shows minor variations from H. suturalis at its base and in the basalis (Fig. 15). The labium (Fig. 20) is similar to that of Helichus sp. A.

The pronotum and prosternum are illustrated in

Figures 24 and 29.

The elytron is more than twice the length of the prosternum, with seven visible striae. Each puncture of the striae is enclosed by a round or oblong cell (Fig. 36).

The fifth abdominal sternite is notched as in H. suturalis and may be truncate or convex.

The legs of H. lithophilus are like those of H. sp. A except that the tibiae are not expanded distally and the tomentum on the inside of the middle femur is reduced to a few separate hairs.

Hinton (1937) has described the same three secondary sexual characteristics for H. lithophilus as for H. suturalis. The fourth characteristic which I noted for H. suturalis, the presence of "whisker-like hairs", I find also present in H. lithophilus. In addition, I find it quite easy to distinguish the sexes of H. lithophilus on the shape of the fifth abdominal sternite. In males of the species the sternite is truncate at its apical margin, but is convex in females (Fig. 41).

Helichus basalis. H. basalis is 5 - 5.5 mm long and 2 mm wide across the elytral humeri. Except in the area of the elytral suture the body is uniformly pubescent. The sutural area of the elytra forms a distinct vitta (Fig. 37).

The antenna is 11-segmented (Fig. 4). The anterior margin of the clypeus is arcuate and even. The maxilla is like that of H. suturalis. The labium and mandibles are shown in Figures 9 and 15.

The pronotum (Fig. 25) provides a readily distinguishable characteristic for H. basalis. It is raised in the form of a transverse ridge in the middle, resulting in its anterior and posterior halves being depressed. The depressed region in front of the scutellum is glabrous. The prosternum (Fig. 30) and the meso-metasternum are as in H. suturalis.

Each elytron has very shallow strial punctures at its base, the punctures being slightly deeper posteriorly. Each puncture is enclosed by a rounded cell (Fig. 37).

The abdominal sternites are equally pubescent. The fifth abdominal sternite may be truncate or rounded (Fig. 42).

Legs are as in H. lithophilus.

The fifth abdominal sternite of the male is truncate and that of the female is broadly convex (Fig. 42). This characteristic can readily be used for determining the sex of specimens of this species.

Helichus sp. B. Helichus sp. B is 3.5 - 4 mm long and 1.5 mm across the elytral humeri. The elytral striae are quite distinct as are the cells enclosing each strial puncture. All striae begin at the base of the elytra and extend to near the apex (Fig. 38).

The body is uniformly but sparsely pubescent. The antenna is eight-segmented (Fig. 5). The anterior margin of the clypeus is arcuate and weakly dentiform. Mouthparts are shown in Figures 10, 16, and 22.

The pronotum has crenate lateral edges (Fig. 26). The prosternal process (Fig. 31) is short and convex.

The elytra (Fig. 38) are discussed above.

The abdominal sternites are illustrated in Figure 43. The four male secondary sexual characteristics noted for _H. suturalis_ apply to this species.

The venation of the hind wing is similar in all species of _Helichus_ which were examined. The hind wing of _Helichus_ sp. A is shown in Figure 50. The naming of the veins is based on the Forbes system of nomenclature (Forbes, 1922). According to Segal (1933), the hind wing of _Helichus_ represents the most primitive type of the Dryopidae, since it is the most fully developed wing of the family. He describes a fully developed wing as being elongate and rounded at the apex, with two distinct areas. The proximal 2/3 of the wing is venated and the remainder is clear and transparent. These two areas are set off by a constriction on the costal margin and an incision on the outer margin. Segal suggested that the irregular dark spots in the clear apical area of the wing represent traces of lost veins.

Differences and similarities in the scutelli of the five species can best be seen by comparing the illustrations in Figures 45 - 49. It can be seen that the scutelli differ in the shape of the apical or raised triangular portion which is visible between the bases of the elytra of an intact specimen. The expanded lateral edge of the triangular piece is slightly rounded in Helichus sp. A as opposed to the pointed condition in H. basalis. The lateral edges of the other species are rounded as in Helichus sp. A.

Internal Morphology

Alimentary Canal (Fig. 51). The alimentary canals of the five species examined show no significant differences. The most conspicuous part of the alimentary canal is the midgut, which has its outer surface covered with dense crypts. The narrow pharynx empties into a broader esophagus. The posterior end of the esophagus is invaginated into the midgut to form the cardiac valve. The anterior margin of the midgut is without ceca.

The approximate length of the alimentary canal for each species is as follows: Helichus sp. A, 7 mm; H. suturalis, 4.5 mm; H. lithophilus, 5 mm; and Helichus sp. B, 3.4 mm.

The hindgut of Helichus sp. A and H. lithophilus is three times as long as the midgut. In the other three species the hindgut is longer than the midgut but not by more than a third the length of the midgut. In all species the hindgut is looped in the abdominal region.

Hinton (1939b) reports that all Dryopidae have six Malpighian tubules. I have found this to be the correct number for Helichus sp. A and H. basalis. In the other three species the condition of the tubules made it impossible to determine the exact number of tubules present. The tubules originate at the junction of the midgut and hindgut. The distal ends are embedded in the walls of the hindgut.

Central Nervous System (Fig. 52). The central nervous systems of the five species are alike (Fig. 52). The bilobed brain rests above the pharynx just anterior to the esophagus. It is joined to the ventral nerve cord by a pair of connectives, one on each side of the esophagus. Just beneath the esophagus, anterior to the sub-esophageal ganglion, the cord is anchored to the ventral body wall by a sclerite. The large thoracic ganglia are three in number (I, II, III), each distinctly located in one of the three thoracic segments. There are eight abdominal ganglia. The first five of these are distinctly separate from one another. The last three are fused but can be distinguished by the lines of fusion.

Male Reproductive system (Figs. 53 - 65). A general statement on the morphology of the male reproductive system, exclusive of the penis, will serve for all five of the species. The paired testes contain 6 sperm tubes each, and are covered by a thin sheath. All sperm tubes empty directly into the vas deferens. The vasa deferentia lead from the testes and enter the ejaculatory duct dorsally, at its anterior end, quite close to the region where the bases of the median lateral accessory glands come together.

The largest, and hence the most conspicuous structures, are the paired median lateral accessory glands. These glands have their distal ends enlarged and lobular. The paired lateral accessory glands are oblong, pliable sac-like structures which are nearly transparent and enter the ejaculatory duct at the same level as the median lateral accessory glands. Due to its pliable nature the lateral accessory gland is often folded, wrinkled, or even shriveled in appearance. When extended, it usually reaches to or beyond the distal ends of the ejaculatory duct.

The long ejaculatory duct is enlarged into a pouch-like structure before entering the penis.

The greatest variation in the male reproductive system is to be found in the male genitalia. The genitalia of <u>Helichus</u> sp. A are illustrated in Figures 58 -60. They are easily distinguishable from those of the other species, on the basis of relative width (2 - 3 times greater than in the other species), and the fact that the median lobe of the penis extends to the apices of the lateral lobes.

Figures 61 - 65 illustrate the genitalia of the other four species. From these figures the genitalia of these species can be separated on the basis of the shape of the lateral lobe, the length of the median lobe in relation to the apex of the lateral lobe, and the shape of the basal lobe, particularly at its base and its junction to the lateral lobes.

The supporting penial spicule of H. lithophilus is shown in Figure 62. The spicules of the other species are similar in morphology and the species cannot be distinguished on this basis.

Female Reproductive System (Figs. 66 - 77). In all of the female specimens I have examined, the ovaries were so distorted by eggs, that the shape of the ovary and the number of egg tubes in each could not be determined. The mass of eggs is often so great that they occupy the greater part of the abdominal cavity. The eggs number as high as 35 per female, but more often were 20 - 24 in number. Some investigators have found the eggs to be helpful in separating some species of this family. For this reason I have illustrated the eggs of all five species in Figure 68. The eggs of all five species are smooth. In Helichus sp. A the eggs are larger than those of the other species, due mainly to their wider short axis. On the other hand, the egg of H. basalis is distinguishable by its relatively greater length. The egg of Helichus sp. B is by far the smallest of the eggs. Eggs of H. suturalis and H. lithophilus are similar in shape and size. A small light rounded area is visible on the egg of H. suturalis, but is not visible on the egg of H. lithophilus. Whether this structure, which may be a micropyle, is a constant distinguishing character between the two species is questionable.

The female genitalia (ovipositors) of Helichus sp. A are markedly different from those of the other four species (Figs. 66 and 67). The apical lobes are relatively short and the basal lobe is reduced to a small spicule.

The female genitalia of the remaining four species are superficially similar. The right apical lobe of the ovipositor is always longer than the left lobe and both lobes are curved ventrally (Figs. 69, 71, 74, and 76).

The shape of the basal lobe of the female genitalia is a useful criterion in identifying the species. The variation in the shape of the basal lobes in different species is best seen in dorsal views of the genitalia. These are illustrated in Figures 70, 72, 75, and 77.

PLATE I

Figure 1. _Helichus_ sp. A, antenna.

Figure 2. _Helichus_ _suturalis_, antenna.

Figure 3. _Helichus_ _lithophilus_, antenna.

Figure 4. _Helichus_ _basalis_, antenna.

Figure 5. _Helichus_ sp. B, antenna.

Figure 6. _Helichus_ sp. A, labrum

Figure 7. _Helichus_ _suturalis_, labrum.

Figure 8. _Helichus_ _lithophilus_, labrum.

Figure 9. _Helichus_ _basalis_, labrum.

Figure 10. _Helichus_ sp. B, labrum.

Figure 11. _Helichus_ sp. A, maxilla.

Figure 12. _Helichus_ _suturalis_, maxilla.

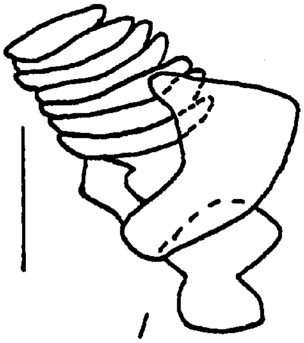
Figure 13. _Helichus_ sp. A, mandible.

Figure 14. _Helichus_ _suturalis_, mandible.

Figure 15. _Helichus_ _lithophilus_, mandible.

Figure 16. _Helichus_ _basalis_, mandible

Figure 17. _Helichus_ sp. B, mandible.



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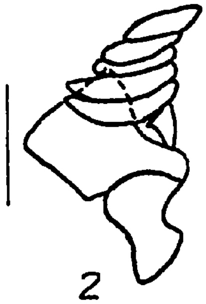

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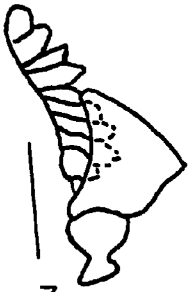

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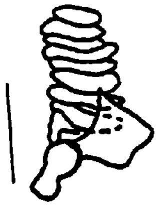

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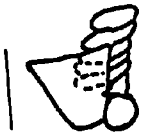

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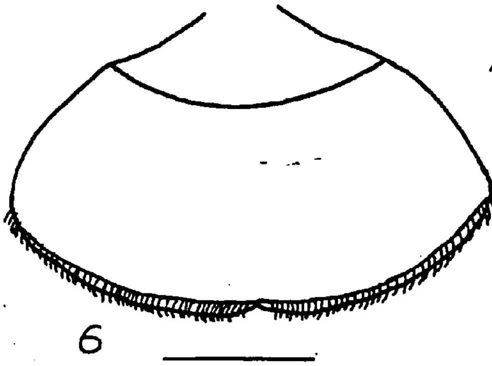

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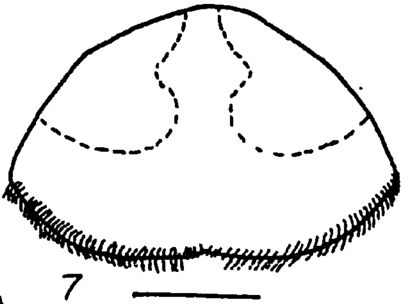

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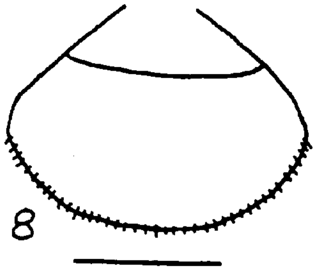

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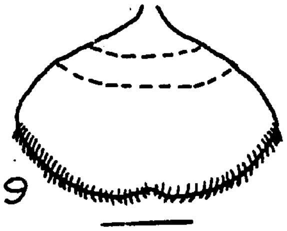

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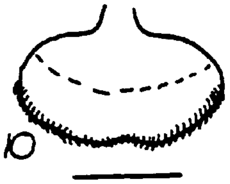

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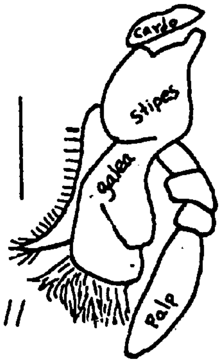

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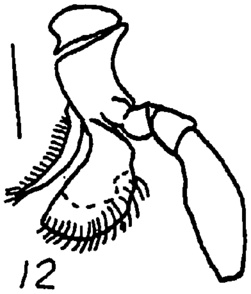

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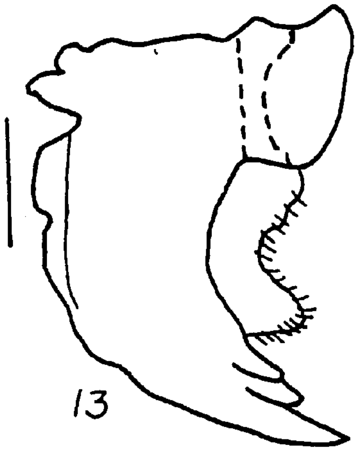

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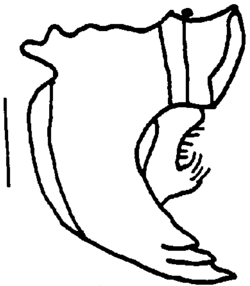

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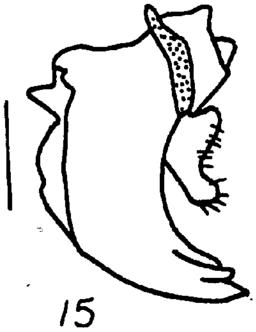

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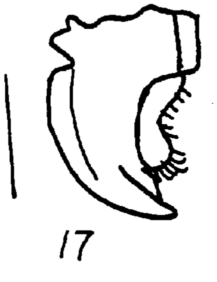

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PLATE II

Figure 18.—*Helichus* sp. A, labium.

Figure 19. *Helichus suturalis*, labium.

Figure 20. *Helichus lithophilus*, labium.

Figure 21. *Helichus basalis*, labium.

Figure 22. *Helichus* sp. B, labium.

Figure 23. *Helichus* sp. A, pronotum.

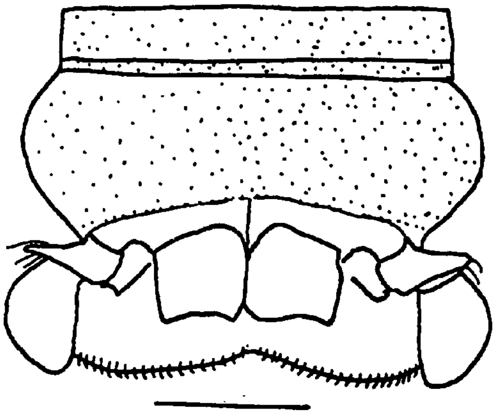
Figure 24. *Helichus lithophilus*, pronotum.

Figure 25. *Helichus basalis*, pronotum.

Figure 26. *Helichus* sp. B, pronotum.

Figure 27. *Helichus* sp. A, prosternum.

Figure 28. *Helichus suturalis*, prosternum.



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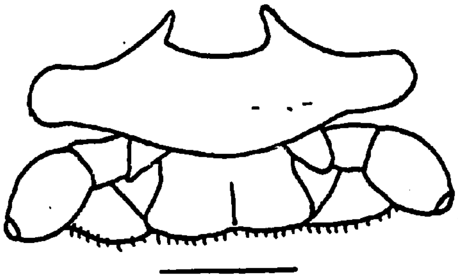

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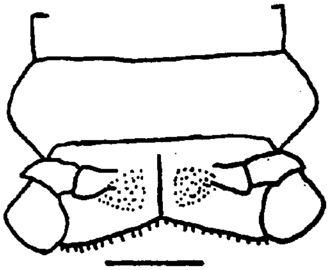

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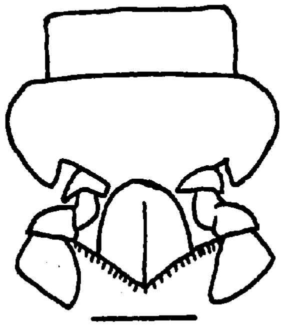

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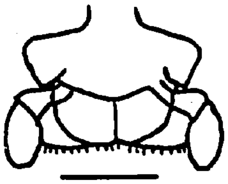

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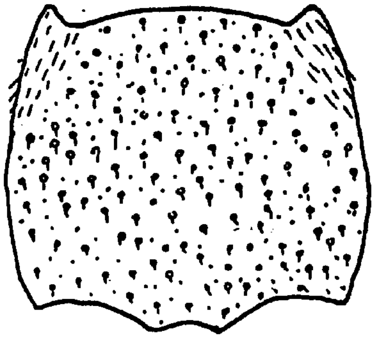

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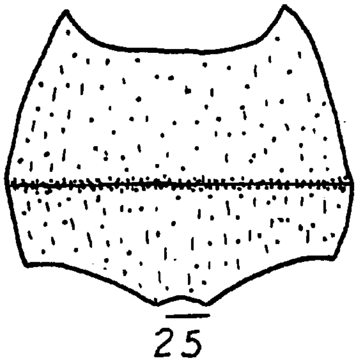

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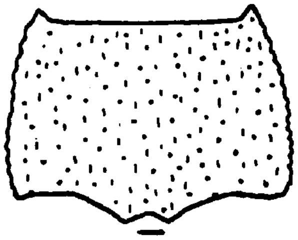

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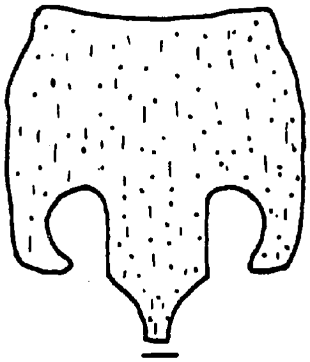

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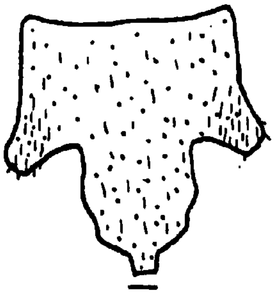

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PLATE III

Figure 29. *Helichus lithophilus*, prosternum.

Figure 30. *Helichus basalis*, prosternum.

Figure 31. *Helichus* sp. B, prosternum.

Figure 32. *Helichus* sp. A, meso-metasternum.

Figure 33. *Helichus suturalis*, meso-metasternum.

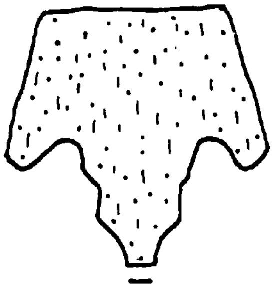
Figure 34. *Helichus* sp. A, elytron.

Figure 35. *Helichus suturalis*, elytron.

Figure 36. *Helichus lithophilus*, elytron.

Figure 37. *Helichus basalis*, elytron.

Figure 38. *Helichus* sp. B, elytron.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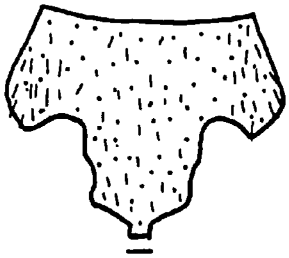
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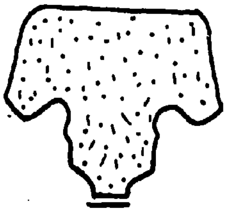
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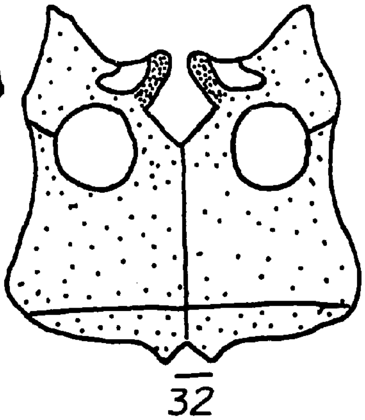
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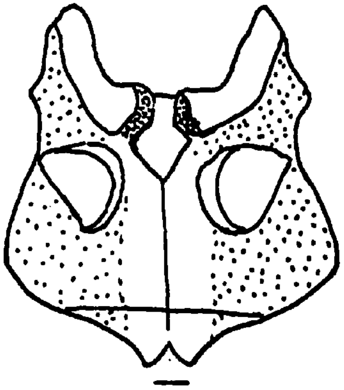
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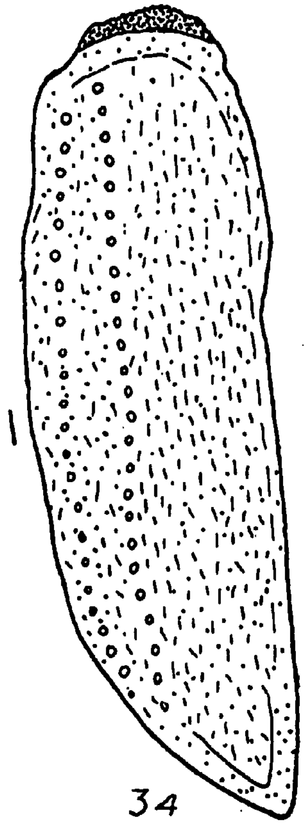
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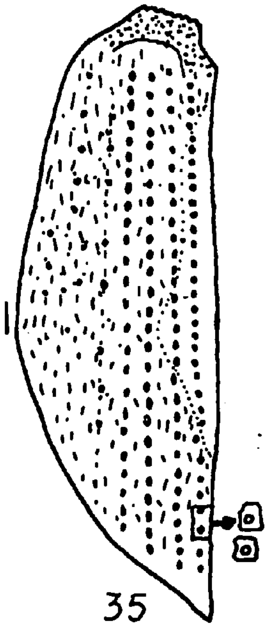
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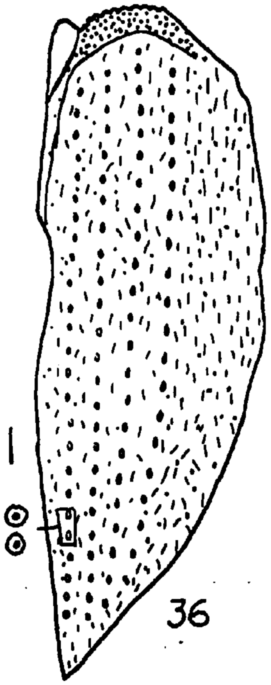
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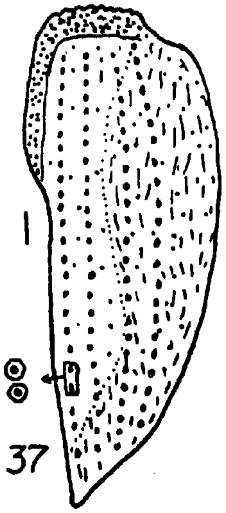
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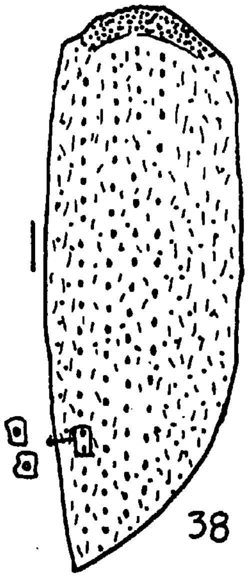
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PLATE IV

Figure 39. Helichus sp. A, abdomen.

Figure 40. Helichus suturalis, abdomen.

Figure 41. Helichus lithophilus, abdomen.

Figure 42. Helichus basalis, abdomen.

Figure 43. Helichus sp. B, abdomen.

Figure 44. Helichus sp. A.

A. Prothoracic leg.

B. Mesothoracic leg.

C. Metathoracic leg.

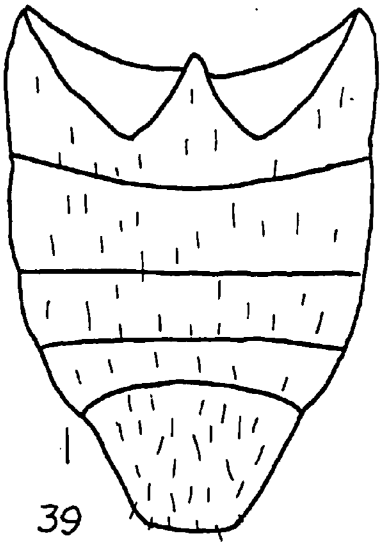
Figure 45. Helichus sp. A, scutellum (inverted).

Figure 46. Helichus suturalis, scutellum (inverted).

Figure 47. Helichus lithophilus, scutellum (inverted).

Figure 48. Helichus basalis, scutellum (inverted).

Figure 49. Helichus sp. B, scutellum (inverted)



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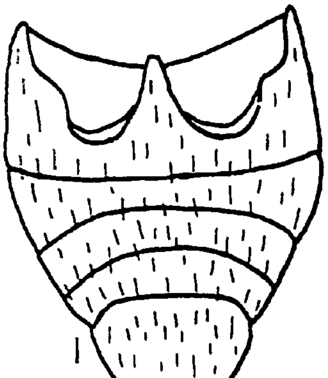

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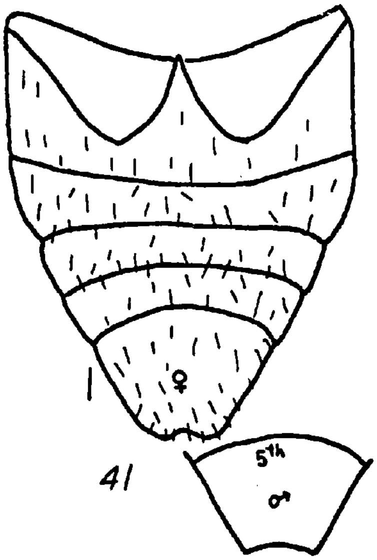

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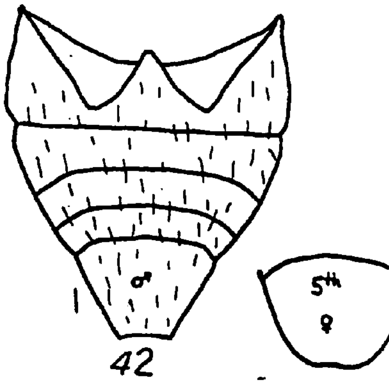

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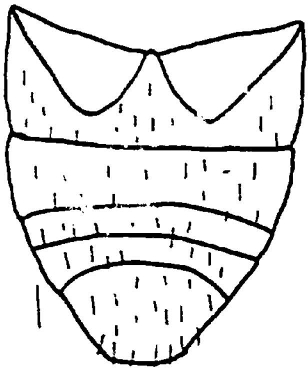

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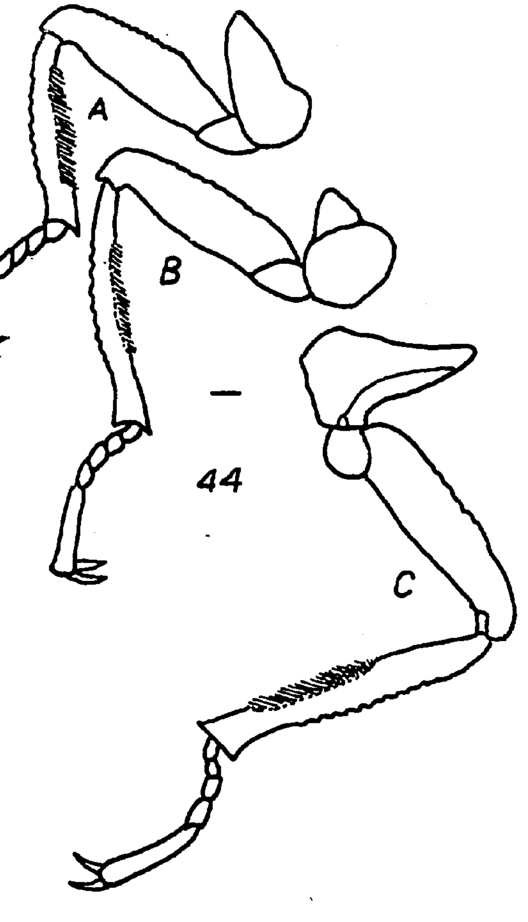

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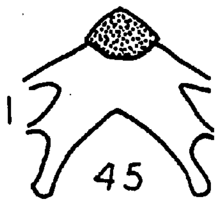

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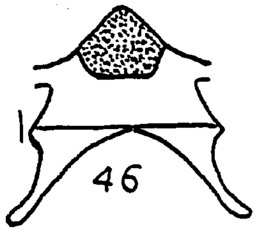

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PLATE V

Figure 50. Helichus sp. A, hind wing.

Figure 51. Helichus sp. A, alimentary canal.

Figure 52. Helichus sp. A, central nervous system.

Figure 53. Helichus sp. A, male reproductive system (ventral view).

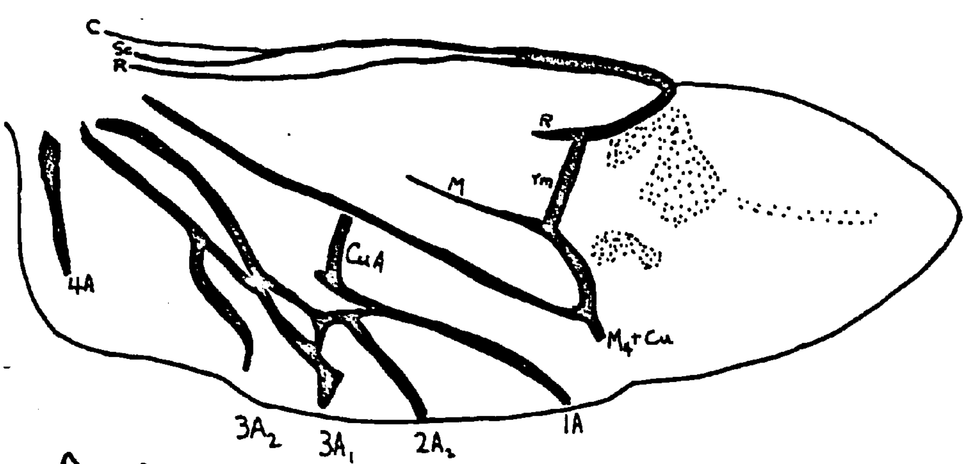
Figure 54. Helichus sp. A, male reproductive system (dorsal view).

Figure 55. Helichus suturalis, male reproductive system (venral view).

Figure 56. Helichus lithophilus, male reproductive system (ventral view).

Legend:

spt - sperm tube
vd - vas deferens
lac - lateral accessory gland
mlac - median lateral accessory gland
ejd - ejaculatory duct



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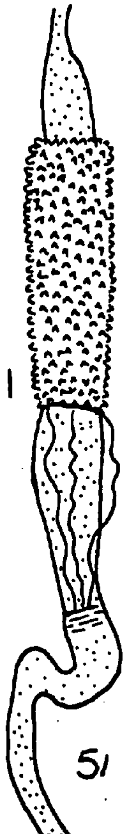

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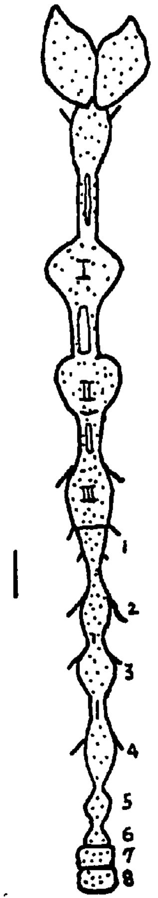

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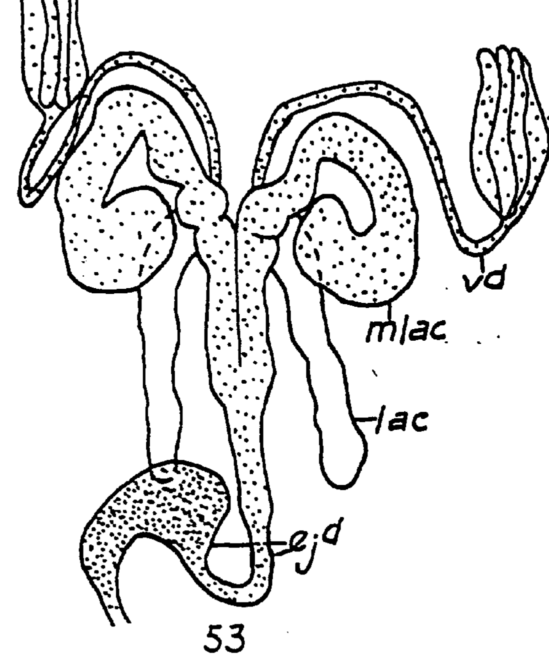

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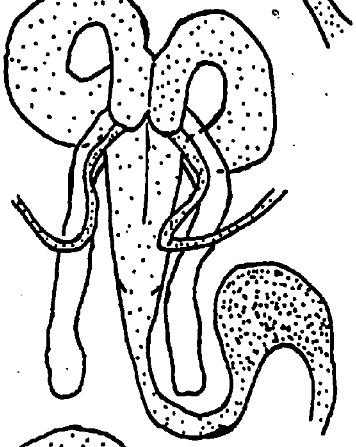

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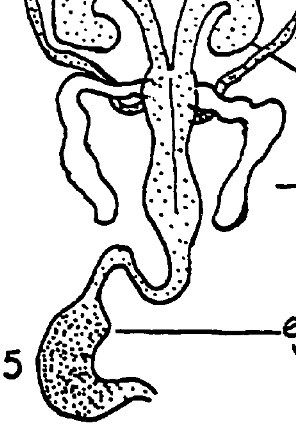

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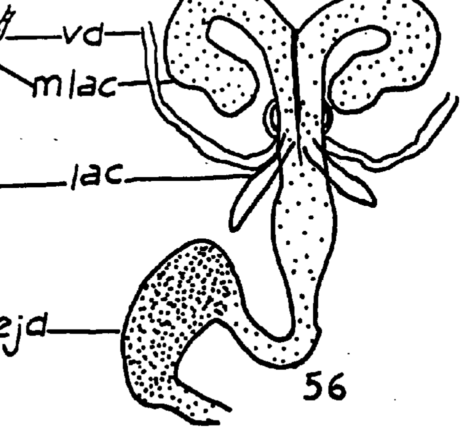

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PLATE VI

Figure 57. Helichus lithophilus, male reproductive system (ventral view).

Figure 58. Helichus sp. A, male genitalia (ventral view).

Figure 59. Helichus sp. A, male genitalia (dorsal view).

Figure 60. Helichus sp. A, male genitalia (lateral view).

Figure 61. Helichus suturalis, male genitalia.

a. Ventral view.

b. Dorsal view.

c. Lateral view.

Figure 62. Helichus lithophilus, male genitalia.

a. Ventral view.

b. Dorsal view.

c. Lateral view.

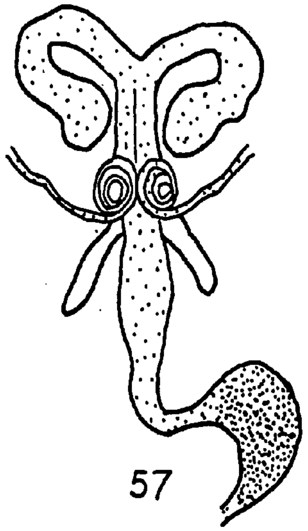
Figure 63. Helichus lithophilus, penial spicule.

Figure 64. Helichus basalis, male genitalia.

a. Ventral view.

b. Dorsal view.

c. Lateral view.



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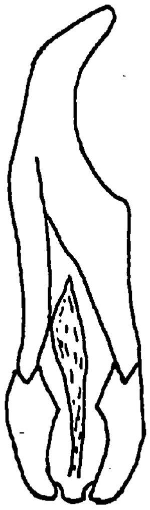

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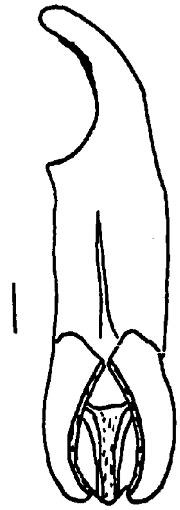

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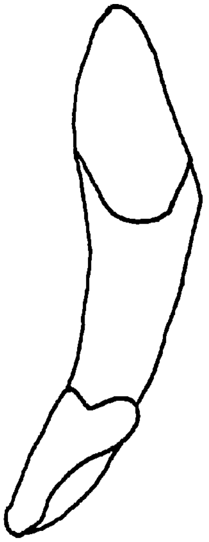

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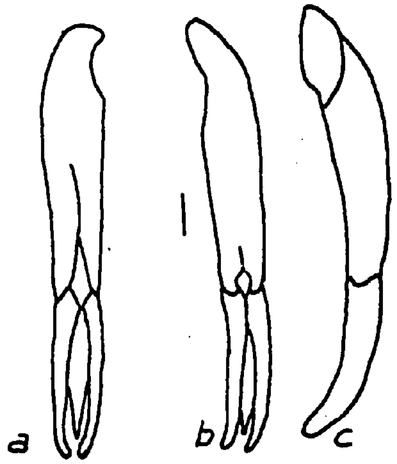

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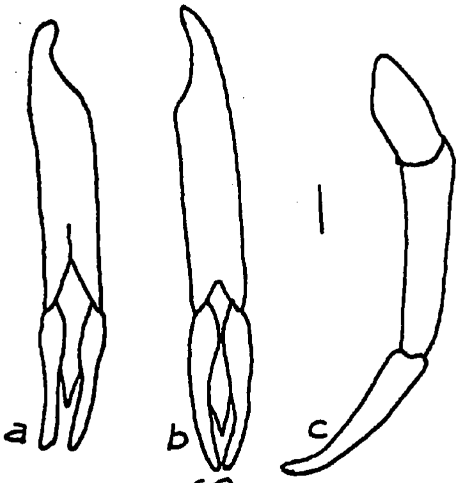

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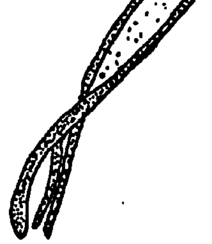

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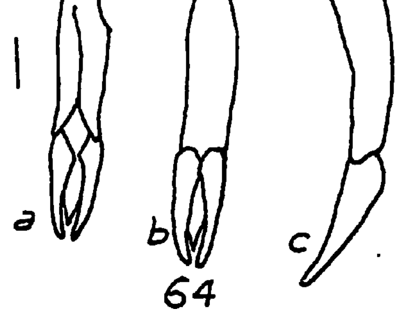

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PLATE VII

Figure 65. _Helichus_ sp. B, male genitalia.

a. Ventral view.

b. Dorsal view.

c. Lateral view.

Figure 66. _Helichus_ sp. A, female reproductive system.

Figure 67. _Helichus_ sp. A, ovipositor (lateral view).

Figure 68. _Helichus_, eggs.

a. _Helichus_ sp. A.

b. _Helichus suturalis_

c. _Helichus lithophilus_

d. _Helichus basalis_

e. _Helichus_ sp. B

Figure 69. _Helichus suturalis_, female reproductive system.

Figure 70. _Helichus suturalis_, ovipositor (dorsal view)..

Figure 71. _Helichus lithophilus_, female reproductive system).

Figure 72. _Helichus lithophilus_, ovipositor (dorsal view).

Figure 73. _Helichus lithophilus_, female spicule.

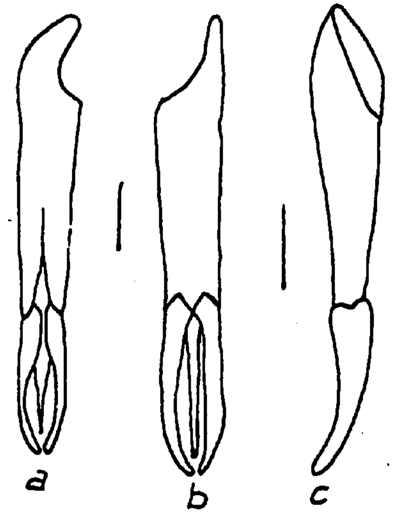
Legend:

bc - bursa copulatrix

sth - spermathecal gland

ovd - oviduct

acg - accessory gland



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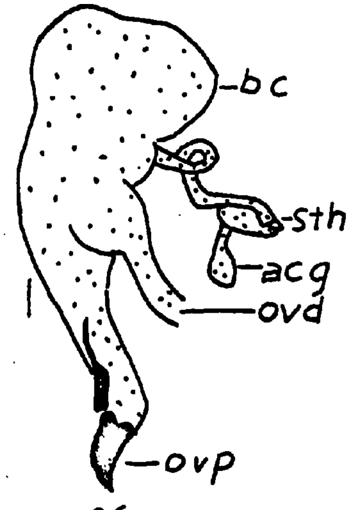

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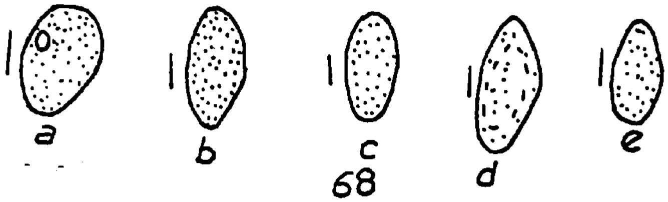

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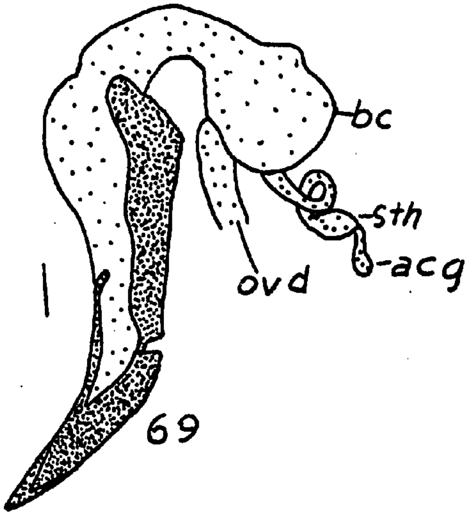

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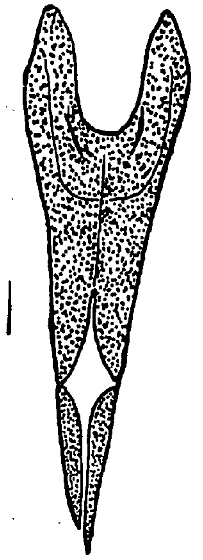

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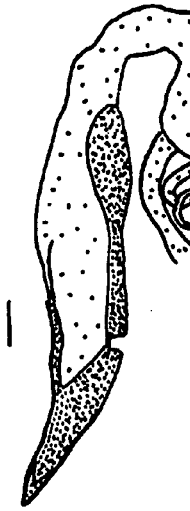

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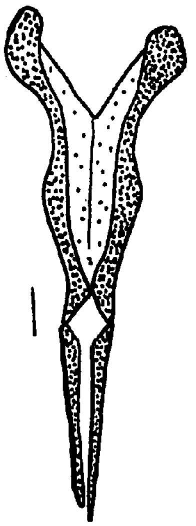

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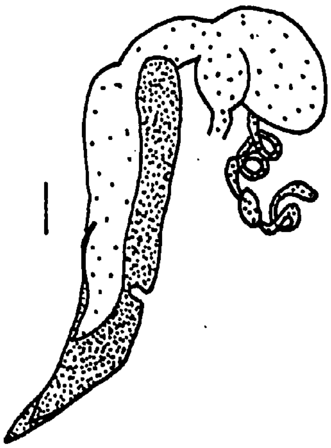
PLATE VIII

Figure 74. Helichus basalis, female reproductive system.

Figure 75. Helichus basalis, ovipositor (dorsal view).

Figure 76. Helichus sp. B, female reproductive system.

Figure 77. Helichus sp. B, ovipositor (dorsal view).



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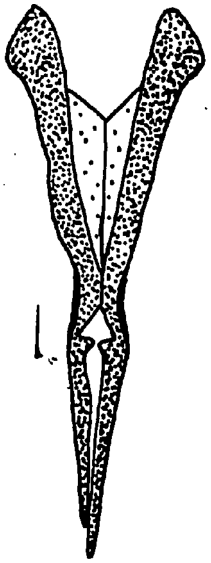

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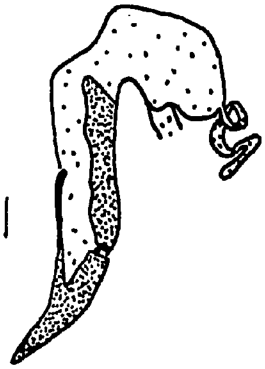

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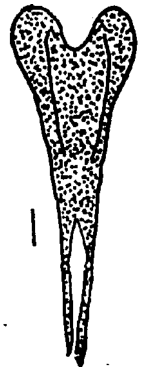

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Dryops (Olivier, 1791)

The history of this genus is reviewed by Sanderson (1938) and Musgrave (1935). The following brief historical account is taken from these two sources.

Dryops was first proposed by Olivier for a species which had been formerly placed in the family Dermestidae by Geoffroy. Many specimens now in Dryops were earlier placed in the genus Parnus, established in 1792 by Fabricius. In 1817 Leach placed Dryops and Parnus in the family Parnidae, after using the name Dryops for a form which rightfully belonged to the genus Helichus. According to Musgrave (1935), Dryops Olivier is the correct name for the genus and Parnus is a synonym of Dryops Olivier.

Four species of Dryops are described here:

Dryops sp. A - Rio Lageado, Brazil (June, 1964). Ten specimens examined, five dissected.

Dryops sp. B - Rio Urbina near Chiapas, Mexico (November, 1964). Nine specimens examined, five dissected.

Dryops sp. C - Rios Apomila, Zapotillo, and El Palmito, Sinaloa, Mexico (November, 1964). Ten specimens examined, three dissected.

Dryops arizonensis - Superior, Arizona (1948). Nine specimens examined, four dissected.

A review of the literature available to me dealing with the genus Dryops failed to reveal any species to which the above three unnamed species (A, B, C) might belong. Sharp (1882) described four species of Dryops (Parnus) from Mexico and South America. I find his descriptions quite brief and of little help in identifying these species. However, on the basis of the sizes given for the species described by Sharp, the species here do not belong to any of his four species. All of the species described here are larger than any species described by Sharp.

Hinton (1939b) figures the male and female reproductive systems of D. germaini. The male reproductive systems of all species examined here are distinctly different.

External Morphology

The general characteristics for Dryops are much the same as those for Helichus. The two genera are usually separated on the basis of the morphology of the pronotum and antennae. The pronotum has a sharp-edged longitudinal groove on each side which extends the length of the structure.

The three unnamed species of Dryops considered here closely resemble one another in nearly every external characteristic. Without the aid of dissection and internal morphology I am unable to separate these three species.

Of the three unnamed species, Dryops sp. A is the largest, measuring 4 - 4.3 mm long and 1.5 - 1.7 mm across the elytral humeri. Both of the species from Mexico have the same size ranges; 3.6 - 3.9 mm long and 1 - 1.3 mm across the elytral humeri. Dryops arizonensis has the same size range as Dryops sp. A. The entire dorsal surface of the body, including the head, is distinctly punctate and covered by dense long hairs, approximately 150 - 165 µ long. On the ventral surface of the body the punctae are finer and appear to be absent in some areas. The hairs on the ventral part of the body are, except for a few areas, much finer and sparser than the dorsal hairs. Long hairs of the type on the dorsal part of the body can be found ventrally only in the following areas: at the postero-lateral margins of the metasternum; on the lateral margins of the first two abdominal sternites, and across the entire width of the third, fourth, and fifth sternites. However, fewer hairs are present on the third sternite than on the fourth and fifth sternites.

The head is without any visible impressions and the antennae (Fig. 78) are 11-segmented. The second segment of the antenna is expanded into an ear-like process such as seen in Helichus. In these species of Dryops the third segment is more greatly produced than in the species of Helichus which were examined. The labrum is as figured (Fig. 79). The lacinia is acute and the galea lobate and tufted (Fig. 80).

The mandible provides one of the few external characteristics in which there is distinct variation among the species. The major differences in the mandibles are in the structure of the basalis and can be observed by comparing Figures 81 - 84. The labia are illustrated in Figures 85 and 86.

The strongly punctate pronotum is always broader than long (Fig. 87). The measurement of width to breadth of the pronotum for each species is as follows: Dryops sp. A, 1.44 mm : 1 mm; Dryops sp. B, 1.32 mm : .92 mm; Dryops sp. C, 1.32 mm : .88 mm; and *D. arizonensis*, 1.45 mm : 1 mm.

The prosternum (Fig. 88) is longer than broad. The structure of the meso-metasternum is shown in Figure 89.

The elytra (Fig. 90) with their strong punctations, are 2 - 3 times as long as broad. No striae are visible at magnification up to 100X. The scutellum (Fig. 91) is pentagonal.

There are five visible abdominal sternites (Fig. 92).

The femora of all legs (Fig. 93) are covered by long hairs on their outer surface and by finer hairs on their inner surface.

The venation of the hind wing is shown in Figure 94.

Males and females are externally similar.

Internal Morphology

Alimentary Canal (Fig. 95). The alimentary canals of the species of Dryops examined are of the same basic type seen in Helichus. The species of Dryops described here differ mainly in the length of the midgut relative to the remainder of the alimentary canal. The total length of the alimentary tract of each species is: Dryops sp. A, 4.5 mm; Dryops sp. B, and C, 3.4 mm each; and D. arizonensis, 4.2 mm. The midgut of Dryops sp A is 2 mm long, the hindgut 1.5 mm; in Dryops sp. B and C the same measurements are 2 mm and .9 mm and 1.5 mm and 1mm respectively. The measurements for the same structures in D. arizonensis correspond to those of Dryops sp. A. Six Malpighian tubules are present.

Central Nervous System (Figure 96). The central nervous system is similar to that of Helichus except that the line of fusion of abdominal ganglia 7 and 8 is not visible, giving the appearance of only 7 discrete abdominal ganglia.

Male Reproductive System (Figures 97 - 110). The male reproductive system provides an easy means for separation of the species of Dryops considered here. In all of the species, each testis contains six sperm tubes enclosed by a common sheath. All sperm tubes empty directly into the vas deferens.

The lateral paired accessory glands are relatively small, oblong, opaque structures. Variations which exist between the median lateral accessory glands of the species are best seen by comparing Figures 97 - 104.

The genitalia differ mainly in the morphology of the lateral and median lobes. Figures 105 - 107 and 109 - 110 show the genitalia of the four species.

The morphology of the supporting penial spicule is similar in all four species (Fig. 108).

Female Reproductive System (Figures 111 - 119). The female reproductive systems of all four species are similar in all respects except in the morphology of the ovipositor. The female reproductive system, exclusive of the ovipositor, compares well with that figured by Hinton (1939b) for *D. germaini*.

A study of the ovipositors of the four species shows them to be similar, with the left lateral lobe always shorter than the right lateral lobe. These ovipositors can be separated when viewed from a dorsal aspect. In dorsal view the morphology of the basal lateral lobes, whether fused completely (*Dryops* sp. A and *D. arizonensis*, Figs. 116 and 119), partially fused (*Dryops* sp. C, Fig. 115), or separate (*Dryops* sp. B, Fig. 112), can be determined and is useful in identifying the species.

PLATE IX

Figure 78. Dryops sp. B, antenna.

Figure 79. Dryops sp. B, labrum.

Figure 80. Dryops sp. B, maxilla.

Figure 81. Dryops sp. B, mandible.

Figure 82. Dryops sp. C, mandible

Figure 83. Dryops sp. A, mandible.

Figure 84. Dryops arizonensis, mandible.

Figure 85. Dryops sp. B, labium.

Figure 86. Dryops sp. C, labium.

Figure 87. Dryops sp. B, pronotum.

Figure 88. Dryops sp. B, prosternum.

Figure 89. Dryops sp. B, meso-metasternum.

Figure 90. Dryops sp. B, elytron.

a. Entire elytron of Dryops sp. B

b. Cells of elytra of Dryops arizonensis.

Figure 91. Dryops sp. B, scutellum.

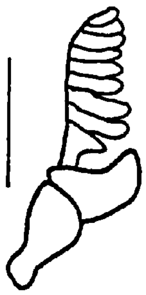
Figure 92. Dryops sp. B, abdomen.

Figure 93. Dryops sp. B, legs.

a. Prothoracic

b. Mesothoracic

c. Metathoracic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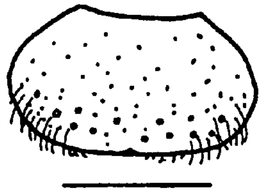
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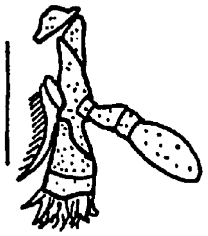
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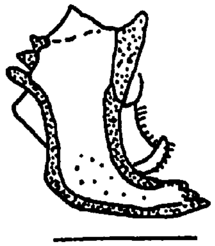
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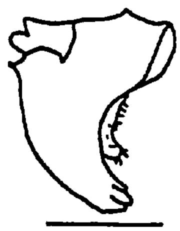
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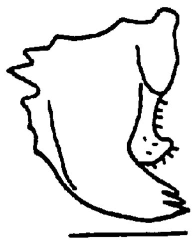
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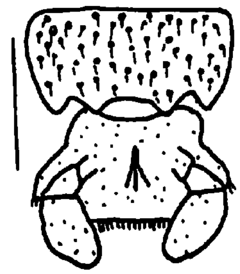
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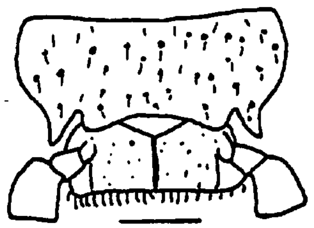
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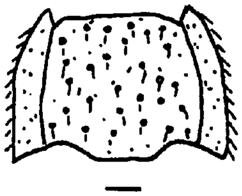
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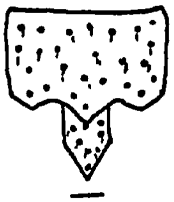
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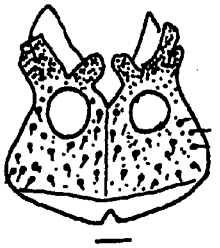
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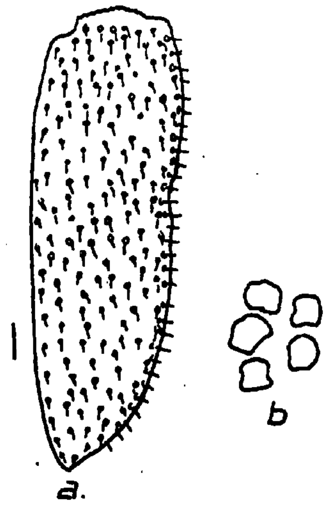

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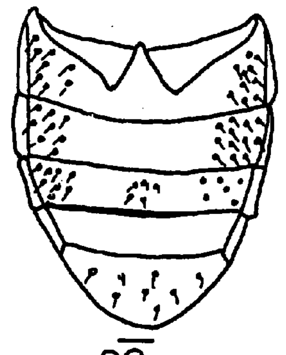
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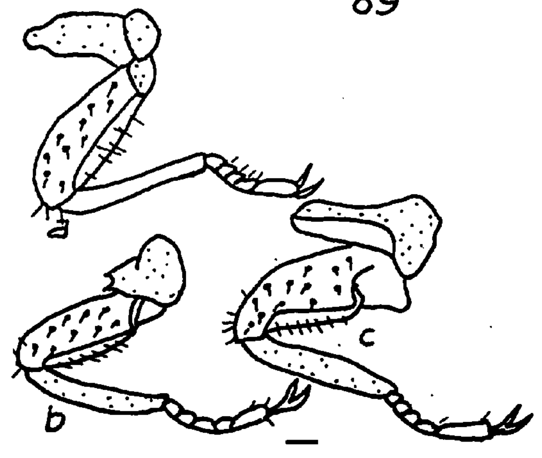

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PLATE X

Figure 94. *Dryops* sp. B, hind wing.

Figure 95. *Dryops* sp. A, alimentary canal.

Figure 96. *Dryops* sp. B, central nervous system.

Figure 97. *Dryops* sp. B, male reproductive system (ventral view).

Figure 98. *Dryops* sp. B, male reproductive system (dorsal view).

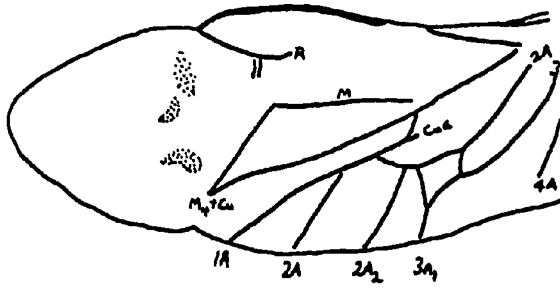
Figure 99. *Dryops* sp. C, male reproductive system (dorsal view).

Figure 100. *Dryops* sp. C, male reproductive system (ventral view).

Figure 101. *Dryops* sp. A, male reproductive system (ventral view).

Legend:

ejd - ejaculatory duct
lac - lateral accessory gland
mlac - median lateral accessory gland
vd - vas deferens



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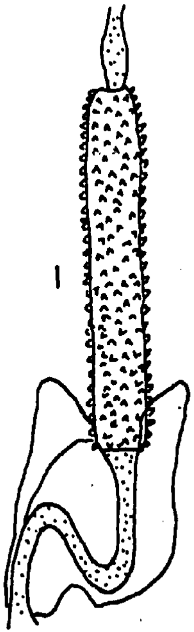

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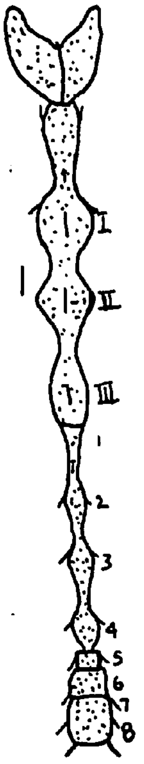

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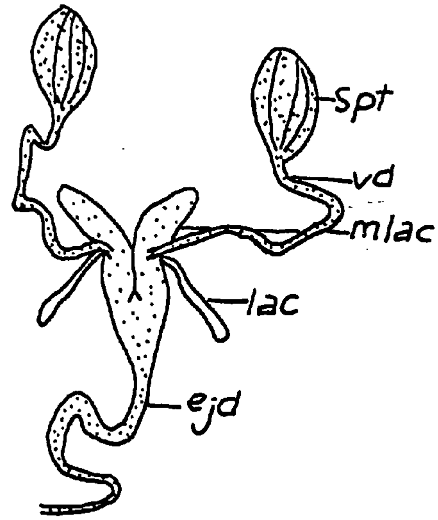

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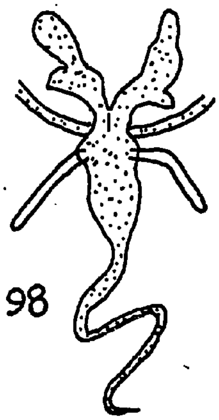

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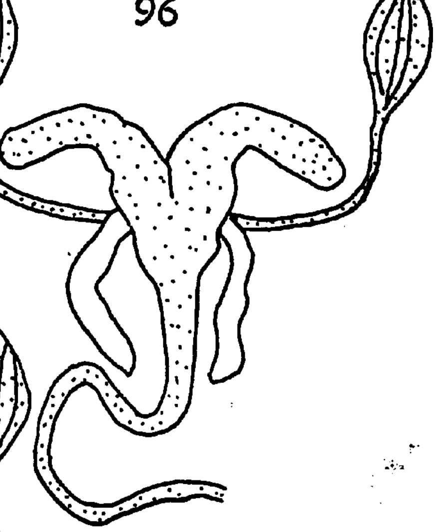

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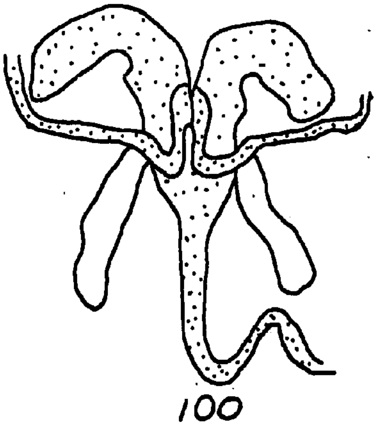

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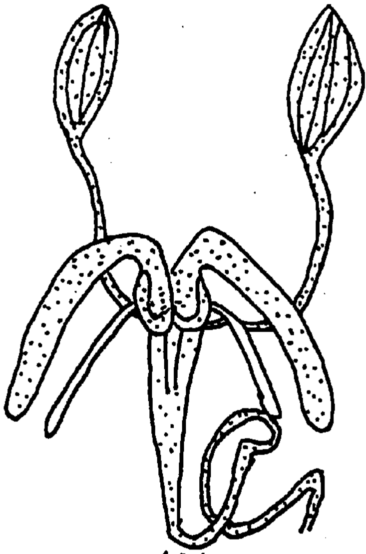

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PLATE XI

Figure 102. *Dryops* sp. A, male reproductive system (dorsal view).

Figure 103. *Dryops arizonensis*, male reproductive system (ventral view).

Figure 104. *Dryops arizonensis*, male reproductive system (dorsal view).

Figure 105. *Dryops* sp. B, male genitalia.

a. Ventral view
b. Dorsal view
c. Lateral view
d. Median lobe

Figure 106. *Dryops* sp. C, male geniatalia.

a. Ventral view
b. Dorsal view
c. Lateral view

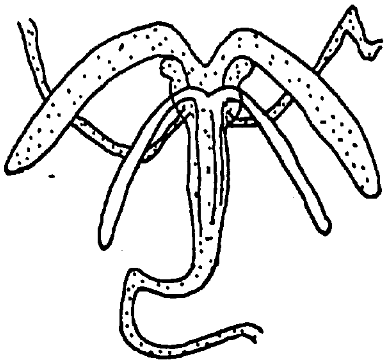
Figure 107. *Dryops* sp. A, male genitalia.

a. Ventral view
b. Dorsal view
c. Lateral view
d. Median lobe

Figure 108. *Dryops* sp. A, penial spicule.

Figure 109. *Dryops arizonensis*, male genitalia.

a. Ventral view
b. Dorsal view



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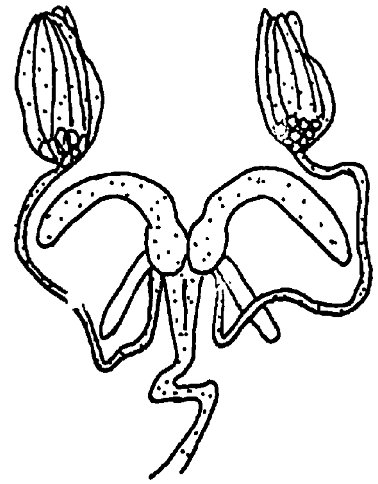

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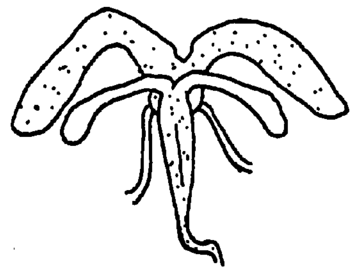

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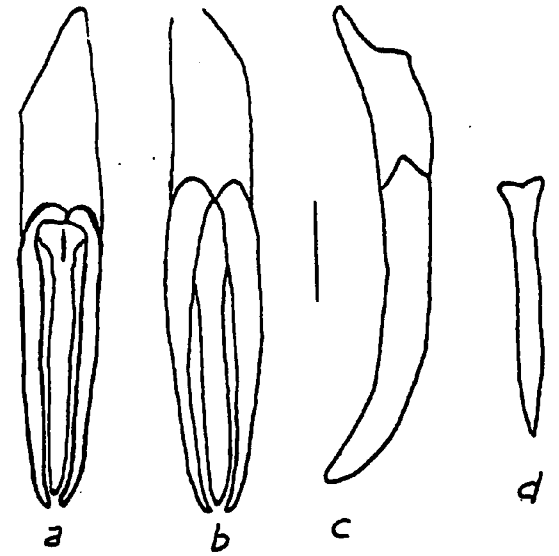

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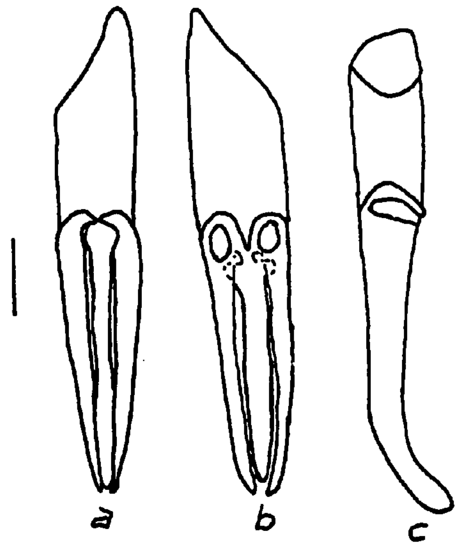

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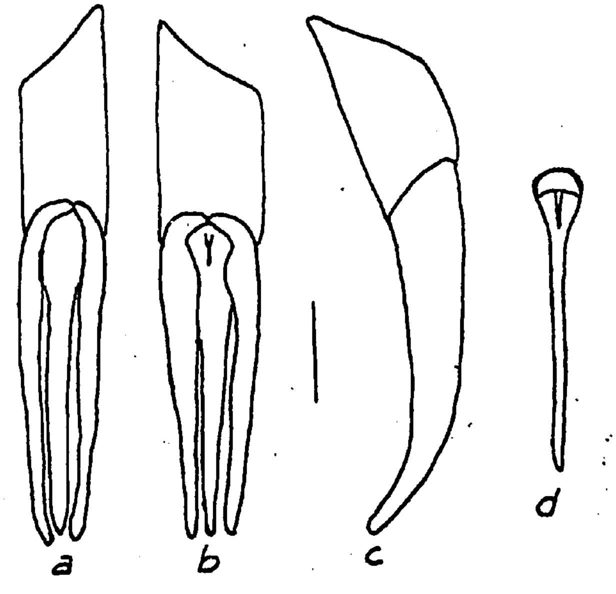

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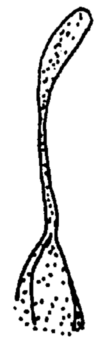

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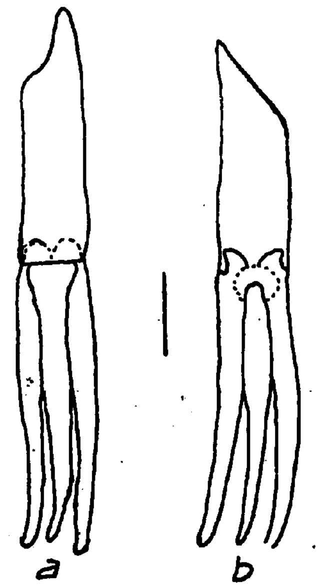

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PLATE XII

Figure 110. _Dryops arizonensis_, male genitalia (lateral view).

Figure 111. _Dryops_ sp. B, female reproductive system.

Figure 112. _Dryops_ sp. B, ovipositor (dorsal view).

Figure 113. _Dryops_ sp. B, female spicule.

Figure 114. _Dryops_ sp. C, ovipositor (lateral view).

Figure 115. _Dryops_ sp. C, ovipositor (dorsal view).

Figure 116. _Dryops_ sp. A, ovipositor (lateral view).

Figure 117. _Dryops_ sp. A, ovipositor (dorsal view).

Figure 118. _Dryops arizonensis_, ovipsitor (lateral view).

Figure 119. _Dryops arizonensis_, ovipositor (dorsal view).

Legend:

acg - accessory gland

egt - egg tube

ovp - ovipositor

sth - spermathecal gland

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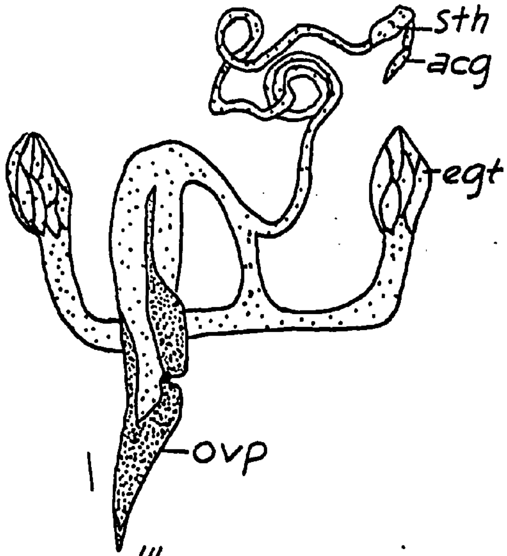

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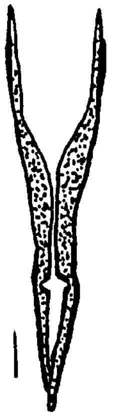

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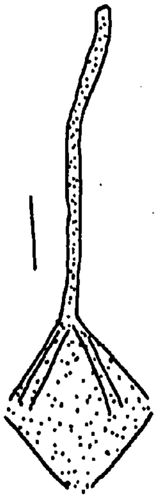

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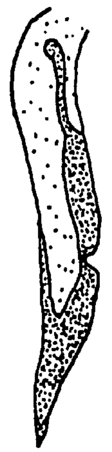

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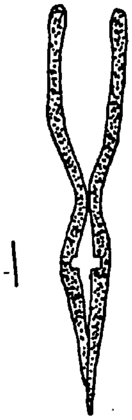

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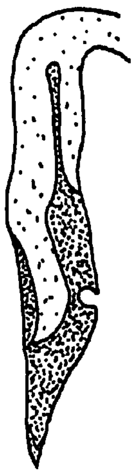

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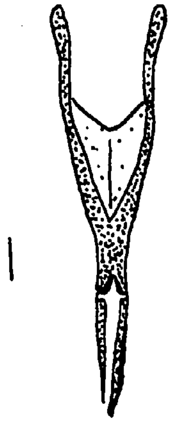

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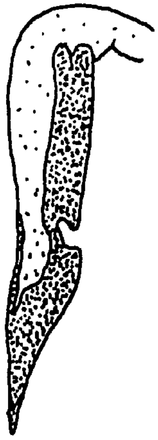

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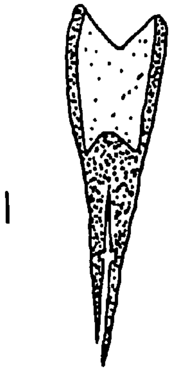

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Limnichidae (Erichson, 1845)

The Limnichidae were first considered as a tribe of the family Byrrhidae by Erichson in 1845 (Hinton, 1939b). According to Hinton (1939b), Thomson raised the rank of the group to the family level in 1860. Thomson's classification for this group was not followed in subsequent years. Hinton (1939b) returned to Thomson's classification, and in addition, removed the Limnichidae from the superfamily Byrrhoidea to the superfamily Dryopoidea. Hinton based this change largely on the relationship which appears to exist between Limnichidae and Dryopidae.

The Limnichidae are generally characterized by filiform antennae with 10 - 11 segments; large distinct clypeus; 4-segmented maxillary palpi and 3-segmented labial palpi; pronotum subquadrate and punctate; anterior and hind coxae transverse and middle coxae rounded. Midgut with dense projecting crypts; 6 Malpighian tubules with distal ends free or embedded in hindgut; sperm tubes sessile and collectively ensheathed; female genitalia symmetrical or asymmetrical and without coxites.

The morphology of 4 species of Limnichidae is described here.

Lutrochus (Erichson, 1847)

Four (?) species of the genus Lutrochus, from 7 localities have been examined here:

Lutrochus luteus - Blue River, Johnston County, Oklahoma (June, 1963). Eight specimens examined, 6 dissected.

Lutrochus sp. A - Rio Pilon, Mexico (October, 1964). Ten specimens examined, 4 dissected.

Lutrochus sp. B - Devil's River, Val Verde County, Texas (October, 1964), and Mexico Highway 80. Ten specimens examined, 5 dissected.

Lutrochus sp. C - Rio Sucupira, Porto Franco, Maranhao, Brazil and south of Porto Franco (June, 1964). Eight specimens examined, 5 dissected.

External Morphology

The antennae of Lutrochus are 11-segmented, with the basal two segments larger than the others, the remaining antennal segments filiform (appearing poorly pectinate). Head partly retractile, but mouthparts and eyes remain exposed; first visible abdominal sternite not grooved to receive femora and tibiae.

Lutrochus luteus. These specimens are oval, 3 - 3.6 mm long and 1.2 - 1.5 mm across the elytral humeri. The entire dorsal surface is clothed with dense short hairs, each arising from a relatively large distinct puncture. The enlarged punctures lend a porous appearance to the body surface. The body has a metallic luster. Similar punctures are present on the ventral surface and hairs appear to be equally as dense. The antennae (Fig. 120) bear 11 segments each. The anterior margin of the clypeus is truncate. The labrum (Fig. 121) is transverse and punctate with an unindented apical margin. The lacinia is acute and internally setiferous (Fig. 123), the galea lobate with an apical tuft of spinose hairs.

The relatively large mandibles (Fig. 124) give a conspicuous broad appearance to the anterior-most part of the head. Each mandible has a membraneous prostheca and is bidentate at its apex.

The labium (Fig. 128) is punctate, with the lateral lobes of the mentum notched at the base. The apical segment of the labial palp is longer than the other two segments combined.

The pronotum (Fig. 131) is broader than long. The punctures of the pronotum, as elsewhere on the body, are irregular. The prosternum (Fig. 134) is arcuate at its anterior margin. The meso-metasternum is shown in Figure 137.

The elytron (Fig. 138) is twice as long as broad, with irregularly arranged punctae. The scutellum (Fig. 141) is flat and triangular with bluntly rounded angles and a transverse base.

The abdomen (Fig. 144) has five visible, equally pubescent sternites. The fifth sternite of the abdomen is distinctly convex at its posterior margin.

The middle tibia has only very fine hairs on its surfaces and appears bare in comparison with the front and hind tibiae (Fig. 146). The femur of each leg is clothed with dense hairs on the inner and outer surfaces. On the hind foot, males have a spur at the inner apex of the fifth tarsal segment.

Lutrochus sp. B. This species is 2.5 - 3.1 mm long and 1.5 - 1.9 mm across the elytral humeri. In general appearance it is shorter and more robust than L. luteus. It is similarly punctated and clothed by hair. The antennae, labrum, and maxillae are as in L. luteus.

The mandibles (Fig. 126) are similar in size and morphology to those of L. luteus.

The labium (Fig. 130) is notched at the base of the lateral lobe, more deeply than in L. luteus. There are also proportional differences in the palps and the lateral lobes between this species and L. luteus.

The pronotum and prosternum (Figs. 133 and 136) are similar to those of L. luteus, except that the posterolateral margins of the prosternum are slightly indented.

The elytron (Fig. 140) is approximately one and three-fourths times longer than broad, being otherwise similar to that of L. luteus. The exposed portion of the scutellum (Fig. 143) also resembles that of L. luteus.

The legs and abdomen are morphologically like those of L. luteus. Males and females are externally similar.

Lutrochus sp. A. This species is so similar to

Lutrochus sp. B that it is doubtful if these two should be placed in separate species. This species is in the same size range as Lutrochus sp. B, but does not exceed 1.5 mm across the elytral humeri or 3 mm in length. It is on the basis of morphological differences in the mandibles and minor variations in the morphology of the genitalia (discussed below) that the two species are separated.

The mandible (Fig. 127) is larger in Lutrochus sp. A and the apex is turned more mediad and is much longer than in Lutrochus sp. B.

Lutrochus sp. C. Specimens available measured 3.9-4.25 mm in length. The greatest elytral width is 2.4 mm. The entire body is covered by dense hairs, approximately 130µ long. The punctae from which the hairs arise are quite small and can only be seen at magnifications of 30X or more.

The antennae are 11-segmented as in L. luteus. The labrum (Fig. 122) is not as broad as in L. luteus and the fringe of hairs along the anterior margin is much longer, particularly at the lateral borders. Maxillae are as in L. luteus.

The labium (Fig. 129) is not as deeply notched at the base of its lateral lobes as in the above species. The outline given to the middle portion of the mentum by the pigmentation between the palpi is also different from the above species. In addition, the hairs of the labial surface are much longer.

The pronotum (Fig. 132) is much narrower at its anterior margin than across the lobes of the posterior margin, a difference which is not so pronounced in the other species examined. The prosternal process (Fig. 135) is wider at its apex than in any of the other species considered here. The meso-metasternum is similar to that of _L. luteus_.

The elytra (Fig, 139) are approximately twice as long as broad, and except for the long hairs and small punctae, are similar to the other species in morphology.

The apex of the fifth visible sternite of the abdomen (Fig. 145) is more rounded than in _L. luteus_.

The legs (Fig. 147), though similar in morphology to those of _L. luteus_, are densely clothed with long hairs. The middle tibia appears to be bare of hairs. Males and females are externally similar.

The morphology of the hind wing is shown in Figure 148. The naming of the veins is based on the Forbes System (Forbes, 1922).

Internal Morphology

Alimentary Canal (Figures 149 - 150). The alimentary canals of the species examined here are similar in morphology. The pharynx is narrow but leads into a broader esophagus. The midgut bears dense crypts and is without ceca on its anterior margin. The hindgut is looped in the abdominal cavity and is longer than the midgut in all species. There are 6 Malpighian tubules, originating at the posterior midgut and having their distal ends free.

Central Nervous System (Figures 151 - 152). The central nervous system has three discrete thoracic ganglia, one in each thoracic segment of the body. There are 8 abdominal ganglia. The first abdominal ganglion is fused to the third thoracic ganglion. Abdominal ganglia 5 - 8 are also fused.

Male Reproductive System (Figures 153 - 165). The male reproductive system of L. luteus (Fig. 153) has two large lateral accessory glands which are opaque. The median accessory glands are rounded structures. The vasa deferentia empty on the ventral side just above the median accessories. The ejaculatory duct leads from the ventral side of the median accessory glands to the penis.

The male reproductive systems of Lutrochus sp. A and B (Fig. 156) are alike and quite similar to that of L. luteus. The lateral accessory glands here are also opaque and oblong, but are much reduced in size. The median accessory glands are also reduced in size. The vasa deferentia enlarge conspicuously a short distance from the testes, forming what is probably a seminal vesicle.

In Lutrochus sp. C (Figs. 154 - 155) the median lateral accessory glands are the largest of the system. At their distal ends the glands enlarge into a rounded lobe and curl ventrally. The lateral accessory glands appear as two oblong, opaque sacs, lying above the median lateral accessory glands. The vasa deferentia empty into abruptly enlarged vesicles which are shorter than the vasa deferentia .

The male genitalia of L. luteus (Fig. 158) are pointed at the apex. On the lateral margin of the apex the penis is expanded and notched, but only on one side. Three supporting sclerotized strands extend through the body of the penis, two lateral and one median. The two lateral strands are embedded beneath a sheath which covers muscle at the base of the penis. From the base these two strands extend to the apex. The median strand extends from the base of the penis to near the apex. At the base of the penis the median strand coils around the basal lobe of muscle tissue.

In Lutrochus sp. B (Fig. 160) the genitalia are similar to the penis of L. luteus except at the apex. The expanded lobes of the apex of the penis are entire along both margins, i.e., they are not notched.

Only a minor variation exists between the genitalia of Lutrochus sp. A and B. The apex of the penis of Lutrochus sp. A (Fig. 163) is slightly longer. The difference is quite clear when the two genitalia are observed alongside each other. The genitalia of Lutrochus sp. B have a shorter and blunter apex.

The morphology of the genitalia of Lutrochus sp. C (Fig. 159) is vastly different from that of the other species. The morphology is best seen by observing Figure 159. Figures 161 - 162 show the structure of the supporting penial spicules.

Female Reproductive System (Figures 164 - 170). In this reproductive system of L. luteus (Fig. 164) the duct from the spermatheca enlarges and becomes coiled just prior to connecting to the bursa copulatrix. This structure may well represent a part of the bursa copulatrix proper. No similar structure has been found in the other species examined. Figure 165 shows a dorsal view of the ovipositor of L. luteus.

The female reproductive system of Lutrochus sp. B is illustrated in Figure 168. This illustration is also adequate for that system of Lutrochus sp. A. The ovipositors of the two species are like that of L. luteus.

Lutrochus sp. C (Fig. 166) has an enlarged bursa copulatrix with the oviducts entering the bursa on its underside. No accessory structures were seen in the three females of this species which were dissected, despite an intensive search for them. The ovipositor is shown in dorsal view in Figure 167.

All of the females contained eggs and the morphology of the ovaries could not be determined. The eggs of Lutrochus sp. C (Fig. 171) are oblong and slender, being more than three times longer than wide. The eggs of the remaining three species were morphologically alike (Figs. 171 - 172). The eggs of *L. luteus* are larger than those of *Lutrochus* sp. A or B. *Lutrochus* sp B and C have identical eggs.

PLATE XIII

Figure 120. Lutrochus luteus, antenna.

Figure 121. Lutrochus luteus, labrum.

Figure 122. Lutrochus sp. C, labrum.

Figure 123. Lutrochus luteus, maxilla.

Figure 124. Lutrochus luteus, mandible.

Figure 125. Lutrochus sp. C, mandible.

Figure 126. Lutrochus sp. B, mandible.

Figure 127. Lutrochus sp. A, mandible.

Figure 128. Lutrochus luteus, labium.

Figure 129. Lutrochus sp. C, labium.

Figure 130. Lutrochus sp. B, labium.

Figure 131. Lutrochus luteus, pronotum.

Figure 132. Lutrochus sp. C, pronotum.

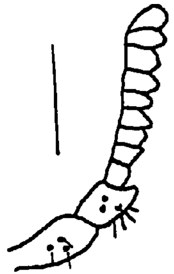
Figure 133. Lutrochus sp. B, pronotum.

Figure 134. Lutrochus luteus, prosternum.

Figure 135. Lutrochus sp. C, prosternum.

Figure 136. Lutrochus sp. B, prosternum.

Figure 137. Lutrochus luteus, meso-metasternum.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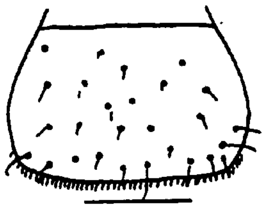
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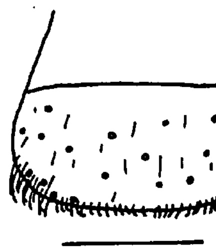
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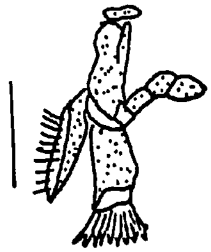
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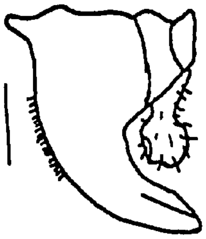
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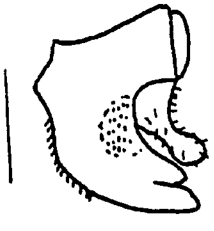
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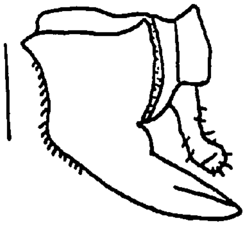
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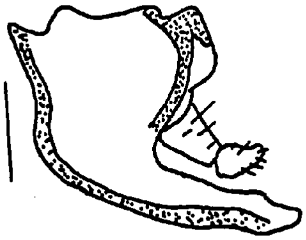
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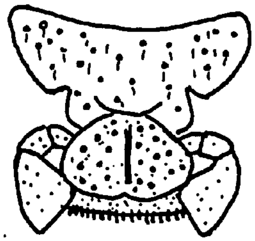
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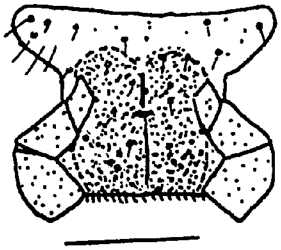
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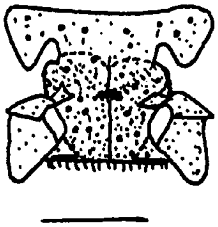
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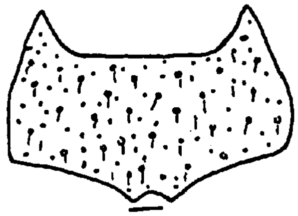
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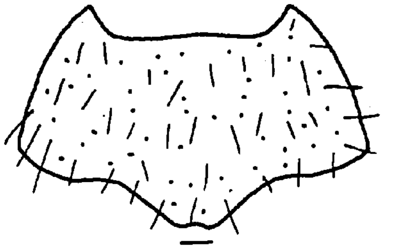
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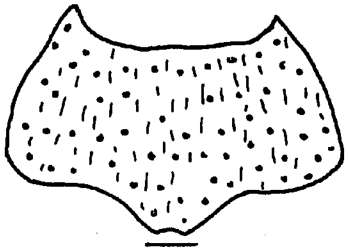
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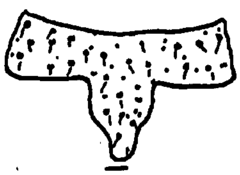
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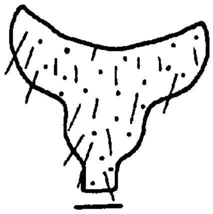
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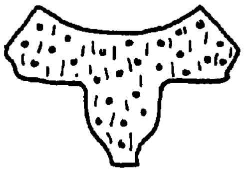
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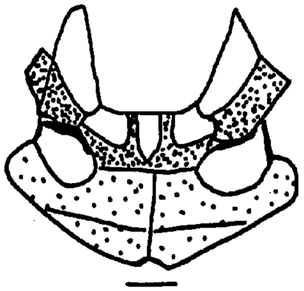
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PLATE XIV

Figure 138. Lutrochus luteus, elytron.

Figure 139. Lutrochus sp. C, elytron.

Figure 140. Lutrochus sp. B, elytron.

Figure 141. Lutrochus luteus, scutellum.

Figure 142. Lutrochus sp. C, scutellum.

Figure 143. Lutrochus sp. B, scutellum.

Figure 144. Lutrochus luteus, abdomen.

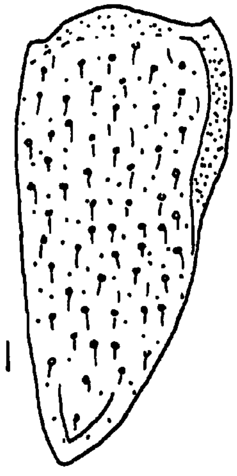
Figure 145. Lutrochus sp. C, abdomen.

Figure 146. Lutrochus luteus, legs.

- a. Prothoracic leg
- b. Mesothoracic leg
- c. Metathoracic leg

Figure 147. Lutrochus sp. C, legs.

- a. Prothoracic leg
- b. Mesothoracic leg
- c. Metathoracic leg



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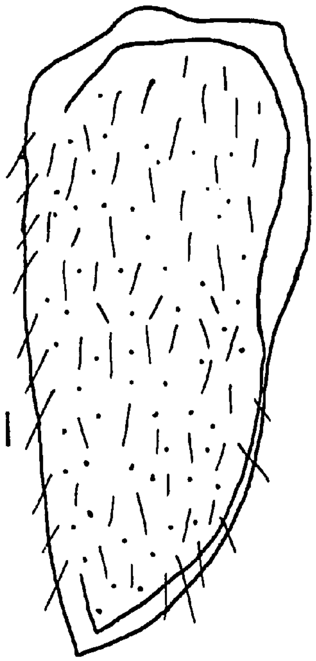

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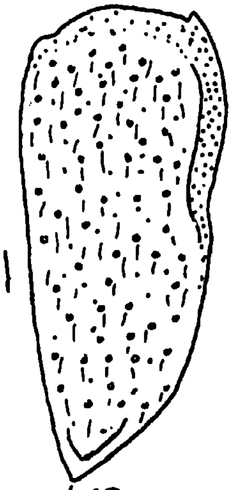

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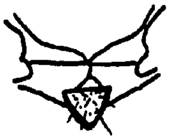

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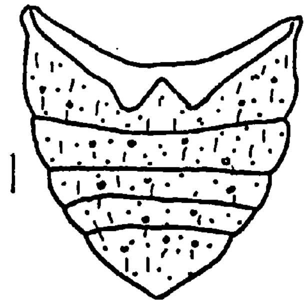

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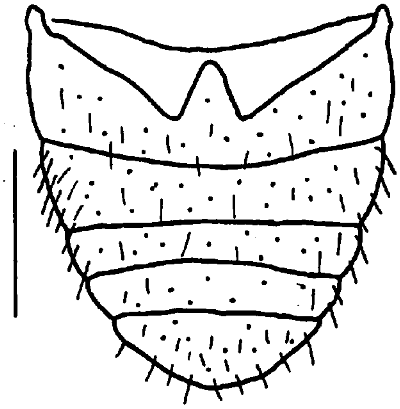

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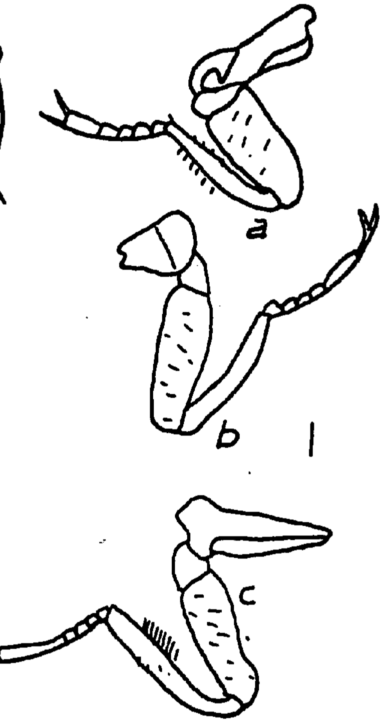

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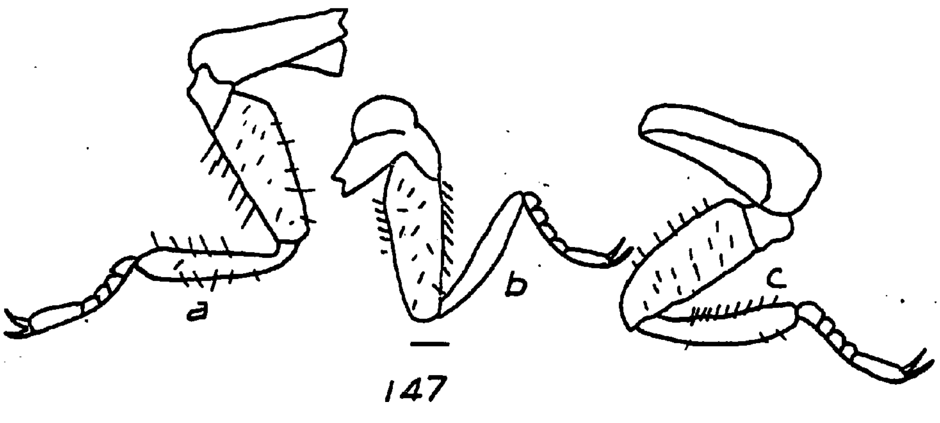

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PLATE XV

Figure 148. *Lutrochus luteus*, hind wing.

Figure 149. *Lutrochus luteus*, alimentary canal.

Figure 150. *Lutrochus* sp. C, alimentary canal.

Figure 151. *Lutrochus luteus*, central nervous system.

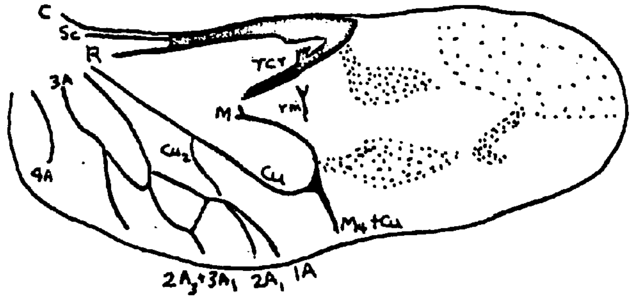
Figure 152. *Lutrochus* sp. C, central nervous system.

Figure 153. *Lutrochus luteus*, male reproductive system (dorsal view).

Figure 154. *Lutrochus* sp. C, male reproductive system (dorsal view).

Legend:

lac - lateral accessory gland
mlac - median lateral accessory gland
spt - sperm tube
sv - seminal vesicle



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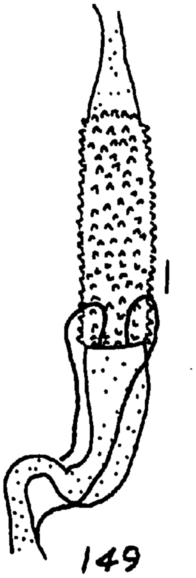

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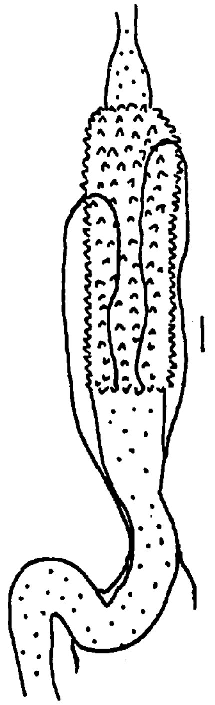

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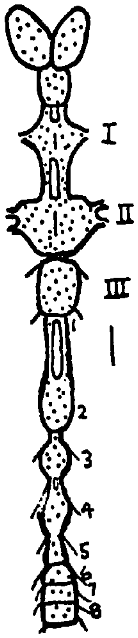

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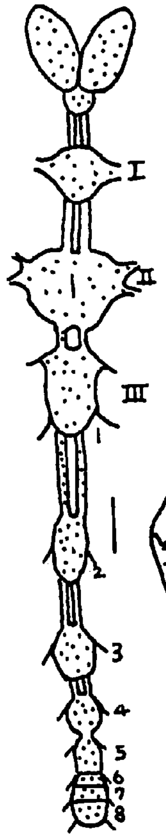

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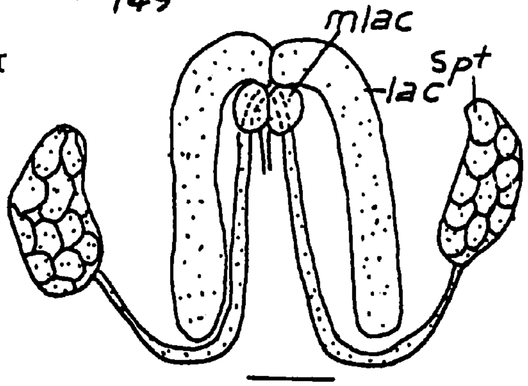

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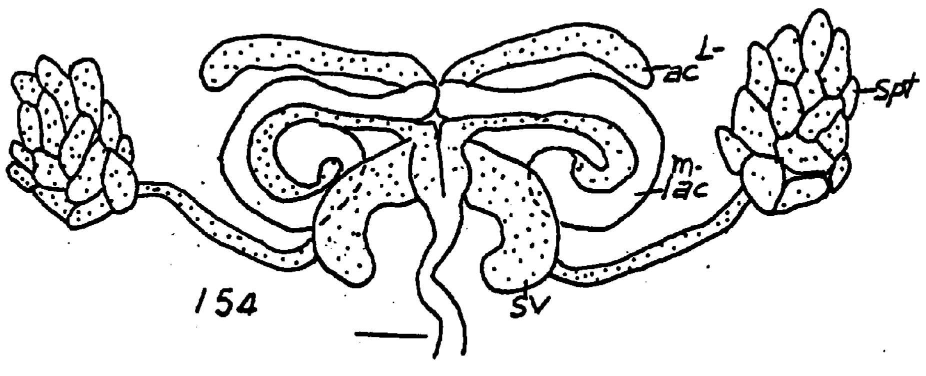

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PLATE XVI

Figure 155. *Lutrochus* sp. C, male reproductive system (ventral view).

Figure 156. *Lutrochus* sp. B, male reproductive system (ventral view).

Figure 157. *Lutrochus luteus*, penial spicule.

Figure 158. *Lutrochus luteus*, male genitalia.

- a. Right lateral view
- b. Ventral view
- c. Left lateral view

Figure 159. *Lutrochus* sp. C, male genitalia.

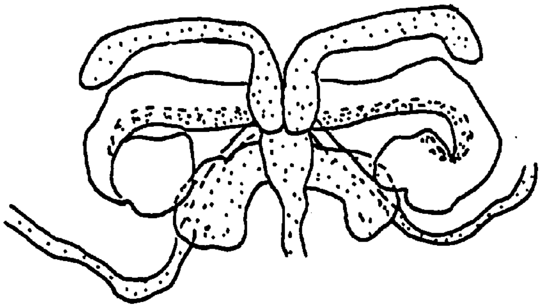
- a. Ventral view with apical lobes parted.
- b. Dorsal view with apical lobes parted.
- c. Ventro-lateral view with apical lobes parted.
- d. Ventral view with apical lobes closed.

Figure 160. *Lutrochus* sp. B, male genitalia.

- a. Right lateral view
- b. Left lateral view
- c. Dorsal view of apex

Legend:

lac - lateral accessory gland
spt - sperm tube
mlac - median lateral accessory gland



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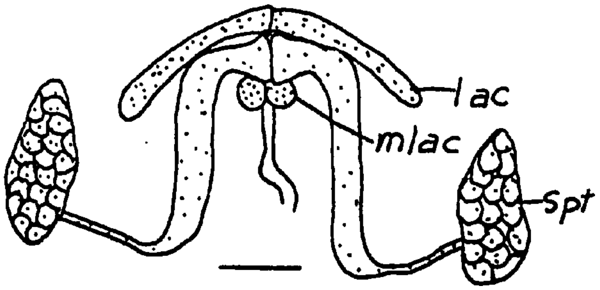

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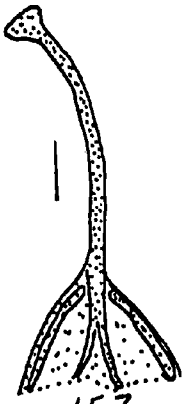

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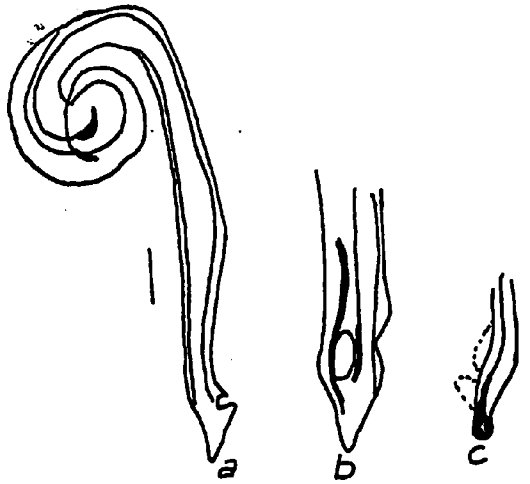

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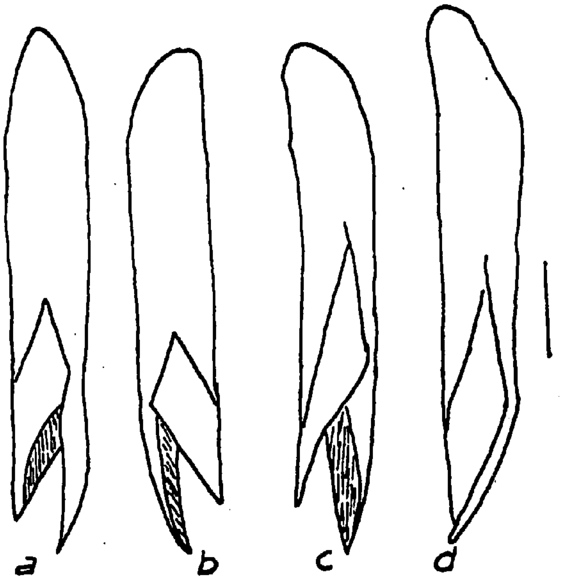

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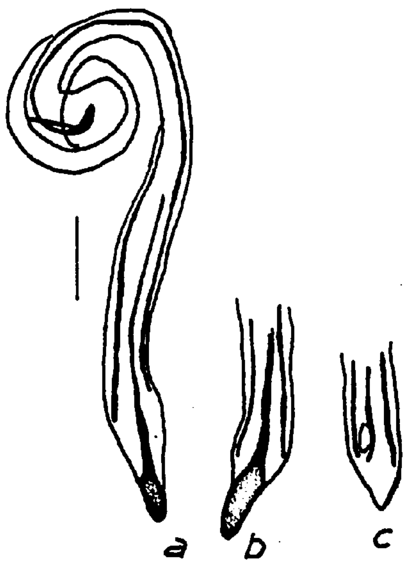

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PLATE XVII

Figure 161. Lutrochus sp. B, penial spicule.

Figure 162. Lutrochus sp. C, penial spicule.

Figure 163. Lutrochus sp. A, male genitalia.

Figure 164. Lutrochus luteus, female reproductive system.

Figure 165. Lutrochus luteus, ovipositor (dorsal view).

Figure 166. Lutrochus sp. C, female reproductive system.

Figure 167. Lutrochus sp. C, ovipositor (dorsal view).

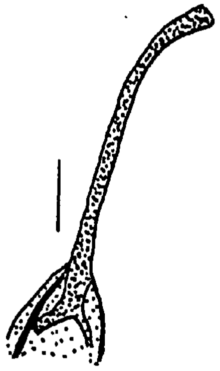
Figure 168. Lutrochus sp. B, female reproductive system.

Figure 169. Lutrochus sp. B, ovipositor (dorsal view).

Figure 170. Lutrochus luteus, egg.

Figure 171. Lutrochus sp. C, egg.

Figure 172. Lutrochus sp. B, egg.



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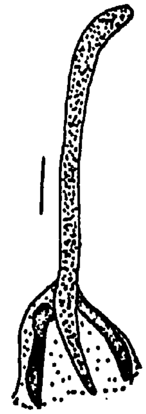

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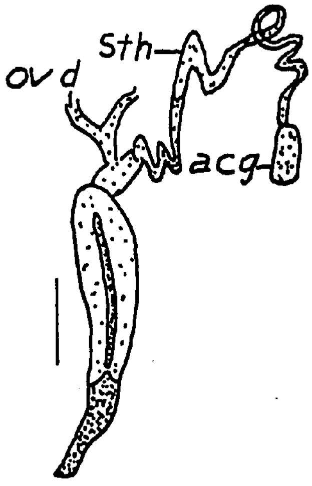

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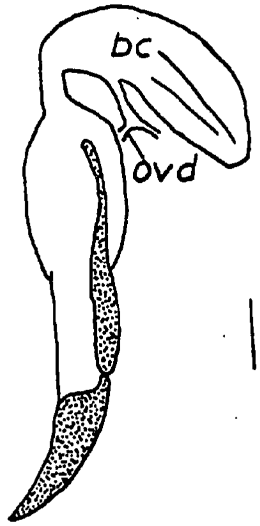

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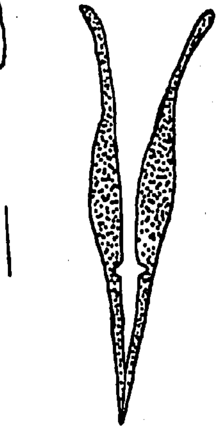

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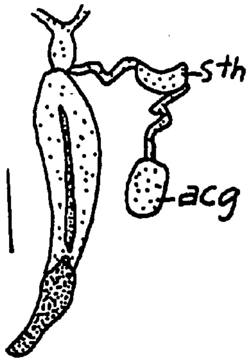

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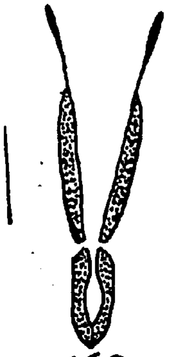

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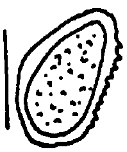

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Psephenidae (Lacordaire, 1854)

Sanderson (1938), in a historical review of the family Dryopidae, has included a partial account of the family Psephenidae. The following brief account is taken from his review.

The Psephenidae were first considered a sub-family of the Dryopidae (Parnidae) by Leconte in 1861. In 1920 Leng considered the genus Psephenus as constituting the family Psephenidae. Boving, in 1929, placed Eubrianax, then in Dascyllidae, with Psephenidae. This change in taxonomy was based on larval characteristics. In the following year Boving and Craighead divided the family Psephenidae into its present sub-families, Psepheninae and Eubrianacinae. The family now consists of the genera Psephenus, Eubrianax, Ectopria, Acneus, Psephenops, Pheneps, and Psephenoides.

Arnett (1963) includes the following family characteristics for Psephenidae. The body is oval, depressed, 4 - 6 mm long; frons declivous; maxillary palpi long, slender, 4-segmented; mandibles much reduced and hidden beneath the labrum; antennae 11-segmented, filiform, serrate, pectinate, or ramose.

The pronotum is broader at base than apex, sometimes explanate; elytra entire and soft, with rounded apices; abdomen with 6 or 7, rarely 5 visible abdominal sternites; anterior coxae rounded.

Hinton (1939b) includes the following characteristics in his description of the family: female genitalia symmetrical, each with a movable stylus; alimentary canal frail and midgut without projecting regenerative crypts.

The morphology of 6 species of 2 genera is described here.

Psephenus Haldeman, 1863

Four species of Psephenus are described here. They are:

P. herricki - Cucumber Creek, Leflore County, and Barron Fork Creek, Adair County, both in Oklahoma. Twelve specimens examined, 4 dissected.

Psephenus sp. A - Del Rio, Texas; Rio Cabisones and Ojo de Agua, Sabinas Hidalgo, Neuvo Leon in Mexico. Thirteen specimens examined, 5 dissected.

P. palpalis - Rio Macuilapa, west of Los Amates, Chiapas; Rio Tehuantepec, El Camaron; Rio Hondo, Oaxaca, and Rio de Chalma, Cocoyotla, Morelos; all in Mexico. Fifteen specimens examined, 4 dissected.

P. usingeri - Izucar de Matamoros, Puebla, Mexico. Twelve specimens examined, 5 dissected.

External Morphology

The genus Psephenus may be separated from the other genera of the family by the following characteristics: hind margin of prothorax smooth; head visible from above, clypeus bent beneath head; antennae relatively short, may reach to base of elytra or slightly beyond, but never extending to middle of elytra; tarsi of both male and female slender and without dilated joints or large pubescent soles.

P. herricki. P. herricki is 4.5 - 5.2 mm long and 2 mm across the elytral humeri. In all specimens examined the male is smaller than the female. In addition, the male differs from the female in the following secondary sexual characteristics: antennae and maxillary palpi slightly longer and heavier; prothorax less explanate at sides; first two joints of front and middle tarsi with many short, slender papillae; middle coxae more approximate; mesosternum between them narrower; abdomen with 7 visible sternites, not 6 as in female.

The body is minutely punctate and pubescent on the dorsal and ventral surfaces. In the head region the antennae (Fig. 173) are 11-segmented and do not reach to the base of the elytra. The first antennal segment is longer than any other one, the third is longer than the second, the fourth longer than the fifth, and the apical segment second only to the basal segment in length. The maxillary palp (Fig. 174) is 4-segmented and approximately half as long as the antenna. The basal segment of the maxillary palp is short, the second segment is approximately 3.5X, the third approximately 3X, and the fourth approximately 5X the length of the basal segment. The remainder of the maxilla is greatly reduced. The clypeus is truncate or nearly so at its base where it is in contact with the frons, but is arcuate at its apex where it receives the labrum. The labrum (Fig. 180) is arcuate at its base and broadly indented at its median apical margin. The mandibles (Fig. 184) are greatly reduced and hidden beneath the labrum. The labium (Fig. 186) is as figured.

The pronotum of the male (Fig. 189) has the apex not more than half as wide as the base. That of the female (Fig. 190) is broader than the male's, with much less difference in the widths of the apex and base. The prosternum (Fig. 192) has the anterior margin weakly arcuate. The prosternal process is slender and longer in the male. The apex of the process varies in shape, usually being pointed at the extreme tip and slightly expanded immediately above. The apex is ocassionally rounded and without expansion.

The meso-metasternum is shown in Figure 196.

The elytra (Fig. 197) are widest at the apical third, the outer margins darker, and the apices separately rounded and diverging. The scutellum (Fig. 194) is pen--tagonal in shape.

The abdomen of the male (Fig. 199) differs from that of the female (Fig. 200) in that the former has 7 visible sternites and the latter six. The sixth abdominal sternite of the male is visible only at the sides of the seventh, in the emargination of the fifth. Although the entire abdomen is pubescent, the hairs in the median area extending the length of the abdomen appear slightly longer.

The papillae on tarsal segments 1 and 2 of the first and second legs (Fig. 201) have been mentioned above.

In the wings (Fig. 203), veins 1A and 2A are reduced and weak.

Psephenus sp. A (new). Male specimens of this species from Texas and Mexico have been examined. This species, though quite similar to P. herricki , shows several constant variations: 1) the antennae extend to or slightly beyond the base of the elytra, whereas the antennae of P. herricki fail to reach the base of the elytra; 2) the shape of the labrum (Figs. 180 and 181) differs in the two species; 3) the labia, when removed from the specimens, are seen to differ slightly at their bases (Figs. 186 - 187); 4) the base of the clypeus of Psephenus sp. A, when viewed with ventral side of the specimen up, varies in shape from P. herricki (Figs. 180 and 181). The clypeus of the former is always seen to be distinctly indented at the median area of the basal margin, In P. herricki the same view of the clypeus shows it to be in most cases truncate, and in a few cases very feebly indented in the median area of the basal margin, but never sufficiently indented to be confused with Psephenus sp. A; 5) in specimens examined, the specimens of the new species are larger than those of P. herricki, but the difference in size is very small and is of little value by itself for separating the two; 6) finally, the genitalia of the two species vary slightly. Discussion of this difference is deferred here until the discussion of the male reproductive system below.

In all other respects the description given for the male specimens of *P. herricki* apply equally to those of *Psephenus* sp. A.

Psephenus palpalis. Males of this species which were examined are 3.7 - 4.2 mm long and 1.8 - 2 mm across the elytral humeri. The females measured 5.0 - 5.2 mm long and 2.5 mm across the elytral humeri. The differences noted between the sexes of *P. herricki* are also true for *P. palpalis*. The body punctations and pubescence are similar to those of *P. herricki*. The male antennae (Fig. 175) do not reach to the base of the elytra, whereas the female antennae, though shorter than the male's, reach just about to the base of the elytra. Of the 11 segments composing the antenna, segments 3 - 5 are elongate, and 6 - 10 gradually shorter in males. In females the third segment is slightly longer than the fourth and segments 4 - 11 gradually becoming shorter. Hinton (1934) figures 12 segments in the male antenna of *P. palpalis*. However, only 11 segments are present. The maxillary palp (Fig. 179) of the female is less than half the length of the antenna. The male palpi (Fig. 176), which are approximately twice the length of those in the female, are approximately 3/4 the length of the male antennae. The labrum (Fig. 182) is arcuately emarginate at the apex as is the clypeus. The mandibles are as in _P_. _herricki_. The labium is as figured (Fig. 188).

The shapes of the prothorax, mesosternum and metasternum are like those described for _P_. _herricki_.

The elytra are similar to those of _P_. _herricki_ and also diverge at the apices.

The fifth abdominal sternite is broadly emarginate in the male but truncate in the female. The legs are as in _P_. _herricki_.

The wing venation in _P_. _palpalis_ varies slightly from that of _P_. _herricki_, in that the vein Cu_2 and the basal portion of 1A are completely lacking, and a trace of $3A_2$ extends from the basal side of 3A.

Psephenus usingeri (?). The species of _Psephenus_ from Izucar de Matamoros is believed to be _P_. _usingeri_ although it shows some variations from the description of this species given by Hinton (1934). Only the male of this species is available for study. The length of this species is 3.3 - 3.8 mm and the width 1.5 - 1.7 mm. The body is oblong, oval, moderately depressed, pubescent and nigropiceous, as described by Hinton (1934).

The antennae (Fig. 177) do not reach to the base of the elytra. The third antennal segment is slightly longer than the fourth, segments 4 - 10 subequal, and the eleventh nearly twice the length of the shorter tenth. Maxillary palpi (Fig. 178) are approximately 2/3 as long as the antennae. The first segment of the maxillary palp is short, the second is approximately 5X the length of the first but not longer than 3 and 4 combined as reported by Hinton (1934), and the fourth is slightly longer than the third. The labrum (Fig. 183) is arcuate in the apical margin. The mandible (Fig. 185) is as figured.

The pronotum (Fig. 191) is minutely punctate, with the apex more than 1/2 the width of the base. The apical angles are broadly rounded and the basal angles acute. The prosternum (Fig. 193) is as figured.

The scutellum (Fig. 195) is transverse and round behind. The elytra (Fig. 198) are paler at the extreme margins, minutely punctate, widest at the apical third, with apices rounded and slightly diverging.

The abdominal sternites of *P. usingeri* are described as being somewhat testaceous. This is not the case in the specimens of *P. usingeri* studied here. Generally, the morphology of the abdomen is the same as in the males of *P. palpalis*.

The tibia of the middle leg (Fig. 202) is finely serrate on its inner margin. The tarsal claws, when magnified 100X or more, are seen to be feebly toothed at the base.

The wing venation is the same as in *P. herricki* except that a trace of $3A_2$ extends from the 3A vein on the basal side and the Cu_2 and 1A veins are barely visible.

Internal Morphology

Alimentary Canal (Figures 204 - 205). The alimentary canals which were dissected were similar in general morphology. These compare well with the description of the alimentary tract of P. palpalis given by Hinton (1939b). The tracts are extremely frail and devoid of any solid food. However, the gut of a single specimen of P. usingeri contained algae and grit. The dissection of the guts of two other specimens of this species however, showed no such content. The guts of several specimens of P. palpalis contained many large white globules, tentatively identified as gametocysts of a gregarine.

The surface of the gut is smooth, without any projecting crypts or ceca. The Malpighian tubules, which according to Hinton (1939b) are 6 in number, are attached at the base of the hindgut and end freely in the body cavity. Figures 204 and 205 show alimentary tracts of P. herricki and P. palpalis, respectively. The tract of P. usingeri is like that of P. palpalis. The figures of the alimentary tracts shown are based on the tracts of single specimens. Dissections of several specimens of each species reveal small morphological differences, probably resulting from the frail nature of the tract.

Central Nervous System (Figures 206). The central nervous systems of the 4 species which were dissected are similar to that shown for *P. herricki* (Fig. 206). There is an esophageal ganglion which connects directly to the brain and is overlain by it, and 3 thoracic ganglia, one in each thoracic segment. All of the abdominal ganglia are fused and crowded into the metathoracic segment, resulting in a relatively short nerve cord. Only 7 abdominal ganglia can be distinguished.

Male Reproductive System (Figures 207 - 218). In all 4 species each testis consists of multiple sperm tubes which are not enclosed in a sheath. Hinton (1939b) has reported a single sperm tube per testis for the genus *Psephenoides*. The sperm tubes empty directly into vasa deferentia which extend from the bases of the paired median lateral accessory glands. A lateral accessory gland is immediately outside of each median lateral accessory gland. The vasa deferentia and the accessory glands empty into the ejaculatory duct on the ventral surface.

The genitalia of the 4 species differ in morphology. In Figures 211 - 218 several differences in the morphology are observed, the most obvious being variations in the shape of the median spicules and the ventro-lateral lobes.

Careful observation shows minor morphological variations between the genitalia of *P. herricki* (Figs. 211 - 212) and *Psephenus* sp. A (Figs. 213 - 214). In a ventral view the median spicule of *Psephenus* sp. A (Fig. 214) is seen to be wider than that of *P. herricki* (Fig. 212) and to have a deeper grooved V-shaped base. In addition, the bases of the lateral lobes in *P. herricki* turn outward so that their highest point is on the lateral margin of the genitalia. In *Psephenus* sp. A the bases of the lateral lobes turn inward so that their highest point is medial and pointing away from the lateral margins.

Female Reproductive System (Figures 219 - 223). Female specimens of *P. herricki* and *P. palpalis* have been dissected. The female reproductive systems of the two differ only in morphology of the ovipositors (Figures 220 - 223). Hinton (1939b) has figured the female reproductive system, exclusive of the ovipositor, for *P. palpalis*. My findings for this part of the system agree with his figure.

The difference in the ovipositors of the two species examined can be seen by comparing Figures 220 and 221 with Figures 222 and 223.

PLATE XVIII

Figure 173. *Psephenus herricki*, antenna (male).

Figure 174. *Psephenus herricki*, maxilla (male).

Figure 175. *Psephenus palpalis*, antenna (male).

Figure 176. *Psephenus palpalis*, maxilla (male).

Figure 177. *Psephenus usingeri*, antenna (male).

Figure 178. *Psephenus usingeri*, maxilla (male).

Figure 179. *Psephenus palpalis*, maxilla (female).

Figure 180. *Psephenus herricki*, labrum and clypeus.

Figure 181. *Psephenus* sp. A, labrum and clypeus.

Figure 182. *Psephenus palpalis*, labrum.

Figure 183. *Psephenus usingeri*, labrum.

Figure 184. *Psephenus herricki*, mandible.

Figure 185. *Psephenus usingeri*, mandible.

Figure 186. *Psephenus herricki*, labium.

Figure 187. *Psephenus* sp. A, labium.

Figure 188. *Psephenus palpalis*, labium.

Figure 189. *Psephenus herricki*, pronotum (male).

Figure 190. *Psephenus herricki*, pronotum (female).

Figure 191. *Psephenus usingeri*, pronotum (male).

Figure 192. *Psephenus herricki*, prosternum (male).

Figure 193. *Psephenus usingeri*, prosternum (male).

Figure 194. *Psephenus herricki*, scutellum.

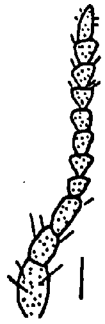
Figure 195. *Psephenus usingeri*, scutellum.

Figure 196. *Psephenus herricki*, meso-metasternum (male).

Figure 197. *Psephenus herricki*, elytron.

PLATE XVIII (continued)

Figure 198. *Psephenus usingeri*, elytron.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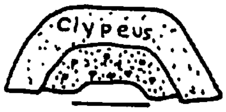

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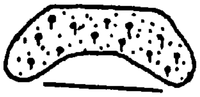
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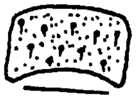
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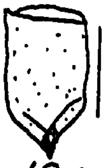
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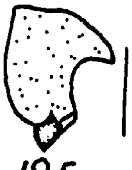
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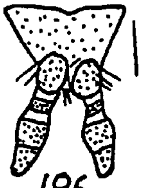
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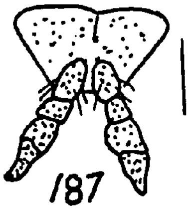
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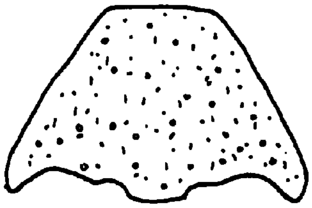
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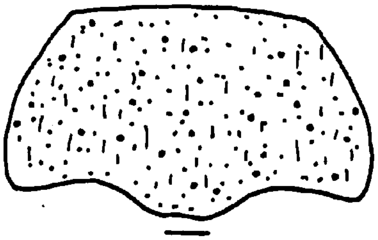
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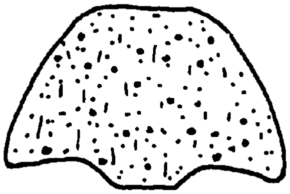
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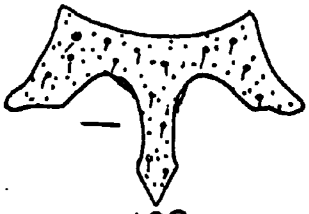
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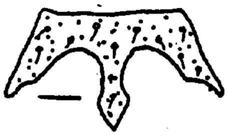
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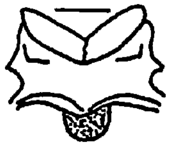
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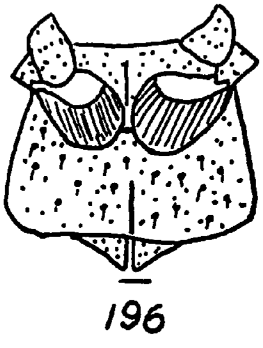
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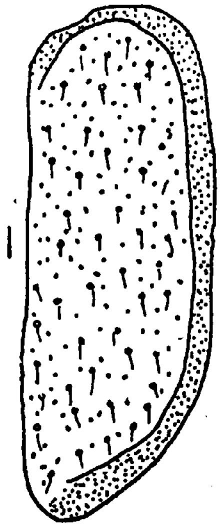
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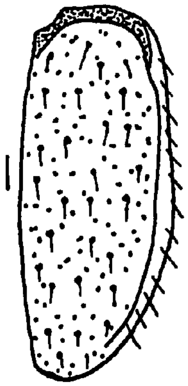
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PLATE XIX

Figure 199. *Psephenus herricki*, abdomen (male).

Figure 200. *Psephenus herricki*, abdomen (female).

Figure 201. *Psephenus herricki*, legs.

- a. Metathoracic leg
- b. Mesothoracic leg
- c. Prothoracic leg

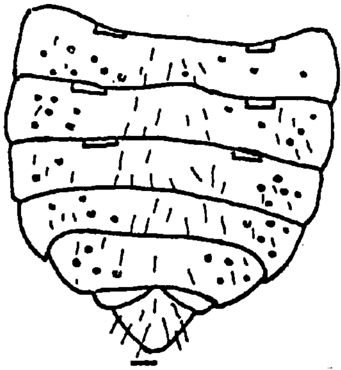
Figure 202. *Psephenus usingeri*, mesothoracic leg (male).

Figure 203. *Psephenus herrichi*, hind wing.

Figure 204. *Psephenus herricki*, alimentary canal.

Figure 205. *Psephenus palpalis*, alimentary canal.

Figure 206. *Psephenus herricki*, central nervous system.



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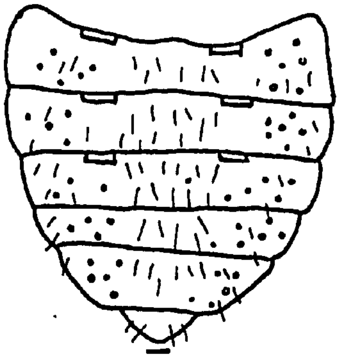

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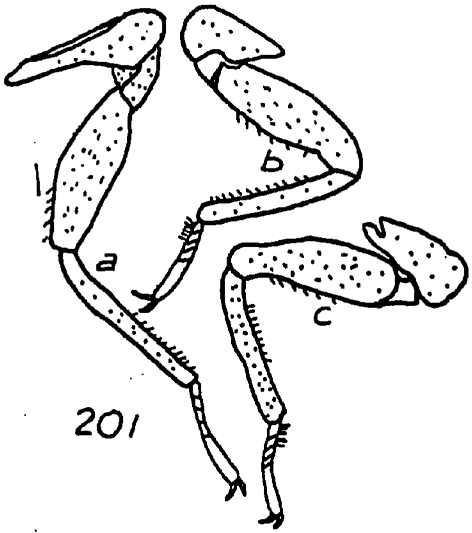

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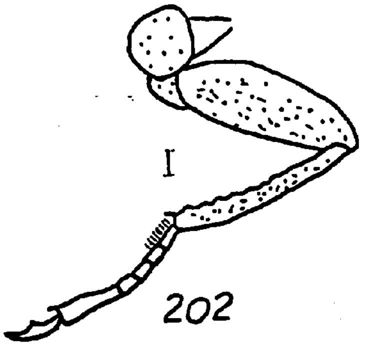

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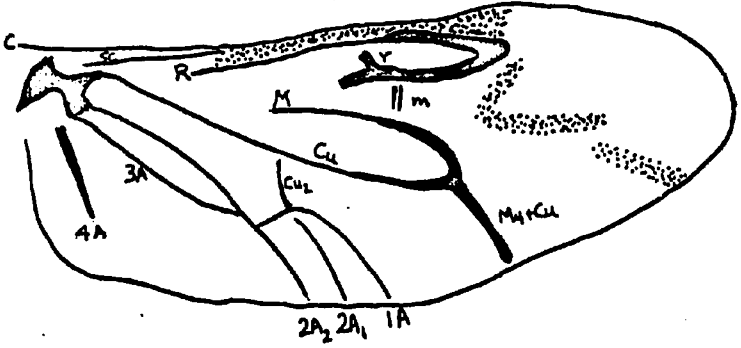

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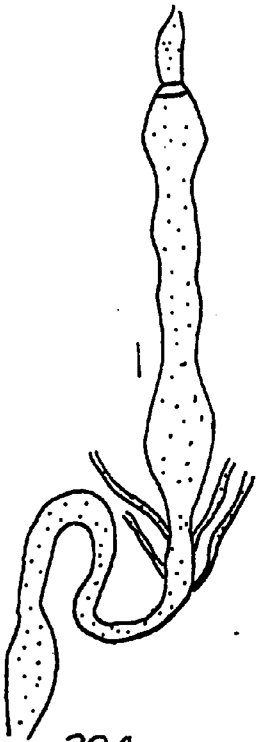

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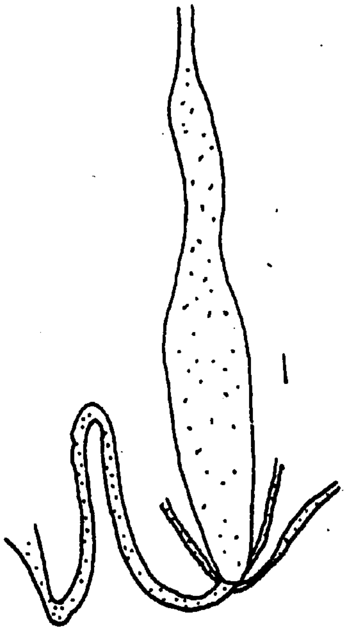

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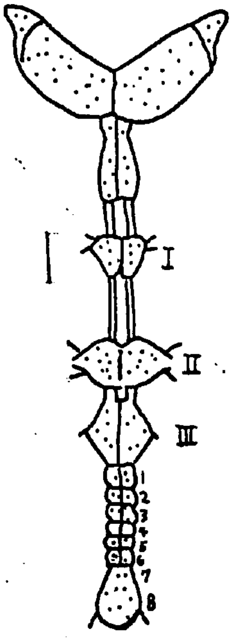

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PLATE XX

Figure 207. Psephenus herricki, male reproductive system (ventral view).

Figure 208. Psephenus herricki, male reproductive system (dorsal view).

Figure 209. Psephenus sp. A, male reproductive system (ventral view).

Figure 210. Psephenus sp. A, male reproductive system (dorsal view).

Figure 211. Psephenus herricki, male genitalia (dorsal view).

Figure 212. Psephenus herricki, male genitalia (ventral view).

Figure 213. Psephenus sp. A, male genitalia (dorsal view).

Figure 214. Psephenus sp. A, male genitalia (ventral view).

Figure 215. Psephenus palpalis, male genitalia (dorsal view).

Figure 216. Psephenus palpalis, male genitalia (ventral view).

Figure 217. Psephenus usingeri, male genitalia (dorsal view).

Figure 218. Psephenus usingeri, male genitalia (ventral view).

Figure 219. Psephenus herricki, female reproductive system.

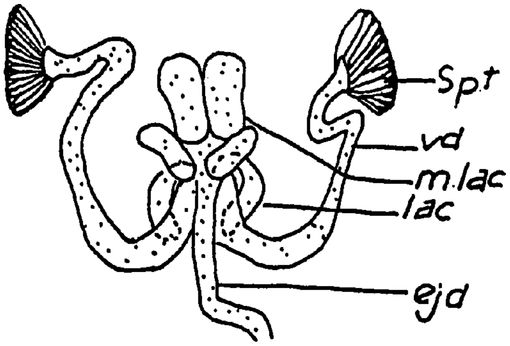
Figure 220. Psephenus herricki, ovipositor (dorsal view).

Figure 221. Psephenus herricki, ovipositor (ventral view).

PLATE XX (continued)

Figure 222. *Psephenus palpalis*, ovipositor (dorsal view).

Figure 223. *Psephenus palpalis*, ovipositor (ventral view).



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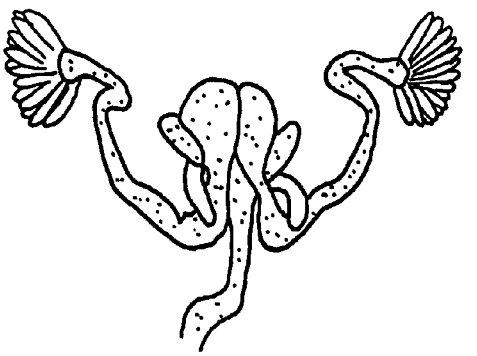

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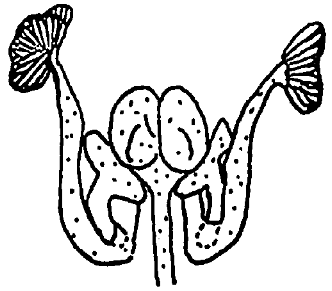

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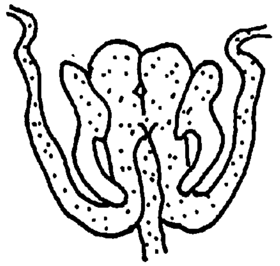

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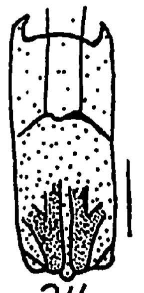

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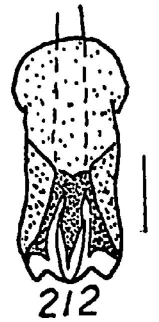

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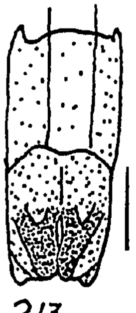

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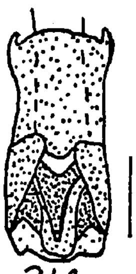

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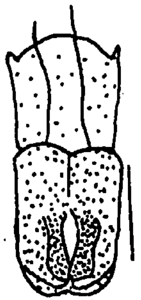

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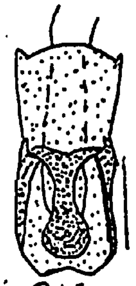

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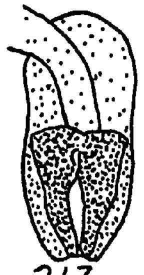

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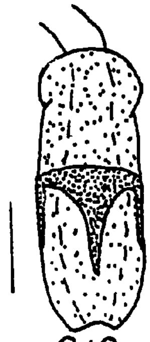

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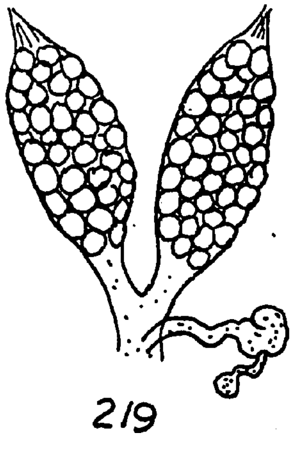

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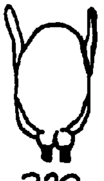

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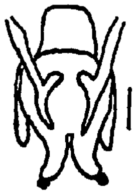


223

Psephenops Grouvelle, 1898

The genus Psephenops is a member of the sub-family Psepheninae, which also includes Psephenus. According to Champion (1913) this genus was established with a single species, Psephenops smithi Grouvelle, from the Antillean Islands of Grenada and St. Vincent. At the time only the male was known, this having a very large, elongate, acuminate-ovate fourth joint on the maxillary palp.

Champion (1913) described a new species, P. grouvellei from Guatemala, based on what he believed was a single female specimen. Darlington (1936) states that Champion's specimen of P. grouvellei is now believed to be male rather than female, and that a female specimen from the type locality of P. smithi and called Xexanchorinus latus by Grouvelle, is probably the female of P. smithi.

Darlington (1936) described two other species of this genus, P. maculicollis from Colombia and P. haitianus from the West Indies.

In males the dilated first and second joints of the front, middle, and in some species, also the hind tarsi, plus the expanded pubescent soles, appear as readily distinguishable features of the genus.

The morphology of 2 new species of Psephenops from Mexico is described here: Psephenops sp. A from Rio Escopetazo near Ixtapa, Chiapas, collected November, 1964; and Psephenops sp. B from Rio de Chalma, Cocoyotla, Morelos, collected October, 1964.

External Morphology

Psephenops sp. A (new). Six females and a single male were collected. Females measured 3.5 - 3.7 mm long and 1.5 - 1.7 mm across the elytral humeri. The same dimensions for the male were 3 mm and 1.3 mm, respectively.

Female - Psephenus-like, body depressed and oval, and moderately pubescent. The dorsal head region (Fig. 224) is divided into two visibly distinct regions. The anterior region extending from just behind the eyes to the apex of the frons forms a densely pubescent patch. The pubescence extends behind and beneath the eyes to form a brown pubescent patch on each gena. The posterior limits of the pubescent region is marked by a weak transverse impression. A well-defined groove extends posteriorly from the transverse impression to the posterior margin of the head in a median longitudinal plane. On either side of the groove the vertex region is raised to form a prominent area. The antennae (Fig. 225) have the two basal joints slightly enlarged. The first joint is slightly less than twice the length of the second, and the third only slightly longer than the second. The terminal joint is acuminate and approximately the same length as the third, which is longer than any one of segments 4 - 10. The antennae are not serrate. The maxillary palpi (Fig. 226) are less than 1/3 the length of the antennae and extend slightly beyond the tip of the second antennal joint; the second joint is approximately 2.5X the length of the short first segment. The clypeus and labrum (Fig. 229) are distinctly arcuate and of nearly equal width. The labium (Fig. 232) is as shown.

The pronotum (Fig. 234) is darker than the elytra, wide at the base and narrowed at the apex. The anterior margins have rounded angles, the base is lobed at the middle and emarginate, and the lateral margins explanate. The basal third of the pronotum bears a relatively wide carina with basal impressions on both sides. The prosternum (Fig. 236) has its process expanded immediately anterior to its apex.

The meso-metasternum is shown in Figure 238.

The elytra (Fig. 240) have independently rounded apices and diverge beginning at the apical fifth. Weak stria-like sculpturing is present on each elytron, and hairs arise from minute punctae. Each elytron of the female is distinctly wider at the apical third.

The scutellum (Fig. 242) is transverse, with the margin of the apex rounded and without emargination or indentation.

The abdomen (Fig. 245) has 6 visible sternites. The first and second sternites are emarginate, the second less than the first. All others are truncate. In the dissected abdomen a small patch of minute punctae is seen on both sides of the median areas of the first and second sternites.

The legs are slender and psephenus-like.

The wing venation (Fig. 246) is much like that of Psephenus. The basal part of vein 1A is completely lost, leaving no trace and the remainder of 1A is present but barely discernible.

Male - The male differs in its external morphology from the female in those secondary sexual characteristics listed for Psephenus. These include stronger antennae and maxillary palpi, middle coxae more approximate, prothorax narrower with narrow carina, and abdomen with 7 sternites. In addition, the first and especially the second joint of each tarsus is dilated and elongate, with enlarged pubescent soles (Fig. 247)

Psephenops sp. B (new). Three males of this species were included in a collection with several males of Psephenus palpalis. No females of either Psephenops or Psephenus were collected at this particular site.

All specimens of Psephenops sp. B are larger than the male specimen of Psephenops sp. A, measuring 3.2 - 3.5 mm long and 1.3 - 1.5 mm across the elytral humeri. The dorsal surface of the head and the antennae (Fig. 227) are similar to those of Psephenops sp. A. The maxillary palpi (Fig. 228) are slightly less than 1/2 the length of the antennae and reach slightly beyond the second antennal joint. The first joint is short, the second joint is approximately 3X as long as the first, the third is shorter than the second, and the fourth joint is equal to or slightly longer than the second joint. The labrum (Fig. 230) and clypeus are arcuate at their apices and of equal or nearly equal width.. The mandibles (Fig. 231) and labium (Fig. 233) are as shown.

The pronotum (Fig. 235) is not quite 1.5X as wide as long. In other features the descriptions given for the pronotum of _Psephenops_ sp. A is also satisfactory for this species. The prosternum is shown in Figure 237.

The meso-metasternum (Fig. 239) can be compared with that of _Psephenops_ sp. A (Fig. 238) to note differences in the distance of the middle coxae in males and females.

The elytra (Fig. 241) together are approximately 0.3 - 0.4X wider than the prothorax and similar to the elytra of _Psephenops_ sp. A in all other features.

The scutellum (Fig. 243) is transverse, with the posterior margin of the apex weakly indented (in dissected specimen).

The abdomen (Fig. 244), legs, and wing venation are as in _Psephenops_ sp. A.

From the above descriptions of the external morphology of the two species they are seen to differ externally in size of the males, morphology of the maxillary palpi, and the posterior margin of the scutellum.

In P. haitianus Darlington the second joint of the hind tarsus is not dilated. This differs from the condition in both species described here.

The antennae of P. grouvellei Champion are said to be slightly serrate. The antennae of the two species described here are not serrate. In addition, segments 4 - 10 are as broad or broader than long in the two new species whereas they are said to be slightly longer than broad in P. grouvellei. The prothorax of P. grouvellei is described as almost 1.75X as wide as long. In Psephenops sp. B the prothorax is not quite 1.5X as wide as long.

The labrum of P. maculicollis is described as much narrower than the clypeus. In the two new species the labrum is equal or nearly equal to the clypeus in width.

The large, elongate fourth joint of the maxillary palpi and subtriangular scutellum in the male described for P. smithi (Grouvelle, 1898) would distinguish it from either of the Mexican species.

Therefore, these two Mexican species of Psephenops appear to represent new species.

Internal Morphology

Alimentary Canal (Figure 248). The alimentary canals of the two species are psephenus-like, in that they are frail and devoid of solid material and regenerative crypts. The midgut is approximately 1.5X as long as the foregut. The long narrow hindgut is equal in length to the midgut and foregut combined. Six Malpighian tubules are present.

Central Nervous System (Figure 249). The abdominal ganglia are fused and crowded anteriorly as in Psephenus. The first abdominal ganglion is connected beneath the ventral side of the third thoracic ganglion, and is partly obscured by it when viewed dorsally. Only six abdominal ganglia can be distinguished, the lines of fusion of the first four and the last are clearly seen, though not as well as in Psephenus. The line of fusion between the fourth and fifth abdominal ganglia is difficult to see.

Male Reproductive System (Figures 250 - 257). In the male reproductive system of Psephenops sp. A only the genitalia (Figs. 252 - 254) have been observed. The entire male reproductive system Psephenops sp. B has been observed.

The testes of Psephenops sp. B. are rounded (Fig. 250). The condition of preservation of the testes made it impossible to determine the number of sperm tubes present. The vasa deferentia communicate with the basal portions of the median lateral accessory glands, as in Psephenus. The lateral accessory glands are elongate and sac-like, but without the enlarged bulb-like basal portion which is seen in Psephenus.

The male genitalia of the two species considered here are quite different and provide an easy means for separation of the species. The genitalia of Psephenops sp. A (Figs. 252 - 253) are broader than those of Psephenops sp. B (Figs. 255 - 256). In addition to several other features easily distinguished in the figures of the genitalia of the two species, the median spicules of the species differ. This difference is seen by comparing Figure 254 and Figure 257.

Female Reproductive System (Figures 258 - 259). As stated above, only the female of Psephenops sp. A was available for study. The ovaries and accessory glands are similar to those of Psephenus in morphology (Fig. 219). The ovipositor of Psephenops sp. A is shown in Figures 258 and 259.

PLATE XXI

Figure 224. Psephenops sp. A, dorsal view of head.

Figure 225. Psephenops sp. A, antenna (male).

Figure 226. Psephenops sp. A, maxilla (female).

Figure 227. Psephenops sp. B, antenna (male).

Figure 228. Psephenops sp. B, maxilla (male).

Figure 229. Psephenops sp. A, labrum.

Figure 230. Psephenops sp. B, labrum.

Figure 231. Psephenops sp. B, mandible.

Figure 232. Psephenops sp. A, labium.

Figure 233. Psephenops sp. B, labium.

Figure 234. Psephenops sp. A, pronotum (female).

Figure 235. Psephenops sp. B, pronotum (male).

Figure 236. Psephenops sp. A, prosternum (female).

Figure 237. Psephenops sp. B, prosternum (male).

Figure 238. Psephenops sp. A, meso-metasternum (female).

Figure 239. Psephenops sp. B, meso-metasternum (male).

Figure 240. Psephenops sp. A, elytron (female).

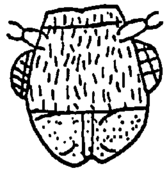
Figure 241. Psephenops sp. B, elytron (male).

Figure 242. Psephenops sp. A, scutellum (female).

Figure 243. Psephenops sp. B, scutellum (male).

Figure 244. Psephenops sp. B, abdomen (male).

Figure 245. Psephenops sp. A, abdomen (female).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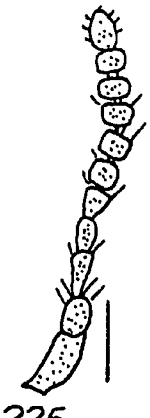
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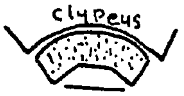

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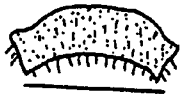
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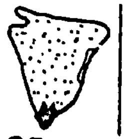
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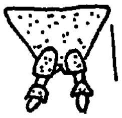
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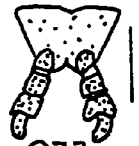
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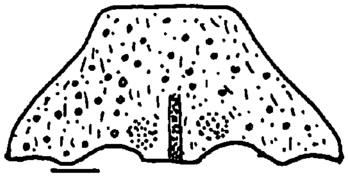
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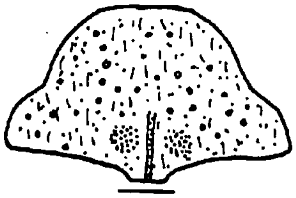
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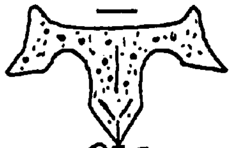
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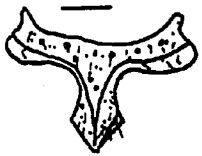
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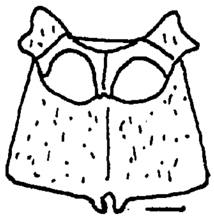
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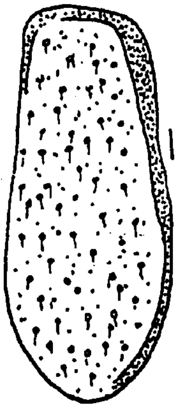
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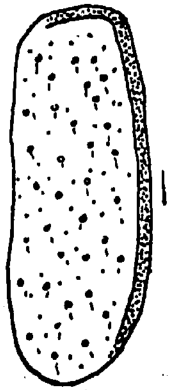
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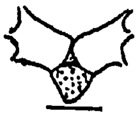
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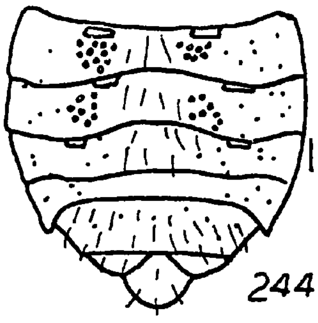
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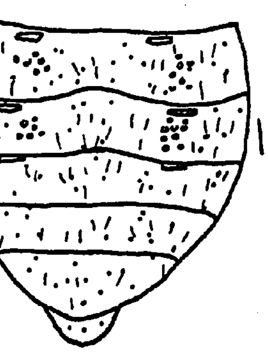
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PLATE XXII

Figure 246. Psephenops sp. A, hind wing.

Figure 247. Psephenops sp. A, tarsus (metathoracic leg).

Figure 248. Psephenops sp. A, alimentary canal.

Figure 249. Psephenops sp. A, central nervous system.

Figure 250. Psephenops sp. B, male reproductive system (dorsal view).

Figure 251. Psephenops sp. B, male reproductive system (ventral view).

Figure 252. Psephenops sp. A, male genitalia (dorsal view).

Figure 253. Psephenops sp. A, male genitalia (ventral view)

Figure 254. Psephenops sp. A, median spicule of male genitalia.

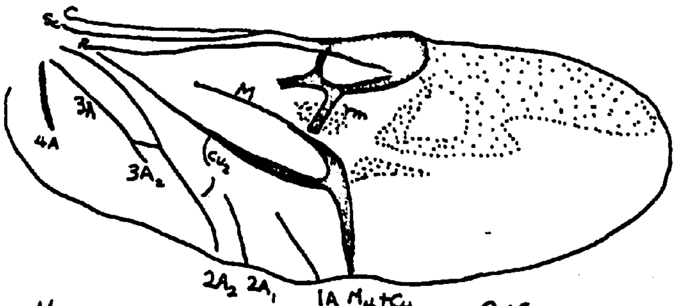
Figure 255. Psephenops sp. B, male genitalia (dorsal view).

Figure 256. Psephenops sp. B, male genitalia (ventral view).

Figure 257. Psephenops sp. B, median spicule of male genitalia.

Figure 258. Psephenops sp. A, ovipositor (dorsal view).

Figure 259. Psephenops sp. A, ovipositor (ventral view).



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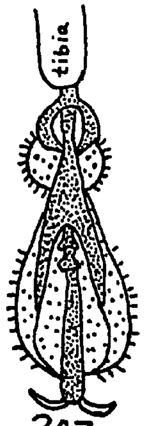

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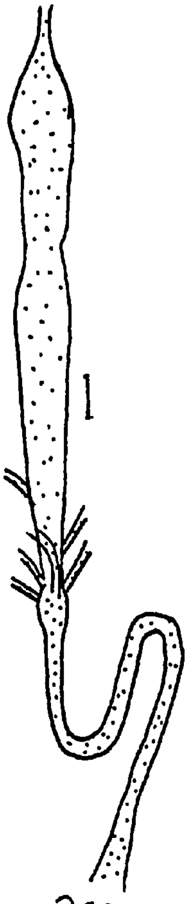

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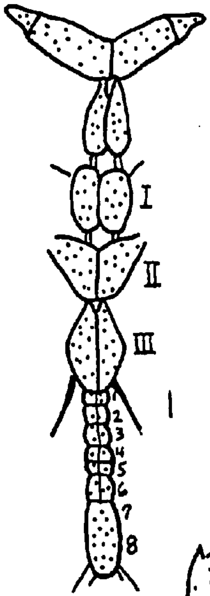

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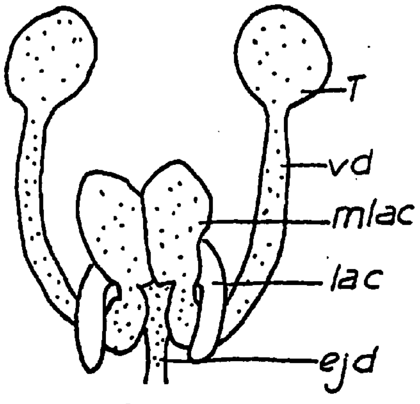

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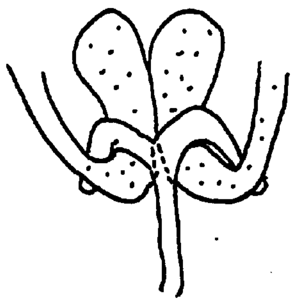

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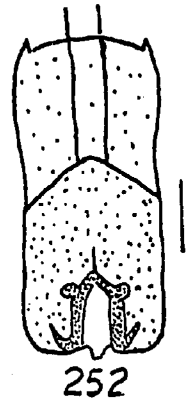

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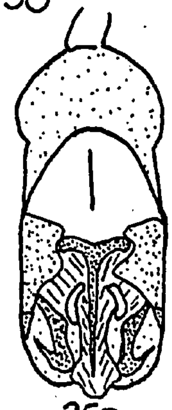

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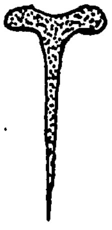

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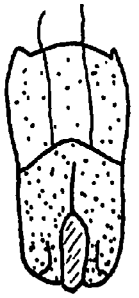

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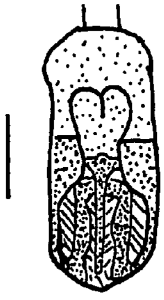

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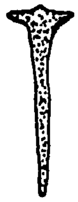

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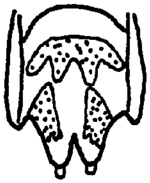

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Elmidae (Westwood, 1838)

According to Sanderson (1938) the Elmidae were considered a sub-family of Parnidae (Dryopidae) by Westwood in 1838. Leconte in his classification of Coleoptera of North America in 1861, also listed the Elmidae as a sub-family of Parnidae, and in 1920 Leng raised Elminae to family rank, using the name Helmidae (Sanderson, 1938).

Hinton (1935) recognized Elminae as a sub-family of Dryopidae, but later (1939b) raised Elminae to their present family rank.

Arnett (1963) distinguished the Elmidae on the basis of rounded anterior coxae without exposed trochantin, slender antennae, hairless eyes, and aquatic or subaquatic habits. Other descriptive characteristics which he listed include the following: Body elongate, somewhat depressed, 1 - 8 mm long; antennae inserted between eyes, well separated from the moderately curved mandibles; maxillary palpi 4-segmented.

Pronotum broader than head, irregularly quadrate, produced in front. Legs with anterior and middle coxae globose, the coxae separate; hind coxae transverse and separate; tibia slender, the apical spurs absent; tarsal formula 5:5:5, segments filiform; claws simple.

Abdomen with 5 visible sternites. Male genitalia of the trilobed type.

Hinton (1939b) has the following characteristics included in his description of the family: Female genitalia with styli symmetrical; midgut with outer surface usually smooth, rarely set with projecting regenerative crypts. Malpighian tubules usually six, but sometimes four, with distal ends free in the body cavity. Testes of one or more sperm tubes, each joined to the vas deferens by a separate vas efferens.

The morphology of 13 species belonging to 11 genera is described here. These species and their collection sites are as follows:

Disersus sp. (new) - Porto Franco, Maranhao, Brazil (June, 1964). Twelve specimens examined, 8 dissected.

Hexanchorus caraibus - St. Joseph, Martinique (May, 1965). Ten specimens examined, 5 dissected.

Phanocerus clavicornis - Las Estacas, Morelos, Mexico (October, 1964). Ten specimens examined, 6 dissected.

Macronychus glabratus - Tallawanda Creek, Oxford, Ohio (September, 1964). Ten specimens examined, 4 dissected.

Ancyronyx variegatus - Poteau River, Leflore County, Oklahoma (July, 1963). Twelve specimens examined, 7 dissected.

Pseudancyronyx perfectus - South of Porto Franco, Maranhao, Brazil (June, 1964). Six specimens examined, 4 dissected.

Zaitzevia parvula - Boulder, Colorado (August, 1964). Six specimens examined, 5 dissected.

Dubiraphia quadrinotata - Cache Creek, Comanche County, Oklahoma (July, 1963). Ten specimens examined, 4 dissected.

Hexacylloepus ferrugineus - Bryan County, Oklahoma (July, 1962). Twelve specimens examined, 5 dissected.

Microcylloepus pusillus - Devil's Den, Johnston County, Oklahoma (July, 1963). Fifteen specimens examined, 6 dissected.

Heterelmis obesa - Oaxaca, Mexico (October, 1964). Ten specimens examined, 4 dissected.

Optioservus seriatus - Mendocino County, California (July, 1954). Five specimens examined, 4 dissected.

Optioservus pecosensis (?) - Zion National Park, Utah (August, 1962); Ruidosa Downs, New Mexico (May, 1964), and Boulder, Colorado (August, 1964). Eleven specimens examined and 6 dissected.

Heterlimnius corpulentus - Phillipsburg, Montanta (August, 1934). Five specimens examined, 3 dissected.

External Morphology

Disersus sp. (new). The specimens examined here are 7.0 - 7.2 mm long and 2.2 mm across the elytral humeri. The body is elongate, subparallel and quite pubescent. The head is retractable to the submentum. The posterior portion of the vertex of the head is covered by a pubescent patch which extends to the inner margin of each eye, and is continuous with a similar patch on the upper part of the genae. The remainder of the head has a finer silky pubescence.

The other species of *Disersus* known from Brazil, *D. goudotii*, has the head glabrous (Sharp, 1882). The antenna (Fig. 260) is 11-segmented and serrate; the basal segment is 3X the length of the second. The mandible (Fig. 261) has three apical teeth and a membraneous prostheca. The maxilla (Fig. 262) has a 4-segmented palp. The labrum (Fig. 263) and labium (Fig. 264) are as figured.

The pronotum (Fig. 265) has a median longitudinal carina which is very feeble in the anterior fifth and not quite reaching to the anterior margin. The carina becomes distinct in the central area of the pronotum, but again becomes faint and disappears before reaching the basal margin. The pronotal impressions are well-defined. In the anterior third there is a strong transverse impression which is deepest and widest in the median area and narrows as it proceeds antero-laterally, giving the anterior third of the pronotum a collar-like appearance. Hinton (1940b) is in error in describing the pronotum of *Disersus* as being without a transverse impression. At the postero-lateral edges of the pronotum is a rectangular-shaped impression, and in the posterior fifth on either side of the carina is a shorter diagonal groove which terminates in a small rounded impression. The prosternum (Fig. 266) is roughly campanulate in shape. The scutellum (Fig. 267) is triangular, with the lateral margins slightly curved and terminating in a rounded point. The meso-metasternum (Fig. 268) is as figured.

Each elytron (Fig. 269) has ten punctured striae and diverges slightly at the posterior tip. The divergence of the elytra is greater in males than females. The sexes may be separated on the basis of this characteristic.

There are 5 distinct abdominal sternites (Fig. 270, a). The sixth sternite is barely visible, with only its posterior edge extending from beneath the fifth. The 5th and 6th sternites, as well as the terminal tergites differ in the sexes. The posterior margin of the 5th male sternite (Fig. 270, a) has a slight median emargination, whereas that of the female (Fig. 270, b) is more or less truncate. The difference in the fifth sternites is difficult to detect in intact specimens and hence, not very useful for sex determination. The 6th sternite of the male (Fig. 271) has its median process elongate and pointed, with the lateral processes raised to produce moderately deep sinuses. The posterior margin is broadly indented medially. The 6th sternite of the female (Fig. 272) is truncate at its anterior and posterior margins, with shallow lateral sinuses.

The terminal two tergites extend beyond the posterior tip of the elytra. The terminal tergites of the two sexes may be used to separate the sexes. The terminal male tergite (Fig. 273) is acuminate at its posterior margin, and truncate at the anterior margin. In the female the terminal tergite (Fig. 274) is rounded at its posterior margin. This characteristic is easily observed by viewing the specimens with ventral sides up.

The coxae of the prothoracic legs project laterally, whereas those of the mesothoracic legs are raised and nearly rounded. The metathoracic coxae are flattened and project laterally (Fig. 275). A feeble median sulcus is present on the lateral projections of the hind coxae. The legs, particularly the femora, are pubescent, but no tomentum is present. The claws are simple.

Figure 276 shows the venation of the hind wing.

Hexanchorus caraibus. Specimens of H. caraibus examined here measured 2.8 - 3.4 mm long and 1.0 - 1.2 mm across the elytral humeri. The dorsal and ventral surfaces of the body are covered by dense, moderately long hairs. The head, which can only be retracted into the prothorax to the base of the submentum, is covered by pubescence similar to that on the remainder of the body. The pubescence on the gena forms a distinct tomentose patch which extends behind and beneath each eye. The antenna (Fig. 277) is 11-segmented, with the basal segment slightly more than 2X the length of second segment. The mouthparts are as figured (Figs. 278 - 281).

The pronotum (Fig. 282) has the anterior third set off by a strong transverse impression similar to that described above for Disersus sp. There are also two small rounded impressions on the area of the pronotum just anterior to the scutellum, and a more or less rectangular impression at each lateral margin of the base. No carina is present on the pronotum. The prosternum (Fig. 283) is similar to that described for <u>Disersus</u> sp. The scutellum (Fig. 284) and the meso-metasternum (Fig. 285) are as figured.

Each elytron (Fig. 286) has ten punctured striae. Beginning at the inner margin of the elytron, the first 5 striae are distinct and in nearly straight lines. The next 3 striae are visible but not as clear as the first 5, due to the rows becoming more approximate and curving laterally at each end. The last two rows of striae are distinguishable only near the median lateral margin. The inner apices of the elytra are turned up vertically in females, whereas in males they are weakly diverged.

The abdomen (Fig. 287, a) has 6 visible ventral segments. The 6th segment has only its posterior margin extending from beneath the 5th segment. The 5th (Fig. 287, a and b) and the 6th sternites (Fig. 288, a and b) differ in the sexes.

All legs have fine, nearly erect setae on the ventral apex of the 4th tarsal segment. The coxae of the first two pairs of legs are raised and rounded and that of the third pair of legs transverse. All coxae are pubescent and the upper half of each femur is a brownish orange and much lighter in color than the remainder of the leg. The inner apex of the middle tibia (Fig. 289) of the male bears a very fine short longitudinal carina.

The wing venation is as figured (Fig. 290).

Phanocerus clavicornis. Hinton (1940b) has described much of the morphology of this species. My findings agree with Hinton's, except for a minor detail discussed under the male reproductive system.

Male specimens of P. clavicornis are 2.7 - 3.0 mm long and 1.1 - 1.2 mm across the elytral humeri. The body is elongate and subparallel. The body surfaces are clothed with brownish hairs approximately 50µ long. The head can be retracted only to the base of the prementum. The antenna (Fig. 291) is 11-segmented and clubbed. The length of the basal antennal segment is slightly more than 2X the length of the second. The length of the first two antennal segments equals or exceeds the combined lengths of the remaining segments. The mandible (Fig. 292) has two apical teeth. The remainder of the mouthparts are as figured (Figs. 293-295).

The pronotum (Fig. 296) has a broad longitudinal impression on each side which anteriorly turns outwards to meet the lateral margin at the apical half. There is also a median impression which fails to reach to the anterior or posterior margin. At the base of the median impression on each side is a smaller depression. The posterior margin is finely serrated. The prosternum is as figured (Fig. 297).

The mesosternal groove (Fig. 298) which receives the prosternal process merges posteriorly into a deeper depression which is partly formed by the metasternum.

The elytra (Fig. 299) bear 10 punctured striae each, the two most lateral ones being very close together. The striae are feebly impressed but become narrower and deeper towards the apex. The scutellum (Fig. 300) is flat and broader than long, with a broadly arcuate base.

The anterior margin of the second abdominal sternite (Fig. 301) is weakly emarginate medially. The 6th sternite is concealed by the 5th. The differences in the male and female 6th sternites are seen by comparing Figures 302 and 303.

The tarsal claws are simple and untoothed.(Fig. 304).

Figure 305 shows the venation of the hind wing.

Macronychus glabratus. Hinton (1940a) has described most of the morphology which characterizes the genus Macronychus. Included in his description are the following external characteristics: Body ovate, with hairy or scaly tomentum confined to 1) the genae (and front of head in one species); 2) sides of elytra; 3) epipleura; 4) most of hypomera; 5) sides of pro-, meso-, and metasternum; 6) most of the abdominal sternites; and 7) nearly all of the femora and tibiae. Head when seen from above, capable of being retracted so that none of mouthparts is visible; antennae 7-segmented; mandibles with three apical subacute teeth and membraneous prostheca. Pronotum with anterior margin moderately strongly arcuate and broadly moderately-deeply sinuate; posterior margin broadly moderately-deeply sinuate on sides. Elytra striated and punctate, each with a prominent carina on the 9th interval. Prosternum long in front of anterior coxae; prosternal process long and broad. Mesosternum with a deep and broad groove for reception of prosternal process.

M. glabratus - Of the specimens examined, males of M. glabratus measured 2.7 - 2.8 mm long and 1 mm across the elytral humeri. The same dimensions for the females were 3.1 - 3.3 mm and 1.0 - 1.1 mm. This species can be distinguished from others of the genus by the densely tomentose front portion of the head. The antenna (Fig. 306), mandibles (Fig. 307), and maxillae (Fig. 308) are as described by Hinton (1940a). The labrum (Fig. 309) is slightly rounded at its antero-lateral margins with each of these margins having dense spiny hairs. The labium (Fig. 310) is truncate at its base with the palps 3-segmented.

The pronotum (Fig. 311) is as described by Hinton (1940a) and is sparsely minutely punctate. The prosternum (Fig. 312) and the meso-metasternum (Fig. 313) are as figured.

The elytron (Fig. 314) has each puncture of the striae enclosed by a cell which is rectangular in shape or is nearly so. The scutellum (Fig. 315) is as figured.

The abdomen (Fig. 316) has the quadrate abdominal process of the first sternite separating the hind coxae. The fifth abdominal sternite is weakly indented in its median posterior margin.

The legs (Fig. 317) have simple claws without teeth.

In all specimens examined, the hind wings were reduced to scale-like rudiments.

Ancyronyx variegatus. Males are 2.0 - 2.2 mm long and 0.8 - 0.9 mm across the elytral humeri. Similarly the females are 2.2 - 2.5 mm and 0.9 - 0.95 mm. The most readily distinguishable characteristics of this species are the arrangement of red or yellow markings on the elytra (Fig. 326) and the basal tooth on each tarsal claw (Fig. 328).

The antenna (Fig. 318) is 11-segmented with segments 8 - 11 gradually increasing in size. The mouthparts (Figs. 319 - 322) are as figured.

The pronotum (Fig. 323) bears two oblique transverse depressions at the anterior third and its lateral margins are finely serrated. The anterior margin is produced and arcuate. Characteristic red or yellow markings occur at the anterior and posterior margins. The broad prosternal process (Fig. 324) has its posterior margin slightly serrated on either side of the median area. The anterior margin of the prosternum is concave.

The meso-metasternum (Fig. 325) is slightly expanded at its posterior third and darker along its lateral margins than the remaining areas.

As mentioned above, each elytron bears characteristically arranged markings. The larger of the two markings extends from the outer margin in a postero-mesial direction towards the inner margin to half the length of the elytron, and then curves back out towards the outer margin. The smaller marking is confined to the apical third of the elytron near the inner margin. The outer margin of the apical third of each elytron is finely serrated. No sublateral carina is present.

The abdomen (Fig. 327) bears very little pubescence.

Markings similar to those of the elytra and pronotum are located on the legs (Fig. 328). These markings are confined to the upper third of the femora and the entire tibiae. There are no patches of tomentum present on the tibiae. Each tarsal claw bears a basal tooth. All coxae are widely separated, so that the legs appear to arise from the sides of the body.

No specimen examined possessed a hind wing.

Pseudancyronyx perfectus. This species is 2.2 - 2.5 mm long and 0.8 - 0.85 mm across the elytral humeri. The antenna (Fig. 329) is 11-segmented and filiform. The eleventh segment is equal or nearly equal the combined lengths of segments 8 - 10, and except at its tip, is darker than any of the other segments. The mouthparts are shown in Figures 330 - 333.

The pronotum (Fig. 334) has two feeble oblique transverse depressions in the anterior third. The median and extreme lateral areas of the pronotum are red and the remaining areas a dark brown. This pigment distribution results in two dark brown areas in the form of two lateral bands extending the length of the pronotum. A feeble impression extends from the posterior median margin to approximately one-third the length of the pronotum. The prosternum (Fig. 335) is rather similar to that of Ancyronyx variegatus.

The meso-metasternum (Fig. 336) of P. perfectus is not as expanded as that of Ancyronyx variegatus. The entire surface, except at the extreme antero-lateral margins, is light brown in color. The antero-lateral margins are dark brown.

Each elytron (Fig. 337) possesses three granular carinae. The marking pattern characteristic of the species is shown in the figure of the elytron. Each elytral puncture is enclosed by a rounded cell. The scutellum (Fig. 338) has a truncate anterior margin and is pointed posteriorly.

The abdomen (Fig. 339) has the fifth sternite produced into an extended process at each posterior angle.

Each tarsal claw bears a basal tooth and the tibiae are without tomentum (Fig. 340).

The wing venation is shown in Figure 341.

Zaitzevia parvula. Z. parvula is 2.0 - 2.2 mm long and 0.8 - 0.85 mm across the elytral humeri. The body is dark brown to black in color. The antennal segments (Fig. 342) are reduced to eight, with the last segment much enlarged. The mouthparts are as figured (Figs. 343 - 346).

The median longitudinal groove of the pronotum (Fig. 347) is one of the distinguishing characteristics of the genus. The prosternum (Fig. 348) and the meso-metasternum (Fig. 349) are as figured.

Another distinguishing characteristic of the genus is the presence of three sublateral granular carinae on each elytron (Fig. 350). The determination of the number of striae is made difficult by the presence of the carinae. However, from the inner margin of the elytron to the first carina there are 4 striae in this species. The scutellum is shown in Figure 351.

The abdomen (Fig. 352) has the process of the first sternite pointed and somewhat narrowed, the hind coxae being closer together than the other coxae. The pubescence of the lateral areas of sternites 2 - 4 is dense, that of the median area being so sparse as to give the appearance of being absent. Each tibia (Fig. 353) has a patch of tomentum on its inner margin. The tarsal claws are simple.

The venation of the hind wing is shown in Figure 354.

Dubiraphia quadrinotata. This species is 2.0 - 2.3 mm long and 0.8 mm across the elytral humeri. The head possesses a continuous patch of tomentum below and behind each eye. The antenna (Fig. 355) is slender and 11-segmented. The mouthparts are shown in Figures 356 - 359.

The pronotum (Fig. 360) has its anterior margin arcuate, produced at a lateral angle, and is convex above. Its surface is smooth and evenly punctured. The prosternum (Fig. 361) has a short diagonal carina on either side. The scutellum (Fig. 362) is narrowed, truncate at its anterior margin and pointed posteriorly.

Each elytron (Fig. 363) has a longitudinal pale orange to red area which extends most of its length. Sanderson (1953) reports that the elytral spots may also be circular or absent. There are nine striae on each elytron.

The metasternum (Fig. 364) has a carina arising from the inner margin of the middle coxal cavity and extending posteriorly and obliquely for two-thirds the length of the metasternum.

The abdomen (Fig. 365) is evenly punctured, with the anterior margins of sternites 2 - 4 weakly emarginate. There is a very feeble carina extending a short distance from either side of the abdominal process of the first sternite.

The tibiae (Fig. 366) have tomentose patches on their inner lateral margins. The tarsal claws are simple.

The venation of the hind wing is shown in Figure 367.

Hexacylloepus ferrugineus. H. ferrugineus is approximately 2 mm long and 0.7 mm across the elytral humeri. The body is elongate and the dorsal and ventral surfaces clothed by short sparse hairs. In the head region a patch of tomentum is confined to the genae. The antenna (Fig. 368) is 11—segmented. The mandibles (Fig, 369) possess three acute apical teeth and a membraneous prostheca. The maxilla (Fig. 370) has a 4-segmented palp and a well-developed palpifer. The labial palps (Fig. 371) are 3-segmented. The base of the labrum (Fig. 372) has the apical margin curved.

On each side of the pronotum (Fig. 373) there is a longitudinal carina extending from the base to the apex. A median longitudinal impression extends the length of the pronotum, but is barely discernible in the basal fourth. The lateral edges of the pronotum are serrated. A tomentose band is present on the prothoracic hypomeron. The prosternum (Fig. 374) and the meso-metasternum (Fig. 375) are as figured.

Each elytron (Fig. 376) has two sublateral carinae. Seven distinct punctured striae are present, the others being obscured by the carinae. The scutellum (Fig. 377) is expanded at the middle and pointed posteriorly to give a pentagonal shape.

The abdomen (Fig. 378) has a broad but very short first sternite process, with an acute median apex.

Each tibia (Fig. 379) bears a distinct tomentose patch. Tarsal claws are simple and without teeth.

Figure 380 shows the venation of the hind wing.

Microcylloepus pusillus. M. pusillus is approximately 1.8 mm long and 0.7 mm across the elytral humeri. The gena bears a distinct tomentose patch. The antenna (Fig. 381) is 11-segmented. The mouthparts are shown in Figures 382 - 385..

The base of the pronotum (Fig. 386) is trisinuate. There is a sublateral carina on each side, extending from the apex to the base. A transverse depression is present at the anterior two-fifths. A broad median longitudinal impression begins at the base on each side in front of the recess receiving the scutellum and extends obliquely anteriorly, crossing the sublateral carinae near the middle of the pronotum. A tomentose patch extends along the lateral margins of the prosternum (Fig. 387) and the meso-metasternum (Fig. 388).

Each elytron (Fig. 389) has two distinct sublateral carinae. There are four striae between the inner margin of the elytron and the first carina. Two other striae are visible between the carinae. The scutellum (Fig. 390) is expanded at the middle and pointed posteriorly.

The abdominal sternites (Fig. 391) have a continuous patch of tomentum extending along their lateral margins.

Each leg (Fig. 392) has a patch of tomentum on the inner margin of the tibia and finer pubescence over the remainder of the leg except for the tarsus.

Figure 393 shows the venation of the hind wing.

Heterelmis obesa. Hinton (1940b) has described most of the morphology of this species. My findings agree with those reported by him.

H. obesa is 2.3 - 2.5 mm long and 1.2 - 1.5 mm across the elytral humeri. The body is elongate and subparallel and clothed by testaceous hairs arising from minute punctures. A patch of tomentum is confined to the genae. The antenna (Fig. 394) is 11-segmented. Mouthparts are as figured (Figs. 395 - 398).

The pronotum (Fig. 399) has a sublateral carina on each side which extends from the base to the anterior margin. A broad transverse impression extends across the middle of the pronotum. The prosternum (Fig. 400) has a carina on each side in the basal three-fourths and a patch of tomentum along each lateral margin.

The meso-metasternum is as figured (Fig. 401).

Each elytron (Fig. 402) has two longitudinal carinae, is punctate and striate. In the area between the inner margin and the first carina are five punctured striae, and in the area between the carinae are two punctured striae. Three striae are present between the lateral margin and the second carina. The scutellum is subovate and the surface has fine sparse punctures.

The abdominal process (Fig. 403) of the first sternite is broad and short. On each side of the process a weak curved carina extends to the posterior margin of the first sternite.

The legs except for the tarsi are tomentose. The venation of the hind wing is as figured (Fig. 404).

<u>Optioservus seriatus</u>. This species is 2.5 - 3.0 mm long and 1.0 - 1.1 mm across the elytral humeri. The head has a patch of tomentum behind and below each eye. The antenna (Fig. 405) is 11-segmented. The last three antennal segments are slightly enlarged, each being approximately 1.5X the width of the eighth segment. The mouthparts are as figured (Figs. 407, 409, 411 and 413).

The pronotum (Fig. 415) is convex and punctured, with a short carina in the basal third between the meson and the lateral margin. The prosternum (Fig. 416) is broad, narrowed between the coxae, with two divergent carinae which may reach to or near the anterior margin. The meso-metasternum is as figured (Fig. 418).

The elytra (Fig. 420) of the specimens examined have two red markings, one near the base and the other near the apex. Seven of the ten striae are distinct. The outer margin is finely serrate. The scutellum is as figured (Fig. 423).

The first abdominal sternite (Fig. 424) has a feeble carina on each side of the median lobe which does not reach to the posterior margin. Sternites 2 and 3 have lateral expansions and sternite 4 is produced at its antero-lateral margins.

Each tibia (Fig. 425) has a fringe of tomentum. The tarsal claw is simple and untoothed. The hind wing is as figured (Fig. 426).

A species of Optioservus (O. pecosensis ?) taken from localities in Utah, Colorado, and New Mexico resembles O. seriatus except for two characteristics; 1) the absence of any elytral markings (Fig. 421), and 2) a slight difference in the male genitalia.

Heterlimnius corpulentus. H. corpulentus differs from Optioservus in only a few characteristics. The antenna (Fig. 406) is 10-segmented, with the last three segments enlarged and each approximately 2X the width of the seventh. The difference in size of the three apical segments is a distinctive characteristic. The mandible (Fig. 408) has its inner margin more curved in this species than in Optioservus.. A comparison of the remaining mouthparts (Figs. 409 - 414) shows other slight differences.

The prosternum (Fig. 417) differs in shape and proportion from that of Optioservus. This is best seen in dissected specimens. The same is true of the meso-metasternum (Fig. 419).

The punctures of the elytral striae of *H. corpulentus* are not visible in an intact specimen unless viewed under magnifiaction of at least 20X. In *Optioservus* the striae appear as fine line indentations under magnification as low as 7X.

The apex of the fifth abdominal sternite of *H. corpulentus* is either truncate or emarginate, whereas it is more or less rounded in *Optioservus*. In other characteristics I find *Heterlimnius* similar to *Optioservus*.

Internal Morphology

Alimentary Canal (Figures 427 - 434). *Disersus* sp. has the outer surface of the gut smooth (Fig. 427). Eight ceca are present on the anterior margin of the midgut and 6 Malpighian tubules, some embedded in the wall of the hindgut and some ending free in the body cavity, are present.

Hexanchorus caraibus has a gut similar to *Disersus* sp. in morphology.

The alimentary tract of *Phanocerus clavicornis* (Fig. 428) has a smooth outer surface, 8 ceca, and 6 Malpighian tubules which end freely in the body cavity.

Dufour (1838) reported that the alimentary canal of *Macronychus quadrituberculatus* has six ceca on the anterior margin of the midgut. This number was confirmed by Hinton (1940a) for *Macronychus glabratus* and is also true for all specimens of this species examined here (Fig. 429).

There are 4 Malpighian tubules with their distal ends embedded in the hindgut as reported by Hinton (1940a). Dufour (1838) reported only two Malpighian tubules present in the species of *Macronychus* which he dissected. According to Hinton (1940a) no species of this genus has two Malpighian tubules. The surface of the gut of *M. glabratus* is smooth. The description of the gut of *M. glabratus* is also adequate for the species of *Ancyronyx* and *Pseudancyronyx* which were examined.

The gut of *Zaitzevia parvula* (Fig. 430) has crypts on its outer surface. Only 4 ceca were counted on the anterior margin of the midgut. The number of Malpighian tubules could not be determined due to their poor state of preservation.

Dissection of specimens of other species showed the following results in regard to the morphology of the gut:

Dubiraphia quadrinotata (Fig. 431) - Outer surface with crypts, 6 ceca, and the number of Malpighian tubules undetermined.

Hexacylloepus ferrugineus - Outer surface smooth, 6 ceca, and 4 Malpighian tubules which end freely in the body cavity.

Microcylloepus pusillus (Fig. 432) - Outer surface smooth, 2 ceca, and 6 Malpighian tubules ending freely in the body cavity.

Heterelmis obesa (Fig. 433) - Outer surface smooth, 6 ceca, and 6 Malpighian tubules ending freely in the body cavity. *Optioservus seriatus* (Fig. 434) - Outer surface with crypts, 8 ceca, and 6 Malpighian tubules embedded in hindgut. *Optioservus* sp. (*O. pecosensis*?) and *Heterlimnius corpulentus* - Similar to *Optioservus seriatus*.

Central Nervous System (Figures 435 - 440). In all of the species which were dissected there are three distinct thoracic ganglia, and except for three species, the first abdominal ganglion is fused or partly fused to the third thoracic ganglion. Only in *Disersus* sp. (Fig. 435), *Phanocerus clavicornis* (Fig. 436) and *Hexanchorus caraibus* is the fusion between the abdominal and third thoracic ganglia complete. In all others there is partial fusion or none.

In *Heterelmis obesa* (Fig. 440) and *Pseudancyronyx perfectus* (Fig. 438) abdominal ganglia 1 - 5 are distinct, and 6 - 8 partly fused as a terminal ganglion.

Microcylloepus pusillus has the first three abdominal ganglia distinct and 4 - 8 partly fused as a terminal ganglion.

In *Dubiraphia quadrinotata*, *Hexacylloepus ferrugineus* (Fig. 439) and *Disersus* sp. (Fig. 435) abdominal ganglia 2 - 5 are distinct and 6 - 8 partly fused.

Macronychus glabratus (Fig. 437) and *Ancyronyx variegatus* have abdominal ganglia 2 - 3 distinct and the remaining five fused as a terminal ganglion.

Male Reproductive System (Figures 441 - 493). In *Disersus* sp. there are four oblong lobular sperm tubes (Fig. 441). The lateral and median accessory glands are bulbous. The male genitalia are as figured (Figs. 442 - 444).

My examination of the male reproductive system of *Phanocerus clavicornis* shows it to agree with the description of this system given by Hinton (1940a) except for one minor detail. Hinton figures the testes as consisting of nearly rounded lobular sperm tubes. In all specimens I examined the sperm tubes are distinctly oblong structures (Fig. 449). This difference may be due to the state of sexual activity in the different specimens. The remainder of the system (Figs. 450 - 453) is as described by Hinton. It is interesting to note that Hinton (1940a) has reported that several other species of *Phanocerus* have male genitalia identical to those of *P. clavicornis*.

In *Hexanchorus caraibus* there are two oblong sperm tubes to each testis (Fig. 445). The male genitalia are as shown (Figs. 446 - 448).

Hinton (1940a) has described the male reproductive system of *Macronychus glabratus* (Fig. 454) as having two sperm tubes in each testis, without special seminal vesicles, and the accessory gland simple. My dissections of this species confirm this description. The genitalia are as figured (Figs. 455 - 456).

In Ancyronyx variegatus there are three sperm tubes in each testis (Fig. 457), each with a distinct vas efferens. The apex of the median lateral accessory is slightly bulbous and the lateral accessory gland ovoid. The male genitalia are shown in Figures 460 - 461.

Pseudancyronyx perfectus also has three sperm tubes in each testis (Fig. 458). The rest of the reproductive system is as figured (Figs. 458 - 459). The male genitalia are shown in Figures 462 - 464.

Zaitzevia parvula has two rounded lobular sperm tubes to each testis (Fig. 465). The lateral accessory glands are enlarged and bulbous. The male genitalia are as figured (Figs. 466 - 468).

The morphology of the sperm tubes of Dubiraphia quadrinotata was difficult to determine because they were not well preserved. However, each testis appears to consist of two lobular tubes (Fig. 469), although this could not be determined for every specimen dissected. The male genitalia are as figured (Figs. 470 - 471).

Hinton (1940b) has figured the male reproductive system of Hexacylloepus smithi. The reproductive system of H. ferrugineus (Fig. 472) is like that of H. smithi. The male genitalia of H. ferrugineus (Fig. 473) are as figured by Hinton (1940a) for this species.

Hinton (1940b) has figured the male reproductive system of Microcylloepus carinatus. My dissections of M. pusillus show its reproductive system to differ in several respects from that figured by Hinton for M. carinatus. Each testis has two rounded, lobular sperm tubes (Fig. 474). The lateral accessory glands are oblong and lobular. The median lateral accessory glands (Figs. 474 - 475) are nearly rounded, lobular and translucent, but give the distinct appearance of being coiled on the ventral side. The male genitalia are as figured (Figs. 476 - 478).

Hinton (1940b) has also described and figured the male reproductive system of Heterelmis obesa. My findings for this system (Figs. 479 - 480) are in agreement with those reported by Hinton.

In Optioservus seriatus the morphology of the male reproductive system (Figs. 481 - 482) shows some variation. There are always three sperm tubes to each testis and the median lateral gland is always oblong and lobular. The lateral accessory glands vary, however. In most cases the lateral accessory gland has a single oblong tubular portion portion which extends down from the main body of the gland and then curves in towards the midline and turns up towards the base in a hook-like fashion. In some specimens this portion of the lateral accessory gland is doubled, both arms arising from the main body of the gland at the same point, but one going to the ventral side and the other to the dorsal side of the median lateral accessory glands.

The other variations occur in the size of the genitalia and in the lateral lobes of the genitalia (Figs. 487 - 489). The variation in the lateral lobes is shown in Figure 488.

The male reproductive system of Optioservus sp. (O. pecosensis?) (Figs. 483 - 484) is quite similar to that of O. seriatus. However, in no specimen was the tubular portion found to be doubled. The male genitalia of Optioservus sp. are as figured (Figs. 490 - 492).

The male reproductive system of Heterlimnius corpulentus (Figs. 485 - 486) can only be distinguished from that of Optioservus through very careful observation. The male genitalia of H. corpulentus (Fig. 493) differs from those of Optioservus in the following ways: 1) the median lobe is stouter in Heterlimnius corpulentus; 2) the apex of the median lobe in H. corpulentus is different, and 3) the bases of the lateral lobes in H. corpulentus are more acute (less rounded).

Female Reproductive System (Figures 494 - 507). The ovaries of Disersus sp. (Figs. 494 - 495) were filled with eggs. The bursa copulatrix is much enlarged. The spermatheca which has an accessory gland, opens into the apex of the bursa copulatrix. The ovipositor is shorter than in the other species described here.

Two female specimens of Hexanchorus caraibus have been dissected. In each the body cavity was filled with eggs which obscured much of the reproductive system. The reproductive system (Fig. 496) resembles that of *Disersus*, with the major difference occurring in the morphology of the ovipositor.

Hinton (1940b) has described and figured the female reproductive system of *Phanocerus clavicornis* (Fig. 497). My findings agree with those reported by him.

The female reproductive system of *Macronychus glabratus* has also been described and figured by Hinton (1940a). My findings for this system (Fig. 498) agree with Hinton's findings.

The female reproductive system of *Ancyronyx variegatus* (Fig. 499) is similar to that of *Macronychus glabratus*. There are approximately twelve egg tubes to each ovary. The spermathecal duct opens just below the apex of the bursa copulatrix. The ovipositor is as figured.

In *Pseudancyronyx perfectus* (Fig. 500) the ovaries have their egg tubes more compactly arranged than in *Ancyronyx variegatus*. The spermatheca opens laterally into the bursa copulatrix and there is an enlarged accessory gland leading into the apex of the bursa copulatrix. The ovipositor is narrower and longer than in *Ancyronyx variegatus*.

Dubiraphia quadrinotata shows approximately eight egg tubes per ovary (Fig. 501). The oviducts of some specimens were greatly enlarged, probably due to the presence of eggs. The spermatheca enters the bursa copulatrix just below its apex. The ovipositor is as figured.

In the ovaries of *Zaitzevia parvula* (Fig. 502), all egg tubes arise from the apex of the oviduct at about the same level and each is rounded distally. The spermatheca enters the bursa copulatrix at its apex. The ovipositor is as figured.

There are 7 egg tubes per ovary in *Hexacylloepus ferrugineus* (Fig. 503). The spermatheca enters the apex of the bursa copulatrix. The ovipositor is as figured (Figs. 503 - 504).

I have been unable to determine the number of egg tubes in the ovary of *Heterelmis obesa* due to the presence of a great number of eggs. According to Hinton (1940b) there are 11 egg tubes in each ovary in this genus. The remainder of the system is as figured (Fig. 508).

The female reproductive system of *Microcylloepus pusillus* (Fig. 505) is as figured.

In *Optioservus seriatus* the spermatheca opens into the apex of the bursa copulatrix.(Fig. 507). The egg tubes are compactly arranged in the ovaries. I have been unable to detect any differences in the female reproductive systems of *Optioservus seriatus*, *Optioservus* sp. (*O. pecosensis*?) and *Heterlimnius corpulentus*.

PLATE XXIII

Figure 260. *Disersus* sp., antenna.

Figure 261. *Disersus* sp., mandible.

Figure 262. *Disersus* sp., maxilla.

Figure 263. *Disersus* sp., labrum.

Figure 264. *Disersus* sp., labium.

Figure 265. *Disersus* sp., pronotum.

Figure 266. *Disersus* sp., prosternum.

Figure 267. *Disersus* sp., scutellum.

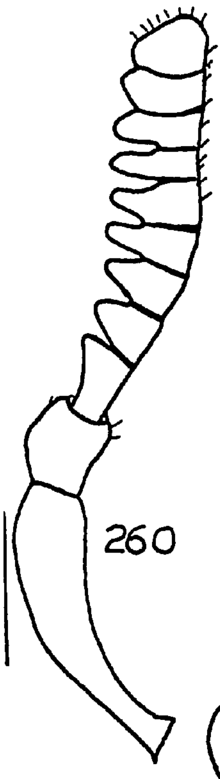
Figure 268. *Disersus* sp., meso-metasternum.

Figure 269. *Disersus* sp., elytron.

Figure 270. *Disersus* sp., abdomen.

a. Male

b. Female



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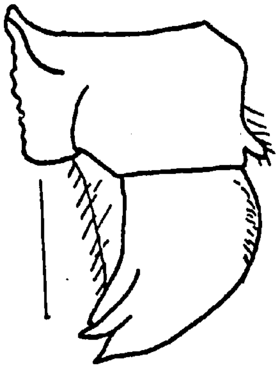

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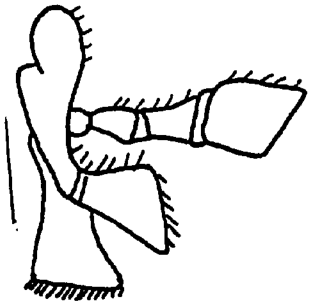

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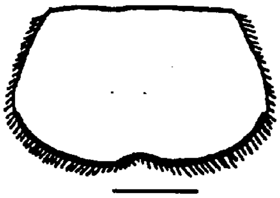

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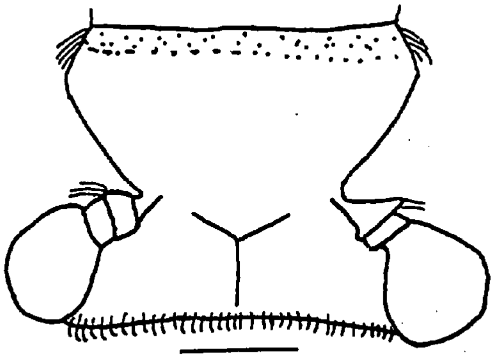

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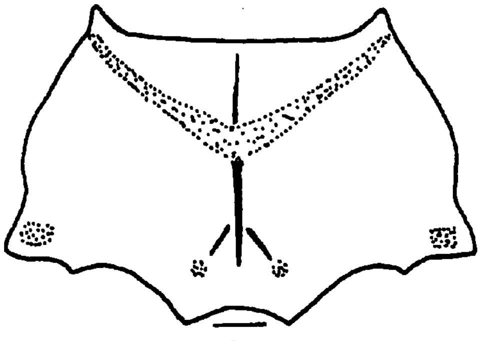

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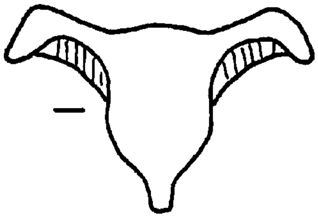

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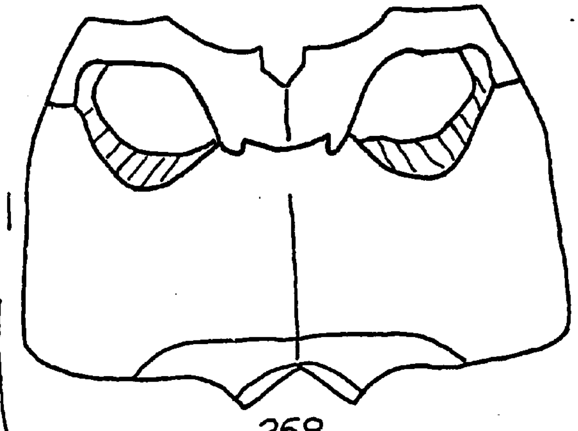

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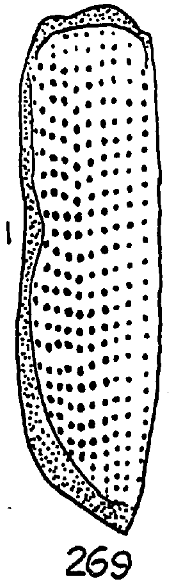

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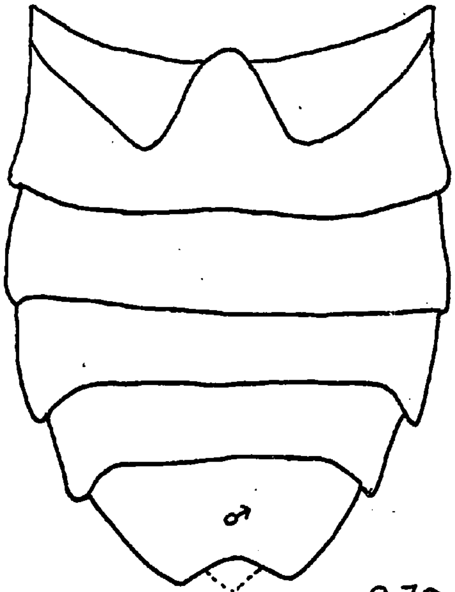

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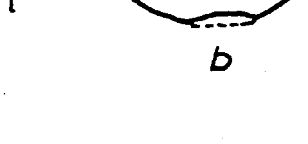

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PLATE XXIV

Figure 271. *Disersus* sp., male sternite (6th).

Figure 272. *Disersus* sp., female sternite (6th).

Figure 273. *Disersus* sp., terminal male tergite.

Figure 274. *Disersus* sp., terminal female tergite.

Figure 275. *Disersus* sp., legs.

  a. Prothoracic leg

  b. Metathoracic leg

Figure 276. *Disersus* sp., hind wing.

Figure 277. *Hexanchorus caraibus*, antenna.

Figure 278. *Hexanchorus caraibus*, maxilla.

Figure 279. *Hexanchorus caraibus*, mandible.

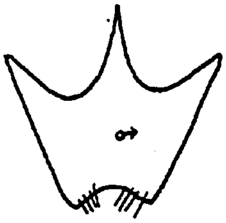
Figure 280. *Hexanchorus caraibus*, labrum.

Figure 281. *Hexanchorus caraibus*, labium.

Figure 282. *Hexanchorus caraibus*, pronotum.

Figure 283. *Hexanchorus caraibus*, prosternum.

Figure 284. *Hexanchorus caraibus*, scutellum.



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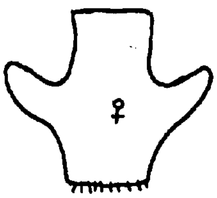

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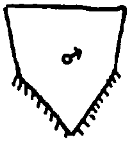

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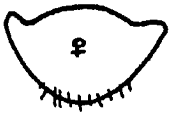

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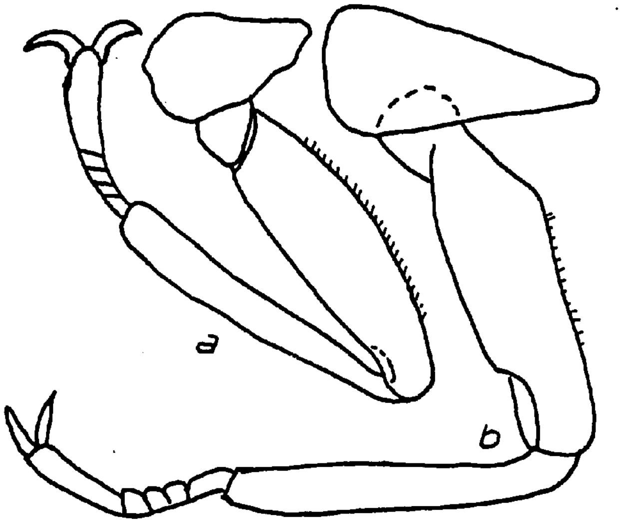

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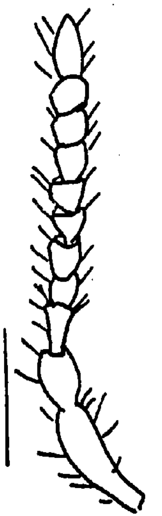

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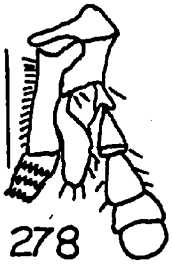

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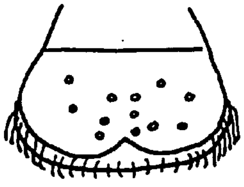

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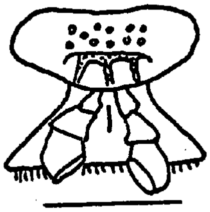

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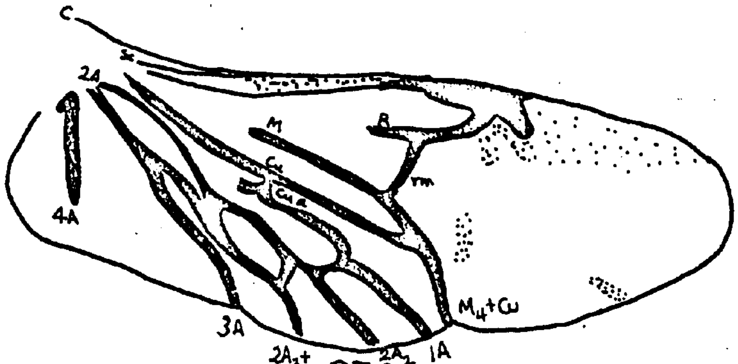

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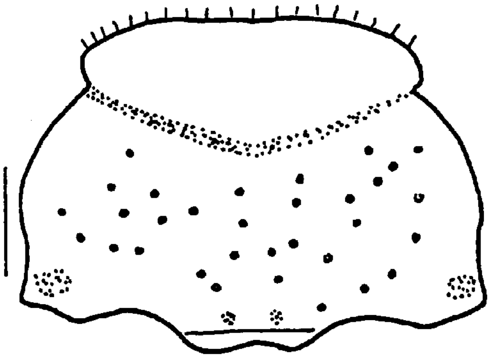

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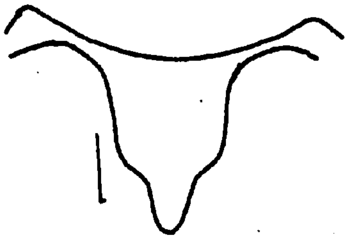

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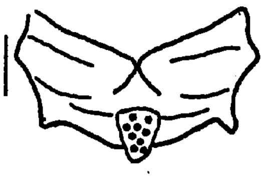

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PLATE XXV

Figure 285. Hexanchorus caraibus, meso-metasternum.

Figure 286. Hexanchorus caraibus, elytron.

Figure 287. Hexanchorus caraibus, abdomen.

a. Male

b. Female

Figure 288. Hexanchorus caraibus, abdominal sternite (6th).

a. Male

b. Female

Figure 289. Hexanchorus caraibus, mesothoracic leg.

Figure 290. Hexanchorus caraibus, hind wing.

Figure 291. Phanocerus clavicornis, antenna.

Figure 292. Phanocerus clavicornis, mandible.

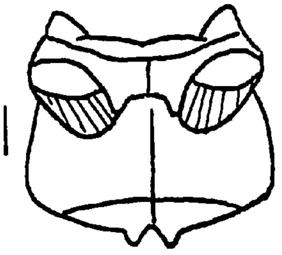
Figure 293. Phanocerus clavicornis, maxilla.

Figure 294. Phanocerus clavicornis, labrum.

Figure 295. Phanocerus clavicornis, labium.

Figure 296. Phanocerus clavicornis, pronotum.

Figure 297. Phanocerus clavicornis, prosternum.



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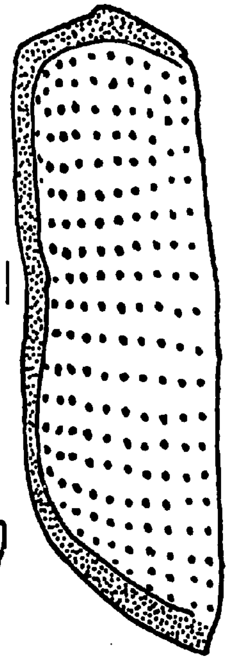

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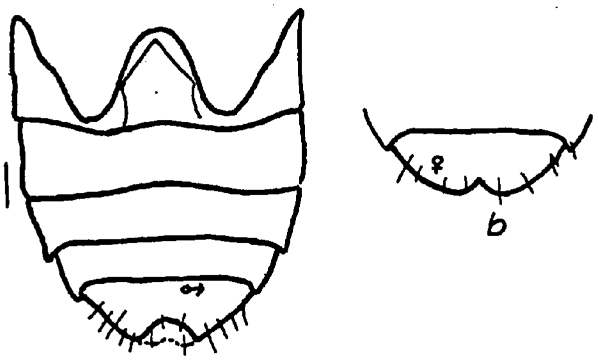

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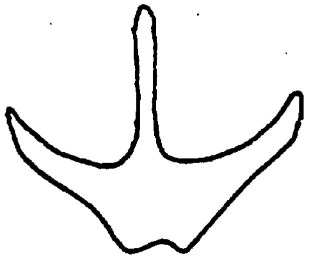

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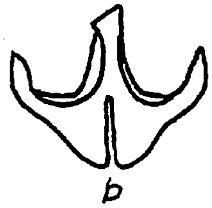

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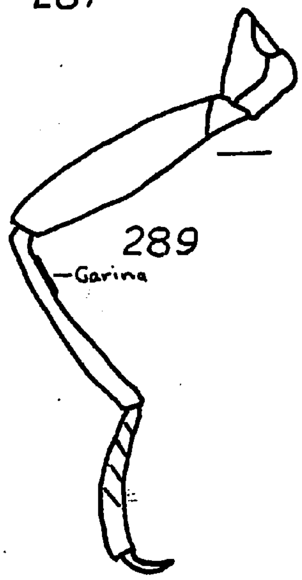

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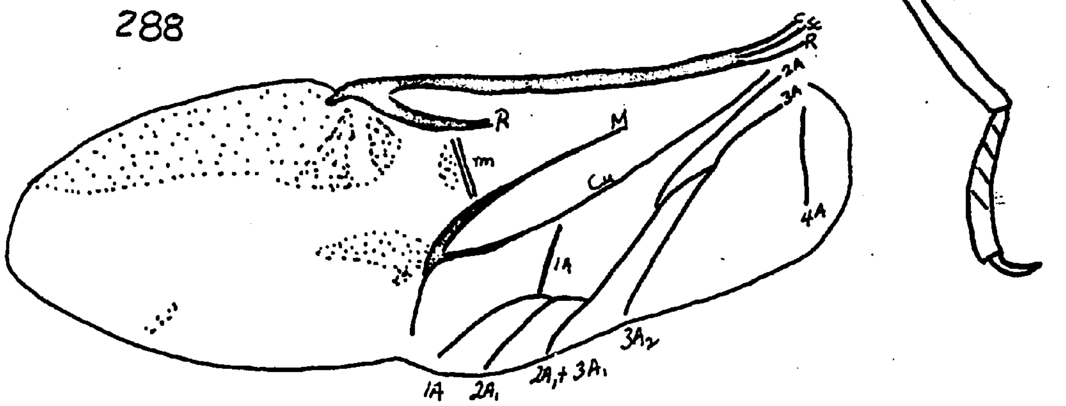

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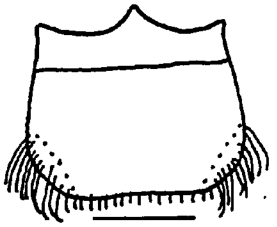

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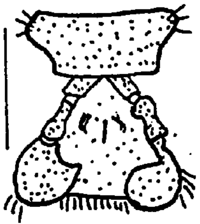

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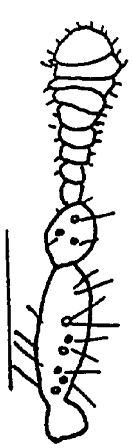

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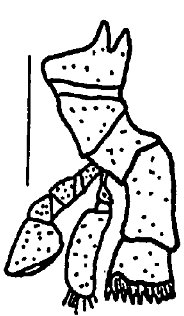

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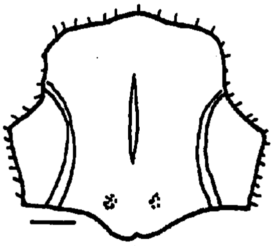

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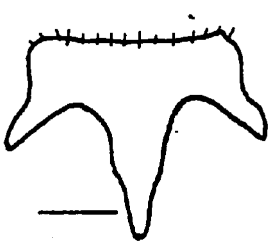

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PLATE XXVI

Figure 298. Phanocerus clavicornis, meso-metasternum.

Figure 299. Phanocerus clavicornis, elytron.

Figure 300. Phanocerus clavicornis, scutellum.

Figure 301. Phanocerus clavicornis, abdomen.

Figure 302. Phanocerus clavicornis, male abdominal sternite (6th).

Figure 303. Phanocerus clavicornis, female abdominal sternite (6th).

Figure 304. Phanocerus clavicornis, metathoracic leg.

Figure 305. Phanocerus clavicornis, hind wing.

Figure 306. Macronychus glabratus, antenna (after Sanderson).

Figure 307. Macronychus glabratus, mandible.

Figure 308. Macronychus glabratus,maxilla.

Figure 309. Macronychus glabratus, labrum.

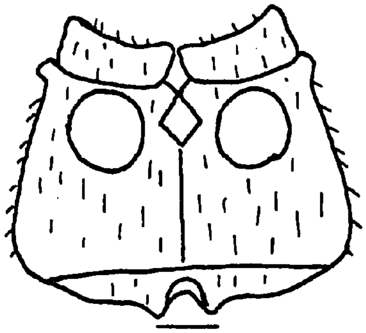
Figure 310. Macronychus glabratus, labium.

Figure 311. Macronychus glabratus, pronotum.

Figure 312. Macronychus glabratus, prosternum.

Figure 313. Macronychus glabratus, meso-metasternum.

Figure 314. Macronychus glabratus, elytron.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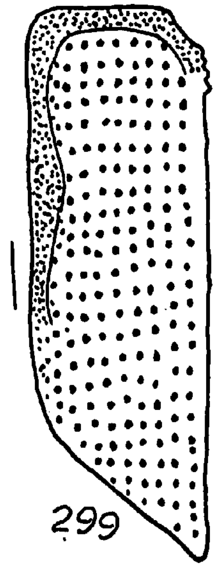
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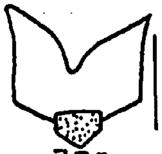
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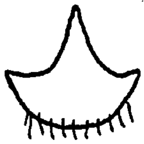
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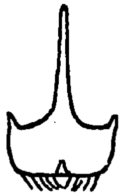
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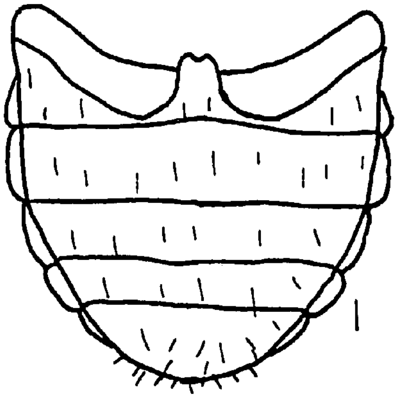
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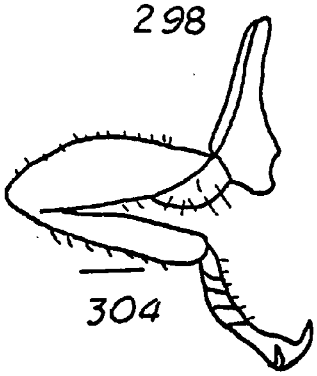
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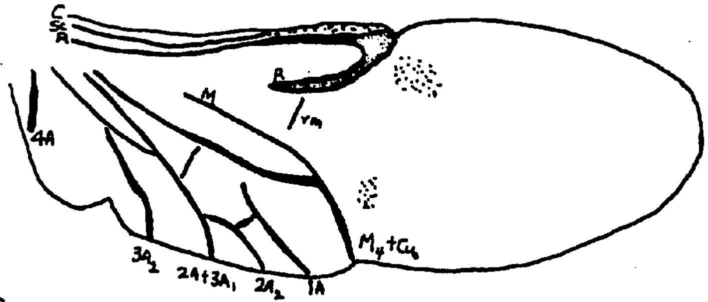

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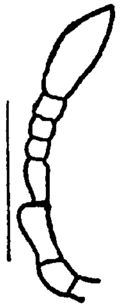
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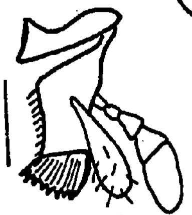
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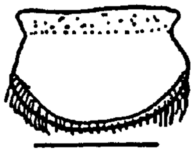
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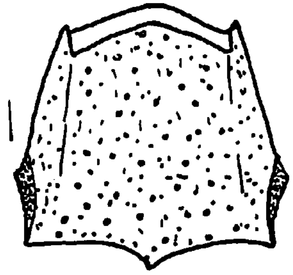
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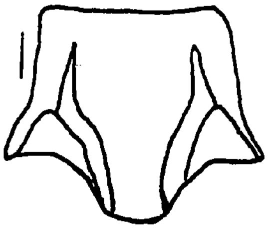
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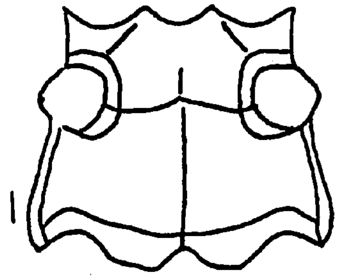
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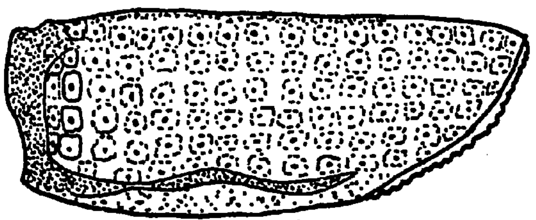
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PLATE XXVII

Figure 315. *Macronychus glabratus*, scutellum.

Figure 316. *Macronychus glabratus*, male abdomen (after Sanderson).

Figure 317. *Macronychus glabratus*, metathoracic leg.

Figure 318. *Ancyronyx variegatus*, antenna.

Figure 319. *Ancyronyx variegatus*, mandible.

Figure 320. *Ancyronyx variegatus*, maxilla.

Figure 321. *Ancyronyx variegatus*, labium.

Figure 322. *Ancyronyx variegatus*, labrum.

Figure 323. *Ancyronyx variegatus*, pronotum.

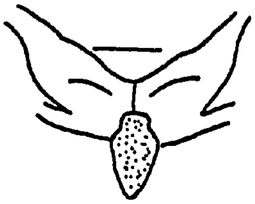
Figure 324. *Ancyronyx variegatus*, prosternum.

Figure 325. *Ancyronyx variegatus*, meso-metasternum.

Figure 326. *Ancyronyx variegatus*, elytron.

Figure 327. *Ancyronyx variegatus*, abdomen.

Figure 328. *Ancyronyx variegatus*, metathoracic leg.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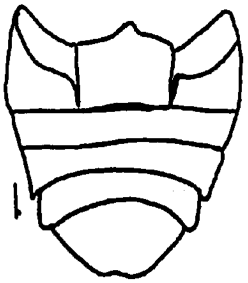
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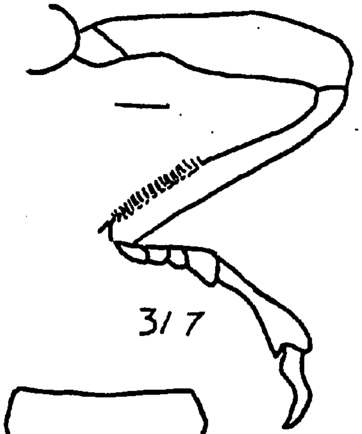
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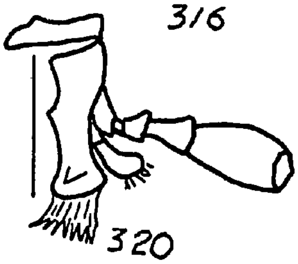
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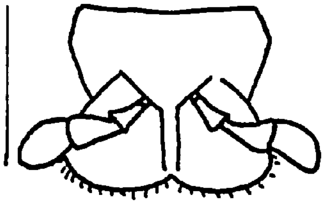
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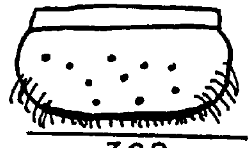
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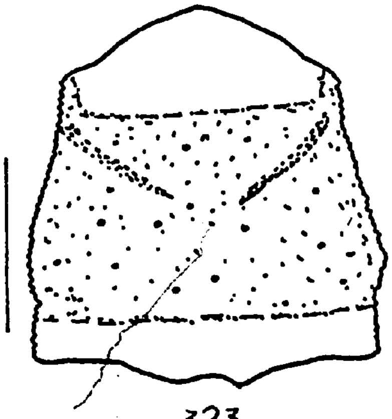
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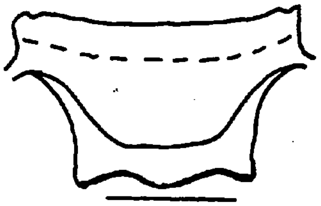
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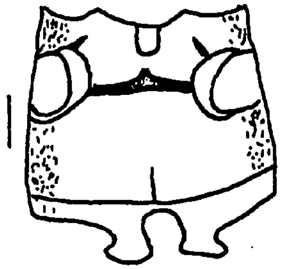
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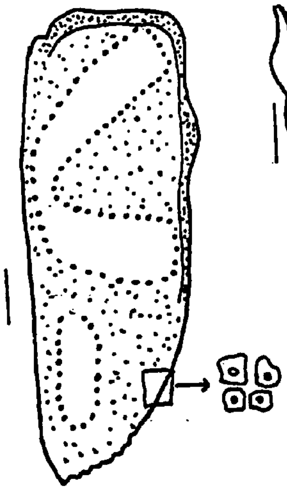
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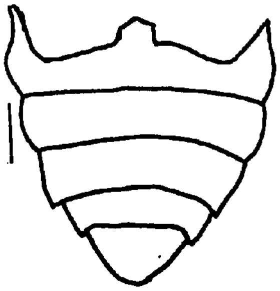
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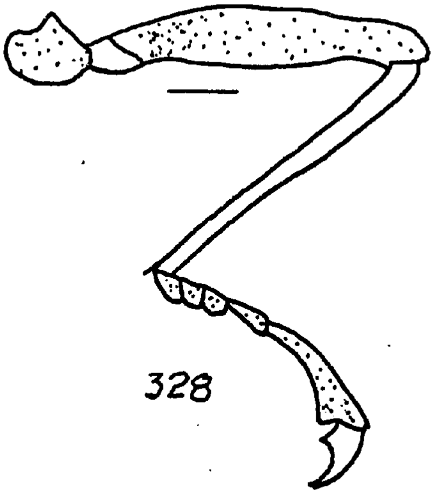
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PLATE XXVIII

Figure 329. *Pseudancyronyx perfectus*, antenna.

Figure 330. *Pseudancyronyx perfectus*, mandible.

Figure 331. *Pseudancyronyx perfectus*, maxilla.

Figure 332. *Pseudancyronyx perfectus*, labrum.

Figure 333. *Pseudancyronyx perfectus*, labium.

Figure 334. *Pseudancyronyx perfectus*, pronotum.

Figure 335. *Pseudancyronyx perfectus*, prosternum.

Figure 336. *Pseudancyronyx perfectus*, meso-metasternum.

Figure 337. *Pseudancyronyx perfectus*, elytron.

Figure 338. *Pseudancyronyx perfectus*, scutellum.

Figure 339. *Pseudancyronyx perfectus*, abdomen.

Figure 340. *Pseudancyronyx perfectus*, metathoracic leg.

Figure 341. *Pseudancyronyx perfectus*, hind wing.

Figure 342. *Zaitzevia parvula*, antenna (after Usinger).

Figure 343. *Zaitzevia parvula*, mandible.

Figure 344. *Zaitzevia parvula*, maxilla.

Figure 345. *Zaitzevia parvula*, labrum.

Figure 346. *Zaitzevia parvula*, labium.

Figure 347. *Zaitzevia parvula*, pronotum.

Figure 348. *Zaitzevia parvula*, prosternum.


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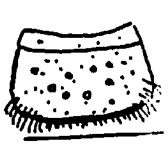
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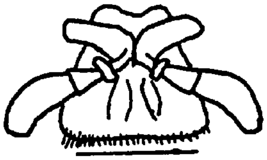
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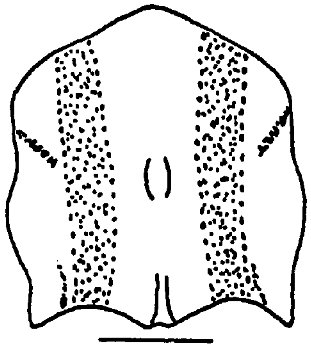
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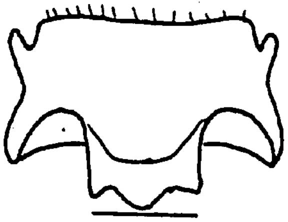
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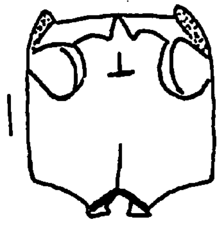
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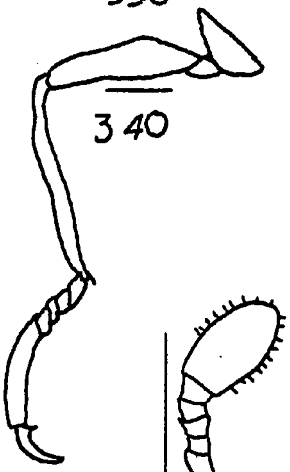
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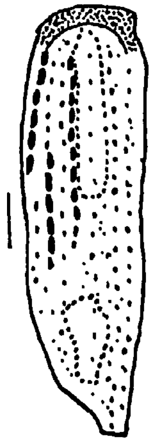
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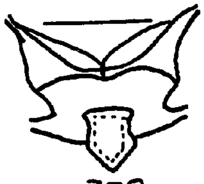
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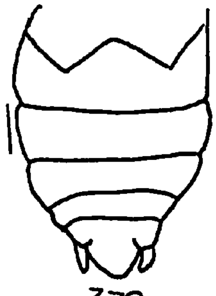
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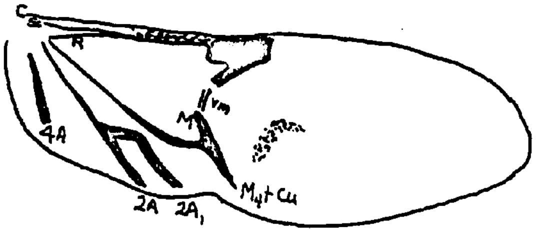

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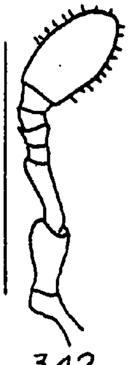
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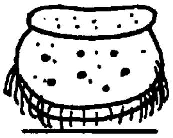
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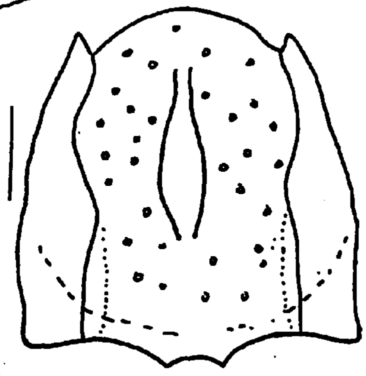
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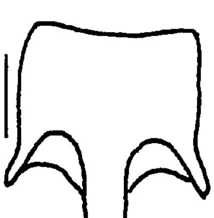
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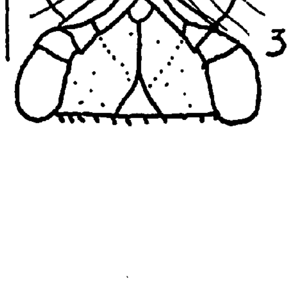
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PLATE XXIX

Figure 349. _Zaitzevia parvula_, meso-metasternum.

Figure 350. _Zaitzevia parvula_, elytron.

Figure 351. _Zaitzevia parvula_, scutellum.

Figure 352. _Zaitzevia parvula_, abdomen.

Figure 353. _Zaitzevia parvula_, metathoracic leg.

Figure 354. _Zaitzevia parvula_, hind wing.

Figure 355. _Dubiraphia quadrinotata_, antenna.

Figure 356. _Dubiraphia quadrinotata_, mandible.

Figure 357. _Dubiraphia quadrinotata_, maxilla.

Figure 358. _Dubiraphia quadrinotata_, labrum.

Figure 359. _Dubiraphia quadrinotata_, labium.

Figure 360. _Dubiraphia quadrinotata_, pronotum.

Figure 361. _Dubiraphia quadrinotata_, prosternum.

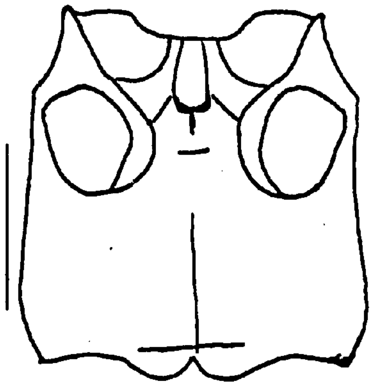
Figure 362. _Dubiraphia quadrinotata_, scutellum.

Figure 363. _Dubiraphia quadrinotata_, elytron.

Figure 364. _Dubiraphia quadrinotata_, meso-metasternum.

Figure 365. _Dubiraphia quadrinotata_, abdomen.

Figure 366. _Dubiraphia quadrinotata_, metathoracic leg.



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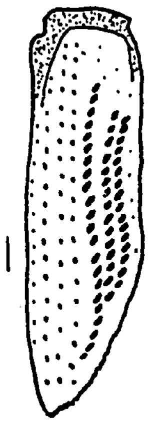

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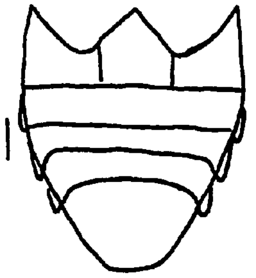

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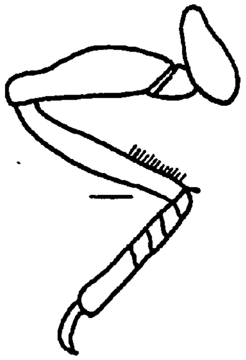

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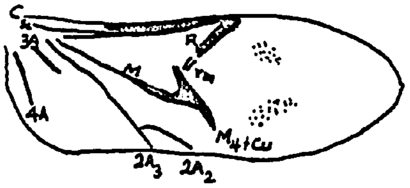

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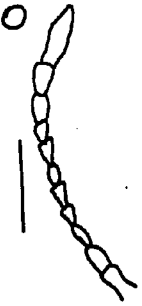

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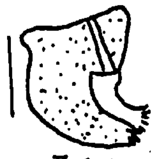

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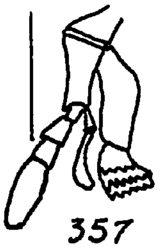

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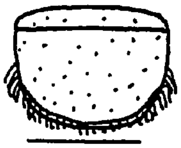

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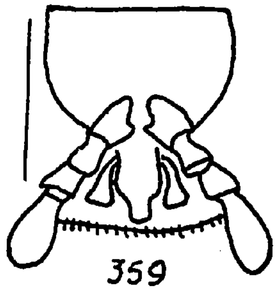

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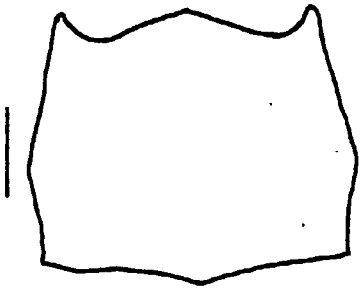

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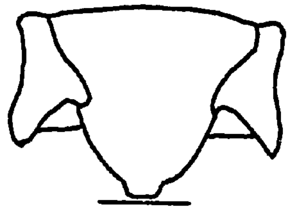

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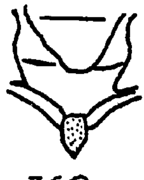

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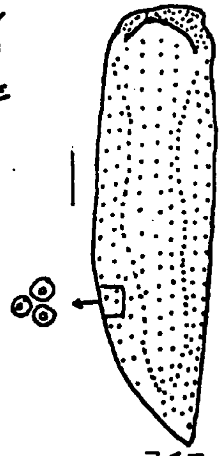

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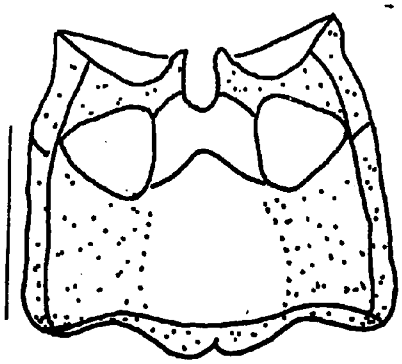

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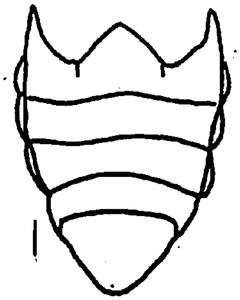

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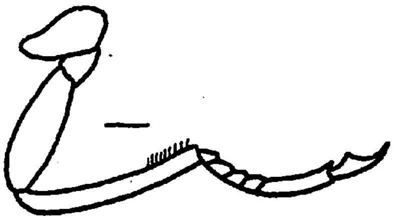


PLATE XXX

Figure 367. *Dubiraphia quadrinotata*, hind wing.

Figure 368. *Hexacylloepus ferrugineus*, antenna.

Figure 369. *Hexacylloepus ferrugineus*, mandible.

Figure 370. *Hexacylloepus ferrugineus*, maxilla.

Figure 371. *Hexacylloepus ferrugineus*, labium.

Figure 372. *Hexacylloepus ferrugineus*, labrum.

Figure 373. *Hexacylloepus ferrugineus*, pronotum.

Figure 374. *Hexacylloepus ferrugineus*, prosternum.

Figure 375. *Hexacylloepus ferrugineus*, meso-metasternum.

Figure 376. *Hexacylloepus ferrugineus*, elytron.

Figure 377. *Hexacylloepus ferrugineus*, scutellum.

Figure 378. *Hexacylloepus ferrugineus*, abdomen.

Figure 379. *Hexacylloepus ferrugineus*, metathoracic leg.

Figure 380. *Hexacylloepus ferrugineus*, hind wing.

Figure 381. *Microcylloepus pusillus*, antenna.

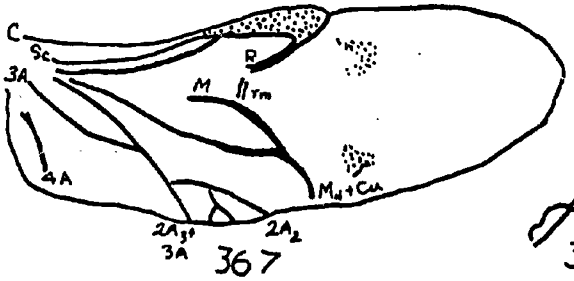
Figure 382. *Microcylloepus pusillus*, mandible.

Figure 383. *Microcylloepus pusillus*, maxilla.

Figure 384. *Microcylloepus pusillus*, labrum.

Figure 385. *Microcylloepus pusillus*, labium.

Figure 386. *Microcylloepus pusillus*, pronotum.



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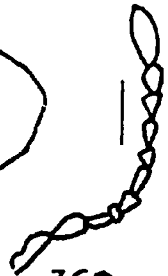

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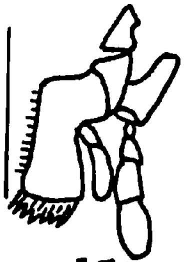

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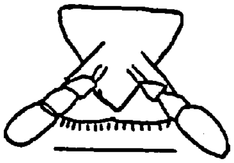

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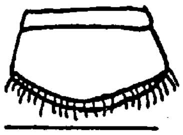

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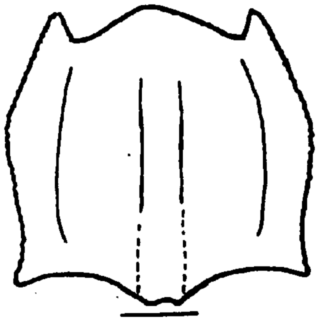

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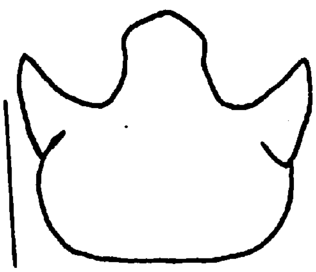

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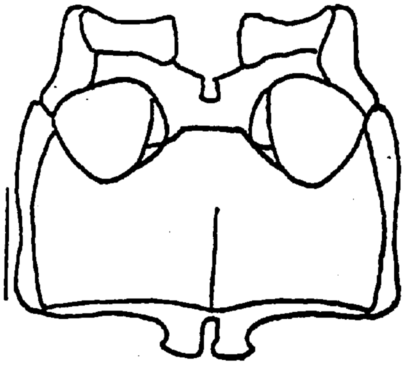

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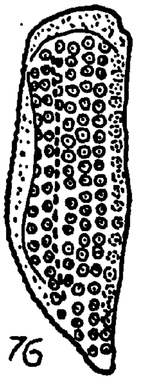

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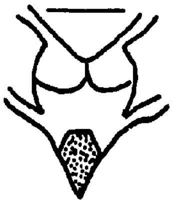

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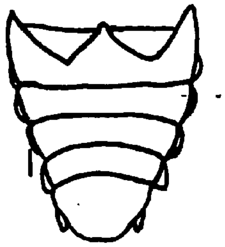

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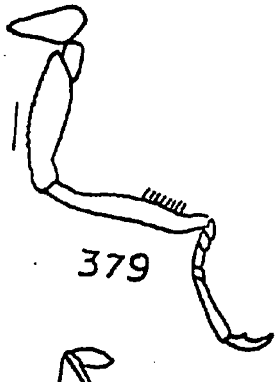

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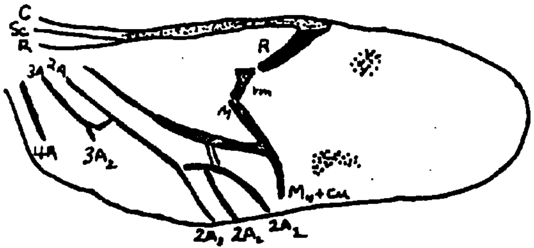

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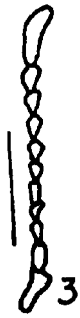

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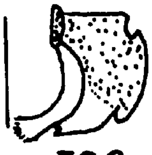

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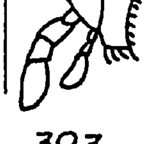

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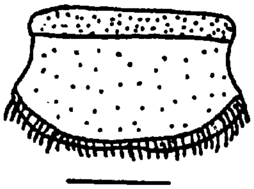

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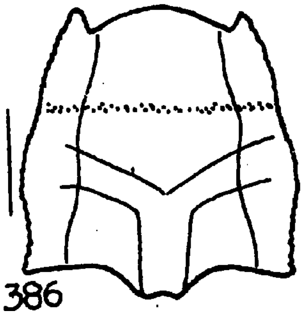

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PLATE XXXI

Figure 387. Microcylloepus pusillus, prosternum.

Figure 388. Microcylloepus pusillus, meso-metasternum.

Figure 389. Microcylloepus pusillus, elytron.

Figure 390. Microcylloepus pusillus, scutellum.

Figure 391. Microcylloepus pusillus, abdomen.

Figure 392. Microcylloepus pusillus, legs.

- a. Prothoracic leg
- b. Mesothoracic leg

Figure 393. Microcylloepus pusillus, hind wing.

Figure 394. Heterelmis obesa, antenna.

Figure 395. Heterelmis obesa, mandible.

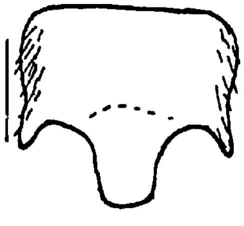
Figure 396. Heterelmis obesa, maxilla.

Figure 397. Heterelmis obesa, labrum.

Figure 398. Heterelmis obesa, labium.

Figure 399. Heterelmis obesa, pronotum.

Figure 400. Heterelmis obesa, prosternum.



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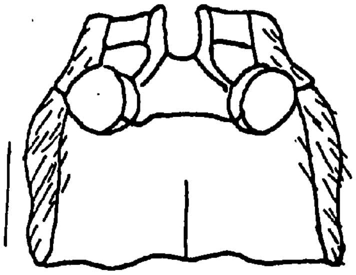

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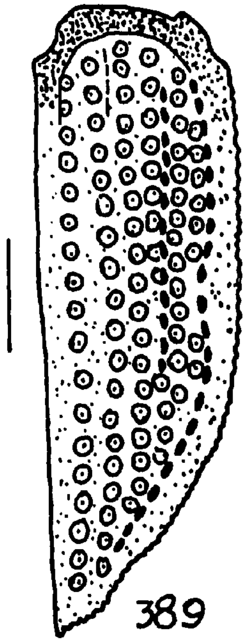

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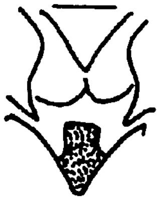

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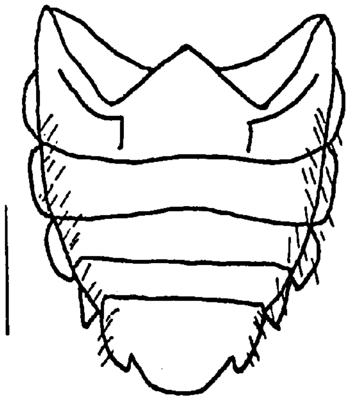

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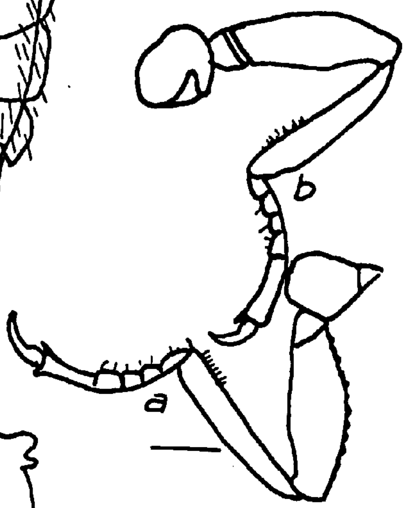

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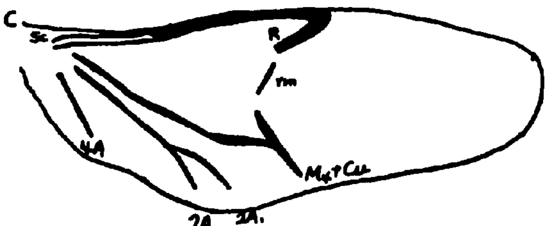

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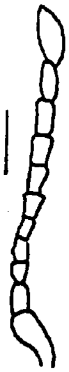

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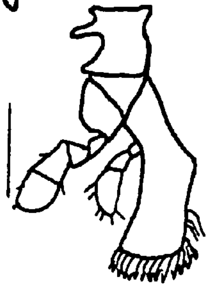

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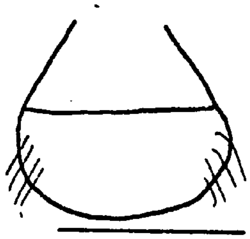

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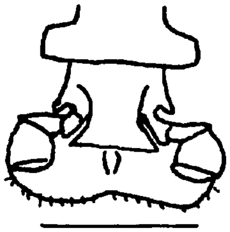

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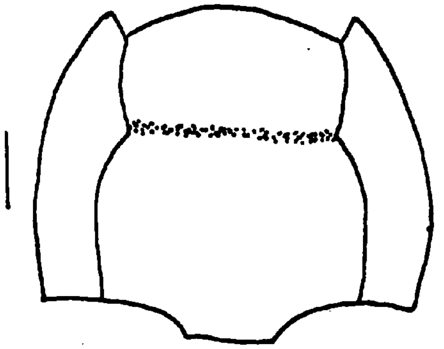

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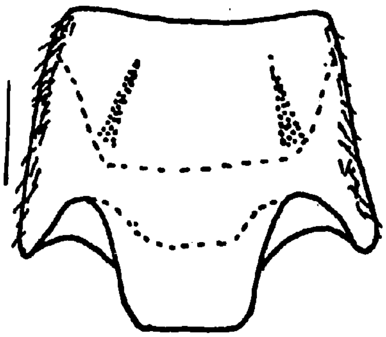

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PLATE XXXII

Figure 401. Heterelmis obesa, meso-metasternum.

Figure 402. Heterelmis obesa, elytron.

Figure 403. Heterelmis obesa, abdomen.

Figure 404. Heterelmis obesa, hind wing.

Figure 405. Optioservus seriatus, antenna.

Figure 406. Heterlimnius corpulentus, antenna.

Figure 407. Optioservus seriatus, mandible.

Figure 408. Heterlimnius corpulentus, mandible.

Figure 409. Optioservus seriatus, maxilla.

Figure 410. Heterlimnius corpulentus, maxilla.

Figure 411. Optioservus seriatus, labrum.

Figure 412. Heterlimnius corpulentus, labrum.

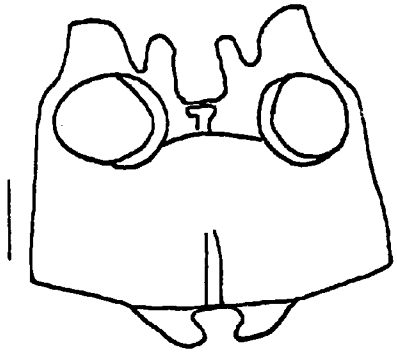
Figure 413. Optioservus seriatus, labium.

Figure 414. Heterlimnius corpulentus, labium.

Figure 415. Optioservus seriatus, pronotum.

Figure 416. Optioservus seriatus, prosternum.

Figure 417. Heterlimnius corpulentus, prosternum.



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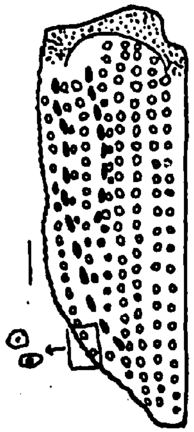

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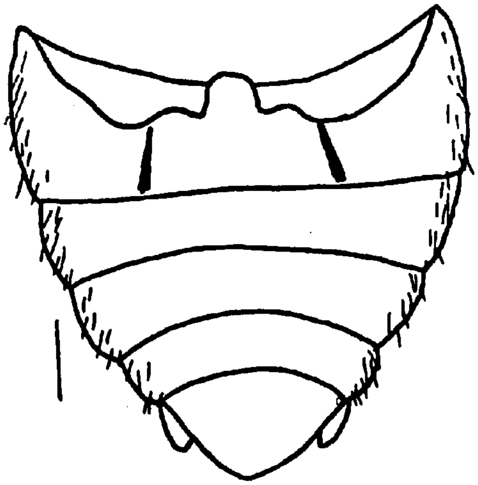

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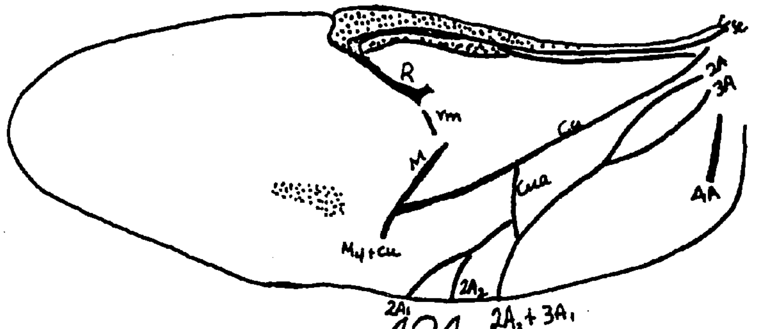

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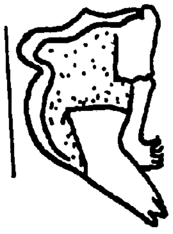

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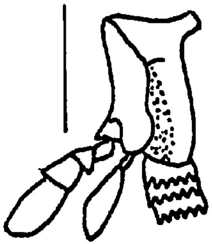

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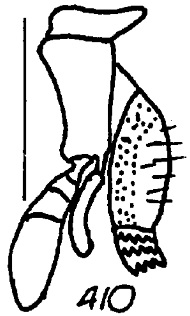

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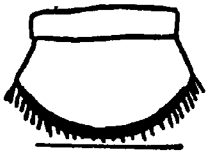

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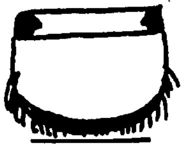

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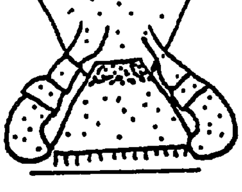

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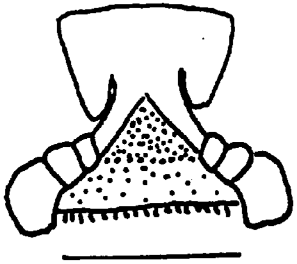

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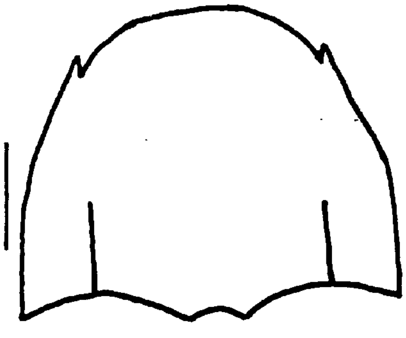

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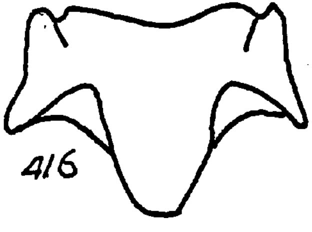

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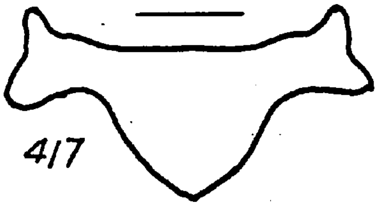

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PLATE XXXIII

Figure 418. *Optioservus seriatus*, meso-metasternum.

Figure 419. *Heterlimnius corpulentus*, meso-metasternum.

Figure 420. *Optioservus seriatus*, elytron.

Figure 421. *Optioservus* sp. A, elytron.

Figure 422. *Heterlimnius corpulentus*, elytron.

Figure 423. *Optioservus seriatus*, scutellum.

Figure 424. *Optioservus seriatus*, abdomen.

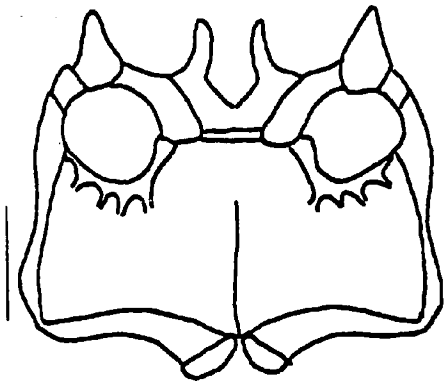
Figure 425. *Optioservus seriatus*, metathoracic leg.

Figure 426. *Optioservus seriatus*, hind wing.

Figure 427. *Disersus* sp., alimentary canal.

Figure 428. *Phanocerus clavicornis*, alimentary canal.

Figure 429. *Macronychus glabratus*, alimentary canal.



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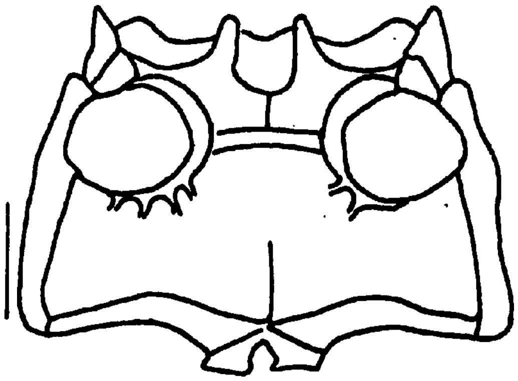

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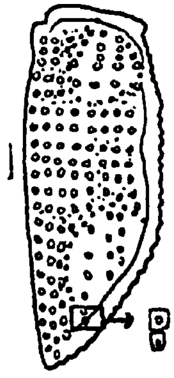

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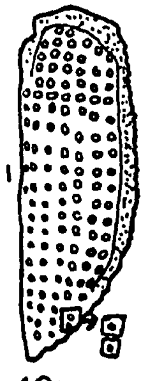

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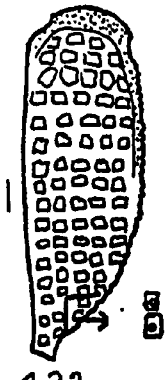

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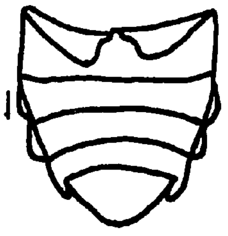

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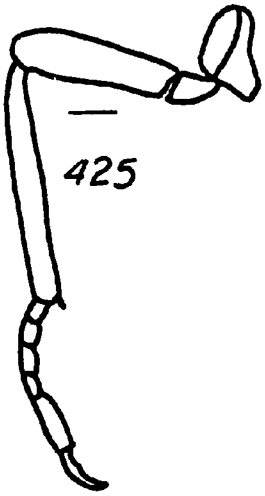

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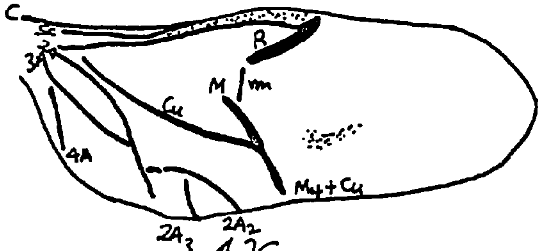

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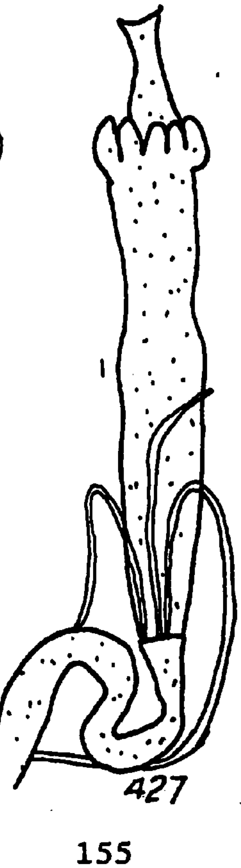

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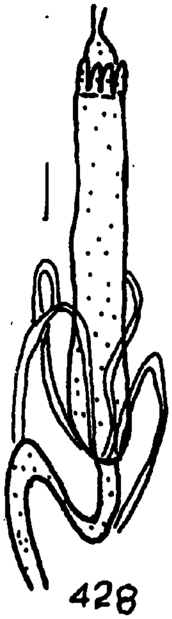

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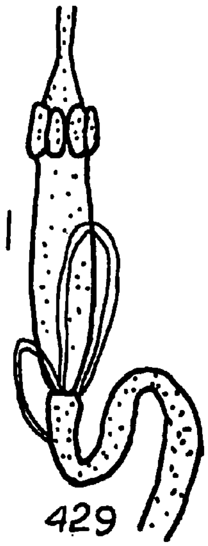

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PLATE XXXIV

Figure 430. *Zaitzevia parvula*, alimentary canal.

Figure 431. *Dubiraphia quadrinotata*, alimentary canal.

Figure 432. *Microcylloepus pusillus*, alimentary canal.

Figure 433. *Heterelmis obesa*, alimentary canal.

Figure 434. *Optioservus seriatus*, alimentary canal.

Figure 435. *Disersus* sp., central nervous system.

Figure 436. *Phanocerus clavicornis*, central nervous system.

Figure 437. *Macronychus glabratus*, central nervous system.

Figure 438. *Pseudancyronyx perfectus*, central nervous system.

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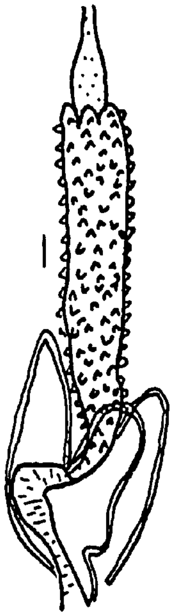

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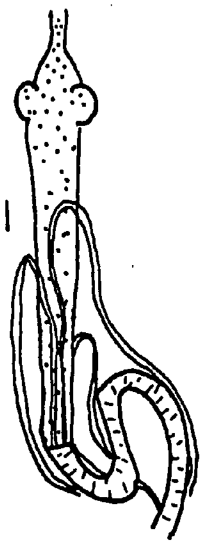

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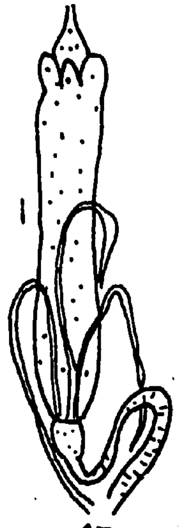

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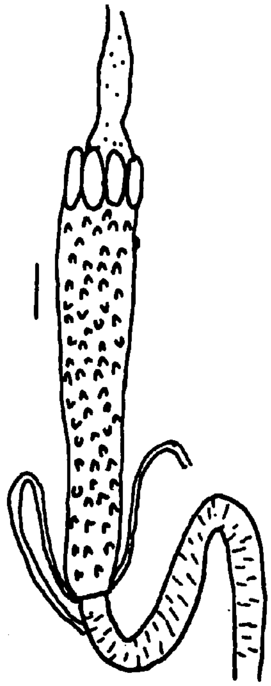

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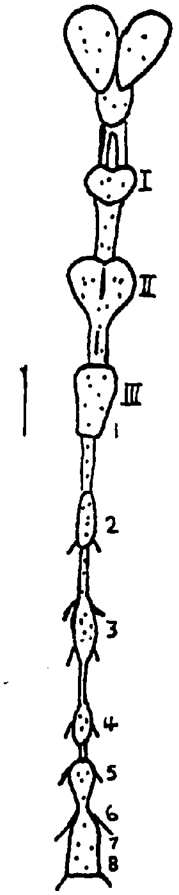

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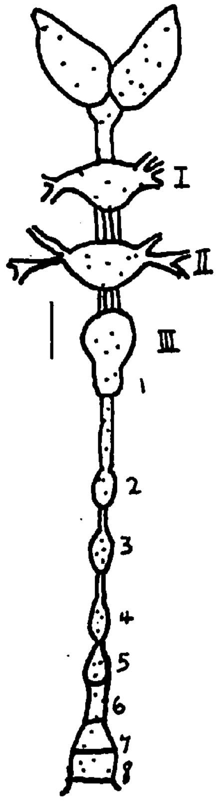

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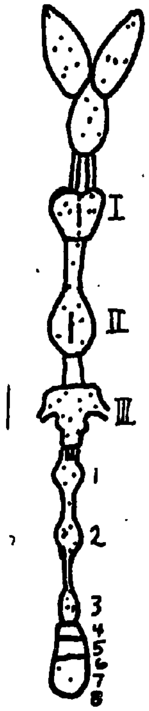

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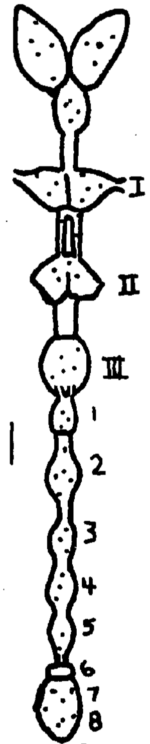

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PLATE XXXV

Figure 439. *Hexacylloepus ferrugineus*, central nervous system.

Figure 440. *Heterelmis obesa*, central nervous system.

Figure 441. *Disersus* sp., male reproductive system.

Figure 442. *Disersus* sp., male genitalia (ventral view).

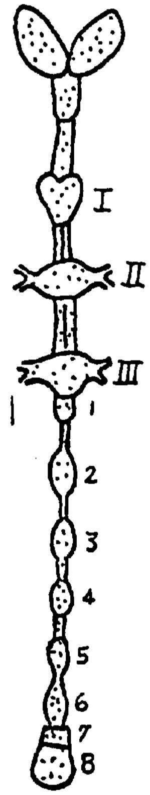
Figure 443. *Disersus* sp., male genitalia (lateral view).

Figure 444. *Disersus* sp., male genitalia (dorsal view).

Figure 445. *Hexanchorus caraibus*, male reproductive system.

Legend:

ejd - ejaculatory duct
lac - lateral accessory gland
mlac - median lateral accessory gland.
spt - sperm tube



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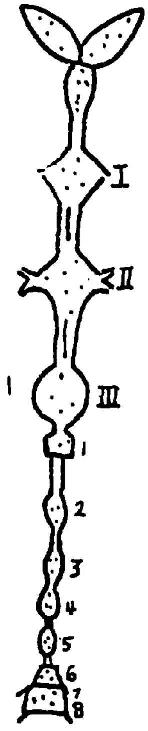

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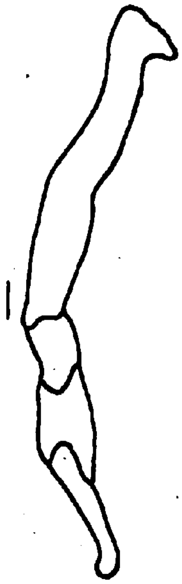

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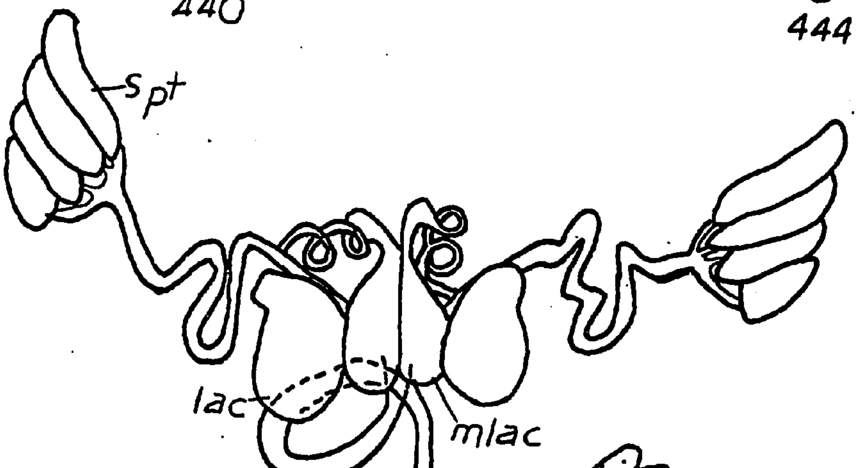

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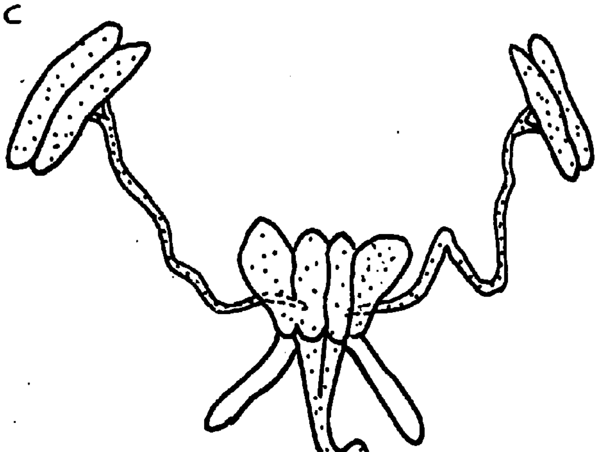

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PLATE XXXVI

Figure 446. Hexanchorus caraibus, male genitalia (dorsal view).

Figure 447. Hexanchorus caraibus, male genitalia (lateral view).

Figure 448. Hexanchorus caraibus, male genitalia (ventral view).

Figure 449. Phanocerus clavicornis, male reproductive system.

Figure 450. Phanocerus clavicornis, male genitalia (dorsal view).

Figure 451. Phanocerus clavicornis, male genitalia (lateral view).

Figure 452. Phanocerus clavicornis, male genitalia (ventral view).

Figure 453. Phanocerus clavicornis, supporting penial spicule.

Figure 454. Macronychus glabratus, male reproductive system (after Hinton).

Figure 455. Macronychus glabratus, male genitalia (dorsal view).

Figure 456. Macronychus glabratus, male genitalia (lateral view).

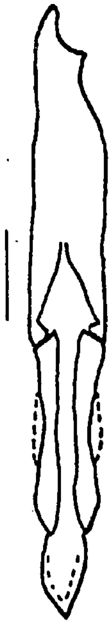
Figure 457. Ancyronyx variegatus, male reproductive system (dorsal view).

Legend:

ejd - ejaculatory duct

lac - lateral accessory gland

vd - vas deferens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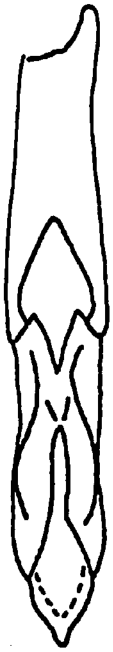
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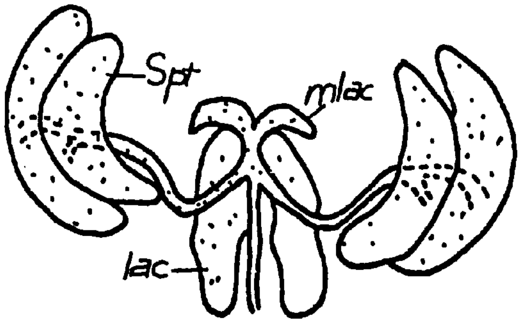

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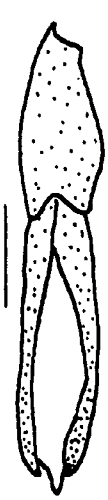
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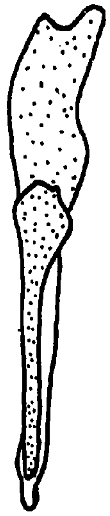
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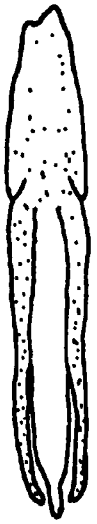
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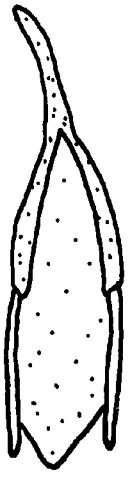
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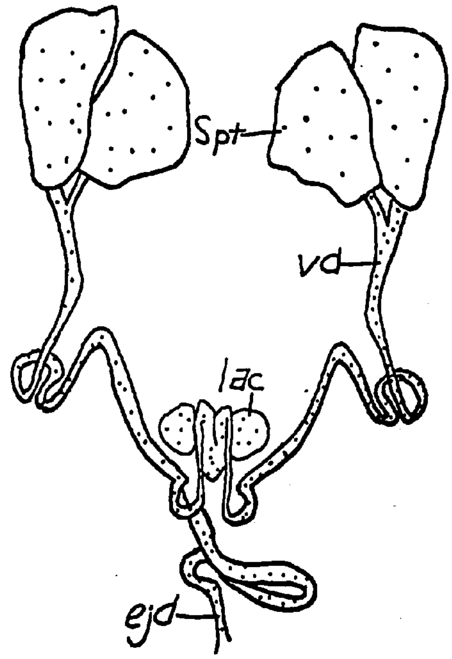

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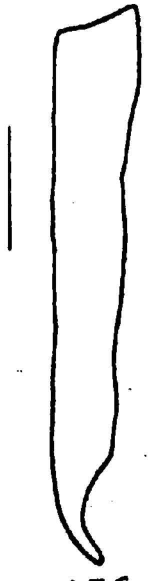
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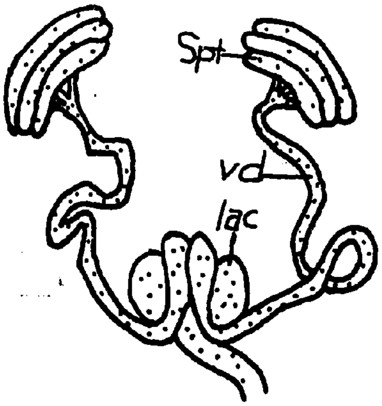

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PLATE XXXVII

Figure 458. *Pseudancyronyx perfectus*, male reproductive system (dorsal view).

Figure 459. *Pseudancyronyx perfectus*, male reproductive system (ventral view).

Figure 460. *Ancyronyx variegatus*, male genitalia (dorsal view).

Figure 461. *Ancyronyx variegatus*, male genitalia (ventral view).

Figure 462. *Pseudancyronyx perfectus*, male genitalia (dorsal view).

Figure 463. *Pseudancyronyx perfectus*, male genitalia (lateral view).

Figure 464. *Pseudancyronyx perfectus*, male genitalia (ventral view).

Figure 465. *Zaitzevia parvula*, male reproductive system.

Figure 466. *Zaitzevia parvula*, male genitalia,(dorsal view).

Figure 467. *Zaitzevia parvula*, male genitalia (lateral view).

Figure 468. *Zaitzevia parvula*, male genitalia (ventral view).

Figure 469. *Dubiraphia quadrinotata*, male reproductive system.

Figure 470. *Dubiraphia quadrinotata*, male genitalia (dorsal view).

PLATE XXXVII (continued)

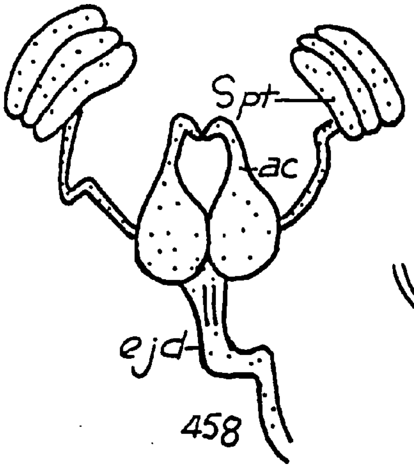
Figure 471. Dubiraphia quadrinotata, male genitalia (ventral view).

Figure 472. Hexacylloepus ferrugineus, male reproductive system.

Figure 473. Hexacylloepus ferrugineus, male genitalia (dorsal view, after Hinton).

Legend:

ac - accessory gland
ejd - ejaculatory duct
spt - sperm tube



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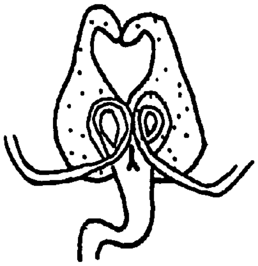

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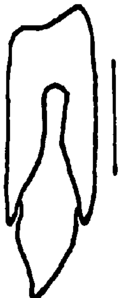

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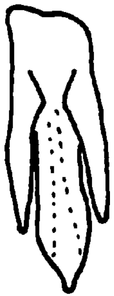

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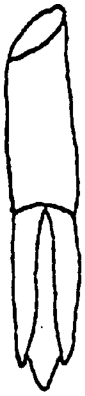

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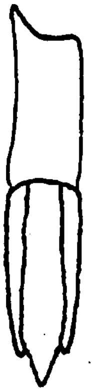

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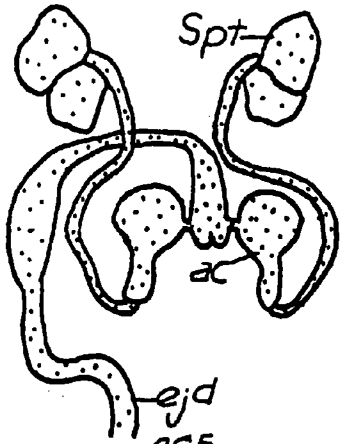

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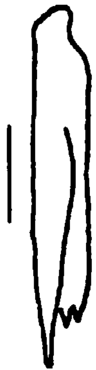

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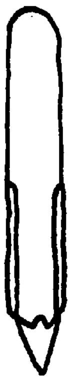

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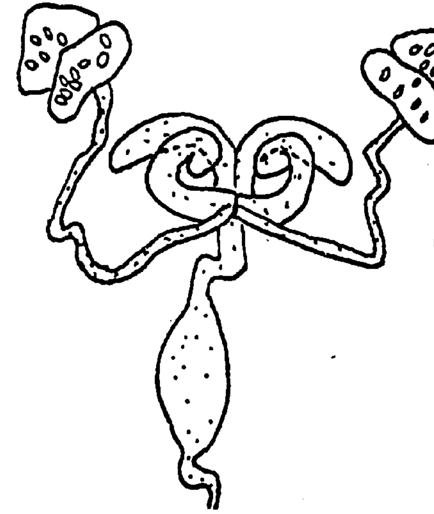

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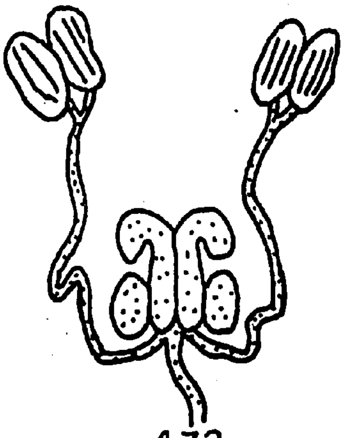

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PLATE XXXVIII

Figure 474. *Microcylloepus pusillus*, male reproductive system (dorsal view).

Figure 475. *Microcylloepus pusillus*, male reproductive system (ventral view).

Figure 476. *Microcylloepus pusillus*, male genitalia (dorsal view).

Figure 477. *Microcylloepus pusillus*, male genitalia (lateral view).

Figure 478. *Microcylloepus pusillus*, male genitalia (ventral view).

Figure 479. *Heterelmis obesa*, male reproductive system.

Figure 480. *Heterelmis obesa*, male genitalia (after Hinton).

Figure 481. *Optioservus seriatus*, male reproductive system (dorsal view).

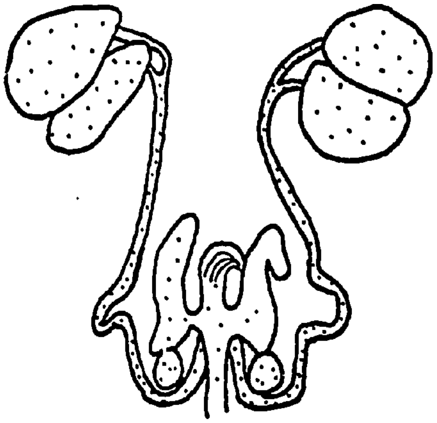
Figure 482. *Optioservus seriatus*, male reproductive system (ventral view).

Figure 483. *Optioservus* sp. A, male reproductive system (dorsal view).

Figure 484. *Optioservus* sp. A, male reproductive system (ventral view).

Figure 485. *Heterlimnius corpulentus*, male reproductive system (dorsal view).

Figure 486. *Heterlimnius corpulentus*, male reproductive system (ventral view).



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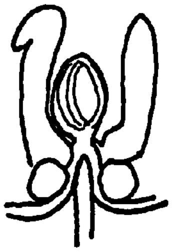

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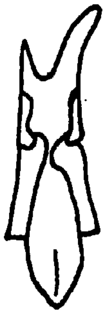

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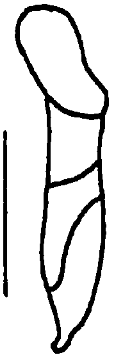

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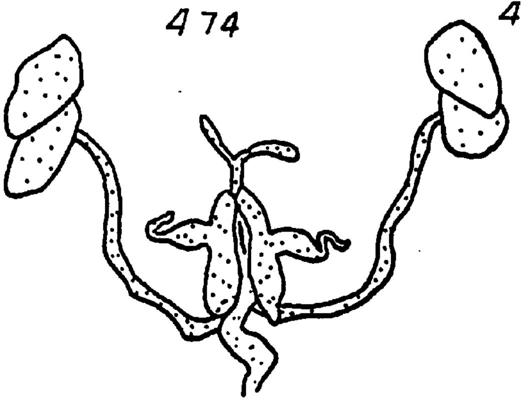

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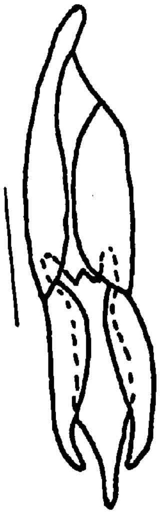

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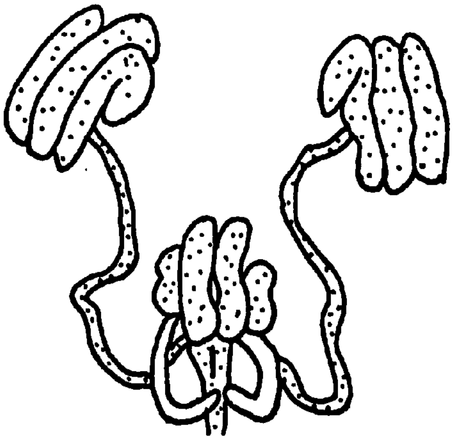

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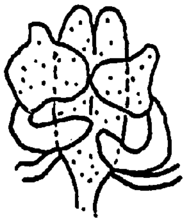

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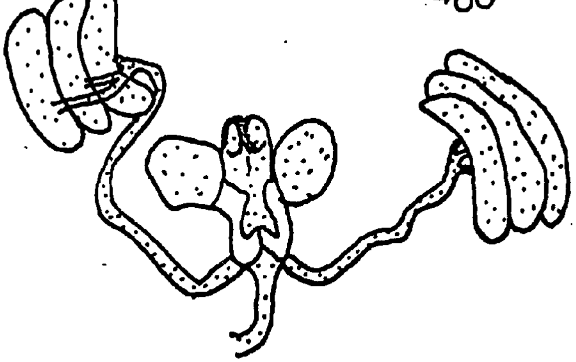

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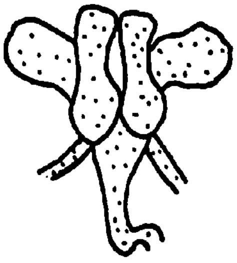

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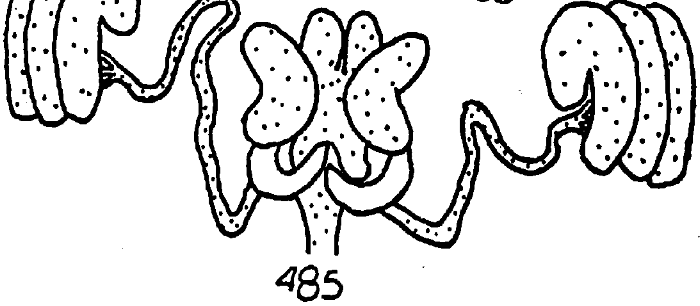

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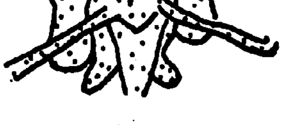

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PLATE XXXIX

Figure 487. Optioservus seriatus, male genitalia (dorsal view).

Figure 488. Optioservus seriatus, male genitalia (lateral views).

Figure 489. Optioservus seriatus, male genitalia (ventral view).

Figure 490. Optioservus sp. A, male genitalia (dorsal view).

Figure 491. Optioservus sp. A, male genitalia (lateral view).

Figure 492. Optioservus sp. A, male genitalia (ventral view).

Figure 493. Heterlimnius corpulentus, male genitalia (dorsal view).

Figure 494. Disersus sp., female reproductive system (dorsal view).

Figure 495. Disersus sp., female reproductive system (ventral view).

Figure 496. Hexanchorus caraibus, female reproductive system.

Figure 497. Phanocerus clavicornis, female reproductive system.

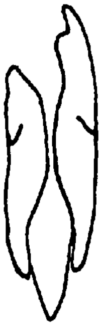
Figure 498. Macronychus glabratus, female reproductive system (after Hinton).

PLATE XXXIX (continued)

Figure 499. *Ancyronyx variegatus*, female reproductive system.

Legend:

acg - accessory gland
bc - bursa copulatrix
ovp - ovipositor
sth - spermathecal gland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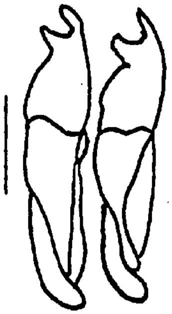
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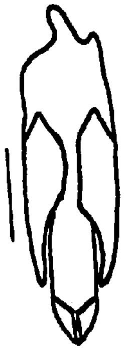
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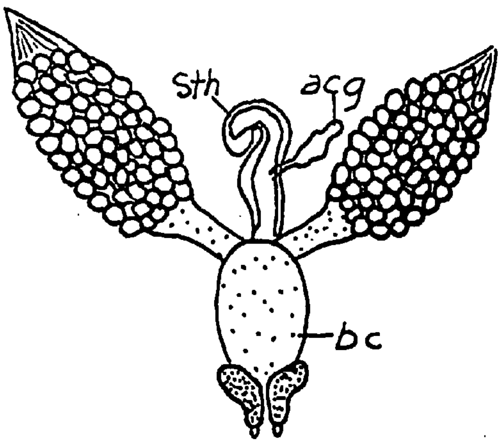

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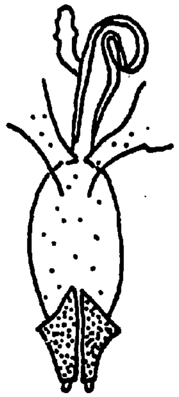
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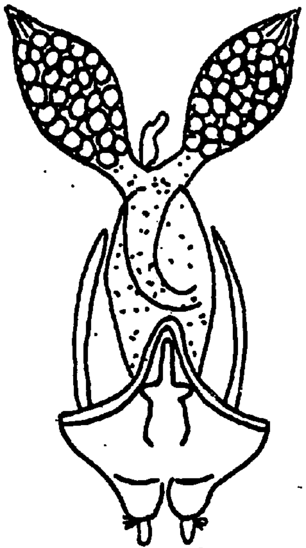
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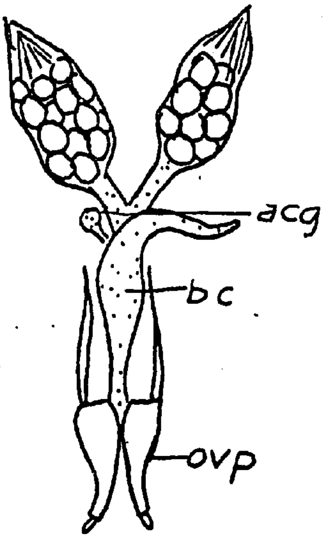

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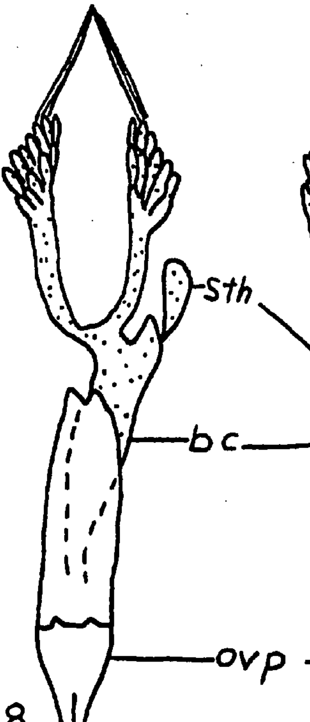

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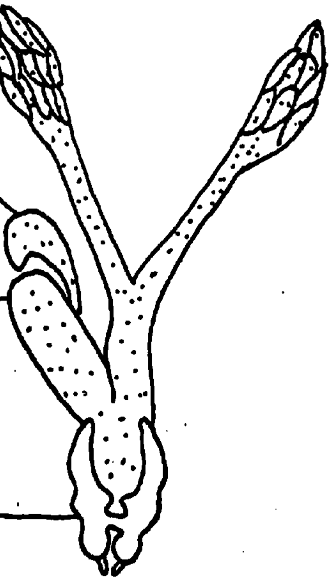
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PLATE XL

Figure 500. Pseudancyronyx perfectus, female reproductive system.

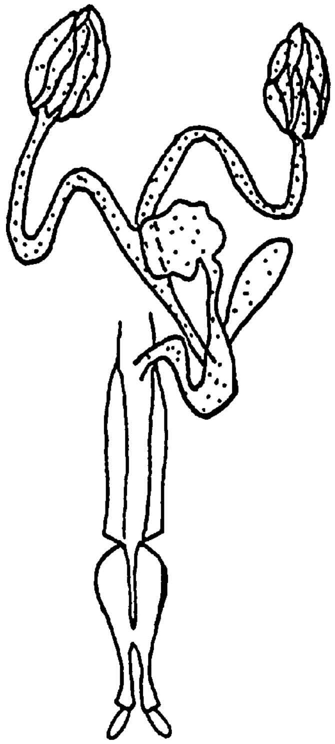
Figure 501. Dubiraphia quadrinotata, female reproductive system.

Figure 502. Zaitzevia parvula, female reproductive system.

Figure 503. Hexacylloepus ferrugineus, female reproductive system (dorsal view).

Figure 504. Hexacylloepus ferrugineus, ovipositor (ventral view).

Figure 505. Microcylloepus pusillus, female reproductive system.



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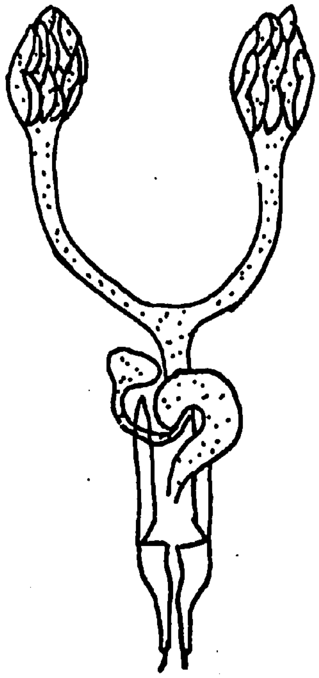

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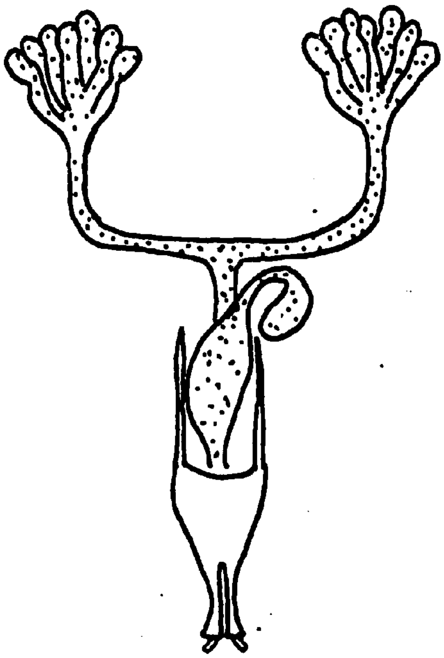

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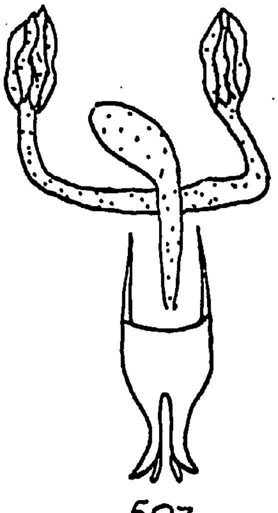

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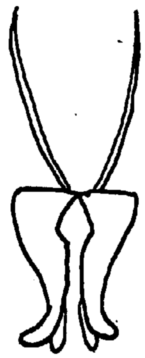

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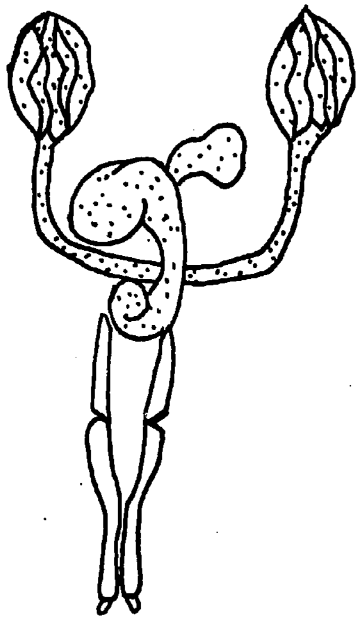

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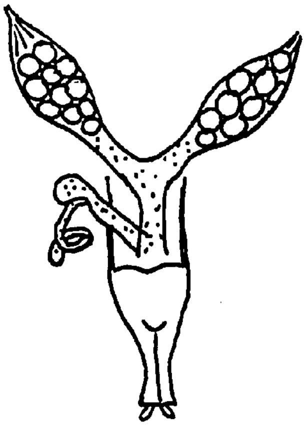
PLATE XLI

Figure 506. Heterelmis obesa, female reproductive system (after Hinton).

Figure 507. Optioservus seriatus, female reproductive system.



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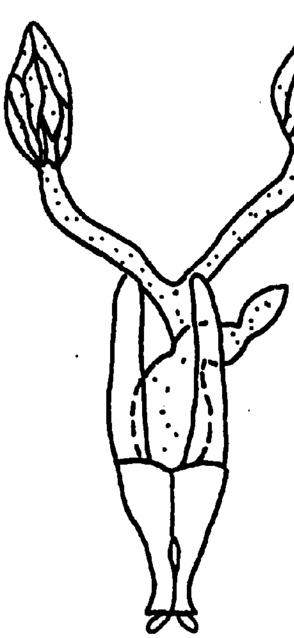

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CHAPTER IV

DISCUSSION

Here comparisons between families based on external and internal morphology will be considered. It will be shown that many characteristics usually ignored by taxonomists can be used for taxonomy. Detailed study of many genera must still be made, but some idea of relationships existing within the Dryopoidea can be obtained from the findings reported here. These will also be considered.

External Morphology

General Body Form and Appearance. General body form and appearance are often included among taxonomic characters. The descriptions of small variations in shapes are difficult to give and at best have only limited use. Comparisons made of specimens studied here permit only very broad generalizations concerning shapes and sizes of the body.

The Dryopidae are moderately small, usually no more than 8 mm in length, with the body shape variable, but generally elongate, oval and convex.

The Limnichidae are broadly oval and very convex. Arnett (1963) reports that limnichids are 1 - 2 mm long.

However, the species studied here are 2.5 - 4.3 mm in length, and Lutrochus gigas is reported to be 6.0 - 6.2 mm long (Hinton, 1939c).

The Psephenidae are oval, depressed, and usually 4 - 6 mm in length.

The adult Elmidae are elongate, somewhat depressed, and 1 - 8 mm long, the majority being less than 3 mm.

In the species of the Dryopidae studied here the head is completely retractile beneath the pronotum so that the antennae and mouthparts are hidden. In the Limnichidae the head is retractable to a point that only the antennae are exposed. The head of members of the Psephenidae can only be slightly retracted beneath the pronotum. The degree of retractability in the elmids is variable.

Hinton (1939b) has pointed out that the degree to which the head can be retracted appears to depend largely upon the length of the prosternum in front of the anterior coxae. The shorter the prosternum in this area, the less the degree of retractility. This correlation between the prosternum and the degree of retactility is true for all specimens examined here. The prosternum of Helichus (Figs. 27 - 31) and Dryops (Fig. 88) of the Dryopidae is relatively long in front of the anterior coxae compared to that of the Psephenidae (Figs. 192 - 193 and 236 - 237). This correlation is best illustrated by comparing the prosternum of elmid genera which vary in the degree of retractility of the head. It can beretracted up to the base of the prementum in *Phanocerus* (Fig. 297), to the base of the gula in *Disersus* (Fig. 266) and hardly at all in *Ancyronyx* (Fig. 324). On the other hand, in elmids such as *Heterelmis* (Fig. 399) and *Dubiraphia* (Fig. 360) the area of the pronotum in front of the anterior coxae is long and the head may be retracted so that none of the mouthparts are visible.

In all of the families examined the specimens were covered by a rather dense, flat, silky pubescence. This pubescence is more striking in *Dryops* and *Lutrochus* because of its greater length. In some elmids the pubescence is restricted mainly to the ventral surface. In addition to the pubescence covering the body surface, tomentose patches of more erect hairs are also common in many genera. Some genera of all families possess tomentose tracts, but they are more commonly used as taxonomic characteristics in the tribe Elmini of the Elmidae. The other tribe of this family, Larini, is usually separated from the Elmini on the basis of the absence of tomentose patches which the Elmini possess. This tomentum is usually found on the head in the area of the genae, the lateral areas of the trunk of the body, and on the tibiae. The use of tomentum as a generic character is illustrated in Chapter III in connection with descriptions of genera such as *Macronychus* and *Hexacylloepus*. In the Dryopidae, particularly the genus *Helichus*, body pubescence is often used as a specific character since it masks many other external characters. This character must be used with care, since the body pubescence may be obscured by dirt and travertine deposits. The distribution of body hairs in relation to sex is discussed in those species in which it occurs.

Antennae. The morphology of the antennae is probably as widely used as any other characteristic in generic descriptions. Even though the antennae are of unquestioned value for generic descriptions, they, like most other external characters are of limited use. Leech and Chandler (in Usinger, 1963), in discussing the family Dryopidae, note that the placement and form of the antennae may serve to separate the nearctic genera but are not reliable for genera of the other parts of the world. It has already been pointed out that within some genera such as Heterlimnius, the variation in the number of antennal segments makes the use of the antennae difficult for generic description. With these limitations in mind, we can note variations in the antennae which can be used as family characteristics. These variations were first mentioned by Hinton (1939b) and have been confirmed for the families studied here.

In the Dryopidae the antenna beyond the second or third segment always forms a pectinate or laminate club (Figs. 1 - 5 and 78). The number of antennal segments (6 - 11) varies from one genus to another, and may even vary within a given species due to reduction of segments by fusion (e.g., Helichus suturalis).

In the Limnichidae the antennae are filiform (Fig. 120) or the apical segments thickened (but never pectinate). The number of antennal segments is reported by Arnett (1963) to be ten, but in the genus Lutrochus there are eleven antennal segments.

Among the Psephenidae the antennae assume several forms. In the genera studied here the antennae may be described as filiform (Figs. 225 and 227) or serrate (Figs. 173, 175 and 177). Pectinate and ramose antennae have also been reported for some members of this family by Hinton (1939b). When the antennae are pectinate in Psephenidae they are reported to never form a club, which distinguishes them from the pectinate antennae of the Dryopidae. The antennal segments number eleven.

The antennae of the Elmidae are usually filiform (Figs. 329, 355, 405 and 406), but may assume other forms. Capitate antennae are found in Zaitzevia (Fig. 342) and Macronychus (Fig. 306), although the latter is less capitate than the former and may be considered clavate. A more distinctly clavate antenna occurs in the genus Phanocerus (Fig. 291) of the tribe Larini. Hinton (1939b) reports no pectinate antennae for the elmids, but in the tribe Larini, Disersus (Fig. 260) has a distinctly pectinate antenna which does not form a club. Arnett (1963) reports eleven antennal segments for Elmidae. However, only ten are present in Optioservus, and in the genera Macronychus (Fig.

306) and Zaitzevia (Fig. 342) the number of antennal segments is reduced to seven and eight respectively.

Mouthparts. In all of the families described here the mouthparts are the typical chewing orthopteroid type found throughout the order Coleoptera. In the Psephenidae these mouthparts are much reduced. The reduced mouthparts are probably related to the fact that the adults are believed not to feed (West, 1929). The morphology of the mouthparts can be studied in much more detail if they are dissected out and separated rather than studied in the intact specimen.

In all families the labrum is a generalized, broad, flat lobe, but various modifications are usually found in different families and often among the several species of a genus. The labrum of the Dryopidae (Figs. 6 - 10 and 79) is generally narrow, distinctly arcuate, and much narrowed at the base. The Limnichidae examined here, in contrast to the Dryopidae, possess a labrum (Figs. 121 - 122) which is very feebly arcuate and is generally described as being transverse. The labrum of Elmidae (Fig. 309 and 322) is moderately arcuate apically. In general morphology the elmid and limnichid labra differ very little. In the Psephenidae the labrum (Figs. 180 - 183 and 229 - 230) is distinctly transverse, very short, and deflexed from the rostrate clypeus. Variations which occur in the labrum within each family are illustrated in the previous chapter.

The mandibles are also of the orthopteroid type.

Unless the mandible is reduced it always consists of a basal molar region and a distal incisor region. The opposite extremes in size of the mandible occur in Limnichidae and Psephenidae. The mandibles of Limnichidae (Figs. 124 - 127) appear to be relatively large, particularly in comparison to other mouthparts of the specimen. The mandibles of Psephenidae (Figs. 184 - 185 and 231) are greatly reduced and smaller than any other mouthpart. The mandibles of Dryopidae (Figs. 13 - 17) are stouter and slightly less acute apically than those of the Elmidae (Figs. 310 and 369). In both Dryopidae and Elmidae the mandibles are moderately curved and distinctly denticulate apically. The mandibles of Limnichidae, though apically denticulate, are not as acute as in Elmidae or Dryopidae.

The variations in the maxillae of Dryopoidea, aside from reduction in size, involve the terminal lobes, mainly of the palps and the laciniae. In all families except Psephenidae, a cardo, stipes, lacinia, galea and palp can be distinguished (Figs. 11, 123, and 357). In Psephenidae all of the maxilla except the palpus (Figs. 174, 176 and 179) has been much reduced. The galea is lobate and tufted and the lacinia is acute and setiferous in Dryopidae (Figs. 11 and 12) and Limnichidae (Fig. 123). In Elmidae the galea (Figs. 293 and 310) is reduced in size to a filamentous structure and the lacinia is enlarged and lobate.

The labium of all families except Psephenidae exhibits a membraneous ligula (Figs. 18, 128, and 264). In Psephenidae no ligula is present.

Prothorax. It is difficult to make generalizations about the morphology of the prothorax in attempting to draw comparisons between the families of Dryopoidea. Even with a relatively small sampling such as has been investigated here, exceptions often crop up and qualifications must constantly be made to any generalizations. It should be borne in mind that the following statements concerning the prothorax are generalizations based on specimens examined here. For greater detail concerning variations in morphology of the prothorax, the reader is referred to the previous chapter.

In Dryopidae the pronotum (Figs. 23 - 26) is ovate, the anterior margins are wider than the head and broadly emarginate, whereas the posterior margin is sinuate. The lateral margins are arcuate. The prosternum (Figs. 27 - 31) is quadrate in shape, with a broad lobed process. The prosternum in front of the anterior coxae is relatively long.

The pronotum of Limnichidae (Figs. 131 - 133), though similar to that of Dryopidae, may more accurately be described as subquadrate. As in Dryopidae, the anterior margins are broadly emarginate but the posterior margin, if sinuate at all, is only feebly so. The prosternum (Figs. 134 - 136) is broad and more transverse than in the Dryopidae.

The Psephenidae have the pronotum (Figs. 189 - 191 and 234 - 235) much narrowed anteriorly, to approximately the width of the head. The posterior margins are much broader and feebly sinuate. The postero-lateral margins are usually explanate. The prosternal process forms an acute style (Figs. 192 - 193 and 236 - 237). The area in front of the anterior coxae is relatively short in comparison to this area in Dryopidae.

The pronotum of the Elmidae (Figs. 265, 340 and 360) may be described as irregularly quadrate and usually produced in front. The prosternum (Figs. 266, 341, 400 and 402) is quite variable and can only be described in general terms as usually being long with a broad lobed process.

Elytra. In all four families the elytra are entire. The elytra of Psephenidae (Figs. 197 - 198 and 240 -241) are distinguishable from those of the other families by their softer, leather-like texture and rounded apices. In the remaining three families the elytral apices are convex or much more nearly so than they are rounded and of much harder texture.

Details of variations in the elytra which are particularly useful in generic description are discussed in the previous chapter.

Abdomen. In the Dryopidae and Limnichidae there are five visible abdominal sternites (Figs. 39 - 43 and

144 - 145). In the Elmini of the family Elmidae there are also five visible abdominal sternites. However, in Larini of this family there may be six visible abdominal sternites as exhibited in Hexanchorus (Fig. 287) and Disersus (Fig. 270). Another feature peculiar to the Elmidae is that in some genera (Figs. 293, 378, and 391) the lateral margins of the fourth or fifth abdominal sternites are prolonged into an acute angle. The Psephenidae usually have six or seven visible sternites, rarely five (Figs. 199 - 200).

Legs. In all four families the hind coxae are transverse and the middle coxae rounded. In Dryopidae the middle coxae (Figs. 44 and 93) are relatively small, whereas they are large and globose in Elmidae (Fig. 392). The structure of the anterior coxae is often used to separate the families. The anterior coxae are round and small in Dryopidae (Figs. 44 and 93), large and globular in Psephenidae (Fig. 201), transverse in Limnichidae (Fig. 146), and globose in Elmidae (Figs. 275 and 392).

Wings. Taxonomists working with Coleoptera have seldom used the hind wings for generic distinctions. Hinton (1940a) took note of this fact and suggested that wing venation could be valuable for generic distinctions, even if used only as a supplementary criterion.

In the members of the families studied here several genera are known to be good flyers; others are unable to fly at all, and for others little is known of their flight ability. Segal (1933) attempted to relate the flying ability of some of the dryopoid beetles to their habitats, noting that reduction in wings is associated with movement from swiftly flowing waters to more sluggish waters. In view of the increasing knowledge of the ecology of these beetles and the structure of their hind wings, this generalization appears to be invalid.

Among the best flyers in the Dryopoidea are the Psephenidae. The wings of the two genera of Psephenidae examined here are quite similar in venation. The genus Psephenus has the more complete wing venation (Fig. 203), although as has been noted earlier, there is some variation in wing venation in different species of the genus. In Psephenops the same wing veins (Fig. 246) found in Psephenus can be identified, but the first anal, the first branch of the second anal, and the second cubitus have missing portions which are present in Psephenus.

Members of the tribe Larini of the Elmidae are known to rate with the psephenids as good flyers. The wings of Hexanchorus and Phanocerus of the Larini are alike in that they both lack an anal cell. According to Hinton (1940b) this lack of an anal cell is peculiar to these two genera in the Larini. In the wing of Hexanchorus (Fig. 276) the cubito-anal cell is absent and the first anal branch is in near contact with the cubitus, whereas the the wing of Phanocerus (Fig. 305) has a well-developed cubito-anal and the first anal is relatively distant from the cubitus. In addition, the anal indentation in the wing of Phanocerus is absent in Hexanchorus.

Of the Larini considered here the wing of Disersus (Fig. 276) is more characteristic of the wing venation in this tribe. The doubly-branched cubito-anal and the presence of an anal cell are two ways in which the venation differs in this genus from that of Phanocerus and Hexanchorus.

In the other tribe, Elmini of the Elmidae, hind wings may be fully developed, reduced or vestigial. In Macronychus glabratus and Ancyronyx variegatus which were examined here the wings were reduced to scaly rudiments. Dufour (1838) and Hinton (1940a) have reported that fully developed as well as reduced wings occur in Macronychus. The wings of Pseudancyronyx perfectus (?) (Fig. 341) examined here were fully developed, with venation much like that figured by Hinton (1940a) for Macronychus indicus.

In all Elmini with wings (Figs. 341, 354, 367, 380 and 393) there is no anal lobe, radial cross vein, anal cell, or first anal vein present. I can find no report of Elmini taking flight when taken from streams, although they have been taken at lights.

Segal (1933) has noted that Helichus of the family Dryopidae, with the most fully developed wings in all of its species, should be considered the most primitive. If this criterion is used, then the species of Disersus (of family Elmidae) described here is equally as primitive. The wing of Disersus (Fig. 276) and that of Helichus (Fig. 50) are easily separable on the basis of the shape of the wing, shape of the anal cell and the distribution of pigmented areas in the apical third of the wing, but both possess equally developed wing veins.

The wing of Dryops (Fig. 94) has lost the second branch of the third anal but in all other respects has venation like that of Helichus.

Lutrochus of the family Limnichidae also has a fully developed wing (Fig. 148). The wing venation in this genus differs from that of Helichus only in that the second cubitus is slightly more feeble in appearance.

Internal Morphology

As mentioned in the introduction, internal morphology is important to the erection of a natural system of classification in the Dryopoidea. In Chapter III the morphology of several internal systems is described for each species examined. Here an attempt will be made to compare these systems at the family level. Since generic and specific differences have been included in Chapter III, they are omitted here except where referred to for examples within particular families.

Alimentary Canal. The alimentary canal of all dryopoid beetles consists of three basic divisions, the esophagus, midgut, and hindgut. In this discussion on the alimentary canal particular attention has been given to several structures which appear to be useful in distinguishing the four families. These are the outer appearance, particularly of the midgut which may contain regenerative crypts; the Malpighian tubules, their numbers and points of attachment, and the presence or absence of ceca.

The midgut (Figs. 204, 205, and 248) in the Psephenidae is always smooth on its outer surface, there being no projecting crypts or ceca present. The alimentary canal is the most frail of that found in the four families and usually is devoid of solid material. There are six Malpighian tubules originating at the base of the hindgut and ending freely in the body cavity.

A smooth outer surface may also be found in the alimentary canal of some Elmidae (Figs. 427, 428, 429 and 432). Others (Figs. 430, 431, and 434) have the outer surface of the midgut covered by dense regenerative crypts. Hinton (1939b) reports that ceca are present on the anterior margin of the midgut of some elmids. They are present on the anterior margin of the midgut in all elmid species examined in this study. In some genera, such as <u>Microcylloepus</u>, only two ceca were present, but there are also genera with four (Figure 430), six (Fig. 429), and quite commonly eight ceca (Figures 427 and 428). Hinton (1939b) reports that as many as fourteen ceca are not uncommon in some elmid genera. The number of Malpighian tubules varies from 4 to 6, depending on the genus, and they usually end freely in the body cavity.

The Limnichidae examined here have the midgut (Figs. 149 - 150) densely set with regenerative crypts, but never with ceca.

The midgut of Dryopidae (Figs. 51 and 95) is quite similar to that of Limnichidae. The six Malpighian tubules present in this family have their distal ends embedded in the walls of the hindgut.

Central Nervous System. In general, the dryopoid families exhibit the same type of central nervous system. In all families there are three thoracic ganglia and eight abdominal ganglia. Genera show different degrees of fusion of the first abdominal ganglion with the third thoracic ganglion and of the terminal abdominal ganglia. These generic differences exist within all four families and no specific condition can be ascribed to any one family. The Psephenidae show the only distinguishing family characteristic in this system. Here the abdominal ganglia (Figs. 206 and 249) are concentrated towards the anterior end of the abdomen, resulting in a much shortened nerve cord.

Male Reproductive System. The male genitalia probably provide the most reliable specific characters. However, there are rare exceptions to this statement. It was pointed out by Hinton (1940b) that several other species of Phanocerus have genitalia like those of P. clavicornis.

The genitalia of Dryopoidea are of the basic morphological type common to Coleoptera. The genitalia are tri-lobed. There is a well-developed base (pars basalis) in all dryopoid families. Two lateral lobes, commonly referred to as parameres, and a median lobe, somewhat dorsal in position and often called an epimere, are in contact with the base. There are several variations of this basic pattern in the Dryopoidea.

In the Dryopidae variations of two generalized types have been observed, neither of which greatly alters the basic tri-lobed pattern. The genitalia of Helichus (Figs. 58 - 65) have the pars basalis approximately twice as long as the apical region containing the parameres and epimere. In Dryops (Figs. 105 - 107) just the opposite is true. The apex of the genitalia in this family is tapered to a point.

In the genus Lutrochus of the Limnichidae, the variations from the basic tri-lobed structure are more pronounced. The species of Lutrochus from Brazil (species A) has the epimere completely fused to the base so that no sutures are visible between the two structures (Fig. 159). The parts composing the apex are compactly fitted together. In the other three species of Lutrochus examined, the genitalia (Figs. 158, 160 and 163) form a single compact unit in which no distinction of sutures differentiating base, parameres, or epimere is visible. The base of the genitalia curves laterally and the two lateral sclerotized strands extending the length of the genitalia extend slightly beyond the base and form a coil. The apex of the genitalia in this family also tapers to a point.

In the male genitalia of Psephenidae (Figs. 211 - 218 and 252 - 257) the base and the apical region are approximately equal length. The parameres are fused or partly fused in the basal half. The apex, though feebly tapered in some genera, is yet nearly or actually as broad as the base.

The male genitalia of specimens belonging to the family Elmidae which were observed in this study show two basic types. The typical tri-lobed type (Figs. 462 - 464 and 487 - 489) with a well-developed basalis which is slightly shorter than the apical region is the more common type. Among the genera with tri-lobed genitalia, some, such as Ancyronyx (Figs. 460 - 461), show greater fusion of the base and the parameres, particularly on the dorsal surface, than other genera. Also among the genera with tri-lobed genitalia, the parameres may be abbreviated in length as in Microcylloepus pusillus (Figs. 476 - 478). The greatest variation from the basic type of genitalia was found in Macronychus glabratus (Figs. 455 - 456). Here the genitalia are compact and appear to be a single unit. However, there is a much reduced basal portion separable by suture lines from the main body of the genitalia. If this is all that remains of the pars basalis, then the main body of the genitalia consists of elongated and fused parameres and epimere.

In the remainder of the male reproductive system the following distinctions, first reported by Hinton (1939b) can be made according to family. The Dryopidae have the testis always consisting of more than one sperm tube enclosed by a thin sheath (Figs. 53 and 97). No vas efferens is present; the sessile sperm tubes empty directly into the vas deferens. A similar condition prevails in the Limnichidae (Figs. 153 and 154).

The testis of Elmidae consists of one or more sperm tubes not enclosed in a sheath and emptying into the vas deferens by way of vasa efferentia (Figs. 441, 445 and 454).

Hinton (1939b) has reported a single sperm tube per testis for Psephenidae based on his examination of a single specimen of Psephenoides. In Psephenus there are sessile multiple sperm tubes in each testis which are not enclosed in a sheath (Fig. 207). Therefore, the testis in this family may consist of one to many sperm tubes.

Female Reproductive System. Hinton (1939b) was the first to report that the structure of the female genitalia could be used as a supplementary family characteristic in the Dryopoidea. His findings have been confirmed for specimens examined here.

In the Dryopidae the genitalia (Figs. 66, 67 and 69) are described as asymmetrical and forming a true ovipositor for inserting eggs into plant tissue. My findings confirm that the genitalia are of the ovipositor type and are usually asymmetrical. However, one species of <u>Helichus</u> possesses an ovipositor which is symmetrical and much abbreviated in length (Figs. 66 - 67).

The ovipositor in Limnichidae is similar to that of Dryopidae. The coxites, which are without styli, may be symmetrical (Figs. 164 - 165 and 168 - 169) or asymmetrical (Figs. 166 - 167).

The female genitalia in Psephenidae (Figs. 220 - 223 and 258 - 259) are symmetrical and the paired coxites bear movable styli. Similar genitalia are present in Elmidae (Figs. 494 - 507).

Relationships

Sanderson (1953), using the generalized type of female genitalia as a basis for his judgement, judged the Elmidae more primitive than the Dryopidae and Limnichidae. In addition to the female genitalia, the structure of the midgut and the male reproductive system of the elmids represent the most primitive type in the Dryopoidea. With the Larini included in this family, the wing venation of this portion of the family is equally primitive. The position of the Larini remains problematical, however. Sanderson (1953) and Hinton (1939b), both of whom have studied adult and immature stages of the Larini, question the validity of giving tribal rank to the Larini, although they agree that they are closely related to the other elmids. To my knowledge no one has suggested that the Larini might constitute a rank higher than that of tribe. In fact, Hinton (1939b) states that no character of higher than generic rank can be found to separate the tribes Larini and Elmini of this family. Yet on the basis of their general appearance, the lack of tomentose tracts, the six visible abdominal sternites in most genera, and their fully developed wings, the adult Larini as a group are readily distinguishable as a more primitive group than the remaining elmids. This would suggest separation of at least tribal, if not subfamily rank.

The immature and adult Psephenidae, particularly the genus <u>Psephenus</u>, are well known and probably have been studied more than any other dryopoid family. Yet, I am unable to find any report of an attempt to determine the phylogenetic position of this family within the Dryopoidea. From a study of the adult characteristics on which the primitive position of the elmids is based, the Psephenidae must also be considered one of the primitive families of this superfamily. The female genitalia, the smooth surface of the midgut, six to seven visible abdominal sternites, and wing structure attest to its primitive state. However, the much reduced mouthparts show specialization in this family. In addition, Hinton (1955) has pointed out that the larval forms may also exhibit some specialization. Of the genera studied here, Psephenidae have many adult characteristics in common with Larini, and except for their specializations, appear to be as primitive.

The adult Dryopidae and Limnichidae exhibit characters which suggest that they are more closely related to each other than either is to the Elmidae or Psephenidae. The female genitalia in these two families are specialized and reportedly used for insertion of eggs into plant tissue. Also, the outer surface of the midgut of both families bears dense regenerative crypts and the sperm tubes are sessile and sheathed.

Based on larval characteristics, Sanderson (1953) suggests that Dryopidae have attained a higher evolutionary level than Limnichidae.

CHAPTER V

SUMMARY

A study of the internal and external morphology of 33 species of beetles representing four families of the superfamily Dryopoidea is presented.

The morphology of twelve new species belonging to six genera of four families is described.

General comparisons among the genera of the four families show that features of internal morphology, such as the surface of the midgut, the number and nature of the Malpighian tubules, and parts of the male and female reproductive systems provide good taxonomic characteristics. In addition, internal structures often provide generic and in some cases, specific characteristics.

The results of this morphological study suggest that the Elmidae and Psephenidae are the more primitive families of the Dryopoidea, with regard to the morphology of the wings, the female ovipositor, the alimentary canal, and the number of visible abdominal sternites. The Limnichidae show characters similar to those of Dryopidae, including specialization of female genitalia, and are believed to be closely related.

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