OBSERVATIONS ON THE TAXONOMY OF THE SUB-FAMILIES ERIRRHININAE AND EUGNOMINAE OF THE CURCULIONIDAE (COLEOPTERA) AND ON THE BIOLOGY OF DIVERSE GENERA OF THIS FAMILY

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CONTENTS

I. INTRODUCTION

The classification of the family Curculionidae is very incomplete and in many places inaccurate. Many of the nineteenth century and some later taxonomists tried to base their classifications on one character alone. This led to an artificial, non-phylogenetic classification as the same characters may have arisen several times in a number of different groups or the character selected may be primitive in some genera while in others it may have been secondarily produced. To obtain a phylogenetic classification, as many morphological and biological characters as possible should be studied. Since many agricultural and horticultural pests belong to this family, a complete and accurate classification would obviously be of great value.

As it appeared that the sub-family Erirrhininae had been very little studied and that it contained many very diverse genera, it was decided to make a study of as many members of this sub-family as possible. An attempt to place them in their correct tribes was made but the variation between the genera is so great that this proved to be very difficult; although it is possible to define the component tribes. As the sub-family now stands, however, I have been unable to define it, nor as far as I am aware has anyone else.

Following Voss (1937) and Marshall (1937) the Eugnominae

was/

was considered to be a separate sub-family and as there was comparatively little variation between the genera, it was possible to enlarge Marshall's definition of the sub-family.

Finally, the biology of various genera of the Curculionidae was studied.

The faunal nomenclature is that used in Junk's "Coleopterorum Catalogus" except where names employed by previous authors are quoted. The floral nomenclature of British plants is that of Clapham, Tutin and Warburg in their "Flora of the British Isles", and of foreign plants that used by Willis in "Flowering Plants and Ferns".

Most of the figures were drawn from microscope slides by means of a microprojector but some were drawn from whole specimens and the remainder adapted from the papers of other authors.

Except where otherwise stated, the scale beside or below the figures is equivalent to 0.20 mm. and the legs figured throughout are one of the metathoracic pair.

II. HISTORICAL REVIEW OF THE MORE IMPORTANT CLASSIFICATIONS OF THE WEEVILS AND THE POSITION OF THE ERIRRHININAE AND THE EUGNOMINAE IN THE FAMILY CURCULIONIDAE

In 1863 the last and most comprehensive classification of the weevils of the world was produced by Lacordaire. Classifications prior to that date were less complete and those since deal either with the weevils of only a part of the world or with the world fauna of only one group of the weevils. As Lacordaire himself admitted, his key was not a natural one. His first division of the super-family into Adelognatha with hidden maxillae and Phanerognatha with normal exposed maxillae is more or less natural when applied to the family Curculionidae alone, but in Lacordaire's classification leads to the inclusion of the primitive Oxycorynids and Belids, etc. with such highly developed groups as the Cossonines and Scolytids. The Phanerognatha were then divided into forms with the anterior coxae contiguous and those with the coxae separate. This led to the separation of such closely related genera as Storeus and Emplesis (vida infra p.73) and, moreover, the coxae are so narrowly separated in some genera that they may appear to be contiguous. Lacordaire subdivided the Synmérides (i.e. forms with the anterior coxae contiguous) into Phalange 1 in which the pygidium is always covered by the elytra and the tarsal claws/

claws are free or connate but never appendiculate, and Phalange 2 in which the pygidium may or may not be exposed and the tarsal claws are appendiculate. This also led to the separation of closely related genera causing Scolopterus to be placed in a different Phalange from the Eugnominae with which it is now classified (vide infra p.113).

Phalange 1 was now divided into weevils with a short metasternum and narrow metathoracic episterna and those with a more or less elongate metasternum and metepisterna at least moderately broad. The Erirrhininae and the Eugnominae, which together formed a tribe in this classification, were placed in the second group. The size of the metasternum is, however, correlated with that of the wing muscles so that in closely related flying and flightless genera, the length may be sufficiently different for them to fall into separate groups.

In 1868 Thomson classified the weevils of Scandinavia. His first division was based on the mobility of the ventral abdominal segments, the first two being connate and the last three movable in the Curculionidae, Scolytidae, Apionidae and Brenthidae, while in most other Curculionoids they are all free or the first four are connate.

Lindemann (1876) in a monograph on Russian bark beetles classified the families of the Curculionoidea on the presence or absence and type of the proventriculus. As this character is/

is difficult to determine and leads to very unequal groupings, it has not been used in succeeding works.

In the same year Leconte and Horn produced a classification of the Rhynchophora of America north of Mexico. Their first division, based on the number of tergites visible in the male and female, leads to the separation of some closely related genera especially in the sub-family Cossoninae where the number is the same in both sexes of Mesites, Cossonus and Pselactus, while in Pentarthrum, Rhyncolus and Caulotrupis 7 are visible in the female and 8 in the male.

The super-family was divided into three groups, the abdomen of the male and female being dissimilar in the Allogastra but alike in the Haplogastra and Heterogastra which were separated by the presence or absence of a lateral fold on the inner side of the under surface of the elytra. The Allogastra contained four families which Leconte and Horn called the Brenthidae, Byrsopidae, Otiorrhynchidae and Curculionidae. The Calandridae and Scolytidae, which are now considered to be more closely related to the Curculionidae than the Brenthidae, were placed in the Heterogastra.

Leconte and Horn then subdivided the 'Curculionidae' into five groups, the last of which they called the Curculionidae (genuini) and in this group the genera of the Erirrhininae are found.

Blatchley/

Blatchley and Leng (1916) classified the Rhynchophora of north-east America and although they followed Leconte and Horn's classification fairly closely, they based their first division on the character Schönherr had used in 1826, namely whether or not the antennae were geniculate. This character may also lead to the separation of some closely related genera (vide infra p.16). Forms with geniculate antennae were then divided into weevils with a similar and those with a dissimilar number of visible abdominal tergites in the male and female. The latter were subdivided into forms with a simple, and forms with a channelled, prosternum. Again this led to the separation of some closely related genera, especially in the Ceuthorrhynchinae in which the prosternum is strongly channelled in some genera but not more than emarginate in others. Weevils in the group with a simple prosternum were subdivided into forms with and those without mandibular scars, genera of the Erirrhininae being placed in the latter.

Fowler in 1891 studied the Rhynchophora of Great Britain. He based his classification of the super-family on that of Bedel (1888). The Curculionidae and Scolytidae were separated from the other families by the rigidity of their maxillary palpi. Fowler split the Curculionidae into four groups, genera now included in the Erirrhininae being found in the group which he called the Curculioninae. This group was separated from the Apioninae by the short trochanters, from the Attelabinae by/

by the geniculate antennae and from the Brachyrrhynchinae by the absence of mandibular appendages and scars. All these divisions are more or less natural and except in the case of Nanophyes (vide infra p.16) closely related genera are usually found in the same group.

Reitter (1912) based his classification of the European Curculionidae mainly on characters which had been used by previous authors but as he used them in a new order, his classification differs from others produced before this time. He divided the family into Adelognatha and Phanerognatha. The latter was then subdivided into eight families, the "Calandrinae", which is the largest, containing the genera now included in the Erirrhininae.

In 1931, Boving and Craighead studied the larval characters of weevils and used them to subdivide the super-family. Having removed the Brenthidae and Proterrhinidae, they divided the rest into two groups, according to the structure of the hypopleuron. In the Attelabidae, Apionidae, "Curculionidae" and Scolytidae the hypopleuron is not subdivided whilst in the "Calendridae" and Platypodidae the hypopleuron is said to be subdivided into at least two lobes, one superimposed upon the other.

Gardner (1934) produced a key to the genera or groups of genera of Indian Curculionidae based on larval characters. He divided the family into two groups according to the shape of the antenna. In the Adelognatha and Ceuthorrhynchinae the apical/

apical segment is sub-globular while it is conical and longer than wide in the remaining Phanerognatha.

Van Emden (1938, 1952) also subdivided the Curculionidae on the basis of larval characters. His first division, however, was based on the number of transverse folds on each abdominal tergum. In the Orbitinae, Stenopelminae, Rhynchaeninae and Mecininae only two tergal folds are visible, while in the remaining sub-families either three or four tergal folds are present. The latter were now subdivided into the Adelognatha and Ceuthorrhynchinae and into the remaining Phanerognatha according to the shape of the antenna (cf. Gardner, 1934).

Bondar (1945) subdivided the Curculionidae on the basis of biological characters. They fall into four groups, forms with free aquatic larvae, e.g. some of the Bagoini, forms with larvae which are free living above ground, e.g. "Cylindrorrhynchinae", Gonipterinae and Hyperinae, forms with free living terrestrial larvae, e.g. the Adelognatha and forms which live within plants, i.e. all the remaining weevils. These divisions, however, lead to the separation of some closely related genera.

Bondar attached great importance to the food-plant, believing that the Curculionidae evolved with the plants so that all the weevils attached to food-plants belonging to the same order were more or less closely related to each other. Although this may be true within a genus or very occasionally higher groups, there are many exceptions.

Table 1

	Mecinus	Miarus	Gymnetron	Orobitis	Rhynchaenus	Rhamphus	Stenopelmus	Nanophyes
Rostrum fairly long/ short	+	+	+	+	+	+	-	+
Number of funicular segments	5	5	5	7	6 or 7	7	7	5
Club indistinctly segmented/ 3 segmented	+	+	+	+	-	-	+	-
Anterior coxae contiguous/ separate	+	-	+	-	+	-	+	+
Femora toothed/ edentate	+	+	+	-	+	-	-	-
Tibiae mucronate/ not mucronate	+	+	+	+ in ♂	-	-	+	-
3rd tarsal seg. strongly bilobed/ weakly bilobed	+	+	+	+	+	+	-	+
Claws simple/ appendiculate	+	+	+	+	-	+	+	+
Claws free/ connate	-	+	-	-	+	+	+	-
Pygidium exposed/ covered	+	+	+	+	-	-	-	-
Tegminal cap-piece bilobed/ tegmen incomplete dorsally	+	+	+	+	-	-	?	+
No. of maxillary palpi seg.	3	3	3	3	2	2	3	3
Proventriculus present/ absent	+	+	+	+	+	+	-	-
Larval spiracles bicameral/ unicameral	-	+	-	-	-*	+	+	-

The possession of the 1st of the pair of characters is indicated by a +, the alternative by a -

*except R. populi in which they are bicameral.

Crowson (1955) separated the Curculionoidea into nine families on the basis of both adult and larval characters. Of the family Curculionidae, in which he included the Scolytids and Platypodids, he wrote that the most fundamental division was probably that between forms having only two tergal folds in each abdominal segment of the larva and forms with three or four such folds. In the first section, i.e. van Emden's Mecininae group, he wrote that the adults, except Orobitis, lack a differentiated proventriculus, the maxillae are never concealed by the mentum, the tibiae never unguiculate, the mesepisterna never ascendant, and the wing venation tends to be more complete than in similarly sized forms of the second section. These characters, the first of which is incorrect (vide infra p.25) are all negative and no positive adult characters have been found to unite the group (see Table 1 opposite). His statement that Orobitis is aberrant in having unicameral larval spiracles whereas they are bicameral in other members of the group is also incorrect, as according to van Emden (1938), Mecinus, Gymnetron and all the species of Rhynchaenus, except R. populi, have unicameral spiracles.

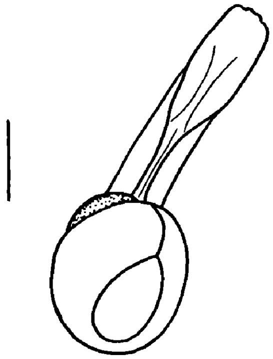
III. CHARACTERS STUDIED

Before endeavouring to re-define the Erirrhininae and the Eugnominae, the characters which had been used for this purpose by previous taxonomists were studied. For comparison and in a search for new characters, the skeletal anatomy of one species of almost all the British genera of the Curculionidae was examined. Few foreign genera were examined, other than those which belonged to the Erirrhininae or the Eugnominae or had been attributed to these sub-families.

Many of the characters used by previous writers were found to have a series of intergradations which rendered them of little use in classification. Others were found to vary so little in the sub-families studied that they were given little consideration.

a) Shape, colour and vestiture

The shape and size of the body, colour of integument and type and pattern of vestiture are characters which can rarely be used beyond the level of genera. The presence or absence of scales may, however, be of importance in some higher groups, e.g. the Cossoninae and Rhynchophorinae, the majority of which are scaleless and to a lesser extent the Barinae. In many Rhynchophorinae, as in most of the Cleoninae, the scales are replaced/



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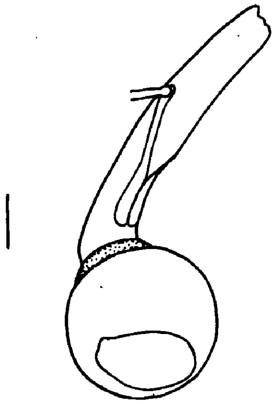

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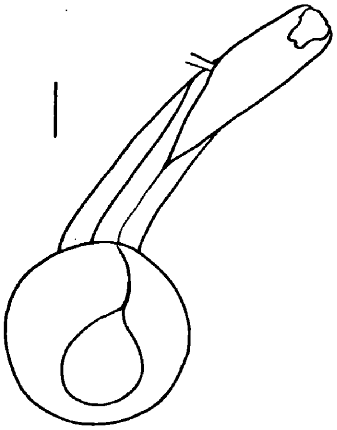

118

replaced by a pruinose covering. The size and shape of the scales may provide specific or generic characters. Their presence is usually associated with more or less regular rows of hairs on the interstices of the elytra which can often be used to separate species.

b) Shape of rostrum

The size and shape of the rostrum is often relatively constant within a genus and is of the same general pattern within some tribes, e.g. the Smicronychini (Figs 116-118). Usually authors have compared the length of the rostrum with that of the head or the head and prothorax together. The width, too, has been used in various classifications and has been compared with the distance between the eyes. The degree of curvature may be stable in a genus though seldom in a tribe. Like the length and breadth of the rostrum, however, the curvature often varies in the two sexes of the species. Usually the rostrum is longer and more slender and curved in the female than in the male. The sex, however, rarely affects the shape of the cross section, i.e. whether it is angular or circular, when the rostrum is then said to be carinate and cylindrical respectively. This character has been used by a number of writers to separate sub-families. It is not, as previously stated, uniform in the sub-family Erirrhininae and cannot be used to separate it from other sub-families.

At/

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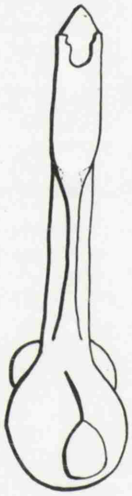

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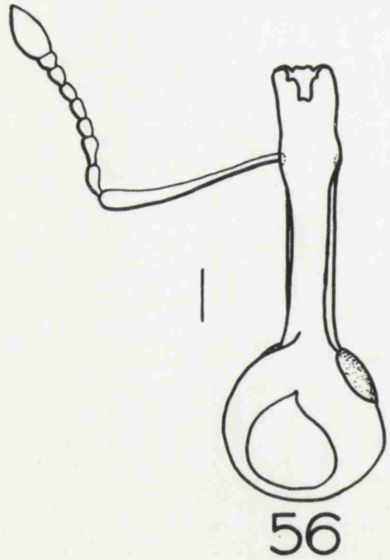

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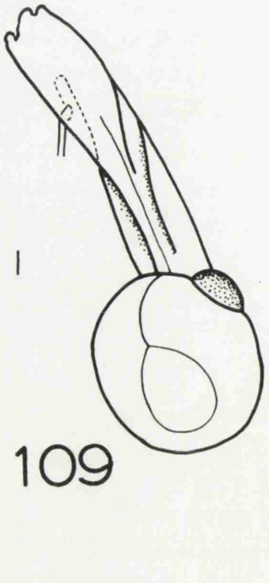

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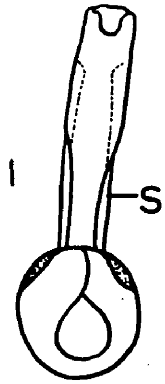
At a higher level, as Reitter noted in 1912, a glabrous triangular area at the tip of the rostrum (Fig. 40A) is characteristic of nearly all the Adelognatha. This is rarely present in the Phanerognatha where the rostrum is usually truncate or triemarginate at the tip. The Australian Meriphini are rather striking exceptions, having the rostrum produced into a triangular flap at the apex (Fig. 231).

The type of departure from the normal shape of the rostrum, as exemplified by Thryogenes, Aoplocnemis, etc. (Figs 56, 109), and the degree of this so-called deformity provides characters which can be used at generic level. It may be associated with protuberances, on and constrictions of, the head capsule. Such characters were used to separate many of the genera of the Eugnominae by Marshall in 1937 in his key to the New Zealand members of this sub-family.

The rostrum is sometimes separated from the head by a groove or constriction. This character has been used by several writers to separate the Smicronychini from other tribes of the Erirrhininae. It is not constant throughout the tribe, however, being absent from some species of Pachyphanes, according to Casey (1891), and from the genera of the Barytychius group. It can also be found in genera which do not belong to the tribe, as in Orthochaetes setiger Beck. According to Reitter (1912) it is also present in all the European Barininae.



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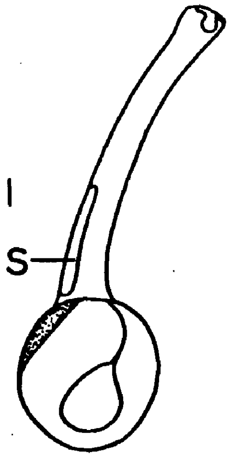
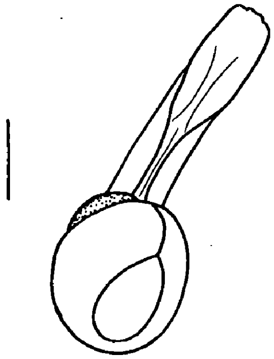


203

c) Scrobes

The shape and position of the scrobes have been used by almost every taxonomist who has classified the Curculionidae, either wholly or in part. They have provided the basis on which many sub-families have been separated. The point of origin of the scrobes has been used in the classification of some groups, e.g. the Otiorrynchinae where they are usually situated dorsally near the apex and are expanded into what are known as pterygae, and the Rhynchophorinae where the scrobes are usually very short and situated near the base of the rostrum. The point of origin may, however, differ in the two sexes. According to Lacordaire (1863) it is nearer the base in the male than in the female. This is certainly so in Mesites tardii Curt. which also has the rostrum dilated in the female so that the male has the narrower rostrum. In many tribes, however, including the Smicronychini and in Celetes binotatus Gyll. the scrobes begin very much nearer the apex in the male than in the female (Figs 202-203, S). This is what might be expected when the female uses her rostrum to drill an oviposition hole. The deeper the scrobes and the further back they are situated the less hindrance the antennae will be when the rostrum is excavating a deep hole in the food plant.

The scrobes may be straight or curved, parallel to the sides of the rostrum and directed towards the eyes or directed below/



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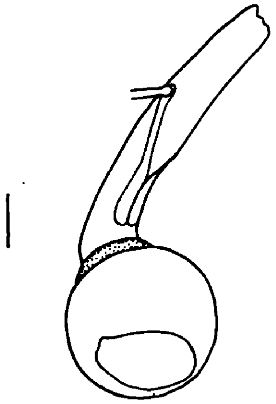

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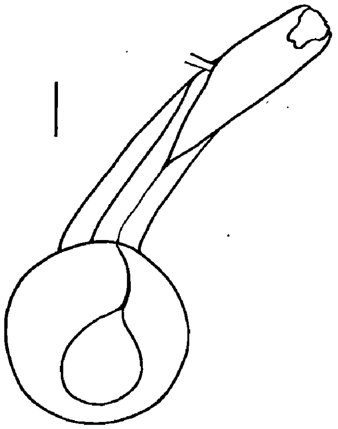

118

below the eyes and converging on the ventral surface. In this case they may be slightly separate apically, connivent or confluent (Figs 116-118). They may provide characters of tribal, generic or specific importance in different groups of genera. The definition of the scrobes, i.e. the distinctness or otherwise of their upper and/or lower borders and also the presence or absence of pits in the scrobes are characters of rarely more than generic value. One of the characters used by Fowler (1891) to separate the British members of the sub-family Erirrhininae from those of the Hylobiinae[*] (Fowler's Curculionine) was whether or not the openings of the scrobes were visible in front when viewed from above. When the world fauna of the two groups is examined, however, this character varies in otherwise closely related genera so that in the Erirrhininae, and probably the Hylobiinae as well, the scrobes are visible in some but not others.

d) Eyes

The eyes vary rather considerably from one genus to another and can seldom be used to characterise tribes. In general, however, as Reitter noted in 1912, the eyes of most Adelognatha are/

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[*] According to the latest recommendation of the International Rules of Zoological Nomenclature (p. 33, paras. 45 and 46) the correct name would be Molytinae unless the longer usage of Hylobiinae is taken into account.

are more or less round and much narrower than the depth of the rostrum, while in the majority of the Phanerognatha the eyes are large, more transverse and usually as broad as the rostrum or if they are small, situated on its under surface. There are many exceptions.

The size, shape, position and texture of the eyes have been used by many authors to separate genera. They may be protuberant or level with the head capsule, circular or elongate in the dorso-ventral or antero-posterior directions, contiguous or separate above or below and coarsely or finely granulate. (In Coleoptera, generally, strongly granulate eyes, i.e. with large ommatidia, are associated with nocturnal habits, and finely granulate eyes, i.e. composed of many smaller ommatidia, are usually associated with diurnal habits.) As Lacordaire noted in 1863, the eyes tend to become flattish and longer vertically if ocular lobes are present, while in their absence the eyes are often rounded and convex or protuberant.

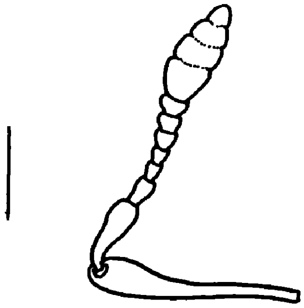
In Rhynchaenus and Rhamphus, two of the saltatorial genera of the Curculionidae, the eyes are closely approximated on the upper surface of the head. This condition is probably associated with their habits although it can be found in some non-jumping weevils, e.g. many of the Zygopinae. The eyes may also be closely approximated on the under side of the head.

e) Antennae

The length of the antenna compared with that of the body and its relative stoutness or fragility are characters which may be used in the definition of genera or occasionally larger groupings. More important in classification is the length of the first antennal segment, the scape, compared with that of the succeeding segments as this may determine whether the antennae can be regarded as geniculate or not, but it is possible to have a short scape with a pronounced geniculation as in the Scolytids or to have a fairly long scape with little or no geniculation as in some Apionids. As already stated, Schönherr (1826) based his first division of the Curculionoidea on this character. The Orthoceri had non-geniculate antennae and the Gonatoceri geniculate ones. The use of this character alone led to the separation of some closely related genera, as the antennae of some genera are primitively non-geniculate while others are secondarily so. In the family Apionidae, for instance, as Reitter (1912), van Emden (1938) and Crowson (1955) have indicated, the antennae of the Nanophyinae are conspicuously geniculate, while in the other sub-families they are usually non-geniculate (See Appendix 1).

There is a certain amount of gradation between geniculate and non-geniculate antennae as in the Magdalinae, some of which have feebly geniculate antennae.

The/

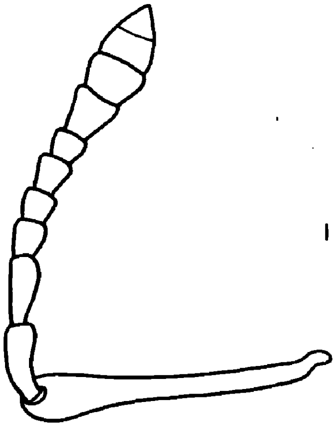


169

The importance of the number of segments in the funiculus as a definitive character varies in different groups of genera. It is sometimes of tribal importance but more often only generic. Indeed Fowler (1891) quotes Rye's discovery of a specimen of Ceuthorrhynchus distinctus Bris. which had one 6- and one 7-segmented funiculus. This character is used in Fowler's key to separate the genera Ceuthorrhynchus and Ceuthorrhynchidius so that the right and left sides of this specimen would have been run down to different genera.

A number of characters can be obtained by comparing the length and breadth of various segments of the funiculus. In particular, many writers have made use of the comparison of the lengths of the first and second with each other and with the remaining segments. Occasionally these characters are found to be fairly constant in a tribe but there are almost always one or two exceptions.

The antennal club may provide a number of characters which can be used at generic, tribal or sub-family level. The club may or may not be segmented. This may be quite constant throughout a sub-family, as in the Eugnominae where it is always distinctly 3-segmented, or it may vary within a tribe. There may be a variation of the apparent number of joints when subdivision of one of them occurs (Fig. 169) or when one or more from the funiculus become attached to the club as in many of/



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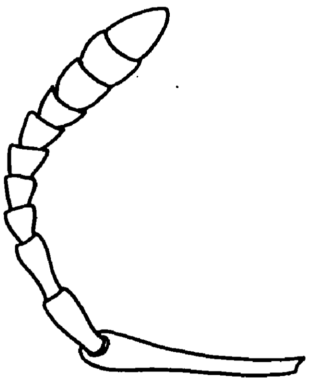

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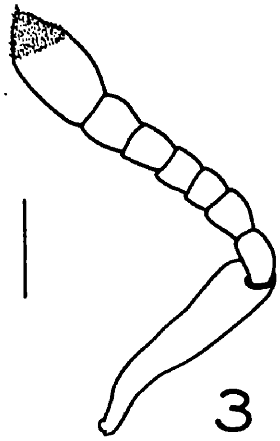

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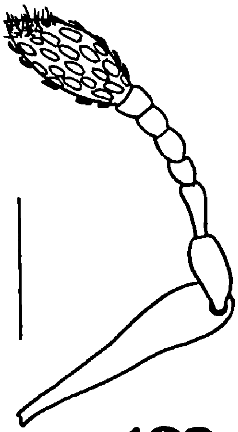

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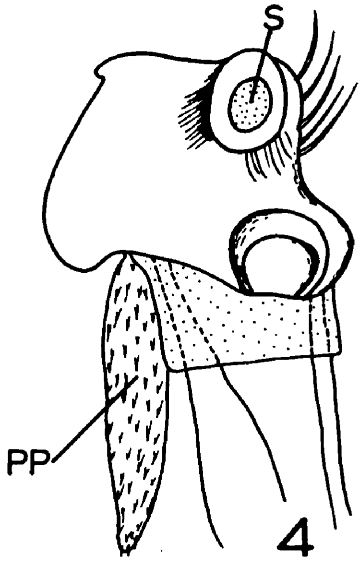

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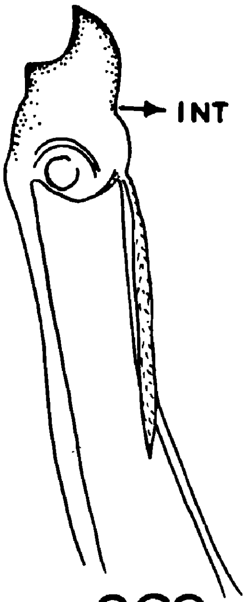
the Hylobiinae (Fig. 1). In some species there is a gradual increase in the size of the segments so that it is difficult to tell where the funiculus ends and the club begins. Within the Curculionidae this is most strongly evident in some of the Cleoninae (Fig. 2).

If the club is unsegmented it may or may not be annulated and it may be pubescent entirely or in part. Some of these characters can be used at sub-family level as in the Rhynchophorinae where the club is basally shining and apically pubescent (Fig. 3). This type of club is also found in some species which are not placed in the sub-family, e.g. some Lissorhoptrus species (Fig. 163).

f) Mouth parts

In some sub-families the pattern of one or more of the mouth parts may be very stable and diagnostic. In others they may vary within a genus. The presence of a cusp, or its scar, the cicatrix, on the mandibles (Fig. 4, S) is a character diagnostic of almost all the Adelognatha and is not found in any of the Phanerognatha. Although the Sitonini do not possess it they have been included in the Adelognatha by van Emden (1952) and Crowson (1955). In addition to their reasons, principally the hidden maxillae of the adult and the Adelognathous type larva (though the bicameral spiracles of the latter are atypical) the fact that the mandibles bear scales also indicates that they belong/



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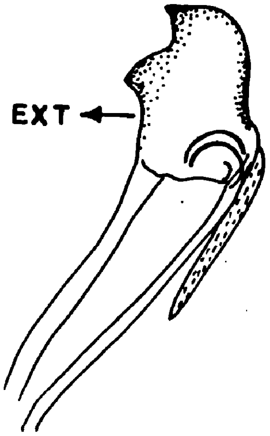

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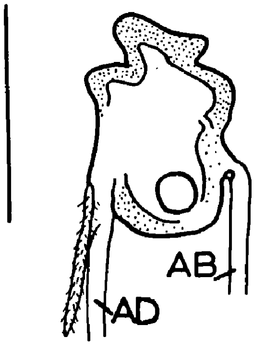
belong to the Adelognatha, few if any Phanerognatha having scaly mandibles. On the other hand, the Alophinae which do have mandibular scars are usually not included in the Adelognatha (See Appendix 2). The presence or absence of the cusps or their scars is now generally considered to be associated with the method of eclosion.

The number and position of setae on the mandibles may be of some importance. They have not been studied to any extent in the Phanerognatha but Marshall (1942) has been able to divide the sub-family Otiorrhynchinae into the Polychaetognatha and the Trichaetognatha on the basis of this character.

The articulation of the mandibular condyles is usually dorsal so that the movement of the mandibles is horizontal. The cutting edges of the mandibles almost always face towards each other. In the Australian Meriphini, however, they face outwards away from each other (Figs 262-263). In the sub--family Curculioninae and in the female <u>Antliarrhinus</u> the mandibular articulation tends to be lateral and the movement is in the vertical plane.

The presence or absence of teeth on the cutting edge of the mandible may be of tribal, generic or specific importance. Their presence on the outer edge of the mandible, as in most of the Smicronychini, is rare in the Curculionidae. The size of the abductor tendons is correlated to a certain extent with

that/



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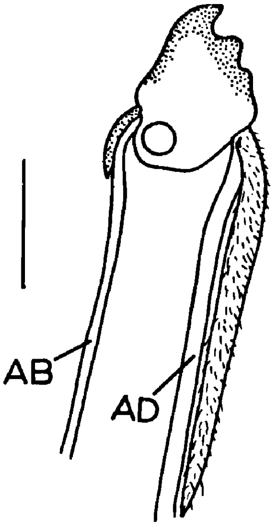

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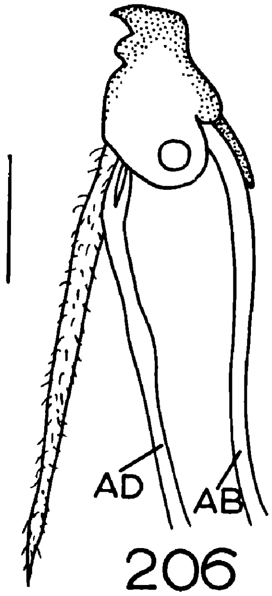

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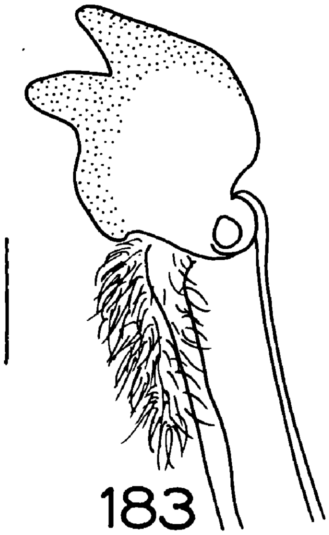

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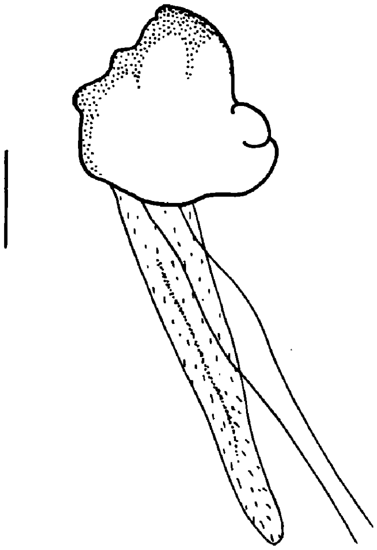

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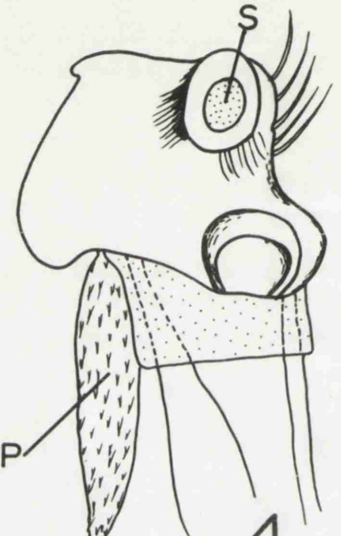
that of the exodont tooth. When the latter is large the abductor almost equals the adductor in size (Fig. 57). In some genera and occasional species the presence and size of an exodont tooth is somewhat variable and cannot be reliably used in classification. In Celetes binotatus the exodont tooth is smaller in the male than in the female and the relative sizes of the abductor and adductor tendons also vary (Figs 205-206). In one or two specimens examined, the right and left mandibles varied almost as much.

Great importance was attached to the number and relative size of the teeth on the inner edge of the mandibles by Leconte and Horn (1867). In their key to the Curculionidae they wrote of their group, the Phytonomini, "Mandibles usually emarginate, 2-toothed at tip....." This separated them from their Emphyastini, Trachodini, Cleonini, Hylobiini and Erirrhinini of which they wrote "Mandibles bi-emarginate, 3-toothed at tip." This is not true of all the Erirrhinini (by which they meant Erirrhininae). One of the teeth can become so reduced that the mandible appears to be 2-toothed, e.g. Alhypera bruchi Hust (Fig. 183). On the other hand, one of the teeth may become subdivided so that the mandible appears to be more than 3-toothed, e.g. Opsittis atomaria Pasc. (Fig. 224) and many of the Cleoninae and Hylobiinae.

The pharyngeal process of the mandible located at its base on/



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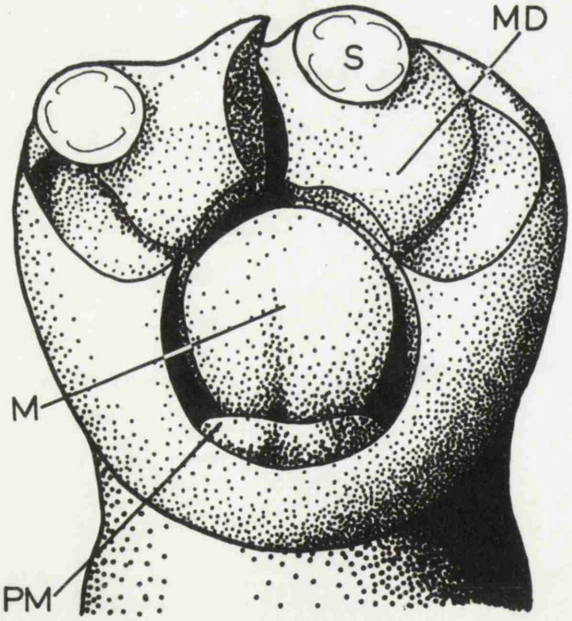

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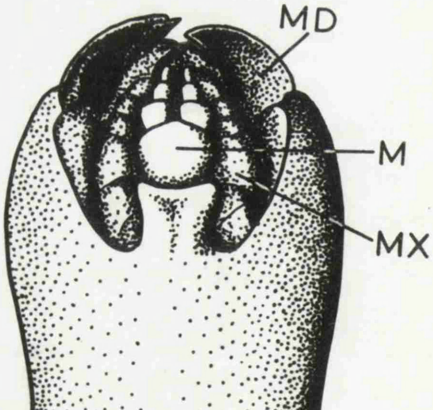

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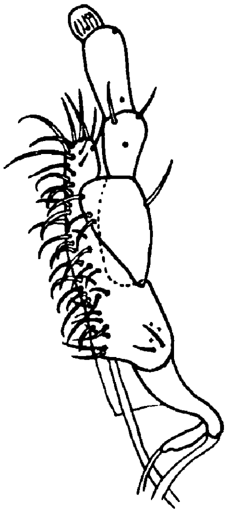
on the mesial angle(Fig. 4, PP) varies little throughout the Curculionidae. According to Ting (1936) "it does not appear to be present in the Platypodidae and is longest in some of the Calendridae."

Lacordaire in 1863 based his first division of the Curculionoidea on whether or not the maxillae were hidden by the mentum (Figs 5-6). This character was probably originally related to the egg-laying habit. When the female uses her rostrum to excavate an oviposition hole in the ground it is probably advantageous to have the maxillae protected by the mentum from grit and dirt. There are, however, a number of anomalies. According to van Emden (1950), Sitona and Otiorrhynchus which have covered maxillae drop their eggs loosely on the surface of the ground. In Cleonus piger Scop., although the female uses her rostrum to excavate a hole in the sand the maxillae are exposed.

The characters provided by a study of the structure of the maxillae have been little used in the classification of the Curculionidae, though this is not true of the Curculionoidea as a whole. Voss, however, in 1937 based his erection of the sub-family Eugnominae on their elongate maxillae and the so-called flexibility of their maxillary palpi (vide infra p114). As a few of the species have short maxillae, Marshall (1937) did not use this character in his definition of the sub-family. It/



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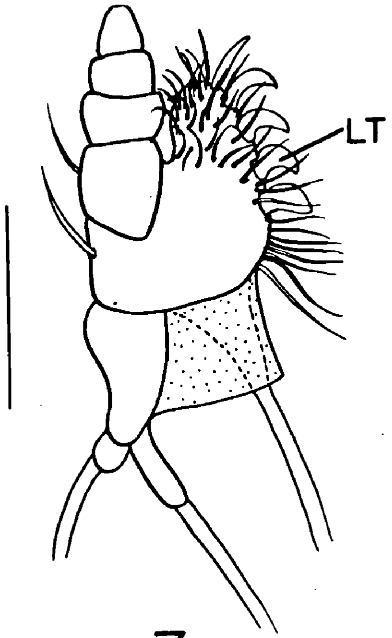

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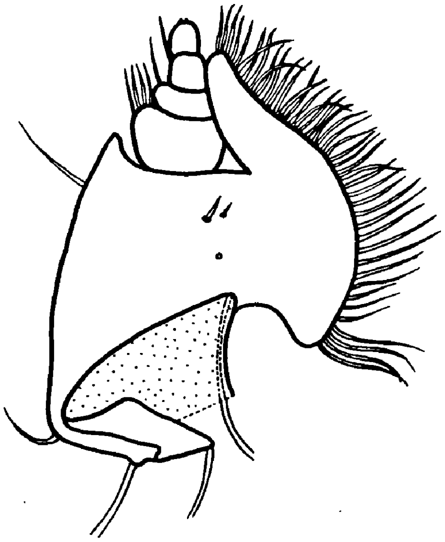

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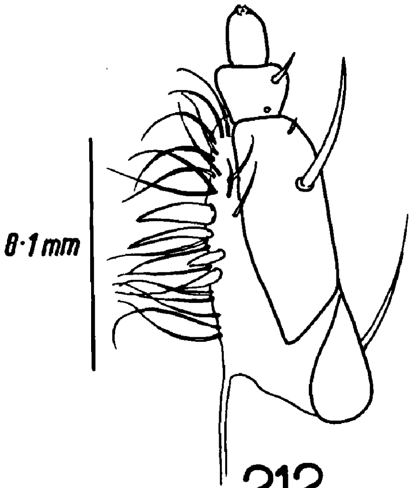

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It is none-the-less true that the maxillae of most members of the sub-family appear to be elongate owing to the narrowness of the maxillary lobe[x] and the length of the second segment of the palpus (Fig. 226).

The size and number of the teeth on the maxillary lobe is of some value in the classification of a number of groups. In the British Cleoninae studied, only 4 large teeth were found along the margin of the maxillae (Fig. 7, LT) while in the Curculio species studied, there were very numerous bristle-like teeth along this margin (Fig. 8). According to Blatchley and Leng (1916), radiating spines are found on the maxillae of bark-boring Scolytids while the maxillae of the closely related wood-boring Ambrosia beetles (which feed on fungi) have pilose lobes.

The maxillary palpi are almost always 3-segmented. Ting (1936) writes that the Apioninae are unique in having the palpi 2-segmented and somewhat retracted into the palpiger. This is not true of all the other sub-families of the Apionidae as the palpi of Nanophyes marmoratus Goeze are 3-segmented. In Rhynchaenus, Rhamphus and Phyllotrox species (Fig. 212) they are 2-segmented but not retracted into the palpiger.

The relative sizes of the palpal segments may also be of importance/

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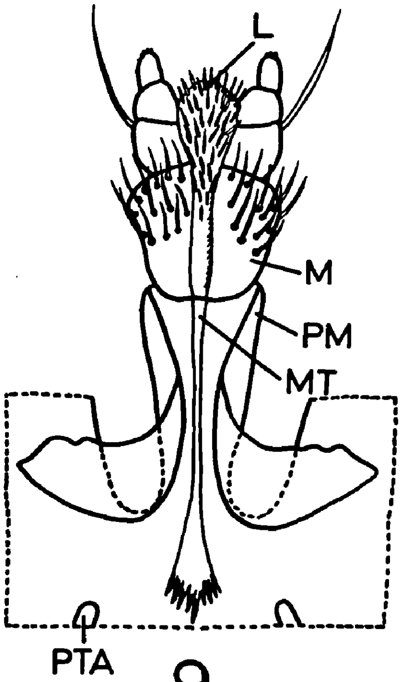
[x] It is difficult to determine whether this is galea, lacinia or mala.



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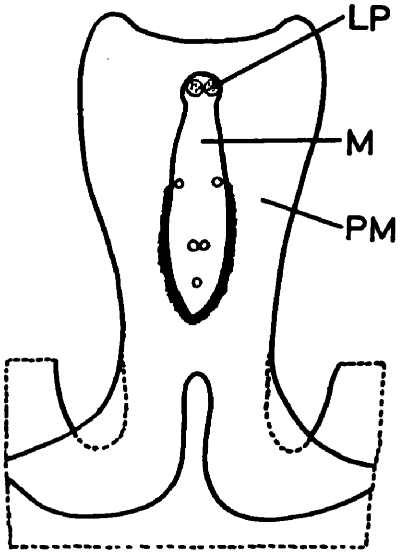

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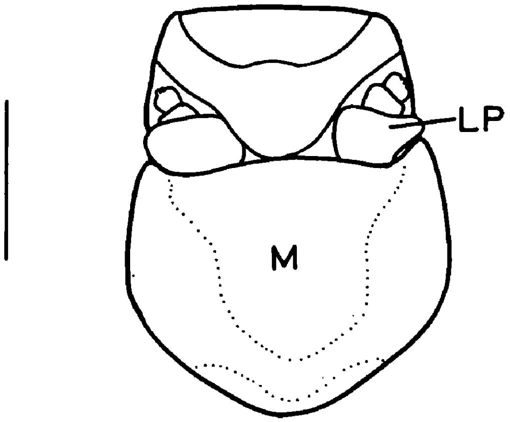

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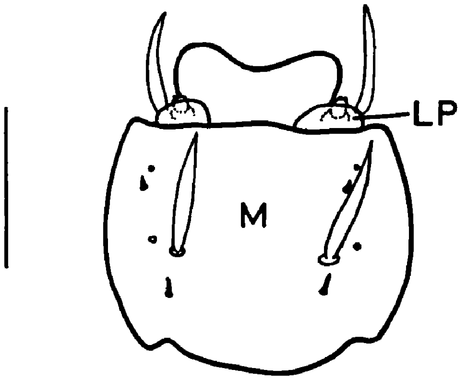

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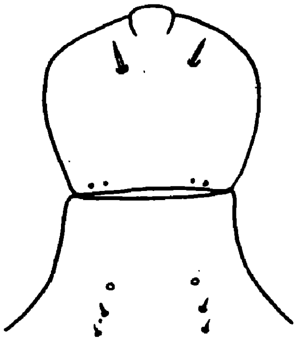
importance in classification as in the Eugnominae where the second segment is usually longer than the first and third.

Ting wrote of the Curculionid labium "It presents a great many characters which should indicate family and generic relationships and which could easily be used in keys for identification". Marshall (1916) called the two visible parts of the labium the mentum and the submentum. According to Ting the mentum and submentum are fused and the parts should be called the prementum and the postmentum. A median tendon is usually situated on the former. The latter is limited posteriorly by the position of the posterior tentorial pits (Fig. 9). In the Adelognatha the mentum or prementum is usually large filling the buccal cavity behind the mandibles, while the sub- or postmentum forms at most a very short peduncle. In the Phanerognatha the size and shape of the prementum is more variable. The postmentum usually forms a peduncle of various dimensions throughout the group. It is quite short in some of the Cleoninae but in the Rhynchophorinae it is the same length as the indentation of the buccal cavity and bears on its inner surface the prementum which is very reduced. There is no median tendon in this group (Fig. 10).

The labial palpi are usually terminal or subterminal but in a number of groups they are attached to the ventral, i.e. outer surface of the prementum, as in all the Cleoninae studied, e.g. _Lixus algirus_ L. and _Larinus planus_ F. (Figs 11-12) where they are ventro-lateral.



191

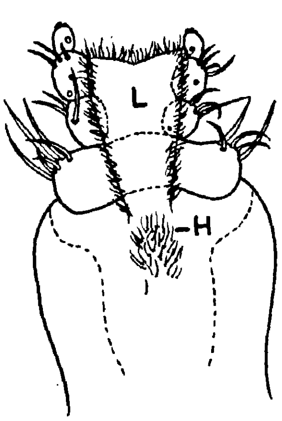
The labial palpi are usually 3-segmented but may also be 1- or 2-segmented or absent. According to Ting (1936) they are absent in *Tachygonus*, reduced to a seta or papilla in the Rhynchophorinae, 1-segmented in the Apioninae and 2-segmented in *Curculio*. In *Curculio cerasorum* Payk., however, they appear to be 1-segmented. They appear to be absent in *Eristus bicolor* Blkb. (Fig. 191) and they are 2-segmented in *Poophagus sisymbrii* F., *Ceuthorrhynchus geographicus* Goeze and *Ceuthorrhynchidius horridus* Panz.

In a number of the Cleoninae the joints have become more or less telescoped into each other so that in some species it is rather difficult to determine how many there are.

Of the three British genera included by Fowler (1891) in the Tychiinae the labial palpi of *Tychius flavicollis* Steph. are 1-segmented, of *Miccotrogus picirostris* Fab. 2-segmented and of *Sibinia potentillae* Germ 3-segmented.

A comparison of the length and breadth of each segment or of either dimension of all the segments and the presence and position of setae on the palps and the pre- and postmentum are of some taxonomic importance but can seldom be used to distinguish groups higher than genera or two or three closely related genera.

The presence or absence, the shape and vestiture of the ligula may also be of some importance. This is notable in the Eugnominae/



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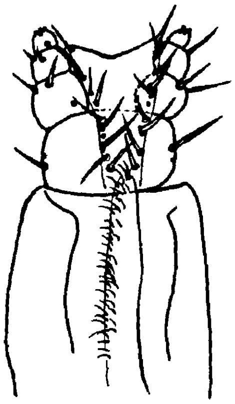


228

Eugnominae where in many of the genera the ligula is well developed and emarginate in a shallow v at the apex (Figs 227-228).

g) Proventriculus

As already stated the structure of the proventriculus was used by Lindemann (1876) as the basis for his first division of the Curculionoidea. He noted that there was no proventriculus in the Apionidae. Crowson (1955) confirmed that it was absent or at least indistinct in the Nanophyinae and added that except in *Orobitis*, a differentiated proventriculus was absent from the British members of van Emden's Mecininae group, i.e. *Rhynchaenus*, *Rhamphus*, *Stenopelmus* and *Mecinus*. He did not mention *Miarus* and *Gymnetron* which van Emden also included in the group. A small but distinct proventriculus can, however, be seen in *Rhynchaenus quercus* L., *Rhamphus pulicarius* Herbst., *Mecinus pyraster* Fab., *Miarus graminis* Gyll. and *Gymnetron antirrhini* Payk. but not in *Stenopelmus*.

The degree of sclerotization varies in different genera so that the proventriculus is much more distinct in some than in others. Its position on the oesophagus varies so that it may be situated within the head-capsule, prothorax, mesothorax, metathorax or possibly the abdomen. This does not appear to be correlated with the length of the rostrum and is rarely constant within a tribe.

h) Prothorax/

h) Prothorax

The shape of the prothorax in the Curculionidae is extremely varied. It provides a number of characters which can be used in the classification of genera and species but is rarely used at a higher level.

In closely related genera it may be globular, or flatter and more uneven, or it may be ornamented with spines or protuberances in related exotic members. It is distinctly flattened, however, in almost all the Rhynchophorinae and Cossoninae and is very convex above in almost all the British Ipidae (Scolytidae).

The outline of the prothorax also varies to a greater or lesser extent in related genera. It may be parallel-sided or evenly rounded or narrowed or constricted in front or behind. It is fairly constant in the Rhynchophorinae and Cossoninae where it is usually trapezoidal. A number of the Ceuthorrhynchinae have one or more tubercles at the sides but this character can be used only at specific or generic level.

The corners of the prothorax may be produced so that it is almost square or rectangular as in some of the exotic Cryptorrhynchinae, or they may be produced into teeth or spines. The angles of the front margin are produced in this way in many of the British Magdalinae, while the angles of the hind margin are toothed in a number of the exotic Hylobiinae. These characters are rarely constant in more than small groups of closely related genera.

The anterior margin of the prothorax may be even or produced into ocular lobes. These are constantly present in some sub-families, e.g. the Cryptorrhynchinae. In the Tanymecinae they are represented by a fringe of vibrissae. They may, however, be present or absent in closely related genera. As Lacordaire noted in 1863 the anterior border of the prosternum is often emarginate when the lobes are present and entire when they are absent, but there are many exceptions.

This edge of the pronotum may be even or produced into a flange above the head as in many Cryptorrhynchinae and Ceuthorrhynchinae. In these sub-families it is associated with ocular lobes and a strongly emarginate or channelled prosternum so that during thanatosis the head is protected by the flange above and the ocular lobes at the sides and the rostrum is held flat against the body.

The prosternum is more or less strongly emarginate in all the Ceuthorrhynchinae and many genera throughout the family, often closely related to others in which the front margin is entire. The emargination may have raised edges in some genera so that it forms a channel for the rostrum. In this case the anterior coxae are often separate and the channel may run between them and if the rostrum is elongate may be continued on the mesosternum or even on to the abdomen. The channel may stop at the anterior coxae on which the rostrum leans in repose as/

as in many Bagous species. In all the Cryptorrhynchinae and most of the long-nosed Ceuthorrhynchinae, however, the channel extends between the anterior coxae and is rather deep.

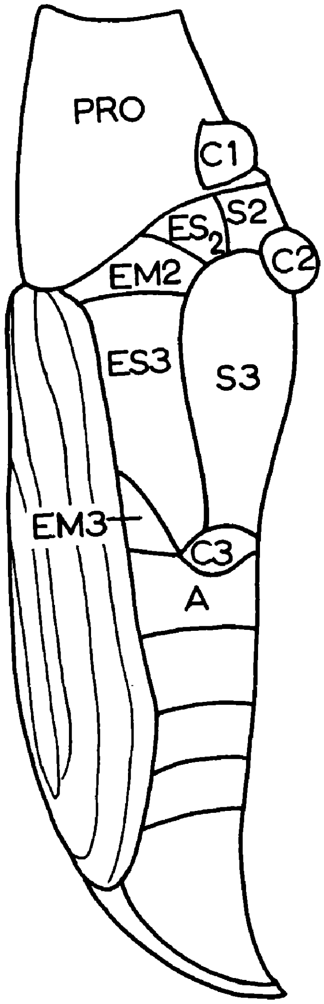
The anterior coxae may be contiguous or separate and situated nearer the anterior or posterior margin of the prosternum or they may be equidistant from them as in almost all the Adelognatha and many Phanerognatha. In the Rhynchophorinae, Cossoninae and some of the Petalochilinae they are considerably nearer the posterior margin. The pronotum in these sub-families is almost always smooth. In other sub-families the pronotum may be smooth or tuberculate in related genera. Keels or grooves on the pronotum can be used to separate species or occasionally genera. The puctuation whether it is strong, faint or absent can rarely be used to separate more than species.

The posterior margin of the pronotum may be straight, curved or emarginate providing a character which is rarely constant within a sub-family.

The ratio of length to breadth of the prothorax and its breadth compared with that of the base of the elytra have been used by many taxonomists to separate species or occasionally genera.

i) Mesothorax

A study of the mesothorax has provided a number of characters which have been used in previous classifications both at/



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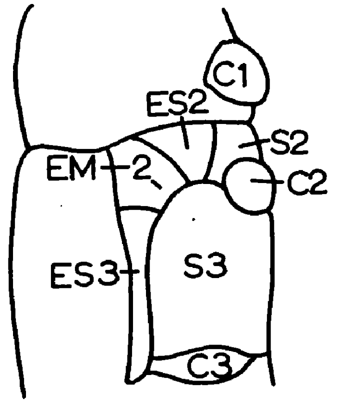

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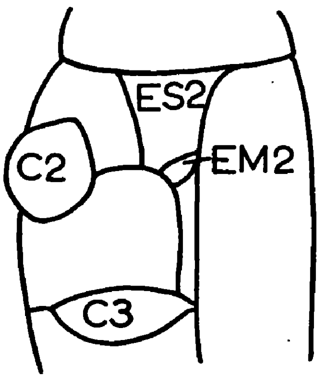
at sub-family and generic levels. Almost all of these are found on the mesosternum as, except for the scutellum, the mesonotum is hidden by the elytra. The scutellum is usually rather small. It is often absent, or at least not visible, in epigeous species and it is largest in some of the Rhynchophorinae. Its shape varies slightly and can sometimes be used to separate species.

The mesosternum is usually shorter than the metasternum and in some groups may be partly hidden by a large prolongation from the prothorax.

The size of the mesothoracic episterna and epimera is correlated with that of the metathoracic episterna. When the latter are broad the mesepimera are also broad and lie between the elytra and the prothorax so that they are visible from above. In this condition they are said to be ascendant (Fig. 13). Ascendant mesepimera are found in all the Ceuthorrhynchinae, the Barinae, the Rhynchophorinae and some of the Curculioninae. When the metepisterna are narrow the mesepimera lie between the sides of the elytra and the mesepisterna (Fig. 14) and cannot be seen from above.

The relative size and position of the mesepisterna and mesepimera were used by Fowler (1891) to divide the British Adelognatha into two groups. In the "Otiorrhynchinae" and "Brachyderinae" they are unequal, the episterna reaching and extending/



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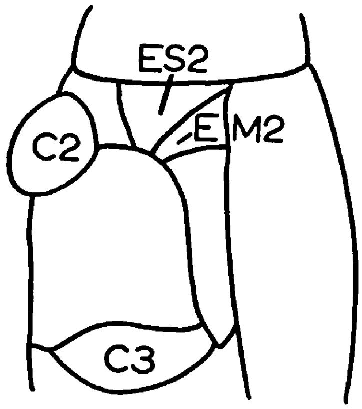

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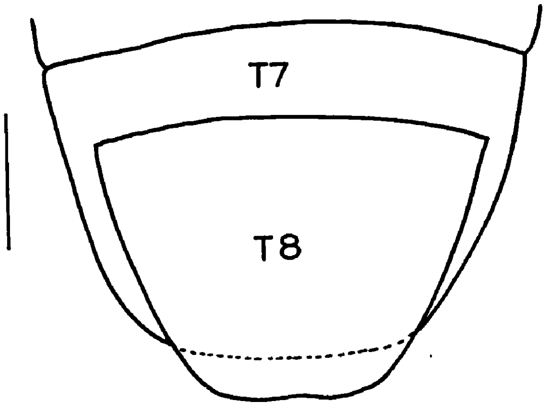
extending along the elytral margin for some distance and the epimera small (Fig. 15). In the other British Adelognatha they are subequal, the episterna reaching the elytral margin only at a point where they join the epimera (Fig. 16). They are also subequal in many Phanerognatha, though the mesepimera tend to be the larger and the mesepisterna rarely reach the elytra. The mesothoracic coxae are always more or less separate.

j) Metathorax

Characters provided by a study of the metathorax have rarely been used in classification. As already stated, Lacordaire subdivided his group B of the Synmérides into genera in which the metasternum is more or less elongate and the metepisterna at least fairly broad, and those in which the metasternum is very short and the metepisterna narrow. There is, however, a considerable overlap between them as the metasternum is usually longer in winged species than in apterous ones. According to Marshall (personal communication) the ability to fly affects the shape of the suture between the posterior coxae of the Brachyderinae. In species which have been flightless for a very long time, it is broadly truncate while in those which can still fly or are in the process of losing their flight, though they may not yet have lost their wings, the suture is emarginate in a shallow *v*.

The variation in shape of the metendosternite within the Curculionidae/



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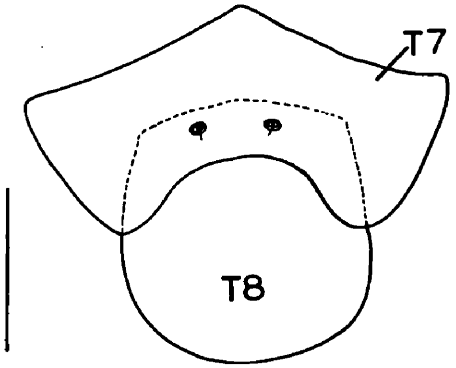

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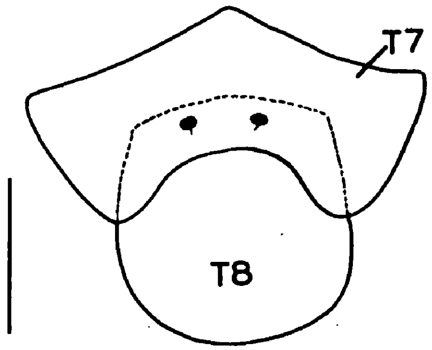
Curculionidae is more or less continuous and has not been used in previous classifications. According to Crowson (1955) it can be used to separate the Curculionidae from the Apionidae.

k) Abdomen

As already noted, Leconte and Horn (1876) based their first division of the Curculionoidea on the number of visible abdominal tergites in males and females. It is true that in the majority of their "Otiorrhynchidae" and "Curculionidae", the eighth abdominal tergite is visible in the male and hidden in the female; there are, however, many exceptions. In the Bagoini the eighth tergite is hidden in both sexes, while according to Marshall (1916), the eighth tergite is exposed in both sexes of a number of African species of several Adelognathan genera. Many of Leconte and Horn's "Calandridae" and "Scolytidae" do have the eighth tergite internal in both sexes but in a number of Cossonid and Scolytid genera it is exposed in the male, and in some other Scolytids it is exposed in both sexes.

The shape of the seventh tergite is affected by the position of the eighth. It is similar in shape to the eighth when the latter is internal (Fig. 17) but is usually straight or emarginate at the apex when the eighth is external (Fig. 126). Either or both tergites may be ornamented with enlarged sensillae or spines as in the Smicronychini where the presence of two large sensillae on the seventh and eighth tergites of the male is/



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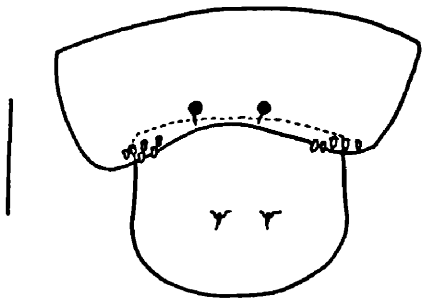

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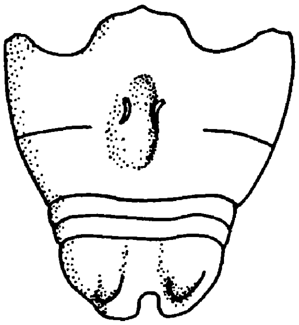
is characteristic of a group of closely related genera (Figs 126-127). Variations in shape of the eighth tergite of the female are dealt with in the discussion of the female genitalia.

The exposure or otherwise of the pygidium is fairly constant within sub-families. It is exposed in the male Tychiinae and in the Ceuthorrhynchinae where it is actually the eighth tergite of the males and the seventh of the females and in the Rhynchophorinae where it is the seventh in both sexes. The pygidium is longitudinally grooved in a number of genera in which it is internal. In some genera in which it is exposed, e.g. Sitophilus, the small area of it below the elytra is grooved so that the elytra are held neatly together.

More convenient classificatory characters can be derived by studying the abdominal sternites. In the Curculionoidea the first two sternites have disappeared so that the first visible sternite belongs to the third segment. Marshall (1916) calls the visible sternites the ventrites and numbers them one to five. In the family Curculionidae the first two ventrites are connate, so that there is not a true suture between them. The shape of the intervening groove, however, may provide specific or generic characters. The shape of the posterior border of the second, third and fourth ventrites may be of generic or tribal importance. Usually it is straight but it may be curved so that it appears to be slightly prolonged at

the/



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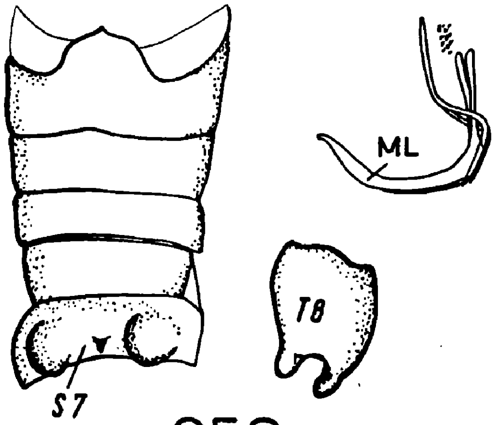

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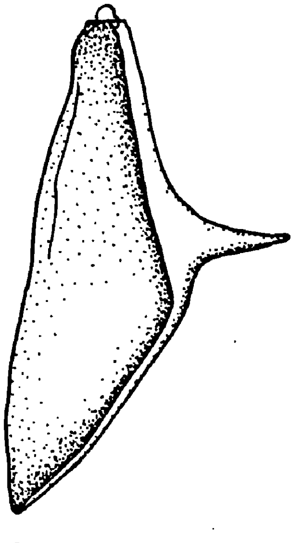

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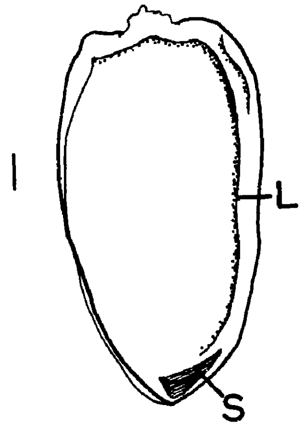
the extremities as in some of the Storeini and Ceuthorrhynchinae and a few other groups. In all the British Tychiinae the posterior margin of the second ventrite is produced at each side extending over the third to the base of the fourth.

The relative lengths of the intermediate ventrites may provide good generic characters. In a few species the ventrites of the male are formed differently from those of the female, e.g. *Echinocnemus* and *Hoplocneme* (Figs 161, 258).

1) Elytra

As already noted, the ratio of the breadth of the base of the elytra to that of the prothorax and whether or not the elytra cover the pygidium are characters used in the classification of genera and sometimes higher groups. The presence or absence of shoulders on the elytra and whether the apices of the elytra are pointed or jointly or separately rounded can also be used at various levels. The presence of shoulders is usually associated with the possession of well developed wings so that in genera with both flightless and flying individuals, this character may be of specific importance. In flightless weevils the elytra may be fused together along the suture. The presence or absence of tubercles and raised interstices of the elytra can rarely be used above the specific level, although the cone-like projections found in some Eugnominae (Fig. 254) have been used to separate genera.

According/



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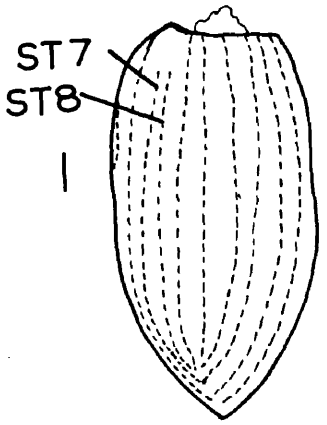

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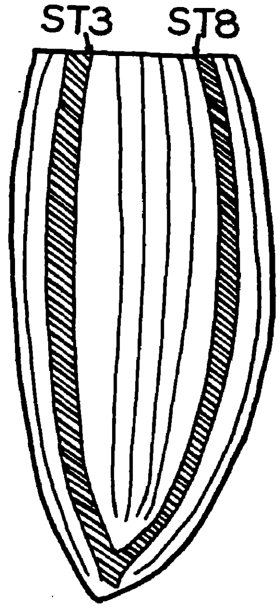
According to Reitter (1912) a membranous fringe is found at the apex of the elytra in Sitophilus and insects with a channelled prosternum.

A closer study of the lateral fold on the under surface of the outer margin of the elytra which was first noticed by Leconte and Horn may provide a number of classificatory characters as it seems to vary in length and breadth throughout the family (Fig. 133, L).

The elytra may or may not be striate and the interstices impunctate or evenly or irregularly punctate. There are usually ten striae but in some groups the tenth may be incomplete or absent. If the shoulders are well developed, one or more of the striae in this region may not reach the base. In Pachyphanes the seventh and eighth do not reach the base (Fig. 18) and in some Eugnomine genera the sixth stria does not reach the base.

Kuschel (1952) wrote that in all the Petalochininae the third stria is united to the sixth at its apex while in most other Curculionidae which he had examined, except some genera of the Barinae, it is united to the eighth. In some Gymnetron species, however, the third stria is united at its apex to the sixth and in others to the eighth.

According to Crowson (1955) the elytral tracheae are found to underlie the interstices and the homologies suggested by him are/



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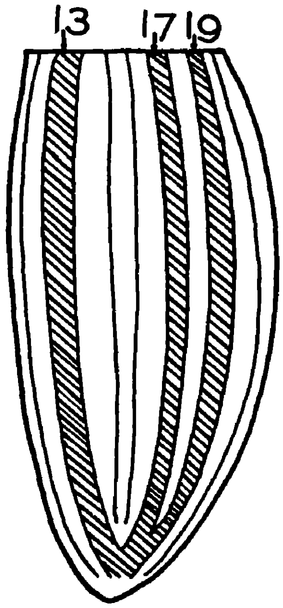

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are based on a comparison of the tracheae of the pupal elytra with the tracheae and venation of the wings of the pupae. The trachea lying nearest the suture, below interstice one, is 2A, 1A lies below interstice three, Cu below five, M below seven, R below nine and C+Sc at the outer edge; this last trachea being known as C or Sc by different authors. The tracheation is fairly variable in the Curculionidae. In most of them trachea M is missing but it is present in a few genera throughout the family, e.g. Dorytomus and Hylastes.

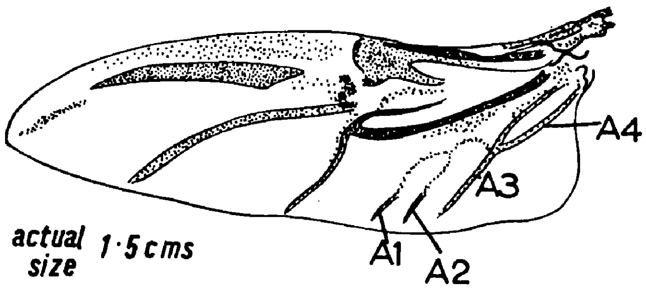
Tracheae C+Sc and 2A are also liable to be reduced or absent but R, Cu and 1A always appear to be present.

Fundamentally, therefore, it appears that one should consider which interstices unite rather than which striae. In the majority of the Curculionids the third interstice runs into the ninth at its apex (Fig. 19) but in some of the Petalochilinae and certain species of Gymetron the seventh interstice runs into the ninth before it meets the third (Fig. 20).

m) Wings

As Lacordaire (1863) noted, the presence or absence of wings is more important in some groups than in others. In many genera winged, apterous and brachypterous species occur; on the other hand, however, the absence of wings is often correlated with terrestrial habits so that it may be characteristic of groups of genera.

Little/



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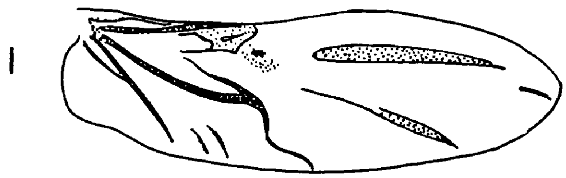

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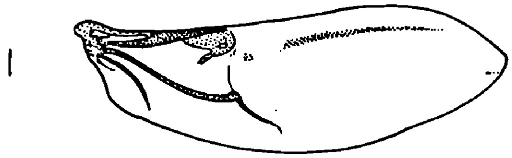

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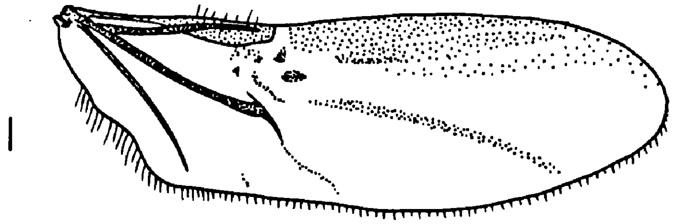
Little use has been made of the size, venation and folding of the wings in the classification of the Curculionidae.

In a study of the wing venation of the Coleoptera, Kempers (1923) figured the wings of a number of Curculionidae but did not name the veins or discuss relationships within the family.

Although Forbes (1926) studied the wing venation and folding of many Coleoptera, he did not figure any Curculionidae. The venation tends to be more complete and more distinct in the more primitive sub-families of the Curculionidae than in the more advanced. There is also a tendency, however, for the veins of large-winged species to be more numerous and distinct than in smaller winged species. In those Curculionidae in which the venation is most complete, as in the Attelabidae, four anal veins are present, second A1, second A2, third A1 and 3rd A2; and second A1 and second A2 may or may not be linked together (Figs 102, 99). (The nomenclature adopted for the veins is derived from Forbes' system with which it was correlated by comparison with <u>Oxycorynus</u> and primitive Cerambycidae.)

In Curculionidae in which the venation is less complete, second A1 and second A2 become very faint or disappear and third A2 becomes very short (Fig. 132). The size and definition of the radial cell is also variable.

The presence or absence of a fringe of hairs on the wing may be characteristic of species. There is a very long one in/



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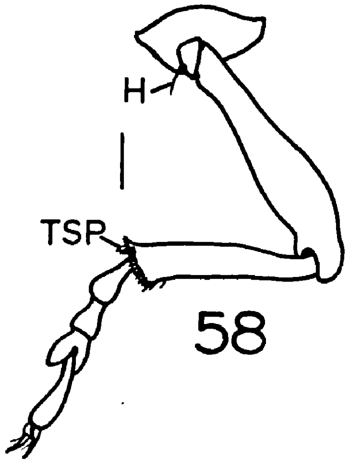

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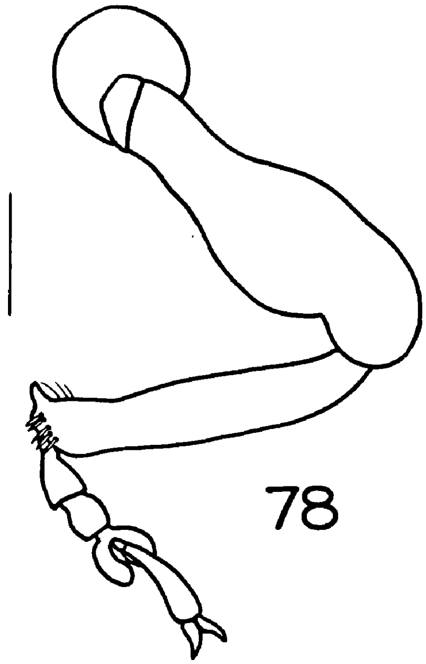

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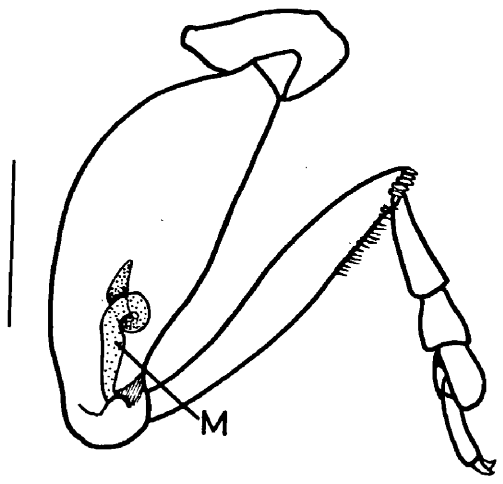

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in Phyllotrox ater (Fig. 21), and Kempers has figured a very fine fringe in a number of weevils.

n) Legs

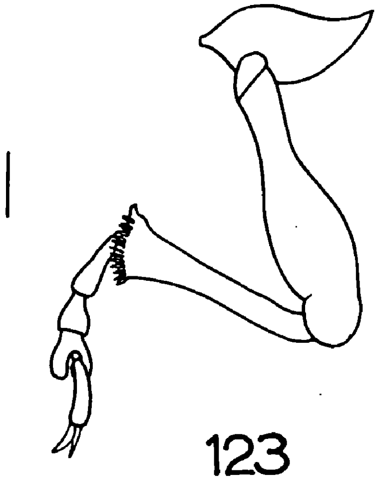
The shape of the anterior coxae is usually fairly constant within a sub-family. Normally they are sub-globose but they may be conical as in all the Eugnominae or cylindrical in genera with elongate legs.

The trochanters are usually small and rarely separate the coxae and femora. I have found no indication of the occurrence of long trochanters as seen in Apion and Nanophyes in the Curculionidae.

A long projecting seta on each trochanter occurs in all or many genera of a number of sub-families, e.g. Cleoninae, Hylobiinae and Erirrhininae (Fig. 58, H). It has also been found in a number of genera which do not belong to these sub-families, e.g. Myelophilus and some of the genera of the Campylocelini.

The femora are usually clavate (Fig. 78). In the saltatorial genera, Rhynchaenus and Rhamphus, however, the posterior pair are greatly swollen and contain a structure known as Maulik's organ (Fig. 22, M).

Fowler'(1891) noted that a number of weevils have the power of leaping side-ways and that it was very noticeable in Rhinoncus perpendicularis/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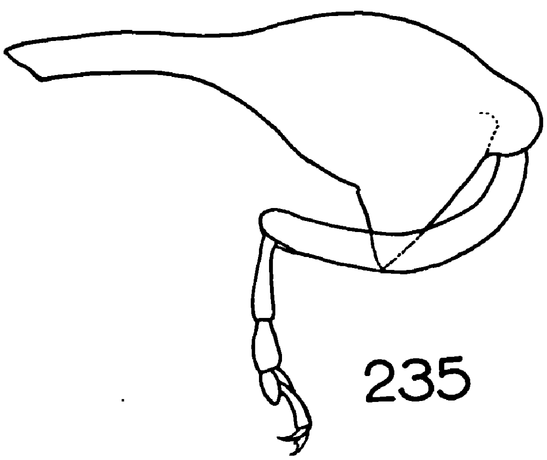
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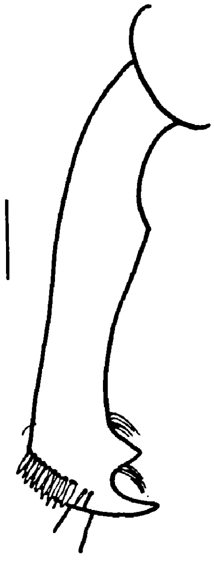
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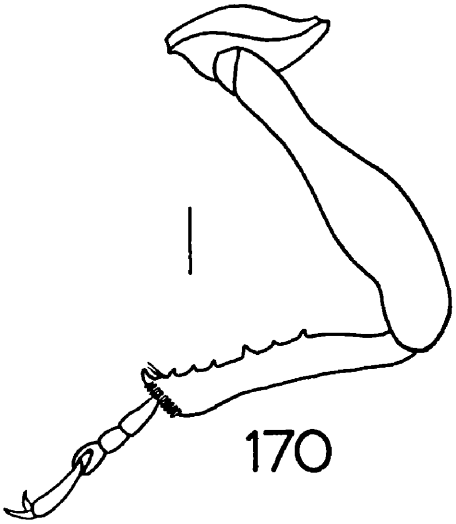
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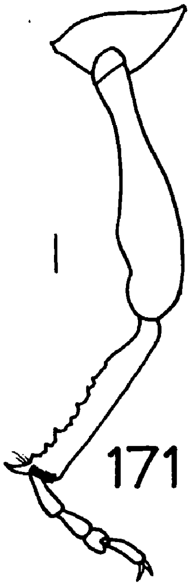
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Rhinoncus perpendicularis and to a lesser degree in *R. castor*, *R. bruchoides*, *Cidnorrhinus quadrimaculatus* and *Ceuthorrynchus hirtulus*. The femora in these weevils, however, are no more strongly enlarged than those of other Ceuthorrhynchinae.

The presence or absence of a tooth on the lower surface of one or all the pairs of femora may be of varying degrees of importance, e.g. dentate femora characterise the sub-family Eugnominae, the genus *Dorytomus* and some species of *Otiorryhynchus*. Their relative sizes on the fore-, mid- and hind-legs may also be of generic or specific value.

The tibiae provide a number of important characters which are used in classification. They may be almost straight as in some of the Erirrhininae (Fig.123) or strongly curved as in many Eugnominae (Fig. 235). The inner margin is distinctly bisinuate in the Hylobiinae while it is so strongly bisinuate in *Grypidiopsis* that there appears to be a tooth near the middle of the inner margin (Fig. 23). A number of genera have numerous small teeth along this margin, e.g. *Endaliscus* and *Jekelia* (Figs 170-171) and the outer edge of the anterior tibiae of almost all the Scolytid genera and at least one Cossonid genus, *Xenocnema*, are dentate.

The tibiae may be cylindrical or compressed while in *Sitophilus* their outer edge is strongly keeled.

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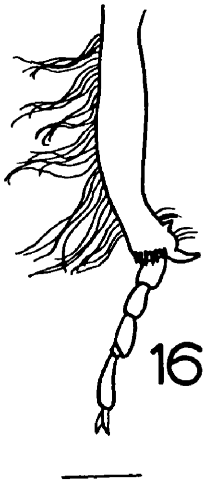

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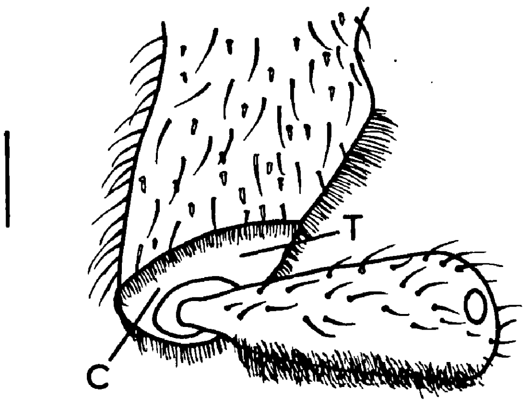

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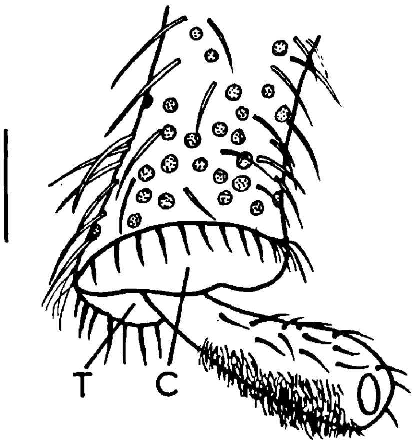

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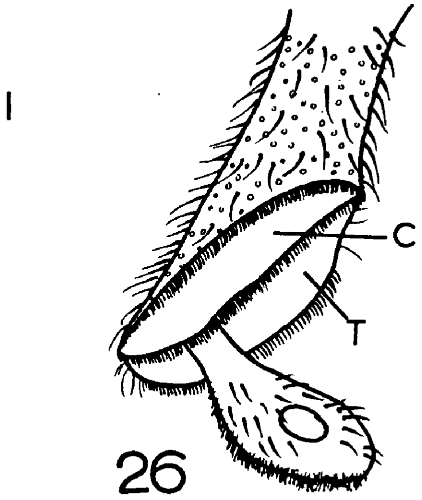

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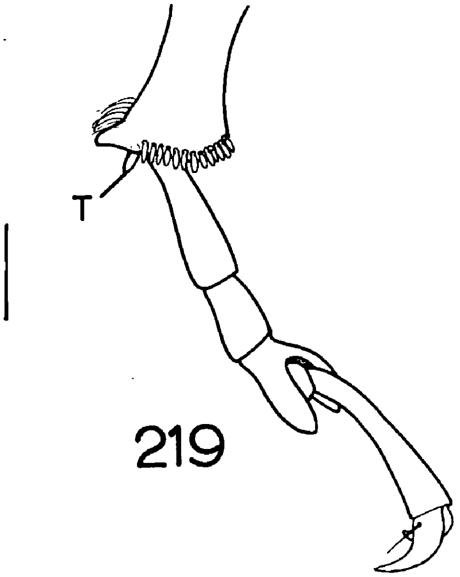

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In some aquatic weevils the tibiae have long fringes of hair, e.g. Helodytes foveolatus which has fringes of hair on its mesothoracic tibiae (Fig. 165).

The apex of the hind tibia which is usually truncate provides a character which is important in the classification of the Adelognatha. When the anterior apical edge is single, the tibia is said to have an open corbel and in this case the apices of the other two pairs of tibiae are formed in this way (Fig. 24). When the edge is double but only the outer edge is fringed whilst the inner edge and the interspace is bare, the corbels are said to be semi-closed. Again the other tibiae are similar (Fig. 25). When the anterior edge is double and both inner and outer edges are fringed, the interspace being bare or squamose, the corbels are said to be closed (Fig. 26). This never occurs on fore- or mid-tibiae. All types of corbel are found in the Adelognatha but the corbels are usually open in the Phanerognatha.

Tibial spurs can be found in a number of Adelognatha but are less common in the Phanerognatha where they occur in some Erirrhininae and Cylindrorrhininae (Fig. 219, T).

There is commonly a claw-like or spine-like prolongation arising from the inner or outer edge of the apex of the tibia. Its presence or absence, size, shape and position have been used by many taxonomists in the classification of the Phanerognatha.

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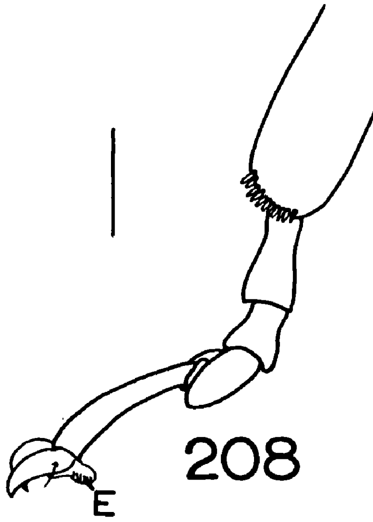

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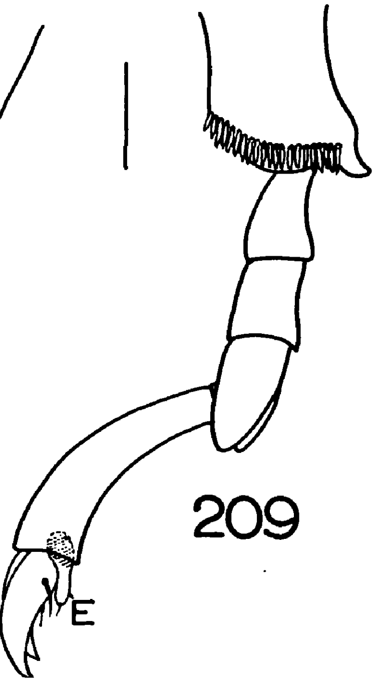

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In the Eugnomini, female Meriphini and Ceuthorrhynchinae and in male Phyllotrox and Phytotribus, the tibiae are not prolonged at the apex and are said to be unarmed (Fig. 208). They are armed, however, in male Meriphini and Ceuthorrhynchinae and in female Phytotribus (Fig. 209).

Describing the tibial prolongations, Lacordaire (1863), who was followed by Marshall (1916), wrote "The tibiae will be called : mucronate when the spine or mucro is situated at their internal angle and perpendicular to their axis; and unguiculate when it leaves the external angle or its vicinity, in which case it is sharply curved towards the internal angle or may remain more or less straight, often then assuming the form of a claw. Sometimes the mucro is only the continuation of a lamina which runs along the apex of the tibia and curves slightly inwards. This is called the mucronal lamina". (My translation.)

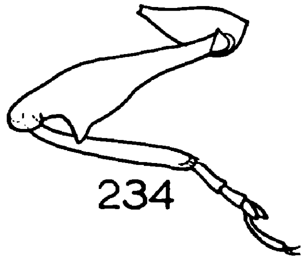
In Vol. VI, p. 290, Lacordaire describes the tibiae of the "Molytides" as unguiculate at the apex. On p. 375 the tibiae of Molytes are said to have a strongly projecting mucronal lamina, the spines simple. Thus the adjective mucronal is rather confusing. Using this definition it is rather difficult to tell whether the tibiae of a number of genera are mucronate or unguiculate.

Leconte and Horn (1876) were not uniform in their application of the terms. In their introduction to "The Rhynchophora of America/

America North of Mexico" they wrote, "It is seldom that more than one fixed mucro occurs, and in species in which the tarsi are inserted laterally near the tip this mucro becomes frequently elongated and curved; the outer angle of the tip is in these instances quite often prolonged into a curved digitation". Later they described the tibiae of the Magdalinae as being strongly unguiculate but those of the Pissodinae which are very similar were described as possessing a terminal hook, strong, but proceeding from the outer rather than the inner part of the apex.

Blatchley and Leng (1916) were not precise on this subject. They wrote, "The tibiae may end in a stout bent hook or spur or in a spine. In the latter case they are said to be mucronate".

In 1951 Kuschel wrote that in the most primitive "Curculionidae" (i.e. Belinae, Rhynchitinae, some Cylindrorrhininae, etc.) which still have tibial spurs and in the Adelognatha the distal comb (i.e. setae on the distal edge of the corbel) extends as far as the internal angle and may bear either two tibial spurs or a spine more or less perpendicular to the axis, the mucron, or it may be unarmed. In the climbing weevils (e.g. Magdalinae, Hylobiinae, etc.) the mucron becomes modified to form a real hook, the uncus, and is usually distant from the internal angle. A groove lies between the uncus and a tooth on the interior edge of the tibia, two large groups of setae being/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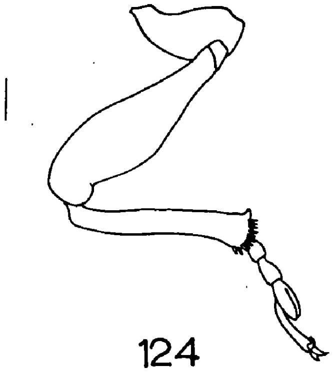
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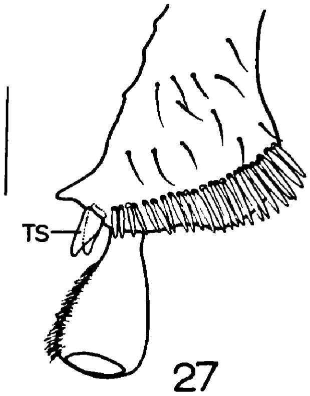

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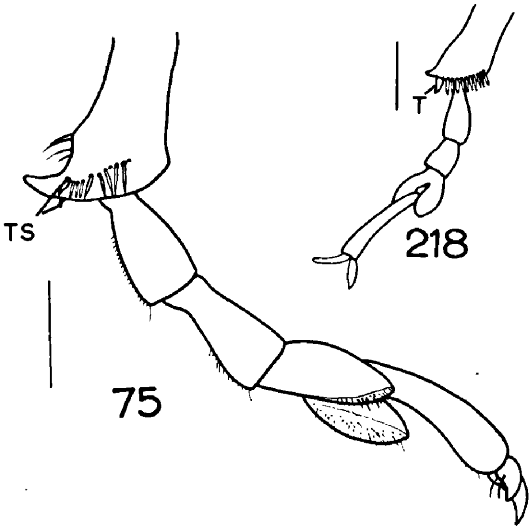

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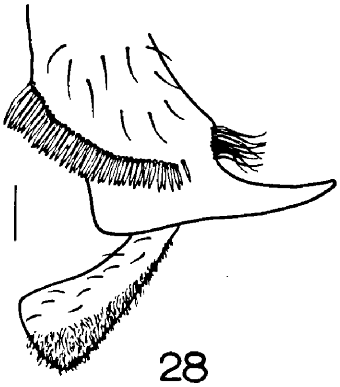
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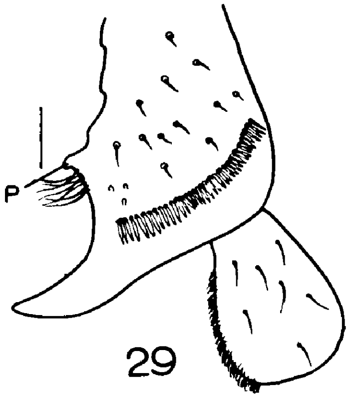

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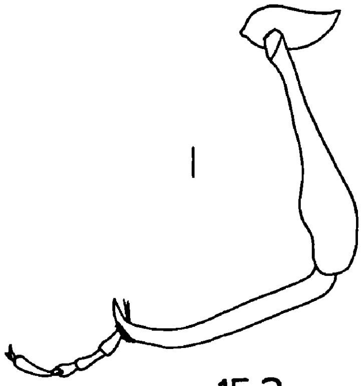
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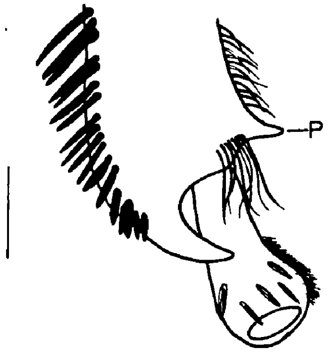

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being found at the base of this tooth which is not homologous with the mucron of the Adelognatha or many Phanerognatha and which Kuschel calls the praemucro. He considers that the mucron of the Adelognatha and some Phanerognatha and the uncus of some Phanerognatha are homologous structures and writes that the first term should be reserved for the spine perpendicular or nearly so to the axis of the tibia and uncus for the hooked or oblique spine further off from the internal angle.

Using Kuschel's definition, tibiae possessing a mucronal lamina would be mucronate, not unguiculate as Lacordaire appears to have regarded them.

During the present study, at least eight distinct types of tibial apex have been seen:

1) Unarmed tibiae, e.g. the Eugnomini (Fig. 234)

2) Tibiae with a simple mucron, e.g. Cleoninae, Smicronychini (Fig. 124).

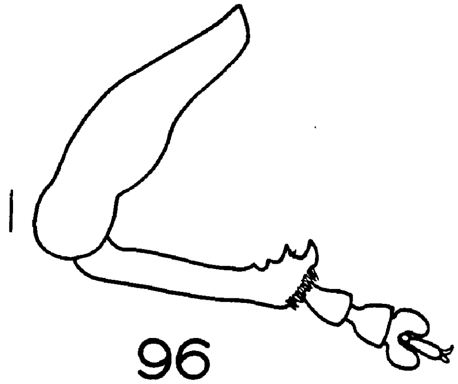
3) Tibiae with a mucron and tibial spurs, e.g. Otiorrhynchus, Thryogenes and Hyperodes (Figs 27, TS; 75, TS; 218, T).

4) Tibiae with a mucronal lamina, e.g. Hylobius (Fig. 28).

5) Tibiae with a mucronal lamina and a distinct praemucro, e.g. Liparus (Fig. 29, P).

6) Tibiae with an uncus, e.g. Bagous (Fig. 153).

7) Tibiae with an uncus and a distinct praemucro, e.g. Pissodes and Magdalis (Figs 30-31, P).



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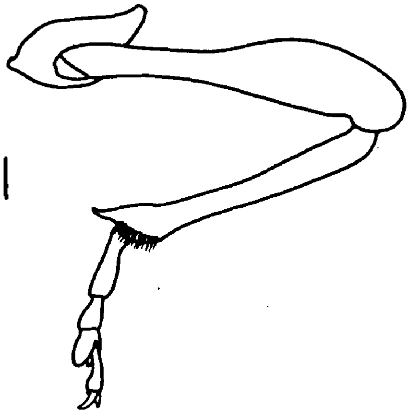

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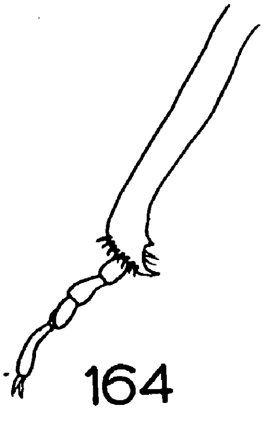

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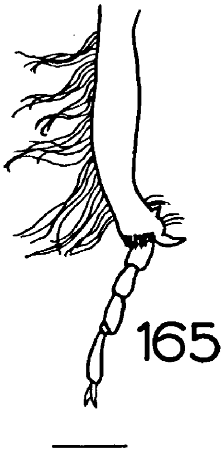

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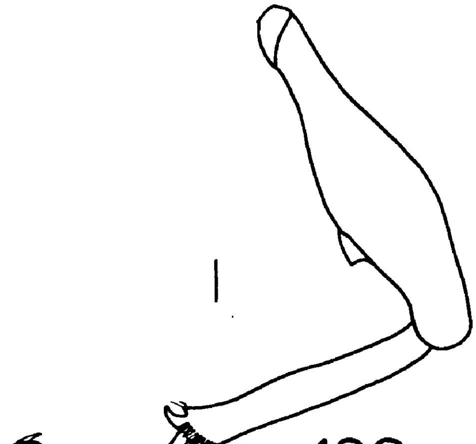

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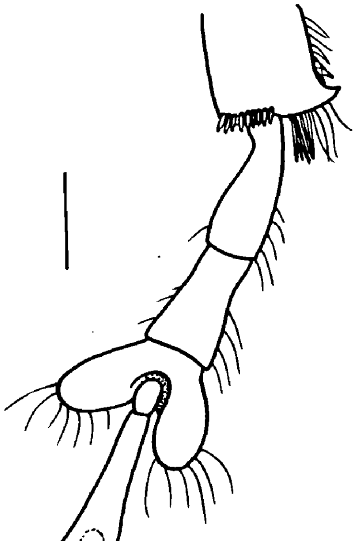

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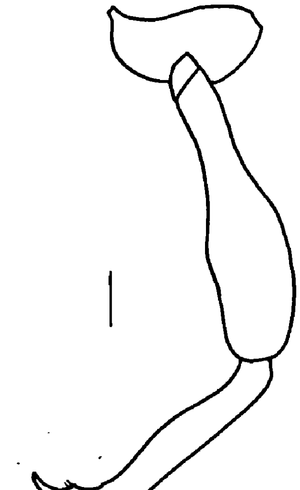

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8) Tibiae with a praemucro and apparent mucron, e.g. Rachiodes (Fig. 96).

There are many intermediate stages, e.g. Erytenna where the praemucro is very small and easily overlooked. The tibiae of Oenopus seem to be intermediate between mucronate tibiae and the type of unguiculate tibiae seen in Bagous (Fig. 187).

The type of prolongation of the tibial apex may vary on the fore-, mid- and hind-legs, e.g. Helodytes foveolatus (Figs 164-166) and it may vary between the sexes of a species, e.g. Celetes binotatus (Figs 196, 204).

The tarsi of most Curculionidae appear to be 4-segmented. The true fourth segment which is usually very reduced is more apparent in some groups than in others. It is best developed in some of the Cossoninae and is distinct in the Platypodids which are exceptional in having an elongate first tarsal segment which almost equals the length of the other segments together.

The breadth of the tarsi is usually fairly constant within sub-families or tribes. Weevils which spend most of their lives on land plants usually possess broad tarsi which have a densely pubescent adhesive pad on the ventral surface of each segment. In weevils which are mainly epigeous or aquatic, however, the tarsi tend to become narrow and sparsely pubescent or spiny on the under-surface, e.g. some Cossoninae, some of the Bagoini and species of Sitophilus (Fig. 175).

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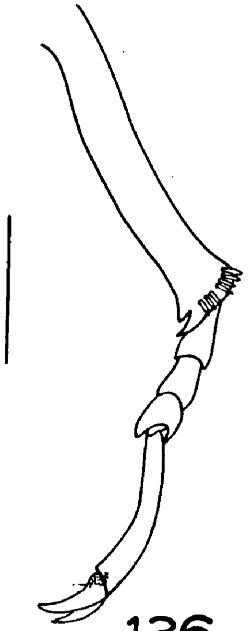

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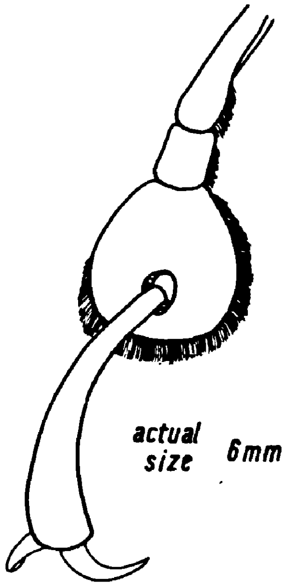

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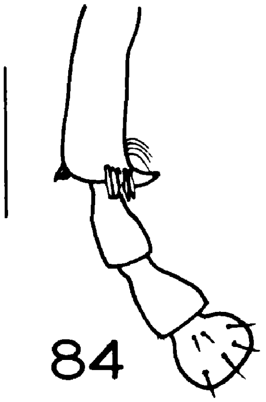

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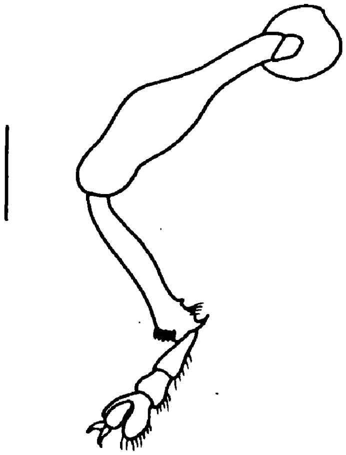

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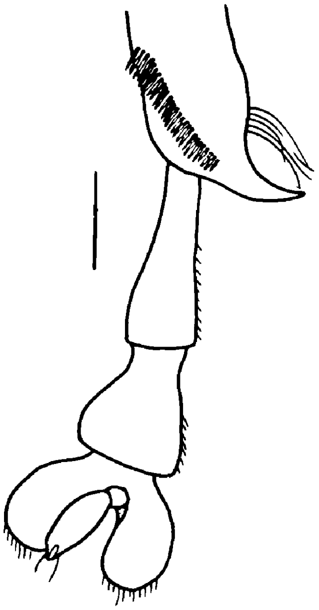

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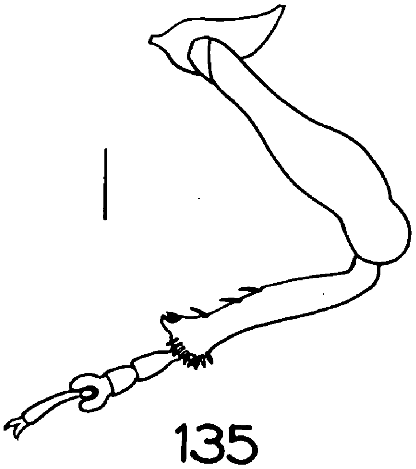

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The shape of the third tarsal segment may be of generic, tribal or sub-family importance. Usually it is strongly bilobed but when the tarsi are narrow it becomes rounded or truncate at the apex or at most weakly bilobed (Fig. 136). In most of the Rhynchophorinae it becomes palette-shaped, the fourth segment arising from a pit or groove on its dorsal surface (Fig. 32). In some Australian Erirrhininae which have lost the claw-bearing segment, it is broad and rounded at the apex or slightly notched, e.g. Misophrice (Fig. 84).

The claw-bearing segment is usually rather long and when the third segment is bilobed it projects well beyond the lobes. In most of the Tanysphyrina, however, it is rather short and just reaches or exceeds the lobes of the third (Fig. 158). Two claws are usually present on the last segment, but in some genera there is only one, e.g. Mononychus, and in others, claws may be absent, e.g. Ephimerus (Fig. 192).

Their structure is of importance in classification. In most groups they are simple and not fused together. In some sub-families and tribes, e.g. the Cleoninae and Smicronychini, they are fused together, or connate, at the base (Fig. 135), and in some genera of the Brachyderinae they are connate as far as, or beyond, the middle. On the other hand the claws may be slightly separate at the base and placed at a wide angle. When this is more than ninety degrees they are said to be divaricate

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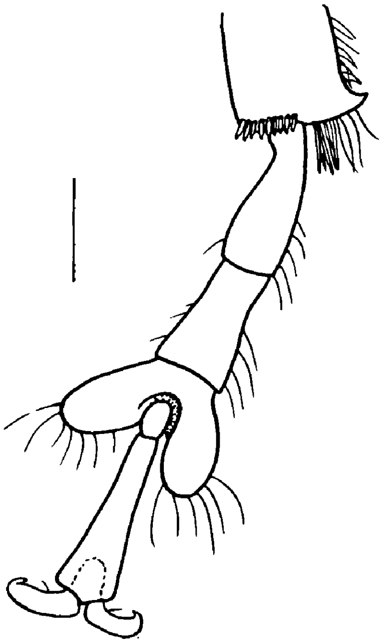

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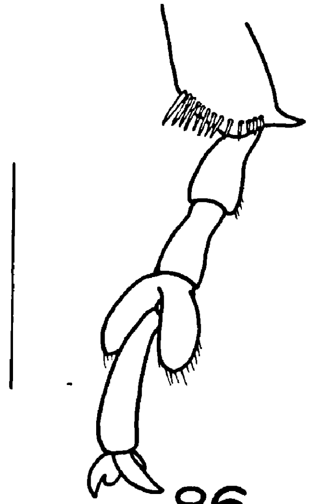

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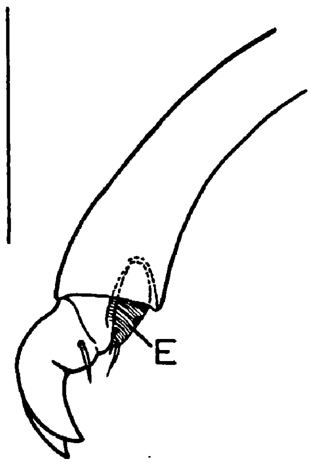

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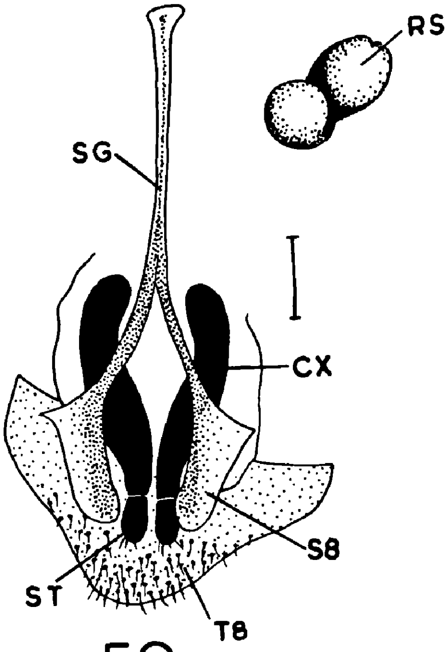

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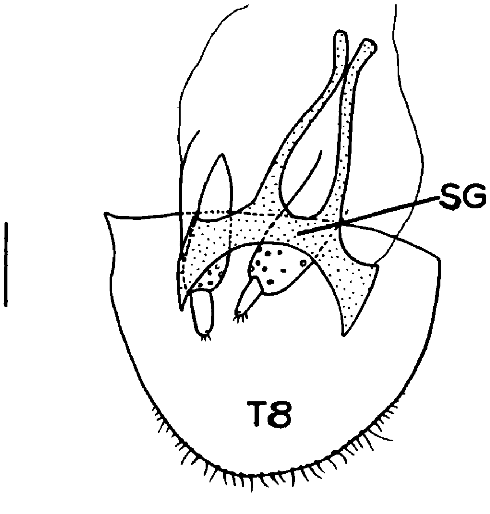

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(Fig. 204). When the angle is less than ninety degrees, some authors call them divergent.

In a number of sub-families, especially the Anthonominae and Tychiinae and in Peristoreus, the claws are appendiculate at the base (Fig. 86). In some genera, e.g. Storeus, the appendiculation is so slight that the claws are said to be obtusely angled at the base (Fig. 105).

o) Female genitalia

The female genitalia has seldom been used in the classification of the Curculionidae. Tanner in 1927 made a study of the female genitalia of the entire order and found that the only structures present in the super-family Curculionoidea were coxites and styli except in Pantomorus which has a small baculum.

In 1943 in a study of the "Hydronomini" he wrote that the amount of chitinisation of the eighth sternite was fairly definite for each species, thus providing a specific character. (Only the sclerotised portion has been drawn in the figures in this thesis and it is referred to as the spiculum gastrale, although it is not homologous to that of the male.) Its basal portion is usually single (Fig. 59, SG) but in Cionus it has become two-branched (Fig. 33, SG). Tanner also wrote that the absence of styli and the largely membranous coxites of Lissorhoptrus simplex justify its separation from other members

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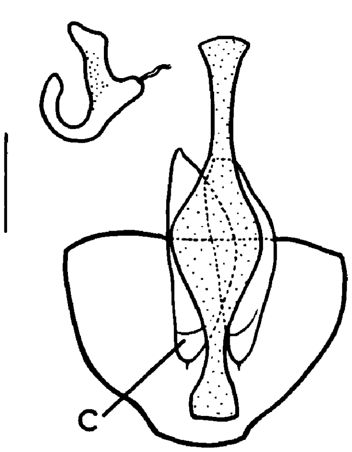

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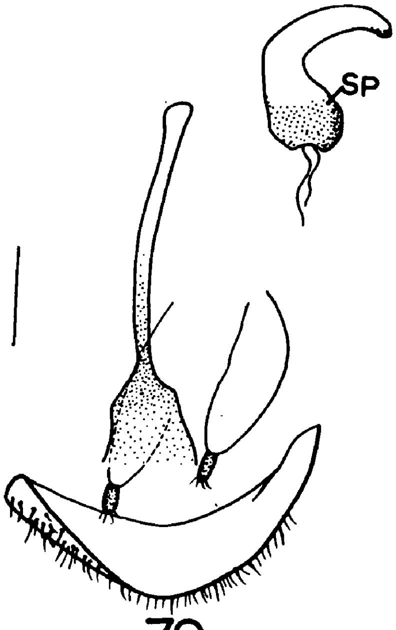

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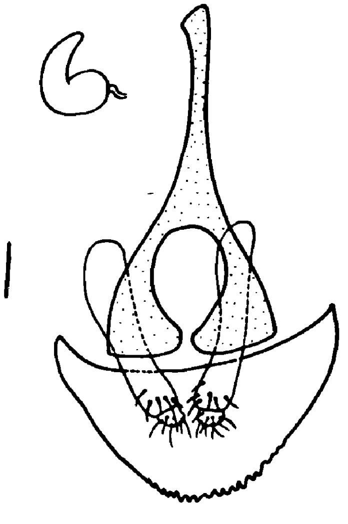

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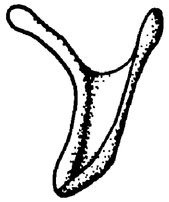

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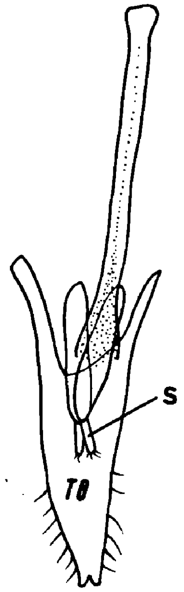

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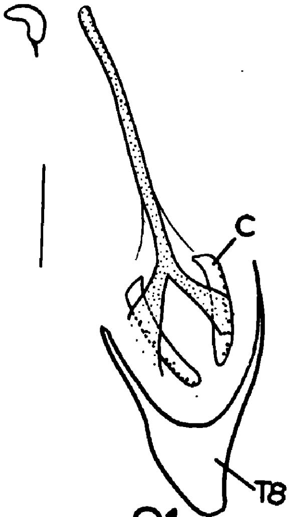

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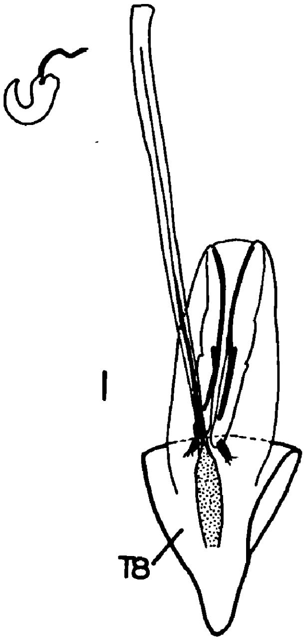

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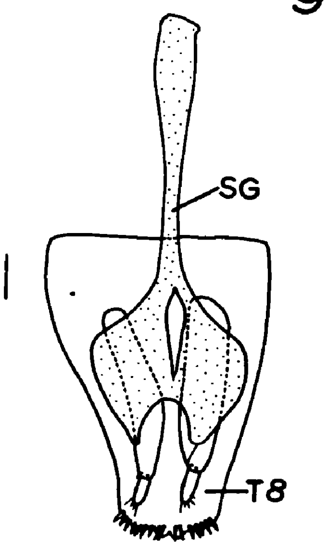

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of the sub-tribe. They are also missing, however, in the closely related Helodytes foveolatus (Fig. 167), many other genera of the Erirrhininae, all the Meriphini and the British Tychiinae and in Sitona and Sitophilus. The spermathecae, he writes, may be used in generic as well as specific separation of members of the Bagoini. It is rarely pigmented in the Erirrhininae but there is a little pigmentation in the spermatheca of Helodytes foveolatus and that of Dorytomus vorax is strongly pigmented (Figs 167, 79).

Variations in the shape of the eighth tergite may also be of importance in classification. Usually it is very similar in shape to that of the seventh tergite but the apical edge may be strongly serrated as in Opsittis atomaria Pasc. (Fig. 225). In the Eugnomini it is more or less pointed at the apex, though it is bilobed in some (Figs 239-240). This may be connected with the mode of oviposition as the rostrum tends to be short and broad in most of the genera (vide infra p.119. A similar type of eighth tergite can, however, be found in Misophrice, Aoplocnemis and Cryptorrhynchus (Figs 91, 111, 34, T8) which have long slender rostra, while in Eristus and Stenopelmus which have very short rostra the eighth tergite is normal.

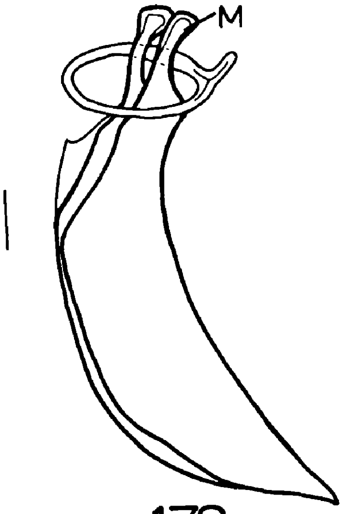
Kuschel (1952) in a study of Lissorhoptrus and closely related genera made use of two characters derived from the female/

female genitalia. He separated the sub-genera Dythelus and Helodytes s.str. by the presence or absence of an apical seta on the coxites. He also used a comparison of the seventh tergite of the female with that of the male as a specific character.

Smith (1953) examined the chromosome numbers of several genera of the Curculionidae and found that the basic number was eleven, i.e. ten pairs of autosomes and one pair of sex chromosomes. A few of the Adelognatha examined, however, were polyploids possessing thirty-three, forty-four or fifty-five pairs of chromosomes. The normal number of chromosomes in Coleoptera is ten, i.e. nine pairs of autosomes and one pair of sex chromosomes. Unfortunately as all the species so far examined have been Curculionidae s.str. it is not known whether eleven pairs of chromosomes is characteristic of the superfamily or only of the family Curculionidae.

p) Male genitalia

Much more use has been made of the male genitalia in classification. In 1918 Sharp studied the male genitalia of a number of weevil genera and paid particular attention to the spiculum gastrale (sternite nine), the struts and orifice of the median lobe and to the tegmen. He noted that although the spiculum gastrale is present in nearly all the Curculionidae it is absent in one division of the "Calandridae and Platypidae". In a previous paper, 1912, he alleged that in the Curculionidae there is a reduction from a tegmen with a dorsal cap-piece to a Y-shaped tegmen where the dorsal part is unsclerotized.



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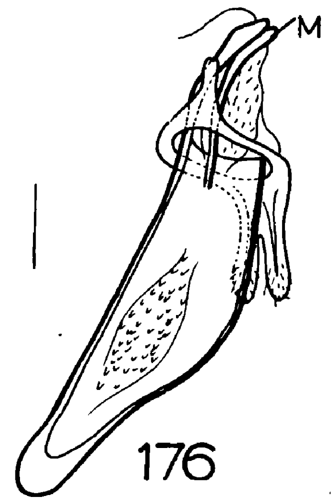

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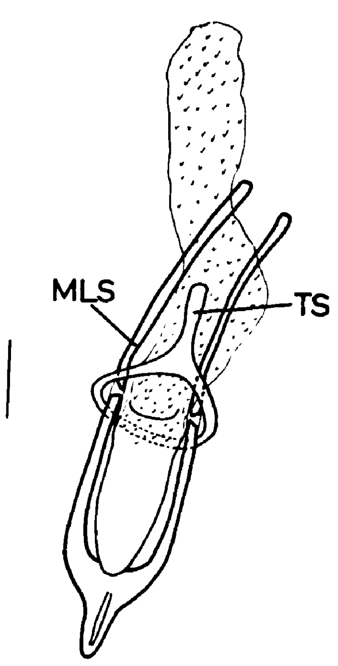

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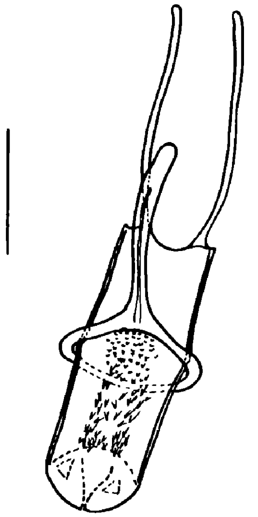

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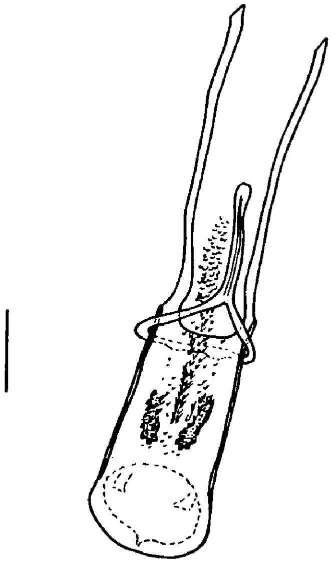

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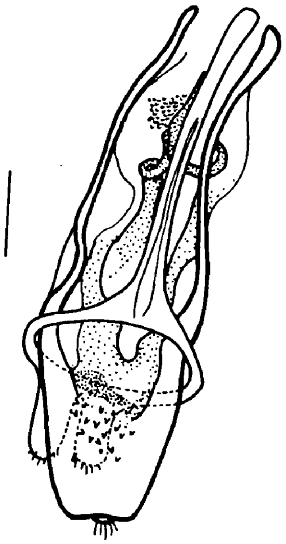

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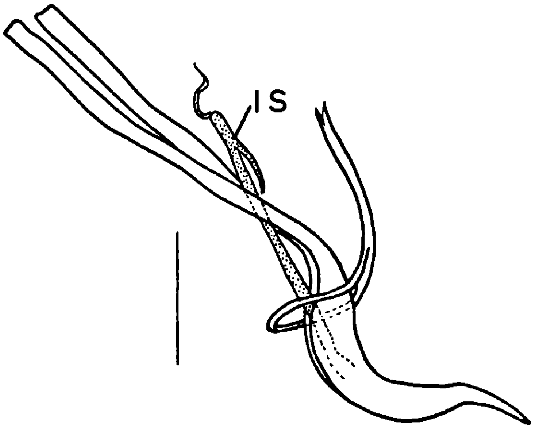

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Jeannel and Paulian (1944) in their work on the external genitalia of the Coleoptera also noticed this regressive evolution of the tegmen in the Curculionidae and with it what they called a progressive evolution of the median lobe.

Characters derived from the male genitalia have since been used by many authors to separate species and they can sometimes be used to separate tribes.

The size and shape of the spiculum gastrale present specific variations. The shape of the median lobe and the shape and position of its orifice have been used at this level by a number of taxonomists.

Sharp (1918) laid great stress on the length of the median lobe struts. He found that they were very short and shaped like calipers in the Cleoninae and a number of Bagous species (Figs 178, 176, M). He also noticed that in some species they appear to be jointed owing to the absence of sclerotization in a small region at their base, e.g. Stenocarus (= Coeliodes) (Fig. 35, MLS).

The shape of the internal sac of the median lobe was studied by Jeannel and Paulian. The sclerotizations which are frequently present vary in different species.(Figs 134, 139, 159). Occasionally the sac is so sclerotized distally that it appears to form a third strut, e.g. Peristoreus, Emplesis, Nanophyes, Baris, etc. (Fig. 87, IS).

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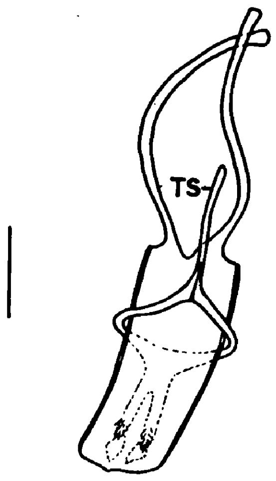

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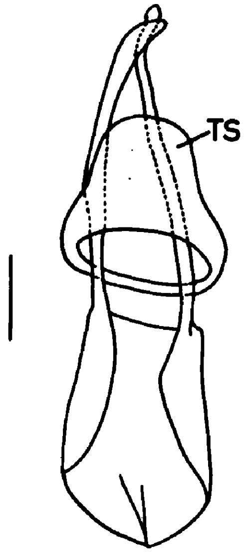

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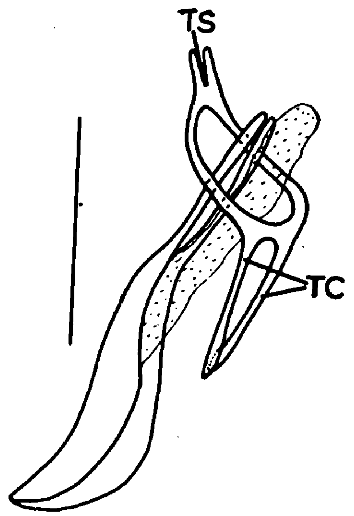

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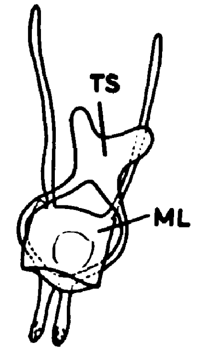

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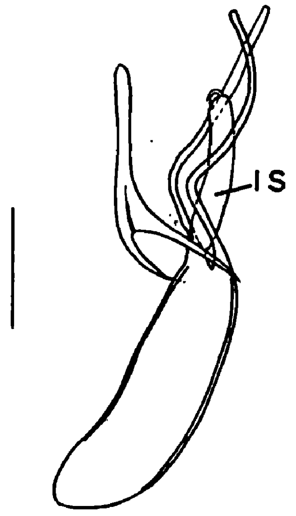

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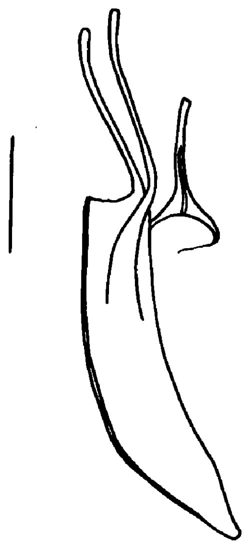

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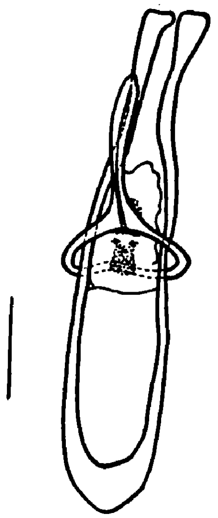

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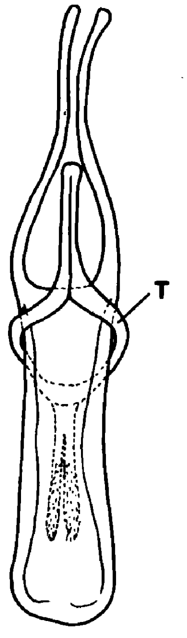

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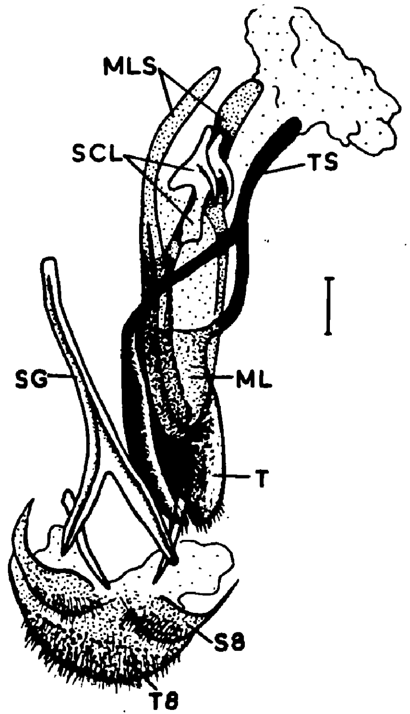

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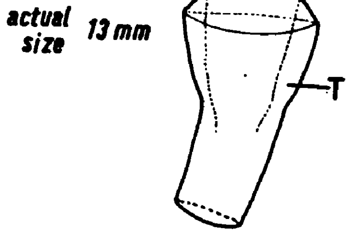

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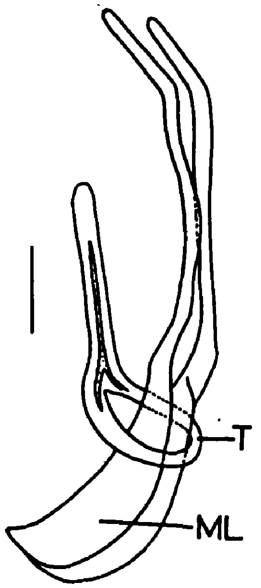
The shape of the tegmen has been used less often in taxonomy although both Kuschel and Peyerimhoff have figured it in a number of papers. The length and shape of its strut may be constant in sub-families or in closely related genera or species. It is usually rather long and slender (Fig. 131, TS) but it is very short as in the sub-family Cleoninae and some Bagous and Phycocoetes species, very broad as in a number of Cossoninae (Fig. 36, TS) or bilobed as in Anoplus and Tysius (Figs 37, 257).

There may be no dorsal sclerotization of the tegmen so that it appears to be Y-shaped as in many Scolytids and in Philernus and Sharpia, etc. (Figs 85, 129) or there may be a thin band of sclerotization so that it is ring-shaped as in almost all the Storeini, the British Ceuthorrhynchinae, etc. (Fig. 81). Often a bilobed cap-piece is present dorsally as in the Eugnominae (Fig. 237). The two lobes may be quite separate or fused for some distance.

In 1948 Brühn noticed that the tegminal cap-piece of Notaris was very large, almost as long and broad as the median lobe, and bilobed only at the tip. This type of tegmen has been found in all the genera which in the present work are retained in the tribe Erirrhinini (Fig. 60).

Sharp (1918) found that the area of the tegmen which is usually membranous is more or less strongly and completely sclerotized in certain Rhynchophorinae (Fig. 38, T). In Sitophilus/



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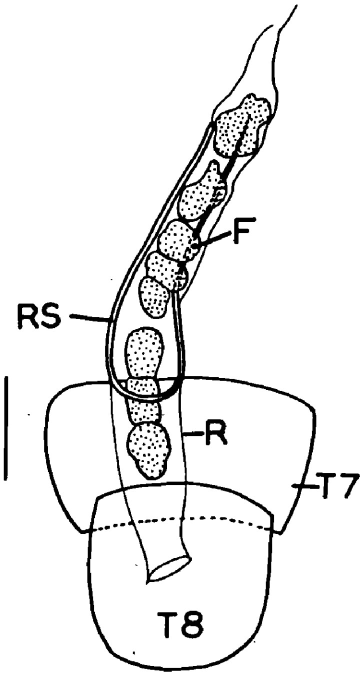

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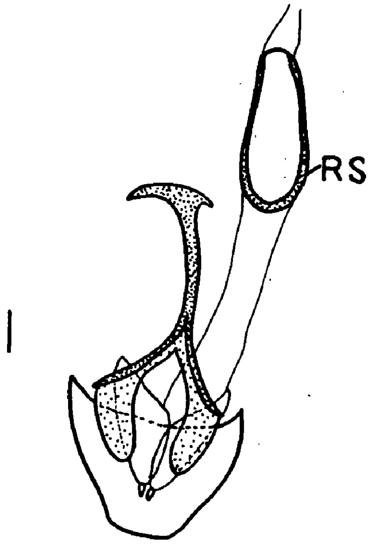

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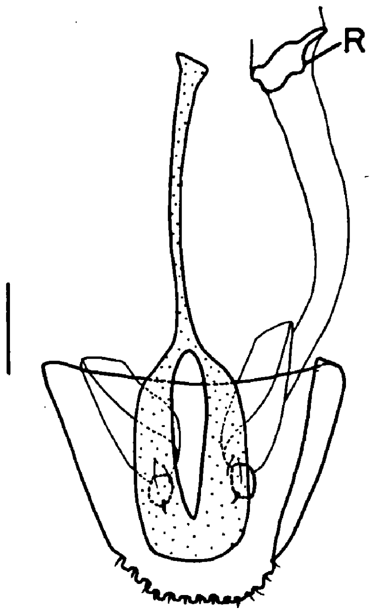

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Sitophilus, however, the tegmen is ring-shaped (Fig. 39, T).

q) Sclerotizations connected with the rectum

A character which does not seem to have been considered previously is the presence or absence of sclerotizations connected with the rectum. A U-shaped sclerite has been found supporting the rectum in all the British Cossoninae (except the genus Cossonus) and in Sitophilus and Spermologus (Figs 40, 201, RS) and in the very unusual genus, Cylindrotrypetes.

A ring of sclerotization is present in the wall of the rectum of Desiantha, Hylesinus, Hylastes and the Scolytid-like Cossonine, Xenocnema (Fig. 222, R). It is possible that both types of sclerotization are connected with the diets of these genera which in every case are exceptionally dry. If this is so, it is strange that the sclerotization has not been found in other genera with a similar diet.

r) Sexual dimorphism

Sexual dimorphism is more evident in some groups than in others. It is very slight in most of the Adelognatha and some of the Phanerognatha. In certain Otiorrhynchus species, according to Hustache (1923), the fifth sternite of the male is more or less striated, in others it is grooved or it may have a pubescent fringe. In a few species, the eyes are smaller and more convex in the male than in the female.

In/

In general, throughout the family the male is smaller and narrower than the female and the first visible sternite of the male tends to be impressed while that of the female is more often flat or convex.

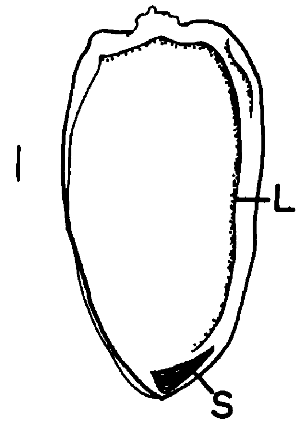
In many of the Phanerognatha the length and diameter of the rostrum is affected. In genera where the length varies little in the sexes, the rostrum may be more strongly and completely punctured in the male than in the female. In some of the Rhynchophorinae, according to Marshall (1916), the rostrum of the male may bear a row of tubercles or a dense fringe of hairs.

In some of the Petalochilinae, according to Vaurie (1954), the pronotum is proportionally wider and the third and fourth abdominal segments proportionally longer in the male than in the female. In Ancylorrhynchus variabilis, she writes, there is only one colour phase in the male, whereas the female may have five or six.

s) Stridulation

The presence or absence of stridulating organs and their position on the body may be of importance at generic and specific level or possibly higher levels.

According to Gahan (1900), they are present on the lower surface of the head in some species of Scolytus, the files being long and narrow in some species but shorter and broader in others/



133

others. The scraper is an inwardly projecting ridge at the anterior edge of the prosternum. Stridulating organs are found on the elytra and abdomen of many Cryptorrhynchinae and Ceuthorrhynchinae and in various genera not belonging to these sub-families, e.g. many of the Smicronychini and Orobitis (Fig. 133, S).

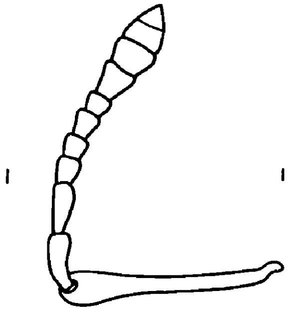
They are said to be present in the male only of Cryptorrhynchus lapathi and in both sexes of other species of the genus and of Plinthus, Acalles, Monochyus, etc.. The files may be found on the elytra in both sexes or may be found on the elytra of the male but the abdomen of the female. Scrapers are correspondingly found on the abdomen or elytra, being found on the pygidium of the female or the propygidium of the male when they occur on the former.

Haskell (1957) wrote that most beetles produce disorganized sound, so that it is unlikely that the type of sound can be used to separate species as it can in some of the Hemiptera.

PLATE I: Figs 1-12

1. *Lepyrus capucinus* Schall., antenna
2. *Lixus algirus* L., antenna
3. *Sitophilus granarius* L., antenna
4. *Eupagoderes* sp., mandible (after Ting, 1936)
5. *Tanymecus palliatus* F., underside of tip of rostrum
6. *Liparus coronatus* Goeze, underside of tip of rostrum
7. *Lixus paraplecticus* L., maxilla
8. *Curculio* sp., maxilla (after Ting, 1936)
9. *Anthonomus* sp., labium, dorsal view (after Ting, 1936)
10. *Cactophagus* sp., labium, dorsal view (after Ting, 1936)
11. *Lixus algirus* L., labium, ventral view
12. *Larinus planus* F., labium, ventral view

L, ligula; LP, labial palp; LT, maxillary teeth; M, prementum; MD, mandible; MT, median tendon; MX, maxilla; PM, postmentum; PP, pharyngeal process; PTA, posterior tentorial arm; S, mandibular scar.



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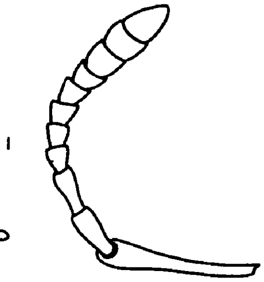

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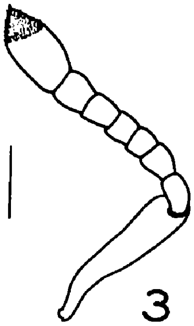

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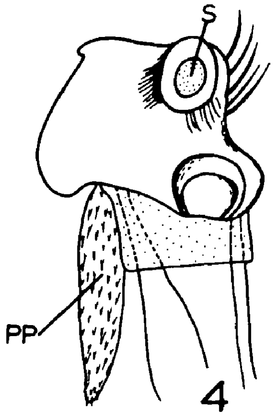

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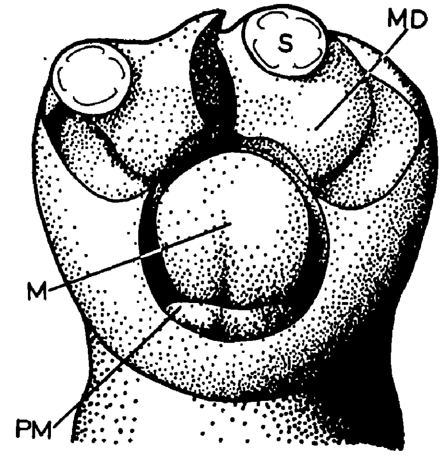

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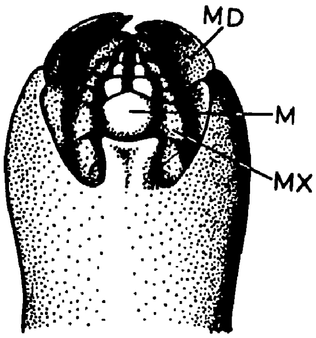

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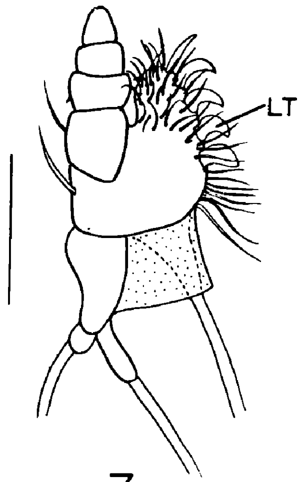

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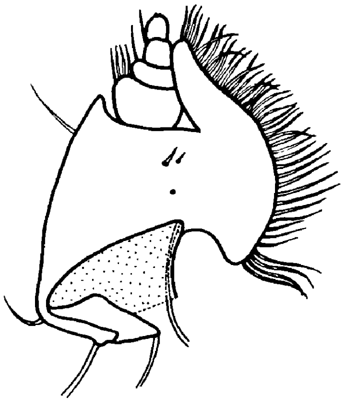

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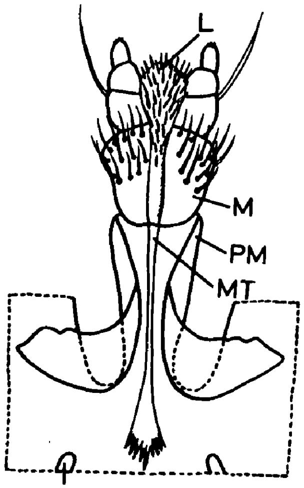

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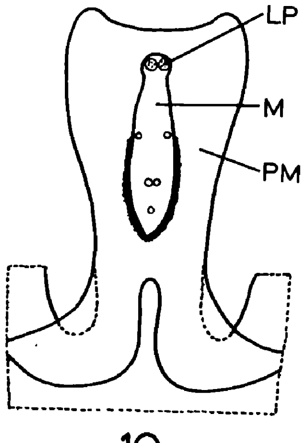

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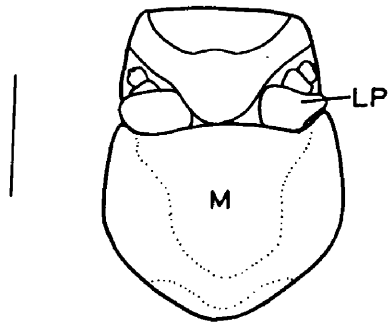

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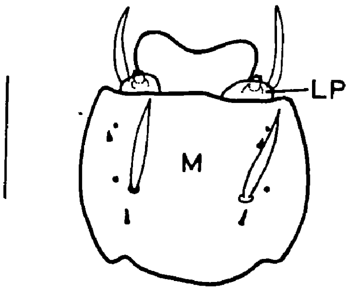

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PLATE II: Figs 13-23

13. Rhynchophorine sp., thorax and abdomen

14. *Hylobius abietis* L., thorax

15. *Otiorrhynchus morio* F., meso- and metathorax

16. *Liophleus tessulatus* Muell., meso- and metathorax

17. *Bagous argillaceus* Gyll., 7th and 8th tergites, ventral view

18. *Pachyphanes discoideus* Lec., elytron, dorsal view

19. Diagrammatic elytron

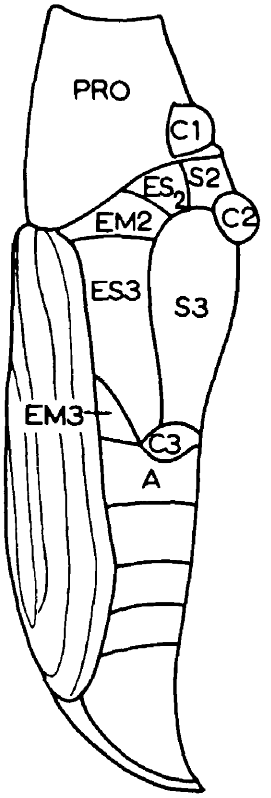
20. Diagrammatic elytron

21. *Phyllotrox ater* Champ., wing

22. *Rhamphus pulicarius* Hbst., leg

23. *Grypidiopsis variegatus* Champ., prothoracic tibia

A, abdomen; C1, C2, C3, pro-, meso- and metathoracic coxae; EM2, EM3, mes- and metepimera; ES2, ES3, mes- and metepisterna; I3, I7, I9, interstices 3, 7 and 9; M, Maulik's organ; PRO, prothorax; S2, S3, meso- and metasternum; ST3, ST7, ST8, striae 3, 7 and 8; T7, T8, tergites 7 and 8.



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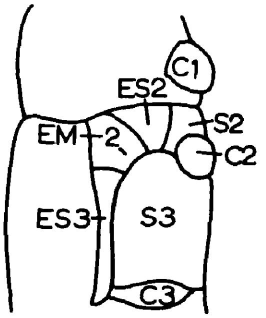

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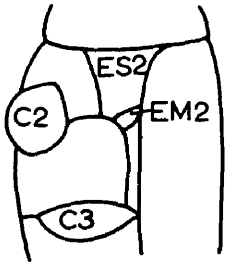

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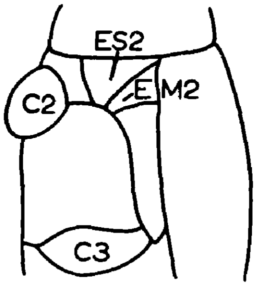

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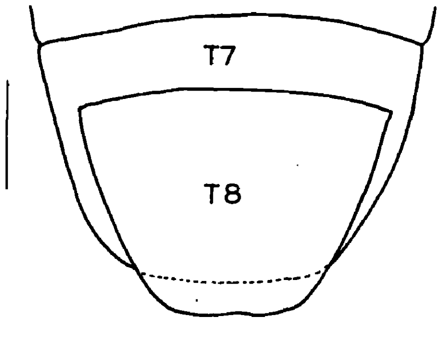

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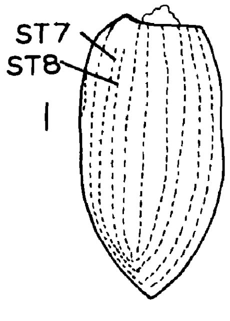

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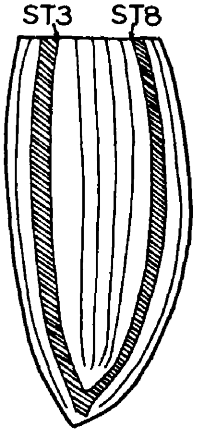

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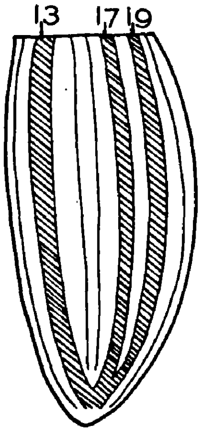

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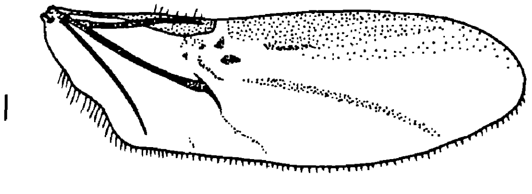

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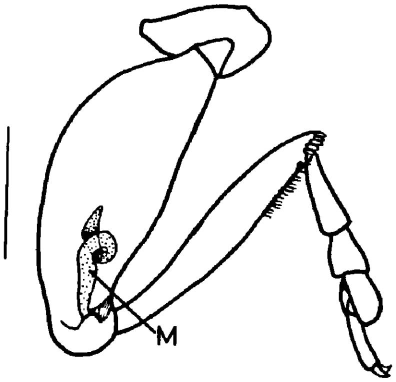

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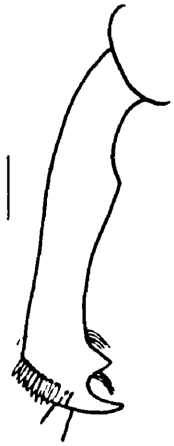

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PLATE III: Figs 24-34

24. *Brachyderes incanus* L., apex of left tibia (after van Emden, 1944)

25. *Amystax fasciatus* Roel., apex of left tibia (after van Emden, 1944)

26. *Catapionus viridanus* Tourn., apex of left tibia (after van Emden, 1944)

27. *Otiorrhynchus singularis* L., apex of right tibia

28. *Hylobius abietis* L., apex of left tibia

29. *Liparus coronatus* Goeze, apex of right tibia

30. *Pissodes pini* L., apex of left tibia

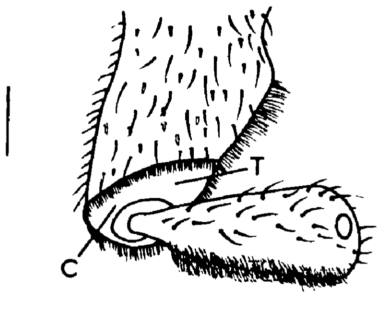
31. *Magdalis carbonaria* L., apex of left tibia

32. Rhynchophorine sp., tarsus

33. *Cionus scrophulariae* L., female genitalia

34. *Cryptorrhynchus lapathi* L., female genitalia

C, corbel; P, praemucro; SG, spiculum gastrale; T, tarsal groove; T8, tergite 8; TS, tibial spur.



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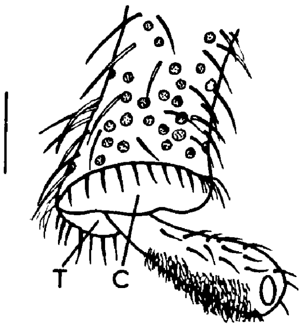

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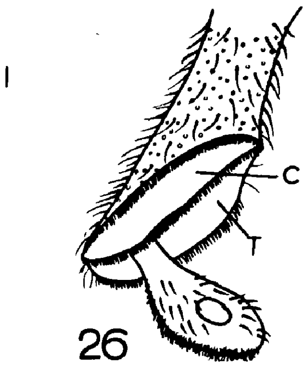

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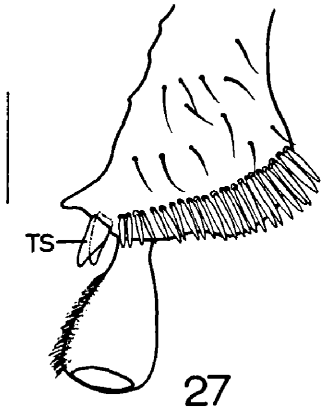

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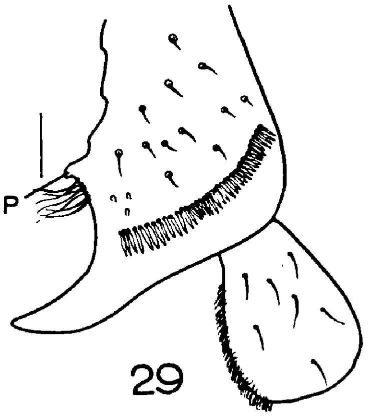

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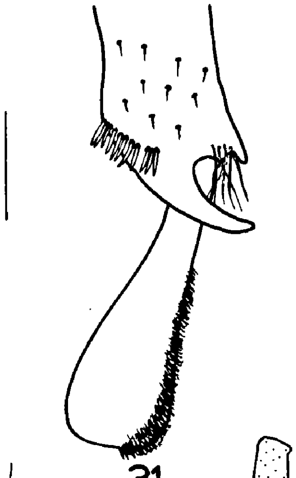

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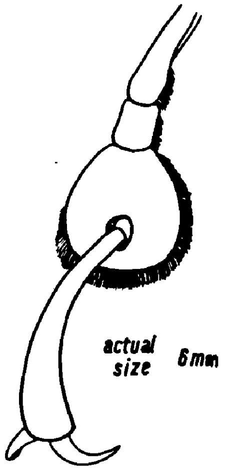

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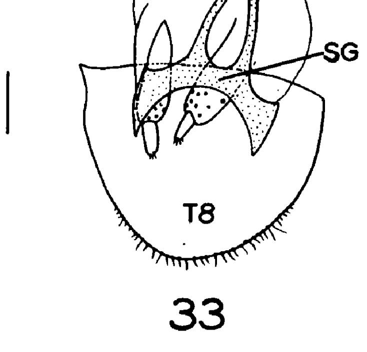

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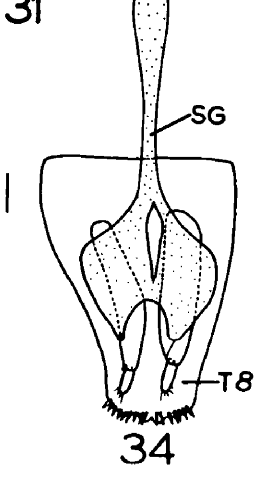

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PLATE IV: Figs 35-40A

35. *Stenocarus (= Coeliodes) cardui* Herbst., male genitalia

36. *Cossonus parallelepipedus* Herbst., male genitalia

37. *Anoplus plantaris* Naez., male genitalia

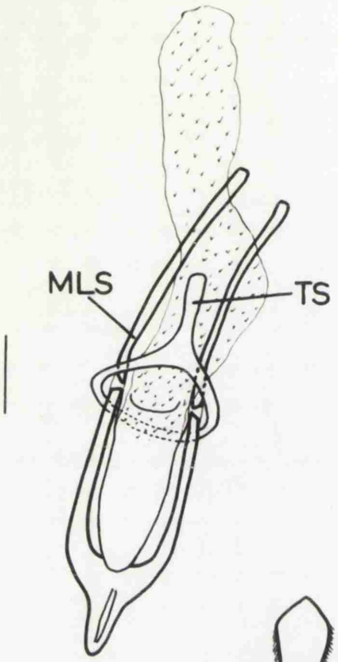
38. Rhynchophorine sp., tegmen

39. *Sitophilus granarius* L., male genitalia

40. *Rhyncolus truncorum* Germ., end of rectum and tergites 7 and 8

40A. *Cyphus* sp., dorsal view of head with cusps on the mandibles

C, cusp; F, frass; ML, median lobe; MLS, median lobe strut; R, rectum; RS, rectal sclerite; T, tegmen; TC, tegminal cap-piece; TS, tegminal strut; T7, T8, tergites 7 and 8.



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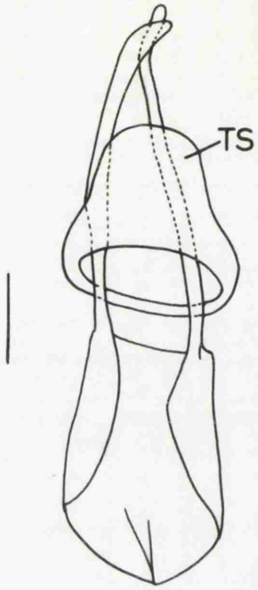

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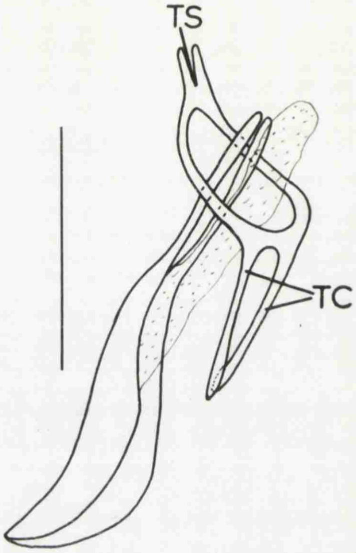

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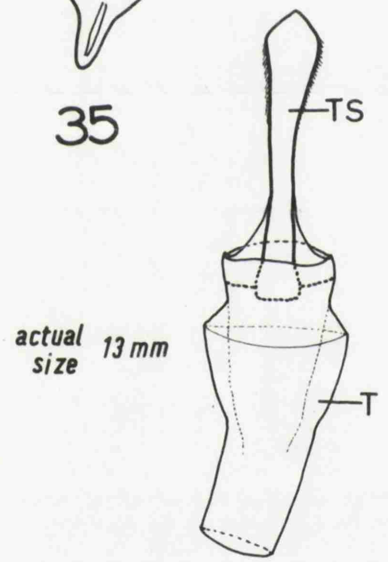

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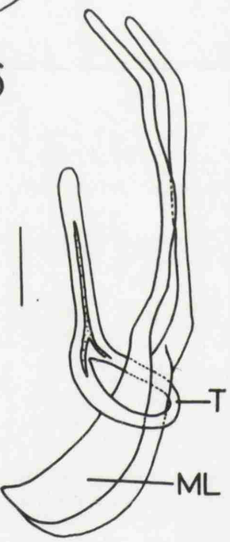

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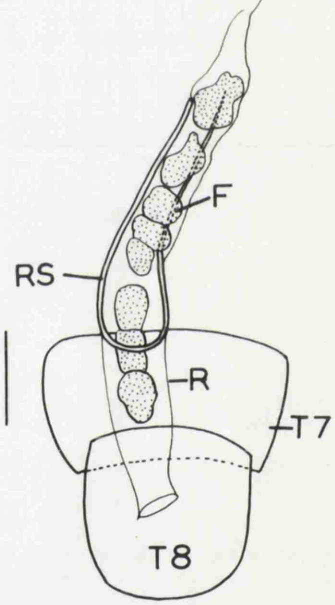

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40A

IV. THE SUB-FAMILY ERIRRHININAE

In Junk's Coleopterorum Catalogus, Pars 140, Klima (1934) listed 229 genera in the sub-family Erirrhininae. I have been able to study representatives of 86 of these genera, usually only one, but occasionally two, species from each genus. Several of the genera appeared to have been placed in the wrong tribe or even sub-family. They are listed below in Table 2. Changes of name, if any, are noted in the second column, their position according to Klima in the third and their new position in the fourth, a "+" indicating that this is unchanged.

TABLE 2

Genera studied	Change of name since 1934	Position in Col. Cat.	New position
-		Itini	
Dorytomus		Erirrhinini	Orthochaetini ?
Grypidiopsis		"	Incertae Sedis
Hypsomus		"	Smicronychini ?
(Dorytomodes)	Peristoreus	"	Orthochaetini ?
Procas		"	+
Phytotribus		"	Petalochilinae
Celetes		"	Petalochilinae
Notaris		"	+
Thryogenes		"	+
(Grypus)	Grypidius	"	+
Aoplocnemis		"	Storeini ?
(Oenochroma)	Oenopus	"	Incertae Sedis
Eristus		"	Incertae Sedis
Desiantha		"	Cylindrorrhininae
Opsittis		"	Hylobiinae

TABLE 2 (Contd)

Genera studied	Change of name since 1934	Position in Col. Cat.	New position
Eniopea		Erirrhinini	Storeini
(Mascarauxia)	Hyperodes	"	Cylindrorrhininae
Echinocnemus		"	Bagoini
Pachytychius		"	Smicronychini
Barytychius		"	Smicronychini
Spermologus		"	Petalochilinae ?
Aubeonymus		"	Smicronychini ?
Jekelia		"	Bagoini
Acentrus		"	Smicronychini ?
Pseudostyphlus		Orthochaetini	+
Philernus		"	Incertae Sedis
Geranorrhinus		"	Incertae Sedis
Orthochaetes		"	+
Olanea		Storeini	+ ?
Gerynassa		"	+
Cydmaea		"	+
Dicomada		"	+
Erytenna		"	+
Emplesis		"	+
Storeus		"	+
Antyllis		"	+ ?
Eugnomus		Eugnomini	Eugnominae
(Caenophanus)	Eugnomus	"	+
Udeus		"	+
(Oreocharis)	Oreocalus	"	+
Tysius		"	+
Hypselus		"	Erirrhinini
Rhopalomerus		"	+
Callistomorphus		"	+
Stephanorrhynchus		"	+
Hoplocneme		"	+
Meriphus		"	+
Orpha		"	+
(Macropoda)	Pactola	"	+
Phrenozemia		"	Erirrhininae ?
Ophthalmoborus		"	Incertae Sedis
Myossita		"	+
Acanthopterus		"	Incertae Sedis
Ancistropterus		"	+
Scolopterus		"	+
Nyxetes		"	+

TABLE 2 (Contd)

Genera studied	Change of name since 1934	Position in Col. Cat.	New position
Oropterus		Eugnomini	Anthonominae
Tithene		"	Tripetini
(Cyttalia)	Eugnomus	"	+
Thechia		"	Erirrhininae ?
Cratoscelocis		"	Erirrhininae ?
Desmoris		Smicronychini	+
Pachyphanes		"	+
Sharpia		"	+
Smicronyx		"	+
Synertha		"	+
Stenopelmus		Bagoini	+ ?
Endalus		"	+
Endaliscus		"	+
Misophrice		"	Incertae Sedis
Rachiodes		"	Storeini
Anchodemus		"	Cylindrorrhininae
(Lixellus)	Anchodemus	"	Cylindrorrhininae
Lissorhoptrus		"	+
Hydronomidius		"	+
Bagous		"	+
Phycocoetes		"	Petalochilinae
Tanysphyrus		Tanysphyrini	Bagoini
Derelomus		Derelomini	Petalochilinae
Phyllotrox		"	Petalochilinae ?
-		Acalyptini	
Alhypera		Incertae Sedis	Bagoini ?
(Brexius)	Desiantha	"	Cylindrorrhininae
Ephimerus		"	?
Pactola		"	Eugnominae
Peristoreus		"	Orthochaetini ?
Stenopactola		"	Eugnominae

The larva of one genus, Grypidius equiseti F., was examined (Figs 41-55). According to W.H. Anderson (personal communication) several/

several diverse types of larvae are included in the Erirrhininae. Usually there is a reduction in the number of setae on the frons. There are only four pairs in <u>Dorytomus</u> and <u>Derelomus</u> and three pairs in <u>Smicronyx</u>. In <u>Grypidius</u>, however, which is more primitive than these genera in a number of ways, there are five pairs of frontal setae, four and five being sub-equal and long, and there is a short endocarina. According to Anderson there is a faint indication of ocelli in older larvae. Apart from the head, the only sclerotization is a small pronotal one. The thoracic and pedal lobes each bear one and the abdominal pleura two large setae. Bicameral spiracles are found on the prothorax and segments one to eight of the abdomen, and egg--bursters in the first instar larva on the first six abdominal segments. The terminology of Anderson (1947) was used.

<u>1. Tribe Erirrhinini</u>

The rostrum is rather slender and elongate with straight, parallel scrobes reaching the eyes which are fairly large, usually round and not protuberant (Fig. 56). The mandibles are usually, but not always, exodont (Fig. 57). The antennae are rather long and slender, the funicle 7-segmented, either the first, or the first and second being longer than the others. The club is usually compact with ill-defined segments. The anterior coxae are contiguous and the prosternum is not

emarginate/

emarginate. The femora are edentate, the tibiae usually weakly mucronate, tibial spurs being found at the apex in some genera (Fig. 58, TSP). The third tarsal segment is strongly bilobed, the last strongly projecting and bearing free simple claws. The suture between the first and second abdominal segments is complete and distinct, the sutures between the other abdominal segments straight. Well developed styli are present in the female genitalia and the eighth tergite is normal (Fig. 59). The tegminal cap-piece of the male genitalia is of a type rarely found in the Curculionidae, being very large, covering the aedeagus dorsally and bilobed only at the tip (Fig. 60). The eighth tergite is exposed in this sex. All the species studied were winged. They are found in aquatic or sub-aquatic habitats, living on Monocotyledons or Cryptogams.

According to Klima (1934) Erirrhinus Schön. is a junior synonym of Notaris Germar but according to the latest Copenhagen Decisions on Zoological Nomenclature, it may still be retained for the tribal and sub-family names in which it has priority.

The following genera have been retained in this tribe: Grypidius, Procas, Notaris and Thryogenes, and the genus Hypselus is tentatively included.

Study of genera

i) Grypidius Schön

This genus was studied in more detail than the others.

Zumpt (1929), followed by Klima (1934), attempted to revive the generic name Grypus Grm., 1817, in place of Grypidius Schön., 1826. As the latter name has been used by every other writer since 1826 and, according to Hustache (1930), Germar's Grypus is a nomen nudum, I see no reason for following Zumpt in this.

In Junk's Coleopterorum Catalogus, Pars 140, Grypidius has five species listed - atrirostris F., brunnirostris F., equiseti F., mannerheimi Faust and vittatus Cooper. Zumpt (1935) gives a key to separate the first four and another species, rugicollis Voss, which had been described in 1935. Zumpt writes of atrirostris, "It resembles equiseti in shape and size but the scales of the dorsal surface are small and not so crowded. The setae are somewhat longer and more numerous. It can be distinguished from equiseti at a glance by the reddish-brown scales of the elytral protuberances." (My translation.) I could not on these criteria or any others distinguish equiseti from the single specimen in the British Museum and the four in the Armitage collection (Glasgow University), labelled atrirostris. There seemed to be no less crowding of the scales nor any difference in their size when compared with the sixty or so specimens of equiseti in the British Museum collection which varied/

varied considerably in colour. Tournier (1874) describes *atrirostris* as a variety of *equiseti*. Uyttenboogaart (1943) is also of the opinion that *atrirostris* is a form of *equiseti*, not a separate species.

Neither *atrirostris* nor *vittatus* has been included in the key which I have drawn up. Of the latter, Leconte (1876) wrote "A Canadian specimen was sent me by Mr. Cooper which I determined simply as *Grypidius* n.sp.?, but by some confusion of the labels in describing the species to which I had given no definite names, he has given the name *G. vittatus* to a small species of *Sitones* apparently *S. tibialis* of Europe, which occurs in Canada and in Hudson Bay territory, perhaps imported, perhaps indigenous."

The British Museum collection contained two *Grypidius* species which could not be identified with Zumpt's key. One of these, represented by a single specimen only, I have referred to in the key as *Sp.X*. Further specimens of the second species were obtained from the California Academy of Sciences by courtesy of Mr. Hugh B. Leech. As I have been unable to find any described species to which they could be attributed, the species is described as new below.

Grypidius leechi sp.nov.

Female. Derm reddish-brown to brownish-black with light golden/

golden brown and yellowish scales. Head clothed with narrow golden scales. Rostrum bare, curved, finely punctured with a median dorsal keel, about as long as the head and prothorax together. Antennal insertions slightly nearer the apex than the base of the rostrum with scrobes extending to the anterior margin of the eye. Basal segment of funicle three times, and second segment twice, as long as broad, remaining five segments approximately as broad as long. Antennal club oval and compact, the first segment as long as the other segments together. Prothorax narrower at the apex than the base. Dorsum closely punctured except for a rather distinct band at the anterior edge and a less distinct longitudinal band running back from it towards, but not reaching, the base. These punctures much larger than those on the head and elytra and many of them, especially at the sides, covered by large yellowish or light brown feathery-looking scales. More slender hair-like scales present both on the pronotum and elytra. Scutellum with a dense covering of scales - abraded in some specimens. Elytra, twice as long as broad, almost parallel for the anterior two-thirds, then narrowing to the apex. Shoulders well marked. Striae rather deep and interstices fairly flat and covered with golden brown scales. An indistinct patch of lighter scales present in the middle of interstice three. Legs dark reddish-brown with hair-like scales. Length 5.0-6.0 mm. (excluding rostrum). Colorado, Wyoming and Alberta, 10 females. (Fig. 61)

The/

The holotype and seven paratypes are in the collection of the California Academy of Sciences where they had been identified as G. brunnirostris, the other two paratypes in the British Museum (Nat. Hist.).

Key to the species of the genus Grypidius

1. All interstices of elytra flat...........................2

   Interstices of elytra with tuberosities, or alternate ones raised...3

2. Elytra evenly widened from the shoulders, which are not well marked, to just behind the middle (Fig. 62).

   Body blackish-brown, vertex of head with a few slender scales. Prothorax sub-globose, pronotum dull and closely punctured. Elytra granulate and dull, covered with an indefinite pattern of dark brown and yellow scales and also with yellow hair-like scales. Length 5.0-6.0 mm.. Japan, Siberia.

   ....G. mannerheimi Fst

   Elytra more or less parallel for anterior two-thirds, and not widened posteriorly; shoulders well marked (Fig. 63).

   Body blackish-brown. Vertex of head with numerous broader scales. Prothorax broader at the base, pronotum with larger and less crowded punctures than mannerheimi, rather shiny especially on a central longitudinal impunctate band. Elytra more shiny in appearance than mannerheimi, with ochreous scales/

ochreous scales and hair-like scales. Length 5.0-6.0 mm.. U.S.A., Canada......<u>G. leechi</u> sp.nov.

3. Prothorax broadest in the anterior half.....................4

Prothorax not broadest in the anterior half..................5

4. Body blackish-brown, covered with various shades of brown scales and short recumbent pubescence. Every interstice of the elytra, except the first, with large low tuberosities.

Pronotum narrowed like a collar in front, and tapering behind; dorsal surface coarsely wrinkled, with a narrow abbreviated central callosity. Length 7.0 mm.. China*................<u>G. rugicollis</u> Voss

Body rich reddish-brown with narrow black scales, and with broad yellowish scales at the sides and posteriorly. Third, fifth and seventh interstices unevenly raised.

Pronotum with the sides evenly curved. It is densely punctured except for a narrow band at the anterior edge. There is no trace of a central callosity. Length 5.0 mm.. Siberia...........<u>Sp. X</u>

5. Interstices 3, 5 and 7 weakly raised and without tuberosities.

Body/

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* This species was not seen. The characters used have been taken from a translation of Voss's description of the species.

Body dark brown. Upper surface densely covered with unicoloured ochreous scales. Length 3.5-4.5 mm.. Europe and North America.
................................<u>G. brunnirostris</u> Fab.

Interstices 3, 5 and 7 with marked protuberances.

Body blackish-brown. Upper surface with scales of two colours. Length 5.0-7.0 mm.. Europe, Siberia, North America..............................6

6. Upper surface with black and white scales....<u>G. equiseti</u> Fab.

Upper surface with dark brown and gray scales.
...........................<u>G. equiseti</u> var. <u>atrirostris</u> Fab.

The adult anatomy of <u>Grypidius equiseti</u> F. does not appear to differ greatly from other Curculionids seen or described by other authors (Figs 64-72). The sex ratio appears to be even since seven of the fifteen adults dissected were male and eight female. The mandibles are only slightly exodont (Fig. 73), the first joint of the antennal club is distinct and the other two fused (Fig. 74). There are no tibial spurs. It lives on <u>Equisetum arvense</u> L. and <u>E. palustre</u> L..

ii) <u>Procas</u> Steph.

<u>Procas armillatus</u> F. was examined. The mandibles are only slightly exodont. Little is known about its biology. According to Fowler (1891) it is found in marshy places not far from the sea. Hustache (1930) suggests that it is nocturnal.

iii)/

iii) *Notaris* Germ. (= *Erirrhinus* Schön.)

According to Bedel (1884), *E. aethiops* was designated by Schönher as the type of his *Erirrhinus*, making the genus synonymous with *Notaris* Germar as defined by Stephens in 1831.

Notaris scirpi F. was examined. The generic characters are very similar to those of *Procas* and *Thryogenes* but the mandibles are more strongly exodont. All the species are found on Monocotyledonous plants in marshy places. Urban (1927) recorded the life cycle of *N. acridulus* L. in *Glyceria spectabilis* (Gramineae) and of *N. bimaculatus* F. in *Typha latifolia* L. (Typhaceae).

iv) *Thryogenes* Bedel (= *Erirrhinus* Steph.)

Thryogenes festucae Hbst. was examined. The tibial spurs are rather small (Fig. 75, TS). Fowler (1891) wrote that Boie had found the larva of this species in *Scirpus lacustris* (L.) (Cyperaceae). Urban (1914) found *T. nereis* Payk. in *Heleocharis palustris* (Cyperaceae).

v) *Hypselus* Schön.

Hypselus ater Boh. was examined. The eyes are prominent and the head capsule slightly indented between and behind them. The antennal club is rather elongate and its three segments fairly well defined. The tibiae, unlike the preceding genera, have/

have a praemucro and there are no tibial spurs. Despite these marked differences the genus has been included in the Erirrhinini principally owing to the similarity of the male genitalia and the biology. According to Kuschel (1950a), H. seniculus Kuschel is found on Nymphaea species (Nymphaeaceae) and plants belonging to the Gramineae. Bondar (1953) wrote that H. ater Boh. develops in the roots of Sagittaria (Alismataceae) and belongs to the tribe Erirrhinini.

Discussion

Grypidius, Procas, Notaris and Thryogenes are widely distributed in Europe and Siberia and the first three in North America and China but they have not been found in South America where Hypselus is endemic. It is therefore possible that the ecological similarities between Hypselus and the other genera are due to parallel evolution and not common ancestry. The fact that the unusual male tegmen found in this genus resembles that of the other genera is, however, remarkable.

2. Tribe Orthochaetini

The rostrum is fairly long and slender with parallel lateral scrobes and eyes level with the curve of the head capsule (Fig. 76). The antennal funiculus may be 6- or 7-segmented, the first segment always longer than the others and the club unsegmented/

unsegmented (Fig. 77). The anterior coxae are contiguous and the prosternum not, or very slightly, emarginate. The femora are usually edentate and the tibiae mucronate. The third tarsal segment is strongly bilobed, the last segment long and projecting with free claws which are usually simple (Fig. 78). The female genitalia may or may not have styli (Figs 79-80) and the eighth tergite is normal. The tegmen of the male forms a complete ring round the aedeagus (Fig. 81) and the eighth tergite is external in this sex. Wings are weakly veined or absent.

Orthochaetes and *Pseudostyphlus* have been retained in this tribe and *Dorytomus* and *Peristoreus* have been very tentatively included.

Geranorrhinus and *Philernus*, included in the tribe by Klima (1934) appear to be more closely related to *Misophrice* and *Thechia* than to *Orthochaetes* and *Pseudostyphlus*. In Table 2 they have been included in the list of genera of uncertain position but as they have more characters in common with the Orthochaetini than any other tribe studied, they are discussed in this section.

They differ mainly in the structure of the antennal club which is distinctly 3-segmented (Fig. 82) and the third tarsal segment which is never strongly bilobed (Figs 83-84). The tegmen/

Table 3

	Orthochae-:tes	Pseudosty-:phlus	Dorytomus	Peristo-:reus	Philer-:nus	Geranorr-:hinus	Misoph-:rice	Thechia
Rostrum long and slender	+	+	+	+	+	+	+	+
Scrobes parallel	+	+	+	+	+	+	+	+
Eyes not protuberent	+	+	+	+	+	+	+	+
No. of funicular segs	6	7	7	6	7	7	6	7
1st seg. elongate	+	+	+	+	+	+	+	+
Club unsegmented/ 3 segmented	+	+	+	+	-	-	-	-
Anterior coxae contiguous	+	+	+	+	+	+	+	+
Femora edentate/ toothed	+	+	-	+	+	+	+	+
Tibiae mucronate	+	+	+	+	+	+	+	+
3rd tarsal seg. strongly bilobed/ weakly or not bilobed	+	+	+	+	-	-	-	-
5th seg. elongate	+	+	+	+	+	+	none	none
Claws simple/ appendiculate	+	+	+	-	+	+	none	none
Styli not present in♀ / present	+	+	-	-	?	+	+	+
Tegmen complete dorsally/ incomplete	?	+	+	+	-	-	?	?
Mandible not exodont/ exodont	+	+	+	+	-	+	-	+
Distribution	Palearctic	Palearctic	Holarctic Ethiopia?	New Zealand	Palearc-:tic	Palearc-:tic	Austra-:lia	Austra-:lia

The possession of the 1st of the pair of characters is indicated by a +, the alternative by a -

tegmen of the male genitalia in the genera where this sex was seen is incomplete dorsally (Fig. 85)

The characters of the eight genera are compared in Table 3, opposite.

Study of genera

i) *Orthochaetes* Germ.

Orthochaetes setiger Beck. was examined. There is a transverse furrow at the base of the rostrum, the funiculus is 6-segmented, there are no wings in this species and no styli in the female. No males were found in the twenty or so specimens examined. Hering (1937) found the larvae mining the leaves of *Hieracium* and *Senecio* species (Compositae).

ii) *Pseudostyphlus* Tourn.

Pseudostyphlus pilumnus Gyll. was examined. The funiculus is 7-segmented, the wings very reduced and there are no styli in the female. Urban (1926) found the larva in the flower heads of *Matricaria chamomilla* (Compositae).

iii) *Dorytomus* Germ.

Dorytomus taeniatus F. was examined. The funiculus is 7-segmented, the femora toothed and the female has styli (Fig. 79). The larva is found in the female catkins of *Salix* species (Salicaceae).

iv)/

iv) *Peristoreus* Kirsch

Gourlay (1950) synonymised *Dorytomodes* Mshl. 1926 with *Peristoreus* Kirsch 1877.

Peristoreus decussatus (Mshl.) was examined. The claws, like those of the Anthonominae, are very strongly appendiculate (Fig. 86) and the female has styli. The proximal portion of the internal sac of the male genitalia is sclerotized so that the median lobe appears to have three struts (Fig. 87).

Discussion

Orthochaetes, *Pseudostyphlus* and *Dorytomus* species are found in Europe and North Africa. *Orthochaetes* and *Dorytomus* species are also found in Asia and species of *Dorytomus* in North America. *Peristoreus* is endemic in New Zealand and the Auckland Islands.

Orthochaetes and *Pseudostyphlus* are very closely related to each other. The similarities to these and to each other shown by *Dorytomus* and *Peristoreus* may be due to parallel evolution.

v) *Philernus* Schön.

Philernus farinosus Gyll. was examined. The funiculus is 7-segmented and the club distinctly 3-segmented (Fig. 82). The third tarsal segment is weakly bilobed (Fig. 88). No females were obtained, the tegmen of the male is incomplete dorsally (Fig. 85)/

(Fig. 85). The mandibles have a small exodont tooth (Fig. 89) and there are no wings.

vi) Geranorrhininus Chevr.

Geranorrhininus pusillus Motsch. was examined. The funiculus is 7-segmented and the tarsi are very similar to those of Philernus (Fig. 83). There are no styli in the female and the tegmen of the male is incomplete dorsally in the specimen examined. According to Peyerimhoff (1931), however, the tegmen is complete dorsally. He has recorded the species from Tamarix nilotica and T. gallica L. (Tamaricaceae).

vii) Misophrice Pasc.

Misophrice variabilis Blackb. was examined. The funiculus is 6-segmented, the third tarsal segment is not bilobed and the claw-bearing segment is missing (Fig. 84). The mandibles are distinctly exodont (Fig. 90) and the eighth tergite of the female is strongly sclerotized and more or less trowel-shaped at the apex. There are no styli in this sex (Fig. 91). No males were seen. According to Lea (1927a) it is very common on Casuarina (Casuarinacea). He wrote, "It is a curious feature of several sub-families that when the claw joint is absent, or apparently absent, there may often be a loss of one or more of the funicular segments." This is true of Misophrice species but not of Thechia.

viii)/

viii) *Thechia* Pasc.

Thechia pygmaea Pasc. was examined. The funiculus is 7-segmented, the third tarsal segment notched at the apex and the claw-bearing segment missing (Fig. 92). No males were seen, and styli were not present in the female. According to Lea (1927*a*) it occurs on *Eucalyptus* species (Myrtaceae).

Discussion

Philernus and *Geranorrhinus* occur in parts of South Russia and Asia, the latter also occurring in North Africa. *Misophrice* and *Thechia* are found only in Australia and New Caledonia. The genera of each pair are closely related but resemblances between those of one pair and those of the other may be due to parallel evolution.

3. Tribe Storeini

The rostrum is fairly long and slender, the scrobes usually parallel and reaching the eyes which are very rarely protuberant (Fig. 93). The antennae are fairly long and slender, the funiculus, except that of *Antyllis*, 7-segmented with the first and second segments elongate and usually sub-equal, the club almost always distinctly 3-segmented (Fig. 94). In most genera the anterior coxae are slightly separate with the prosternum slightly, or not, emarginate, rarely the coxae are contiguous. The femora are usually edentate, and the tibiae are/

are simply mucronate or with both a mucron and a praemucro (Figs 95-96). There are no tibial spurs, the third tarsal segment is strongly bilobed, the last long and projecting, bearing claws which are usually divergent, occasionally connate and either simple or obtusely toothed at the base. Styli are almost always present in the female (Fig. 97) and, except in Aoplocnemis, the eighth tergite is normal. In the male the eighth tergite is external and the tegmen usually forms a complete ring dorsally without a bilobed cap-piece (Fig. 98). The suture between the first and second ventrites is complete and the wing venation is usually fairly well developed (Fig. 99).

Cydmaea, Erytenna, Gerynassa, Storeus, Emplesis and Dicomada are retained in this tribe; Antyllis and Olanea, although in many ways aberrant, are tentatively associated with it. Eniopea and Rachiodes have been included in the tribe while Aoplocnemis has a number of characters in common with Antyllis and Olanea.

Study of genera

i) Cydmaea Pasc.

Cydmaea major Blackb. was examined. Deep circular pits similar to those seen in Erytenna are found in the scrobes. The tibiae have a distinct praemucro. The anterior coxae are very slightly separate in this species. According to Lea (1899, 1927/

1927) the anterior coxae are contiguous in some species but separate in others. In some of the latter species a pectoral channel is found similar to that of some *Storeus* and *Emplesis* species. *Cydmaea* spp. can be found on *Eucalyptus* (Lea, 1899).

ii) *Erytenna* Pasc.

Erytenna dispersa Pasc. was examined. A small praemucro is found on the tibiae and the anterior coxae are slightly separate.

iii) *Eniopea* Pasc.

Eniopea bivittata Lea was examined. Circular pits are found in the scrobes as in *Cydmaea* and *Erytenna*. Unlike these genera the first segment of the funiculus is longer and broader than the second (Fig. 100). The tibiae are simply mucronate, the anterior coxae contiguous and the prosternum emarginate.

iv) *Rachiodes* Schön.

Rachiodes bicaudatus Boisd. and *R. granulifer* Chevr. were examined. The scrobes are oblique and do not have circular pits (Fig. 101). The anterior coxae are contiguous and the prosternum very slightly emarginate. The tibiae have a strongly developed praemucro (Fig. 96) and the wing venation is very well developed in some species where 2nd A1 and 2nd A2 are linked to each other and to 3rd A1 (Fig. 102).

v)/

v) *Gerynassa* Pasc.

Gerynassa picticornis Blackb. was examined. The eyes are slightly protuberant, the anterior coxae are contiguous and the prosternum not emarginate. The tibiae are mucronate and the claws connate at the base (Fig. 95). A row of pits is found along the base of the first abdominal ventrite (Fig. 103). The tegmen of the male is not sclerotized dorsally; ventrally there is a fine fringe of hair on each side of the strut (Fig. 104).

vi) *Storeus* Schön.

Storeus variegatus Boh. was examined. The anterior coxae are contiguous and the prosternum emarginate, the edges of the emargination being slightly raised so that the prosternum is weakly channelled in front of the coxae. As in *Gerynassa* a row of pits is found along the base of the first ventrite. The femora are toothed and there is a praemucro on the tibiae, the claws are obtusely angled at the base (Fig. 105). Lea (1927*b*) wrote of this species, "The claws seen under the microscope are distinctly appendiculate, the genus must, therefore, be transferred to the Tychiides." The appendiculation is so slight, however, and *Storeus* appears to be so closely related to *Emplesis* in which the claws of at least some species are simple that it has been retained in the Storeini. According to Lea (1899) the adults have been beaten from *Melaleuca* (Myrtaceae) and found under the loose bark of living trees.

vii) Emplesis Pasc.

Emplesis femoralis Lea was examined. The antennal club is not distinctly segmented (Fig. 106), the anterior coxae are contiguous and the prosternum strongly channelled in front of them. The tibiae are mucronate, the claws simple and the wing venation poorly developed. Pits are found along the base of the first ventrite. The inner sac of the male aedeagus is strongly sclerotized (Fig. 107) and the tegmen has a bilobed cap-piece. According to Lea (1927c), the adults can be found under the bark of Eucalyptus species.

viii) Dicomada Pasc.

Dicomada rufa Blackb. was examined. The antennal club is not clearly segmented (Fig. 108). The anterior coxae are narrowly separate, the femora weakly toothed and the tibiae mucronate.

The three genera Aoplocnemis, Antyllis and Olanea together differ from the majority of the Storeini in that the scrobes are not parallel, and individually in a number of characters enumerated below.

ix) Aoplocnemis Schön.

Aoplocnemis tasmanicus Blackb. was examined. The scrobes are oblique, converging ventrally (Fig. 109) and the mandibles very/

very slightly exodont (Fig. 110). The anterior coxae are contiguous, the prosternum emarginate and the tibiae mucronate. The eighth tergite of the female of <u>A. phaleratus</u> Er. is strongly sclerotized and pointed at the apex and unusual sclerotized rods are present in the coxites (Fig. 111) which, unlike the baculi of <u>Pantomorus</u>, do not continue beyond the coxites into the abdomen.

x) <u>Olanea</u> Pasc.

<u>Olanea metropolitana</u> Blackb. was examined. The scrobes are oblique, converging ventrally and the eyes protuberant. The anterior coxae are contiguous and the prosternum very slightly emarginate. The tibiae are weakly mucronate and the claws connate at the base. A row of pits is found along the base of the first ventrite similar to those seen in <u>Gerynassa</u> which this genus also resembles in the protuberant eyes, connate claws and the tegmen of the male which is incomplete dorsally and has a fine ventral fringe (Fig. 112). There are no styli in the female (Fig. 113).

xi) <u>Antyllis</u> Pasc.

<u>Antyllis togata</u> Lea was examined. The scrobes are strongly convergent ventrally and the eyes protuberant (Fig. 114). The funiculus is 6-segmented and the club indistinctly 3-segmented (Fig. 114). The anterior coxae are contiguous and the prosternum very slightly emarginate. The tibiae are mucronate

and/

and the claws free and simple. There are no styli in the female (Fig. 115). The tegmen of the male is incomplete and the inner sac of the median lobe heavily sclerotized as in Olanea.

Discussion

The genera are all Australian. The remarkable presence of pits in the scrobes of Erytenna, Cydmaea and Eniopea seems to indicate that they are closely related to each other. The similar pits round the base of the first ventrite of Gerynassa, Storeus, Emplesis and Olanea, although less uncommon in occurrence probably have the same significance, but Olanea differs from the other genera in the converging scrobes and absence of styli in the female. In this it is very similar to Antyllis to which it is probably more closely related.

4. Tribe Smicronychini

The rostrum is fairly slender and elongate, usually with a furrow or constriction at the base. The scrobes are convergent, usually connivent or confluent on the under-side of the head and the eyes are not protuberant, their shape varying considerably in different genera (Figs 116-118). The mandibles are almost always exodont (Figs 119-120). The antennae have rather a stout appearance, the funiculus being 7-segmented and the club usually unsegmented, occasionally indistinctly 3-segmented (Figs 121-122). The/

The anterior coxae are contiguous and the prosternum emarginate though very slightly in some. The femora are usually edentate and the tibiae mucronate sometimes with a praemucro. The third tarsal segment is almost always strongly bilobed, the claw-bearing segment long and projecting and the claws basally connate or very rarely free (Figs 123-124). The posterior border of the intermediate ventrites is usually curved at the sides (Fig. 125) and the seventh, or seventh and eighth abdominal tergites of the male bear enlarged sensillae in all the genera (Figs 126-127) except the very aberrant *Hypsomus*. The female has styli and the eighth tergite is normal (Fig. 128). The eighth tergite of the male is exposed and the tegmen incomplete, complete or with a bilobed cap-piece dorsally (Figs 129-131). Wings, where present, are usually small and weakly veined (Fig. 132) and what appear to be stridulatory files are found at the apex of the elytra of many of the genera (Fig. 133).

Smicronyx, *Sharpia*, *Pachyphanes*, *Desmoris* and *Synertha* have been retained in the tribe, *Barytychius* and *Pachytychius* have been included and *Aubéonymus*, *Acentrus* and *Hypsomus* are also tentatively placed in the Smicronychini.

Study of genera

i) *Smicronyx* Schön.

Smicronyx reichi Gyll. was examined. The scrobes converge but/

but are not connivent or confluent (Fig. 116). Both the seventh and eighth tergites of the male bear a pair of enlarged sensillae. The tegmen is complete dorsally and the inner sac of the median lobe bears sclerotized spines (Fig. 134). A narrow striated area is present at the apex of the elytra of the sex examined,* the male. According to Hustache (1930), species belonging to the sub-genus Chalybodonotus live in the bulbs of Orobanche (Orobanchaceae) while species of the sub-genus Smicronyx s.str. live in Cuscuta (Convolvulaceae), galls being formed on both plants.

ii) Sharpia Tourn.

Sharpia bella Faust and S. rubida Rosenh. were examined. The scrobes are connivent in both species and what appears to be a stridulatory file is present on the elytra of the male, and only the seventh tergite bears a pair of enlarged sensillae. In S. bella a small praemucro is present on the tibia, the third tarsal segment is strongly bilobed (Fig. 135) and the mandibles are strongly exodont. S. rubida differs from this species in that the praemucro is more strongly developed and the third tarsal segment is weakly bilobed (Fig. 136) and the mandibles are only weakly exodont. Little is known about the habits of this genus. According to Hustache (1930), it has been captured at night in light traps. Zumpt (1936) revised the palearctic species/

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*Except in Pachytychius, only the elytra of the sex cited were examined.

species of the genus. In these species he wrote that the terminal hook was on the outer edge of the tibia, the third tarsal segment was narrow and only weakly emarginate at the apex and the claws were free. This led him to suggest that a new tribe, the Sharpiini, should be erected. In S. rubida, however, which Zumpt examined, the terminal hook can hardly be said to be on the outer edge of the tibia (Fig. 136) and in the specimen examined by the present author the claws were connate and not free. S. bella, which was not studied by Zumpt, as it is an Oriental species occurring in India, has the third tarsal segment strongly bilobed and connate tarsal claws (Fig. 135). Thus the erection of a tribe Sharpiini is unjustifiable.

iii) Pachyphanes Dietz.

Pachyphanes discoideus Lec. was examined. The scrobes are connivent, the elytra of the female have a striated area which appears to be a stridulatory file (Fig. 133). An enlarged pair of sensillae are found on both the seventh and eighth tergites of the male (Fig. 127) and the tegmen has a bilobed cap-piece (Fig. 131). Casey (1891) wrote of the genus, to which he incorrectly referred as Pachytychius, that the rostrum is occasionally not constricted or furrowed at the base and the claws are sometimes free and diverging. Pierce (1911) found the adults on Helenium (Compositae) and Rudbeckia (Compositae) and collected it at light traps.

iv) *Desmoris* Lec.

Desmoris constrictus Say was examined. The scrobes are connivent and what appears to be a stridulatory file is seen on the elytra of the female. Enlarged sensillae are present on both the seventh and eighth tergites of the male, two pairs on the seventh and one on the eighth (Photos 1-3) and the tegmen has a bilobed cap-piece. According to Leconte and Horn (1876), this species breeds in sunflower seeds. Blatchley and Leng (1916) wrote that *D. scapalis* is found on *Sideranthus rubiginosus* (Compositae).

v) *Synertha* Dietz.

Synertha imbricata Cas. was examined. The scrobes are connivent. The seventh and eighth tergites of the male bear a pair of enlarged sensillae and the tegmen is complete dorsally, forming a ring (Fig. 130). There is no definite striated area on the elytra of the male.

vi) *Barytychius* Jekel

Barytychius hordei Brullé was examined. The rostrum is not furrowed at the base, the scrobes are confluent and the antennae rather slender in appearance, the club, like that of *Pachytychius*, being indistinctly segmented. The labial palpi have two, instead of the usual three segments (Fig. 137). There is/

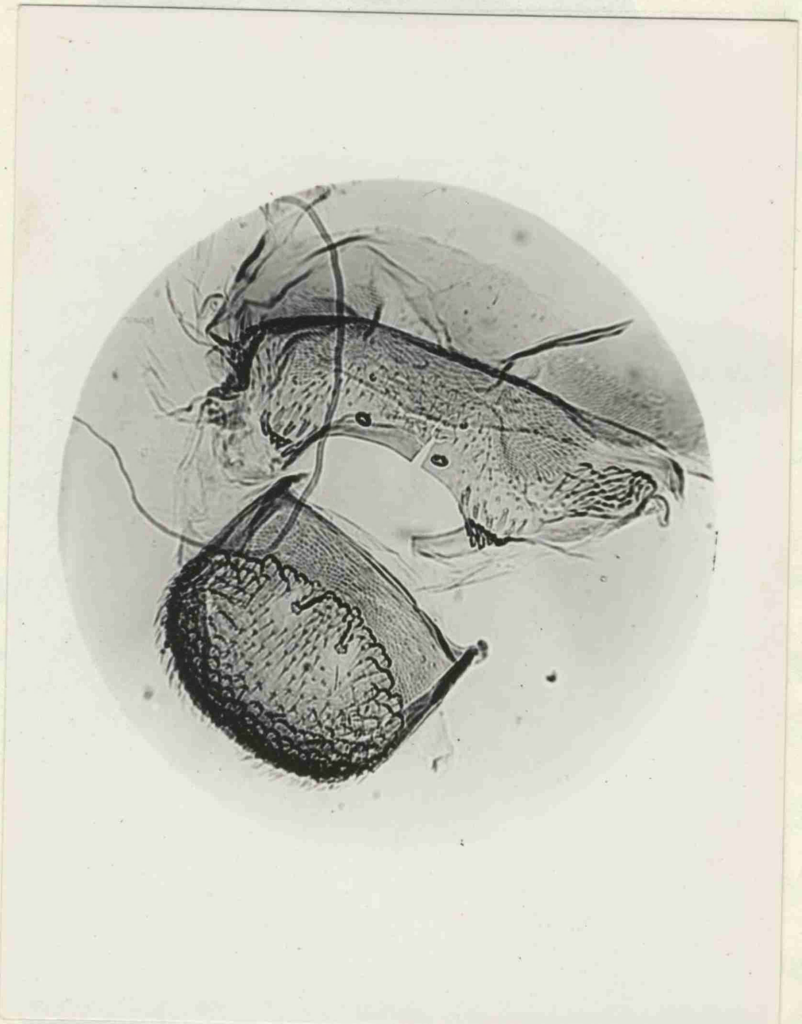
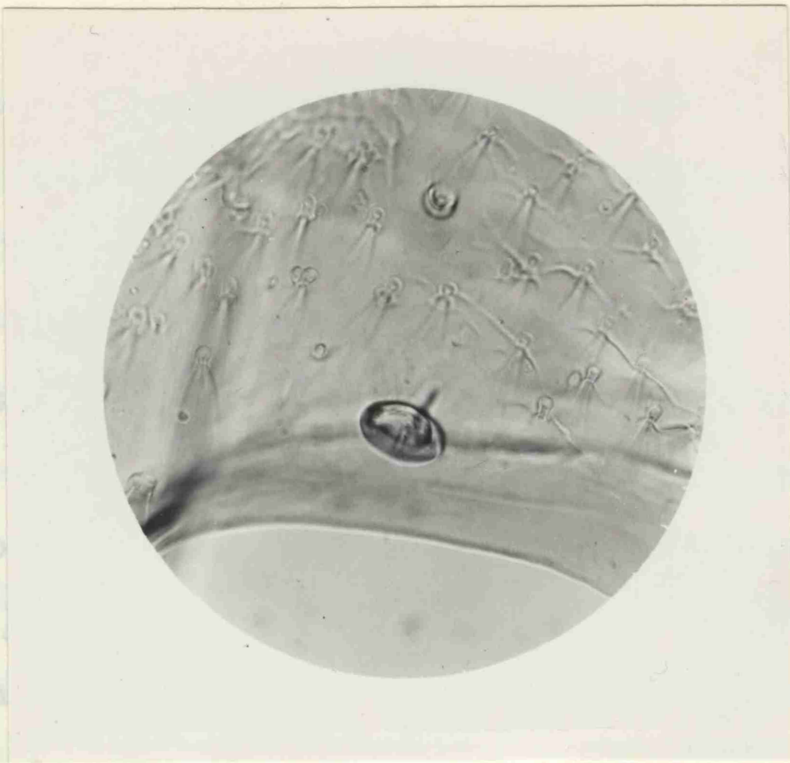


Photo. 1. Desmoris constrictus Say

Tergites 7 and 8 of male showing position of sensillae.



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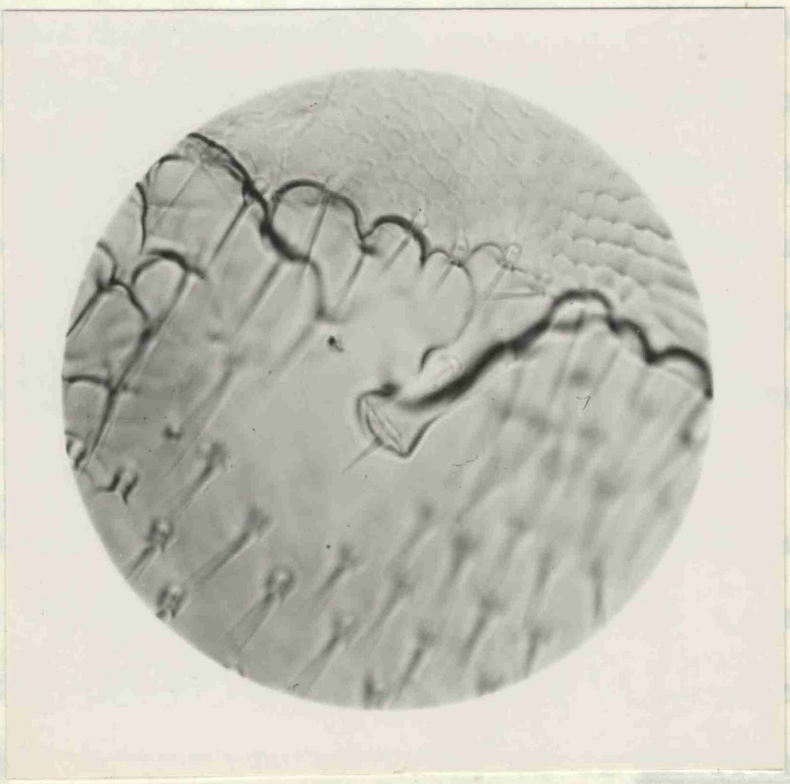

3

Photos. 2. and 3. <u>Desmoris constrictus</u> Say

2. Enlargement of part of tergite 7 to show sensillae.

3. Enlargement of part of tergite 8 to show sensillae.

is a rather large finely-striated area present at the apex of the elytra of the male, the seventh tergite of which has two rows of small but distinct sensillae (Fig. 138). The tegmen has a bilobed cap-piece. There are no wings. Hustache (1930) who did not study this species, synonymised the genus with Pachytychius. It is, however, retained as a separate genus in the Coleopterorum Catalogus (Klima, 1934). A comparison of B. hordei and Pachytychius haematocephalus suggests that Hustache may have been justified in sinking the genus.

vii) Pachytychius Jekel

Pachytychius haematocephalus Gyll. was examined. The rostrum is not furrowed at the base and the scrobes are confluent (Fig. 118). What appears to be a small stridulatory file is present at the apex of the elytra of the male though not of the female, and the wings are greatly reduced. The posterior femora are toothed, the tibiae have a distinct praemucro and the claws are free or occasionally connate on one or more legs of some specimens. The seventh tergite of the male bears sensillae similar in shape and arrangement to those of Barytychius, the tegmen has a trace of a bilobed cap-piece and the internal sac of the median lobe, as in Smicronyx, contains numerous horny spicules (Fig. 139). The larva of this species is found in the pods of Lotus corniculatus (Papilionaceae).

P. sparsatus, according to Hustache (1930), can be found in Genista and Laburnum species (both Papilionaceae). Peyerimhoff (1911) found P. subasper and P. discithorax on Helianthemum species (Cistaceae). He wrote that the species of Pachytychius are distributed in two series, one developing in the pods of Papilionaceae, the other attached to the Cistaceae.

viii) Aubeonymus Jacq. du Val

Aubeonymus carinicollis Luc. was examined. The mandibles are only slightly exodont (Fig. 140). The rostrum is not constricted or furrowed at the base, the scrobes are confluent and the antennal club unsegmented (Fig. 141). The prosternum is rather strongly grooved in front of the coxae, the tibiae have a distinct praemucro and the tarsal claws are free. The elytra of the male haveno striated area at the apex, the seventh tergite in this sex bears small dispersed sensillae and the tegmen has a bilobed cap-piece. There are no wings.

ix) Acentrus Schön.

Acentrus histrio Falderm was examined. The mandibles are only very slightly exodont. The antennal scrobes are confluent and there is a transverse furrow at the base of the rostrum. The antennal club is unsegmented (Fig. 142), the prosternum rather strongly grooved in front of the coxae and the tarsal claws free and appendiculate (Fig. 143). The seventh tergite of/

of the male bears two rows of sensillae (Fig. 144) very similar to those seen in *Barytychius* and *Pachytychius* which it also resembles in the strong sclerotization of the internal sac of the median lobe and there is a bilobed tegminal cap-piece (Fig. 145). No striated area was seen at the apex of the elytra of the female. According to Hustache (1930), the adult can be found on *Glaucium flavum* (Papaveraceae) in the roots of which the larvae feed.

x) *Hypsomus* Schön.

Hypsomus scapha Boh. was examined. The scrobes are confluent, the head very similar in shape to that of *Pachytychius*. The mandibles have a small exodont tooth, the antennal club is compact but distinctly 3-segmented (Fig. 146). The anterior coxae are contiguous, the prosternum emarginate, the tibiae very weakly mucronate and the claws are free. There are no wings and there is no striated area at the apex of the elytra of the female, in which sex there are no styli (Fig. 147). Unlike the other Smicronychini, there are no enlarged sensillae on the seventh or eighth tergite of the male. The tegmen is complete dorsally (Fig. 148). According to Marshall (1906) and Hesse (1928) in the species *H. parvus* and *H. bellus* respectively, the rostrum is separated from the head by a faint impressed line.

Table 4

	Striated area on ♂ elytron	Striated area on ♀ elytron	No. of pairs of sensillae on tergite 7 of ♂	No. of pairs of sensillae on tergite 8 of ♂
Smicronyx	+	?	1	1
Sharpia	+	?	1	-
Pachyphanes	?	+	1	1
Desmoris	?	+	2	1
Synertha	-	?	1	1
Barytychius	+	?	sev	-
Pachytychius	+	-	sev	-
Aubeonymus	-	?	sev	-
Acentrus	?	-	sev	-
Hypsomus	?	-	-	-

+ = present; - = absent

sev = several

Discussion

The presence or absence of a striated area at the apex of the elytra and of sensillae on the seventh and eighth tergites of the male are shown in Table 4 opposite. Smicronyx, Sharpia, Pachyphanes, Desmoris and Synertha occur in North America. Smicronyx and Sharpia also occur with species of Barytychius and Pachytychius in Europe and North Africa where Aubeonymus and Acentrus are found, and in parts of Asia. Hypsomus has so far been recorded only from Africa.

The North American genera are very closely related to each other as are Barytychius, Pachytychius and Aubeonymus. Acentrus and Hypsomus are in many ways aberrant, the former has some characters in common with both groups, the latter is even more aberrant and although it seems to be related to the second group, this may be due to convergent evolution rather than close relationship.

5. Tribe Bagoini

As the Bagoini and Tanysphyrini have so many characters in common and as some of the genera appear to belong to the Bagoini in one respect but to the Tanysphyrini in another, it seems unjustifiable to consider them to be two distinct tribes and in this work they are united to form the Bagoini. The genera Tanysphyrus/

<u>Tanysphyrus</u>, <u>Echinocnemus</u>, <u>Endalus</u> and <u>Lissorhoptrus</u>, however, are so closely related to each other that they form a distinct sub-tribe, the Tanysphyrina, the other genera being included in the Bagoina.

The rostrum tends to be fairly broad and not very long. The scrobes are parallel in some genera but converge ventrally in the sub-tribe Tanysphyrina and a few of the Bagoina (Figs 149-150). The eyes are not or very slightly projecting, the funiculus 6- or 7-segmented with either the first or the first and second segments elongate. The funiculus is always 6-segmented in the Tanysphyrina and the first segment much broader than the second. The club is usually compact, rarely indistinctly segmented (Figs 151-152). The anterior coxae are contiguous, the prosternum usually weakly emarginate and occasionally channelled in front of the coxae. The femora are edentate, the tibiae mucronate or unguiculate and usually provided with a praemucro (Figs 153-154). The third tarsal segment may be strongly, weakly, or not bilobed and spongy or not below, the last segment being long and projecting or very short, not extending beyond the lobes of the third and the claws always simple and free. The female usually possesses styli and the eighth tergite is normal in shape (Fig. 155). The tegmen of the male usually has a bilobed cap-piece but occasionally may be incomplete dorsally (Figs 156-157) and unlike other tribes of/

of the Erirrhininae the eighth tergite is internal in both sexes. The suture between ventrites one and two is usually evanescent in the centre. Many of the species are provided with a hydrofuge covering and as far as is known they are all found in aquatic or sub-aquatic habitats.

The following genera have been retained in the Bagoini:- Endalus, Endaliscus, Lissorhoptrus, Hydronomidius and Bagous and very tentatively Stenopelmus. Of these, Endalus and Lissorhoptrus belong to the Tanysphyrina, the others to the Bagoina. Tanysphyrus and Echinocnemus have been included in the Tanysphyrina, while Jekelia and tentatively Alhypera are included in the Bagoina.

Study of genera

i) Tanysphyrus Schön.

Tanysphyrus lemnae Payk. was examined. The scrobes converge ventrally, the antennal club is compact. The prosternum is not emarginate or channelled, the tibiae have a very distinct praemucro and the last tarsal segment is very short, not projecting beyond the lobes of the third (Fig. 158). The tegmen of the male is incomplete dorsally (Fig. 157) and there is a hydrofuge covering. Urban (1922a) described the life cycle of this species in Lemna minor (Lemnaceae). The larvae are leaf miners and are able to swim with a snake-like movement/

movement through the water from one leaf to another. The adults, according to Thorpe (1949), can walk easily over the surface film but are helpless when forcibly submerged.

ii) Echinocnemus Schön.

Echinocnemus gemallus Mshl. was examined. The scrobes converge ventrally, and the antennae are similar to those of Tanysphyrus (Fig. 152). The prosternum is not emarginate or channelled, the tibiae have a distinct praemucro and in this species the last tarsal segment is short, not projecting beyond the third (Fig. 154). The tegmen has a bilobed cap-piece and the inner sac of the median lobe is very heavily sclerotized (Fig. 159). In this sex there is a depression on the apical third of the first abdominal ventrite and a groove at the apex of the fifth (Fig. 161). The labial palpi are reduced (Fig. 160). This species is found on rice (Gramineae). According to Hustache (1930), the last tarsal segment of E. globicollis Fairm. is long, projecting considerably beyond the lobes of the third.

iii) Endalus Cast.

Endalus aeratus Lec. was examined. The scrobes converge ventrally, the prosternum is very slightly emarginate and the antennae and legs are very similar to those of Echinocnemus gemallus. The tegmen is complete but not distinctly bilobed dorsally/

dorsally (Fig. 162). There is a hydrofuge covering. Tanner (1943) recorded Endalus on various Scirpus species (Cyperaceae). Bondar (1953) found the species E. bondari Kuschel developing in the roots of unspecified aquatic Cyperaceae.

iv) Lissorhoptrus Lec. and Helodytes Kuschel

Lissorhoptrus foveolatus Duval, which Kuschel (1951) made the genotype of a new genus and renamed Helodytes foveolatus (Duval) was examined.

The scrobes converge ventrally. The funiculus is 6-segmented, the first segment is much broader than the second and the club compact and scaly except for a small pubescent patch at the tip (Fig. 163). The prothorax is weakly emarginate and the apices of the fore-, mid- and hind-tibiae are different (Figs 164-166) and the mesothoracic tibiae have a fringe of long hair. The third tarsal segment is not strongly bilobed and the last is long and not spongy below. The female has no styli (Fig. 167), the tegmen has a bilobed cap-piece (Fig. 168) and there is a hydrofuge covering. Pierce (1916) wrote that the larva of Lissorhoptrus simplex* could not only be found in rice but also in the roots of Echinochloa (Gramineae) and noted that the larva/

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* This species was renamed Lissorhoptrus oryzophilus by Kuschel in 1952.

larva was an external as well as an internal feeder. Boving and Craighead (1931) found that the larva of "L. simplex" had projecting dorsal spiracles and 2-segmented antennae. These peculiarities led them to erect a new sub-family for the genus. Tanner (1943) included the genus in the "Hydronomini" (equivalent to the Bagoini in the present paper) but noted that it could be separated from the other genera by the lack of styli in the female genitalia and that "L. simplex" will feed on rice, arrowhead, bullrushes and water-lilies. Although Lissorhoptrus and Helodytes are in some ways aberrant they certainly belong to the Bagoini and are probably more closely related to the Tanysphyrina than the Bagoina.

v) Endaliscus Kirsch.

Endaliscus skalitzkyi Kirsch was examined. The scrobes are oblique, converging ventrally. The funiculus is 7-segmented, the first segment distinctly broader than the second and the club indistinctly segmented (Fig. 169). The prosternum is slightly emarginate. The tibiae are denticulate along the inner margin, the third tarsal segment is weakly bilobed and the last long and projecting (Fig. 170). Styli are present in the female and the tegmen has a bilobed cap-piece (Fig. 156). Faust (1890) in his description of E. kirschi wrote that the first three/

three tarsal segments are short and broad and that the claw segment barely surpasses the lobes of the third. In this and the structure of the first funicular segment, Endaliscus is more closely related to the Tanysphyrina than the Bagoina.

vi) Jekelia Tourn.

Jekelia notata Muls. was examined. The scrobes converge ventrally, the funiculus is 7-segmented, the first segment elongate but scarcely broader than the second and the club unsegmented. The prosternum is very slightly emarginate, the tibiae denticulate along the inner margin and the third tarsal segment very weakly bilobed (Fig. 171). No female was seen and the tegmen of the male has a bilobed cap-piece (Fig. 172). Tournier (1873) placed the genus between Pachytychius and Barytychius and in Reitter's key (1916) the genus is found between Barytychius and Acentrus. It is, however, quite unlike the Smicronychini in that the tibiae are not simply mucronate, the third tarsal segment is not strongly bilobed, the claws are not connate, the mandibles not exodont and the eighth tergite of the male is internal.

vii) Hydronomidius Faust

Hydronomidius molitor Faust was examined. The mandibles have a slight trace of an exodont tooth (Fig. 173). The scrobes/

scrobes are parallel, the funiculus 7-segmented, the first segment elongate and the club not distinctly segmented (Fig. 151). The prosternum is not emarginate. As in Endaliscus and Jekelia, the tibiae are denticulate along the inner margin, the third tarsal segment very weakly bilobed and the claw segment long and projecting. The female has styli, the tegmen a bilobed cap-piece and is very similar to that of Endaliscus.

viii) Bagous Germ.

Bagous argillaceus Gyll. and B. binodulus Hbst. were examined. The scrobes in both species are parallel, the antennae similar to those of Hydronomidius (Fig. 174). The prosternum of both species is strongly channelled in front of the coxae and the tibiae unguiculate, a praemucro is barely visible in B. binodulus (Fig. 153) while there is a small praemucro in B. argillaceus (Fig. 175). The third tarsal segment is very weakly emarginate in both species. According to Hustache (1930), the degree of emargination varies throughout the genus. Styli are present in the female and the tegmen of the male has a bilobed cap-piece. In B. argillaceus, however, the tegminal and median lobe struts are very short (Fig. 176), while the struts of B. binodulus are much longer (Fig. 177). Both species have a hydrofuge covering. Sharp (1916, 1917) split the genus Bagous into a number of genera in two tribes, the Bagoini and the Pseudobagoini which he placed in the sub-families/

Table 5

	Cleonus	Lixus	Larinus	Rhinocyllus	Lepyrus	Bagous argillaceus	Bagous binodulus
Rostrum median length/ short	+	+	+	-	+	+	+
Scrobes strongly converging/ parallel	+	+	+	+	+	-	-
Antennae stout/ slender	+	+	+	+	+	-	-
Club distinctly 3 seg./ not distinctly 3 segtd	+	+	+	+	-	-	-
Prosternum not emarginate/ emarginate	+	+	+	+	+	-	-
Tibiae mucronate/ unguiculate	+	+	+	+	+	-	-
3rd tarsal seg. strongly bilobed/ not bilobed	+	+	+	+	+	-	-
Claws connate/ free	+	+	+	+	-	-	-
Tegmen without a bilobed cap./ with a bilobed cap-piece	+	+	+	+	-	-	-
Median lobe struts very short/ elongate	+	+	+	+	+	+	-
Tergite 8 of ♂ exposed/ internal	+	+	+	+	+	-	-
Labial palpi not terminal/ terminal	+	+	+	+	+	-	-

The possession of the 1st of the pair of characters is indicated by a +, the alternative by a -

sub-families Cleoninae and Erirrhininae respectively. He based this transfer of some of the species of _Bagous_ to the Cleoninae solely on the form of the aedeagus which, he wrote, differs from that of all other weevils except the Cleoninae in the possession of a pair of short calipers in the place of elongate median lobe struts. _B. argillaceus_ Gyll. was placed in this tribe and _B. binodulus_, which Sharp called _Parabagous binodulus_ was placed in the Pseudobagoini. According to Sharp, the tegmen varies throughout the genus from having no cap-piece to the distinct bilobed cap-piece of _B. argillaceus_ and _B. binodulus_; except for _Lepyrus_* this is not found in the British Cleoninae (Fig. 178) and the eighth tergite which is internal in the male sex of _Bagous_ species is always external in the Cleoninae. There are so many differences between _Bagous_ and the Cleoninae that, as can be seen from Table 5 opposite, this transfer is quite unjustifiable. It is probable, however, that _Bagous_ can be divided into sub-genera on the basis of the length of the median lobe struts. Urban (1922_b_) found the larva of "_B. nigritarsus_" Thoms. (_B. lutulentus_ Gyll. in Coleopterorum Catalogus) in _Equisetum fluviatile_. In 1923 he found the larva of _B. binodulus_ mining the mid-rib of the leaves of _Stratiotes aloides_ (Hydrocharitaceae) and noted that they could move freely to new leaves by snaking across the surface film/

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* _Lepyrus_, sometimes classed in the Hylobiinae, is more nearly related to the Cleoninae.

film when it was calm. Larvae of *B. glabrirostris* Hbst. were found eating the *Stratiotes* buds. Tanner (1943) recorded *B. tingi* Tanner apparently breeding in a *Potamogeton* species (Potamogetonaceae). McGaha (1954) recorded the larva of *B. americana* Lec. mining the leaves and petioles of *Nymphaea odorata* and the larva of *B. longirostris* Tanner mining galls formed on the petioles of *Nymphaea tuberosa*. Thorpe (1949) wrote that the adults of some *Bagous* species are better adapted to an aquatic mode of life than others, especially *B. subcarinatus* Gyll. which is an excellent swimmer.

ix) *Alhypera* Hust.

Alhypera bruchi Hust. was examined. The scrobes converge ventrally, the funiculus is 6-segmented, the first segment scarcely broader than the second and the club unsegmented (Fig. 179). The prosternum is not emarginate. The tibiae are mucronate and there is no praemucro. The third tarsal segment is rather strongly bilobed, the last short, projecting little beyond the lobes of the third (Fig. 180). Styli are present in the female. The tegmen was indistinct in the specimen examined and the inner sac of the median lobe was partially sclerotized distally (Fig. 181). The suture between ventrites one and two is distinct even in the centre. The segments of the labial palpi are telescoped into each other to a certain extent (Fig. 182) and the mandibles 2-toothed (Fig. 183).

Hustache/

Hustache (1926) described *Alhypera* as a new genus of the Hylobiinae. Kuschel (1950*a*) synonymised the genus with *Argentinorrhynchus* Brèthes which had been classified in the Cleoninae. He transferred the genus to the Bagoini but unfortunately did not give his reasons for doing so. The antennae are of the type found in the Bagoina although the 6-segmented funiculus is found in the Tanysphyrina. The tarsi are similar to those of the latter sub-tribe so that the genus may be intermediate between the two sub-tribes. Although the mandibles of the Erirrhininae are almost always 3-toothed, the fact that the eighth tergite of *Alhypera* is internal in both sexes seems to indicate that it does belong to the Bagoini.

x) *Stenopelmus* Schön.

Stenopelmus rufinasmus Gyll. was examined. There is apparently no differentiated proventriculus. The rostrum is very short and broad, the apex of the scrobes is visible when viewed from above and the scrobes are oblique. The funiculus is 7-segmented, the first segment rather broad and the club unsegmented. The prosternum is emarginate and very weakly channelled, the tibiae, at least of the female, mucronate and not "unarmed" as Hustache wrote in 1930, and the third tarsal segment very weakly bilobed (Fig. 184). Styli are present in the female and there is a hydrofuge covering. None of the sixteen specimens examined was a male. Adults and larvae are found/

found on Azolla (Azollaceae). According to van Emden (1938), the abdominal terga of the larvae have only two dorsal folds as in the Mecininae, Rhynchaeninae and Orobitinae. In this and the absence of a differentiated proventriculus in the adult, Stenopelmus differs from all the other Bagoini (in which the larva has been studied) and it is only very tentatively included in this tribe.

Discussion

Representatives of the Bagoini are found all over the world. Bagous is the most widespread genus, having been found in every region except South America. Tanysphyrus species are found in Europe, North America and Japan, Echinocnemus species in Europe, India, Africa and Asia, Endalus, Lissorhoptrus and Stenopelmus are found in both North and South America, species attributed to Endalus are recorded from Tasmania and Africa, while Stenopelmus has been introduced into Europe. Endaliscus and Hydronomidius species are found in India, Alhypera species in South America and Jekelia in Europe and North Africa.

6. Genera of the Erirrhininae of uncertain position

i) Grypidiopsis Champ.

Grypidiopsis variegatus Champ. was examined. In many ways it resembles the Bagoini. The rostrum is fairly long and the scrobes slightly convergent. The eyes are flat, the funiculus 7-segmented/

7-segmented with both first and second segments elongate and the club distinctly 3-segmented. The anterior coxae are contiguous and the prosternum very slightly emarginate. The femora are toothed, the tibiae very strongly bisinuate on the inner surface and mucronate with a well defined praemucro rather similar to that of _Endalus_. The third tarsal segment is strongly bilobed, the last long and strongly projecting, bearing simple free claws (Fig. 185). The female has styli; the male was not seen. The 3-segmented antennal club and toothed femora are not seen in the Bagoini. If the eighth tergite of the male is found to be internal, however, and the habits aquatic or semi-aquatic, although there is no hydrofuge covering, _Grypidiopsis_ could be regarded as an aberrant member of the Bagoini. It occurs in Central America.

ii) _Oenopus_ Mshl.

Marshall (1943) found that the genus _Oenochroma_ Pasc. 1872 was preoccupied and renamed it _Oenopus_.

Oenopus triquetra (Lea) was examined. It is similar in many ways to the aberrant genera, _Antyllis_ and _Olanea_, which are tentatively classed with the Storeini. The rostrum is fairly long, the eyes flat and the scrobes slightly convergent. The funiculus is 7-segmented, both first and second segments elongate and the club distinctly 3-segmented. The femora are edentate, the hind-tibiae apparently mucronate (Fig. 186) and the/

the prothoracic tibiae apparently unguiculate, very similar to those of Bagous binodulus (Fig. 187). The third tarsal segment is strongly bilobed, the last long and projecting, bearing free simple claws. There are no styli in the female and the tegmen of the male is incomplete dorsally. Oenopus differs from Antyllis and Olanea in that the eyes are not protuberant but level with the head capsule and in this it is akin to the other Storeini. The very unusual tibiae, however, are found in none of the Storeini. It occurs in New Zealand.

iii) Eristus Blackb.

Eristus bicolor Blackb. was examined. It does not appear to be closely related to any of the genera studied and may not in fact belong to this sub-family. As Blackburn (1892) wrote in his description of the genus, it is certainly an extremely aberrant form if it is indeed an Erirrhine. The rostrum is very short and not cylindrical but rather strongly flattened dorso-ventrally. The scrobes are oblique and the eyes closer together above than the width of the rostrum (Fig. 188). The funiculus is 7-segmented, the club 3-segmented. The anterior coxae are contiguous, the prosternum not, or scarcely, emarginate. The femora are edentate and the tibiae can probably be regarded as mucronate although the spine is more nearly parallel with, than perpendicular to, the axis of the tibia. The third tarsal segment is bilobed, the last projecting and bearing free simple claws/

claws (Fig. 189). The female has styli and the tegmen of the male is complete dorsally. The maxillary palpi are to some extent retracted into the palpiger (Fig. 190) and there are no labial palpi (Fig. 191). It occurs in Australia.

iv) *Ephimerus* Schön.

Ephimerus sexguttatus Bohem. was examined. This genus has a few characters in common with the Bagoini. The rostrum is fairly long, the scrobes converging and the eyes more or less level with the head capsule. The funiculus is 7-segmented and the club distinctly 3-segmented. The anterior coxae are separate, the prosternum in front of them being channelled. The femora are toothed, the tibiae unguiculate, the third tarsal segment bilobed and the last short, not projecting beyond the lobes of the third and without claws (Fig. 192). No female was seen and the tegmen of the male has a bilobed cap-piece. There is a finely striated area at the apex of the elytra. This genus differs from the Bagoini in the distinctly segmented club, separate anterior coxae, toothed femora, lack of claws and possession of a striated area on the elytra. Separate anterior coxae are only found in one tribe of the Erirrhininae, the Storeini, from which *Ephimerus* differs in the toothed femora, unguiculate tibiae, lack of claws and bilobed cap-piece of the tegmen. It occurs in Jamaica.

7./

Table 6 Contd

Tribes	Erirrhinini	Orthochaetini & Philernus group	Storeini	Smicronychini	Bagoini
3rd tarsal segment	bilobed	strongly, weakly or not bilobed	bilobed	bilobed	bilobed or not
5th tarsal segment	long	long or absent	long	long	long or short
Tarsal claws	free, simple	free, a.a. simple or absent	free or connate, simple	u. connate at base rarely free, u. simple	free, simple
Styli of ♀ genitalia	present	present or absent	u. present	present	a.a. present
Tegmen of ♂ genitalia	large cap., bilobed at tip	incomplete or complete dorsally without cap.	u. complete, without bilobed cap.	incomplete, complete or with a cap.	with bilobed cap. sometimes incomplete
8th tergite of ♂	external	external	external	external	internal
Mandibles	sometimes exodont	u. normal, rarely exodont	normal	a.a. exodont	normal
Special characters	tibial spurs u. present		pits may be found in scrobes or round base of 1st ventrite of some sp.	sensillae u. found on tergite 7 of ♂ and striated area at apex of some elytra	u. with a hydrofuge covering
Distribution	a.a. Holarctic	Holarctic and Australian	Australian	a.a. Holarctic	world-wide

u., usually; a.a., almost always; seg., segmented; cap., cap-piece;

unseg., unsegmented

Table 6

Tribes	Erirrhinini	Orthochaetini & Philernus group	Storeini	Smicronychini	Bagoini
Shape of rostrum	long, slender	u. fairly long, slender	u. long, slender	u. long, slender with a transverse furrow at the base	u. rather short broad
Scrobes	parallel	parallel	u. parallel, sometimes converging	converging, u. confluent	converging or sometimes parallel
Shape of antennae	long, slender	fairly long	fairly long	u. short, stout	rather stout in some sp.
Number of funicular segments	7	6 or 7	a.a.7	7	6 or 7
Elongate segments of funiculus	1st or 1st & 2nd	1st	1st & 2nd	1st	1st, often very broad
Antennal club	u. indistinctly seg.	unseg. or clearly 3 seg.	u. clearly 3 seg.	u. unseg.	u. compact, not clearly 3 seg.
Anterior coxae	contiguous	contiguous	u. separate, sometimes contiguous	contiguous	contiguous
Femora	edentate	a.a. edentate	u. edentate	u. edentate	edentate
Tibiae	a.a. weakly mucronate	mucronate	mucronate often with a praemucro	mucronate sometimes with a praemucro	mucronate or unguiculate sometimes with praemucro

u., usually; a.a., almost always; seg., segmented; cap., cap-piece;

unseg., unsegmented

7. Discussion

The last definition of the Erirrhininae comprising the world fauna was that published by Lacordaire in 1863. He included 44 genera in the Erirrhinides, several of which are now placed in other sub-families. In 1934 Klima included 229 genera in the sub-family. It is not surprising therefore that there are now so many exceptions to the characters which Lacordaire used in his definition of the sub-family, that as the Erirrhininae stands at present, his definition is of little use. In all the genera studied by the present author, however, it is true that the submentum has a projecting peduncle, the pygidium is always more or less covered by the elytra and the mesepimera are never ascendant. The rostrum is usually elongate and slender but there are many exceptions, especially in the Bagoini. The scrobes usually commence some distance from the commisures of the "mouth" but they are sub-terminal in a number of genera, e.g. Hypsomus and Philernus, and, except in a few genera such as Alhypera and Oenopus, they are not visible, even at the point of insertion, when the rostrum is seen from above. The mandibles are almost always 3-toothed and, except in genera where they are strongly exodont, the middle tooth is usually the most prominent.

Most of the other characters used in the definition of the Erirrhininae by Lacordaire and later authors can be seen in the comparison of the tribes studied in the present work (Table 6 opposite).

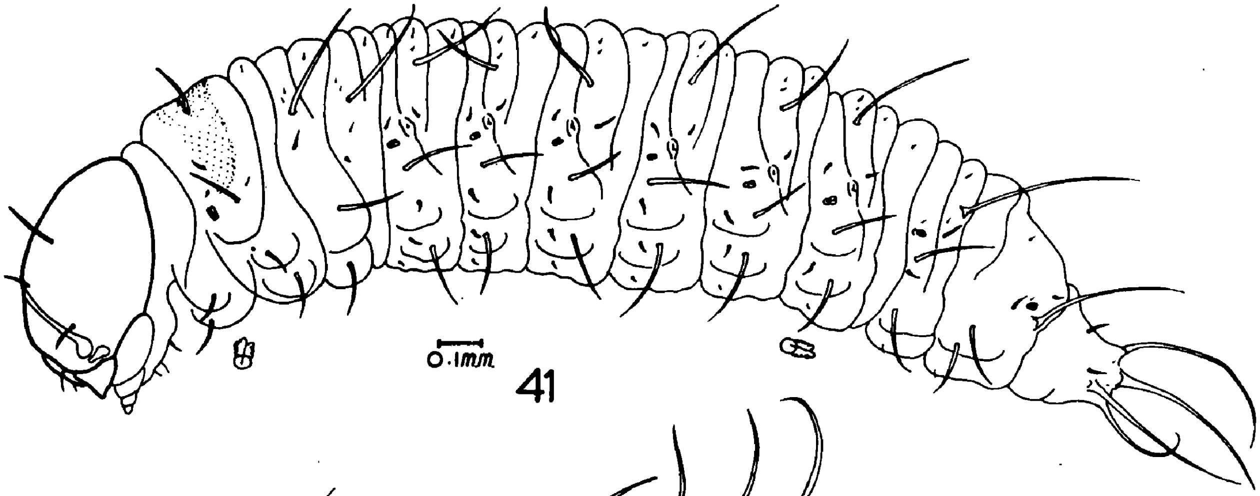
It seems probable that the Erirrhininae contains genera belonging to a number of sub-families and a fuller study of the genera included by Klima may well enable the group to be separated naturally.

PIATE I: Figs 41-50

Grypidius equiseti F.

41. First instar larva
42. An abdominal segment showing the sculpture
43. Dorsal view of segments 8 and 9
44. Dorsal view of head capsule
45. Antenna
46. Ventral view of head capsule
47. Mandible
48. Maxillae and labium
49. Dorsal view of labrum
50. Epipharynx

des, dorsal epicranial seta; enc, endocarina; fs, frontal seta; HB, hypopharyngeal bracon.



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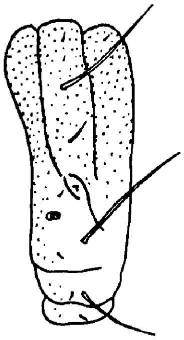

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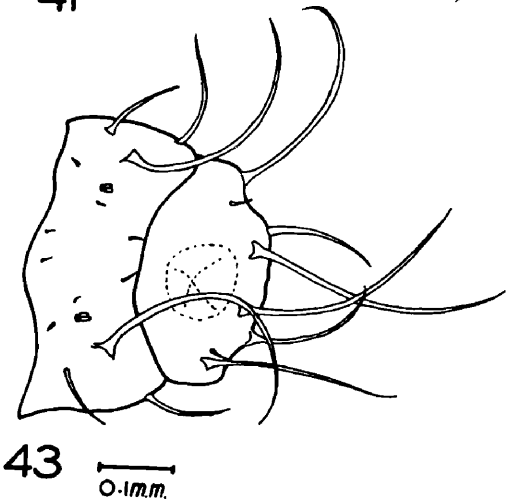

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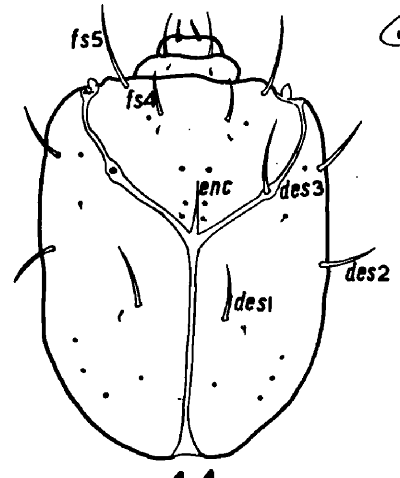

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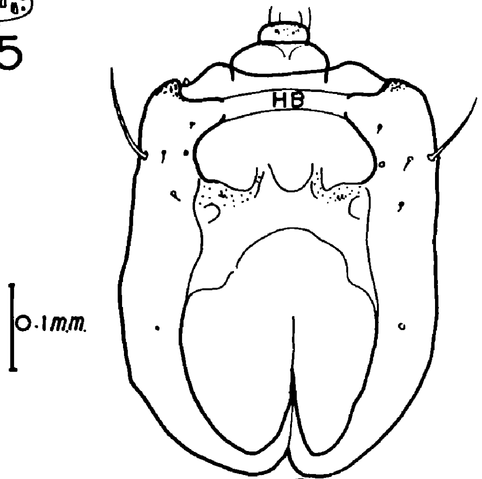

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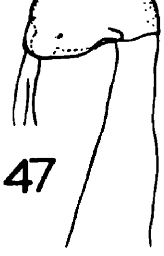

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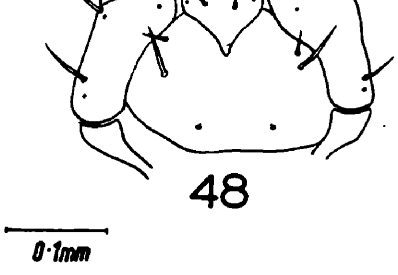

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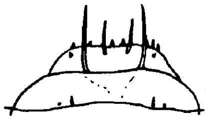

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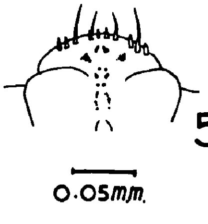

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PLATE II: Figs 51-60

Figs 51-55 Grypidius equiseti F., third instar larva

51. Head capsule

52. Maxillae and labium

53. Mandible

54. Dorsal view of labrum

55. Epipharynx

56. Thryogenes festucae Herbst., head and antenna

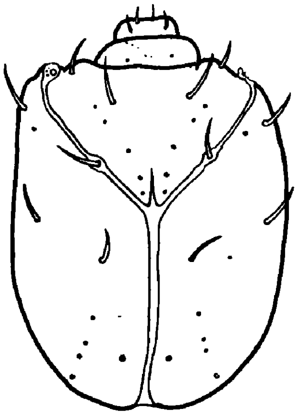
57. Notaris scirpi F., mandible

58. Procas armillatus F., leg

59. Grypidius equiseti F., female genitalia

60. G. equiseti F., male genitalia

AB, AD, abductor and adductor tendons; CX, coxite; H, hair; ML, median lobe; MLS, median lobe strut; RS, spermatheca; SCL, sclerites; SG, spiculum gastrale; ST, stylus; S8, sternite 8; T, tegmen; TS, tegminal strut; TSP, tibial spur; T8, tergite 8.



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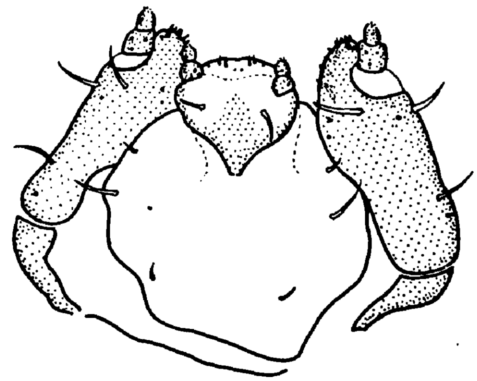

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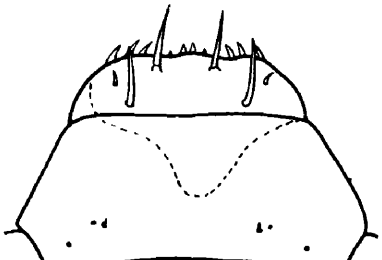

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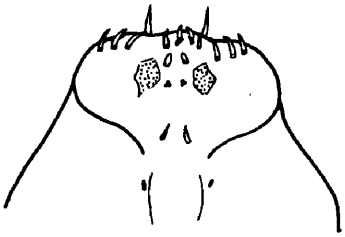

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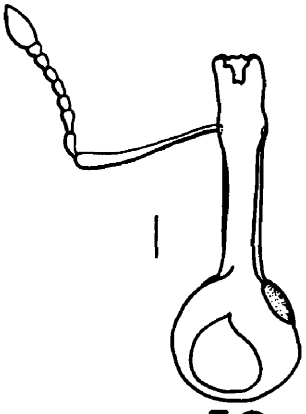

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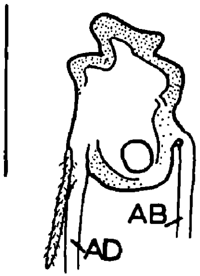

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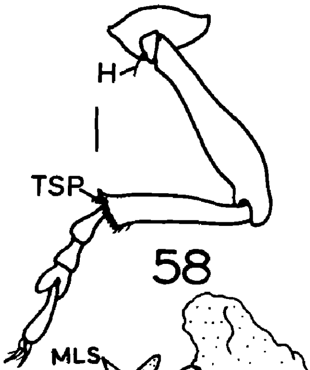

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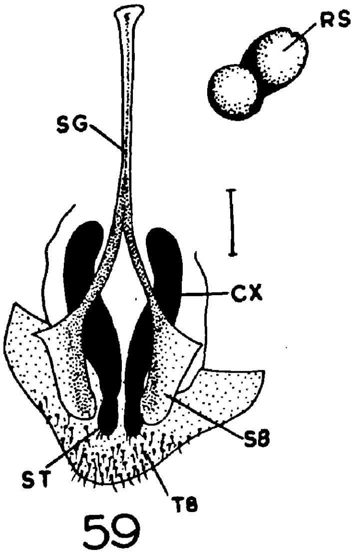

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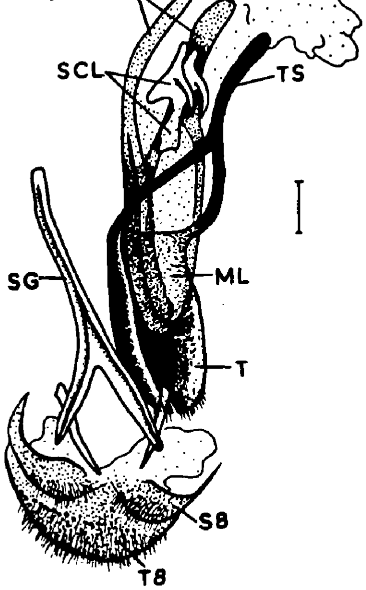

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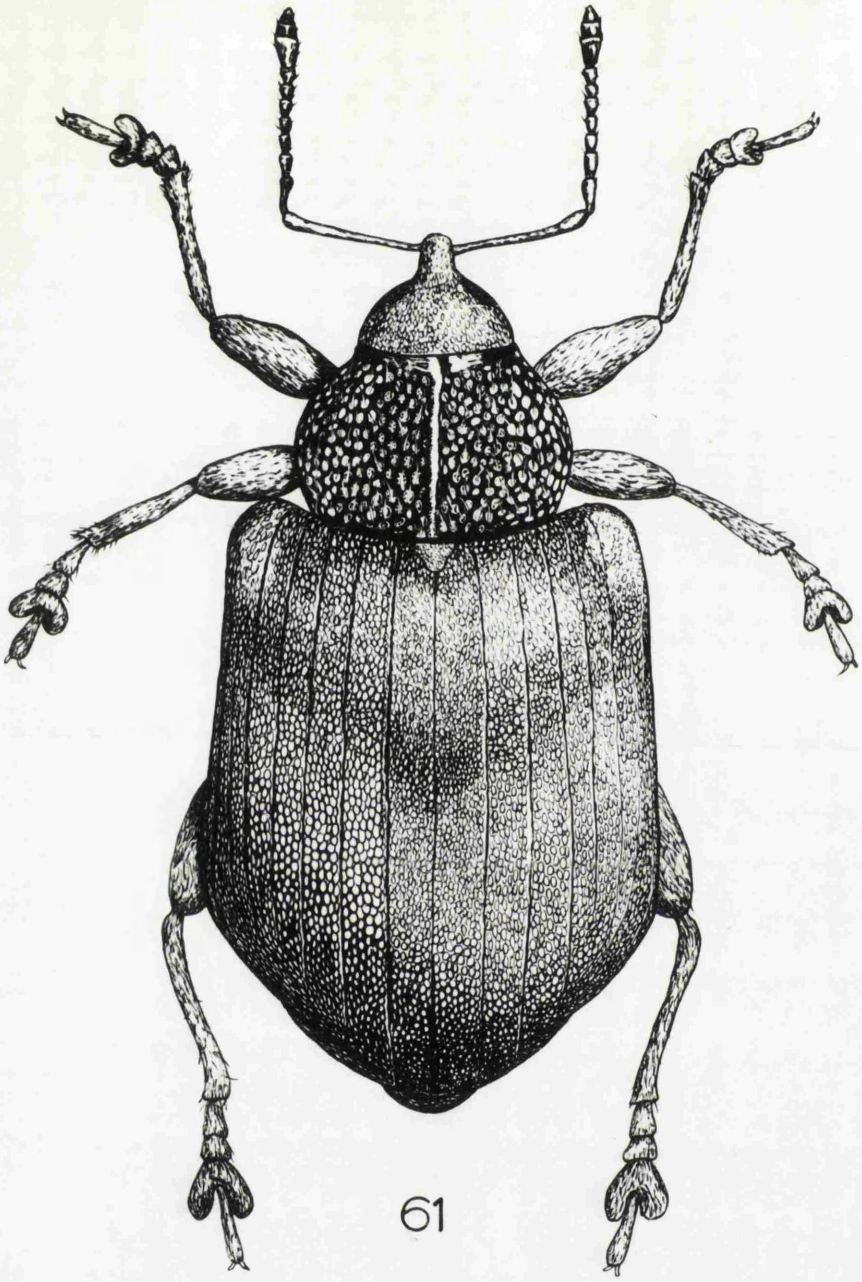
PLATE III: Figs 61-63

61. *Grypidius leechi* n.sp., female

62. *G. mannerheimi* Fst., pronotum and elytra

63. *G. leechi* n.sp., pronotum and elytra



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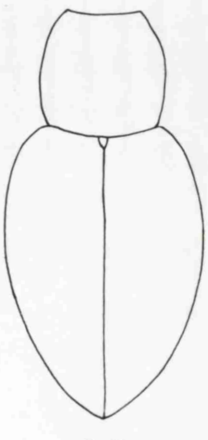

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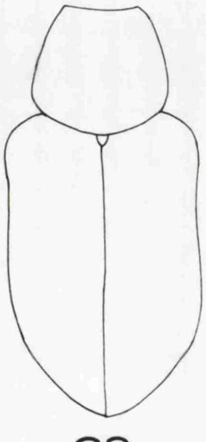

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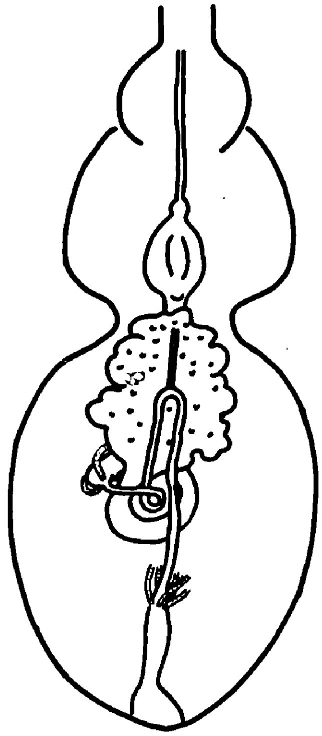
PLATE IV: Figs 64-72

Grypidius equiseti F.

64. Digestive system in situ
65. Digestive system
66. Transverse section at junction of mid- and hind-gut showing the origin of the six malpighian tubules
67. Central nervous system
68. Sympathetic nervous system
69. Female reproductive system in situ
70. Female reproductive system
71. Male reproductive system in situ
72. Male reproductive system

A, aorta; 1AG, first abdominal ganglion; AGL, accessory gland; AN, antennary nerve; C, crop; CA, corpus allatum; CC, corpus cardiacum; ED, ejaculatory duct; EPN, external paracardiac nerve; FG, frontal ganglion; G, genitalia; I, intestine; IPN, internal paracardiac nerve; L, ligament; ME, mature egg; MG, mid-gut; MSG, mesothoracic ganglion; MT, malpighian tubule; MTG, metathoracic ganglion; O, ovariole; OES, oesophagus; OV, oviduct; PG, prothoracic ganglion; PGL, prostate gland; PMN, paracardio-maxillary nerve; PRO, proventriculus; R, rectum; RAG, remaining abdominal ganglia; RN, recurrent nerve; RS, spermatheca; SBOG, suboesophageal ganglion; SPOG, supra-oesophageal ganglion; TC, testicle; TE, testis; TENT, tentorium; TF, terminal filament; V, vagina; VG, ventricular ganglion.



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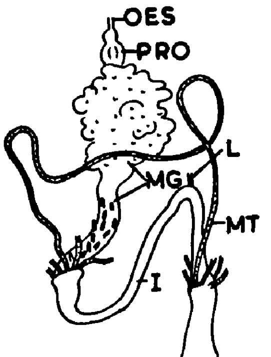

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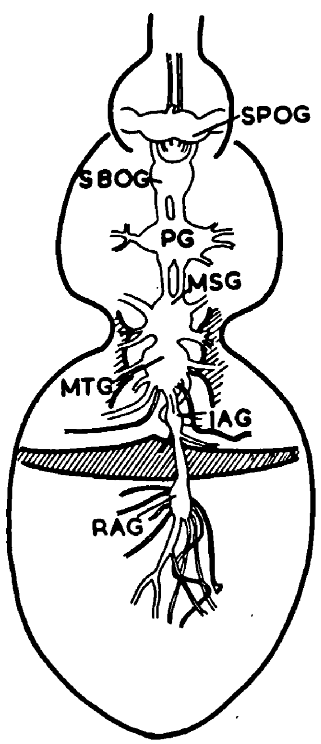

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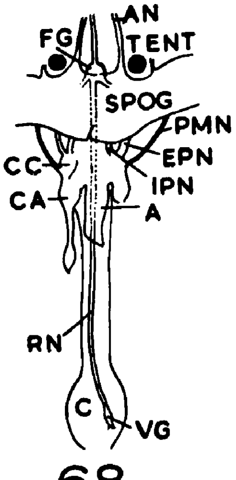

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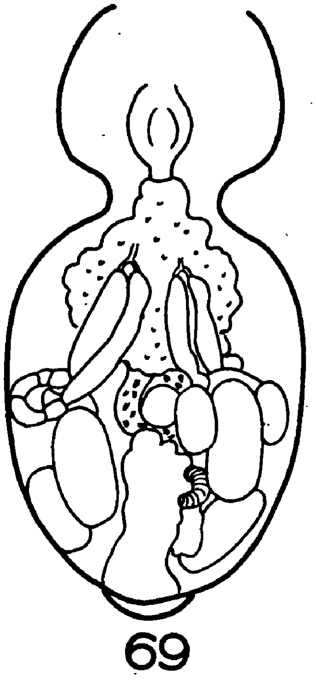

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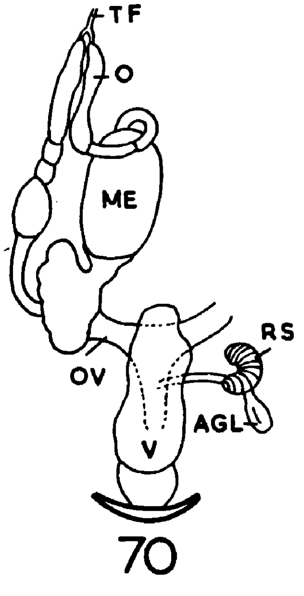

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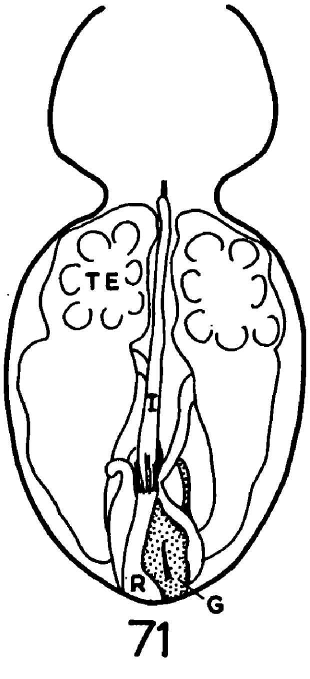

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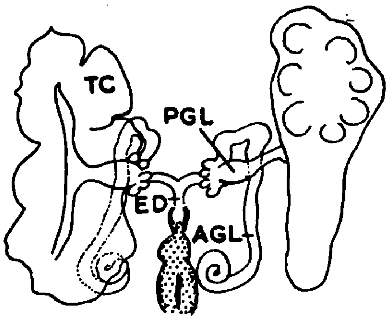

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PLATE V: Figs 73-84

73. *Grypidius equiseti* F., mandible

74. *G. equiseti* F., antenna

75. *Thryogenes festuca* Herbst., apex of tibia and tarsus

76. *Pseudostyphlus pilumnus* Gyll., head

77. *Orthochaetes setiger* Beck., antenna

78. *Pseudostyphlus pilumnus* Gyll., mesothoracic leg

79. *Dorytomus taeniatus* F., female genitalia

80. *Orthochaetes setiger* Beck., female genitalia

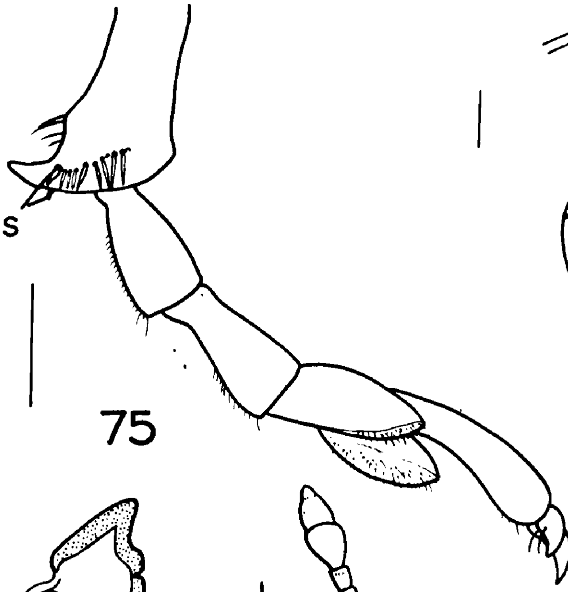
81. *Pseudostyphlus pilumnus* Gyll., male genitalia

82. *Philernus farinosus* Gyll., antenna

83. *Geranorrhinus pusillus* Motsch., apex of tibia

84. *Misophrice variabilis* Blackb., apex of tibia

C, coxite; E, empodium; SP, spermatheca; TS, tibial spur.



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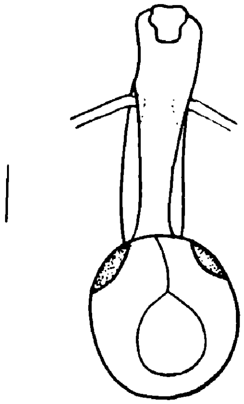

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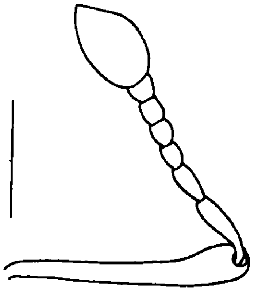

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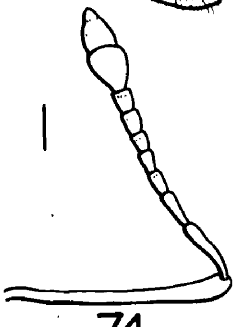

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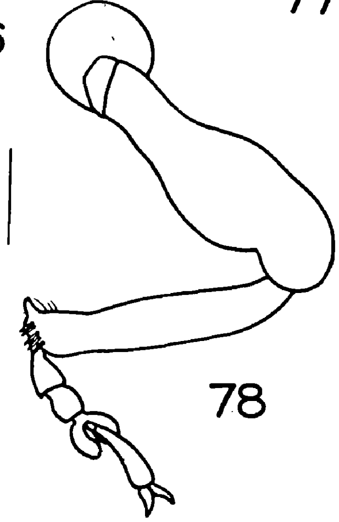

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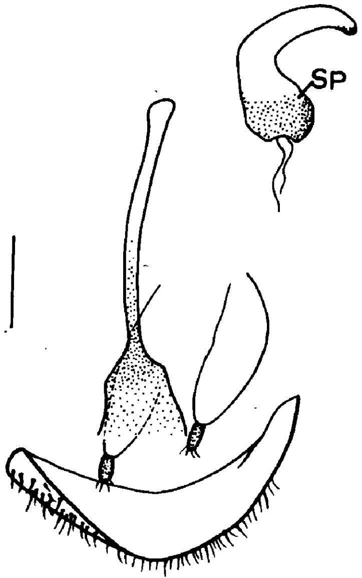

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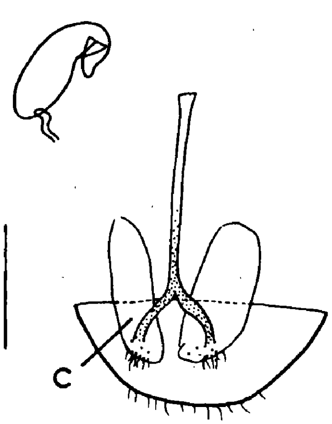

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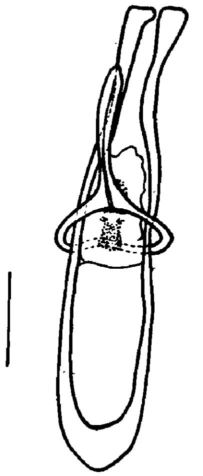

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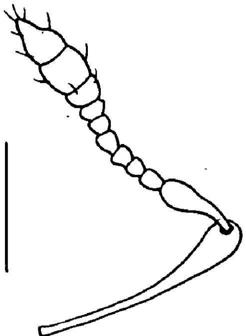

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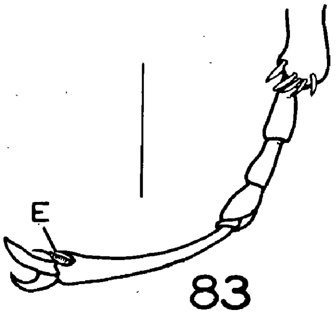

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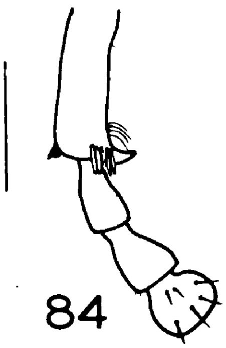

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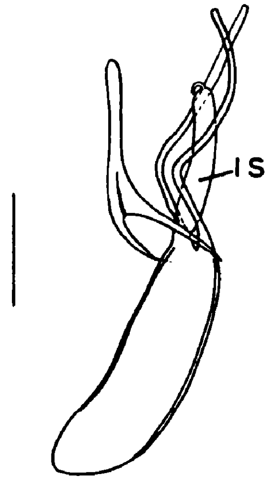
PLATE VI: Figs 85-96

85. Philernus farinosus Gyll., male genitalia
86. Peristoreus decussatus Mshl., apex of tibia
87. P. decussatus Mshl., male genitalia
88. Philernus farinosus Gyll., apex of tibia
89. P. farinosus Gyll., mandible
90. Misophrice variabilis Blackb., mandible
91. M. variabilis Blackb., female genitalia
92. Thechia pygmaea Pasc., leg
93. Erytenna dispersa Pasc., head
94. Cydmaea major Blackb., antenna
95. Gerynassa picticornis Blackb., leg
96. Rachiodes granulifer Chevr., leg

C, coxite; IS, internal sac of median lobe; T8, tergite 8.



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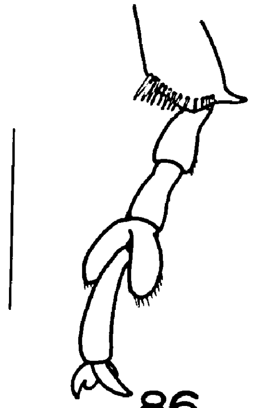

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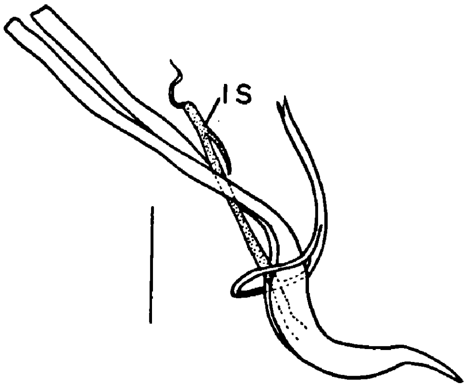

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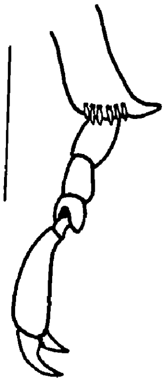

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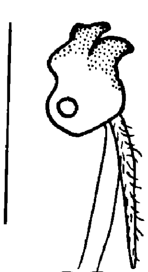

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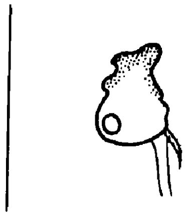

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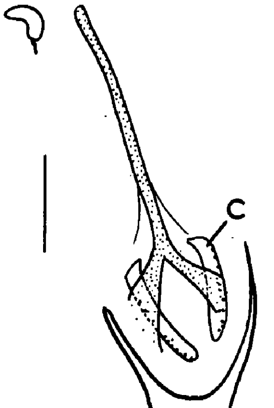

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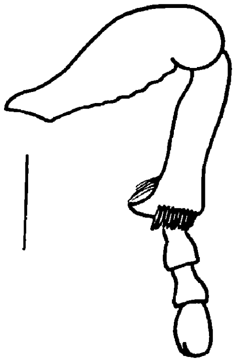

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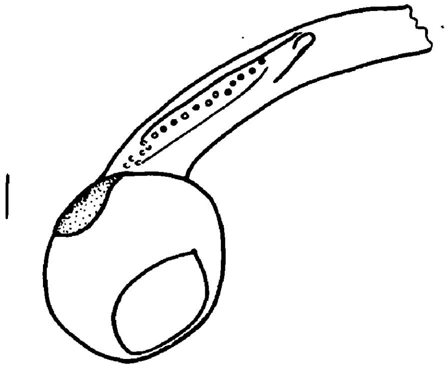

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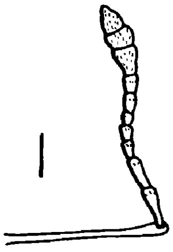

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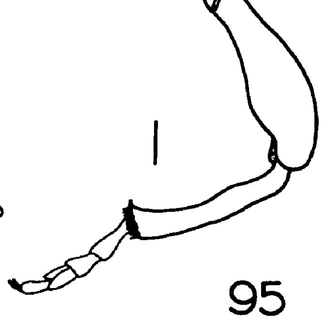

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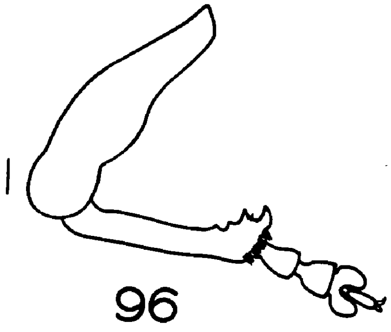

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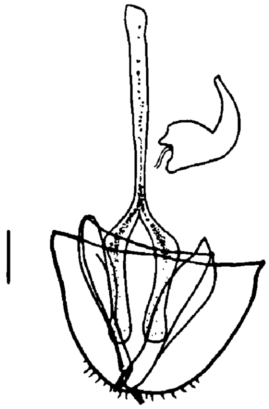
PLATE VII: Figs 97-110

97. Storeus variegatus Boh., female genitalia
98. Dicomada rufa Blackb., male genitalia
99. Eniopea bivittata Lea, wing
100. E. bivittata Lea, antenna
101. Rachiodes granulifer Chevr., head
102. R. granulifer Chevr., wing
103. Gerynassa picticornis Blackb., abdomen
104. G. picticornis Blackb., tegmen
105. Storeus variegatus Boh., claw-bearing segment of tarsus
106. Emplesis femoralis Lea, antenna
107. E. femoralis Lea, male genitalia
108. Dicomada rufa Blackb., antenna
109. Aoplocnemis tasmanicus Blackb., head
110. A. tasmanicus Blackb., mandible

E, empodium; IS, internal sac of median lobe.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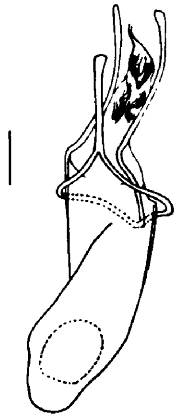
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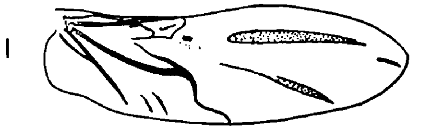
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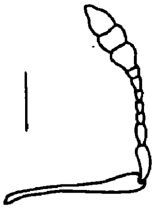
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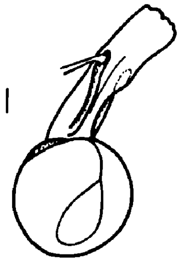
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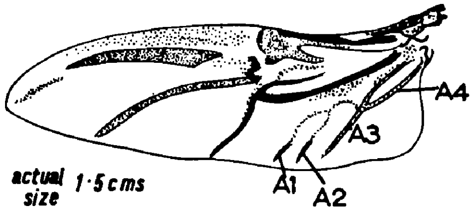

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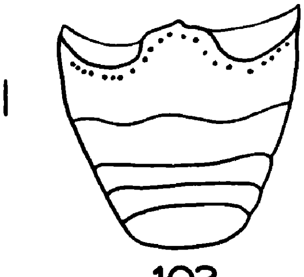
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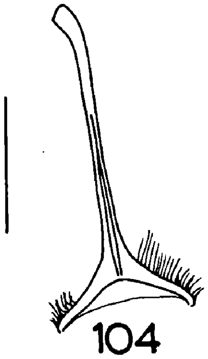
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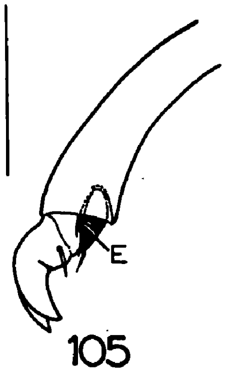

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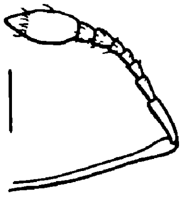
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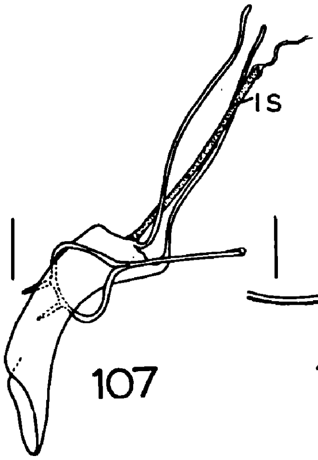

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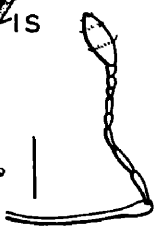
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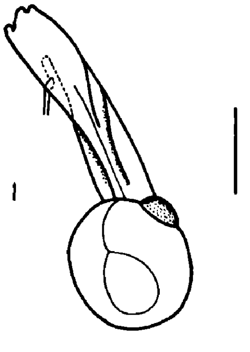
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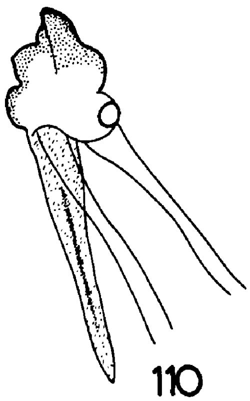
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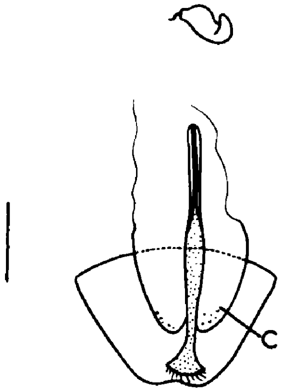
PLATE VIII: Figs 111-122

111. Aoplocnemis phaleratus Er., female genitalia
112. Olanea metropolitana Blackb., tegmen
113. O. metropolitana Blackb., female genitalia
114. Antyllis togata Lea, head and antenna
115. A. togata Lea, female genitalia
116. Smicronyx reichi Gyll., head
117. Pachyphanes discoideus Lec., head
118. Pachytychius haematocephalus Gyll., head
119. Pachyphanes discoideus Lec., mandible
120. Barytychius hordei Brullé, mandible
121. Synertha imbricata Cas., antenna
122. Pachytychius haematocephalus Gyll., antenna

C, coxite; T8, tergite 8.



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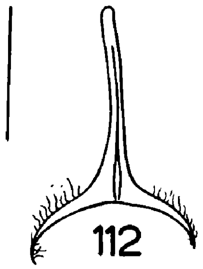

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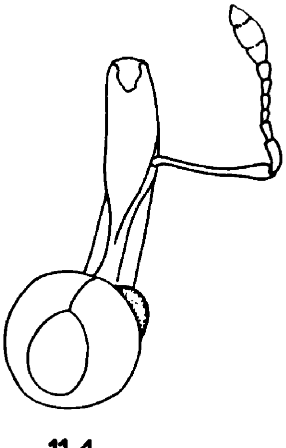

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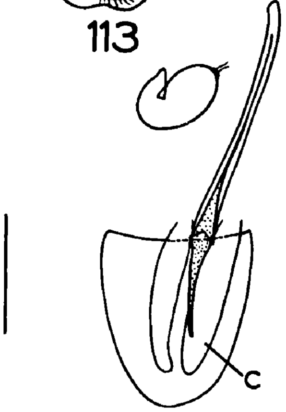

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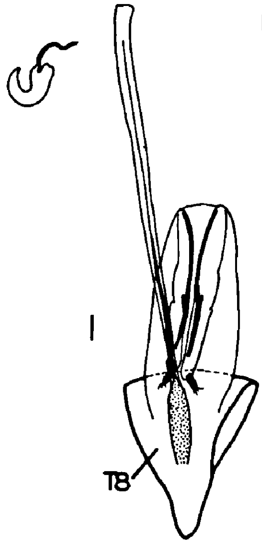

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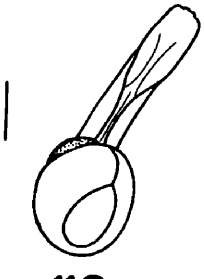

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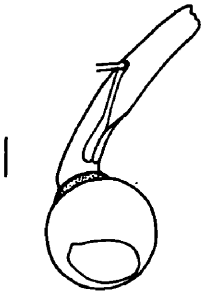

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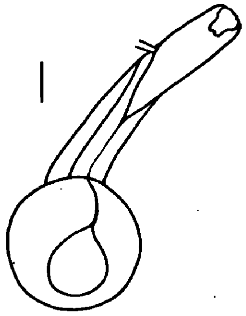

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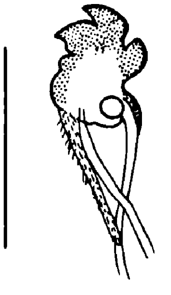

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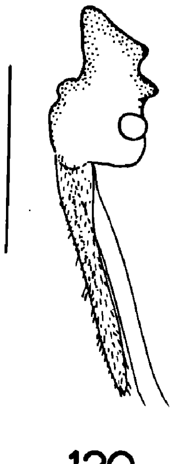

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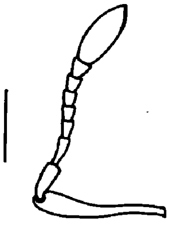

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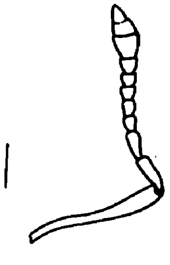

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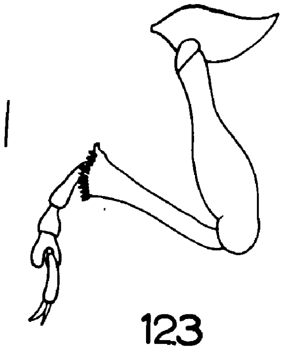
PLATE IX: Figs 123-136

123. *Desmoris constrictus* Say, leg
124. *Barytychius hordei* Brullé, leg
125. *Sharpia bella* Faust, abdomen
126. *S. bella* Faust, tergites 7 and 8 of male
127. *Pachyphanes discoideus* Lec., tergites 7 and 8 of male
128. *Smicronyx reichi* Gyll., female genitalia
129. *Sharpia bella* Faust, male genitalia
130. *Synertha imbricata* Cas., male genitalia
131. *Pachyphanes discoideus* Lec., male genitalia
132. *Synertha imbricata* Cas., wing
133. *Pachyphanes discoideus* Lec., elytron, ventral view
134. *Smicronyx reichi* Gyll., male genitalia
135. *Sharpia bella* Faust, leg
136. *S. rubida* Rosenh., tibia and tarsus

L, lateral fold; S, striated area; T7, T8, tergites 7 and 8.



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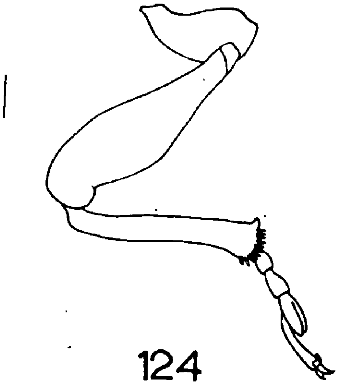

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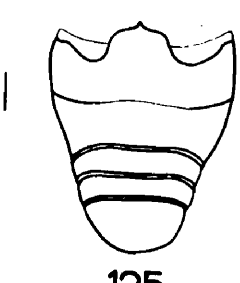

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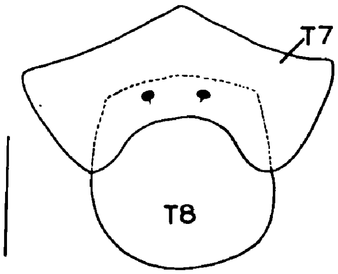

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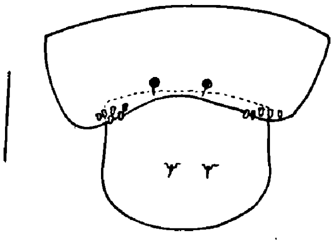

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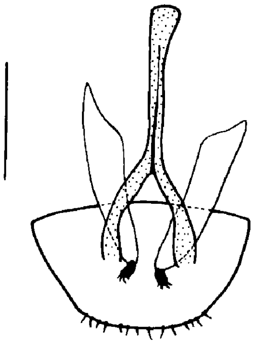

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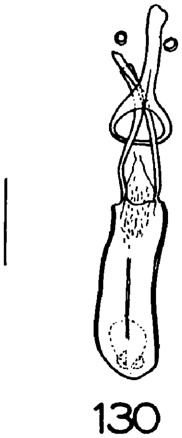

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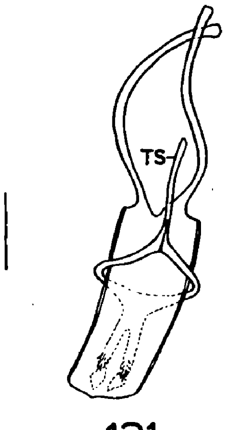

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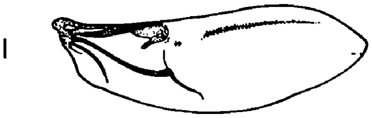

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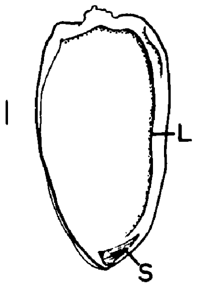

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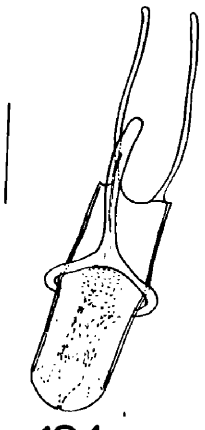

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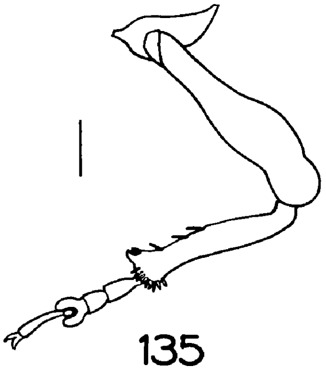

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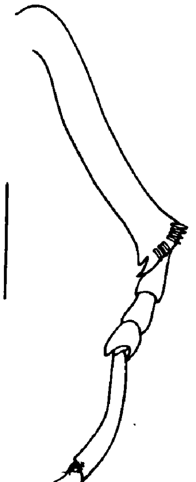

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PLATE X: Figs 137-148

137. Barytychius hordei Brullé, labium, side view

138. B. hordei Brullé, tergite 7 of male

139. Pachytychius haematocephalus Gyll., male genitalia

140. Aubeonymus carinicollis Luc., mandible

141. A. carinicollis Luc., antenna

142. Acentrus histrio Falderm., antenna

143. A. histrio Falderm., claw-bearing segment of tarsus

144. A. histrio Falderm., tergites 7 and 8 of male

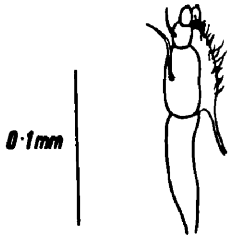
145. A. histrio Falderm., male genitalia

146. Hypsomus scapha Boh., antenna

147. H. scapha Boh., female genitalia

148. H. scapha Boh., tegmen

C, coxite



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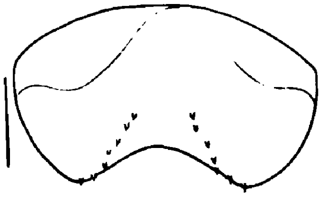

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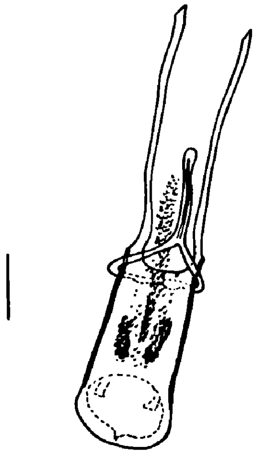

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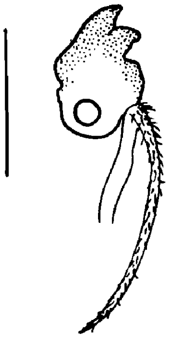

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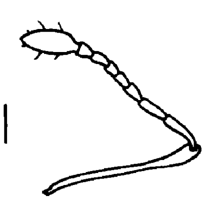

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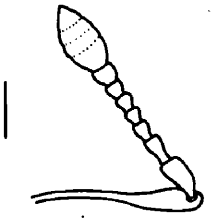

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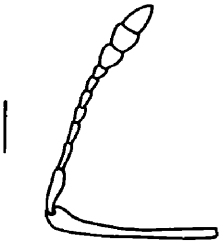

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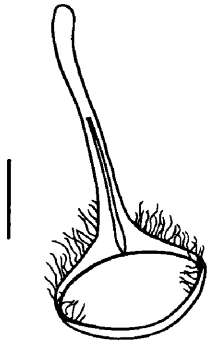

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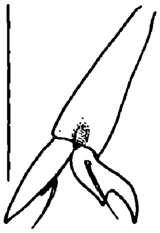

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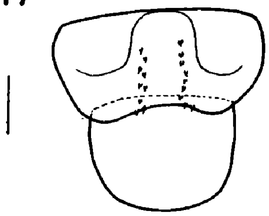

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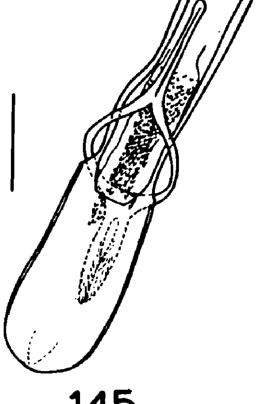

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PLATE XI: Figs 149-160

149. *Bagous argillaceus* Gyll., head

150. *Endalus aeratus* Lec., head

151. *Hydronomidius molitor* Faust, antenna

152. *Echinocnemus gemallus* Mshl., antenna

153. *Bagous binodulus* Herbst., leg

154. *Echinocnemus gemallus* Mshl., leg

155. *Endalus aeratus* Lec., female genitalia

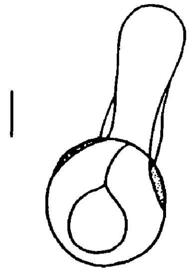
156. *Endaliscus skalitzkyi* Faust, male genitalia

157. *Tanysphyrus lemnae* Payk., male genitalia

158. *T. lemnae* Payk., mesothoracic leg

159. *Echinocnemus gemallus* Mshl., male genitalia

160. *E. gemallus* Mshl., labium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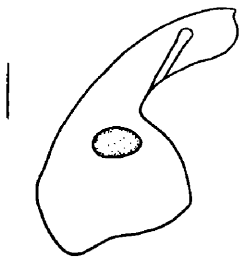
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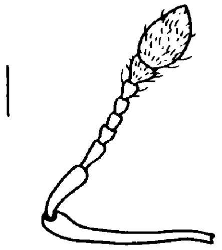
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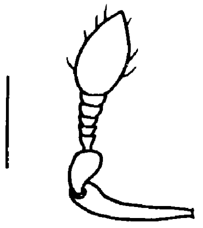
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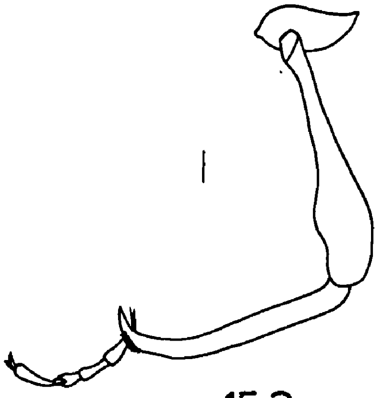
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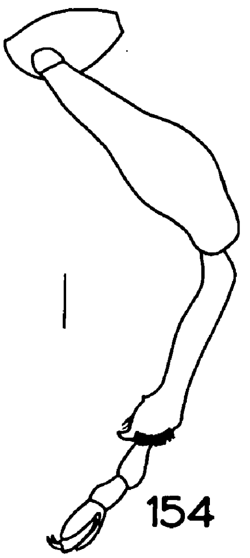
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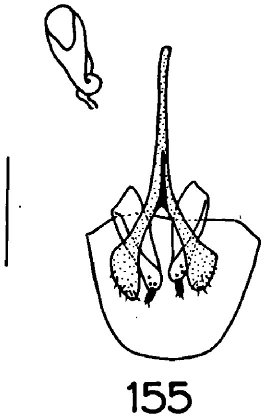
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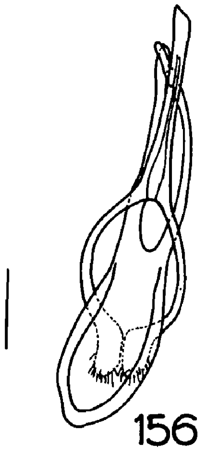
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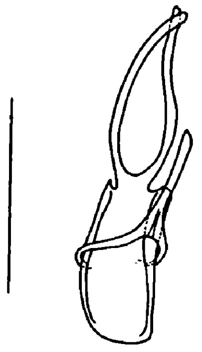
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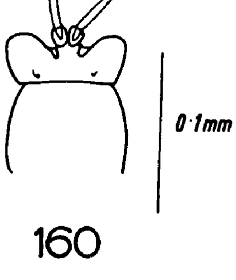

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PLATE XII: Figs 161-175

161. _Echinocnemus gemallus_ Mshl., abdomen

162. _Endalus aeratus_ Lec., tegmen

163. _Helodytes foveolatus_ Duval, antenna

164. _H. foveolatus_ Duval, prothoracic tibia and tarsus

165. _H. foveolatus_ Duval, mesothoracic tibia and tarsus

166. _H. foveolatus_ Duval, metathoracic tibia and tarsus

167. _H. foveolatus_ Duval, female genitalia

168. _H. foveolatus_ Duval, male genitalia

169. _Endaliscus skalitzyki_ Faust, antenna

170. _E. skalitzyki_ Faust, leg

171. _Jekelia notata_ Muls., leg

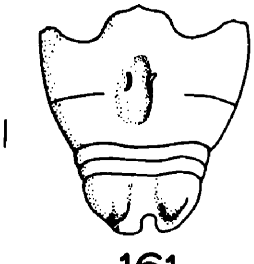
172. _J. notata_ Muls., male genitalia

173. _Hydronomidius molitor_ Faust, mandible

174. _Bagous binodulus_ Herbst., antenna

175. _B. argillaceus_ Gyll., leg

C, coxite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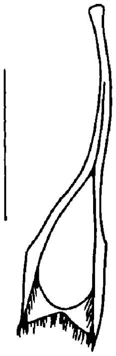
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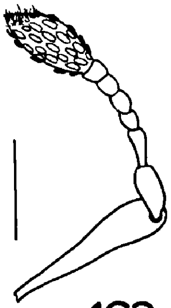
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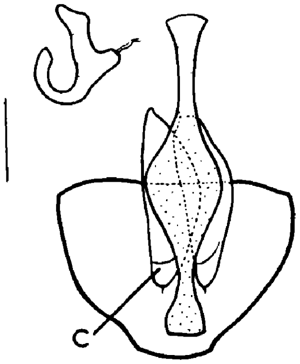

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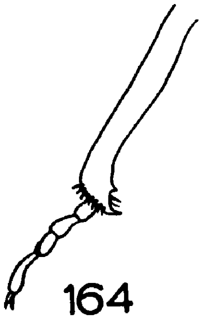
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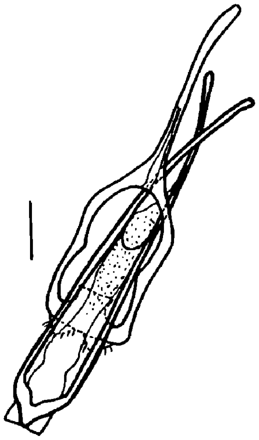
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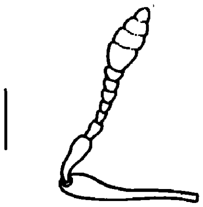
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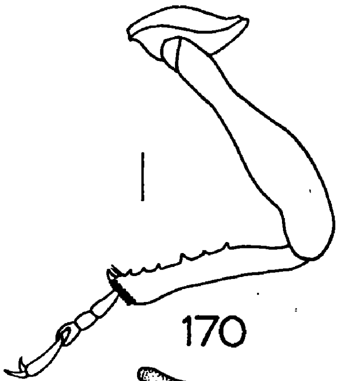
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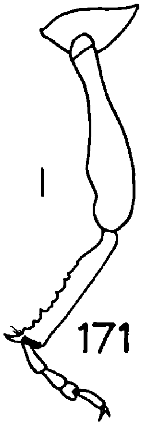
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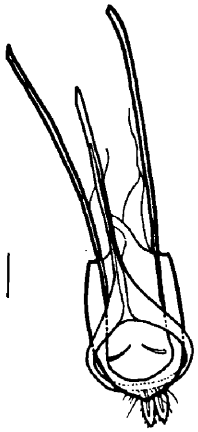
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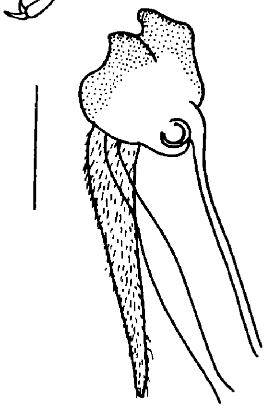
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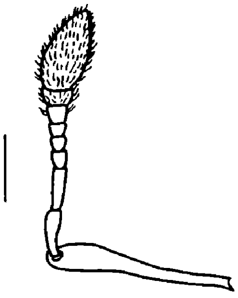
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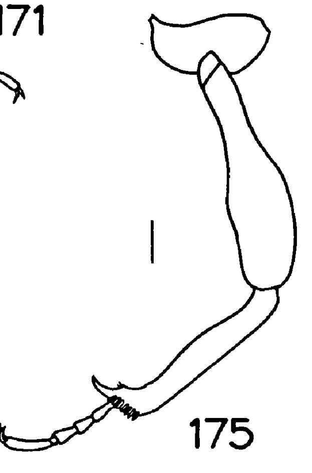
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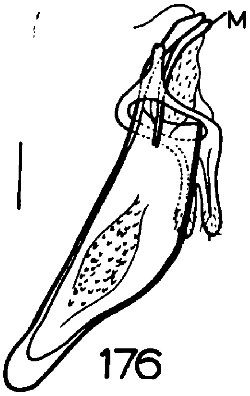
PLATE XIII: Figs 176-192

176. Bagous argillaceus Gyll., male genitalia
177. B. binodulus Herbst., male genitalia
178. Rhinocyllus conicus Froel., male genitalia
179. Alhypera bruchi Hust., antenna
180. A. bruchi Hust., apex of tibia and tarsus
181. A. bruchi Hust., male genitalia
182. A. bruchi Hust., labium
183. A. bruchi Hust., mandible
184. Stenopelmus rufinasus Gyll., tibia and tarsus
185. Grypidiopsis variegatus Champ., leg
186. Oenopus triquetra (Lea), prothoracic leg
187. O. triquetra (Lea), metathoracic leg
188. Eristus bicolor Blackb., head
189. E. bicolor Blackb., apex of tibia and tarsus
190. E. bicolor Blackb., maxilla
191. E. bicolor Blackb., labium
192. Ephimerus sexguttatus Boh., apex of tibia and tarsus

H, hypopharynx; L, ligula; M, median lobe strut



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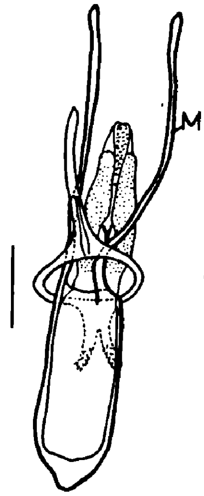

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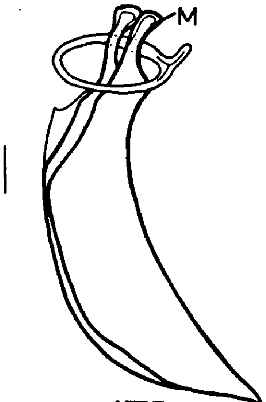

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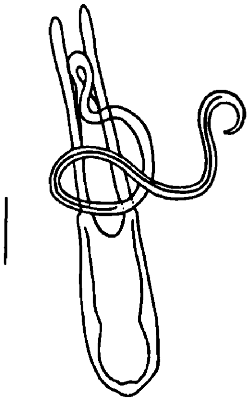

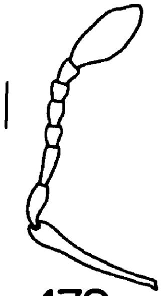

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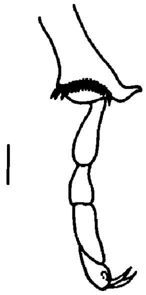

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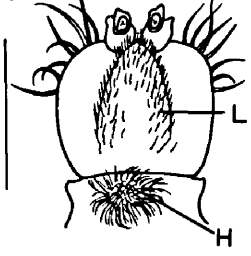

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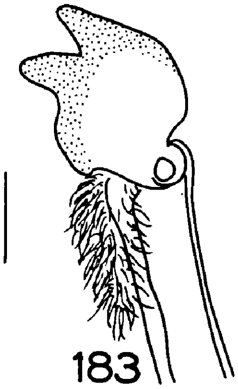

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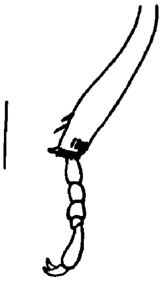

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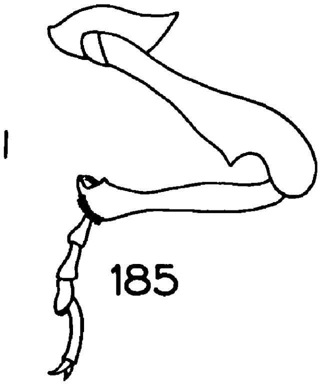

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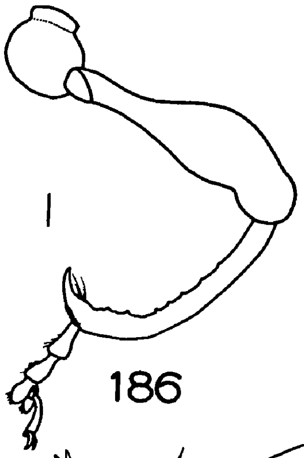

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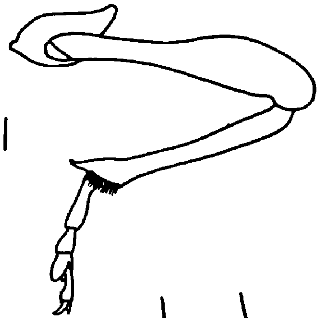

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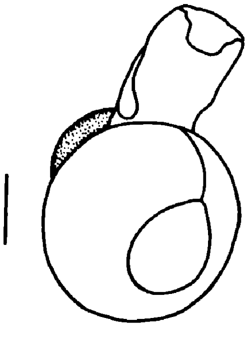

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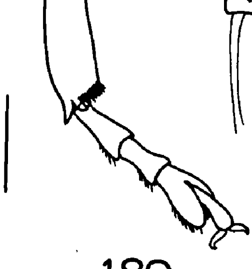

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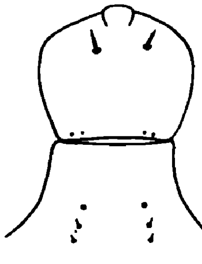

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V. GENERA INCORRECTLY PLACED IN THE ERIRRHININAE

1. Genera transferred to the sub-family Petalochilinae

Following Kuschel (1952) the genera Celetes and Phytotribus and with dubiety the genera Spermologus and Phyllotrox are transferred from the Erirrhininae to the Petalochilinae. Derelomus, about which Kuschel was uncertain, and Phycocoetes, which he did not discuss, have also been transferred to this sub-family.

Characters of the Petalochilinae

Kuschel based his transfer of the genera on six characters. "Not only", he wrote, "are the genera all found on palms but they have a number of morphological characters in common, the superficial scrobes, the elongate antecoxal region of the prosternum and the characteristic form of the femora". Unfortunately, as he has not drawn any figures it is not very clear what he means by the last character. "The tibiae of some of the genera of the Petalochilinae (of the transferred genera, only certain species of Celetes)", he continued, "are very unusual in possessing an uncinate mucron at the external distal angle of the tibia and in all the genera of the Petalochilinae the third elytral stria is united to the sixth at the apex, not to the eighth as in most other Curculionids." This is not the case, however, in Phyllotrox ater and Derelomus bivirgatus.

In/

In the genera studied, the rostrum is fairly long, the scrobes are usually parallel and either superficial or lateral, and the eyes flat or protuberant (Fig. 193). The antennae are rather stout in appearance, the funiculus is 7-segmented, with the first and second joints elongate, and the club is indistinctly, or not, segmented (Fig. 194). The anterior coxae may be contiguous or separate and the antecoxal region of the prosternum is usually, though not always, elongate (Fig. 195). The femora are usually edentate, the tibiae have an uncinate mucron or are simply mucronate; in some genera they may be unarmed in one sex. The third tarsal segment is bilobed, the last long and projecting and usually bearing free simple claws (Figs 196-197). The female has styli (Fig. 198) and the tegmen of the male may be incomplete, complete or with a bilobed cap-piece dorsally (Figs 199-200). The eighth tergite of the male is external, and the suture between the first and second ventrites complete.

Study of genera

i) Spermologus Schön.

Spermologus rufus Bohem. was examined. The scrobes are parallel and lateral, the anterior coxae contiguous and the antecoxal portion of the prosternum not elongate, but longer than the postcoxal portion. The femora are edentate; the tibiae of the male mucronate (Fig. 197). According to Kuschel (1950a)/

(1950*a*) in *S. weyrauchi* Kuschel the posterior tibiae of the male are hooked but those of the female are unarmed. The claws are basally connate. The tegmen has a bilobed cap-piece. In both male and female a sclerite is found round the rectum (Fig. 201). The wings are well developed. This species breeds in cocoa grains (Sterculiaceae). Marshall (1926) recorded the species *S. impressifrons* Mshl. breeding in the fruits of *Camphora* (Lauraceae). Kuschel (1952) wrote that some of its species occur on palms. He transferred the genus to the Petalochilinae as he considered that it was closely related to *Petalochilus*. It differs from the other Petalochilinae, however, in the unarmed tibiae of the female, connate claws, rather short antecoxal region and the possession of a rectal sclerite.

ii) *Celetes* Schön.

Celetes binotatus Gyll. was examined. The scrobes are parallel and much longer in the male than in the female (Figs 202-203, S). The anterior coxae are separate; the antecoxal portion of the prosternum is long. The femora are toothed, the tibiae of the female appear to possess what Kuschel calls an uncinate mucron and those of the male are mucronate (Figs 196, 204). The tarsal claws are free and the tegmen incomplete dorsally. The mandibles are weakly exodont in the male, more strongly exodont in the female (Figs 205-206) and the labium has/

has many setae (Fig. 207). The wings are well developed. According to Bondar (1940) it is found on palms of the genus *Cocos* (Palmaceae).

iii) *Phytotribus* Schön.

According to Kuschel (1952) this genus is synonymous with *Celetes*.

Phytotribus unicolor Bohem. was examined. The scrobes are parallel and are longer in the male than in the female. The anterior coxae are separate, and the antecoxal region of the prosternum is elongate (Fig. 195). The femora are toothed, the tibiae of the female having what appears to be Kuschel's so-called uncinate mucron, those of the male being unarmed (Figs 209, 208). The tarsal claws are free. The eighth tergite of the female is serrated along the apical edge (Fig. 210) and the tegmen of the male is complete (Fig. 199). It is doubtful whether Kuschel was correct in synonymising the two genera, although they are certainly very closely related. Bondar (1953) recorded *Phytotribus* from palms and Moraceae.

iv) *Phyllotrox* Schön.

Phyllotrox ater Champ. was examined. The scrobes converge slightly, the eyes are strongly protuberant and the antennal club is distinctly 2-segmented (Fig. 211). The anterior coxae are contiguous and the antecoxal region of the prosternum is short. The femora are edentate and, as in *Phytotribus*, the tibiae/

tibiae of the male are unarmed and the tarsal claws free and simple. The tegmen is incomplete dorsally and the maxillary palpi are 2-segmented (Fig. 212). The third elytral stria in this species is united to the eighth, not the sixth, at its apex. Champion (1902) wrote that Phyllotrox and Derelomus were closely related and placed Phyllotrox in the Derelomini. Hustache (1929) followed earlier taxonomists in placing Phyllotrox in the Eugnominae. Kuschel (1952) transferred it to the Petalochilinae and wrote that although the majority of species are found on palms, those in Bolivia, where there are no palms, are found on Malvaceae.

v) Derelomus Schön.

Derelomus bivirgatus Mshl. was examined. The scrobes are almost parallel, the eyes protuberant and the club unsegmented. The anterior coxae are slightly separate, the antecoxal region of the prosternum being elongate. The femora are edentate, the tibiae of the male mucronate and the tarsal claws free and simple. The tegmen is incomplete dorsally and the seventh tergite of the male bears two rows of sensillae rather similar to those seen in some of the Smicronychini (Fig. 213). The third elytral stria is united to the eighth at its apex. Leconte and Horn (1876) noted that the anterior coxae are slightly to distinctly separate in various species. In the species they examined, the tibiae were unarmed and the tarsal claws simple or toothed. Hustache (1930) wrote that Derelomus species/

species are usually found gregariously in palm flowers. According to Bondar (1953) members of the tribe Derelomini develop on the male flowers of palms and grasses.

vi) Phycocoetes Lec.

Phycocoetes testaceus Lec. was examined. The scrobes are parallel and somewhat superficial and the eyes are rather small (Fig. 193). The anterior coxae are slightly separate and the antecoxal portion of the prosternum is elongate. The femora are edentate, the tibiae of the male unguiculate with a well developed praemucro and the tarsal claws are free and simple (Fig. 214). The tegmen has a bilobed cap-piece (Fig. 200). There are no wings. The third elytral stria is united to the sixth at its apex. According to Leconte and Horn (1876) it is found under seaweed cast up on the beach. Tanner (1943) included Phycocoetes in the "sub-tribe Hydronomini", but gave no reasons for doing so.

Discussion

Spermologus, Celetes and Phytotribus have been found only in South America; Phyllotrox is also found in North America where Phycocoetes occurs. Derelomus species are found in Europe, Africa, India and North and South America.

The antecoxal region of the prosternum is elongate in Celetes, Phytotribus, Derelomus and Phycocoetes, while in Spermologus although longer than the postcoxal region it is not/

not very long and in Phyllotrox it is as short as the postcoxal region.

The third elytral stria is united at the apex to the sixth in Spermologus, Celetes, Phytotribus and Phycocoetes but to the eighth in Derelomus and Phyllotrox.

Phyllotrox also differs from the other Petalochilinae in the possession of 2-segmented, instead of the usual 3-segmented, labial palpi and a distinctly segmented antennal club. As Kuschel made no reference to the elytral striae in Phyllotrox it is, however, possible that in the species he examined, the third was united to the sixth at its apex.

2. Genera transferred to the sub-family Cylindrorrhininae*

According to Marshall (1931) Mascarauxia Desbr., 1899, is a synonym of Hyperodes Jekel, 1864, which belongs to the Cylindrorrhininae. Kuschel (1950) transferred Anchodemus from the Bagoini to this sub-family. The genus Desiantha, which is very closely related to Hyperodes, should also be transferred to the Cylindrorrhininae.

Characters of the three cited genera of the Cylindrorrhininae

The rostrum is not very long and tends to be rather broad. The commencement of the scrobes which is very near the apex is visible/

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* Kuschel (1950b) called it the Cylydrorhininae.

visible when the rostrum is viewed from above, the scrobes are parallel and the eyes are level with the head capsule (Fig. 215). The antennae are fairly long and slender, the funicle is 7-segmented, the first and second joints being elongate, and the club is usually faintly annulated but not distinctly segmented (Fig. 216). The anterior coxae are contiguous, the prosternum is longer in front of the coxae than behind and very slightly emarginate. The femora are edentate, the tibiae mucronate with a single tibial spur at the apex, the third tarsal segment is bilobed, the last being long with free simple claws (Figs 217-219). Styli are present in the female (Fig. 220) and the tegmen is complete dorsally (Fig. 221). The suture between ventrites one and two is complete.

Study of genera

i) Anchodemus Lec.

According to Kuschel (1950b) Lixellus Lec., 1876, is a synonym of Anchodemus Lec., 1876.

Anchodemus angustus Lec. was examined. The rostrum is more slender than that of the other two genera and the wings are vestigial. Despite the hydrofuge covering Anchodemus differs from the Bagoini principally in the possession of tibial spurs and in the fact that the eighth tergite of the male is external. The third tarsal segment is bilobed and the last is elongate,

a/

a combination seldom found in the Bagoini. According to Pierce (1907) and Blatchley and Leng (1916) it is found on sedges round ponds and eats *Sagittaria*.

ii) *Hyperodes* Jekel

Hyperodes cyrtica (Desbr.) was examined. Wings are present but weakly veined. An unusual sclerite is found anterior to the coxites of the female in a similar position to the sclerite found in *Phytotribus* (Fig. 220, S). No males were seen. Hustache (1910) found one pair below the bark of a plane tree (Platanaceae) at Dax, France. According to Champion (1916) and Marshall (1931) it is probably an acclimatized exotic species, having been found in Buenos Aires and may have been introduced to France. Champion wrote, "It probably hibernates or aestivates under plane bark and may live on *Senecio erraticus* or *aquaticus* (Compositae)."

iii) *Desiantha* Pasc.

According to Marshall (1943), *Brexius* Pasc., 1870, is a synonym of *Desiantha* Pasc., 1870.

Desiantha maculata Blackb. was examined. The eighth tergite of the female has a serrated apical edge rather similar to that of *Phytotribus* (Fig. 222) and there is a faint ring of sclerotization in the wall of the rectum. Blackburn (1890) recorded *D. maculata* under bark, stones and rotten wood and

D. nigra/

D. nigra Blackb. from flood refuse. Lea (1899) recorded a species of Desiantha attacking vines. Pierce and Mitchel (1911) recorded D. caudata Pasc. on wheat. Champion (1902) was of the opinion that Desiantha had many affinities with the Cylindrorrhininae. According to Marshall (1931) D. praemorsa Lea should become Listroderes praemorsa (Lea) and to Kuschel (1955) Desiantha foveata Lea should become Listroderes foveatus (Lea) and Desiantha nociva Lea is synonymised with Listroderes obliqus Klug.

Discussion

The species of Anchodemus occur in North America, of Hyperodes in both North and South America and an introduced species in Europe, and of Desiantha in Australia and probably South America.

All three genera possess tibial spurs, an allegedly primitive character. A number of their characters resemble those of the Petalochilinae. Indeed Kuschel seems to have been greatly influenced by Bondar's theory that weevils on one type of food plant must be closely related and he has classed many of the palm-eating weevils in the Petalochilinae, although some of the genera are obviously not closely related to the others. This sub-family is fast becoming as heterogeneous as the Erirrhininae.

c) Genus transferred to the Hylobiinae/

3. Genus transferred to the Hylobiinae

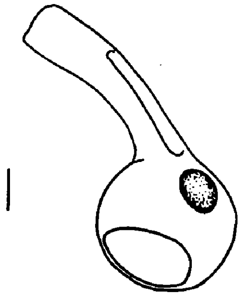
Opsittis Pasc.

Opsittis atomaria Pasc. was examined. As the rostrum is fairly short and very stout and the apex of the scrobes is readily visible when viewed from above (Fig. 223), and as the mandibles are strong and pincer-shaped (Fig. 224), this genus appears to belong to the Hylobiinae rather than the Erirrhininae. The antennae are stout, the funicle is 7-segmented and the club is unsegmented. The prosternum is slightly shorter than the pronotum and slightly emarginate. The femora are edentate and the tibiae mucronate, the third tarsal segment is bilobed, the last projecting beyond its lobes and bearing free simple claws. Stout styli are present in the female, the eighth tergite of which has a serrated apical edge (Fig. 225). The tegmen has a short strut and is complete dorsally. There are no wings. Lea (1910) described it as Sediantha, believing that it was closely related to Desiantha and wrote that it could be found under dry seaweed. It appears to be much more closely related to Plinthus with which Pascoe (1870) compared it in the original description of the genus.

PLATE I: Figs 193-207

193. Phycocoetes testaceus Lec., head
194. Derelomus bivirgatus Mshl., antenna
195. Phytotribus unicolor Boh., prothorax
196. Celetes binotatus Gyll., leg of female
197. Spermologus rufus Boh., leg of male
198. Phylltrox ater Champ., female genitalia
199. Phytotribus unicolor Boh., male genitalia
200. Phycocoetes testaceus Lec., male genitalia
201. Spermologus rufus Boh., female genitalia
202. Celetes binotatus Gyll, head of male
203. C. binotatus Gyll., head of female
204. C. binotatus Gyll., apex of tibia and tarsus of male
205. C. binotatus Gyll., mandible of male
206. C. binotatus Gyll., mandible of female
207. C. binotatus Gyll., labium

AB, AD, abductor and adductor tendons; C, coxa; RS, rectal sclerite; S, scrobe.



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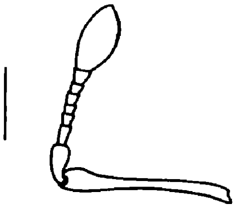

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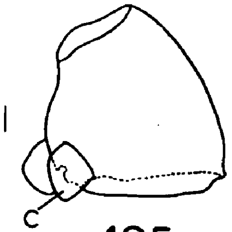

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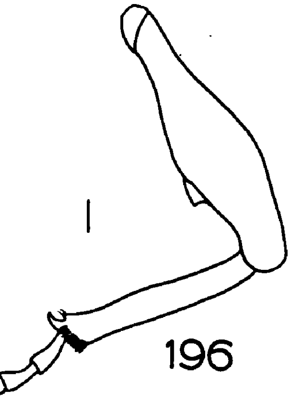

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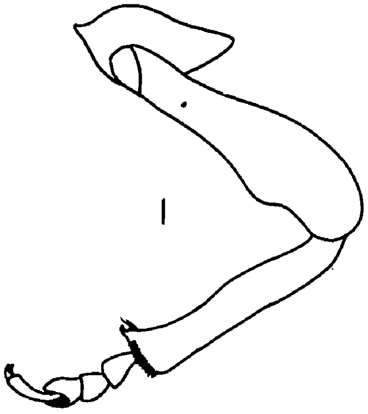

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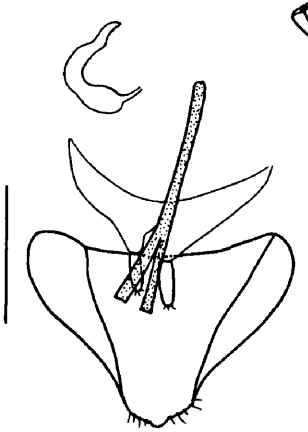

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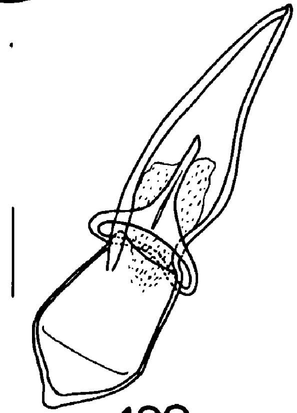

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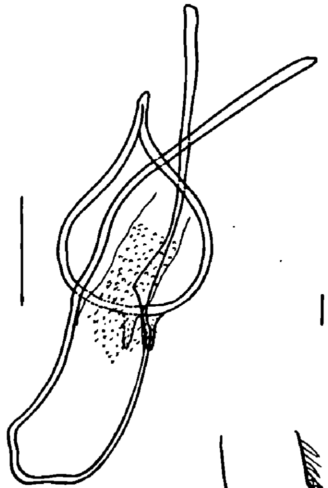

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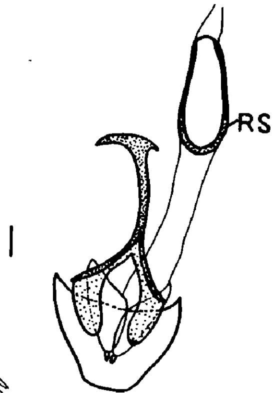

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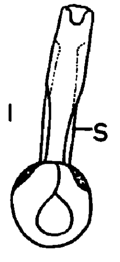

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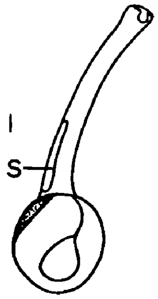

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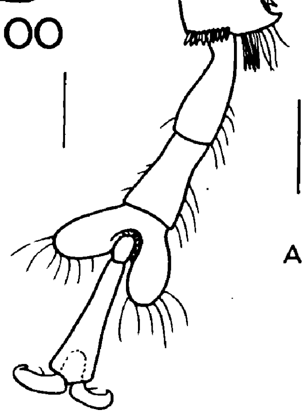

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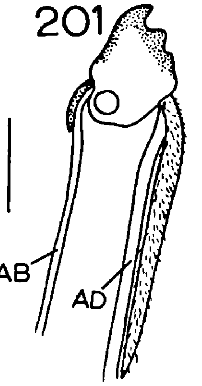

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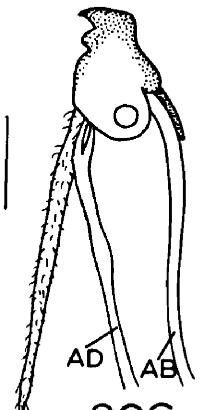

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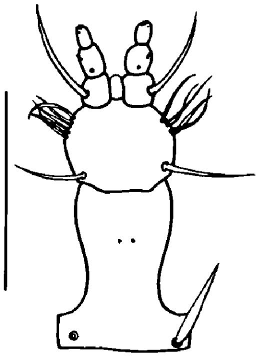
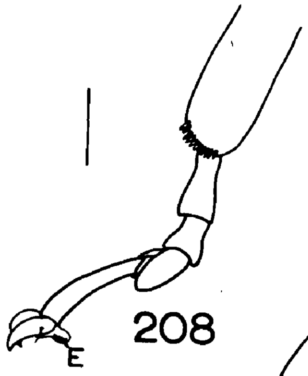


207

PLATE II: Figs 208-222

208. Phytotribus unicolor Boh., apex of tibia of male
209. P. unicolor Boh., apex of tibia of female
210. P. unicolor Boh., female genitalia
211. Phyllotrox ater Champ., antenna
212. P. ater Champ., maxilla
213. Derelomus bivirgatus Mshl., tergite 7 of male
214. Phycocoetes testaceus Lec., apex of tibia of male
215. Desiantha maculata Blackb., head
216. Hyperodes cyrtica (Desbr.), antenna
217. Anchodemus angustus Lec., leg
218. Hyperodes cyrtica (Desbr.), apex of tibia and tarsus
219. Desiantha maculata Blackb., apex of tibia and tarsus
220. Hyperodes cyrtica (Desbr.), female genitalia
221. Desiantha maculata Blackb., male genitalia
222. D. maculata Blackb., female genitalia

E, empodium; R, rectal sclerite; S, sclerite; T, tibial spur.



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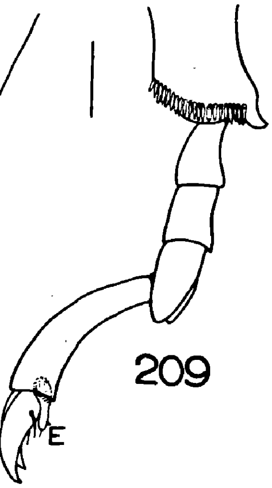

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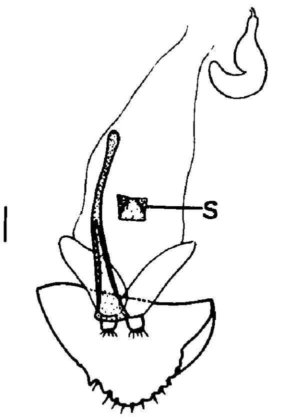

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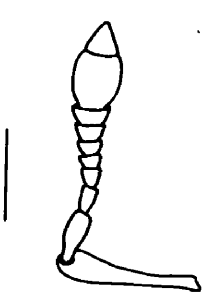

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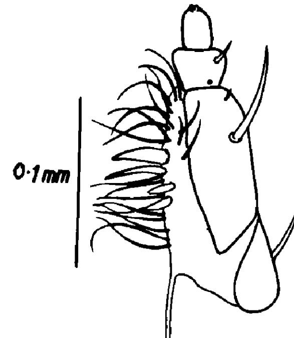

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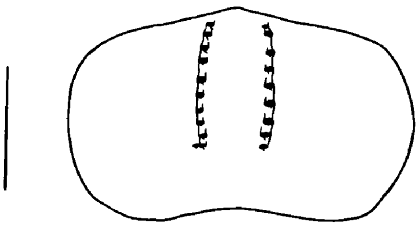

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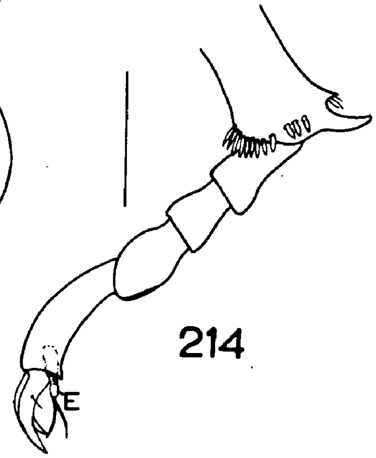

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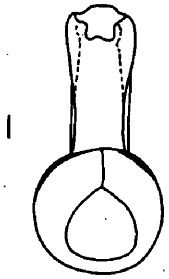

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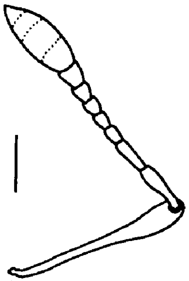

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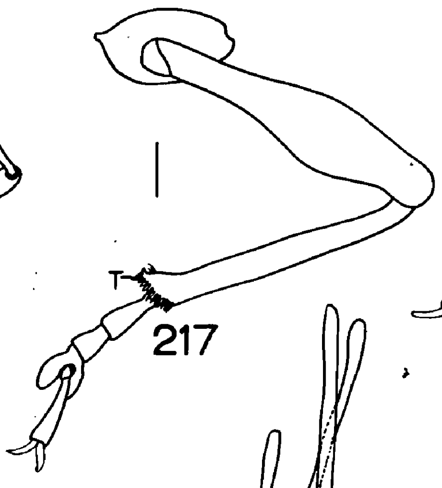

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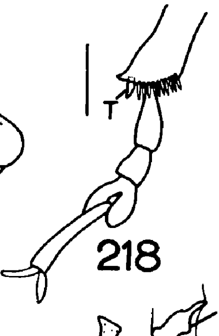

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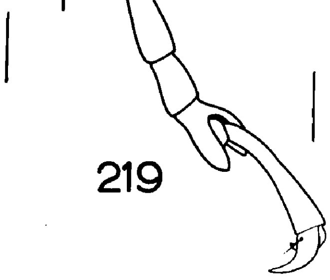

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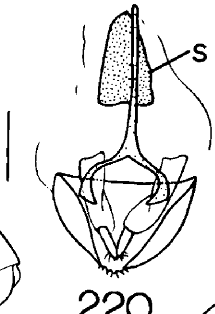

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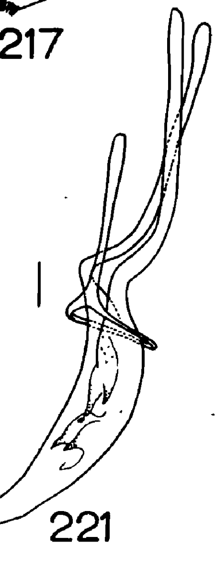

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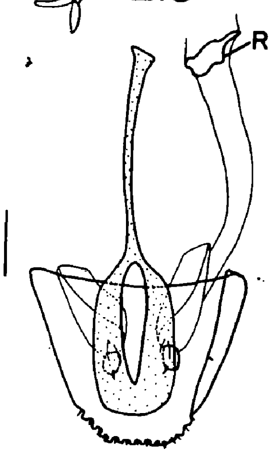


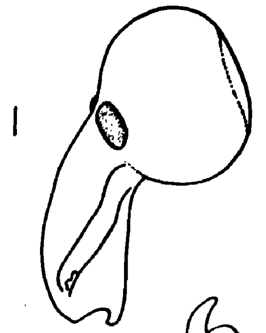
222

PLATE III: Figs 223-225

223. Opsittis atomaria Pasc., head

224. O. atomaria Pasc., mandible

225. O. atomaria Pasc., female genitalia



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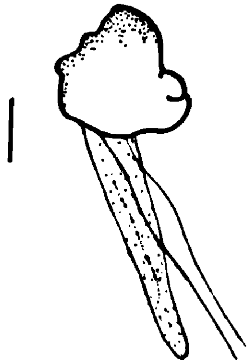

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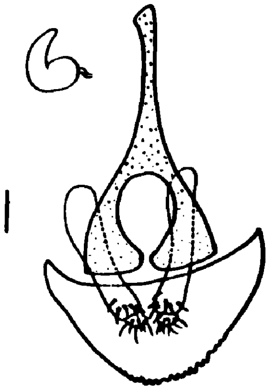


225

VI. THE SUB-FAMILY EUGNOMINAE

Introduction

Lacordaire (1863) separated the tribe Erirrhinides into five groups, one of which he named the Eugnomides. The eight genera which he included in this group possess the following characters which separate them from the genera of the other four. The head is elongate behind the eyes which are round and projecting and more or less distant from the prothorax, except in Phyllotrox and Brachonyx where the head is not elongate behind the eyes which are very small and almost contiguous to the prothorax. The tarsi are more or less broad with the third segment bilobed and the fourth projecting well beyond it. The posterior edge of the intermediate abdominal segments is straight and not curved or angled at the extremities.

Only four of the eight genera in Lacordaire's group Eugnomides are now included in the sub-family Eugnominae. These are Eugnomus, Stephanorrhynchus, Rhopalomerus and Meriphus. Brachonyx was transferred to the sub-family Anthonominae by Bedel (1884) and Phyllotrox to the sub-family Petalochilinae by Kuschel (1952). According to Lacordaire Ophthalmoborus closely resembles Phyllotrox. It may, therefore, also belong to the sub-family Petalochilinae, although Kuschel has made no reference to it. Hypselus appears to be more closely related to the aquatic and sub-aquatic genera of the tribe Erirrhinini than to the Eugnominae.

Lacordaire placed the genus Scolopterus, now included in the Eugnominae, in a separate tribe, the Scoloptérides, of which it was the sole member. As some of the Scolopterus species possess appendiculate tarsal claws, the tribe was described in a different section of the Synmérides from the tribe Erirrhinides.

Included in his list of genera of uncertain position are Ancistropterus, Hoplocneme, Macropoda and Omoides which are now considered to be members of the Eugnominae.

Faust (1885) united the Scoloptérides and the Eugnomides. He wrote that Lacordaire over-emphasised the importance of the structure of the claws and that as two of the three known species, Scolopterus tetracanthus White and S. penicillatus White, have free simple claws they should be included with the Eugnomides. S. bidens F. referred to as Nyxetes by Pascoe, is so closely related to the other two species that Faust considered that it too should be included in the Eugnomides.

In Junk's Coleopterorum Catalogus (Pars 140), and until 1936, the Eugnomini were always placed in a subdivision of the Erirrhininae.

Voss (1937) gave the Eugnominae sub-family status. In this and his previous paper (1936), he wrote "Most of the genera related to Scolopterus have large flexible maxillary palpi". In Eugnomus antennalis Broun, according to Voss, the maxillary/

maxillary palpi are reduced, their second segment being hardly longer than broad, but the palpi are still flexible. Voss wrote that here, to some extent, was proof that in Eugnomus there is a development from flexible to stiff maxillary palpi. Voss is wrong in regarding the palpi as flexible. According to the observations of Crowson (in litt.) on living Eugnomines in New Zealand, the maxillary palpi are not separately flexible but the entire maxilla has an unusual lateral flexibility.

Marshall (1937) defined the sub-family on a number of characters but did not use the shape of the palpi as he considered that they vary a fair amount in length and structure, especially in the genus Eugnomus, while in Pactola they are hardly longer than those of the normal Curculionid type. The characters which he used to define the Eugnominae exclude the genera Meriphus, Myossita and Orpha from the sub-family. Marshall suggested that a new sub-family, the Meriphinae, be erected to include them.

Although these three genera differ in many ways from other Eugnomines they also have many characters in common with them so that they cannot be regarded as a separate sub-family. I consider that the sub-family Eugnominae should be divided into two tribes, the Eugnomini and the Meriphini.

The distinguishing characters of the sub-family Eugnominae/

The distinguishing characters of the sub-family Eugnominae

The following definition of the sub-family includes some characters not previously mentioned in the literature, but is otherwise the definition Marshall used in 1937 modified so as to include the Meriphini.

The maxillae are variable in size and structure but the majority do appear to be strongly attenuate owing to the elongate second segment of the palpi and the narrowness of the lacinial region, e.g. Nyxetes (Fig. 226). The ligula of the labium is variable but usually well developed and slightly emarginate apically, e.g. Eugnomus and Meriphus (Figs 227-228). The rostrum is usually short and broad, e.g. Stephanorrhynchus and Eugnomus (Figs 229-230) but in some of the Meriphini, e.g. Meriphus and Myossita (Figs 231-232), it is fairly long and less broad. The head is elongate with the temples as long as or longer than the eyes which are more or less prominent. The antennal scrobes are oblique, turning rapidly downwards and continued on the lower side of the rostrum (Figs 229-232). The scape always extends beyond the front margin of the eye. The funiculus is long and slender, usually 7-, sometimes 6-, segmented. The club is loosely 3-segmented. With few exceptions, e.g. Pactolotypus, they are winged. The venation of larger species is usually well developed, e.g. Oreocalus (Fig. 233). The front coxae are conical, usually contiguous,

sometimes/

sometimes slightly separate. The posterior femora are toothed, usually strongly, e.g. Rhopalomerus and Pactola (Figs 234-235). In the Eugnomini the tibiae have no trace of a mucron in either sex (Figs 234-235) but in the Meriphini there is a small mucron on the tibia of the male, e.g. Myossita (Fig. 236). The third tarsal segment is deeply bilobed and the ultimate segment projects well beyond the lobes. The tarsal claws are various but never connate. The tegminal cap-piece of the aedeagus is bilobed, e.g. Pactola and Meriphus (Figs 237-238).

There are a number of characters in which the Eugnomini and the Meriphini differ. The rostrum tends to be short and stout in the Eugnomini, while it tends to be rather long and thinner in the Meriphini but there is a certain amount of overlap. In both tribes the female tibiae are amucronate at the apex but in the Meriphini the male tibiae have a small mucron at the internal angle. In the Eugnomini, the eighth tergite of the female is more or less pointed at the tip and usually curved, and well developed styli are always present, e.g. Oreocalus, Rhopalomerus, Tysius and Scolopterus (Figs 239-242, T8, S). It seems likely that this is connected with the length of the rostrum. The latter being short and stout would probably be unsuitable for digging an oviposition hole. This may be the function of the eighth tergite which certainly seems to be morphologically suited for the task. In the Meriphini, where the rostrum is longer/

longer, the eighth tergite of the female is similar to that of most other Curculionids. There are no styli, e.g. *Meriphus*, *Myossita* and *Udeus* (Figs 243-245, T8). Presumably in these genera the rostrum rather than the eighth tergite is used in making the hole for the eggs.

The larva of one genus, *Scolopterus penicillatus* White, was examined (Figs 246-252). There are five pairs of frontal setae but no endocarina and two distinct pairs of ocelli are visible in the later instars. Apart from the head, the only sclerotization is a small dorsal area of the prothorax. The pedal lobes, unlike those of the Erirrhine genus, *Grypidius*, bear six setae. Bicameral spiracles are found on the prothorax and segments one to eight of the abdomen.

1. Tribe Eugnomini

i) *Eugnomus* Schön.

Marshall (1937) writes that *Caenophanus* Broun and *Cyttalia* Pasc. are synonyms of *Eugnomus* Schön..

Eugnomus durvillei Schön. was examined and found to adhere in every point to the definition of the Eugnominae. Most of the species of this genus are to be found in New Zealand, but a number of those previously included in the genus *Cyttalia* are Australian and at least one species, *Eugnomus griseipila* (Pasc.) is alleged to occur both in New Zealand and in New South Wales.

ii) Goneumus Mshl.

This genus was erected by Marshall in 1937 to include Eugnomus bryobius Broun which differs from other Eugnomus species in that the antennal scrobes, although of the normal Eugnomus type anteriorly, soon gradually disappear and are not continued on the lower surface of the rostrum.

iii) Rhopalomerus Blanch.

Kuschel (1952) considers that Aneugnomus Mshl. (1937) is a synonym of Rhopalomerus Blanch. (1851). Although the species attributed to Rhopalomerus occur in Chile, while those attributed to Aneugnomus by Marshall are from New Zealand, Kuschel found that Rhopalomerus tenuirostris Blanch. scarcely differed in the slightest detail from Aneugnomus nubilans (Broun).

Rhopalomerus fasciatus (Broun) was examined and found to be typically Eugnomine in every character.

iv) Oreocalus Mshl.

This genus listed in the Coleopterorum Catalogus as Oreocharis Broun was renamed Oreocalus in 1943 when Broun's name was found to have been preoccupied. Oreocalus pullata (Broun) was examined and found to be typically Eugnomine. In this species the antennal funiculus is 6-jointed (Fig. 253). The eighth tergite of the female is very markedly "trowel-shaped" (Fig. 239).

v) *Nyxetes* Pasc.

Nyxetes bidens F. was examined and found to be typically Eugnomine. The antennal funiculus like that of *Oreocalus pullata* is 6-jointed. The elytra each bear a hollow cone-like projection (Fig. 254).

vi) *Scolopterus* White

Scolopterus tetracanthus White was examined. Like *Nyxetes bidens* there is a cone-like prolongation on each elytron (Fig. 255). The aedeagus differs from that of other genera studied in the possession of a transverse connecting band between the median lobe struts (Fig. 256, B). The eighth tergite of the female is heavily sclerotized, "trowel-shaped", and rather strongly bilobed at the tip (Fig. 242, T8).

vii) *Tysius* Pasc.

Tysius amplipennis Pasc. was examined and found to be typically Eugnomine. The median lobe of its aedeagus, however, is almost square and the tegminal strut is expanded and bilobed apically (Fig. 257, ML, TS). As in *Scolopterus tetracanthus*, the eighth tergite in the female is bilobed at the tip (Fig. 241, T8).

viii) *Ancistropterus* White

This genus is included by both Voss (1937) and Marshall (1937) in the Eugnominae and according to the former is closely related to *Scolopterus*.

ix) Amylopterus Broun

This genus is not mentioned in the Coleopterorum Catalogus but is included in the Eugnominae by Marshall (1937). Both he and Broun (1880) place it near Ancistropterus.

x) Icmalius Broun

Icmalius is not mentioned in the Coleopterorum Catalogus but is included in the Eugnominae by Marshall (1937). Both he and Broun (1880) placed it near Scolopterus and Ancistropterus.

xi) Gonoropterus Broun

This genus is not mentioned in the Coleopterorum Catalogus. According to Broun (1904) it is closely related to Ancistropterus from which it differs in the broader rostrum and the large depressed eyes. Marshall (1937) is of the opinion that Psuedancistropterus Voss is a synonym of Gonoropterus. Despite the fact that the front coxae are separate and the mesosternum is shallowly excavate to receive the rostrum, he includes this genus in the Eugnominae.

xii) Hoplocneme White

Hoplocneme forcipata Mshl. was examined and found to be a typical Eugnomine. In this species the median lobe of the aedeagus is strongly curved and the abdomen of the male is modified in that the seventh sternite and the eighth tergite fit very closely together (Fig. 258, ML, S7, T8). The female abdomen is normal.

xiii) Stephanorrhynchus White

Stephanorrhynchus attelaboides F. was examined. It differs in only one respect from the Eugnomine definition in that the tegminal cap-piece of the male genitalia is not bilobed but is unsclerotized behind (Fig. 259, T). In every other respect it is a true Eugnomine.

xiv) Callistomorphus Perroud

According to Perroud (1864) this genus is a member of the Eugnomides and should be placed near Stephanorrhynchus. From his description I have no doubt that this is correct.

xv) Pactola Pasc.

In the Coleopterorum Catalogus this genus is found in the Incertae Sedis at the end of the sub-family Erirrhininae. Voss (1936) included Pactola in the tribe Tachygonini because its maxillae are of the normal Curculionid type (Fig. 260) and the hind tibiae are strongly curved. Marshall (1937) repudiated this placing of the genus since, among other reasons, the tibiae are not mucronate at the tip. According to Marshall (1952) Pactola Pasc., 1876, is a synonym of Macropoda Montr., 1860, but as the latter name is preoccupied, Pactola stands and the Macropoda species which occur in New Caledonia must be transferred to it.

Pactola variabilis Pasc. was examined. Although the

maxillae/

maxillae are of the normal Curculionid type and the ligula of the labium is not emarginate (Fig. 261), it possesses all the other Eugnomine characters.

xvi) Stenopactola Broun

This genus is also found in the Incertae Sedis at the end of the Erirrhininae. According to Broun (1914) it is closely related to Pactola. Marshall (1937) included it in the sub-family Eugnominae and wrote that Parapactola Voss is a synonym of Stenopactola.

xvii) Pactolotypus Broun

This genus is not mentioned in the Coleopterorum Catalogus. It was erected by Broun in 1909 for a beetle from the Auckland Islands which, although similar to the species of Pactola, had a sufficient number of dissimilarities for it to be given generic status.

Marshall (1937) included it in the sub-family Eugnominae.

2. Tribe Meriphini

i) Meriphus Er.

Meriphus guttatus Pasc. was examined. The rostrum is longer than that of most Eugnominae and the epistome is produced over the mandibles (Fig. 231). These are strikingly toothed on the outer edge whereas the inner edge has a convex curve/

curve (Fig. 262). The tibiae are mucronate in the male though not in the female. The eighth tergite of the female has the normal Curculionid shape and there are no styli (Fig. 243). The maxillae, labium (Fig. 228), antennae, bilobed tegminal cap-piece, femora and female tibiae are very similar to those found in the Eugnomini, the tegmen in particular being very similar to that of <u>Pactola variabilis</u> (Figs 237-238).

ii) <u>Myossita</u> Pasc.

Myossita cirrifera Pasc. was examined. The head (Fig. 232), mandibles (Fig. 263) and female genitalia (Fig. 244) are similar to <u>Meriphus guttatus</u>. The maxillae are elongate, the femora toothed, the tegminal cap-piece bilobed and the tibiae mucronate only in the female (Fig. 236). The antennae (Fig. 264) are shorter and stouter than those of <u>Meriphus guttatus</u> or of any Eugnomini which I have seen. The ligula of the labium does not appear to be emarginate at the apex (Fig. 265, L) as it is in <u>Meriphus</u>.

iii) <u>Orpha</u> Pasc.

One specimen of <u>Orpha flavicornis</u> Pasc. was seen. The shape of the head, epistome and mandibles is similar to that of <u>Meriphus</u> and <u>Myossita</u>. Like the latter, the antennae are rather short with the segments of the club somewhat compact.

iv)/

iv) Udeus Champ.

Udeus eugnomides Champ. was examined. Like the three genera of the Meriphini described above, the rostrum is fairly long (Fig. 266), the tibiae are mucronate only in the male, the eighth tergite of the female is of the normal Curculionid type and the coxites have no styli (Fig. 245).

The maxillae are slender and elongate, the femora toothed and the tegminal cap-piece is bilobed. The epistome, however, is not produced over the mandibles which are toothed on the inner edge like those of the Eugnomini. The ligula of the labium is not well developed (Fig. 267) and the antennal funiculus is 6-jointed.

v) Omoides Boh.

In the "Coleopterorum Catalogus" this genus is classed with the Anthonominae. According to Kuschel (1952), however, it belongs to the Eugnominae. He wrote, "Omoides Boh. also possesses all the characters of the sub-family except for one which it shares with Udeus Champ., the sexual dimorphism which affects the tibiae of the male, producing a minute mucron." (My translation.)

3. Discussion

Very little has been recorded about the biology of the Eugnominae/

Table 7

Distribution of the genera of the Eugnomini and Meriphini

Genus	Distribution
EUGNOMINI	
Eugnomus	New Zealand, Australia
Goneumus	New Zealand
Rhopalomerus	New Zealand, Chile
Oreocalus	New Zealand
Nyxetes	New Zealand
Scolopterus	New Zealand, New Caledonia
Tysius	New Zealand
Ancistropterus	New Zealand
Amylopterus	New Zealand
Icmalius	New Zealand
Gonoropterus	New Zealand
Hoplocneme	New Zealand
Stephanorrhynchus	New Zealand
Callistomorphus	New Caledonia
Pactola	New Zealand, New Caledonia
Stenopactola	New Zealand
Pactolotypus	Auckland Islands
MERIPHINI	
Meriphus	Australia
Myositta	Australia
Orpha	Australia
Udeus	Central America
Omoides	Chile

Eugnominae. Lea (1899) reared Myossita carpophaga from the cones of Banksia. According to Crowson (in litt.) the larvae of a number of the genera live in the dead branches of woody plants and the adults are commonly beaten from flowering shrubs and herbs. Larvae of Scolopterus penicillatus White and Rhopalomerus fervidus Pasc. were respectively found in a dead branch of Nothopanax (Araliaceae) and in a rotten Rimu log (Coniferae).

As a well developed bilobed ligula is characteristic of flower-frequenting beetles, the adults are probably mainly nectar feeders. Crowson observed the adults feeding on a sugar solution and noted that the maxillae have a wide lateral sweep but the palpi do not move on the stipes.

As can be seen in Table 7 opposite, the majority of the genera belonging to the Eugnomini are endemic to New Zealand. There are, however, a few exceptions. Some of the species of Eugnomus are Australian and one species is alleged to be found in both countries. Pactola and Scolopterus species may be found in New Zealand or New Caledonia and Rhopalomerus species may be found in New Zealand or Chile, R. nubilans apparently being found in both countries. Pactolotypus species are found in the Auckland Islands and Callistomorphus species in New Caledonia.

Apparently no genera belonging to the Meriphini have been found/

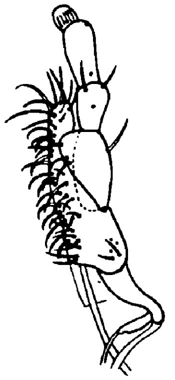
found in New Zealand. *Meriphus*, *Myossita* and *Orpha* are Australian and are very closely related. *Udeus* and *Omoides*, found in Central America and Chile respectively, are less closely related to the three previously described genera than to each other.

Of the twenty-three genera listed in this paper as belonging to the sub-family Eugnominae, three can be found in the Neotropical region and twenty-one in the Australasian region, species of one genus being found in both regions.

PLATE I: Figs 226-235

226. *Nyxetes bidens* F., maxilla
227. *Eugnomus durvillei* Schön., labium
228. *Meriphus guttatus* Pasc., labium
229. *Stephanorrhynchus attelaboides* F., head
230. *Eugnomus durvillei* Schön., head
231. *Meriphus guttatus* Pasc., head
232. *Myossita cirrifera* Pasc., head
233. *Oreocalus pullata* (Broun), wing
234. *Rhopalomerus tenuirostris* Blanch., leg
235. *Pactola variabilis* Pasc., leg

H, hypopharynx; L, ligula



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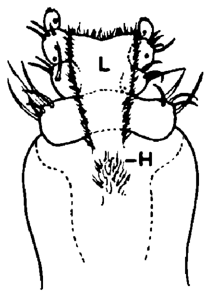

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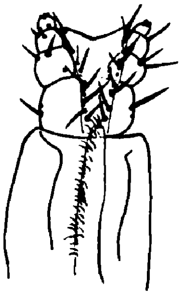

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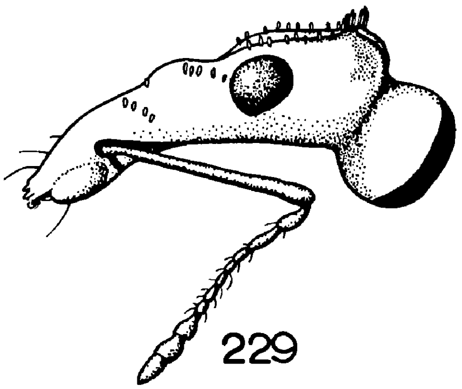

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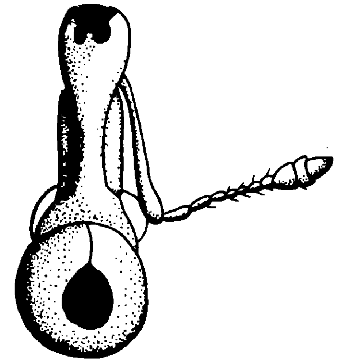

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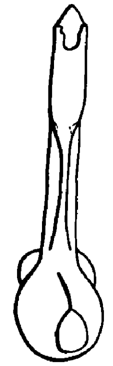

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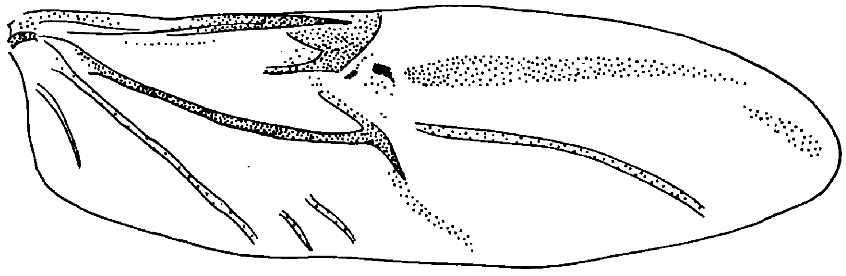

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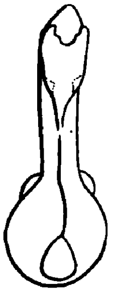

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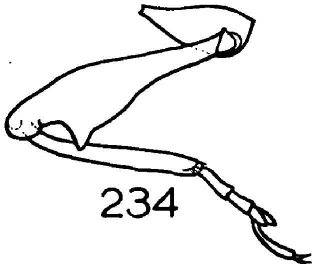

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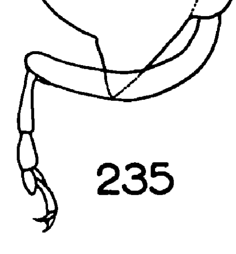

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PLATE II: Figs 236-245

236. Myossita cirrifera Pasc., leg

237. Pactola variabilis Pasc., male genitalia

238. Meriphus guttatus Pasc., male genitalia

239. Oreocalus pullata (Broun), tergite 8 of female

240. Rhopalomerus tenuirostris Blanch., female genitalia

241. Tysius amplipennis Pasc., female genitalia

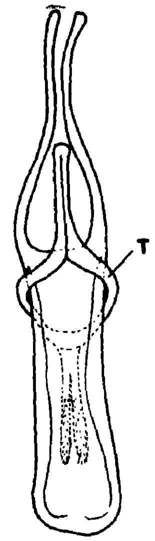
242. Scolopterus tetracanthus White, female genitalia

243. Meriphus guttatus Pasc., female genitalia

244. Myossita cirrifera Pasc., female genitalia

245. Udeus eugnomides Champ., female genitalia

C, coxite; S, stylus; T, tegmen; T8, tergite 8.



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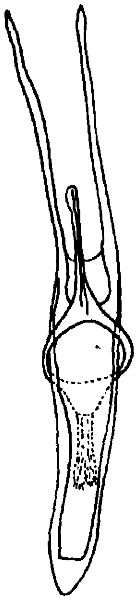

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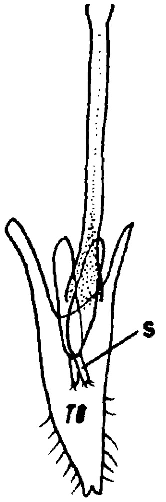

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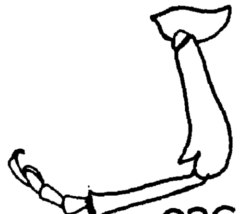

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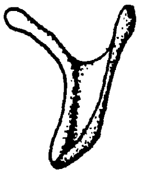

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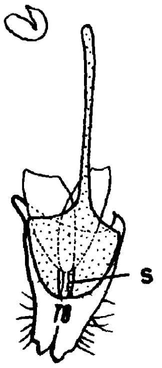

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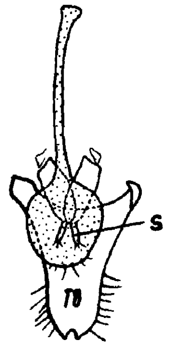

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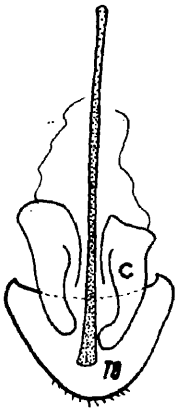

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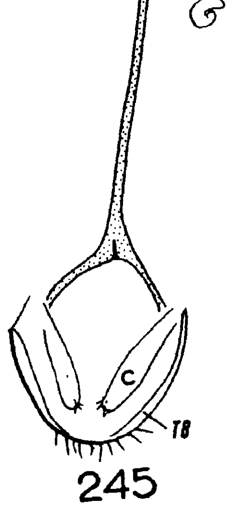

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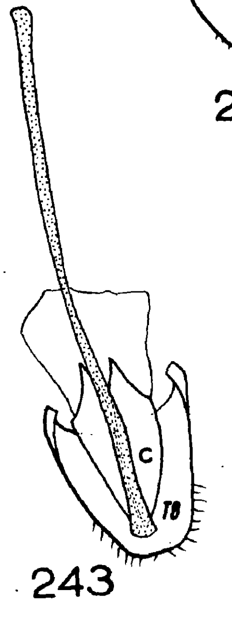

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PLATE III: Figs 246-252

Scolopterus penicillatus White

246. Thorax and abdomen of larva

247. Spiracle

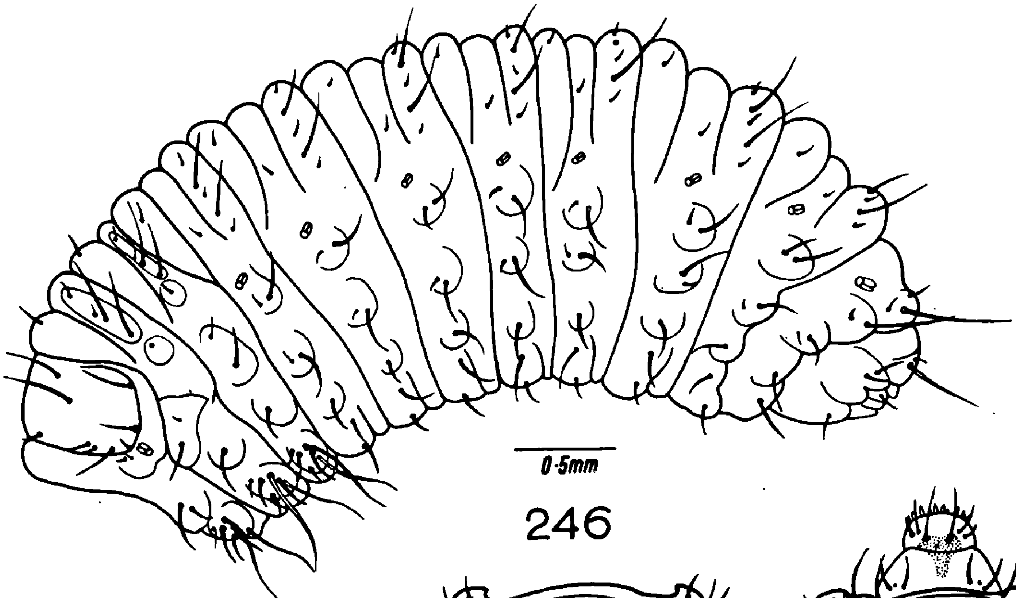
248. Head capsule, ventral view

249. Head capsule, dorsal view

250. Maxillae and labium

251. Epipharynx

252. Mandible



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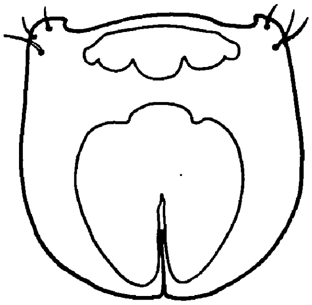

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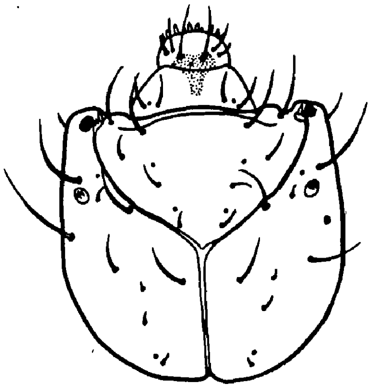

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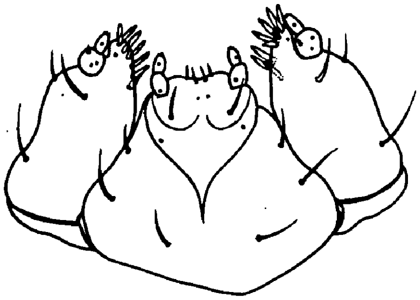

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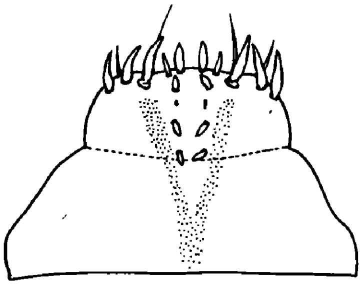

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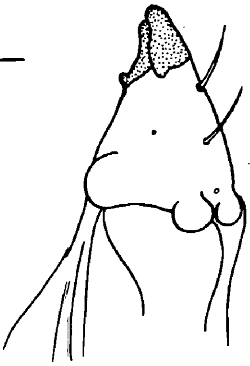

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PLATE IV: Figs 253-267

253. *Oreocalus pullata* (Broun), antenna

254. *Nyxetes bidens* F., elytron

255. *Scolopterus tetracanthus* White, elytron

256. *S. tetracanthus* White, male genitalia

257. *Tysius amplipennis* Pasc., male genitalia

258. *Hoplocneme forcipata* Mshl., abdomen and genitalia of male

259. *Stephanorrhynchus attelaboides* F., male genitalia

260. *Pactola variabilis* Pasc., maxilla

261. *P. variabilis* Pasc., labium

262. *Meriphus guttatus* Pasc., mandible

263. *Myossita cirrifera* Pasc., mandible

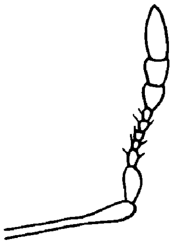
264. *M. cirrifera* Pasc., antenna

265. *M. cirrifera* Pasc., labium, side view

266. *Udeus eugnomides* Champ., head

267. *U. eugnomides* Champ., labium

B, bridge; L, ligula; M, median tendon; ML, median lobe; S7, sternite 7; T, tegmen; T8, tergite 8; TS, tegminal strut.



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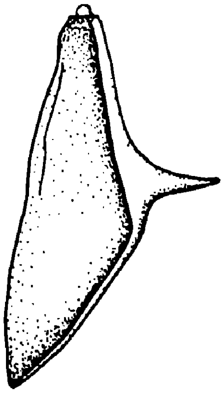

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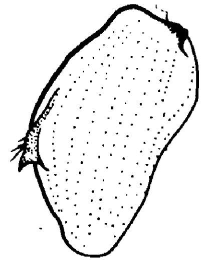

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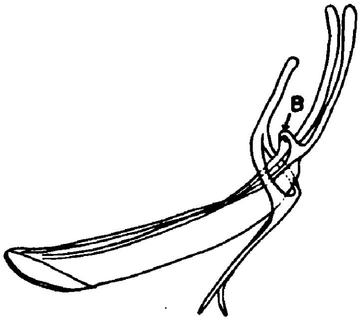

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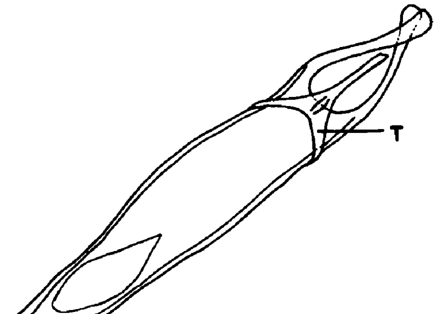

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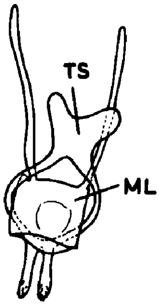

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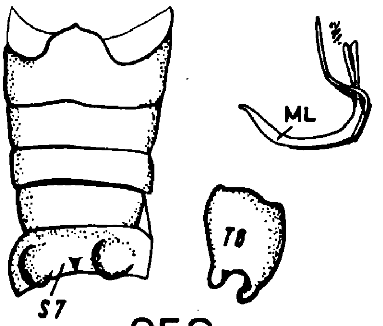

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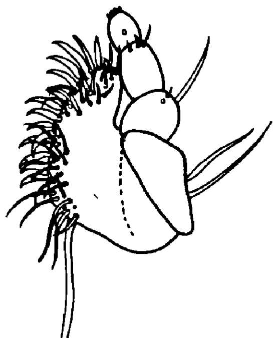

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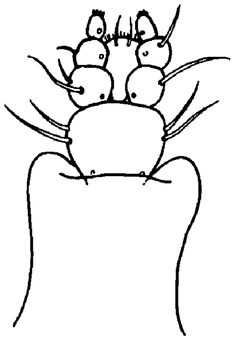

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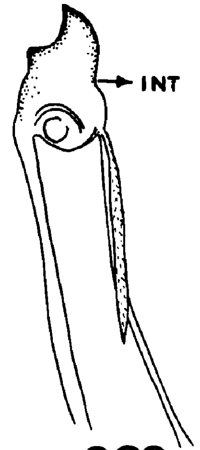

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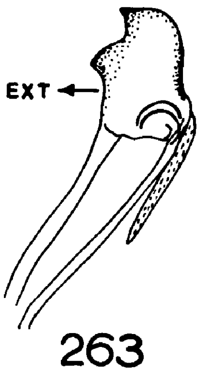

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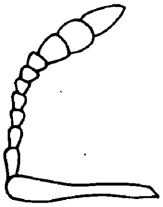

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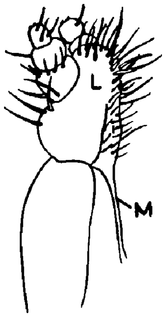

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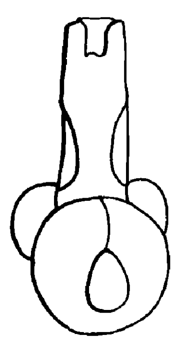

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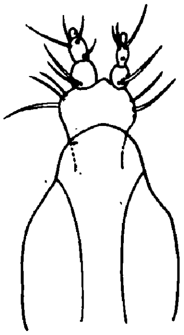

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VII. GENERA INCORRECTLY PLACED IN THE EUGNOMINE SECTION OF JUNK'S COLEOPTERORUM CATALOGUS

i) *Hypselus* Schön.

Hypselus ater Boh. was examined. Its rostrum is curved and rather long, the femora are not toothed and the tibiae are strongly hooked at the apex in both sexes.

Hypselus species are found on aquatic plants in South America and are probably most closely related to the aquatic and semi-aquatic members of the sub-tribe Erirrhinini. As in these genera, there is an unusually large tegminal cap-piece which is as broad and long as the aedeagus and bilobed only at the tip which has long sensitive setae.

ii) *Phrenozemia* Pasc.

Lea (1918) wrote, "The genus looks out of place in the Erirrhinides and more as if it should be associated with *Medicasta* and *Acalonoma* or it possibly may be distantly related to *Desiantha* or *Omorphius*." Marshall (1937) was of the opinion that it belonged to the Erirrhininae.

One specimen of *Phrenozemia lyproides* Pasc. was seen. The antennal club is compact and not clearly segmented. The femora are not toothed and the tibiae are all mucronate at the apex. This genus is Australian.

iii)/

iii) *Ophthalmoborus* Schön.

Its single species, *Ophthalmoborus testaceus* F., is from South America. Lacordaire (1863) wrote of it, "The rostrum is two and a half times as long as the head, filiform and strongly curved. The antennae are very short, the scape suddenly thickening at the apex, and the club well developed, oval and feebly segmented. The eyes are large, round and projecting, the femora slightly club-shaped, the tibiae slender and unarmed at the apex and the third tarsal segment rather short. Apart from the more elongate form of the head, the longer rostrum and the different proportions of the joints of the funiculus, it is very closely related to *Phyllotrox*." (My translation.)

In none of the Eugnominae which I have seen was the rostrum filiform and strongly curved. The antennae in this sub-family are usually fairly long and slender, the clubs distinctly segmented and the femora dentate. Marshall (1937) wrote of *Ophthalmoborus* that the form of the scrobes appears to exclude it from the Eugnominae as they begin only at the middle of the rostrum and continue laterally up to the eyes.

iv) *Oropterus* White

According to Marshall (1937) *Oropterus* should be transferred from the Eugnominae to the Anthonominae.

Oropterus corniger/

Oropterus corniger White was examined. At a quick glance, it resembles Nyxetes bidens owing to the colour, the lack of scales, and the unusual, large cone-like projection on each elytron. In almost every other character, it differs markedly from the Eugnominae. The rostrum is long, the maxillae are the normal Curculionid type, the eyes are large and flat, the tibiae are strongly hooked at the apex and there is no bilobed tegminal cap-piece. This species comes from New Zealand.

v) Acanthopterus Faust

Faust (1889) erected the genus Acanthopterus for a species which Montrouzier (1860) had described as Trachodes? penicillatus. Montrouzier wrote of it, "This species may form a new genus neighbouring Myorhinus and Tanyrhynchus. It recalls by its general form and above all by the elytral spines, the genus Scolopterus White." (My translation.)

Faust included it in the Eugnominae and wrote, "It is similar in habit to Oropterus but differs from it, principally in the fused first two abdominal segments, the strongly developed ocular lobes and the free claws." (My translation.)

Heller (1916) described a new species, Acanthopterus inermis from New Caledonia. In this species the eyes are contiguous with the prothorax, ocular lobes are present, the scrobes begin near the middle of the rostrum and the femora are not toothed.

From these descriptions I conclude that Acanthopterus is not a member of the Eugnominae.

vi)/

vi) Tithene Pasc.

One specimen of Tithene vittata Voss was seen. The rostrum is long and flattened, particularly so at the apex. The eyes are large and flat, and the prothorax is very large, somewhat triangular in shape and depressed. The elytra are truncate and the pygidium is exposed. The anterior femora are largest and strongly toothed, the mid- and hind-femora smaller, with rather small teeth and none of the tibiae are mucronate.

Voss (1940) gave a list of new members of the sub-family Tripetini collected in Java and described Tithene (Hypotithene) barbirostris as one.

vii) Thechia Pasc.

According to Lea (1899, 1927a) this genus is closely related to Misophrice Pasc.. Thechia pygmaea Pasc. was seen. The femora are not toothed, the tibiae are mucronate at the apex and the tarsi are apparently 3-segmented. The third segment is not strongly bilobed at the apex. Thechia species are found in Australia.

viii) Cratoscelocis Lea

Lea (1927a) wrote in his description of the genus, "The rostrum is rather long and thin. The front coxae are moderately separate, the femora edentate, the tibiae short and stout, terminated by an obtuse hook and the tarsi are apparently 3-segmented/

3-segmented, the fourth segment being vestigial. It is probably closely related to Thechia." Cratoscelocis foveicollis Lea is found in New South Wales.

VIII. OBSERVATIONS ON THE BIOLOGY OF SOME BRITISH WEEVILS

1. Introduction.

The biology of a number of genera of the Curculionidae was studied and the first instar larvae of several of them were obtained. Only two of these genera, Dorytomus and Grypidius, belong to the Erirrhininae. If it had been possible to study the biology of more members of this sub-family, the results obtained would have been discussed with the taxonomy, the biology providing a number of taxonomic characters. As it is, however, their biology is considered with that of the other genera studied, which belong to various sub-families of the Curculionidae.

The biological studies were made between 1954 and 1956, and the majority in 1955 in which the months of July and August were exceptional. In Scotland, July had almost twice the amount of sunshine it has in an average year. With the exception of 1947, it was the driest August since 1880. The temperature was above average in both months, by 3.6°F. in July and 4.0°F. in August.

The genera are arranged in the order which Fowler (1891) used in his classification of the British Curculionidae.

2. Genera studied

i) Cleonus piger Scopoli

Cleonus piger Scopoli is the largest as well as one of the commonest/

commonest of the weevils which are found in the Nature Reserve at Aberlady Bay (East Lothian). In 1891 Fowler, who called it Cleonus sulcirostris L., wrote of its distribution, "On various species of thistles local but often common where found; it appears to be chiefly but not altogether confined to districts near the coast......Scotland maritime, rare, Forth district."

In 1921 Beare wrote that on May 8th of that year, hundreds of Cleonus piger were found on the sand at Gullane, near Aberlady Bay, where in 1955, Crowson again found it very common.

On April 20th, 1956, numerous adults were found in this locality. Their remarkable tracks criss-crossed many of the dunes. These are of two distinct patterns, one formed when the weevil is travelling up and the other downhill (Photographs 4, 5). The tracks may be of use in ecological studies since bird tracks were also found close to those of the weevils.

On April 20th, only a few young shoots of the thistle, Cirsium arvense L., were visible among last years withered stems. By May 30th, however, the dunes were covered with young thistle plants, the stems of a number of which were swollen just below or occasionally just at ground level (Photographs 6, 7). When these stems were examined, first, second and third instar larvae were found within. Few adults were found on this occasion.

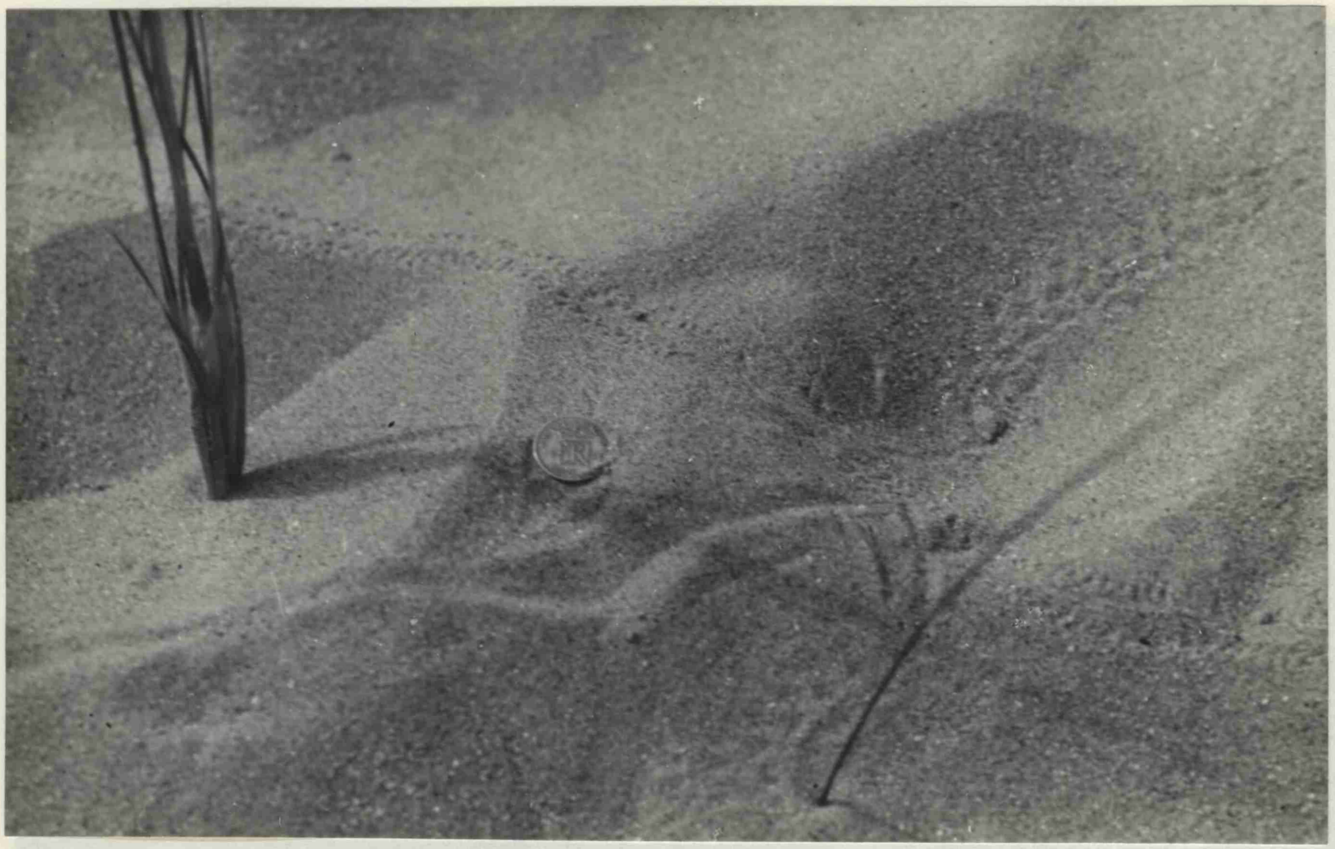


Photo. 4. Tracks of *Cleonus piger* Scopoli

Downhill track from top right to centre.

Uphill track from bottom right to top left.

Photo. 5. Tracks of Cleonus piger Scopoli

Downhill track from top right to centre.

Uphill track from centre to top left.

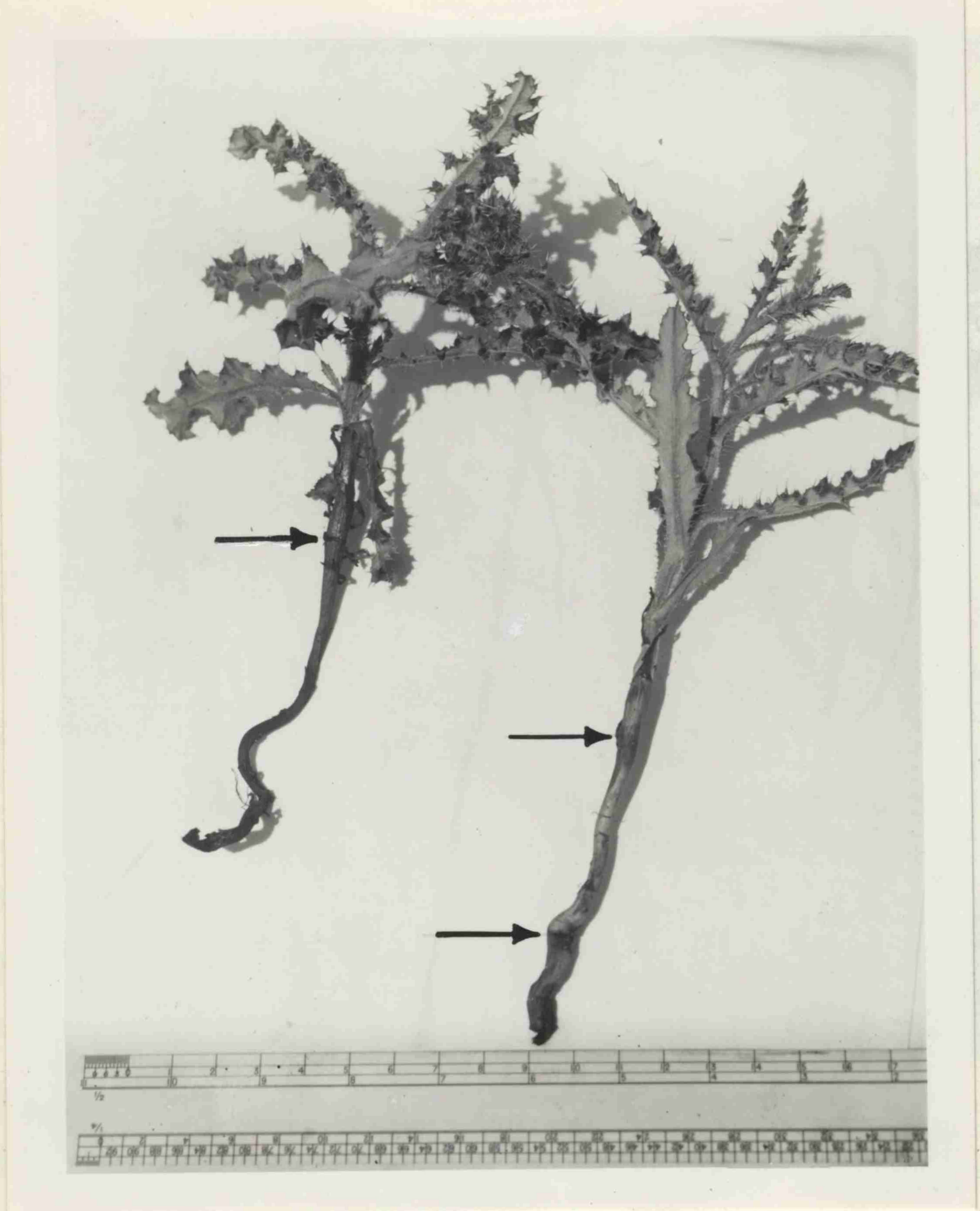


Photo. 6. <u>Cirsium arvense</u> with swellings caused by larvae of <u>Cleonus piger.</u>

Plant on right with 2 swellings (indicated by arrows), plant on left with 1 swelling.

Photo. 7. <u>Cirsium arvense</u> with swellings caused by larvae of <u>Cleonus piger</u>.

Plant on right with 1 swelling,plant on left with 2 swellings the uppermost of which contained 2 larvae.

On July 10th, no adults were found on the dunes at Aberlady Bay but larvae of all instars and a few pupae were found in the Cirsium arvense stems.

On September 6th of the previous year, Crowson found one larva and several pupae in the thistle stems. Many of the new adults had emerged and were very common on the dunes.

Another species of thistle, Carduus tenuiflorus Curt., also grows at Aberlady, behind the dunes and several hundred yards from the sea. Cleonus piger was not found on this species of thistle at Aberlady and although a few Cirsium arvense plants also grew in this vicinity, neither the weevil nor its tracks were found so far from the sea.

Several adult Cleonus piger were kept in cages in the laboratory from April 21st until June 15th. Breffit jars, their tops covered with boulting silk, were used as cages. They contained 1 to 1½ inches of sand into which a number of thistle bases were placed. Water and fresh thistle leaves were supplied when necessary. The beetles usually started to feed either at the edge of the leaves or on one of the lesser veins and ate steadily until only the mid-rib remained. Their strong mandibles tore out quite large areas of the leaf at each bite and their feeding was distinctly audible.

Copulations were frequent and often lasted more than an hour.

One or more eggs were laid in the laboratory almost every day from the 21st of April until late May. Then laying became less frequent until it ceased just before mid-June.

On several occasions a female was observed digging a hole in the sand at the base of a thistle stem. Using the rostrum, a deep hole was made in the sand. In order to make this, the female sometimes held on to the thistle stem with her two hind pairs of legs so that she was almost vertical to the ground on which her prothoracic legs rested. She sometimes remained in this position for more than a quarter of an hour, turning her rostrum from side to side in the hole, probably compacting the walls. Eventually she would come on to the sand and feel the opening with the tip of her abdomen. She now either laid an egg or again climbed on to the stem and probed the hole with her rostrum. After the egg was laid, sand was pushed into the hole on top of it. The female then pressed and smoothed the sand in the vicinity of the hole before leaving the site. Thus the eggs of *Cleonus piger* are usually to be found near or against the thistle plant a centimetre or more below ground level. Occasionally they are found in shallow excavations in the plant at this level but there is often a thin layer of sand between the egg and the plant.

After being kept for a week or two in the laboratory, however, the beetles would very often lay eggs on the surface of the/

the sand or on the walls of the cage. They appear to lay the eggs singly rather than in batches.

The eggs vary in colour from pale yellow to a dull orange. The length varied from 1.5 mm. to 1.9 mm., the average being 1.7 mm. and the breadth varied from 1.15 mm. to 1.31 mm., the average width being 1.18 mm..

Towards the end of the seventh day after laying, the larval head capsule became visible within the egg membrane. Hatching could take place on the eighth day after laying, but might be delayed until the ninth or tenth day or later, especially towards the end of the laying season, i.e. from mid-May. Before hatching, the larva could be seen moving vigorously and opening and closing its mandibles in an effort to escape as there are no egg-bursters in this species (Figs 268-272). On hatching, the larva left the egg membrane and made for the nearest thistle stem which it then entered. In the field rarely more than two larvae survived in each stem and more commonly only one was present.

By the time the larva reaches second instar, a distinct swelling can usually be seen at the base of the thistle just below ground level. Within the cavity of the swelling, the rest of the larval life is spent and pupation takes place.

On July 10th, 80 thistle stems were collected in the <u>Cleonus</u> inhabited part of Aberlady dunes. Of these, 16 showed no trace of/

of attack by Cleonus, 24 contained dead larvae or what appeared to be traces of very young larvae, the remaining 40 contained live larvae or in two cases, pupae. Plants in flower were never found to contain live larvae but well developed larvae could be found in both healthy or stunted non-flowering plants. When two larvae were found in the one plant they were usually in two swellings, separated by a short region of normal plant tissue. In only one shoot were three larvae discovered. In this case two were found in one swelling and the third in a separate one some way below (Photograph 7). Four larvae were found to have been parasitized, two by Dipterous larvae and two by Nematodes.

From a measurement of head capsule widths of these specimens there appear to be four instars present. The smallest ones agreed in head capsule width with the first instar larvae hatched from the eggs.

The average width of the head capsule in the first instar was 0.86 mm., in the second 1.24 mm., in the third 1.70 mm., and in the fourth 2.39 mm..

The ratio of head capsule widths in succeeding instars was calculated and the following results obtained.

$$\frac{1.24}{0.86} = 1.44 \qquad \frac{1.70}{1.24} = 1.37 \qquad \frac{2.39}{1.70} = 1.41$$

The/

Table 8

Instars	No. measured	Minimum head width	Maximum head width	Ratio max./min.	Head width of majority	Average head width
1	36	0.77 mm.	0.92 mm.	1.19	0.85 mm.	0.86 mm.
2	21	1.08 mm.	1.31 mm.	1.21	1.31 mm.	1.24 mm.
3	9	1.54 mm.	1.93 mm.	1.25	1.62 mm.	1.70 mm.
4	21	2.16 mm.	2.62 mm.	1.21	2.46 mm.	2.39 mm.

The measurements of the larval head widths are summarized in Table 8 opposite.

ii) Liosoma deflexum (Panz.)

This species, which Fowler in his work "The Coleoptera of the British Islands", 1891, referred to as Liosoma ovatulum Clairv., was probably more common in Scotland than he realized at that time. It is very common around Glasgow from April until August. One specimen of the variety collaris Rye was found in flood drift on November 2nd, 1954. Although most frequently found on Ranunculus repens L., large numbers have also been found on Ranunculus ficaria L. and Anemone nemorosa L..

Adults caged on a potted plant of R. repens on June 8th, 1955, had laid three eggs by June 24th. They were found in excavation in three different runners. When the larvae hatched they did not eat the egg membrane, but began to mine the runners. On July 15th, several larvae of various instars were found in a number of R. repens plants at Rossdhu (Dúnbartonshire). One was mining a runner, but the others were found in mines at the base of the stem just above the roots. The average width of the head capsule of five first instar larvae was 0.31 mm. and that of four second instar larvae was 0.39 mm..

iii) Dorytomus taeniatus (F.)

The adults, which Fowler referred to as Dorytomus maculatus (Marsh.)/

(Marsh.) are very common in Central Scotland between the end of March and the beginning of May and from June until July; the weevils found in the last two months probably belonging to the newly emerged generation. One adult was found in October hibernating under moss. They were found on both male and female trees of Salix cinerea L.. Adults in captivity were seen to eat young leaves, catkin stalks, the pollen of the male catkins and the ovaries of the female catkins.

Two newly mated pairs were caged on a female willow on April 14th, 1955. Fifteen days later three eggs were found, each in a shallow excavation amongst the lowest pistils, at the base of three separate catkins. They were not completely protected by a covering of plant tissue. On hatching, the larvae did not eat the egg membrane, but at once began to tunnel either into the stem of the catkin or into a nearby pistil. Within the latter they consumed the ovule, leaving behind small dark particles of frass. In five or six days the larvae had usually moulted. One of these second instar larvae was found in a large cavity in a catkin stem and many of the neighbouring ovules had been consumed. The average width of the head capsule of eight first instar larvae was 0.35 mm. and that of two second instar larvae 0.49 mm.

iv) Grypidius equiseti F.

Distribution/

Distribution

Locations for Grypidius equiseti given in Junk's Coleopterorum Catalogus (Klima, 1934) are Central Europe, Siberia and North America. According to Hustache (1930) it is common throughout France. Fowler (1891) wrote, "It is rarely common but apparently widely and generally distributed throughout England and Wales........Scotland local, Solway and Forth districts." I have found it at four different localities within Glasgow city boundary, and there are also unpublished records of its occurrence at Barr and Ayr (Ayrshire) and Crookston (Renfrewshire) in the note-books of Fergusson and Stevens in Glasgow University Library.

Habits

I have not seen it fly nor could I induce it to do so even by raising the temperature to 74° and placing several adults on an unsuitable plant, Chamaenerion (= Epilobium) angustifolium (L.), or by shaking them off a fairly high plant. Instead of releasing their wings they drew in their appendages and were in consequence undamaged by the fall. The elytra of dead specimens are opened with difficulty and the wings are weakly veined (Fig. 273). It appears that the weevils do not fly in this area unless during a very short interval after emergence from the pupa, and that the means of dispersal is walking.

Miss Jackson (1933) found that in the north of Scotland there/

there was a much greater proportion of the flightless to normal forms of the weevil, *Sitona hispidula*, than occurs further south. My observations appear to have been made near the northern limit of the British distribution of *G. equiseti* and it would not be safe to conclude from them that it is flightless throughout its entire range.

Bargagli (1884) wrote of *G. equiseti*, "Fabricio states that it is found in England on *Equisetum arvense* L., and in Scandi:navia. Zetterstedt says it can be found under stones, in low grass, in dry sandy regions in May and June. In Sweden the same author says it is common on *E. arvense*. In Austria it lives on damp grasses. In northern Italy it has been seen on *E. palustra* L.. Priazolli has seen it on *E. vernale* on river banks in the Alps." (My translation.) The latter species could not be traced but is probably a synonym of *E. arvense*. Fowler (1891) and Hustache (1930) say that it is to be found on *E. arvense* and *E. palustre*.

On extensive areas of *E. fluviatile* L. at Possil Marsh (Glasgow) and *E. sylvaticum* L. at Mugdock Wood (Dunbartonshire), no trace of *Grypidius* nor its characteristic feeding scars was found. The stem of these species, especially the former, is probably too thin to provide feeding space for the larvae.

When the adults were given a choice of *arvense* or *sylvaticum* they both fed on and oviposited in the *sylvaticum*, but to a much smaller extent than *arvense*.

E. hyemale L. (Kelvingrove, Glasgow) and E. pratense Ehrh. (Falls of Clyde, Lanarkshire and Saffron Walden, Essex) were examined but neither Grypidius nor its feeding scars were found. When it was given a choice of hyemale or pratense, and arvense its feeding was largely, and its oviposition entirely, restricted to the last mentioned species.

Thus it seems that Grypidius is not only unable to fly but, in addition, is confined to two species of Equisetum. Although Equisetum on roadsides is subject to frequent scything, this need not annihilate the weevil. Only eggs and larvae still in the aerial shoots will die at each felling. But, as there is a long oviposition period in the field and plants are rarely cut down before mid- or late summer, some of the larvae will probably have already penetrated the rhizome safely below ground.

Fergusson's earliest record of Grypidius is of one specimen found at Barr (Ayrshire) on April 14th, his latest an unspecified date in July. On May 29th, I found numerous adults in the University grounds, and the last adult was found on July 30th. It is probable that adults could still have been found in the field after that date as five survived in the laboratory until October 22nd.

Behaviour of adults

The Equisetales support few phytophagous insects, no doubt owing to the deposit of silica in the epidermis which makes it abrasive to most insect mouth parts. Grypidius, however, has strongly/

strongly pointed mandibles which enable it to break through the armoured layer to the succulent underlying vessels. While feeding on the vascular tissue a small area round the tip of the rostrum becomes slightly brown.

When old Equisetum stems were being removed from the cage, a weevil occasionally dropped off and lay motionless with legs and antennae flexed in towards the body. This state of reflex immobility was so readily induced that I tried an experiment similar to that of Fabre's on Scarites gigas. Immobility was induced by dropping the beetle from a height of about 5 cm. on to its back. This could last from twenty seconds to over a minute, then the beetle began to recover. This process was so slow, however, that it might be seven minutes before the beetle eventually turned over and moved away. In a fairly typical case the initial immobility lasted fifty seconds, then the mandibles opened and closed. After another seventy seconds, they moved again. After ten seconds more, the tarsus of the left mesothoracic leg and then the whole of one of the metathoracic legs flexed; twenty-five seconds later the antennae quivered. A further fifty seconds of immobility ensued, then the other metathoracic leg and the mouth parts moved; thirty seconds later all the legs flexed and antennae and mouth parts quivered, and sixty seconds later the tarsi quivered slightly. Then after forty seconds all the legs flexed, and thirty seconds later/

later they were kicked violently and the beetle turned over, fully recovered, after a total time of six minutes five seconds.

Fabre found that when he immobilized Scarites gigas immediately on its recovery, it took successively longer periods to recover but eventually could not be induced to lie still. Grypidius, however, took successively shorter periods to recover, as can be seen from the two typical series below.

1) Duration of first period of immobility (i.e. from dropping on its back until it turned over) four minutes, of second one minute thirty seconds, and of third twenty seconds. After this it would not lie still

2) Duration of first period of immobility three minutes five seconds, of second one minute twenty-five seconds, of third fifty seconds, and of fourth twenty-five seconds. After this it would not lie still.

This type of behaviour in Grypidius can probably be attributed to the well-known physiological phenomenon of adaptation, the reaction of Scarites, it would appear, must be attributed to some form of sensory or central summation.

It was found that weevils narcotized with ethyl acetate lay in similar positions to weevils in thanatosis and, moreover, showed the same sequence of movements in their recovery. This might be taken as supporting Fabre's suggestion that beetles in a state of thanatosis were in fact "unconscious". It is remarkable/

remarkable how readily thanatosis is induced in Grypidius on its food plant in the field. The slightest movement in the vicinity may cause the weevil to drop off but with frequent handling in the laboratory they became much less sensitive. This thanatosis reflex is very widespread in Coleoptera and doubtless has survival value in enabling them to escape from predators, particularly birds.

Observations were made on the laboratory stock of Grypidius at midnight, 3 a.m. and 5 a.m.. The beetles were found on the plant, not on the sides of their cage. On each occasion some were feeding with their rostrums sunk in the tissue.

Feeding holes could be found in almost any stem internode and occasionally very small perforations were seen in the side branches. When newly made the holes could be detected by their small central opening and the surrounding area of lighter epidermis where the underlying tissues had been removed. In the laboratory these excavations frequently reached the opposite epidermis, while in stems brought in from the field they rarely went deeper than the central cylinder. The epidermis above the excavations turned brown within a few days and then became black, rather hard and brittle. Empty cavities in the apical internodes usually became dry and often contained fungi, while cavities in lower internodes were usually moist or even waterlogged.

On July 10th, a large patch of *Equisetum* at the University was cut down. This provided an opportunity to survey the feeding and oviposition scars. The results are given in Table 9 below.

Table 9

Number of scarred stalks examined 472.
Number of stalks with feeding holes only 292.
Number of stalks plus eggs 151, plus larvae 29.
Number of stalks with one egg 108; two eggs 38; three eggs 3; four eggs 1; five eggs 1; six eggs or more 0; one larva 27; two larvae 1; three larvae 1; four larvae or more 0.
Total number of eggs found 202.
Total number of larvae found 32.
Number of first instar larvae 27, and of second instar larvae 5.

Equisetum stems taken from the cage in the laboratory frequently contained up to twelve feeding holes and on one occasion 22 eggs were found in the one stem but in this case nine beetles had been confined with it for forty-eight hours. Occasionally 6 eggs were found in one hole. This is not necessarily due to overcrowding as stalks containing 4 eggs in one hole were occasionally found in the field.

Copulation

Copulations were frequently observed from May 29th until

August/

August 18th, both in the laboratory and in the open and must have occurred before May 29th as eggs were found on that date. They varied in duration from less than ten minutes to over an hour, depending on the response of the female. An isolated pair of beetles were frequently seen in copulation, sometimes more than once a day. This does not necessarily mean that repeated matings are essential for maximum egg production. Unfortunately, it was not possible to determine whether the females taken from the field were virgin or not. The above mentioned pair were isolated on July 14th, and egg laying ceased on August 3rd. During this time 27 eggs were laid.

A female isolated on July 8th laid an egg that day and continued laying until August 5th. Between July 8th and 14th, 15 eggs were laid, while between July 14th and August 5th, 26 eggs were laid, making a total of 41 eggs laid in isolation. This represents an average of 1½ eggs per day, almost the same rate as in the isolated pair which suggests that the presence of the male had little influence on egg production.

Oviposition

Very occasionally eggs were laid on the cage or the surface of the plant. Normally the female excavated a hole with her rostrum in one of the internodes. As the rostrum sinks deeper into the tissue, the antennae fold back into their scrobes. By straightening the hind legs the body is tilted forward so that

the/

the rostrum can reach the tissue below it. After feeding in this way for some time, the rostrum is withdrawn, the weevil turns round and moves backwards until the tip of its abdomen is above the hole. It appears to feel the size and shape of the hole carefully then exserts the ovipositor which forms a short thick tube over it. At first a yellow fluid seems to be secreted then the tube dilates slightly and becomes opaque as the egg enters. The egg remains there for two or three seconds then slips rapidly into the hole below. A white, rather viscous fluid is then secreted over the hole. The trowel-shaped valve of the genitalia, tergite eight (Fig. 274, T8) scrapes the white fluid from the edges neatly over the hole, and dabs up and down as though to compact it. The white secretion solidifies very rapidly and when examined after the beetle has moved away it is found to have formed a hard crust and has not run into the hole. This crust was not invariably found over oviposition holes either in the laboratory or in the field.

Description of eggs and hatching

The eggs vary considerably in shape, size and colour. Just after oviposition they are firm and cylindrical but as the embryo develops they lose the firm symmetrical outline. The average length was 2.0 mm., the extreme limits 1.5 mm. to 2.5 mm. but the majority varied little from the average. Breadth also varies but to a lesser extent, the average being 0.56 mm..

Colour varies from very pale yellow to quite a vivid orange. Frequently eggs brought in from the field were dark brown owing to an enveloping film of brown matter which could readily be scraped away to disclose a yellow or orange egg. As eggs without the brown cover invariably took longer to hatch than those with it, they must have been more recently laid and had not yet had sufficient time to acquire this brown covering. It is possible that the damaged tissues of the growing plant have some connection with its formation. Hatching usually takes place from sixteen to seventeen days after oviposition but if several eggs have been laid in the one hole so that they are closely adpressed, hatching may not take place until the 21st or 22nd day.

On June 23rd an eclosion was observed through a binocular microscope. The position of the larva within the egg prior to hatching can be seen in Figure 275. It alternately contracted and expanded the posterior part of the abdomen until the egg-bursters had torn a hole in the egg membrane. It wriggled round until it succeeded in getting its head out (Fig. 276). In order to make these observations, part of the stem above the egg had been removed so that when the larva had reached the stage shown in Figure 276 it failed to make any contact with the plant and, presumably owing to this, retreated into the egg membrane (Fig. 277). Again it contracted and expanded its abdomen until the egg capsule tore (Fig. 278) and the/

the abdomen was pushed out (Fig. 279). The extruded tail portion made contact with the plant and the larva left its shell backwards. It then worked its way backwards along the central hollow of the Equisetum stem to the node above. In this case the stem had been held with its axis horizontal, instead of the normal vertical. Very occasionally a larval trace could be found starting up stem, but on reaching the node it would turn round and travel back down the internode to the node below. It seemed to require the weight of its body above the mandibles to add sufficient force to penetrate the nodes, which are probably difficult to pass through because of the vascular strands passing out to the lateral branches.

In some places small excavations were visible in the parenchyma where the larva had taken a meal. Elsewhere it had moved straight down the central cylinder. Frass marks the route, the greatest accumulations being found just before each node as though the larva had spent some time there.

Methods used in rearing larvae

Adults kept in the laboratory were given one or two fresh Equisetum stems each day. Some of the old stems containing eggs were dated and put in a jar with a little water at the bottom, the eggs were removed from the others and kept in petri dishes on damp blotting paper where they took up less space and could be examined rapidly.

Newly/

Newly hatched larvae were inserted into freshly gathered Equisetum stems by cutting back a flap of the plant tissue, placing the larva in the central cavity and replacing the flap. To prevent moisture escaping from the damaged area vaseline was rubbed over it, or cellotape applied. Larvae were usually removed and inserted into a fresh stem after about a fortnight and in this way could be reared as far as the third instar. After this stage they had to be transferred to a growing plant.

Description of larval development

Newly hatched larvae are primrose yellow, with long golden setae, and a pair of egg-bursters on each of the first six abdominal segments (Figs 280-282).

In their first instar they are very agile and readily climb glass surfaces. To move over smooth surfaces the head is held in position and the body contracted so that the posterior segments are drawn forwards. The terminal segment is now anchored and the head and the rest of the body moves forward. The movement is caused by waves of contraction and elongation, which are not separate but flow into each other so that the progression of the larva is smooth and undulating.

First instar larvae spent twelve to sixteen days eating and travelling down stem. After moulting the second instar larvae continued down stem, then in a further twelve to sixteen days moulted again. Third instar larvae spent the whole stadium in the/

Table 10

Measurement of head capsule (in millimetres)

Instar	Average	Minimum	Maximum	Difference	Number measured
1st	0.37	0.32	0.42	0.10	25
2nd	0.54	0.47	0.60	0.13	25
3rd	0.73	0.68	0.77	0.09	9
4th or 4th & 5th	0.98	0.84	1.11	0.27	19
(4th	0.91	0.84	0.97	0.13	10)
(5th	1.06	1.00	1.11	0.11	9)

Ratio of head capsule widths

$\frac{0.54}{0.37} = 1.46$ $\quad$ $\frac{0.73}{0.54} = 1.35$ $\quad$ $\frac{0.91}{0.73} = 1.25$ $\quad$ $\frac{1.06}{0.91} = 1.16$

$\frac{1.46}{1.35} = 1.08$ $\quad$ $\frac{1.35}{1.25} = 1.08$ $\quad$ $\frac{1.25}{1.16} = 1.08$

the stem if this was large or entered the rhizome. Fourth instar larvae were always found in the rhizome. That there were at least four instars I was able to ascertain by observing cast skins. An examination of head capsule measurements suggests that there may be five instars, the first three being well defined and the last two intergrading (Table 10). Final instar larvae were found either in the rhizome when they were usually tightly encompassed by the plant, or curled up in the shells of the tubers, the starchy contents of which they had entirely consumed.

Apparently winter is spent in the larval stage, since final instar larvae were still found in the rhizomes on February 28th and no pupae were found.

v) Mecinus pyraster(Herbst)

Adults of this species were common on Plantago lanceolata L. at Earlsferry (Fife) on May 27th and June 16th, 1956. One specimen was found in North Uist (Outer Hebrides) on April 10th, 1957, while on September 25th, 1916, Fergusson (unpublished record in Glasgow University Library) found it at Whiting Bay (Clyde Islands). I have never found them inland.

Two copulating pairs were caged on a potted plant of P. lanceolata on May 30th, 1956. When the plant was examined on June 25th eggs and first, second and third instar larvae were found. The eggs lay in cavities in the flower stem, usually one/

one egg per cavity or very rarely two. When five adults were kept for a few days in a small tube with a number of P. lanceolata inflorescences, eggs were found in the receptacle of the scape and in the flowers themselves where they were sometimes near the top of the floral tube or near the base of one of the bracts. The eggs are usually creamy or light fawn in colour and have an average length and breadth of 0.57 mm. and 0.37 mm. respectively. They hatch in eight or nine days. The newly emerged larvae do not eat the egg membrane, but begin to tunnel down the stem or to consume the ovaries of the flowers. The average width of the head capsule of fifteen first instar larvae was 0.24 mm..

vi) Gymnetron antirrhini (Payk.)

Adults of this species were very common at Slough (Bucks) on August 24th and September 18th, 1955, and at Saffron Walden (Essex) on September 12th, 1953. As pupae were found on both dates in September it is probable that at least some of the adults seen on these occasions belonged to the new generation. On August 24th, 1955, some seed capsules of Linaria vulgaris Mill. were examined and although several contained eggs of Gymnetron antirrhini Payk., no larvae were found. By September 5th, however, both first and later instar larvae were found in the seed capsules and on September 12th final instar larvae and pupae were present.

In/

In 1929 Dr. H. Scott wrote in the Ent. mon. Mag. that he had found pupae of Gymnetron antirrhini at Charlbury (Oxon.) in the seed capsules of Linaria vulgaris on August 5th. Although the summer of 1955 was very hot and dry, the weevils pupated a month later than they did in 1929, a year which Dr. Scott stated was also very hot and dry. It would be interesting to know if a difference in temperature and humidity during the two summers was the cause of the later pupation in 1955 or if there are different strains of Gymnetron antirrhini at Slough, Saffron Walden and Charlbury, or perhaps both factors are involved.

The average width of the head capsule of twelve first instar larvae was 0.23 mm..

vii) Anthonomus pedicularius(L.)

Adults of this species are very common on Crataegus monogyna Jacq. at Rossdhu during May and again about mid-July when the new generation emerges. The adults, which fly readily, feed on young leaves and the flower buds from which they eat the stamens and small areas of the petals.

The white eggs, which are not readily laid in captivity, are inserted into the buds through a hole "drilled" by the female with her rostrum near the top of the receptacle. In a few days the receptacle becomes slightly swollen and asymmetrical and the oviposition/

oviposition hole turns dark brown. The larvae, only one of which can survive in each bud, feed first on the stamens and then on the innermost petals of the bud. This gradually turns brown until, when the larva is about to pupate, it is quite dark and withered and readily falls from the tree. Before pupating, the larva lines the inside of the bud with a smooth, firm layer of frass. On July 15th, 1956, the turf beneath C. monogyna at Rossdhu was examined. Several capped blossoms were found, of which some were empty and others contained pupae or teneral adults. The average width of the head capsule of thirteen first instar larvae was 0.31 mm., and of fourteen second instar larvae 0.48 mm..

Cionini

Three species belonging to this tribe, Cionus scrophulariae (L.), C. alauda Herbst and Cleopus pulchellus (Herbst), have been found in the countryside around Glasgow. As they can all be found on Scrophularia nodosa L. at the same time of year it is difficult to tell in the field to which species the larvae belong. On June 4th, 1955, at Rossdhu two C. scrophulariae adults were found on a plant which was also covered with larvae at all stages of development. When the plant was examined on June 29th, a number of the larvae had made their cocoons. These were found to contain the pupae and adults of C. pulchellus and in four cases the pupae of a Hymenopterous parasite identified by Mr. G.J. Kerrich as an Entedon species (Eulophidae). On July/

July 5th, 1956, two adult C. alauda and several larvae were found on a plant at Dalserf (Lanarkshire). By July 10th, a number of the larvae had pupated. The emerging adults were C. scrophulariae. On July 7th, 1956, adults of C. scrophulariae, C. alauda and C. pulchellus were all found on one plant of S. nodosa at Rossdhu.

viii) Cionus scrophulariae (L.)

Adults of this species have been found from May until August. Pupae were found from early July to the beginning of August and were sometimes very common. Thirty-one were counted on the apical three inches of one plant.

ix) Cleopus pulchellus (Herbst.)

Adults of this species have been found in Central Scotland from May until August on S. nodosa and S. aquatica L..

Like the Cionus species, the eggs are laid in circular cavities between the upper and lower epidermis of the leaves. They are occasionally laid singly, but it is more usual to find two or three in a cavity. The larvae do not eat the egg membrane. They feed externally on the leaves and stem. The average width of the head capsule of four first instar larvae was 0.18 mm..

x) Orobitis cyaneus (L.)

Fowler (1891) wrote of its distribution, "Scotland scarce, Solway/

Solway, Tweed and Forth districts." It has since been found by Fergusson (unpublished record in Glasgow University Library) at several localities in Ayrshire in April, May, July and August. On June 29th, 1954, two adults were found on Viola canina L. at Crieff (Perthshire). In thanatosis they have an extraordinary resemblance to a violet seed.

A small circular hole was seen in the wall of a number of the seed capsules. Some of these appeared to be the feeding holes of the adult weevil. A few of the others were oviposition holes, as the capsules contained eggs or larvae. The eggs are white, slightly broader at one end and with an average length and breadth of 0.69 mm. and 0.31 mm. respectively. The larvae eat the contents of the ripening ovules which at this stage are green and tender. The average width of the head capsule of four first instar larvae was 0.31 mm..

xi) Zacladus geranii (Payk.)

This species, which Fowler (1891) included in the genus Coeliodes, is widely distributed in South and Central Scotland. It was very common at Dalserf on the flowers of Geranium sylvaticum L. and a fortnight to three weeks later on Geranium pratense L. when it flowered, so that they could be found in May and June, the beginning and end of July and August. Mr. R.A. Crowson has also found it on Geranium sanguineum L. at Earlsferry. The fruit of all the Geranium species is composed of/

of five carpels. Zacladus lays its eggs in the ovaries or occasionally the styles.

On July 4th, 1955, some fruits of G. sylvaticum were examined. Small circular scars were seen on the ovaries or styles of many of them. These carpels contained eggs or first or second instar larvae. Although they were always found in separate carpels, as many as three carpels of one fruit might be attacked. Despite the fact that only two carpels are required during development, I have found only one fully grown larva in a fruit. On hatching the larvae consume the ovules although, if they have been laid in the style, they have first to mine this. No adults were found on July 18th, but the G. sylvaticum carpels examined contained second, third and fourth instar larvae. By the time they have reached third or fourth instar only one live larva is found in each fruit. By now they have usually begun to eat the contents of a second carpel which they enter through the adjacent wall. On July 30th, one adult was seen. Some of the G. sylvaticum carpels contained final instar larvae. Near the base of others, emergence holes were found. The G. pratense carpels examined contained first, third and final instar larvae but none were found with emergence holes.

A number of fruits containing final instar larvae were kept in a tube in the base of which was a thin layer of damp cotton wool/

<u>Table 11</u>

	Width of head-capsule in mm.	No. measured in *G. sylvaticum*	No. measured in *G. pratense*
1st instar	0.23 - 0.27	14	3
Later instars (i.e. 2nd-final)	0.39 - 0.62	23	7

wool covered by a disc of filter paper. Within three to eight days most of the larvae had made a circular hole near the base of the carpel and had gone down into the cotton wool. Many of them succeeded in twisting this into a cocoon around themselves and then pupated. Presumably they would have pupated in the ground under normal conditions. Hymenopterous parasites which emerged from the remaining attacked carpels were sent to Mr. Kerrich for identification. As can be seen in Photograph 8, Zacladus can be parasitized in its first instar.

If some of the emergence holes seen on July 30th had been made for some time, new adults could have emerged before that date, so that it is possible that the first instar larvae found on that date in the fruits of G. pratense could have hatched from eggs laid by the newly emerged adults which had spent their larval life in G. sylvaticum.

The eggs have an average length and breadth of 0.62 mm. and 0.39 mm. respectively. The average width of the head capsule of seventeen first instar larvae was 0.25 mm. with a range of ± 0.02 mm.. As can be seen in the Table opposite the head width of the succeeding instars varied from 0.39 to 0.62 mm.,,the range in the final instar being approximately ± 0.04 mm..

xii) Ceuthorhynchus pollinarius(Forst.)

This species, which occurs on Urtica dioica L., is common near/

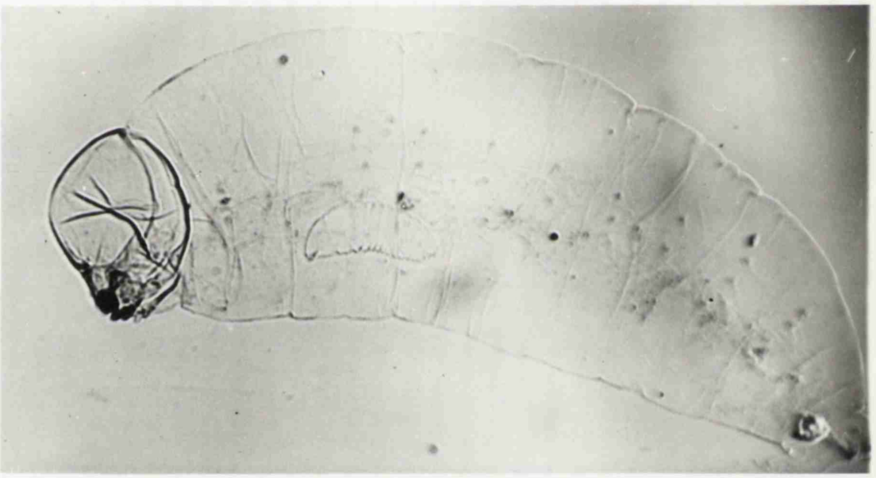


Photo. 8. First instar larva of Zacladus geranii Payk. with a hymenopterous endoparasite.

near Glasgow in April and May. One specimen was also found in August, 1955, on a plum tree where it was presumably about to hibernate. The adults eat large areas of the Urtica leaves and feeding holes are occasionally found in the stem.

The pale creamy yellow eggs, which have an average length and breadth of 0.70 mm. and 0.46mm. respectively, are laid in holes in the stem or leaf petiole which the female has excavated with her rostrum. The orifice of such a hole is sometimes found to have been sealed with a white secretion. Hatching takes place in six or seven days. The larvae do not eat the egg membrane, but start to tunnel down the stem. On May 18th, 1956, several adults were caged on a potted nettle plant. When this was examined on June 8th, first, second and third instar larvae were found. The average width of the head capsule of seven first instar larvae was 0.37 mm., of four second instar larvae 0.53 mm. and of two third instar larvae 0.77 mm..

xiii) Ceuthorhynchidius troglodytes(F.)

This species is widely distributed in Scotland and can be found on Plantago lanceolata L. in May and June and also in August.

On June 22nd, 1955, several adults were caged on a potted Plantago plant. When this was examined on July 25th, eggs, first, second and third instar larvae were found. The eggs are/

are laid in the flower stem or the receptacle. The larvae do not eat the egg membrane, but mine towards the base of the plant. The average width of the head capsule of eleven first instar larvae was 0.23 mm., of fourteen second instar larvae 0.37 mm. and of three third instar larvae 0.60 mm..

xiv) Limnobaris t-album(L.)

Fowler (1891) wrote that this species was local in Scotland; found in Solway, Tweed and Clyde districts. It is common on Carex rostrata Stokes at the Dubh Lochan (Stirlingshire) in June, July and late August. The adults, which fly fairly readily, feed on both the stamens and inflorescence.

The eggs are laid between the upper and lower epidermis of the leaf where it surrounds the stem, usually near the water level. They are white, elongate and slender, the average breadth being 0.21 mm. and the length four to five times as great. The first instar larvae tunnel down the stem, but as their frass is white they are difficult to trace and are easily overlooked. Later instar larvae can be found in the rhizomes. The average width of the head capsule of ten first instar larvae was 0.19 mm..

xv) Mesites tardii(Curtis)

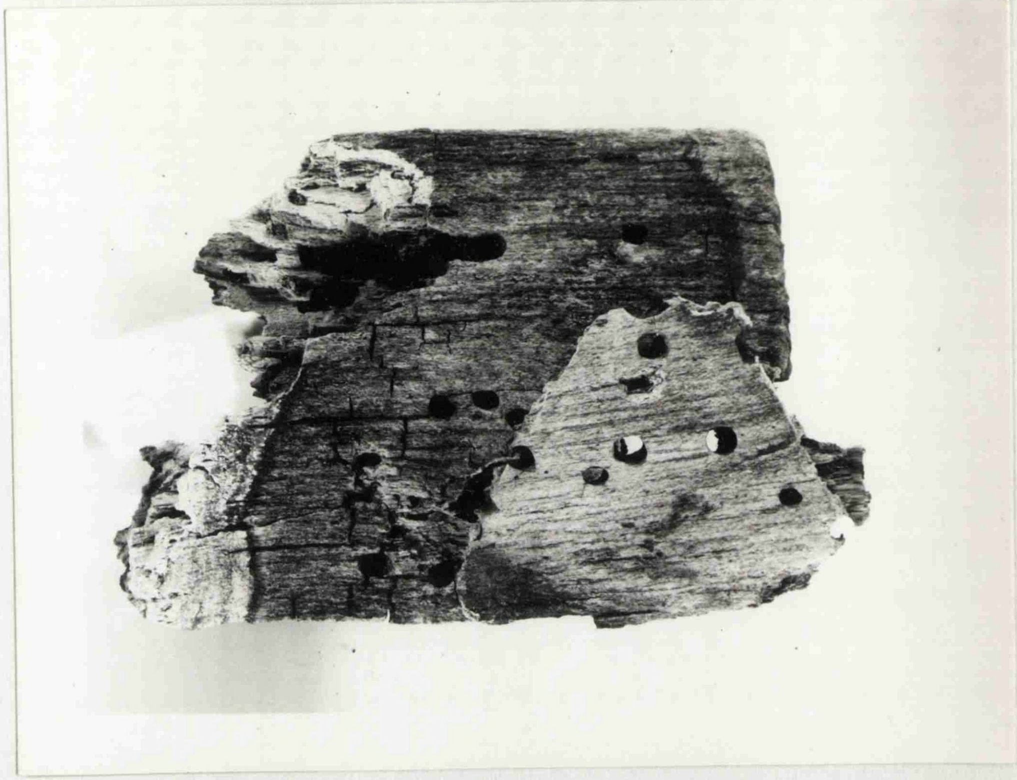
Fowler (1891, 1913) referred to this species as Rhopalomesites tardyi Curtis. He wrote that it was found in old holly trees, also occasionally in beech; very rare in Scotland where/

where it was found in the Clyde and Argyll districts and under birch bark in Arran (Clyde Islands). Fergusson (unpublished record in Glasgow University Library) found it in an ash stump in Arran in June, 1916.

In April, 1956, two adults and larvae of many instars were found in a felled elm stump at West Kilbride (Ayrshire). The larvae were tunnelling in the xylem. The emergence holes at the surface of the wood were usually circular and varied rather considerably in size (Photograph 9). The bark from a small area of the trunk had apparently been absent for more than a year. Just below the surface of this exposed wood, an adult was found in what appeared to be a pupal cell, the enlarged termination of the larval burrow (Photograph 10). A few days later an adult of the opposite sex emerged from one of the old burrows. Both lived in captivity for just over a month, during which time no eggs were laid. The width of the head capsule of the smallest larva present was 0.42 mm..

3. Discussion

The presence or absence and the position of egg-bursters in first instar larvae, the number of instars and the range of the width of the head capsule in each instar show some unusual features and may well provide some important taxonomic characters.



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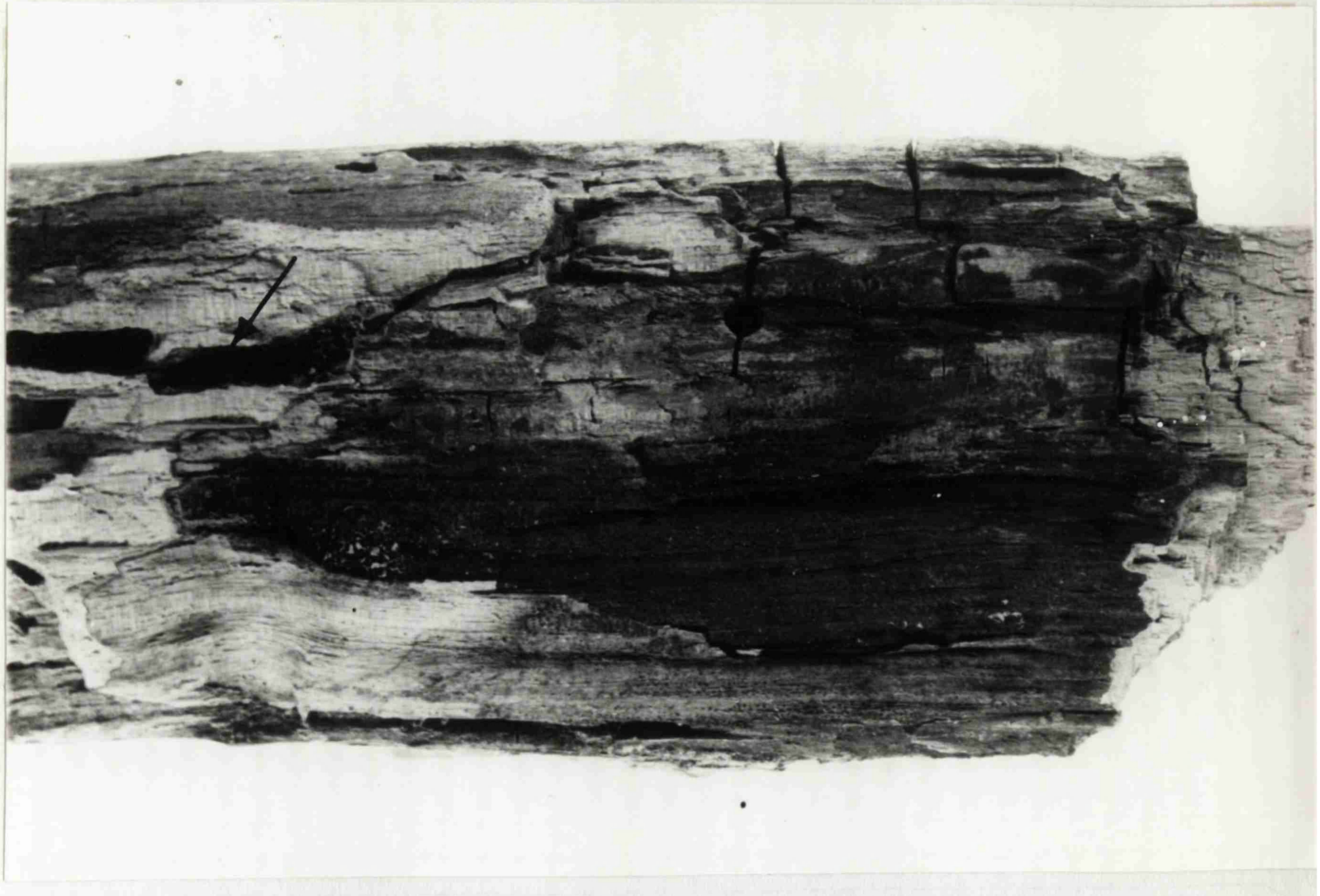

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Photo. 9. Emergence holes of <u>Mesites tardii</u>(Curt.)from a felled elm stump(natural size). 10. Pupal cell of <u>M. tardii</u> (indicated by an arrow.)

Egg-bursters

The first instar larvae of *Grypidius* possess what van Emden (1946) calls "persistent thoraco-abdominal egg-bursters" which he described in only four weevil larvae; *Calandra oryzae* has egg-bursters on abdominal segments four to six, *Deporaus betulae* on one to seven, *Attelabus nitens* on five and six, and *Calomycterus* sp. on segment eight. S.M. Hammad (1955) noted that *Pentarthrum huttoni* had three pairs of egg-bursters on abdominal segments one, two and three. *Grypidius* differs from all of these in having egg-bursters on abdominal segments one to six.

Thus egg-bursters appear to be very uncommon in the Curculionidae, especially in the Adelognatha. *Phyllobius oblongus* L. is illustrated as an example (Fig. 283). Its eggs, which have an average length and breadth of 0.58 and 0.30 mm. respectively, are laid in batches on the ground. The larvae hatch in fifteen to nineteen days through a small hole torn by the mandibles at one end of the egg membrane (Figs 284-285). These holes are much smaller and neater than those which the larvae of *Grypidius equiseti* make with the aid of egg-bursters, or those made by the larvae of *Cleonus piger* which do not have egg-bursters.

Larval instars and head width

O.W. Richards (1947) noted that *Calandra granaria* had four larval/

larval instars. Using Dyar's law, S.M. Hammad (l.c.) deduced that Pentarthrum huttoni had five larval instars. In both Calandra and Pentarthrum there was a variation in the width of the head capsule in each instar but no overlap between adjacent ones.

In one of Richard's Calandra cultures, the mean width of the head capsule in the first instar was 0.24 mm. with a range of ± 0.02 mm., in the second 0.345 mm. ± 0.045 mm., in the third 0.515 mm. ± 0.055 mm. and in the fourth instar 0.68 mm.. ± 0.06 mm.. There is an irregular increase in the range in succeeding instars.

In Pentarthrum, according to Hammad (l.c.), the variation in the width of the head capsule in all five instars is 0.04 mm.; the mean width of the head capsule in the first instar being 0.22 mm. and in the fifth instar 0.61 mm..

In Cleonus piger Scop. there appear to be four instars, the head sizes of which do not overlap in adjacent instars and there is an increasing variation in their widths in succeeding instars. In Zacladus geranii (Payk.) only the first instar is distinct, the others intergrade.

In Grypidius equiseti the range in the head capsule width in the first instar was 0.10 mm., in the second 0.13 mm., in the third 0.09 mm. (nine only were measured; if a larger number had been available the range would probably have been slightly greater)/

greater) and in the succeeding instar or instars (i.e. fourth or fourth and fifth instars) 0.27 mm.. The range is fairly constant in the first three instars and then more than doubles. This may indicate that this last instar is composed of two intergrading ones. If this hypothesis is adopted it is found that the ratio of the head capsule widths, from instar to instar, increases by a constant factor of 1.08 (Table10).

Thus it appears that the number of larval instars varies from genus to genus in the Curculionidae and there appears to be no constancy in the variation in width of the head capsule in each instar, nor in the amount of overlap of head capsule width with adjacent instars.

A study of more closely related species may show these differences to be taxonomically important.

PLATE I: Figs 268-279

Figs 268-272 Cleonus piger Scopoli

268. First instar larva

269. Antenna

270. Maxilla and labium

271. Mandible

272. Epipharynx

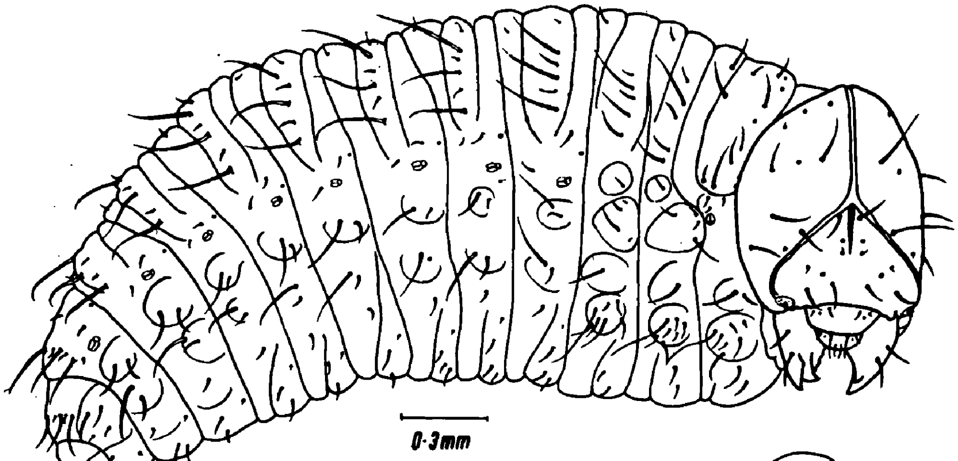
Figs 273-279 Grypidius equiseti F.

273. Wing

274. Position of egg in ovipositor immediately prior to laying

275-279. Hatching of larva

E, egg; S7 sternite 7; T7, T8, tergites 7 and 8.



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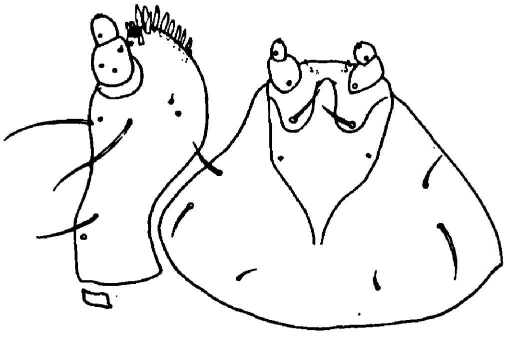

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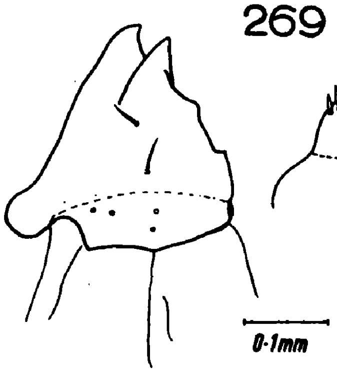

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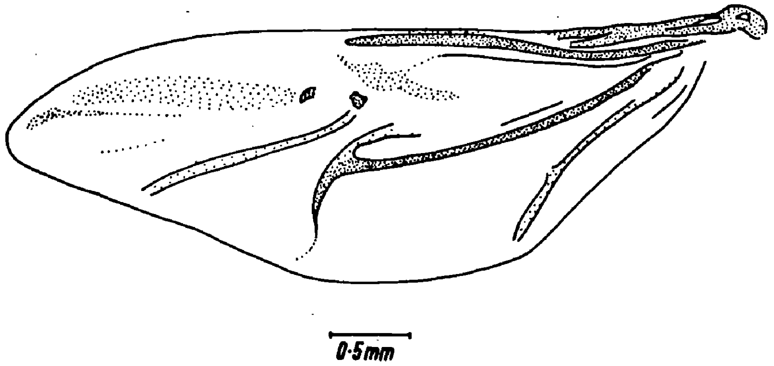

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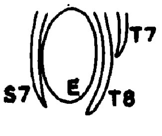

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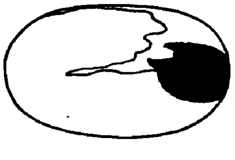

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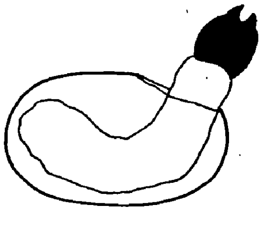

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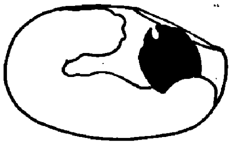

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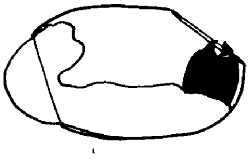

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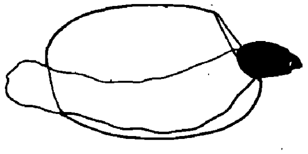

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PLATE II: Figs 280-285

Figs 280-282 Grypidius equiseti F.

280. First instar larva

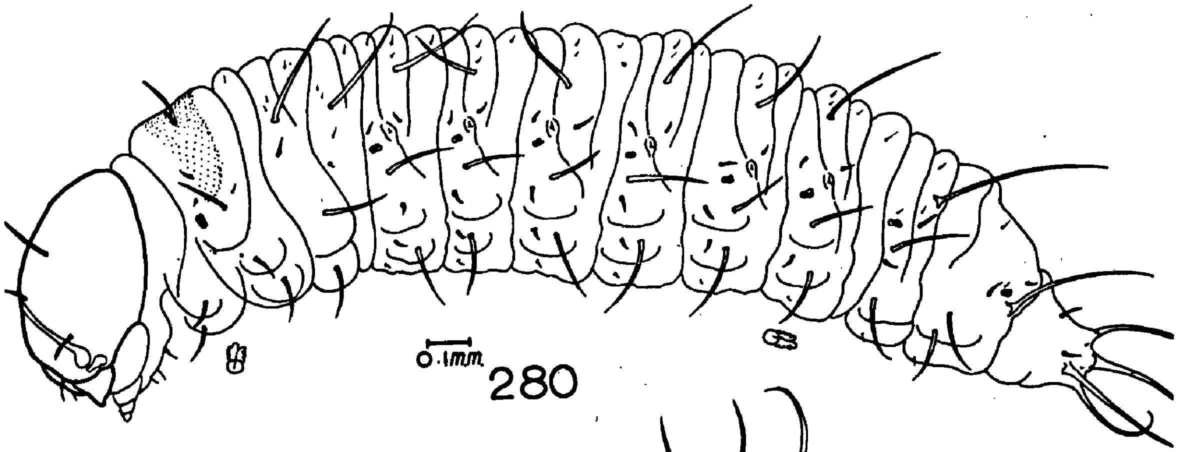
281. Abdominal segment showing the sculpture

282. Abdominal segments 8 and 9, dorsal view

Figs 283-285 Phyllobius oblongus L.

283. First instar larva

284.)
) Newly hatched eggs
285.)



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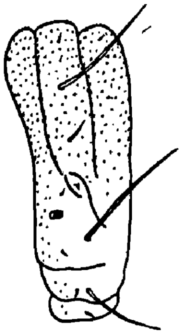

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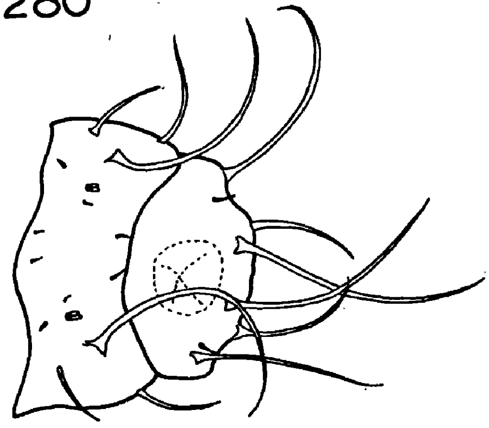

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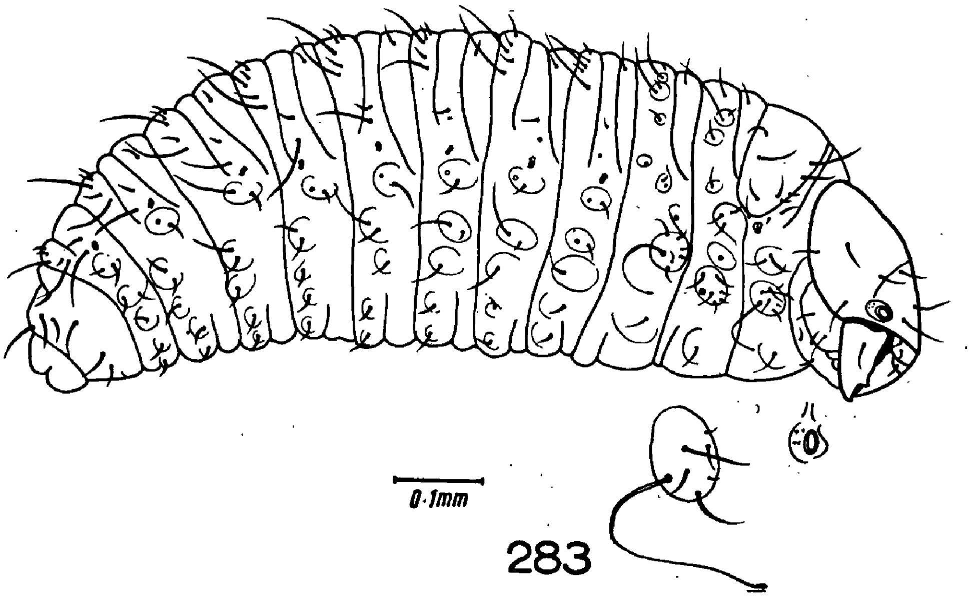

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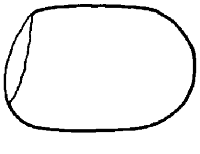

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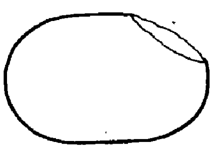


285

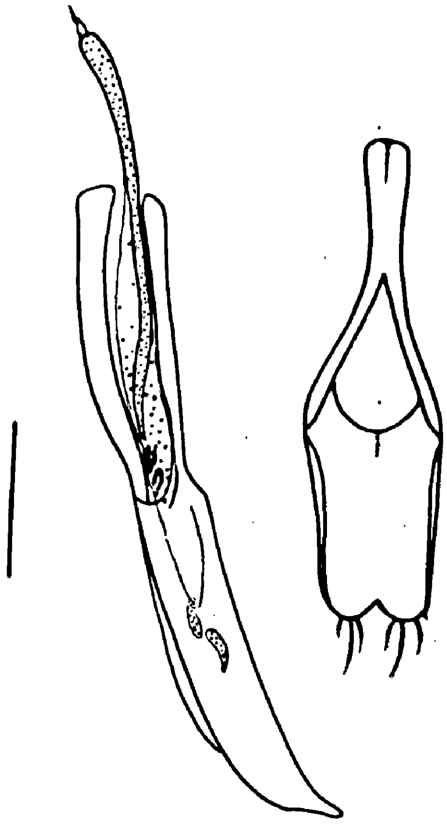
APPENDIX 1

Previous to 1912, the Nanophyinae were usually classed with the Cioninae. Reitter (1912), van Emden (1938) and Crowson (1955), however, placed them in the family Apionidae. They based this transfer on the similarity of their larvae, wing venation, antennal clubs and metendosternites, the trochanters, which are usually long in the species of Nanophyes and Apion, and the indistinct proventriculi.

Crowson (1955) also mentioned the similarity of the mouth parts. These possess, however, a number of marked differences. According to Ting (1936), the maxillary palpi of the Apioninae are 2-segmented and the labial palpi 1-segmented. In Nanophyes marmoratus Goeze, however, the maxillary and labial palpi are 3- and 2-segmented respectively.

Another character supporting the inclusion of the Nanophyinae in the Apionidae is the similarity of the tegmen of the male genitalia. It is rather large, covering the median lobe dorsally and bilobed only at the tip. This type of tegmen is very uncommon in the Curculionidae though it is characteristic of the Erirrhinini s.str. (Fig. 286).

Fig 286 *Nanophyes marmoratus* Goeze, male genitalia



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APPENDIX 2

Ting (1936) wrote that he had found deciduous cusps on the mandibles of certain "Alophini". Despite the differences in the shape, structure and position of their bases from the cusps of the Otiorrhynchinae, he concluded that the Alophini belonged to that sub-family.

Van Emden (1952), having studied the larval characters, found that they were intermediate between those of the Adelognatha and Phanerognatha, so that the Alophinae are probably among the most primitive representatives of the Adelognathan stock.

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