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A DESCRIPTION AND CLASSIFICATION OF THE FINAL
INSTAR LARVAE OF THE ICHNEUMONIDAE (INSECTA,
HYMENOPTERA)

By J. R. T. SHORT¹

Introduction

In this paper are given a description and classification of the final instar larvae of the Ichneumonidae based on a study of species representing 151 genera. Keys are given to the subfamilies, tribes, and genera. Characters of the subfamilies and tribes are described verbally, but the description of each genus usually takes the form of a diagram. Any special features are noted in the text, and when a species differs from that figured for a genus the difference is noted. Diagrams were selected as the most concise and accurate method for recording larval characters.

MATERIAL AND ACKNOWLEDGMENTS

In work of this nature great care must be taken to insure that only reliably identified material is used. Most of the material on which this study is based comes from the U.S. National Museum, Washington, D.C. I wish to thank the Museum for permission to borrow material and I am most grateful to Miss Luella M. Walkley for her help and advice concerning this work. I am also grateful to Mr. G.

¹ Natural History Department, Marischal College, University of Aberdeen, Aberdeen, Scotland.

Stuart Walley of the Canadian Department of Agriculture, Ottawa, for supplying material and to Mr. J. F. Perkins of the British Museum (Natural History) for permission to study material and for his advice on the classification of the Ichneumonidae. I also wish to thank Prof. G. C. Varley of the Hope Department of Entomology, Oxford, for his many helpful suggestions and for lending me a number of slides from his collection; Mr. E. R. Skinner of the Imperial Forestry Institute, Oxford, who supplied me with larvae of *Rhyssa*; and Dr. G. Salt, F.R.S., of the Zoological Department, Cambridge University, who supplied me with larvae of *Collyria* and *Idechthis*.

Since living larvae often give valuable information, I have collected as widely as possible for this study. Most of the slide preparations have been deposited at the U.S. National Museum. Material borrowed from the Canadian Department of Agriculture and the British Museum has been returned. Most of the material sent by Professor Varley has been returned, but material of *Orthopelma* and *Hemiteles* that he did not wish returned has been deposited at the U.S. National Museum. Material of *Collyria* and *Idechthis* sent by Dr. Salt and material of *Rhyssa* sent by Mr. Skinner have also been deposited at the U.S. National Museum. Material returned to the Canadian Department of Agriculture (CDA), to the British Museum (BM), and to Professor Varley (GCV) is indicated by initials. Material not so indicated has been deposited in the U.S. National Museum.

Detailed records (by whom determined, locality, etc.) have not been recorded for any specimens since this information can be obtained from the data labels of the collections of bred material (now returned to the U.S. National Museum and the Canadian Department of Agriculture) from which larval skins were obtained. The procedure adopted in using this bred material was as follows: The collection of preparations of larval skins was numbered and fully labeled; when a larval skin was extracted from the cocoon of a bred specimen a label was added to the pin of the specimen reading "Larval skin removed; slide No. X; J.R.T.S.; 195X." Thus, it is possible to refer from the preparation of a larval skin to the adult and its determination.

METHODS

Much of the material used was available as cast skins in the cocoons of bred ichneumonids. The contents of the cocoon, the final instar larval skin and the meconium, were removed by making a longitudinal cut in the cocoon and then boiled in a 5 percent solution of caustic potash. Sometimes larval skins of instars previous to the final were found in the cocoons. After boiling, the cleaned and softened larval skins were washed in distilled water, stretched, dehydrated, and

mounted in Canada balsam. Balsam was used to ensure a satisfactory permanent mount, but for more rapid work larvae may be transferred from distilled water to Faure's fluid. Where larval material was available in the host pupa, as in the Ichneumoninae and Pimplini, the entire pupa was softened by boiling in caustic potash and the pupa was cut open when soft to extract the ichneumonid larval skin. This method ensured that the brittle pupa was not damaged. Fresh larvae were opened by a midventral cut and then boiled in a 5 percent solution of caustic potash. They were then washed, dehydrated, and mounted.

NOMENCLATURE

The taxonomy of the Ichneumonidae is in a confused state, and the nomenclature of European and American authors differs to some extent. Since much of the material used in this study is North American in origin, the nomenclature of Walkley (1958) is used. The names of larvae described in the literature have been altered, when necessary, to conform with this nomenclature. When genera were not listed by Miss Walkley, her advice was sought on nomenclature, or, if the genera were listed in Kloet and Hincks (1945), the nomenclature of these authors was followed.

Description and Classification

Since the relationships indicated by the larval characters support a classification similar to that given by Townes and Townes (1951) in the U.S. Department of Agriculture's synoptic catalog and by Walkley (1958) in the supplement to that catalog, the classification of these authors has been followed. Although a somewhat different classification could have been constructed on the basis of larval structure alone, every effort was made to avoid this because information on both larvae and adults is essential for an understanding of the taxonomy of the group. A classification based solely on the characters of the larvae would be as unsatisfactory as a classification based solely on the characters of the adults.

It was necessary to depart from the classification in the above-mentioned synoptic catalog in one case: The Anomalinae are here considered as a separate subfamily rather than as a tribe of the Ophioninae. Such differences are to be expected since the independence of larval and adult forms makes a separate evolution possible (Wigglesworth, 1954). Selective factors acting on the legless larvae are different from those acting on the mobile adults.

Studies on larval systematics are of interest from two standpoints; they enable workers to identify larvae and they help in understanding the classification of the adults (see van Emden, 1957). It is hoped

that the keys to subfamilies and tribes will require no great modification as a result of future work, which is expected to take the form of detailed studies within tribes and genera. As a result of such work the keys to genera given here will be greatly modified, for the genera studied were usually represented by but two or three species. This number of species might be satisfactory if one could assume that the larval characters of all the species of a genus would indicate a close relationship. This is very far from being the case. In some genera this may be due to species differing more as larvae than as adults. In others, as in the genus *Scambus*, it appears to be due to the confused state of the taxonomy of the adults. However, it is hoped that the present keys to genera will serve as a basis for future studies.

It is generally believed that, since adult insects show a greater degree of differentiation than larvae, their characters are likely to remain more important for species identification (van Emden, 1955). No attempt has been made in the present study to give a key to species. A vast amount of material would be required for such work. But it is significant that species of the braconid genus *Apanteles* can be arranged into groups corresponding with the groups into which the adults are divided (Short, 1953).

EXTERNAL STRUCTURE OF FINAL INSTAR LARVA

The final instar ichneumonid larva consists of a hemispherical head, three thoracic segments, and ten abdominal segments. The cranium is lightly sclerotized, with the mandibles and certain bands associated with the mouthparts more heavily sclerotized. The body wall of the thorax and abdomen is very lightly sclerotized or unsclerotized, with the exception of the spiracles and setae. The spiracles are situated in most species on the prothoracic and first eight abdominal segments. A line of setae is present in most species encircling each thoracic and abdominal segment. Small projections are present on the skin and these may be lightly sclerotized.

The structures used in this classification are the form of the mandibles and head sclerites, and of the antennae, spiracles, and skin. For the basis of the terminology of the head parts, which is outlined below, reference should be made to Short (1952). The head of ichneumonids (fig. 1) is lightly sclerotized except for certain more heavily sclerotized bands strengthening the cranium in the region of the mandibles, maxillae, and labium. The sclerotic arch, which is sometimes present dorsal to the mandibles (md), is called the epistoma (epst). The anterior tentorial pits (at) are situated in the epistoma. Lateral to each mandible is a pleurostoma (plst). The mandible articulates with two processes of the pleurostoma (fig. 1c). The anterior pleurostomal process (app) fits into a cavity of

the mandible and the posterior pleurostomal process (ppp) ends in a socket which receives the mandibular condyle. The hypostoma (fig. 1B, hst) is a sclerotic band running posteriorly along the subgenal margin of the cranium. Each maxilla (mx) consists of a lightly sclerotized cardo (cd) and a membranous stipes (st) supported ventrally by a sclerotic band called the stipital sclerite (ss(q)). The medial lobe of the maxilla represents the lacinia (lc). The galea is absent. The maxillary palp (mplp) is reduced to a flattened disc. A sclerotic band called the hypostomal spur (hsp) projects ventrally from the hypostoma across the stipes. In many species it fits into a depression in the stipital sclerite. Surrounding the posterior margin of the prelabium (plb) is a labial sclerite (lbs). The labial palps (lplp) are reduced to flattened discs. The silk press (sp) at the orifice (slo) of the silk glands is usually well sclerotized. Some ichneumonid larvae, such as the Campoplegini, have a Y-shaped sclerite, called the prelabial sclerite, on the prelabium. A sclerotic band, the labral sclerite (lms), is often present marking the dorsal limits of the labrum (lm).

The mandible (fig. 1c) consists fundamentally of a broad base (ba) articulating with the pleurostomal processes, and a more slender blade (bl). The base and blade of the mandible of *Xorides* are not differentiated, but usually, as for example in the Ephialtini, the blade is slender. The blade of the mandible may bear teeth (t) on its dorsal and ventral surfaces.

The antennae (ant) may be papilliform or disc-shaped. The ocular lines (ol), which mark the place of the developing imaginal compound eyes, are often sclerotized.

Each spiracle (fig. 1D) consists of a rounded atrium (atr) connected with the closing apparatus (ca) by a length of trachea which is often characteristic of the group to which the larva belongs. Finer details of spiracular structure have not been used in this classification. The prothoracic spiracle is usually figured but, where the preparation did not show the structure of this clearly, another spiracle was selected for illustration. The proportions of the structure of the spiracles are relatively constant.

The length of the setae of the skin and the presence or absence of spines have been found useful taxonomic features. Spines serving as holdfast organs are present on the skin of the Polysphinctini and some Ephialtini.

The drawings of heads which illustrate this paper are morphologically inaccurate since they show it as a flattened object, whereas it is, in reality, a hemisphere. This point is important since Beirne (1941, pp. 149, 167), for example, has attempted to use the position and degree of curving of the hypostomal sclerite as a taxonomic character.

This is unwise since the position and degree of curving of the head sclerites depends to some extent on the position assumed during mounting. However, it has been found a satisfactory method for taxonomic purposes to record the heads from preparations of cast skins and fresh larvae flattened in a standard way. By this method all the head parts can be shown in the one diagram.

The size and appearance of the cocoons have not been used in this classification since precise descriptions, either verbally or by drawings, were found very difficult. The color patterns of cocoons should be useful in future taxonomic work within some genera.

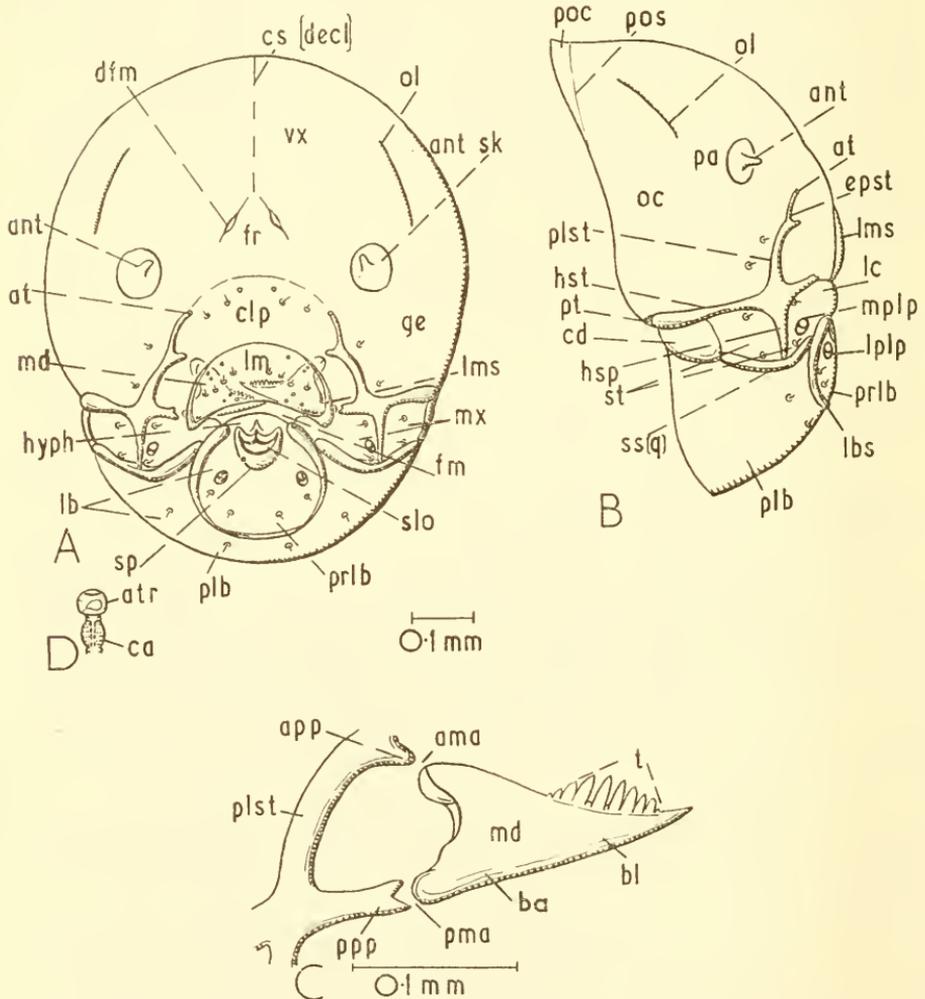


FIGURE 1.—*Xorides* sp.: A, anterior view of head; B, lateral view of head; C, lateral view of mandible; D, spiracle. Explanation of symbols on facing page. Detailed explanation on pages 394, 395.

Larval Key to Subfamilies of Ichneumonidae (except Orthocentrinae)

1. Mandibles unsclerotized and, of the head sclerites, only the pleurostoma and each lateral part of the epistoma are sclerotized; accessory longitudinal tracheal commissure not present **Collyriinae**
 Mandibles well sclerotized, or, if not, then labial sclerite present; accessory longitudinal tracheal commissure present in thorax 2
2. Labral sclerite present 3
 Labral sclerite absent². 5
3. Spur of hypostoma meeting stipital sclerite on or near to its median end or, if not, then with each lateral part of labral sclerite broadened into roughly quadrate area, or with mandible roughly triangular in shape with no clear differentiation between base and blade and with two dorsal rows of large teeth **Pimplinae** other than Pimplini and Acaenitini
 Spur of hypostoma not meeting stipital sclerite close to its median end; each lateral part of labral sclerite not broadened into quadrate area; mandible with blade clearly differentiated from base 4
4. Epistomal arch lightly sclerotized³ **Tryphoninae**
 Epistomal arch not sclerotized⁴. **Cryptinae**

² Except *Opheltes*, *Protarchus* (Mesoleiinae, Mesoleiini).

³ Except *Idiogramma* (Tryphoninae, Idiogrammatini).

⁴ Except *Gambrus* (Cryptinae, Cryptini).

EXPLANATION OF SYMBOLS ON FIGURE 1

- | | |
|---|--|
| ama: Anterior mandibular articulation | lc: Lacinia |
| ant: Antenna | lm: Labrum |
| ant sk: Antennal socket | lms: Labral sclerite |
| app: Anterior pleurostomal process | lplp: Labial palp |
| at: Anterior tentorial pit | md: Mandible |
| atr: Atrium of spiracle | mplp: Maxillary palp |
| ba: Base of mandible | mx: Maxilla |
| bl: Blade of mandible | oc: Occiput |
| ca: Closing apparatus of spiracle | ol: Ocular line |
| cd: Cardo | pa: Parietal region of cranium |
| clp: Clypeus | plb: Postlabium |
| cs(decl): Coronal stem of dorsal
ecdysial cleavage line | plst: Pleurostoma |
| dfrm: Cranial depression associated with
origin of frontal muscles | pma: Posterior mandibular articulation |
| epst: Epistoma | poc: Postocciput |
| fm: Food meatus | pos: Postoccipital sulcus |
| fr: Frons | ppp: Posterior pleurostomal process |
| ge: Gena | prlb: Prelabium |
| hyph: Hypopharynx | pt: Posterior tentorial pit |
| hsp: Sclerotic spur of hypostoma | slo: Salivary orifice |
| hst: Hypostoma | sp: Silk press |
| lb: Labium | ss(q): Stipital sclerite |
| lbs: Labial sclerite | st: Stipes |
| | t: Teeth of mandible |
| | vx: Vertex |

5. Epistomal arch well sclerotized ⁵ 6
 Epistomal arch very lightly sclerotized or absent ⁶ 11
6. Labial sclerite at least moderately sclerotized 7
 Labial sclerite never more than very faintly sclerotized 10
7. Labial sclerite complete ventrally 8
 Labial sclerite incomplete ventrally ⁷ 9
8. Stipital sclerite and hypostomal spur well sclerotized . **Pimplinae, Pimplini**
 Stipital sclerite and hypostomal spur very lightly sclerotized.
Pimplinae, Acaenitini
9. Setae present on prelabium **Metopiinae**
 Setae absent from prelabium ⁷ **Anomalinae**
10. Mandible with grooved blade containing prominent tooth; hypostoma very
 lightly sclerotized; labial palps not disc-shaped **Orthopelmatinae**
 Mandible without grooved blade containing prominent tooth; hypostoma
 well sclerotized; labial palps disc-shaped **Ichneumoninae**
11. Labial sclerite sharply pointed ventrally **Diplazoninae**
 Labial sclerite not sharply pointed ventrally 12
12. Mandible with base sclerotized only at periphery **Mesochorinae**
 Mandible with base evenly sclerotized 13
13. Stipital sclerite not extending laterally beyond point of meeting with spur of
 hypostoma **Plectiscinae**
 Stipital sclerite extending laterally beyond point of meeting with spur of
 hypostoma 14
14. Mandible with numerous fine teeth on dorsal side of blade . **Adelognathinae**
 Mandible not toothed or with short blunt teeth on dorsal and ventral sides
 of blade 15
15. Hypostoma not extending beyond lateral end of stipital sclerite, or with
 sclerotic band connecting posterior pleurostomal processes across dorsal
 surface of food meatus, or with twelve or more setae situated largely within
 the membrane of the prelabium **Lissonotinae**
 Hypostoma extending beyond lateral end of stipital sclerite; sclerotic band
 not present connecting posterior pleurostomal processes; if numerous
 setae present on prelabium, they are scattered over a very broad labial
 sclerite as well as over the prelabial membrane 16
16. Many (more than four) setae scattered over broad labial sclerite and on
 membrane of prelabium **Ophioninae, Ophionini**
 Not more than four setae on prelabium 17
17. Labial sclerite as wide or wider than long (in anteroposterior direction) and
 hypostomal spur longer than blade of mandible 18
 Labial sclerite longer than wide or, if not, then length of hypostomal spur
 is equal to or less than length of blade of mandible.
Ophioninae, Campoplegini
18. Mandible conical in shape with small tooth at apex.
Ophioninae, Tersilochini
 Mandible not of this shape 19
19. Closing apparatus of spiracle not well sclerotized and broader than spiracle.
Ophioninae, Cremastini
 Closing apparatus of spiracle moderately sclerotized and as wide as or more
 narrow than spiracle **Mesoleiinae**

⁵ Except *Listrodromus* (Ichneumoninae, Listrodromini), *Triclistus* (Metopiinae), *Xanthopimpla* (Pimplinae, Pimplini).

⁶ Except *Exetastes* (Lissonotinae).

⁷ Except *Anomalon* (Anomalinae).

In the following descriptions of larval structure in the various subfamilies, a list of species studied is given. A list is also given of those descriptions in the literature which were thought sufficiently accurate and detailed to help workers in identifying material. The standard of published descriptions of ichneumonid larvae is still poor despite Beirne's (1941) paper, and many references to descriptions have been omitted since the figures given are too small and vague.

The biological notes given for the various subfamilies and tribes are based on those of Townes and Townes (1951) and Walkley (1958). The subfamilies, tribes and genera are considered in the order given by Townes and Townes (1951), or Walkley (1958), except in the case of the Mesochorinae, which are moved from a position following the Anomalinae and placed near the Lissonotinae for reasons stated in the section dealing with the Mesochorinae. The species are considered in alphabetical order. When genera are added to the list of Walkley they are placed near what were thought, on larval characters, to be closely related genera.

Subfamily Pimplinae

FIGURES 2-10

On larval characters the Pimplinae fall into two groups; in one are the Pimplini and in the other are the Ephialtini, Polysphinctini, Neoxoridini, Rhyssini, Theroniini, Labenini, and Xoridini. The Acaenitini have a special position. The Pimplini usually have the epistoma well sclerotized, the hypostoma short, and the mandible large and without teeth. The labial sclerite is longer than wide and its ventral side is broad. The labral sclerite is absent. The setae on the skin are small. In the second group the epistoma is, at most, lightly sclerotized, and the hypostoma is long. The mandibles are relatively smaller than in the Pimplini and they usually bear teeth. The form of the mandible is similar in the Ephialtini, Neoxoridini, Rhyssini, and Labenini in having a slender blade and a dorsal and ventral row of small teeth. In the Theroniini and in *Delomerista* (Ephialtini) the blade of the mandible is bifurcated, one part having dorsal and ventral teeth and the other being toothless. The labial sclerite is basically triangular in shape, although in the Rhyssini and Neoxoridini the labial sclerite is pointed ventrally, and in the Theroniini the ventral part of the labial sclerite is broad so that the sclerite resembles that of the Pimplini and Acaenitini. The labral sclerite is present. The setae on the skin are relatively longer than in the first group. The Acaenitini show characters of both groups. The mandible is similar to that of the Pimplini, and the absence of the labral sclerite and the presence of a sclerotized epistoma also suggest this

tribe. But the hypostoma is long and the labial sclerite is roughly triangular in shape, although the ventral part of the sclerite is broad as in the Pimplini. In all tribes of the Pimplinae, with the exception of the Labenini and Xoridini, the hypostomal spur meets the stipital sclerite on or near the point of meeting of this and the labial sclerite. In the Pimplini this results in the sclerites around the mandibles having a ringlike appearance. Apart from this one character the groups in the Pimplinae are distinct.

Since the Pimplini (with the possible exception of *Itopectis*) are endoparasites which emerge from the pupa of the Lepidopterous host, and the remaining tribes of the Pimplinae (with the possible exception of some Acaenitini) are ectoparasites, differences in larval structure might be expected. The Pimplini, with their large, toothless mandibles and well-developed epistomal and pleurostomal sclerites resemble to some degree other ichneumonid larvae with similar habits (see pp. 502, 505, 506).

Beirne (1941) in his classification of larval Ichneumonidae has placed the Polysphinctini, Rhyssini, Ephialtini, and Xoridini with the Cryptinae. This has not been followed in the present study for, although the Pimplini differ in many aspects from the Ephialtini and similar tribes, the position of the hypostomal spur gives a common character for the subfamily. Where this character is not shown clearly, as in the Labenini and Xoridini, the remaining characters indicate the relationships of the tribe. In the Labenini the form of the mandible closely resembles that of the Ephialtini. In the Xoridini the general form of the head sclerites, particularly the labial sclerite, resembles that of most Pimplinae, rather than any other Ichneumonid group. The form of the mandible of the Xoridini differs from that of all other ichneumonids.

It is significant that the Acaenitini and Theroniini show characters resembling those of both the Pimplini and the Ephialtini and similar tribes.

LARVAL KEY

- | | |
|---|-----------------------|
| 1. Setae on body longer than blade of mandible | Polysphinctini |
| Setae on body not longer than blade of mandible | 2 |
| 2. Labial sclerite sharply pointed ventrally | 3 |
| Labial sclerite not sharply pointed ventrally | 4 |
| 3. Ventral point of labial sclerite continuous with sclerite | Rhyssini |
| Ventral point of labial sclerite appearing as distinct plate at end of sclerite. | Neoxoridini |
| 4. Each lateral part of labral sclerite expanded into quadrate-shaped area. | Labenini |
| Each lateral part of labral sclerite not expanded into quadrate-shaped area | 5 |

5. Ventral part of labial sclerite broad and without lobes on ventral surface.
Theroniini
 Ventral part of labial sclerite, if broad, has lobes on ventral surface . . . 6
6. Mandible triangular with no sharp differentiation between base and blade.
Xoridini
 Mandible with sharp differentiation between base and blade . . Ephialtini

Tribe Ephialtini

FIGURES 2-4

The epistoma is absent except in *Tromatobia* where it is present as a thin, lightly sclerotized arch; the pleurostoma is lightly sclerotized; the hypostoma is well sclerotized and may be enlarged posterior to the hypostomal spur; the spur of the hypostoma meets the stipital sclerite at its point of meeting the labial sclerite; the stipital sclerite is always present but it may be short; the cardo is visible in some genera as a lightly sclerotized plate; the labial sclerite is roughly triangular in shape; the labral sclerite is present and its median part is lightly sclerotized and often bilobed; the mandible in most genera has a slender blade with a row of fine teeth on the dorsal and on the ventral surfaces (but *Tromatobia* appears to have only a dorsal row of teeth, and in *Delomerista diprionis* Cushman the blade is bifurcated); the antenna is papilliform; the closing apparatus of the spiracle is narrower than the atrium and is usually separated from the atrium by a length of trachea equal in length to that of the closing apparatus, although in *Alophosternum* the closing apparatus is long and slender; the skin has well developed setae which are usually equal in length to the blade of the mandible; in *Tromatobia* the setae are very small and groups of spines are present; spines are absent from other genera of the tribe.

LARVAL KEY

1. Small lobes present on ventral edge of labial sclerite⁸ 2
 Small lobes not present on ventral edge of labial sclerite 3
2. Hypostomal spur as broad as or broader than posterior part of hypostoma.
Calliephialtes, Ephialtes
 Hypostomal spur more narrow than posterior part of hypostoma . . Scambus
3. Mandible with blade bifurcated⁹ *Delomerista*
 Mandible with blade not bifurcated 4
4. Enlargement present on posterior part of hypostoma *Iseropus*
 Enlargement not present on posterior part of hypostoma 5
5. Slender epistomal arch present *Tromatobia*
 Epistomal arch absent *Alophosternum*

⁸ Except *Scambus pomorum* (Ratzeburg) (Inms, 1918; Speyer, 1925) and *Calliephialtes dimorphus* Cushman (Sauer, 1939).

⁹ Except *Delomerista* sp. (Morris, Cameron and Jepson, 1937).

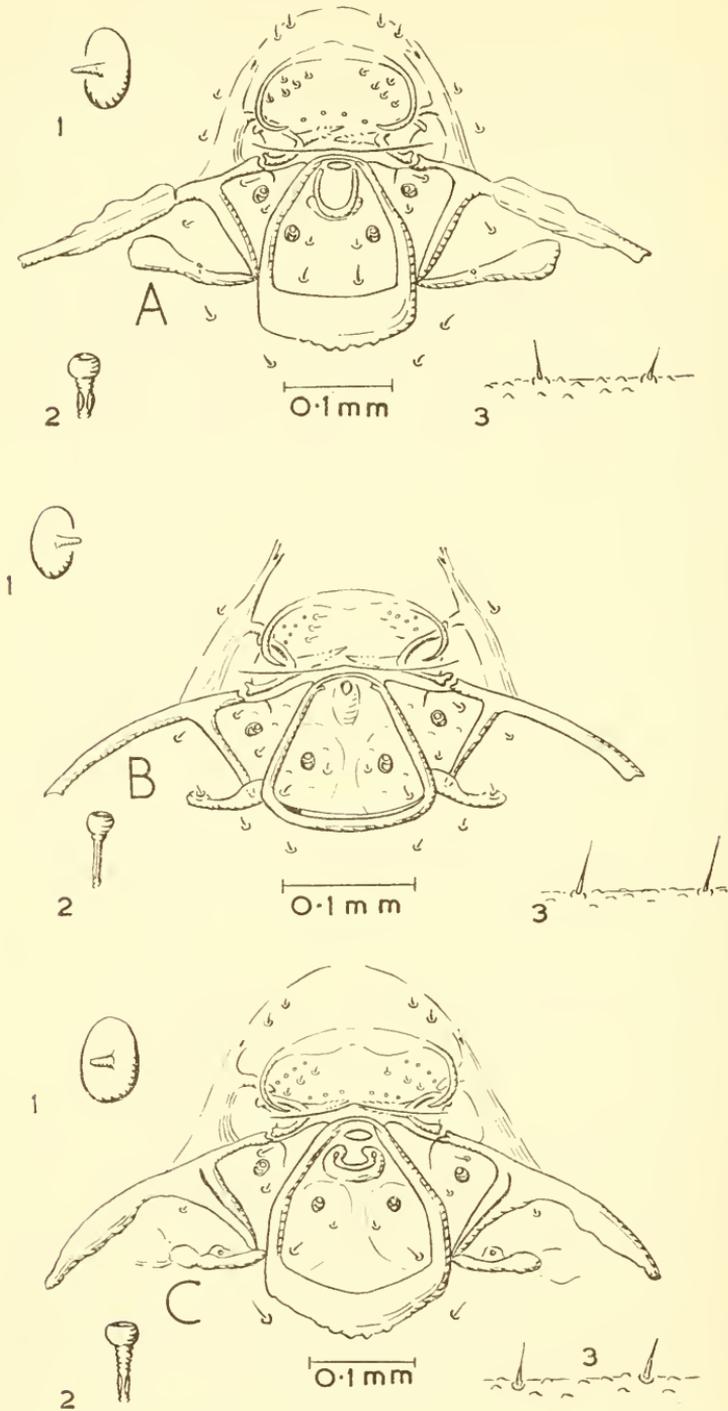


FIGURE 2.—Pimplinae: Ephialtini, head sclerites: A, *Scambus hispae* (Harris); B, *Alophosternum foliicola* Cushman; c, *Calliephialtes variatipes* (Provancher). (1, antenna; 2, spiracle; 3, skin.)

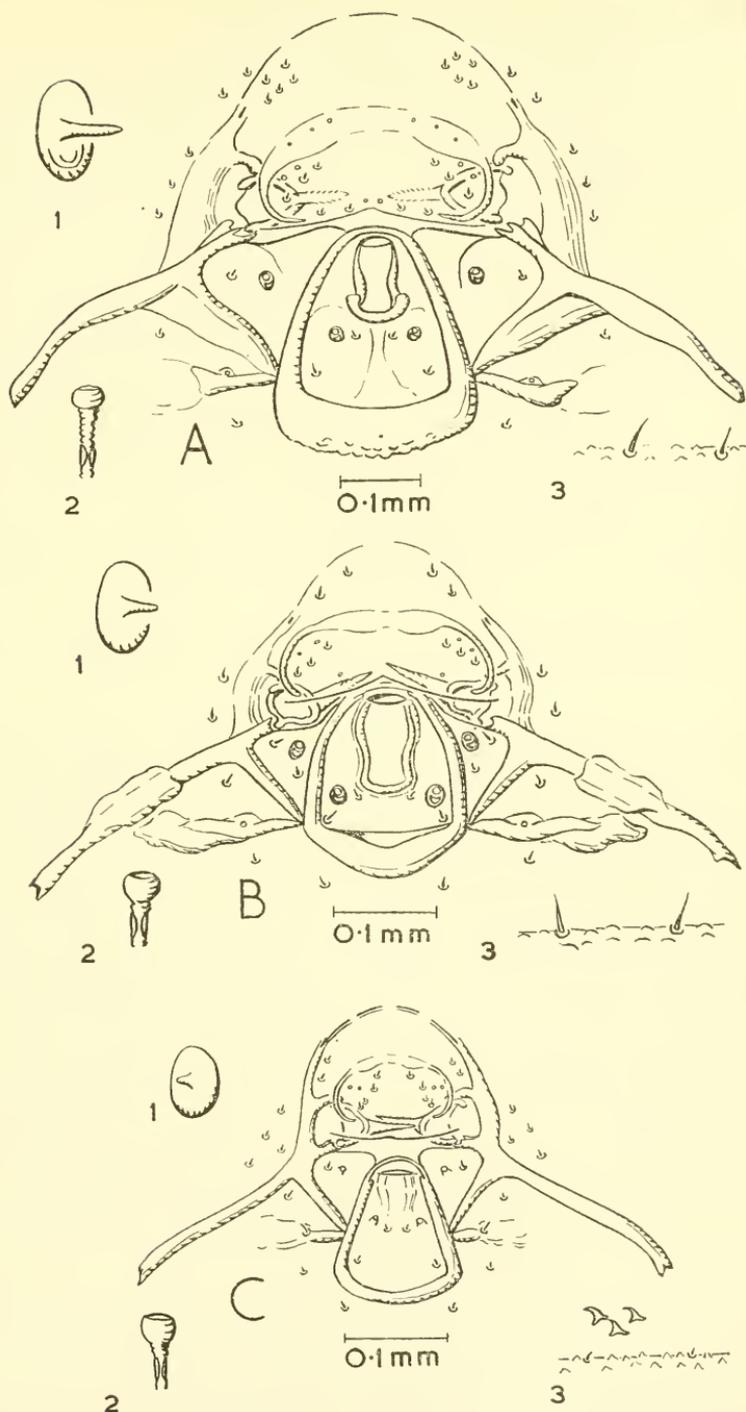


FIGURE 3.—Pimplinae:Ephialtini, head sclerites: A, *Ephialtes irritator* (Fabricius); B, *Iseropus stercorator brunneifrons* (Viereck); C, *Tromatobia rufospectus* (Cresson). (1, antenna; 2, spiracle; 3, skin.)

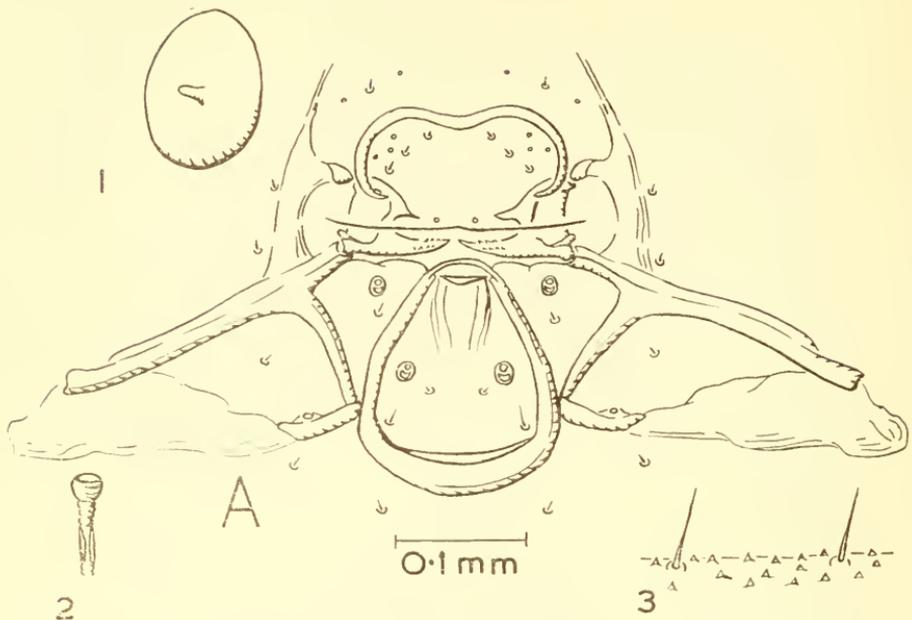


FIGURE 4.—Pimplinae: Ephialtini, head sclerites: *Delomerista diprionis* Cushman. (1, antenna; 2, spiracle; 3, skin.)

The above key must be regarded as provisional, for, on the present material, it is very difficult to decide on any one characteristic of a genus. This may be due to the fact that *Scambus*, to take one example, is a composite genus. Dr. G. S. Walley (in litt.) has reached such a conclusion on *Scambus* from study of the adults.

Genus *Scambus*.—*S. hispae* (Harris) has been examined (fig. 2A). *S. brevicornis* (Gravenhorst) is figured by Thorpe (1930), *S. detritus* (Holmgren) by Salt (1931), *S. foliae* (Cushman) by Dowden (1941), and *S. pomorum* (Ratzeburg) by Imms (1918) and by Speyer (1926). *S. pomorum* has neither lobes on the ventral surface of the labial sclerite nor an enlargement on the hypostoma as has *S. hispae*. *S. brevicornis*, *S. foliae* and *S. detritus* have lobes on the ventral surface of the labial sclerite, but an enlargement is not present on the hypostoma. The ventral surface of the labial sclerite of *S. detritus* is more pointed than in other species. These points are of interest since *Tromera pomorum* (Ratzeburg) and *Epiurus brevicornis* (Gravenhorst) are type species of genera synonymized under *Scambus*.

Genus *Alophosternum*.—*A. follicola* Cushman has been examined (fig. 2B). The closing apparatus of the spiracle of this genus differs from others of the tribe in its long slender shape (fig. 2B₂).

Genus *Calliephialtes*.—*C. nubilipennis* (Viereck) and *C. variatipes* (Provancher) (fig. 2c) have been examined. Both species possess

lobes on the ventral surface of the labial sclerite, which is slightly pointed. The more posterior part of the hypostoma is slightly enlarged in *C. variatipes* but not in *C. nubilipennis*. The body setae are conspicuously large in *C. nubilipennis*. *C. dimorphus* Cushman is figured by Sauer (1939) and lobes do not appear to be present on the ventral surface of the labium, although the figure is too small to show the head structures clearly.

Genus *Ephialtes*.—*E. irritator* (Fabricius) has been examined (fig. 3A). *E. elegans* (Woldstedt) is figured by Beirne (1942a), *E. manifestor* (Linnaeus) by Baumann (1933), *E. punctulatus* Ratzeburg by Beirne (1941) and Rosenberg (1934), and *E. ruficollis* (Gravenhorst) by Thorpe (1930). All these species have numerous lobes on the ventral surface of the labial sclerite.

Genus *Iseropus*.—The species of this genus are gregarious. *I. californicus* Cushman and *I. stercorator brunneifrons* (Viereck) (fig. 3B) have been examined. The enlargement of the hypostoma is more marked in *I. californicus* than in *I. stercorator brunneifrons*. *I. stercorator stercorator* (Fabricius) is figured by Beirne (1941).

Genus *Tromatobia*.—Species of this genus parasitize the egg cocoons of spiders. *T. rufopectus* (Cresson) (fig. 3C) and *T. zonata* (Davis) have been examined. The head sclerites are slender with no lobes on the ventral surface of the labium and no enlargement of the hypostoma. A slight epistoma is visible and teeth appear to be present only on the dorsal surface of the mandible. Maneval (1936) notes the presence of groups of large hooked spines on the dorsal surface of the first seven abdominal segments of *Zaglyptus varipes varipes* (Gravenhorst). Similar spines are present on the abdomen of *Tromatobia* (fig. 3C₃). These spines, which appear to be holdfast organs, closely resemble the body spines of the Polysphinctini. Like *Tromatobia* and *Zaglyptus*, the Polysphinctini are parasites of spiders.

Genus *Delomerista*.—The species of this genus are parasites of the cocoons of sawflies. *D. diprionis* Cushman has been examined (fig. 4A). The bifurcate mandibles may be distinctive of this genus. Morris, Cameron, and Jepson (1937) figure *Delomerista* sp., where the mandible appears to have the same shape as that of other Ephialtini and a more or less complete epistoma is present. It is unfortunate that the identification was not taken further.

Tribe Polysphinctini

FIGURE 5

The members of this tribe are parasites of spiders.

The setae on the head and body are conspicuously long, the setae on the body being at least as long as the blade of the mandible; the dorsal part of the epistoma is not sclerotized and the pleurostoma is

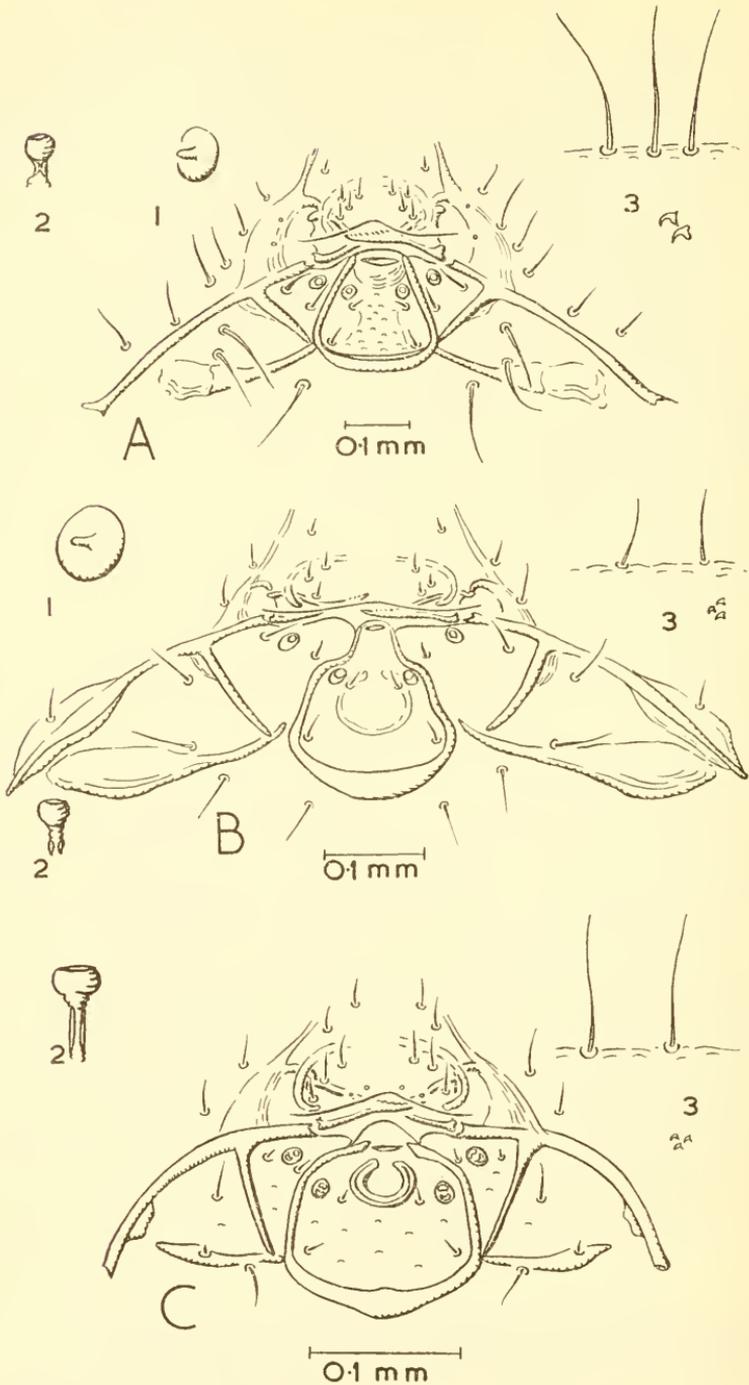


FIGURE 5.—Pimplinae: Polysphinctini, head sclerites: A, *Hymenoepimecis* sp.; B, *Oxyrrhexis carbonator texana* (Cresson); C, *Zatyota* sp., antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

lightly sclerotized; the hypostoma is well sclerotized and in *Oxyrrhexis* and *Acrodactyla* (Beirne, 1941) is expanded at the posterior end; the hypostomal spur is well sclerotized, as is the stipital sclerite which is expanded at its posterior end in *Hymenoepimecis* and *Oxyrrhexis*; the labial sclerite is roughly square in shape in *Zatypota* but roughly triangular in other genera, although the ventral part of the sclerite is pointed in *Zatypota* and *Acrodactyla*; the maxillary and labial palps each have one sensillum in *Hymenoepimecis*, *Oxyrrhexis* and *Acrodactyla*, but there are two sensilla to each palp in *Zatypota*; the labral sclerite is lightly sclerotized in its lateral parts but is unsclerotized dorsally; the mandible is slender and small teeth are present on the dorsal surface of the blade; the antenna is papilliform; the closing apparatus of the spiracle is close to the atrium; long setae are present on the skin; spines, which appear to serve as holdfast organs, are present on the dorsal surface of some body segments. It is not possible to distinguish the precise distribution of these spines from cast skins. Nielsen (1923, 1935, 1936) figures and describes the distribution of these spines in the tribe but gives no adequate figure of the head structure of the larvae.

LARVAL KEY

1. No enlargement present on posterior part of hypostoma . . . **Hymenoepimecis**
 Enlargement present on posterior part of hypostoma 2
2. Lateral end of stipital sclerite expanded **Oxyrrhexis**
 Lateral end of stipital sclerite not expanded 3
3. Ventral part of labial sclerite with small dorsal projection into prelabial area **Zatypota**
 Ventral part of labial sclerite without dorsal projection **Acrodactyla**

The following have been examined: *Hymenoepimecis* sp. (fig. 5A), *Oxyrrhexis carbonator texana* (Cresson) (fig. 5B), and *Zatypota* sp. (fig. 5c). *Acrodactyla degener* (Haliday) is figured by Beirne (1941).

Tribe Pimplini

FIGURES 6, 7

The members of this tribe are endoparasites of a variety of lepidopterous pupae.

The head sclerites are distinctive in that they appear to form a ring around the mouth. The epistoma is well sclerotized, except in *Xanthopimpla*; the pleurostoma is well sclerotized and the hypostoma is short in most species; the hypostomal spur is well sclerotized and the stipital sclerite is short in most species; the labial sclerite is longer than wide with thin lateral parts and a broadened ventral part; the mandible is relatively large and has no teeth on the blade; the labral sclerite is absent and in some genera the sensilla of the labrum

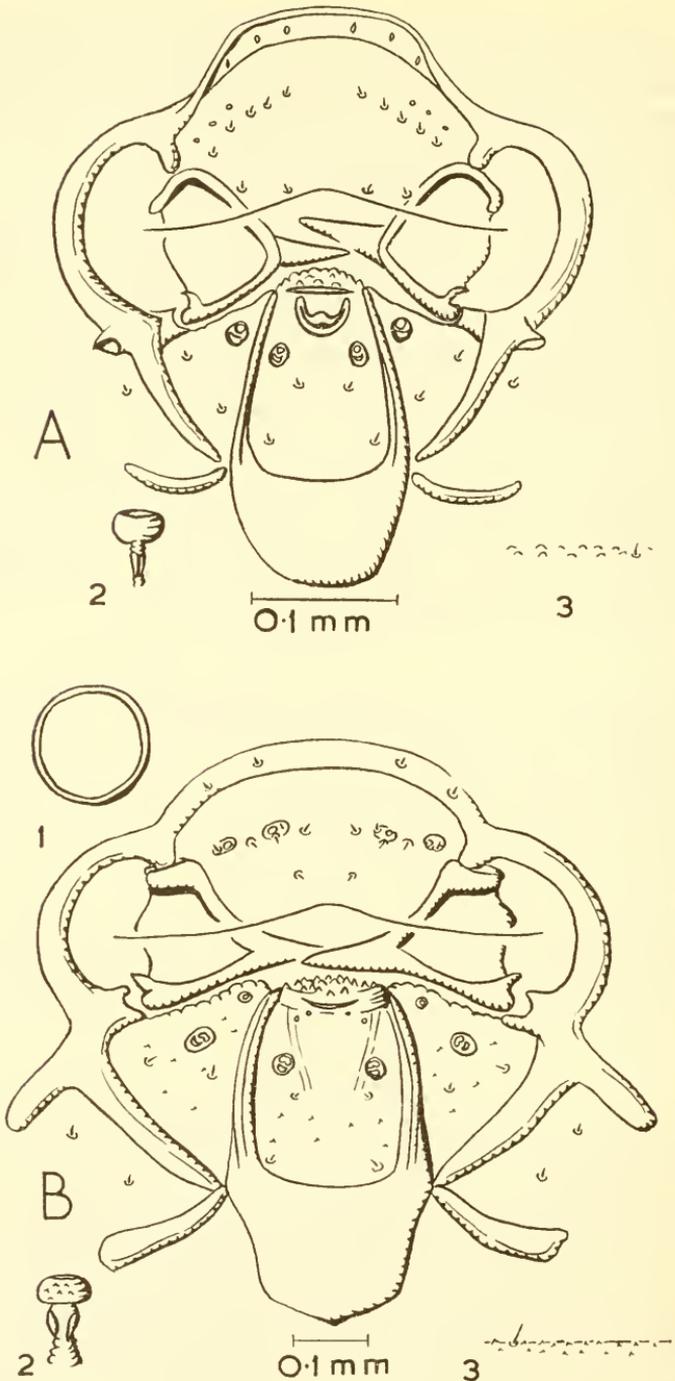


FIGURE 6.—Pimplinae:Pimplini, head sclerites: A, *Pimpla aequalis* Provancher, antenna not visible on preparation; B, *Apechthis compunctor* (Linnaeus). (1, antenna; 2, spiracle; 3, skin.)

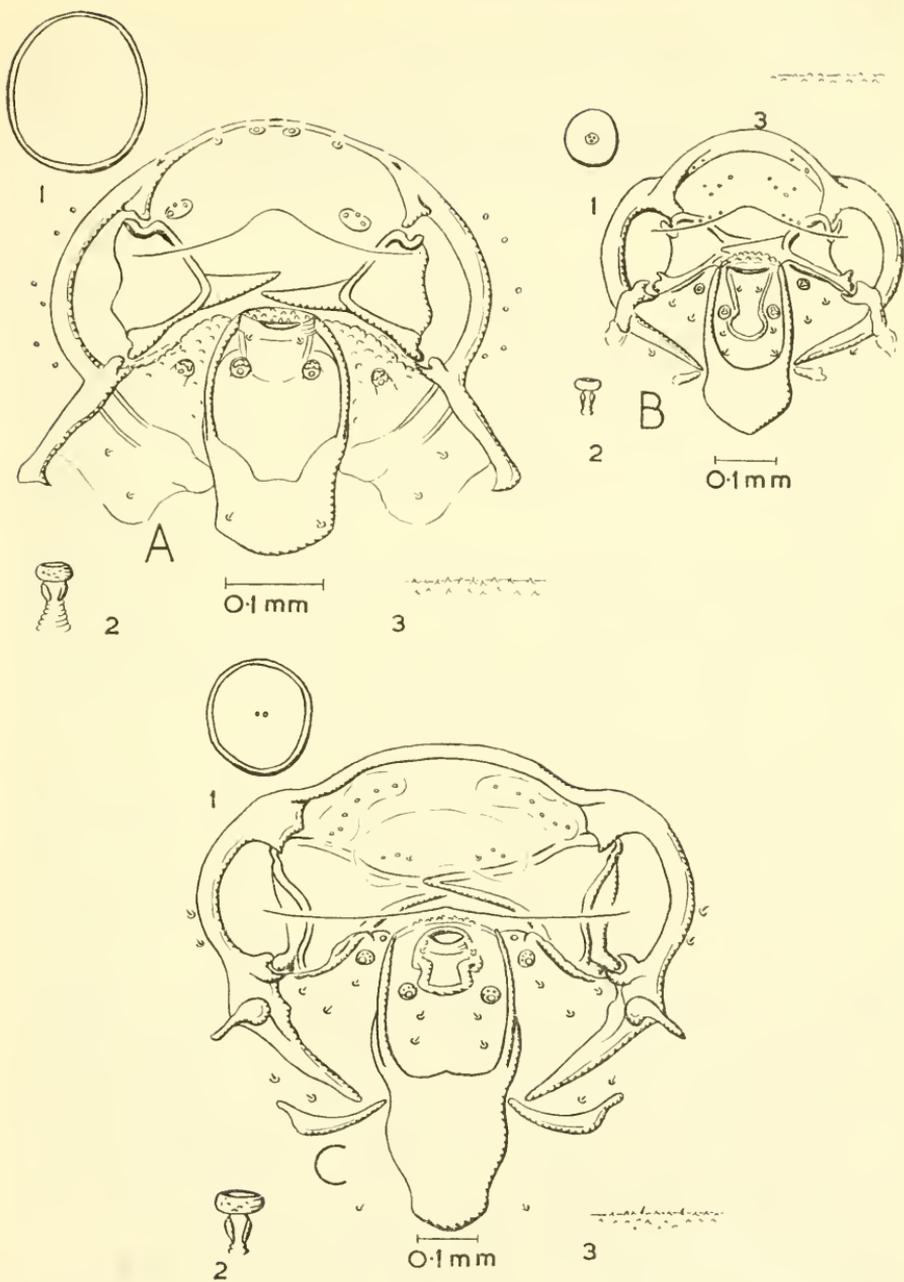


FIGURE 7.—Pimplinae: Pimplini, head sclerites: A, *Xanthopimpla stemmator* (Thunberg); B, *Itoplectis behrensii* (Cresson); c, *Echthromorpha notulatoria* (Fabricius). (1, antenna; 2, spiracle; 3, skin.)

are grouped on certain raised areas; the hypopharynx has numerous small spine-like projections; the antenna is disc-shaped with the circumference lightly sclerotized in some genera, and several sensilla may be visible in the central part of the antenna; the atrium of the spiracle is broad and shallow and the closing apparatus is close to the atrium; the skin is relatively smooth and has small setae.

LARVAL KEY

1. Hypostomal spur with lightly sclerotized lateral expansion . . . **Xanthopimpla**
Hypostomal spur without lightly sclerotized lateral expansion 2
2. Hypostoma approximately equal in length to blade of mandible . **Apechthis**
Hypostoma much shorter than blade of mandible 3
3. Stipital sclerite much shorter than blade of mandible **Itoplectis**
Stipital sclerite approximately equal in length to blade of mandible 4
4. Broadened (ventral) part of labial sclerite about as broad as long and not pointed ventrally **Pimpla**
Broadened (ventral) part of labial sclerite longer than wide and pointed ventrally **Echthromorpha**

Genus *Pimpla*.—*P. aequalis* Provancher (fig. 6A) and *P. inflatus* Townes have been examined. *P. instigator* (Fabricius) is figured by Beirne (1941) and by Meyer (1922), *P. luctunosa* Smith by Itawa (1950), *P. turionellae* (Linnaeus) by Thorpe (1930), Silvestri (1941), and Beirne (1943), and *Pimpla* sp. by Beirne (1942).

Genus *Apechthis*.—*A. compunctor* (Linnaeus) (fig. 6B) has been examined. This species is figured by Beirne (1941).

Genus *Itoplectis*.—The species of this genus may be primary or secondary parasites. Professor Varley (in litt.) informs me that *I. maculator* (Fabricius) appears to be more often a primary parasite on *Tortrix* and other species, although sometimes a secondary parasite. *I. behrensii* (Cresson) (fig. 7B) and *I. conquisitor* (Say) have been examined. *I. alternans* (Gravenhorst) is figured by Morris, Cameron, and Jepson (1937), *I. olivalis* Thomson by Beirne (1941), and *Itoplectis* sp. by Snodgrass (1935). Morris, Cameron, and Jepson (1937) state that the inner aspects of the teeth of *I. alternans* are armed with bristles. Teeth have not been recorded on the blade of the mandible in any other species of this tribe. These authors studied this species as a primary parasite of *Diprion*. It oviposited on prepupae and pupae within the host cocoon and fed externally. All other genera of the Pimplini appear to be endoparasites.

Genus *Echthromorpha*.—*E. insidiator* (Smith) and *E. notulatoria* (Fabricius) (fig. 7C) have been examined. *E. formosa* (Smith) is figured by Beirne (1941).

Genus *Xanthopimpla*.—The broad and lightly sclerotized hypostomal spur and the lightly sclerotized epistoma are characteristic of this genus. The stipital sclerite is short and fused with the hypostomal

spur. *X. cera* (Cameron), *X. enderteini* Krueger, and *X. stemmator* (Thunberg) (fig. 7A) have been examined. *X. pedator* (Thomson), figured by Beirne (1941), differs from other species of the genus in that the lateral parts of the labial sclerite are very broad; however, the hypostomal spur and the stipital sclerite appear to be similar to those of other species. *X. citrina* (Holmgren) is figured by Moutia and Courtois (1952).

Tribe Neoxoridini

FIGURE 8A

The only species of this tribe examined was *Neoxorides borealis* (Cresson) (CDA) (fig. 8A). Members of this genus are parasites of wood-boring Coleoptera.

The dorsal part of the epistoma is unsclerotized but the pleurostoma and hypostoma are well sclerotized; the hypostomal spur has a broad dorsal part but narrows ventrally where it fuses with the narrow stipital sclerite; the lateral end of the stipital sclerite is Y-shaped; the ventral part of the labial sclerite is broad and pointed, although the point appears as a separate cap on the remainder of the labial sclerite; the maxillary and labial palps each have two sensilla, one round and one crescentic in shape; only the lateral parts of the labral sclerite are well sclerotized; the mandible has a slender blade and a dorsal and ventral row of small teeth, thus resembling the mandibles of the Ephialtini, Rhyssini and Labenini; the antenna is papilliform; the atrium of the spiracle is funnel-shaped and the closing apparatus is close to the atrium; the skin has setae of moderate size but no spines.

Tribe Rhyssini

FIGURE 8B

Species of this tribe parasitize wood-boring Coleoptera and sawflies. The only specimen examined was *Rhyssa* sp. (fig. 8B).

The dorsal part of the epistoma is not sclerotized and the pleurostoma is lightly sclerotized; the hypostoma and hypostomal spur are well sclerotized and the hypostomal spur is broad at its dorsal end; the stipital sclerite is well sclerotized and is broad at its lateral end; the labial sclerite is sharply pointed ventrally; the maxillary and labial palps each have two sensilla, one round and one crescentic; the dorsal part of the labral sclerite is not sclerotized; the mandible has a slender blade with a dorsal and ventral row of small teeth; there is a small, lightly sclerotized plate on the clypeus; the antenna is papilliform; the atrium of the spiracle is funnel-shaped and the closing apparatus, which has relatively thick walls, adjoins the atrium; the skin has setae of moderate size but no spines.

Rhyssa sp. is figured by Beirne (1941).

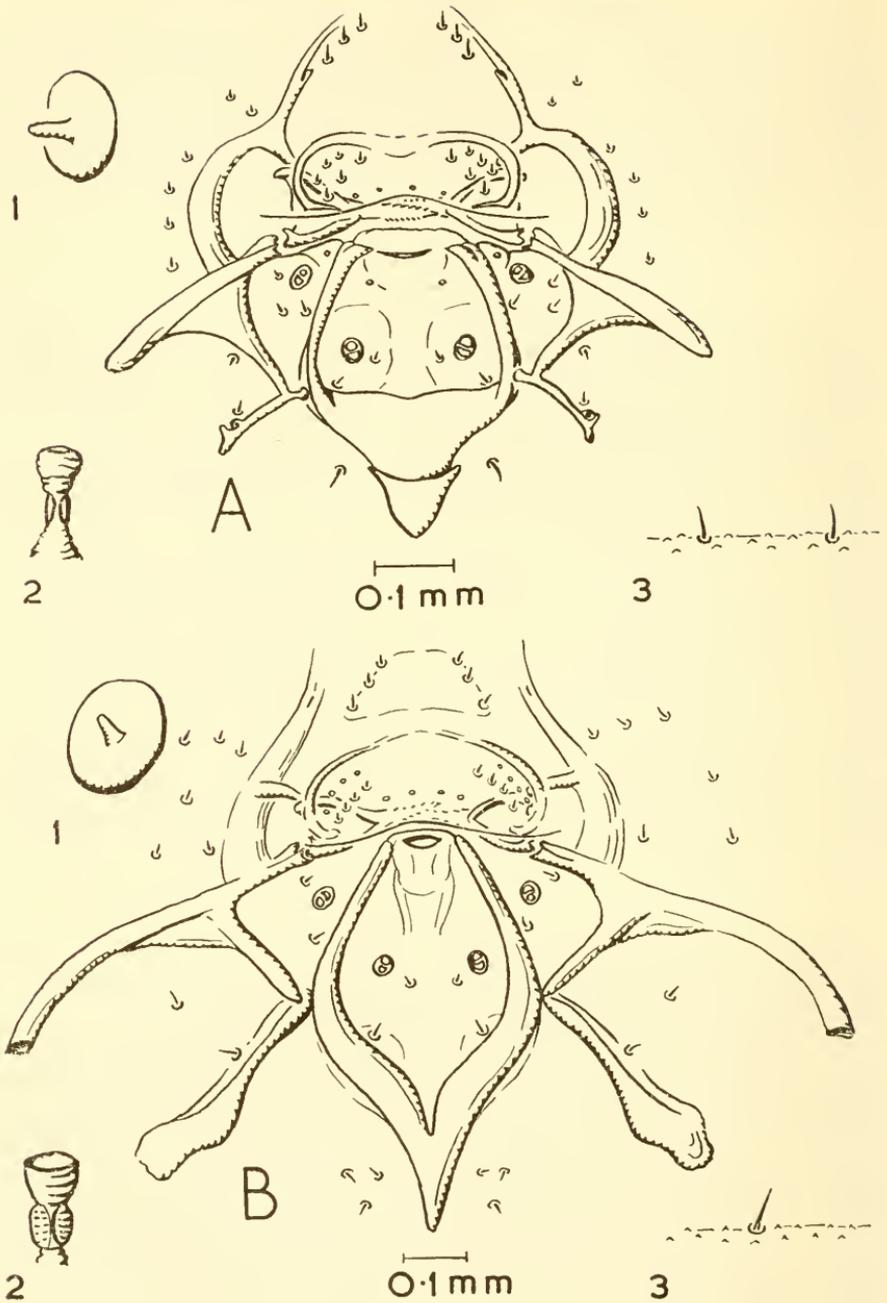


FIGURE 8.—Pimplinae, head sclerites: A, *Neoxorides borealis* (Cresson) (Neoxoridini); B, *Rhyssa* sp. (Rhyssini). (1, antenna; 2, spiracle; 3, skin.)

Tribe Theroniini

FIGURE 9A

The only species examined was *Theronia atalantae* (Poda) (fig. 9A). The species of *Theronia* are usually primary and secondary parasites of the pupae of Lepidoptera.

The dorsal part of the epistoma is unsclerotized and the pleurostoma is lightly sclerotized; the hypostoma and hypostomal spur are slender and well sclerotized; the stipital sclerite is lightly sclerotized and a very lightly sclerotized cardo is present; the lateral parts of the labial sclerite are slender and well sclerotized and the ventral part is broad and lightly sclerotized; each maxillary and labial palp has two sensilla, one round and one crescentic in shape; the labral sclerite is present; the mandible has a broad base and the blade is bifurcated with one part bearing dorsal and ventral teeth and the other, which projects posteriorly, being toothless; the antenna bears a small papillus; the closing apparatus of the spiracle has slender walls and adjoins the atrium; the skin bears setae approximately equal in length to that of the toothed part of the blade of the mandible and has no spines.

The mandible and the labial sclerite of the final instar larva of *T. atalantae* are figured by Meyer (1922).

Tribe Labenini

FIGURE 9B

The only species examined was *Labena grallator* (Say) (fig. 9B). Species of the genus *Labena* parasitize wood-boring Coleoptera.

The dorsal part of the epistoma is very faintly sclerotized; the pleurostoma is well sclerotized and has a lightly sclerotized lateral expansion; the hypostoma is well sclerotized and has a lightly sclerotized posterior expansion; the hypostomal spur is well sclerotized; the stipital sclerite is V-shaped with its lateral part expanded and curved dorsally; the labial sclerite is similar in shape to that of many Ephialtini, but there are no lobes on the ventral surface; on each maxillary and labial palp there are two sensilla, both round and one smaller than the other; the labral sclerite is distinctive with each lateral part bearing a quadrate-shaped expansion and the median (dorsal) part being unsclerotized except for a small, lightly sclerotized plate; the antenna is papilliform; the atrium of the spiracle is oval in shape and the closing apparatus is thick-walled and situated close to the atrium; the skin has setae of moderate size but no spines.

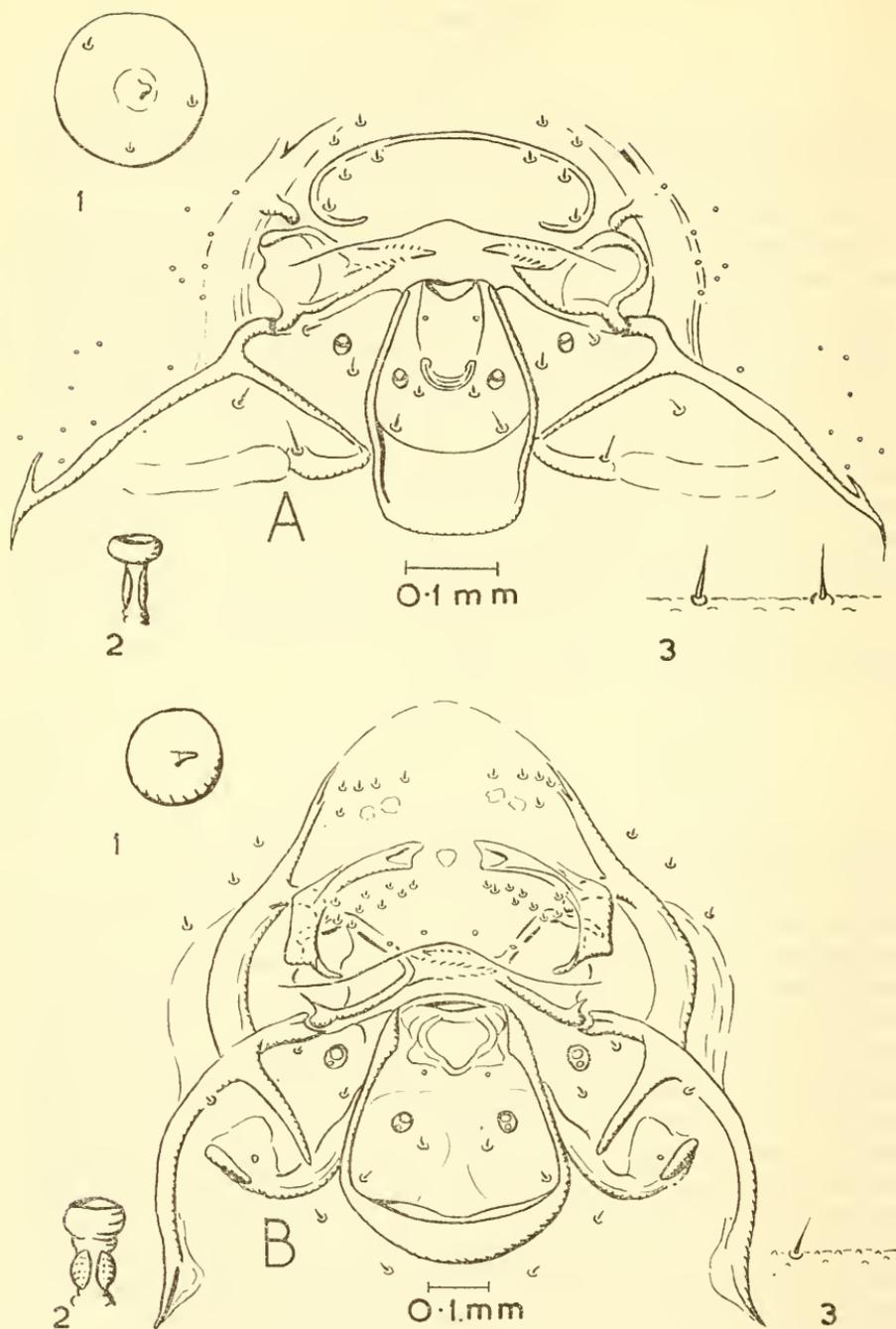


FIGURE 9.—Pimplinae, head sclerites: A, *Theronia atalantae* (Poda) (Theroniini); B, *Labena grillator* (Say) (Labenini). (1, antenna; 2, spiracle; 3, skin.)

Tribe Xoridini

FIGURE 10A

Species of this tribe parasitize wood-boring Coleoptera.

Xorides insularis (Cresson) and *X. rileyi* (Ashmead) (fig. 10A) have been examined.

In the genus *Xorides* the dorsal part of the epistoma is not sclerotized, but the pleurostoma, hypostoma, hypostomal spur, and stipital sclerite are well sclerotized; the labial sclerite is roughly triangular in shape; the maxillary and labial palps each bear two sensilla, one round and one crescentic in shape; the labral sclerite in both species examined does not have the dorsal part sclerotized and each lateral part consists of two sclerotic bands which join ventrally; the mandible is distinctive with a broad blade bearing two rows of large teeth on the dorsal surface; the antenna is papilliform; the spiracular atrium is oval in shape and the closing apparatus is close to the atrium; small setae but no spines are present on the skin.

Ischnoceros rusticus (Geoffroy) is figured by Berine (1941), *Xoridescopus* sp. by Ayyar (1943), *X. brachylabris* (Kriechbaumer) by Chrystal and Skinner (1931), *Xorides praecatorius* (Fabricius) by Beirne (1941), and *Xorides* sp. by Short (1952). All specimens described in the literature appear to have the labral sclerite consisting only of a single sclerotic band and not double as in the species figured in the present paper. Chrystal and Skinner show small lobes on the ventral surface of the labial sclerite of *X. brachylabris*. The labium thus resembles those of some Ephialtini. These authors also record that there is no striking difference between the larva of this species and that of *X. irrigator* (Fabricius) which they also examined. These lobes have not been recorded on the labium of any other species of this tribe, although Ayyar figures what appears to be a sclerotic plate beneath the ventral surface of the labial sclerite in *Xoridescopus*. It is unfortunate that this figure is poor and on bad paper.

Tribe Acaenitini

FIGURE 10B

Members of this tribe are parasites of wood-boring Coleoptera. The only species of this tribe examined was *Arotes formosus* Cresson (fig. 10B). Cushman and Rohwer (1921, p. 392) state that the group is ectoparasitic. The complete epistoma, toothless mandible and small skin setae of *Arotes* suggest that it is an endoparasite, although the larval characters of *Coleocentrus*, as figured by Baumann (1933), suggest that this genus is an ectoparasite.

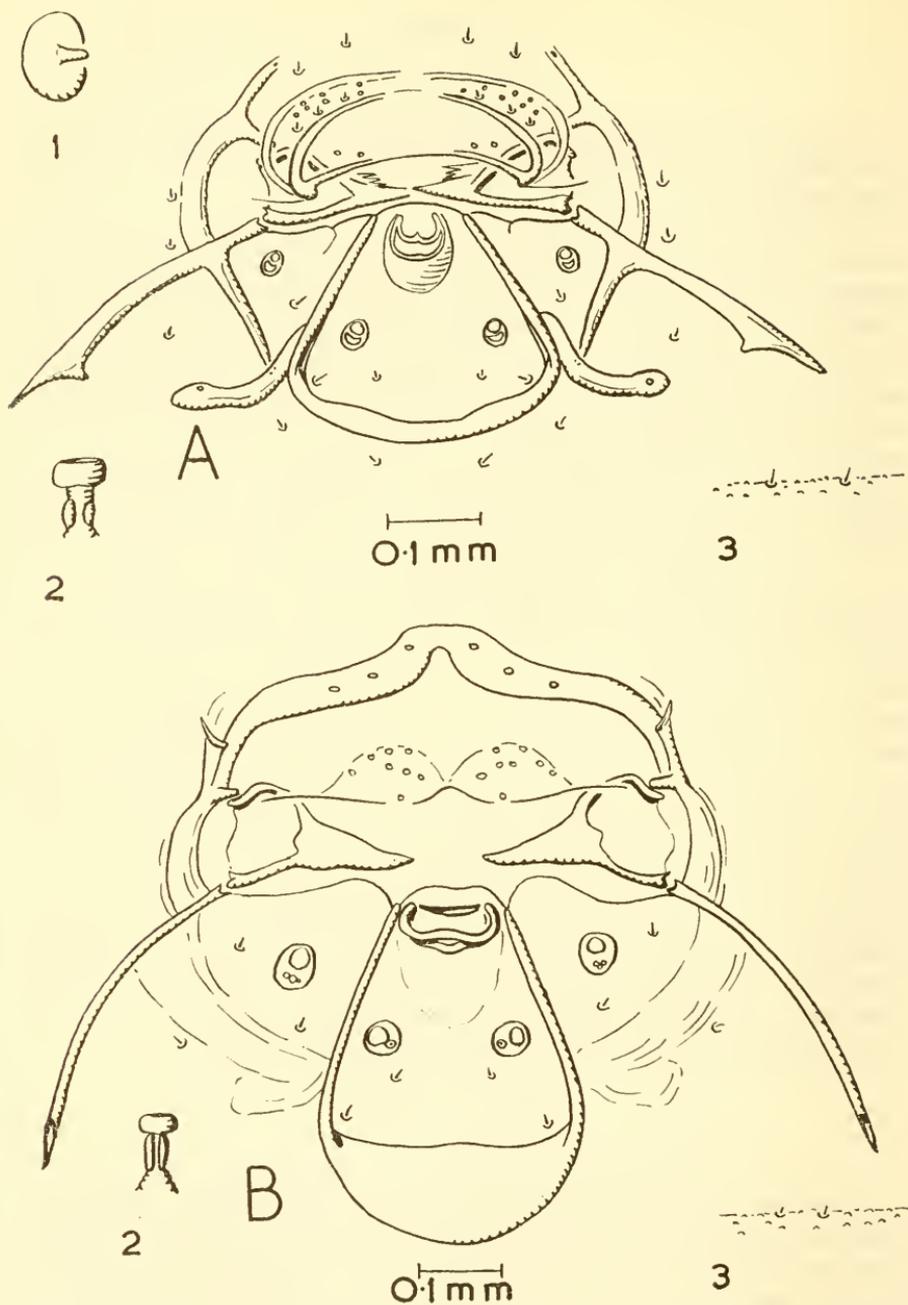


FIGURE 10.—Pimplinae, head sclerites: A, *Xorides rileyi* (Ashmead) (Xoridini); B, *Arotes formosus* Cresson (Acaenitini), antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

It has been already noted that the Acaenitini have characters similar to those of the two groups of the Pimplinae, the Ephialtini and similar tribes, and the Pimplini.

In the genus *Arotas* the epistoma and pleurostoma are moderately sclerotized and broad; the hypostoma is moderately sclerotized but very slender; the hypostomal spur is broad and very lightly sclerotized; the stipital sclerite is short, broad and very lightly sclerotized; the labial sclerite is roughly triangular in shape, but the ventral part is much broader than the lateral parts as in the Pimplini; the maxillary palps each bear one large, round sensillum and a group of smaller sensilla; each labial palp bears one large round sensillum and one small sensillum; the labral sclerite is absent and there are two prominent groups of sensilla on the labrum; the mandibles resemble those of the Pimplini in having a large blade and no teeth; the antennae were not visible on the specimen; the spiracular atrium is oval, and the closing apparatus, which is relatively long and with thin walls, is situated adjacent to the atrium; the skin has very small setae but no spines.

Coleocentrus excitator (Poda) is figured by Baumann (1933). The antenna of this species appears to be disc-shaped. The epistoma appears to be incomplete, but the figure given is too small to make this point clear.

Subfamily Adelognathinae

FIGURE 11A

Members of this subfamily are gregarious external parasites on sawfly larvae. *Adelognathus* and related genera have been placed as a tribe of Tryphoninae by some authors. In the present study it was found necessary to consider this group as a subfamily since the form of the mandible, the absence of an epistoma and a labral sclerite, the presence of a prelabial sclerite and of a clearly papilliform antenna¹⁰ and the absence of spines on the skin all separate *Adelognathus* from other genera of the Tryphoninae. I have been unable to discover whether *Adelognathus* possesses the stalked egg that is characteristic of the Tryphoninae. The ovaries of an adult were examined and the eggs present did not appear to be stalked.

Adelognathus britannicus Perkins (GCV), *A. pallipes* (Gravenhorst) (GCV) and *Adelognathus* sp. (GCV) were examined.

The dorsal part of the cranium is sufficiently sclerotized to appear dark; the epistoma is unsclerotized except for small projections above

¹⁰ A papilliform antenna is present in *Hybophanes scabriculus* (Gravenhorst) and *Phytodietus pulcherrimus* (Cresson) (Simmonds, 1947) of the Tryphoninae. The antenna was not visible in the specimen of *P. pulcherrimus* examined in the present study. In the remainder of the Tryphoninae the antenna is not papilliform, although a relatively large, rounded sensillum may be present in the middle of the disc-shaped antenna as in *Idiogramma*.

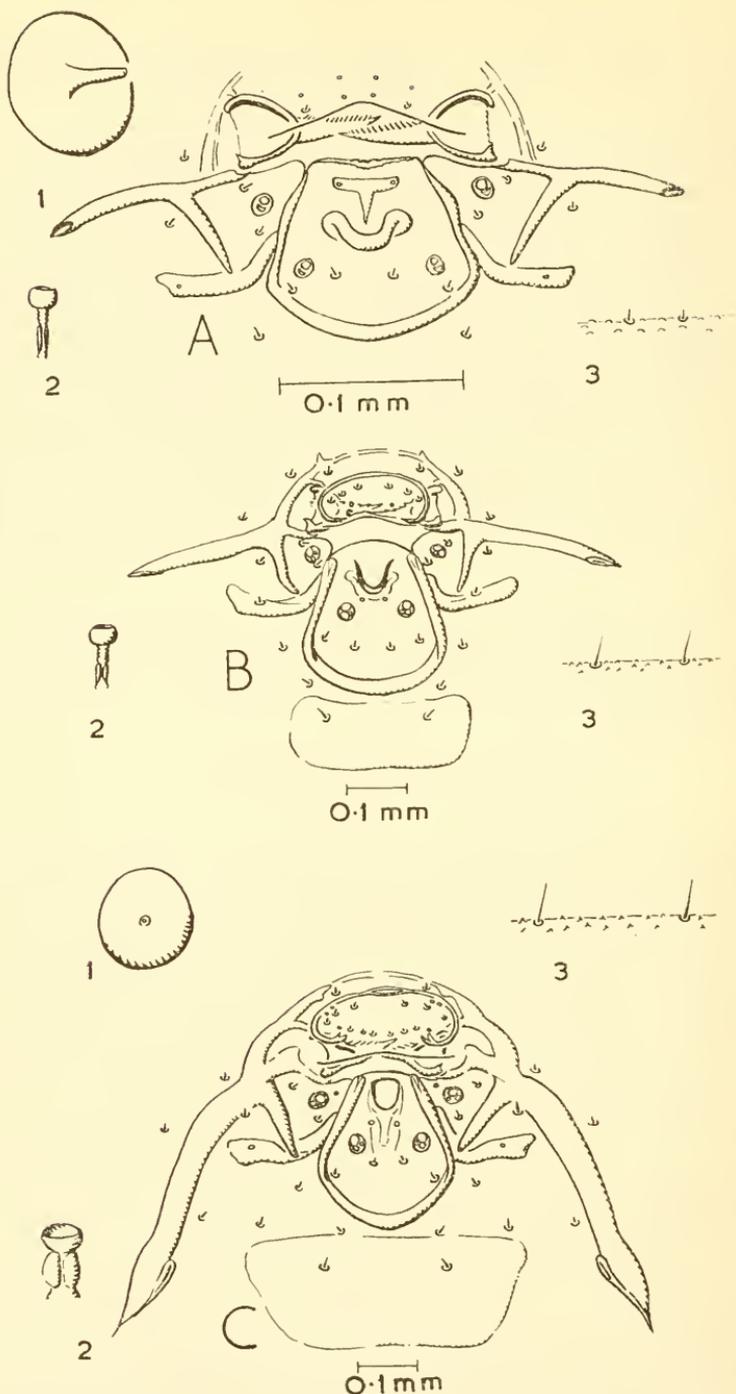


FIGURE 11.—Head sclerites: *Adelognathus pallipes* (Gravenhorst) (Adelognathinae); B, *Phytodietus pulcherrimus* (Cresson) (Tryphoninae:Phytodietini), antenna not visible on preparation; c, *Netelia geminatus* (Say) (Tryphoninae:Phytodietini). (1, antenna; 2, spiracle; 3, skin.)

the anterior pleurostomal processes; the pleurostoma is lightly sclerotized; the hypostoma, hypostomal spur and stipital sclerite are well sclerotized; the labial sclerite is well sclerotized and the lateral parts meet the ventral almost at right angles; a prelabial sclerite is present; each maxillary and labial palp bears two sensilla, one round and one crescentic in shape; the mandibles are distinctive, being large with a long broad blade having a row of fine teeth on the dorsal edge; the labral sclerite is absent; the antenna is papilliform; the closing apparatus of the spiracle is long and slender and is separated from the atrium by a length of trachea equal in length to the atrium; the skin bears small setae but no spines; small bubble-like projections are present on the skin, but these are not pointed and sclerotized as in the Tryphoninae and cannot be called spines.

Beirne (1941) figures *Adelognathus* sp. indescr.

Subfamily Tryphoninae

FIGURES 11B-13D

Members of this subfamily are ectoparasites and the tribes are closely related. The eggs are attached to the skin of the host by a stalk (by other structures in some Cteniscini) and the parasite larva completes its development in the host cocoon.

The head sclerites are all well developed, although the epistoma is only slightly sclerotized in the Phytodietini and the prelabial sclerite is absent; the mandibles are of moderate size and may bear teeth on the dorsal edge of the blade or teeth may be absent; the antenna is disc-shaped with one to three sensilla in the center; the closing apparatus of the spiracle is slender and is situated some distance from the atrium, except in *Netelia* where the closing apparatus is as broad as the atrium and adjoins the atrium; large setae and small spines are present on the skin, except in *Exenterus* where the spines are conspicuously large and are about half as long as the setae.

LARVAL KEY

1. A lightly sclerotized plate is present on the labium ventral to the labial sclerite. **Phytodietini**
 A lightly sclerotized plate is not present on the labium ventral to the labial sclerite 2
2. Dorsal part of epistoma unsclerotized **Idiogrammatini**
 Dorsal part of epistoma sclerotized 3
3. Labial sclerite slender with width much less than that of stipital sclerite. **Boëthini**
 Labial sclerite relatively broad with width approximately equal to that of stipital sclerite 4

4. Mandible without teeth; setae on body with length equal to one-third to one-half that of mandible **Cteniscini**
 Mandible with teeth,¹¹ or, if without teeth, then setae on body large with length equal to approximately three-quarters that of mandible 5
5. Mandible with teeth; maxillary and labial palps each with three sensilla, or, if not, then with two sensilla, one round and one crescentic . . . **Thymaridini**
 Mandible without teeth, or, if with teeth, then maxillary and labial palps each with two sensilla both of which are round **Tryphonini**

Tribe Phytodietini

FIGURE 11B,C

The members of this tribe are parasites of caterpillars. The egg is attached to the host by a stalk and most of the larval development occurs after the host spins its cocoon or makes a pupal cell in the ground.

The lightly sclerotized plate situated on the labium ventral to the labial sclerite is characteristic of this group. In contrast to the other tribes of the subfamily the dorsal part of the epistoma is very lightly sclerotized.

LARVAL KEY

1. Closing apparatus of spiracle narrow and separated from atrium by a length of trachea equal to length of closing apparatus **Phytodietus**
 Closing apparatus of spiracle broad and situated adjacent to atrium . . . **Netelia**

Phytodietus pulcherrimus (Cresson) (fig. 11B), *Netelia exserta* (Cushman), and *N. geminatus* (Say) (fig. 11c) have been examined.

The labral sclerite of *N. exserta* differs from that of *N. geminatus* in that the dorsal part consists only of a single sclerotic band and the lateral parts do not end in forked enlargements. This is of interest since Townes and Townes (1951) place *exserta* in the subgenus *Prosthodocis*, whereas *geminatus* is placed in the subgenus *Netelia*.

There is a relatively large, round sensillum in the center of the antenna in *Netelia*. The sensillum is, however, much smaller than the papillus of a papilliform antenna, and the antenna of *Netelia* is best described as disc-shaped.

Phytodietus pulcherrimus (Cresson) is figured by Simmonds (1947), and *P. gelitorius* (Thunberg) and *Netelia vinulae* (Scopoli) are figured by Beirne (1941). Simmonds does not figure the sclerotized plate on the labium of *P. pulcherrimus*. This is presumably an oversight. Beirne describes a lower row of small teeth near the tip of the blade of the mandible in *Netelia*. This row of teeth was not seen in the species of *Netelia* examined.

¹¹ Teeth are present on the mandible of *Erromenus dolichops* Townes and Townes (Tryphonini) but they are very small. This species (fig. 13A) may be distinguished from the Cteniscini by the shape of the mandible.

Tribe Thymaridini (= Eclytini)

Figure 12A,B

Members of this tribe are parasitic mostly on small Lepidoptera. *Eclytus ornatus* Holmgren is a parasite of Tenthredinidae.

The species examined were *E. ornatus* Holmgren (CDA) (fig. 12A), *E. pleuralis* (Provancher) (CDA), *Hybophanes scabriculus* (Gravenhorst) (GCV) (fig. 12B), and *Neliopisthus elegans* (Ruthe) (GCV).

All the head sclerites are present with the exception of the prelabial and the dorsal part of the labral sclerite is absent in *Hybophanes* and *Neliopisthus*; the epistoma is slender in *Eclytus* but relatively broad, although lightly sclerotized, in *Hybophanes* and *Neliopisthus*; the lateral parts of the labial sclerite meet the ventral almost at right angles in *Eclytus* but the ventral part of this sclerite is rounded in *Hybophanes* and *Neliopisthus*; in *Hybophanes* and *Eclytus ornatus* each maxillary and labial palp has three sensilla, one large, one small and one minute, but in *E. pleuralis* each palp has two sensilla, one round and one crescentic; the mandible has a prominent row of teeth on the dorsal surface of the blade; the closing apparatus of the spiracle is small and the length of trachea which separates it from the atrium is twice as long as the closing apparatus in *Eclytus* and three times as long in *Hybophanes* and *Neliopisthus*; the setae on the skin are prominent, especially in *Hybophanes* and *Neliopisthus*, and there are small spines.

Eclytus fontinalis Holmgren is figured by Beirne (1941).

LARVAL KEY

- 1. Setae on skin of thorax equal in length to blade of mandible **Eclytus**
 Setae on skin of thorax as long as or longer than hypostoma. 2
- 2. Epistoma sharply arched **Hybophanes**
 Epistoma not sharply arched **Neliopisthus**

Tribe Idiogrammatini

FIGURE 12c

Idiogramma sp. was examined. The species of this genus are parasitic on the larvae of *Xyela* feeding in the staminate cones of *Pinus*. *Idiogramma* is an isolated genus showing no close resemblance to other Tryphoninae.

The dorsal part of the epistoma is unsclerotized; the pleurostoma is very lightly sclerotized; the hypostoma, hypostomal spur, stipital sclerite and labial sclerite are moderately sclerotized; each maxillary and labial palp has two sensilla; there is no prelabial sclerite; the silk press is very lightly sclerotized; a labral sclerite is present; the mandibles are distinctive in shape, each having a somewhat square base and a curved toothless blade; the antenna has a large central sensillum

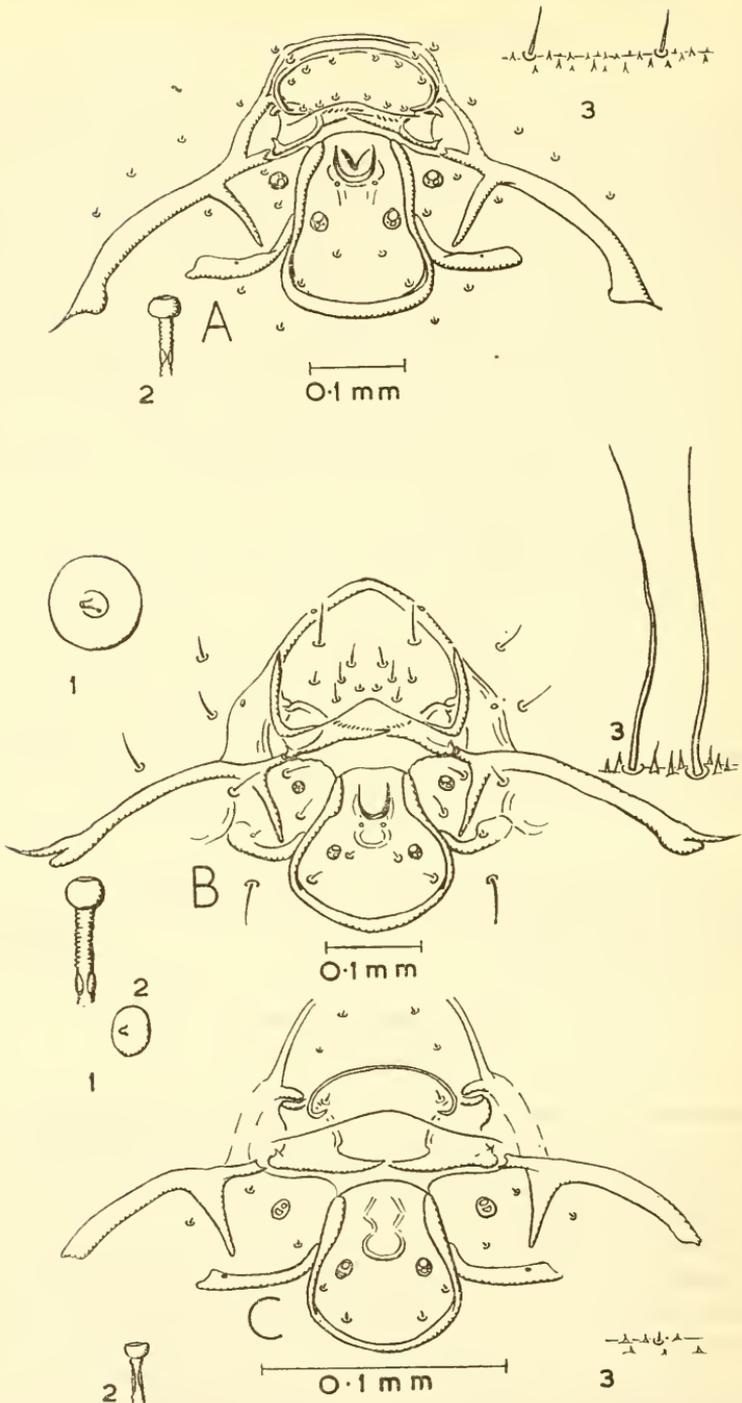


FIGURE 12.—Tryphoninae, head sclerites: A, *Eclytus ornatus* Holmgren (Thymaridini), antenna not visible on preparation; B, *Hybophanes scabriculus* (Gravenhorst) (Thymaridini), with skin showing prothoracic setae and spines; C, *Idiogramma* sp. (Idiogrammatini). (1, antenna; 2, spiracle; 3, skin.)

but is not clearly papilliform; the closing apparatus of the spiracle is separated from the atrium by a length of trachea approximately equal to the depth of the atrium; the skin bears small setae and spines.

It is possible that *Idiogramma* should be placed in a subfamily of its own since the shape of the mandible and the incomplete epistoma separate this genus from other Tryphoninae. However, since the epistoma is partly sclerotized dorsal to the anterior tentorial pits, a labral sclerite is present, the antenna is not papilliform, and the eggs are stalked, the genus has been placed with the Tryphoninae. The structure of the spiracles and the presence of distinct spines on the skin are characteristics similar to those of many Tryphoninae. The characters of *Idiogramma* do not resemble those of any other subfamily of the Ichneumonidae.

Tribe Boëthini

FIGURE 13A

Boëthes sp. was examined. Members of this genus are parasitic on the larvae of argid sawflies.

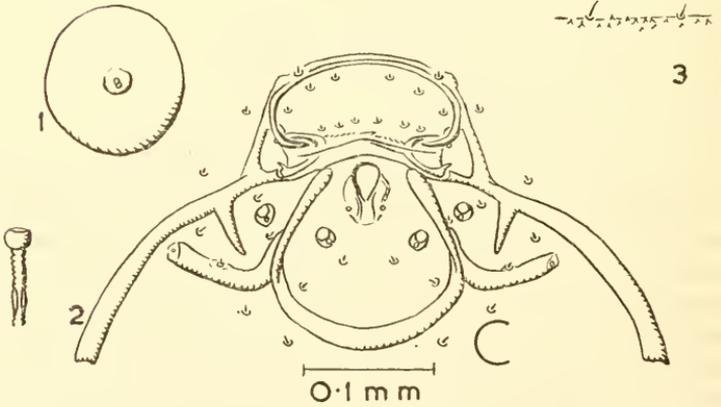
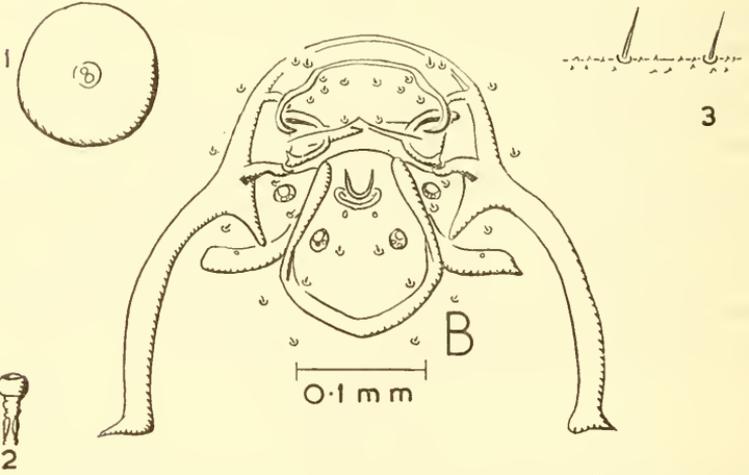
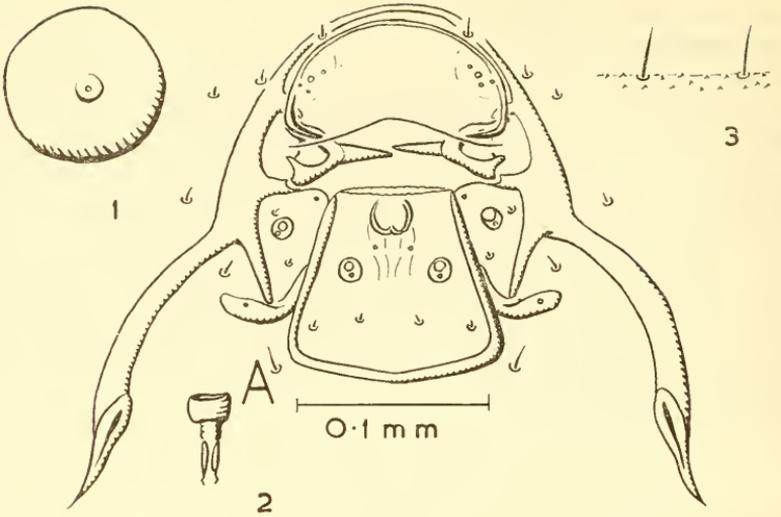
All the head sclerites are present with the exception of the prelabial; the labial sclerite is slender and its lateral parts meet the ventral almost at right angles; each maxillary and labial palp bears two sensilla, both round and one large and one small; two groups each of four sensilla are present on the labrum; the mandibles are without teeth; the antenna is disc-shaped with a prominent sensillum in the center; the length of trachea separating the closing apparatus of the spiracle from the atrium is almost equal to that of the closing apparatus; the skin bears large setae and small spines.

Tribe Tryphonini

FIGURE 13B,C

Members of this tribe are parasites of the larvae of Tenthredinidae. *Polyblastus pedalis* (Cresson) (CDA) (fig. 13B), *Erromenus bedardi* Provancher (CDA), and *E. dolichops* Townes and Townes (CDA) (fig. 13C) have been examined.

All the head sclerites are present with the exception of the prelabial; the ventral part of the labial sclerite is pointed or curved so as to give the sclerite an oval to round appearance; each maxillary and labial palp bears three sensilla in *Polyblastus* and two in *Erromenus*; the mandible is without teeth in *Polyblastus* but has small teeth in *Erromenus*; the disc-shaped antenna has two sensilla; the distance of the closing apparatus of the spiracle from the atrium is about equal in length to the closing apparatus in *Polyblastus*, but the distance is about twice the length of the closing apparatus in *Erromenus*; small spines are present on the skin of both *Polyblastus* and *Erromenus*, but



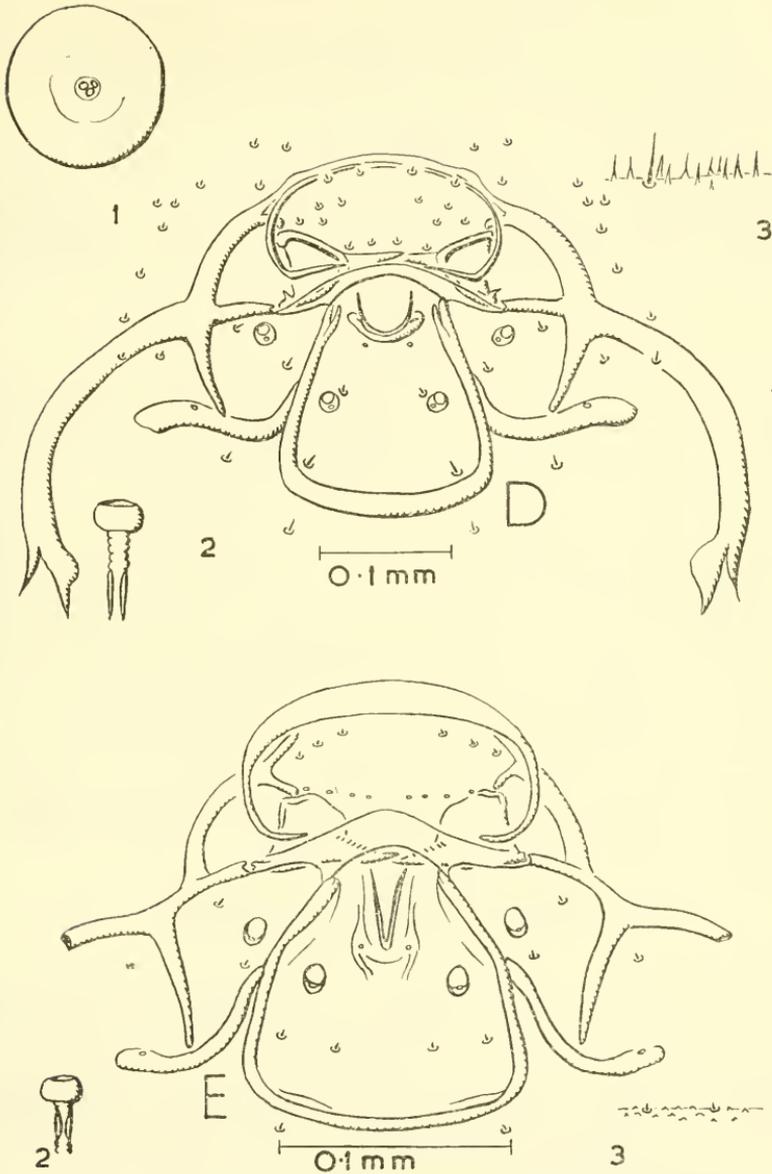


FIGURE 13.—Head sclerites: A, *Boëthes* sp. (Tryphoninae:Boëthini); B, *Polyblastus pedalis* (Cresson) (Tryphoninae:Tryphonini); C, *Errormenus dolichops* Townes and Townes (Tryphoninae:Tryphonini); D, *Exenterus canadensis* Provancher (Tryphoninae:Cteniscini); E, *Brachycyrtus pretiosus* Cushman (Cryptinae:Brachycyrtini), antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

the length of the skin setae is equal to three-quarters of the length of the mandible in *Polyblastus*, whereas in *Erromenus* the setae are small and equal to one-fifth of the length of the mandible.

LARVAL KEY

1. Mandible without teeth; three sensilla on each maxillary and labial palp. **Polyblastus**
 Mandible with teeth; two sensilla on each maxillary and labial palp. **Erromenus**

Tribe Cteniscini

FIGURE 13D

Members of this tribe parasitize the larvae of Argidae, Tenthredinidae and Diprionidae. *Exenterus abruptorius* (Thunberg), *E. adpersus* Hartig, *E. canadensis* Provancher (fig. 13D), *E. claripennis* Thomson, and *E. tricolor* Roman have been examined.

All the head sclerites except the prelabial are present; the lateral parts of the labial sclerite meet the ventral almost at right angles; each maxillary and labial palp has two sensilla, both round, one large and one small; the mandible is without teeth; the antenna is disc-like and has three prominent sensilla; the closing apparatus of the spiracle is long and slender and its distance from the atrium is roughly equal to the length of the closing apparatus; spines are conspicuous on the skin and their length is about half that of the setae.

The following are figured in the literature: *Exenterus abruptorius* (Thunberg) (Morris, 1937), *E. adpersus* Hartig (Beirne, 1941), *E. tricolor* Roman (Morris, Cameron, and Jepson, 1937).

Subfamily Cryptinae (=Gelinae)

FIGURES 13E-27, 64

Most members of this subfamily are ectoparasites but some are, or can be, endoparasites. Mr. J. F. Perkins (in litt.) has informed me that in *Polytribax* (Aptesini) the parasites emerge from the pupa of the host. Rosenberg (1934) states that he reared *Cryptus sexannulatus* Gravenhorst and *Agrothereutes batavus* Vollenhoven from cocoons within the host pupae, but that when he reared the larvae of these species they fed externally on host larvae.

In this very uniform group, the head sclerites are, in general, well developed, although the prelabial sclerite is absent and the epistoma is very lightly sclerotized and is slender and more or less incomplete dorsally, except in *Gambrus* where the dorsal part is broad and complete; the pleurostoma is usually very lightly sclerotized; the labial

sclerite is roughly triangular in shape in most genera, but, as stated below, this sclerite may be circular or otherwise modified; the silk press is well sclerotized and conspicuous and two small sensilla are often visible just beneath the external opening of the press; each maxillary and labial palp usually bears two sensilla, one round and one crescentic in shape, although three or more sensilla are present in some genera; the labral sclerite is usually lightly sclerotized in its dorsal part and this part may be enlarged; the mandibles are relatively small in most genera, except in the Aptesini where they are of moderate size; teeth may be present on the dorsal and ventral surfaces of the blade of the mandible, on the dorsal surface only, or teeth may be absent; the antenna is usually papilliform, although it is disc-shaped in some Hemitelini; the closing apparatus of the spiracle may be some distance from the atrium or it may be close to the atrium; the skin bears setae and small projections which may be sufficiently sclerotized to appear as spines.

LARVAL KEY

1. Hypostoma posterior to hypostomal spur shorter than hypostomal spur. **Brachycyrtini**
 Hypostoma posterior to hypostomal spur at least as long as hypostomal spur . . 2
2. Mandible with a long slender blade bearing a row of fine teeth along entire length of dorsal surface **Sphecophagini**
 Mandible not of this form 3
3. Teeth on dorsal surface of blade of mandible larger than teeth on ventral surface¹² which are very small and few in number, except in *Rhembobius* (fig. 21A) where the blade of the mandible is short, broad and well sclerotized with length equal to one third of that of base of mandible and width of lateral end equal to one third of width of base **Aptesini**
 If teeth present on dorsal and ventral surfaces of blade of mandible and teeth on dorsal surface markedly larger than teeth of ventral surface, then ventral teeth numerous¹³ and blade of mandible longer and more slender than in *Rhembobius*, with length greater than one third of that of base of mandible and with width of lateral end less than one third of that of base 4
4. Closing apparatus of spiracle separated from atrium by length of trachea at least equal to length of closing apparatus, or, if not, then epistoma not sclerotized dorsal to anterior tentorial pits **Hemitelini**
 Closing apparatus of spiracle adjoining atrium, or if not, then at least part of epistoma dorsal to anterior tentorial pits lightly sclerotized¹⁴ . . **Cryptini**

¹² Except *Cubocephalus* where the form and position of the closing apparatus of the spiracle differentiates this genus from Cryptini with a similar type of mandible and either the form of the labial sclerite or the form and position of the closing apparatus of the spiracle differentiates this genus from Hemitelini with a similar type of mandible.

¹³ Except *Trychosis*, *Mallochia* and *Lymeon* (Cryptini). The following characters will distinguish these genera from the Aptesini: the form of the labial sclerite in *Trychosis*, the sharp dorsal bend of the lateral end of the stipital sclerite in *Mallochia*, and the heart-shaped dorsal sensillum on each labial palp in *Lymeon*.

¹⁴ Except *Pseudischnus*.

Tribe Brachycyrtini

FIGURE 13,E

Brachycyrtus pretiosus Cushman (fig. 13,E) was examined.

Members of the genus *Brachycyrtus* are parasitic in the cocoons of Chrysopidae. The Brachycyrtini have been placed by some authors in a tribe of the Pimplinae. From a study of the adults, Walkley (1956) reached the conclusion that the group fits best in the Cryptinae, but that additional material and knowledge might prove that it belongs in a subfamily of its own. The larval characters support this conclusion. The form of the mandibles and head sclerites resemble those of the Cryptinae rather than any other group. The position of the hypostomal spur differs from that of the Pimplinae other than the Labenini and Xoridini. The form of the labral sclerite differs from that of the Labenini. The form of the mandible differs from that of the Xoridini in that the blade is relatively longer. The group is an isolated one on larval characters, and the short hypostoma is distinctive. The form of the hypostoma resembles that of the Sphecophagini to some extent, although the hypostoma of the Brachycyrtini is considerably shorter than that of the Sphecophagini. The head of *Brachycyrtus* is small and delicate and the antenna was not clearly visible on the preparations made. It appears to be disc-shaped.

Tribe Hemitelini (= Gelini)

FIGURES 14-19, 64

Members of this tribe attack a great variety of hosts. Many are occasionally or habitually secondary parasites. The most conspicuous characters of the tribe are the poorly developed epistoma and the distance of the closing apparatus of the spiracle from the atrium.

LARVAL KEY

- | | |
|---|------------------------------------|
| 1. Mandible without teeth | 2 |
| Mandible with teeth | 7 |
| 2. Each ventrolateral part of labial sclerite expanded | 3 |
| Labial sclerite not of this shape | 6 |
| 3. Ventral end of hypostomal spur broader than dorsal. | |
| <i>Isdromas peruviana</i> (Viereck) | |
| Ventral end of hypostomal spur narrower than dorsal | 4 |
| 4. Mandibles with relatively broad blades, the tips of which do not meet in the median line | <i>Isdromas lycanense</i> (Howard) |
| Mandibles with relatively narrow blades, the tips of which meet in the median line | 5 |
| 5. Dorsal part of labral sclerite pointed | <i>Stilpnus</i> |
| Dorsal part of labral sclerite not pointed | <i>Atractodes</i> |

- 6. Labial sclerite round in shape and with lateral parts not meeting ventral approximately at right angles **Thaumatotypus**
 Labial sclerite not round in shape and with lateral parts meeting ventral approximately at right angles **Phygadeuon**
- 7. Mandible with teeth only on dorsal surface of blade 8
 Mandible with teeth on dorsal and ventral surfaces of blade ¹⁵ 11
- 8. Teeth few in number and relatively large **Bathythrix**
 Teeth small and fine 9
- 9. Two sensilla present on each maxillary and labial palp **Otacestes**
 Sensilla not as above 10
- 10. Three sensilla, two large and one small, present on each maxillary and labial palp **Mastrus molestae** (Uchida)
 One large sensillum situated dorsally and two or three small sensilla situated ventrally in the form of a crescent on each maxillary and labial palp. **Thysiotorus**
- 11. Labial sclerite approximately circular in shape **Eibelurgus**
 Labial sclerite not approximately circular in shape; lateral parts meet ventral approximately at right angles 12
- 12. Papillus of antenna reduced to disc bearing three sensilla **Iselix**
 Antenna not of this shape 13
- 13. Two sensilla present on each maxillary and labial palp 15
 Sensilla not as above 14
- 14. Two sensilla of equal size together with one or two smaller sensilla present on each maxillary and labial palp 18
 One large ventral sensillum and a dorsal group of smaller sensilla present on each maxillary and labial palp **Mastrus smithii** (Packard)
- 15. Dorsal sensillum on each maxillary and labial palp larger than ventral. **Endasys**
 Dorsal sensillum on each maxillary and labial palp smaller than ventral or equal in size to ventral 16
- 16. Pleurostoma more lightly sclerotized than hypostoma. **Gelis tantillus** (Cresson)
 Pleurostoma as well sclerotized as hypostoma 17
- 17. Labral sclerite with single median expansion **Hemiteles**
 Labral sclerite not expanded in its median part and with two small dorsolateral expansions **Mastrus argeae** (Viereck)
- 18. Mandible with rounded base and relatively short blade. **Gelis bruesii** (Strickland)
 Mandible with a conical base and relatively long slender blade . . **Phobetres**

Of the characters used in the above key, the form of the labral sclerite and its degree of sclerotization is not a good one. In some cases the character is clear, but in others it may be obscured when the entire length of the sclerite has not been forced into the one plane during mounting. However, since the tribe is extremely uniform and the labral sclerite does differ in shape and degree of sclerotization in different genera, it was found necessary to use this character.

¹⁵ Teeth on the ventral surface of the blade of the mandible are usually very small and must be looked for with great care.

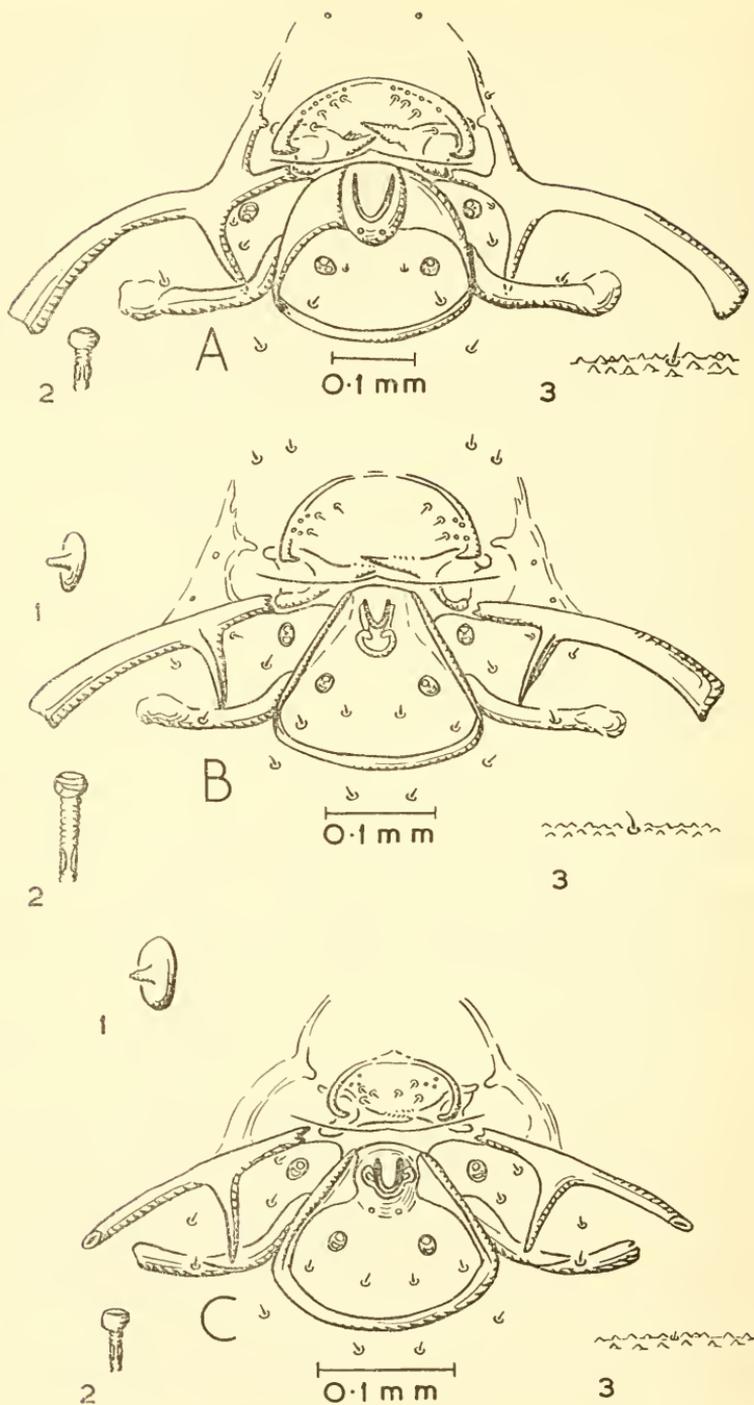


FIGURE 14.—Cryptinae:Hemitelini, head sclerites: A, *Bathythrix* sp., antenna not visible on preparation; B, *Mastrus molestae* (Uchida); C, *Otaustes* sp. (1, antenna, 2, spiracle; 3, skin.)

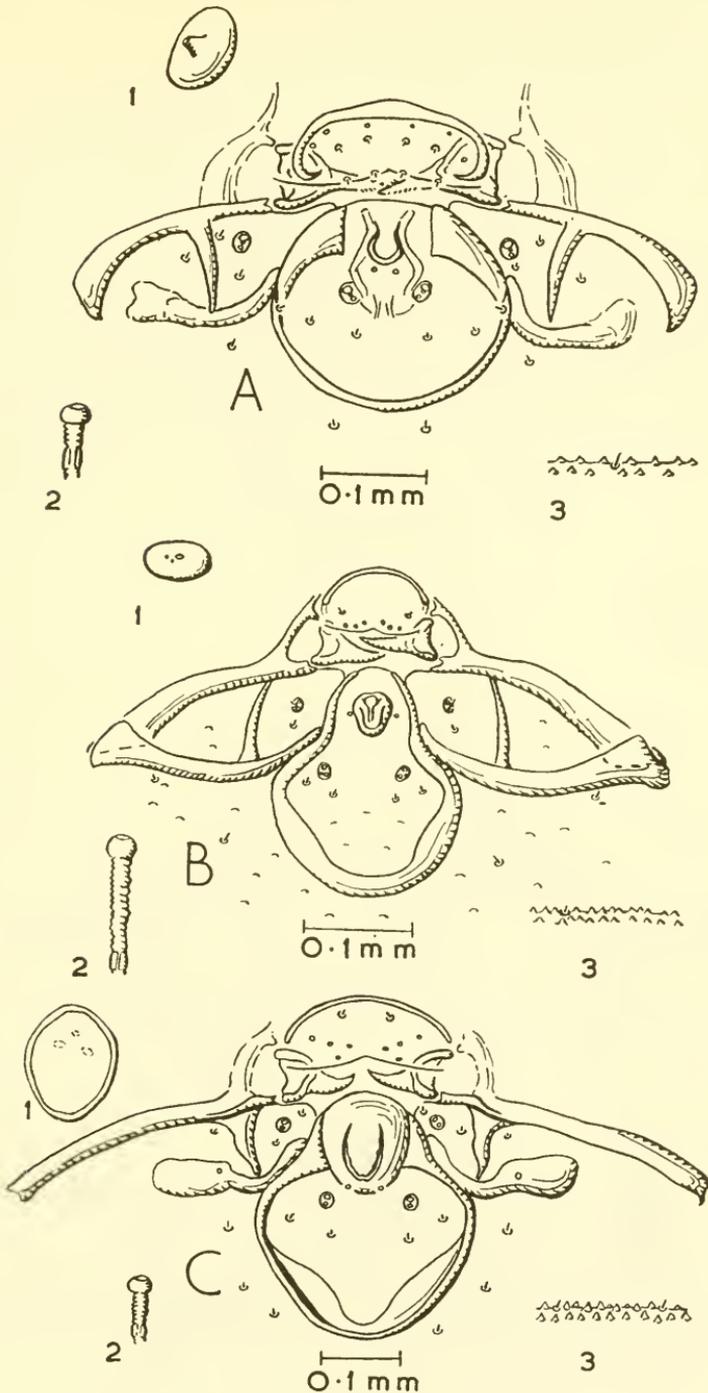


FIGURE 15.—Cryptinae:Hemitelini, head sclerites: A, *Eithelurgus syrphicola* (Ashmead); B, *Isdromas peruviana* (Viereck); c, *Isdromas lycanae* (Howard). (1, antenna; 2, spiracle; 3, skin.)

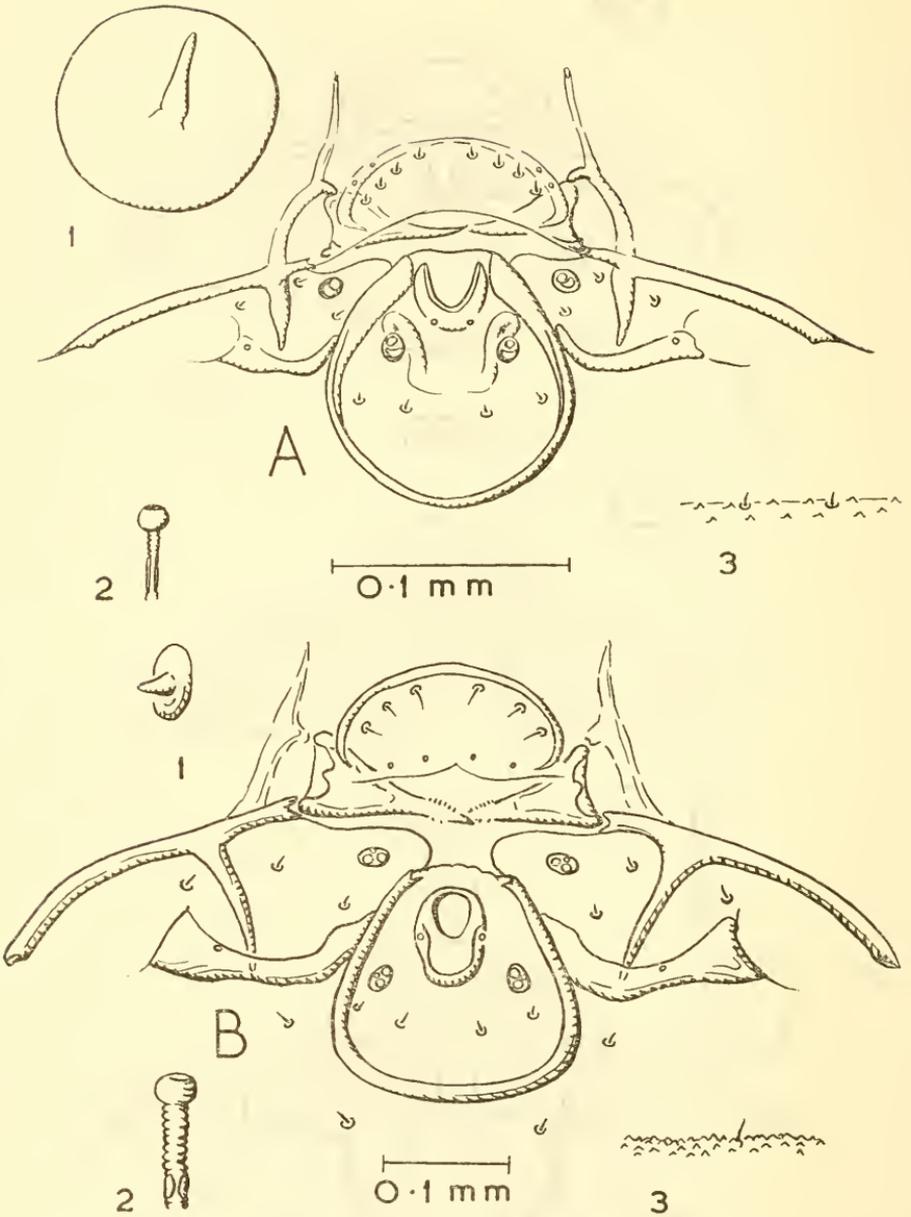


FIGURE 16.—Cryptinae:Hemitelini, head sclerites: A, *Thaumatotypus paradoxus* (Zetterstedt); B, *Phobetes thyridopteryx* (Riley). (1, antenna; 2, spiracle; 3, skin.)

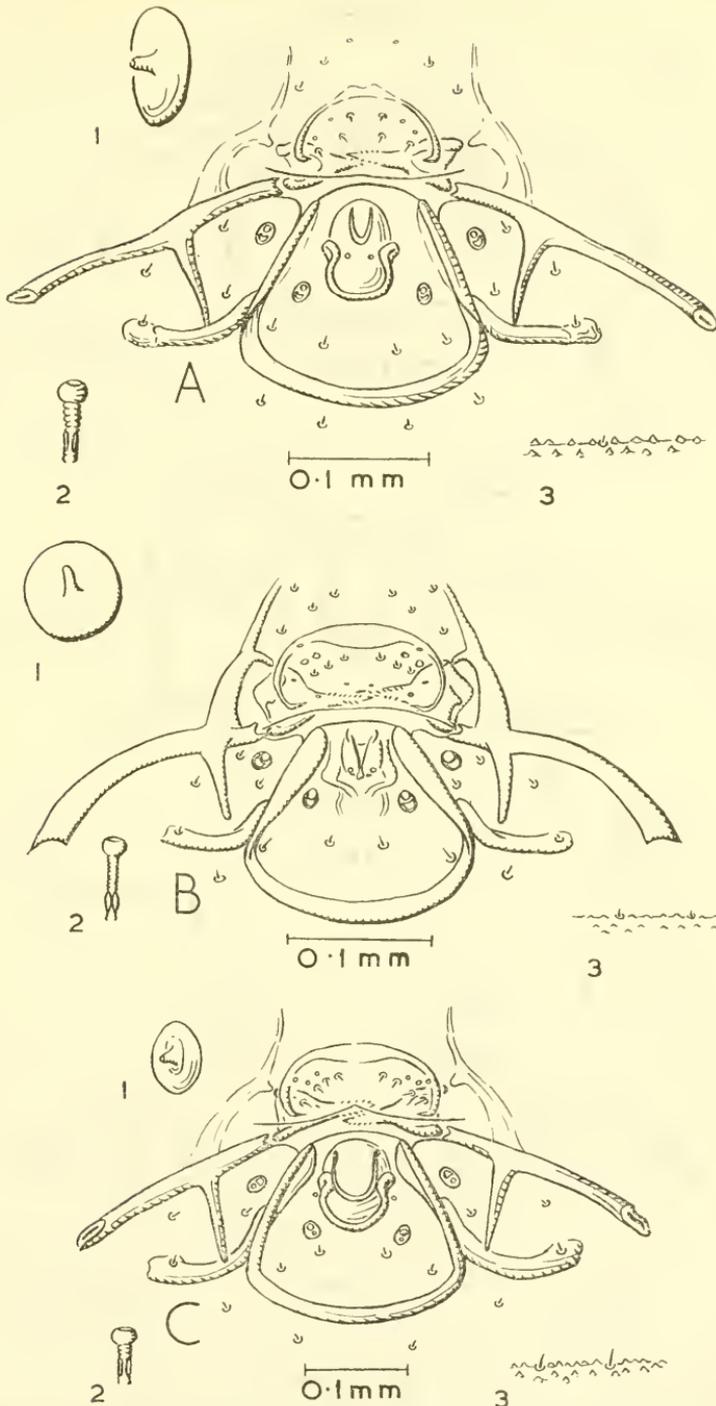


FIGURE 17.—Cryptinae:Hemiteleini, head sclerites: A, *Gelis tantillus* (Cresson); B, *Hemiteles areator* (Panzer); C, *Endasys subclavatus* (Say). (1, antenna; 2, spiracle; 3, skin.)

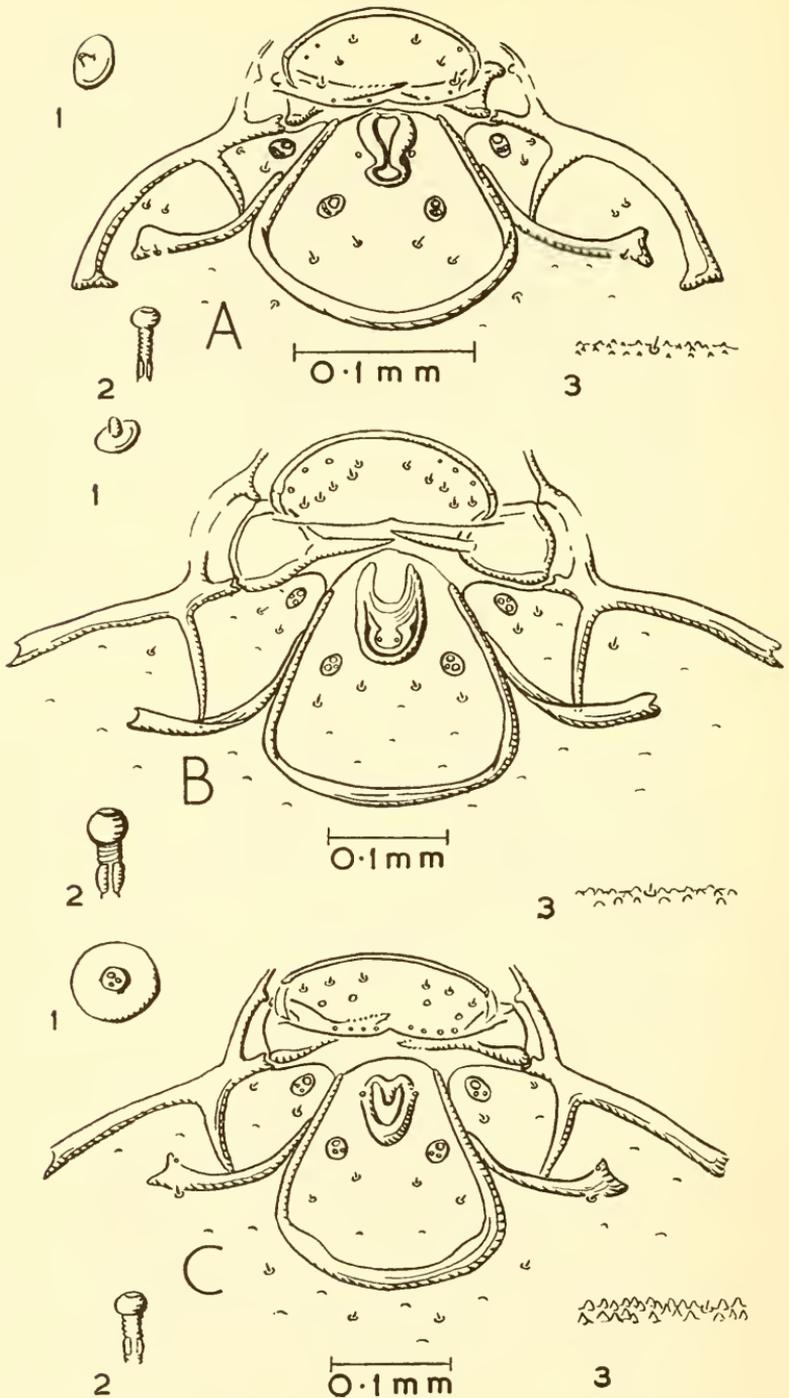


FIGURE 18.—Cryptinae:Hemitelesini, head sclerites: A, *Thysiotorus* sp.; B, *Phygadeuon subfuscus* Cresson; c, *Iselix* sp. (1, antenna; 2, spiracle; 3, skin.)

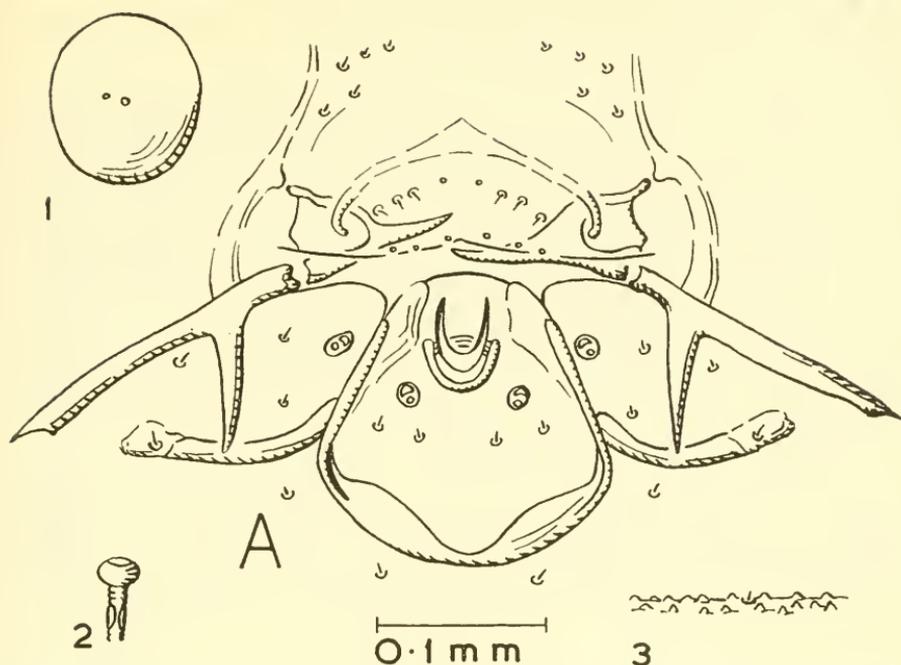


FIGURE 19.—Cryptinae:Hemitelini, head sclerites: *Stilpnus anthomyidiperda* Viereck. (1, antenna; 2, spiracle; 3, skin.)

The following have been examined: *Bathythrix* sp. (fig. 14A), *Mastrus argeae* (Viereck), *M. molestae* (Uchida) (fig. 14B), *M. smithii* (Packard), *Otacustes* sp. (fig. 14C), *Ethelurgus syrphicola* (Ashmead) (fig. 15A), *Isdromas peruviana* (Viereck) (fig. 15B), *I. lycanae* (Howard) (fig. 15C), *Thaumatotypus paradoxus* (Zetterstedt) (fig. 16A), *Phobetes thyridopteryx* (Riley) (fig. 16B), *Gelis bruesii* (Strickland), *G. tantillus* (Cresson) (fig. 17A), *Hemiteles areator* (Panzer) (fig. 17B), *Endasys subclavatus* (Say) (fig. 17C), *Thysiotorus* sp. (fig. 18A), *Phygadeuon subfuscus* Cresson (fig. 18B), *Iselix* sp. (fig. 18C), *Stilpnus anthomyidiperda* Viereck (fig. 19A), *Atractodes* sp. (GCV) (fig. 64A).

Of these specimens, *Mastrus molestae* (Uchida) differs from the other species of this genus examined in that the mandibular teeth are small and are present only on the dorsal surface of the blade. *M. smithii* (Packard) has one large sensillum and a group of smaller sensilla on each maxillary and labial palp and *M. argeae* (Viereck) two sensilla. In the two species of *Isdromas* examined the mandible is basically similar and the ventrolateral part of each labial sclerite is expanded. There are, however, many differences between these species. The larval characters of *Gelis*, *Hemiteles*, and *Endasys* indicate a close relationship. Members of the genus *Gelis* attack various small cocoons,

including those of Ichneumonidae and Braconidae, and many parasitize the egg cocoons of spiders.

Phygadeuon, *Iselix*, *Stilpnus*, and *Atractodes* resemble each other in larval characters and all are parasites of muscoid Diptera. Distinctive features of *Atractodes* are that the head and the base of the mandibles are lightly sclerotized and the well-sclerotized blade of the mandible is toothless, the several very small ridges present on the dorsal surface of the blade not being distinct enough to be called teeth. The antenna, like that of *Stilpnus*, is disc-shaped, but *Stilpnus* differs from *Atractodes* not only in the key characters but also in having the blade of the mandible more slender, the ventral part of the labial sclerite more sharply narrowed in the median line, and the posterior end of the hypostoma straight instead of slightly bent towards the dorsal surface (compare figs. 19 and 64).

The following are figured in the literature: *Otaeustes crassus patruelis* (Cushman) (Clancy, 1946), *Gelis melanocephala* (Schrank) (Beirne, 1941), *G. tenellus* (Say) (Clancy, 1946), *Hemiteles areator* (Panzer) (Morris, Cameron, and Jepson, 1937), *H. hemipterus* (Fabricius) (Salt, 1931), *H. simillimus* (Taschenberg) (Blunk, 1952).

Tribe Aptesini

FIGURES 20-21A

Most of the members of this tribe are parasites of sawflies. Characteristics of the larvae are the development of the lateral parts of the epistoma dorsal to the anterior tentorial pits and the relatively large mandibles. The teeth on the dorsal surface of the blade of the mandible are larger than the teeth on the ventral surface in *Aptesis* and *Rhembobius* but not in *Cubocephalus*.

LARVAL KEY

1. Teeth on the dorsal surface of the blade of the mandible not markedly larger than teeth on the ventral surface **Cubocephalus**
Teeth on dorsal surface of blade of mandible larger than teeth on ventral surface 2
2. Blade of mandible short, broad, and well-sclerotized, with length approximately equal to one-third of that of base of mandible **Rhembobius**
Blade of mandible relatively slender with length approximately equal to one-half of that of base of mandible **Aptesis**

The following have been examined: *Cubocephalus* sp. (fig. 20A), *Aptesis indistincta* (Provancher) (fig. 20B), *A. pteronorum* (Gravenhorst), and *Rhembobius abdominalis* (Provancher) (fig. 21A).

The teeth on the dorsal surface of the blade of the mandible of *A. pteronorum* are smaller than in *A. indistincta*.

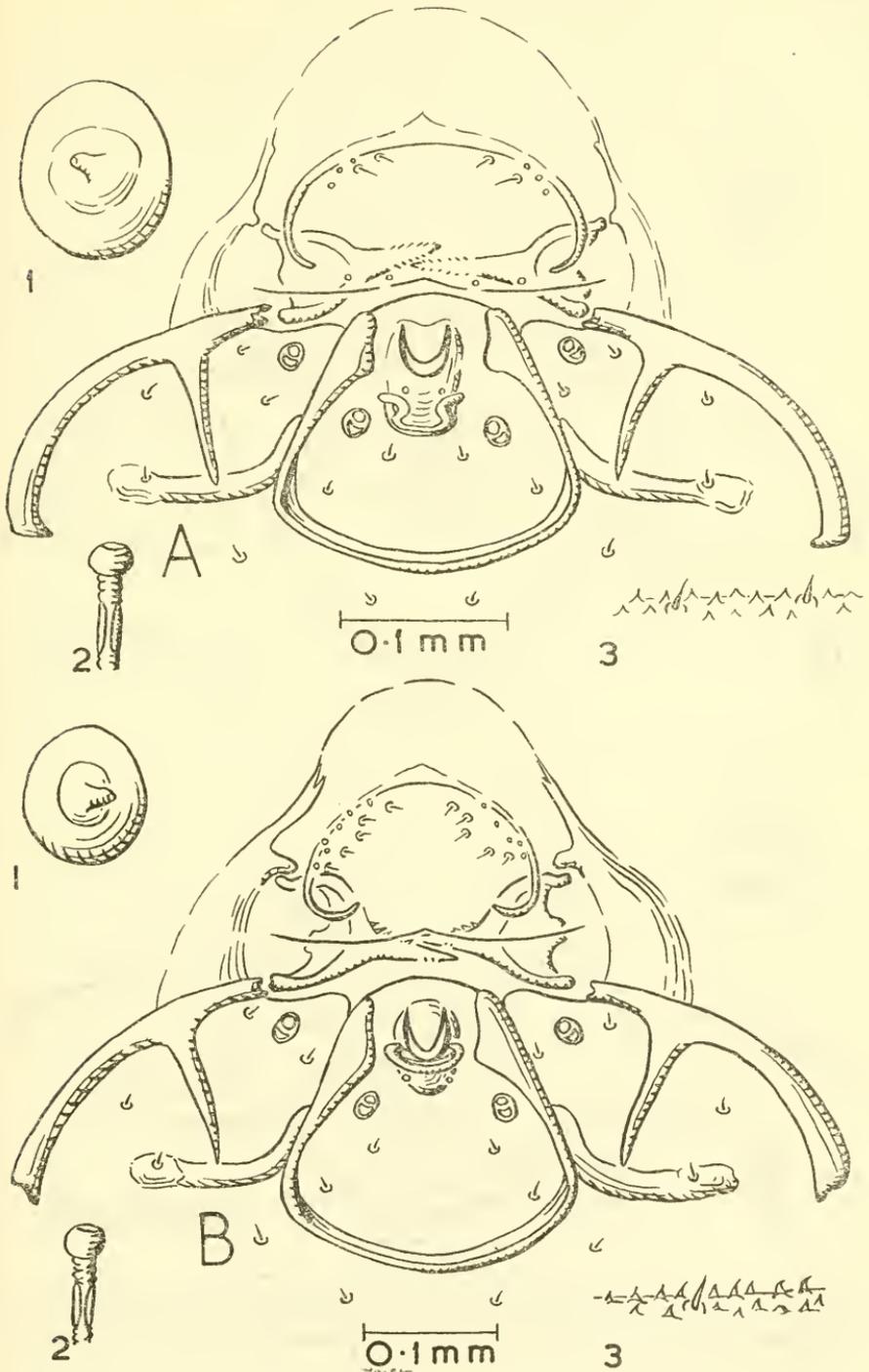


FIGURE 20.—Cryptinae:Aptesini, head sclerites: A, *Cubocephalus* sp.; B, *Aptesis indistincta* (Provancher). (1, antenna; 2, spiracle; 3, skin.)

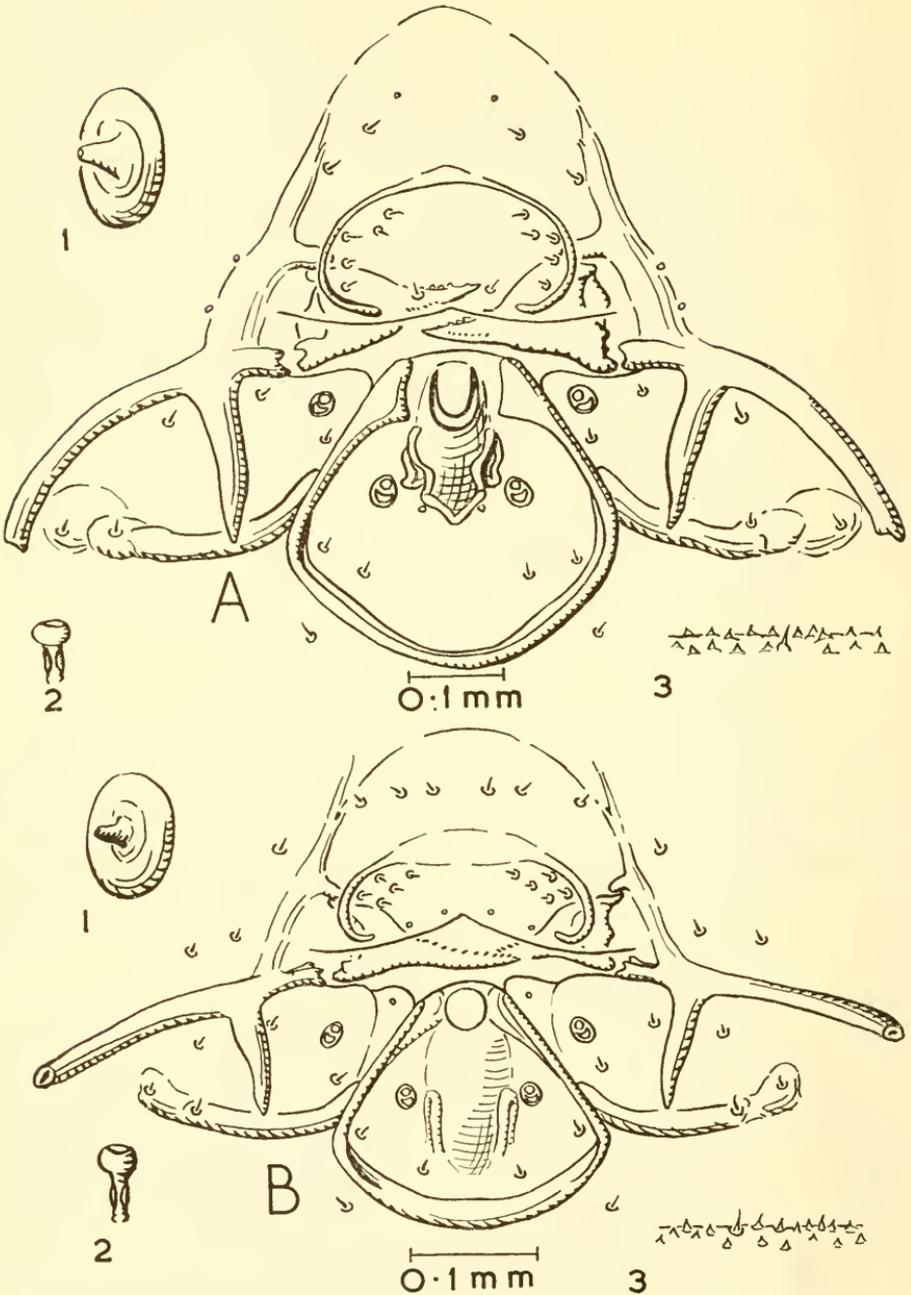


FIGURE 21.—Cryptinae, head sclerites: A, *Rhembobius abdominalis* (Provancher) (Aptesini); B, *Sphecophaga thuringiaca* Schmiedeknecht (Sphecophagini). (1, antenna; 2, spiracle; 3, skin.)

The following are figured in the literature: *Cubocephalus abominator* (Gravenhorst) (Rosenberg, 1934), *C. brumatae* (Silvestri) (Silvestri, 1941), *Aptesis basizonia* (Gravenhorst) (Morris, Cameron, and Jepson, 1937).

Tribe Sphecophagini

FIGURE 21B

Members of this tribe are parasitic in the nests of *Vespa* and *Polistes*.

The mandible is characteristic with its long slender blade bearing a row of fine teeth along the entire length of the dorsal surface.

Sphecophaga thuringiaca Schmiedeknecht (BM) (fig. 21B) and *Sphecophaga* sp. (CDA) were examined.

Sphecophaga vesparum (Curtis) is figured by Beirne (1941) and *Sphecophaga* sp. by Snodgrass (1935).

Tribe Cryptini (=Mesostenini)

FIGURES 22-27

Members of this tribe are parasitic mostly on pupae and prepupae, or on larvae concealed in tunnels or leaf rolls. Hosts include Lepidoptera, Symphyta, Aculeata, and spider eggs.

The larvae have the lateral parts of the epistoma well developed and, in many genera, the closing apparatus of the spiracle adjoins the atrium.

LARVAL KEY

- 1. Epistoma lightly sclerotized, broad and complete **Gambrus**
Epistoma lightly sclerotized, narrow and more or less incomplete dorsally 2
- 2. Labial sclerite with each ventrolateral part indented **Trychosis**
Labial sclerite not of this form 3
- 3. Closing apparatus of spiracle adjoining atrium 4
Closing apparatus of spiracle not adjoining atrium 10
- 4. Dorsal part of labral sclerite expanded into three lightly sclerotized lobes. **Cryptus**
Dorsal part of labial sclerite not of this form 5
- 5. Six setae on prelabium 6
Four setae on prelabium 7
- 6. Median-dorsal part of labral sclerite with lightly sclerotized enlargement. **Goryphus**
Median-dorsal part of labral sclerite without enlargement **Mesostenus**
- 7. Dorsal part of labral sclerite divided into two lightly sclerotized bars. **Polycyrtus**
Dorsal part of labral sclerite not divided into two bars 8
- 8. Mandible with a relatively slender blade bearing a row of fine teeth on the dorsal surface and teeth on ventral surface few and small **Mallochia**
Mandible not of this form 9

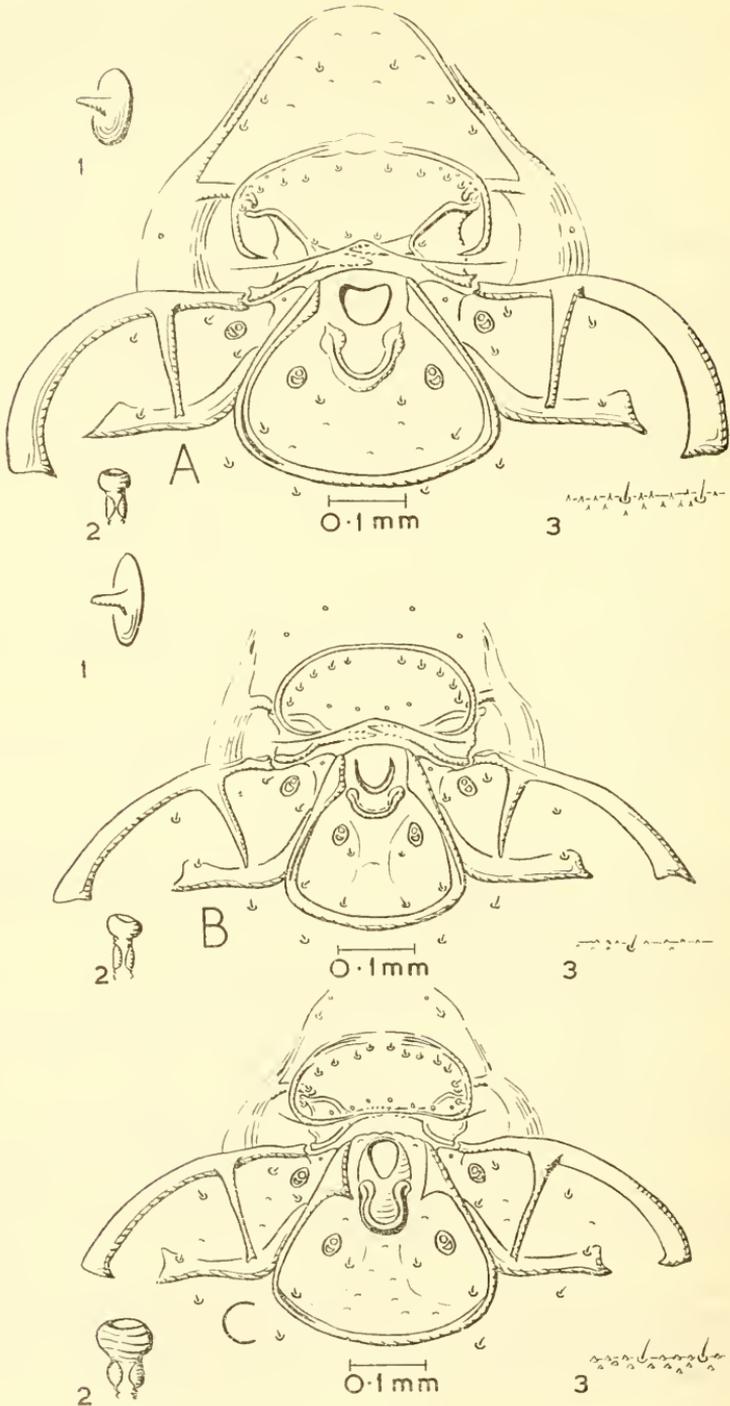


FIGURE 22.—Cryptinae: Cryptini, head sclerites: A, *Cryptus albitarsus albitarsus* (Cresson); B, *Mesostenus* sp. nr. *gracilis* Cresson; C, *Polycyrtus semialbus* (Cresson), antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

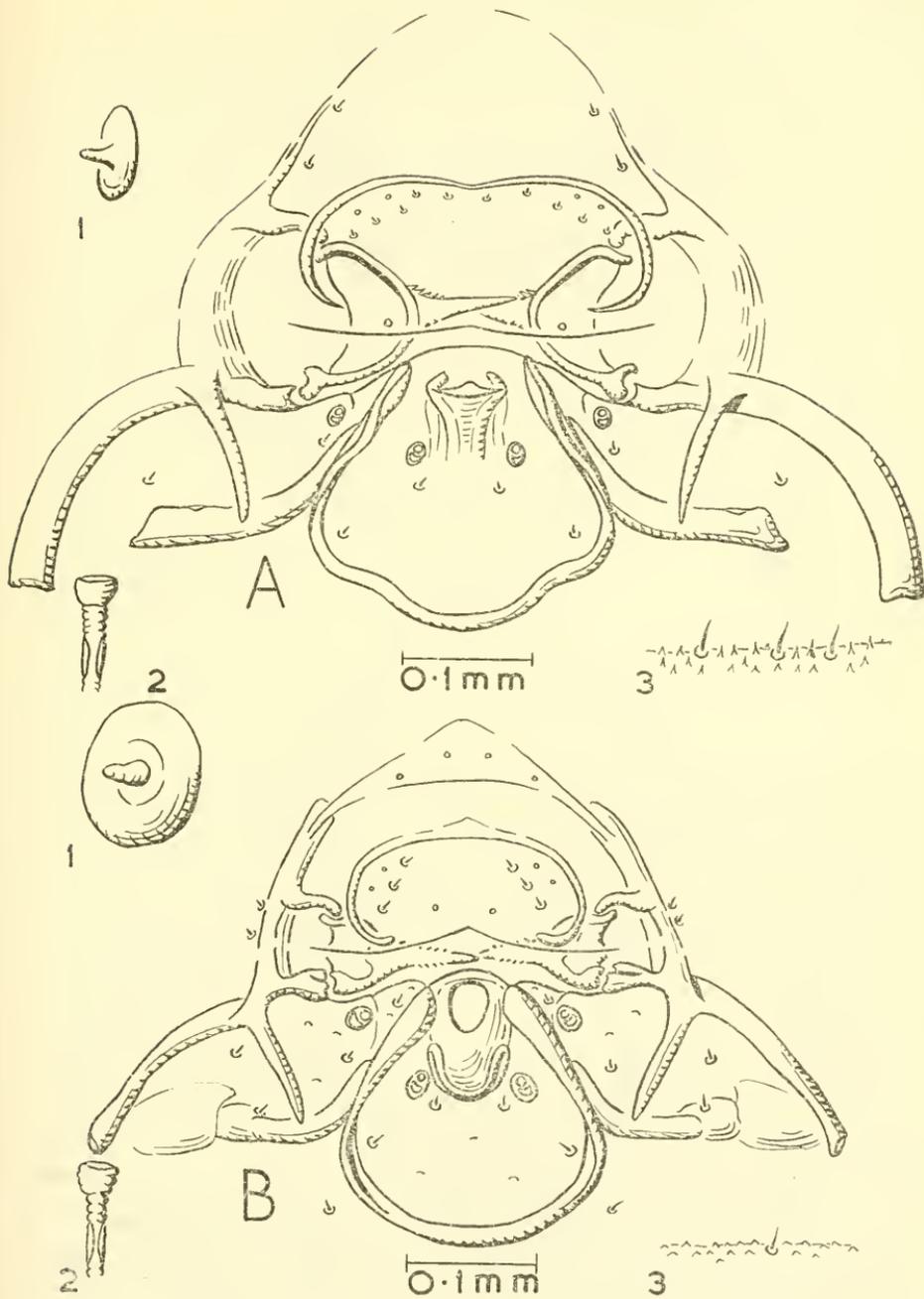


FIGURE 23.—Cryptinae:Cryptini, head sclerites: A, *Trychosis* sp.; B, *Gambrus canadensis* (Provancher). (1, antenna; 2, spiracle; 3, skin.)

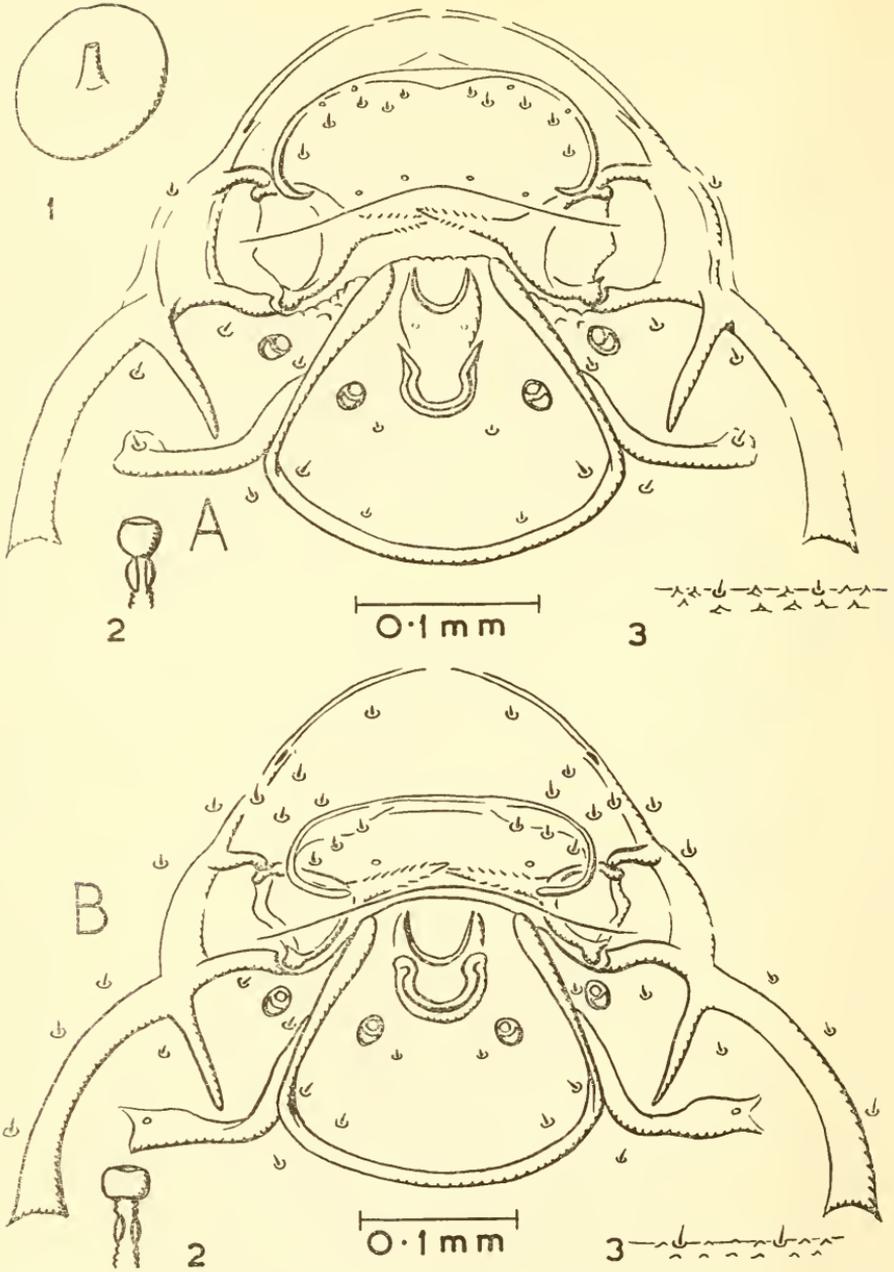


FIGURE 24.—Cryptinae:Cryptini, head sclerites: A, *Goryphus inferus* (Szepliget); B, *Hoplocryptus incertulus* Cushman, antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

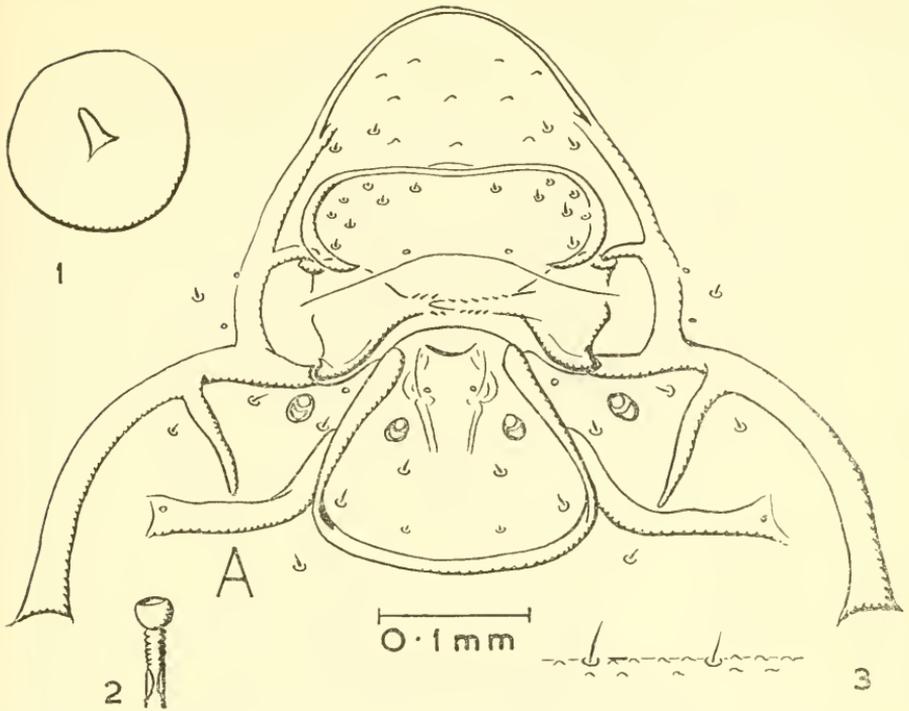


FIGURE 25.—Cryptinae:Cryptini, head sclerites: *Nippocryptus suzukii* (Matsumura) (1, antenna; 2, spiracle; 3, skin.)

9. Width of closing apparatus of spiracle approximately equal to half width of atrium **Agrothereutes**
 Width of closing apparatus of spiracle more than half width of atrium **Eripternimorpha**
10. Ventral row of teeth on mandible poorly developed **Lymeon**
 Ventral row of teeth on mandible well developed 11
11. Epistoma not sclerotized dorsal to anterior tentorial pits **Pseudischnus**
 Epistoma sclerotized dorsal to anterior tentorial pits 12
12. Six large setae on labrum **Hoplocryptus**
 More than six large setae on labrum 13
13. Dorsal part of labral sclerite with three lightly sclerotized lobes . . . **Echthrus**
 Dorsal part of labral sclerite with one lightly sclerotized lobe . **Nippocryptus**

The following have been examined: *Cryptus albitarsus albitarsus* (Cresson) (fig. 22A), *Mesostenus gracilis* Cresson, *Mesostenus* sp. nr. *gracilis* Cresson (fig. 22B), *Polycyrtus semialbus* (Cresson) (fig. 22C), *Trychosis* sp. (fig. 23A), *Gambrus canadensis* (Provancher) (fig. 23B), *G. stokesi* Cameron, *Goryphus inferus* (Szepliget) (fig. 24A), *Hoplocryptus incertulus* Cushman (fig. 24B), *Nippocryptus suzukii* (Matsumura) (fig. 25A), *Agrothereutes grapholithae* (Uchida), *Agrothereutes* sp. (fig. 26A), *Pseudischnus oregonensis* (Cushman) (fig. 26B), *Eripternimorpha javensis* Rohwer (fig. 26C), *Mallochia* sp. (fig. 27A), *Lymeon orbum* (Say) (fig. 27B), *Echthrus niger* Cresson (fig. 27C).

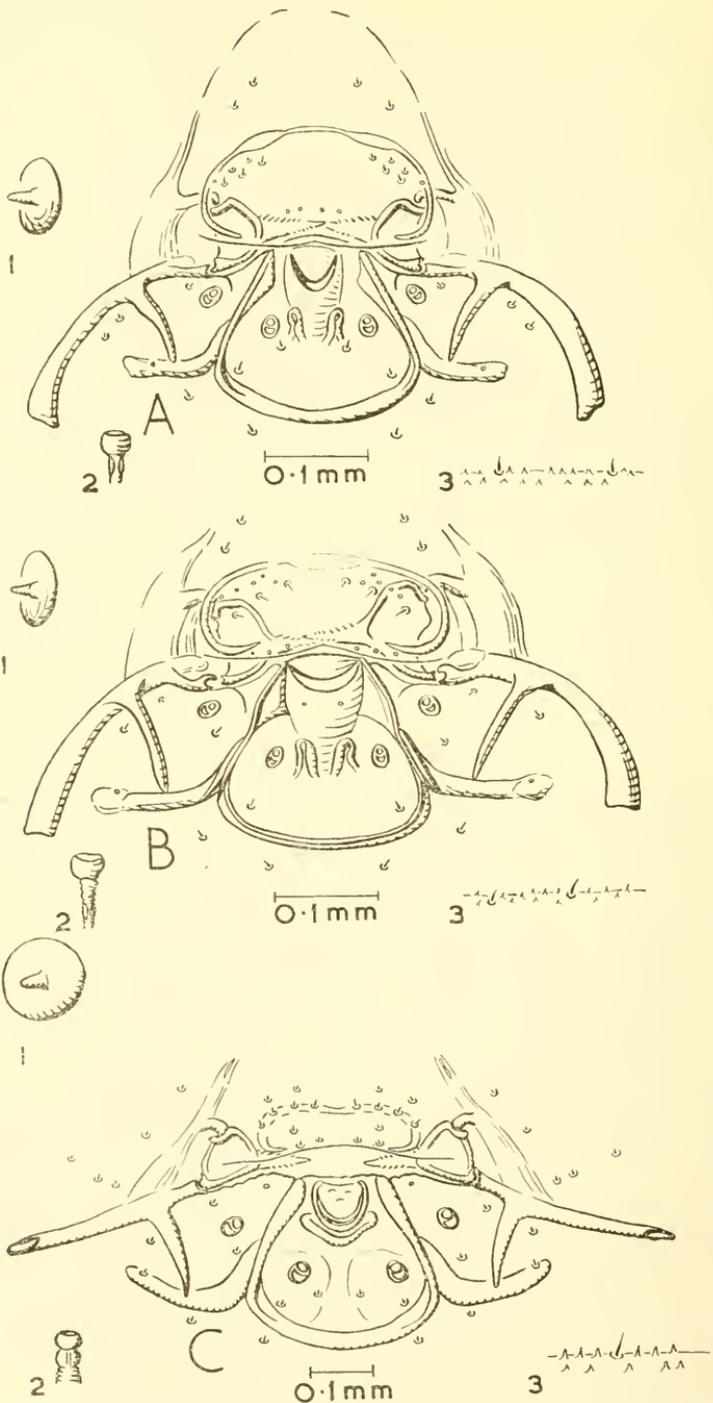


FIGURE 26.—Cryptinae:Cryptini, head sclerites: A, *Agrothereutes* sp.; B, *Pseudischnus oregonensis* (Cushman); C, *Eripternimorpha javensis* Rohwer. (1, antenna; 2, spiracle; 3, skin.)

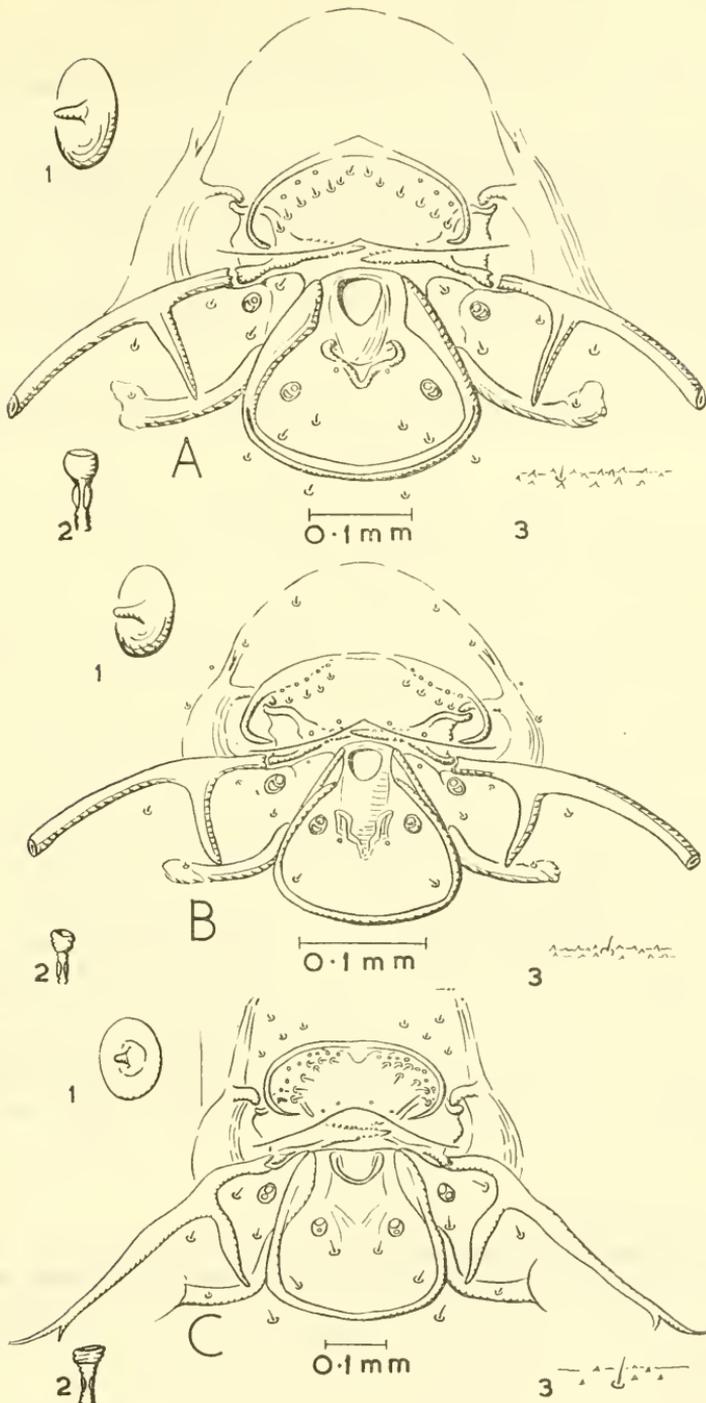


FIGURE 27.—Cryptinae:Cryptini, head sclerites: A, *Mallochia* sp.; B, *Lymeon orbum* (Say); C, *Echthrus niger* Cresson. (1, antenna; 2, spiracle; 3, skin.)

Agrothereutes grapholithae (Uchida) differs from the species illustrated (fig. 26A) in that there is but one median expansion of the labral sclerite and there are eight large setae on the labrum instead of six.

The following are figured in the literature: *Cryptus inornatus* Pratt (Simmonds, 1948), *C. laborator laborator* (Thunberb) (Beirne, 1941), *C. sexannulatus* Gravenhorst (Rosenberg, 1934), *Agrothereutes abbreviator* (Fabricius) (Morris, Cameron, and Jepson, 1937), *A. batavus* Vollenhoven (Rosenberg, 1934), *Ischnus polytomi* (Tschek) (Morris, Cameron, and Jepson, 1937), *Echthrus reluctator* (Linnaeus) (Baumann, 1933).

Subfamily Ichneumoninae (=Joppinae, =Phacogeninae)

FIGURES 28-37

This is a very distinct and uniform subfamily whose members are internal parasites of the Lepidoptera. They oviposit in the host larva or pupa but always emerge from the pupa.

The epistoma is lightly to heavily sclerotized and the pleurostoma and hypostoma are always well sclerotized; sclerotized areas may be present lateral and dorsal to the pleurostoma and epistoma and, to a more limited extent, the hypostoma; sensilla are frequently present on the epistoma and pleurostoma; the hypostomal spur and stipital sclerite are absent; the labial sclerite is usually absent but may sometimes be seen as a very lightly sclerotized strip at the edge of the prelabial area; each maxillary and labial palp is in the form of a flattened disc bearing several sensilla, usually about five to each palp; the silk press is lightly sclerotized and two small sensilla are present ventral to the press; the prelabial sclerite is absent; groups of setae and sensilla are situated on the clypeolabral area, often on lightly sclerotized plates the shape of which is often characteristic of a genus; the mandibles are large and well sclerotized and do not have teeth on the blade; the antenna is disc-shaped; the spiracle has an oval atrium, and the large, thick-walled closing apparatus adjoins the atrium; the skin is smooth with small setae and no spines.

LARVAL KEY

1. Hypostoma sharply bent **Trogini**
Hypostoma may be curved but never sharply bent 2
2. Mandible broad and length of blade is equal to or less than one-third length of mandible **Listrodromini**
Mandible less broad and length of blade is more than one-third length of mandible 3

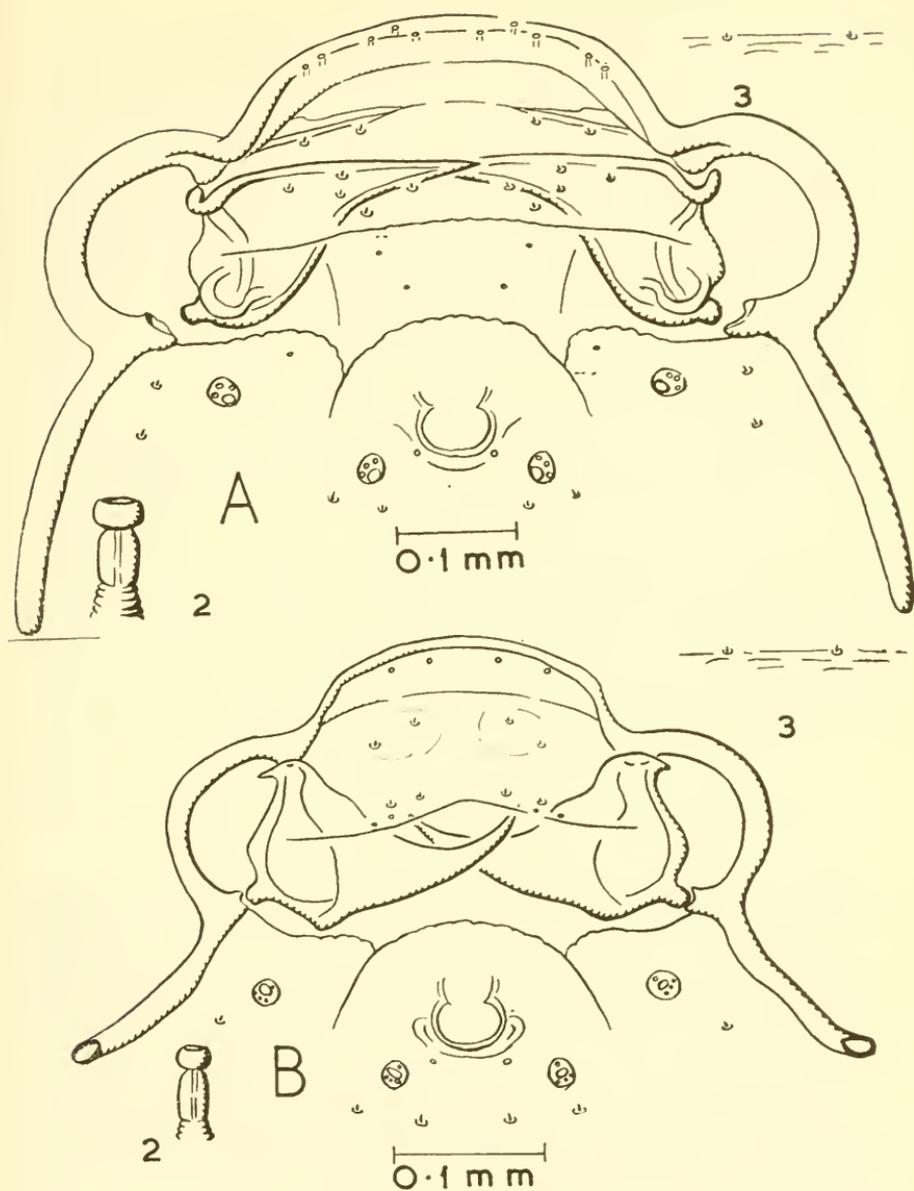


FIGURE 28.—Ichneumoninae:Phaeogenini, head sclerites: A, *Phaeogenes hariolus* (Cresson); B, *Rhexidermus huardi* (Provancher). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

3. A lightly sclerotized plate is present on the clypeus ventral to and continuous with the epistoma and dorsal to the anterior pleurostomal processes; in *Phaeogenes* and in *Diadromus* (Given, 1944) the ventrolateral edges of the plate are prominent as sclerotized bars **Phaeogenini**
A lightly sclerotized plate of this shape is not present on the clypeus 4
4. Clypeolabral region with two slender and lightly sclerotized bands curving dorsally and with a line of setae which follows the curve situated beneath each band **Platylabini**
Clypeolabral region without sclerotized bands of this shape and position ¹⁶ 5
5. The sclerotized area lateral to each pleurostoma is almost as well sclerotized as the pleurostoma so that the lateral limit of the sclerite is not clearly defined **Eurylabini**
If sclerotized area present lateral to each pleurostoma, then pleurostoma more heavily sclerotized than this area and with lateral limit clearly defined ¹⁷ 6
6. Setae and sensilla on clypeolabral region arranged in two elongate-oval areas with a circular area containing two sensilla beneath each oval area. **Protichneumonini**
Setae and sensilla of clypeolabral region not as above **Ichneumonini**

The differences between most tribes are slight in this uniform subfamily. During mounting the lightly sclerotized parts of the cranium adjoining the epistoma are flattened into various shapes. The figures show this region as it appears in the preparations, but it is unlikely that these shapes have any taxonomic significance.

Tribe Phaeogenini (=Alomyini)

FIGURE 28

LARVAL KEY

1. With a sclerotized bar extending across each ventrolateral edge of the lightly sclerotized plate on the clypeus **Phaeogenes**
Diadromus ¹⁸
No sclerotized bar present along each ventrolateral edge of the lightly sclerotized plate on the clypeus **Rhexidermus**

The following were examined: *Phaeogenes ater* (Cresson), *P. haussleri* Uchida, *P. hariolus* (Cresson) (fig. 28A), *P. hebrus* (Cresson), *P. vincibilis* (Cresson), *P. walshiae walshiae* Ashmead, *Rhexidermus huardi* (Provancher) (fig. 28B).

The following are figured in the literature: *Phaeogenes nigridens* Wesmael (Goidanich, 1931), *Diadromus collaris* (Gravenhorst) (Given, 1944), *Proscus suspicax* (Wesmael) (Beirne, 1941), *Herpestomus brunnicornis* (Gravenhorst) (Beirne, 1943).

¹⁶ Except *Pseudamblyteles* (Ichneumonini), where there is no line of setae beneath each sclerotized band as in the Platylabini.

¹⁷ Except *Melanichneumon* (Ichneumonini), where the numerous setae on the prelabium distinguish this genus from *Probolus*.

¹⁸ Of Given (1944).

Tribe Platylabini

FIGURE 29

Platylabus clarus (Cresson) was examined.

The pair of lightly sclerotized plates situated on the clypeolabral region above the setae and sensilla distinguish this ichneumonine from all others examined except *Pseudamblyteles*. In *Pseudamblyteles* there is no line of setae beneath and following the curve of each sclerotized plate as in *Platylabus*.

Tribe Listrodromini

FIGURE 30

Members of this tribe prefer Lycaenidae as hosts.

The broad mandibles with their very short blades are distinctive.

LARVAL KEY

- 1. Each maxillary and labial palp with three sensilla, the middle one raised as a projection **Anisobas**
- Each maxillary and labial palp with five sensilla, but none raised as a projection **Listrodromus**

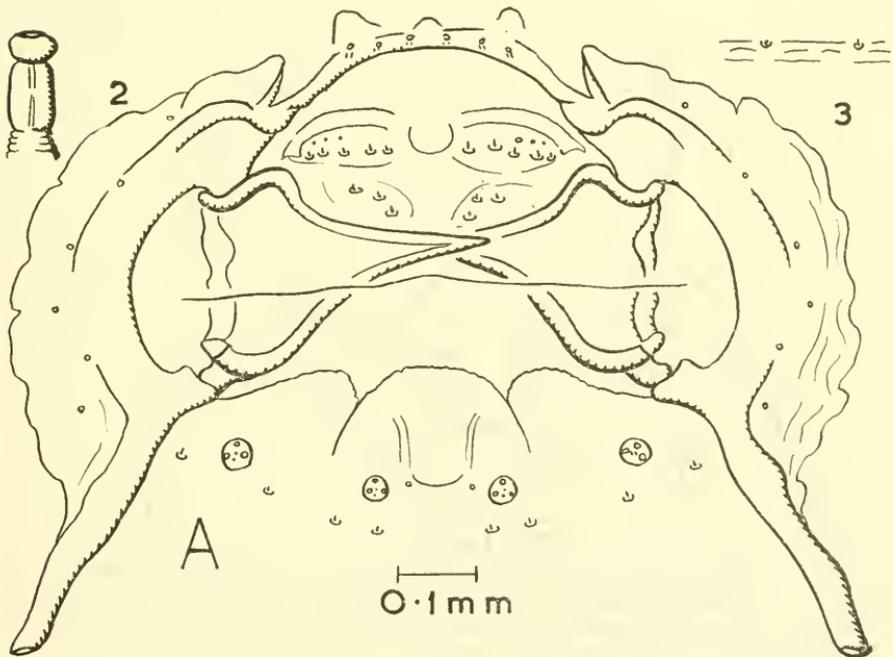


FIGURE 29.—Ichneumoninae:Platylabini, head sclerites: *Platylabus clarus* (Cresson) (Antenna not visible on preparation; 2, spiracle; 3, skin.)

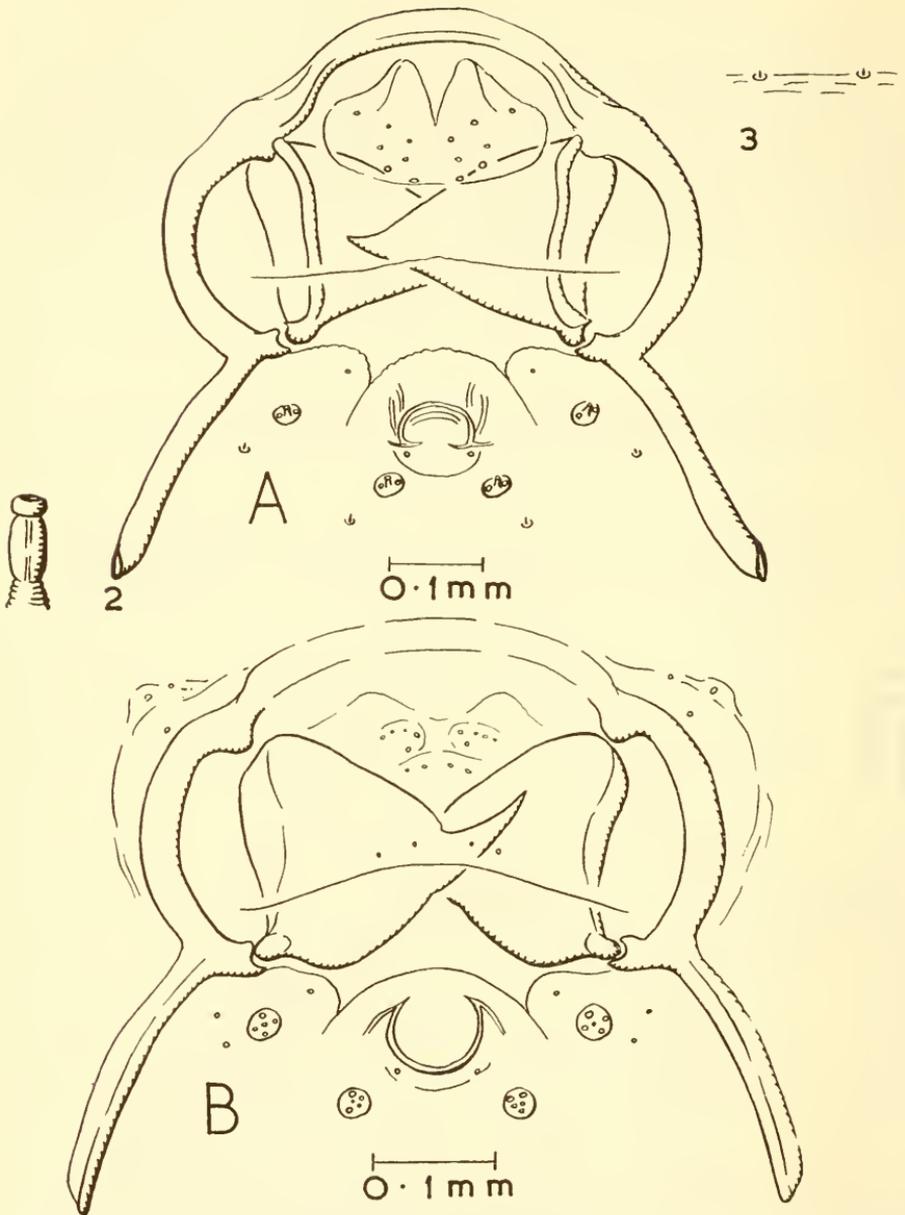


FIGURE 30.—Ichneumoninae:Listrodromini, head sclerites: A, *Anisobas* sp. (antenna not visible on preparation; 2, spiracle; 3, skin); B, *Listrodromus nyctemerus* (Gravenhorst) (other structures not visible on preparation).

The following were examined: *Anisobas* sp. (CDA) (fig. 30A), *Listrodromus nyctemerus* (Gravenhorst) (BM) (fig. 30B).

Tribe Eurylabini

FIGURE 31

Probolus sp. (CDA) was examined.

The absence of a sharp line of demarcation between each pleurostoma and the sclerotized area lateral to it distinguish this ichneumonine from all others examined except *Melanichneumon*, which is distinguished by the numerous setae on the prelabial region.

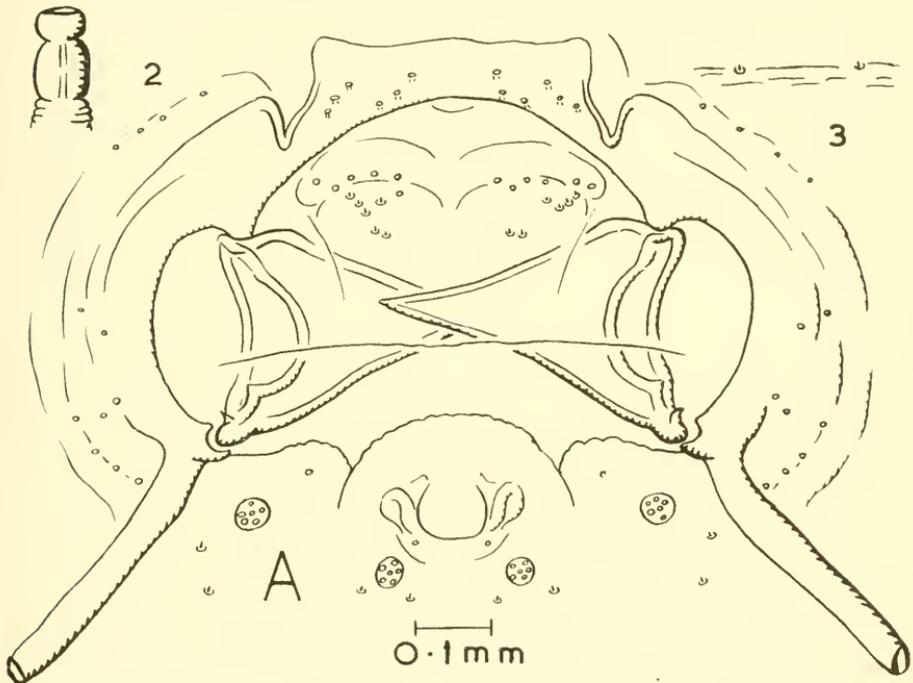


FIGURE 31.—Ichneumoninae:Eurylabini, head sclerites: *Probolus* sp. (antenna not visible on preparation; 2, spiracle; 3, skin.)

Tribe Ichneumonini

FIGURES 32-35

In the following key reference is made to setae and sensilla, but there is no distinction between a small seta and a sensillum.

LARVAL KEY

- 1. Epistoma broad and lightly sclerotized **Carinodes**
- Epistoma narrow and well sclerotized 2
- 2. Some eighteen setae present on prelabium **Melanichneumon**
- No more than six setae present on prelabium 3

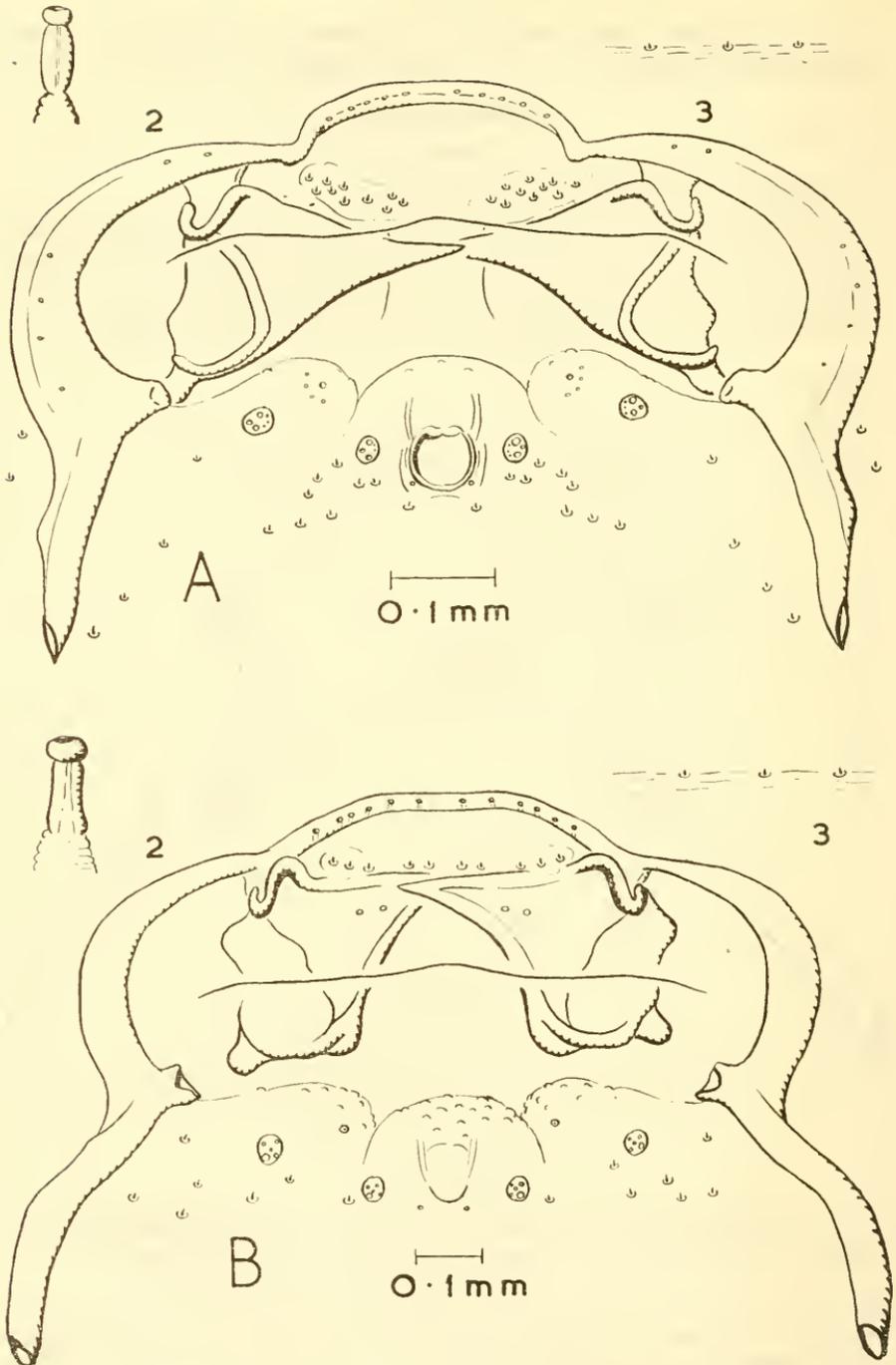


FIGURE 32.—Ichneumoninae:Ichneumonini, head sclerites: A, *Melanichneumon brevicinctor* (Say); B, *Cratichneumon unifasciatus* (Say). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

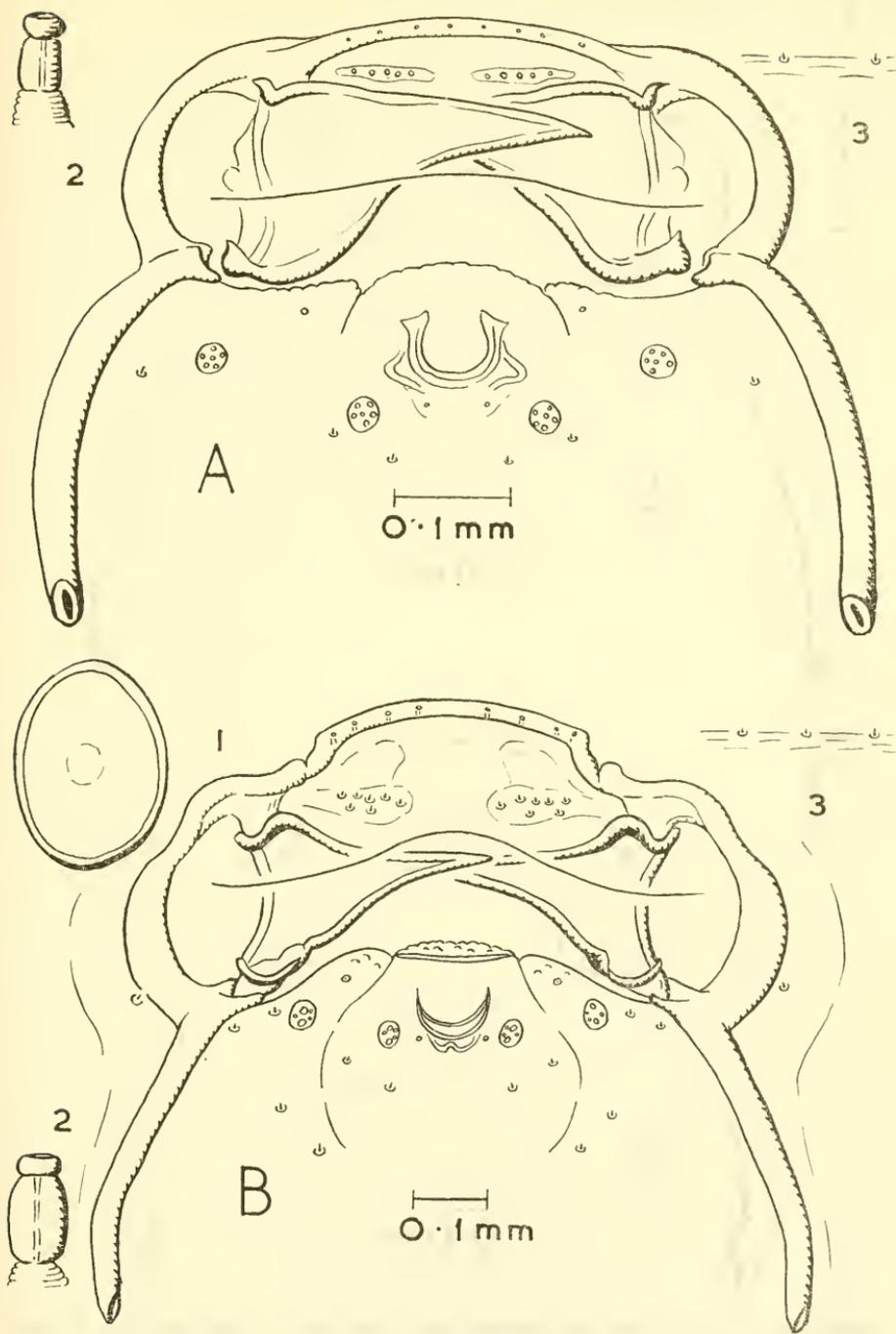


FIGURE 33.—Ichneumoninae: Ichneumonini, head sclerites: A, *Aoplus velox* (Cresson) antenna not visible on preparation; B, *Chasmias scelestus* (Cresson). (1, antenna; 2, spiracle; 3, skin.)

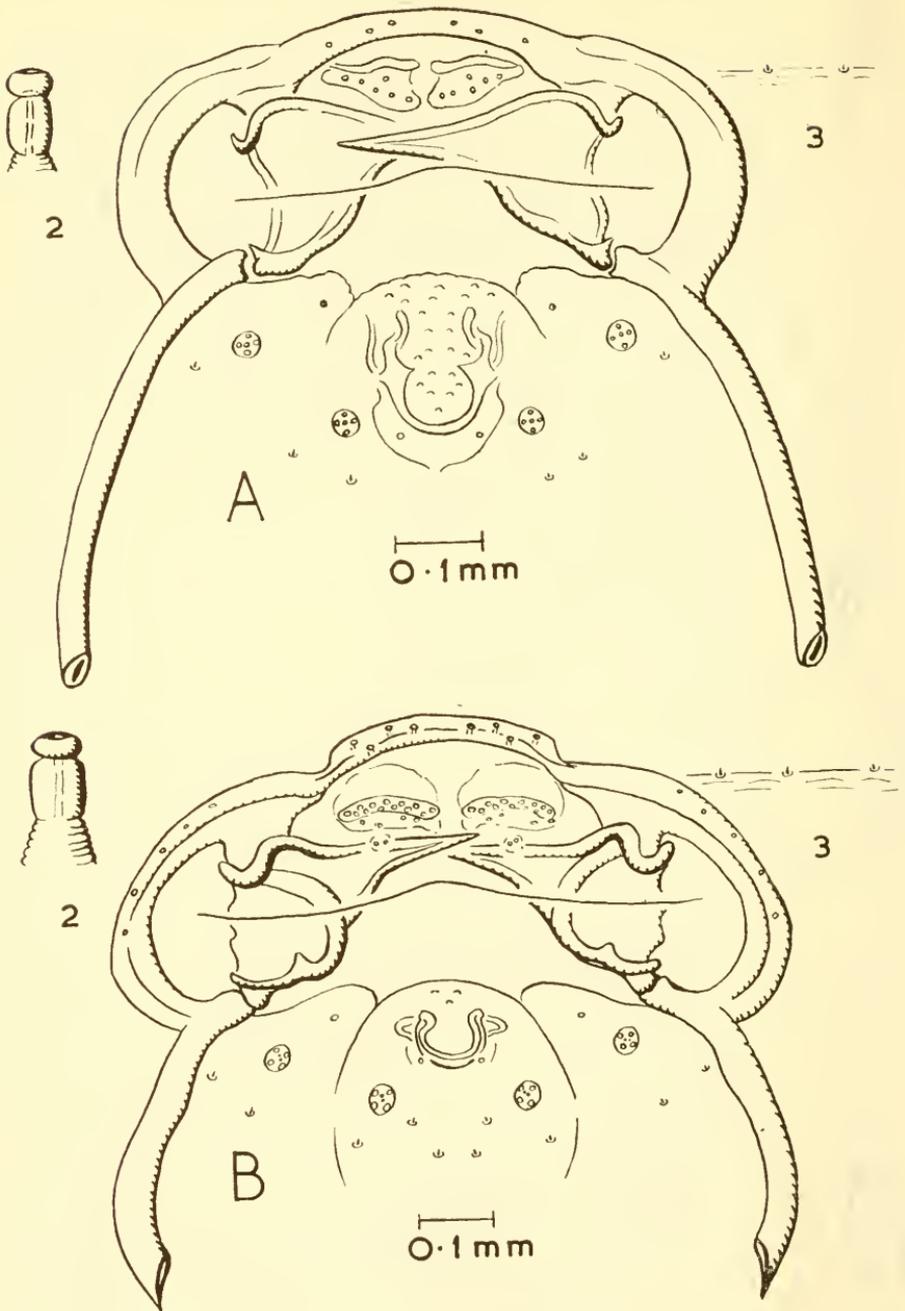


FIGURE 34.—Ichneumoninae:Ichneumonini, head sclerites: A, *Pseudamblyteles nuncius* (Cresson); B, *Amblyteles inconstans* (Cresson). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

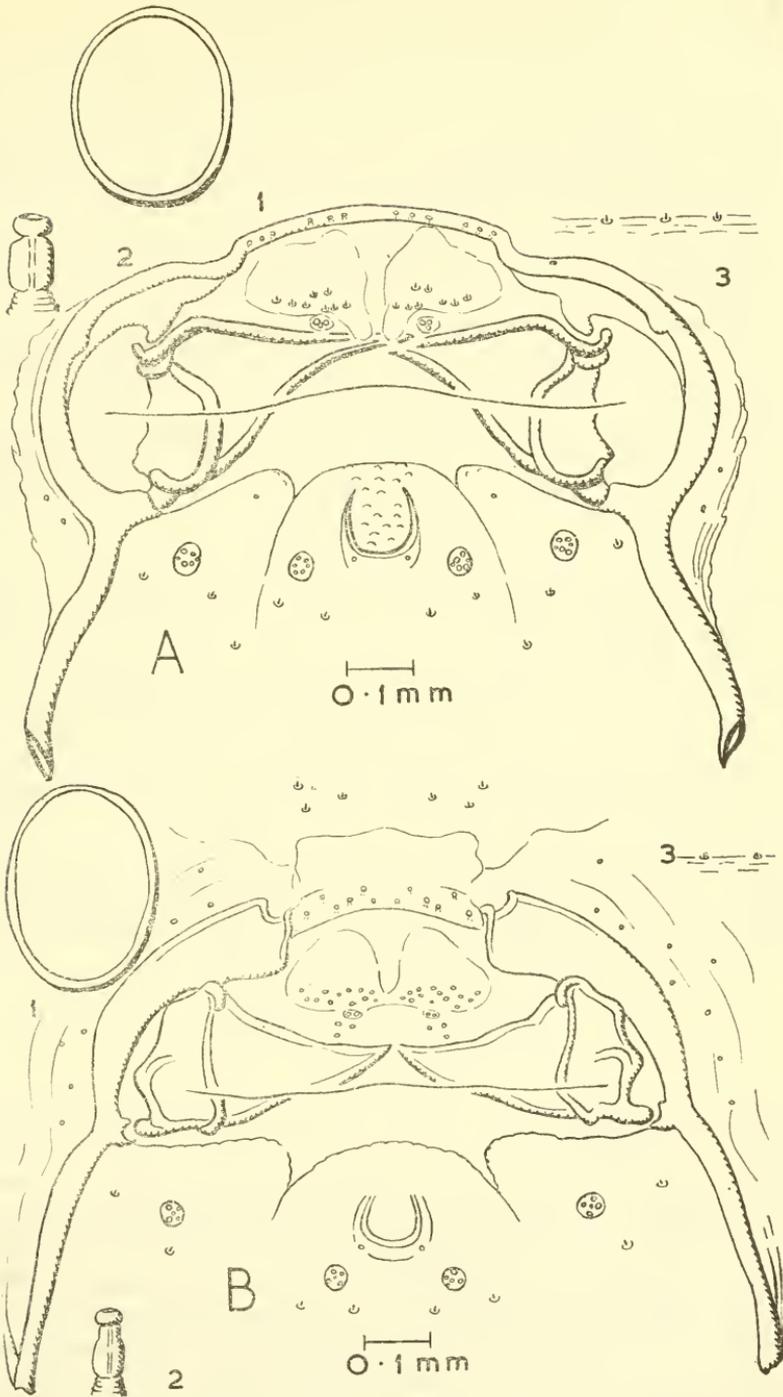


FIGURE 35.—Ichneumoninae:Ichneumonini, head sclerites: A, *Ichneumon ambulatorius* Fabricius; B, *Carinodes havenensis* (Cameron). (1, antenna; 2, spiracle; 3, skin.)

3. Clypeolabral region with ten setae arranged in a line and two groups each of two sensilla beneath this line **Craticheumon**
 Setae and sensilla arranged in two groups on clypeolabrum and not in a line 4
4. Clypeolabral setae grouped as shown (fig. 35A) on two lightly sclerotized plates shaped as shown (fig. 35A) **Ichneumon**
 Setae and sensilla not grouped as shown (fig. 35A) on plates shaped as shown (fig. 35A) 5
5. Raised areas on clypeolabrum containing sensilla narrow and straight . **Aoplus**
 Raised areas on clypeolabrum containing setae or sensilla more broad and not straight 6
6. Each raised area containing sensilla on clypeolabrum curved dorsally.
Amblyteles
 Each raised area containing setae or sensilla on clypeolabrum not curved dorsally 7
7. Each raised area on clypeolabrum with a lightly sclerotized dorsal bar and containing six sensilla **Pseudamblyteles**
 Each raised area on clypeolabrum without sclerotized dorsal bar and containing seven setae **Chasmias**

The following have been examined: *Melanichneumon brevicinctor* (Say) (fig. 32A), *M. rubicundus* (Cresson), *Craticheumon duplicatus* (Say), *C. unifasciatus* (Say) (fig. 32B), *Aoplus velox* (Cresson) (fig. 33A), *Chasmias scelestus* (Cresson) (fig. 33B), *Pseudamblyteles animosus rubellus* (Cresson), *P. nuncius* (Cresson) (fig. 34A), *P. subfuscus* (Cresson), *Amblyteles inconstans* (Cresson) (fig. 34B), *A. subrufus* (Cresson), *Ichneumon ambulatorius Fabricius* (fig. 35A), *I. laetus* Brullé, *I. rufiventrus incertus* Cresson, and *Carinodes havanensis* (Cameron) (fig. 35B).

The following are figured in the literature: *Melanichneumon rubicundus* (Cresson) (Wishart, 1949), *Aoplus pictus* (Gravenhorst) (Beirne, 1941), *Amblyteles armatorius* (Foerster) (Beirne, 1941), *Ichneumon suspiciosus* Wesmæl (Cameron, 1950, 1951).

Tribe Protichneumonini

FIGURE 36A

Coelichneumon pepticus (Cresson) (fig. 36A) and *Protichneumon* sp. (GCV) were examined.

There are no clear characters differentiating this tribe from the Ichneumonini. The head parts are heavily sclerotized and there is a large sclerotized area of the cranium lateral to each pleurostoma. In *Coelichneumon* the ocular line (shown by the antenna in fig. 36A) is well sclerotized and conspicuous. It is also conspicuous in *Protichneumon*. The specimen of *Protichneumon* was not figured since the labral setae and sensilla were not clearly visible on the preparation; however, their arrangement appeared to be similar to those of *Coelichneumon*.

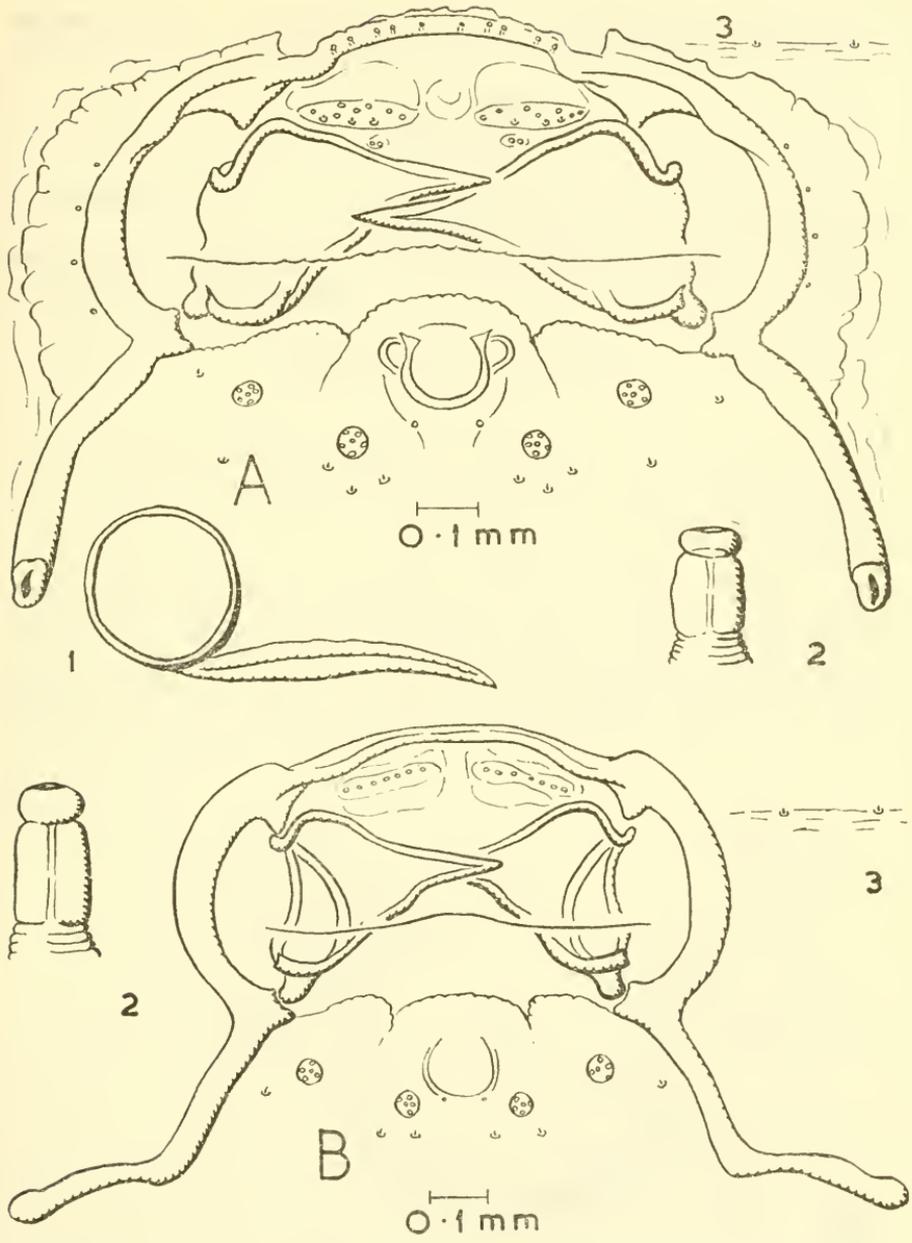


FIGURE 36.—Ichneumoninae, head sclerites: A, *Coelichneumon pepticus* (Cresson) (Protichneumonini); B, *Trogus pennator* (Fabricius) (Trogini), antenna not visible on preparation. (1, antenna and ocular line; 2, spiracle; 3, skin.)

LARVAL KEY

1. Three prominent setae situated beneath each labial palp. . . *Coelichneumon*
 Six prominent setae situated beneath each labial palp. . . . *Protichneumon*

Tribe Trogini

FIGURE 36B

Species of *Trogus* and *Macrojoppa* are parasites of Papilionidae. The rest of the genera attack SpHINGIDAE.

Trogus pennator (Fabricius) (fig. 36B) was examined. This species differs from other Ichneumonines examined in that the hypostoma is sharply bent.

Subfamily Mesochorinae

FIGURE 37

All members of this subfamily are believed to be endoparasites and secondary parasites.

Mesochorus discitergus (Say) (fig. 37) and *Mesochorus* sp. were examined.

The larval characters of the specimens examined indicate an isolated group. Those head sclerites present are lightly sclerotized; the epistoma is unsclerotized; the pleurostoma is present; only the median part of the hypostoma is sclerotized in *Mesochorus*, but the entire hypostoma is sclerotized in *Astiphromma strenuum* (Holmgren)

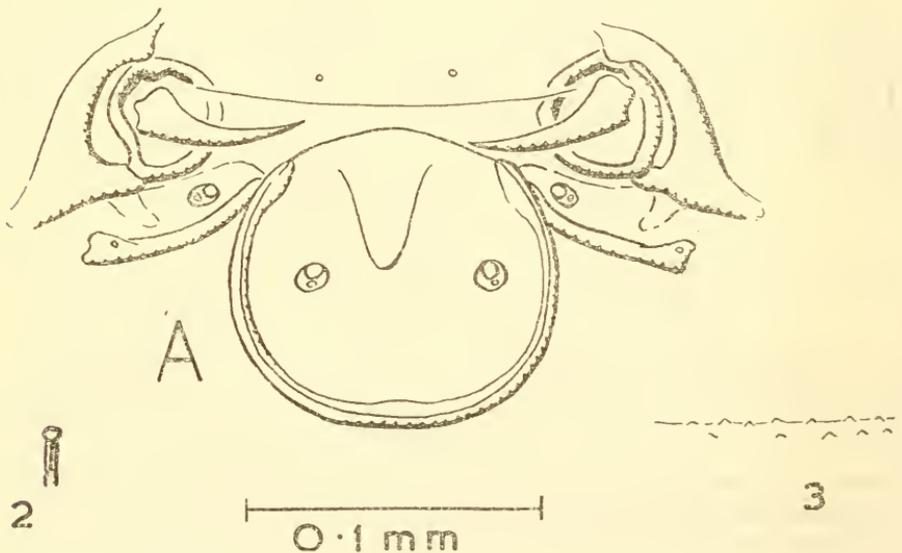


FIGURE 37.—Mesochorinae, head sclerites: *Mesochorus discitergus* (Say). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

(Beirne, 1941); the hypostomal spur is very lightly sclerotized; the stipital sclerite is slender and its lateral end has a small enlargement bearing a sensillum; the labial sclerite is slender; the silk press is not sclerotized; each maxillary and labial palp bears two sensilla, one large and one small; there is no prelabial sclerite and no labral sclerite; two small sensilla are present on the labrum, but labral, maxillary, and prelabial setae appear to be absent; the form of the mandible is distinctive, the base having only the circumference sclerotized and with the blade long, slender, and slightly curved; the width of the base of the mandible is approximately equal to two-thirds the length of the blade; the spiracle is relatively small and the length of the thin-walled closing apparatus, which adjoins the atrium, is approximately equal to twice the depth of the atrium; the skin bears small projections but setae could not be seen.

LARVAL KEY

- 1. Hypostoma with only median part sclerotized **Mesochorus**
- Hypostoma with entire length sclerotized **Astiphronma**¹⁹

The following are figured in the literature: *Mesochorus fulgurans* Curtis (Beirne, 1941), *M. vitticollis* Holmgren (Beirne, 1943).

The Mesochorinae follow the Anomalinae in the classification by Walkley (1958). The larval characters of the Mesochorinae are very different from those of the Anomalinae and in the present study the Mesochorinae have been placed near the Lissonotinae. The rounded labial sclerite of the Mesochorinae resembles that of the Lissonotinae. The mandible, however, is distinctive in form and differs from that of all other Ichneumonids. On larval characters the Mesochorinae are best regarded as an isolated group.

Subfamily Lissonotinae

FIGURES 38-40

Members of this subfamily are internal parasites of caterpillars.

The characters show relationships to those of the Ophioninae and Mesoleiinae. The epistoma is not sclerotized dorsally except in *Exetastes*; the pleurostoma is lightly sclerotized to well sclerotized; the hypostoma is long in the Glyptini and Banchini, but in the Lissonotini it is short and does not extend laterally beyond the lateral end of the stipital sclerite; the hypostomal spur and stipital sclerite are well developed; the labial sclerite, which is relatively large, is basically round to oval and the ventral part is often lightly sclerotized or unsclerotized; the silk press is large; a prelabial sclerite is usually present and two sensilla are situated on this sclerite; each maxillary

¹⁹ Of Beirne (1941).

and labial palp contains one large sensillum and one to three smaller sensilla; the labral sclerite is absent; the mandibles are relatively small and consist of a large base and a small slender blade; this blade may be toothless or may have small blunt teeth on its dorsal and ventral surfaces; in some genera a lightly sclerotized band is present connecting the posterior pleurostomal processes across the dorsal surface of the food meatus; the antenna is disc-shaped; the closing apparatus of the spiracle adjoins the atrium except in *Glypta*; the skin has small setae and small conical projections but no spines.

LARVAL KEY

1. Hypostoma short and not extending laterally beyond lateral end of stipital sclerite **Lissonotini**
 Hypostoma long and extending laterally beyond end of stipital sclerite 2
2. Epistoma complete, or, if not, then with more than 10 setae present on prelabium **Banchini**
 Epistoma incomplete; less than 10 setae on prelabium **Glyptini**

Tribe Glyptini

FIGURE 38A

Glypta sp. was examined.

With its rounded labial sclerite which is incomplete ventrally and its lightly sclerotized prelabial sclerite, *Glypta* resembles the *Lissonotini*. The long hypostoma resembles that of the *Banchini*. As in some *Banchini* and some *Lissonotini* a sclerotized bar connecting the posterior pleurostomal processes is present. The mandibles are distinctive with their slender toothless blades and, unlike other *Lissonotinae*, the closing apparatus of the spiracle does not adjoin the atrium.

Glypta fumiferanae (Viereck) is figured by Brown (1947), *G. haesitator* Gravenhorst by Cameron (1938), and *G. parvicaudata* Bridgman by Beirne (1941).

Tribe *Lissonotini*

FIGURES 38B,C, 39

Members of this tribe are parasites of caterpillars in burrows and leaf rolls.

LARVAL KEY

1. Labial sclerite with ventral part unsclerotized or not as well sclerotized as lateral parts 2
 Labial sclerite with ventral part as well sclerotized as lateral part 4
2. Mandible without teeth **Lissonota**
 Mandible with teeth 3

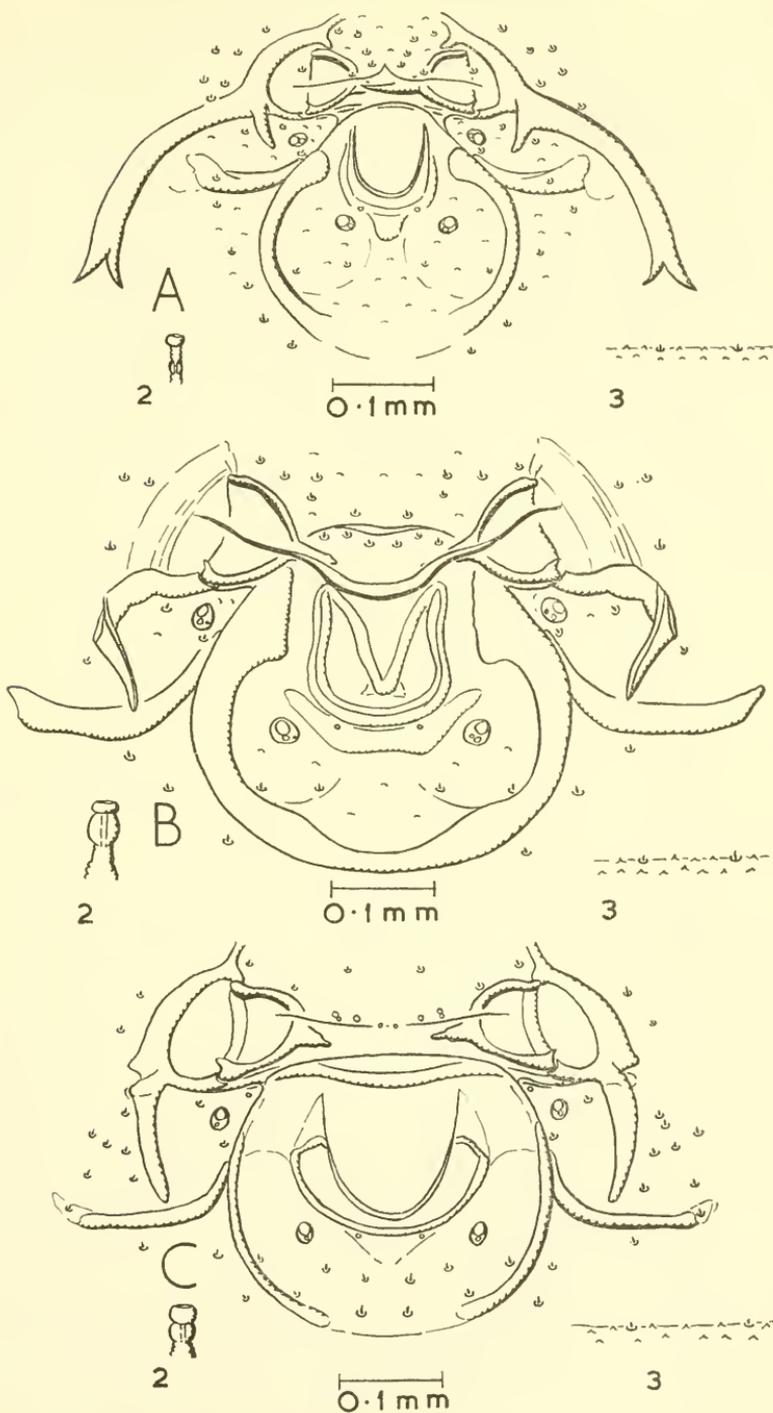


FIGURE 38.—Lissonotinae, head sclerites: A, *Glypta*, sp. (Glyptini); B, *Lampronota* sp. nr. *sesiovora* (Rohwer) (Lissonotini); C, *Leptobatopsis* sp. nr. *lepidus* (Cameron) (Lissonotini). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

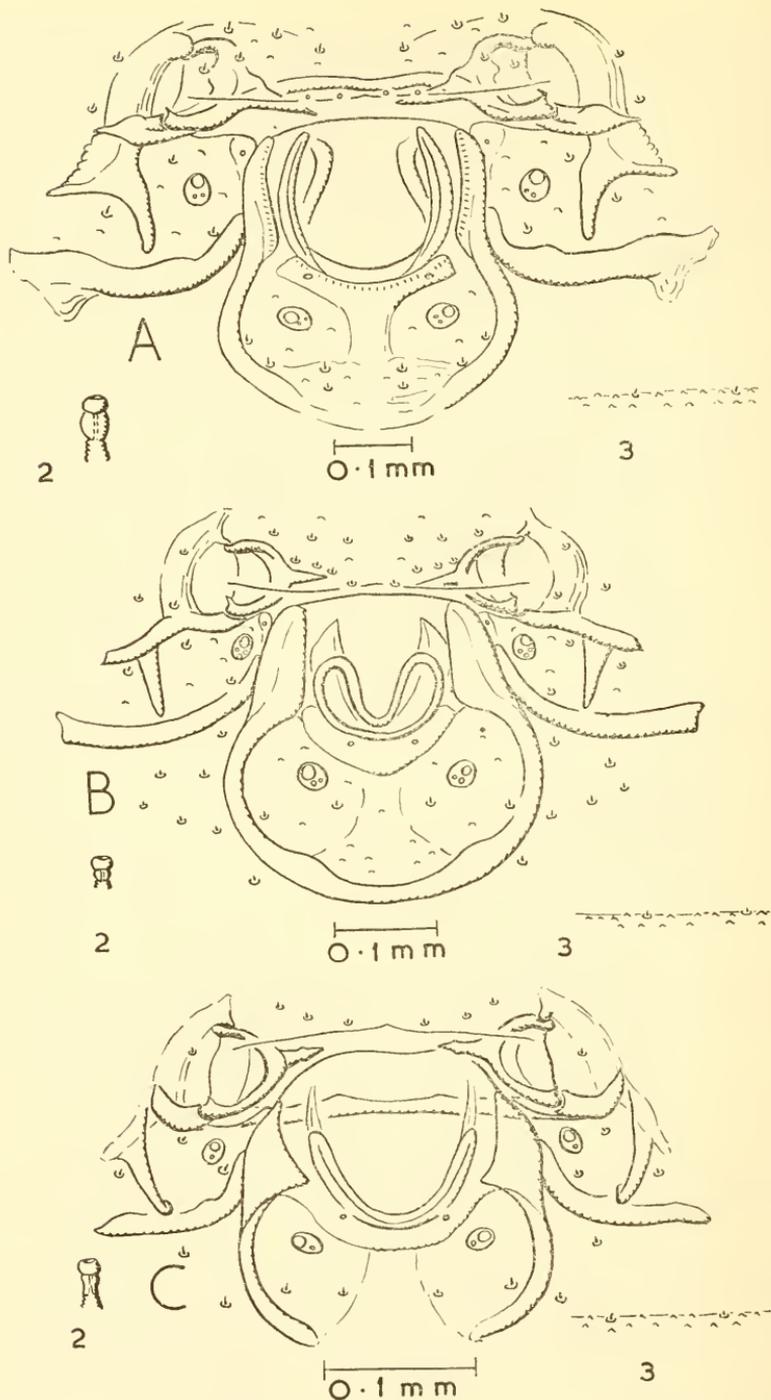


FIGURE 39.—Lissonotinae: Lissonotini, head sclerites: A, *Lissonota*[♂] *brunnea* (Cresson); B, *Pimplopterus rubricus* (Cresson); C, *Asphragis mirabilis* (Cresson). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

- 3. Dorsal ends of labial sclerite broad **Asphragis**
 Dorsal ends of labial sclerite narrow **Leptobatopsis**
- 4. Hypostoma not extending laterally beyond hypostomal spur . **Lampronota**
 Hypostoma with short lateral bar beyond hypostomal spur . **Pimplopterus**

The species of *Lampronota* figured is peculiar in that there is a lightly sclerotized band running along the ventral edge of the labrum. This band is distinct from the band connecting the posterior pleurostomal processes across the dorsal surface of the food meatus in some genera. The functions of these bands are not obvious. Beirne (1941) does not figure a labral band in *L. catenator* (Panzer) although he does figure a band between the posterior pleurostomal processes.

The following were examined: *Lampronota* sp. nr. *sesiovora* (Rohwer) (fig. 38B), *Leptobatopsis* sp. nr. *lepidus* (Cameron) (fig. 38c), *Lissonota brunnea* (Cresson) (fig. 39A), *Pimplopterus rubricus* (Cresson) (fig. 39B), *Asphragis mirabilis* (Cresson) (fig. 39c).

Lampronota catenator (Panzer) and *Syzeuctus maculatorius* (Fabricius) are figured by Beirne (1941). *S. maculatorius* is similar to *Asphragis* although teeth do not appear to be present on the mandible.

Tribe Banchini

FIGURE 40

LARVAL KEY

- 1. Epistoma present **Exetastes**
 Epistoma absent 2
- 2. Ventral part of prelabial sclerite more lightly sclerotized than dorsal parts.

Ceratogastra

Ventral part of prelabial sclerite as well sclerotized as lateral parts . **Banchus**

Banchus and *Ceratogastra* are very similar. The T-shaped prelabial sclerite resembles that of many Ophioninae. *Exetastes* differs from other Lissonotinae in having a complete epistoma, but the remaining characters, such as the shape of the mandible, are typical of the subfamily. Apart from the epistoma, *Exetastes* differs from the other two genera of the Banchini examined in that there are teeth on the mandibles. However, the structure of the spiracle is basically similar in the three genera, the closing apparatus being as long as two or three times the depth of the atrium. In the Lissonotini the closing apparatus is approximately of the same length as the atrium.

The following were examined: *Exetastes bifenestratus* Cushman (fig. 40A), *E. illinoiensis* (Walsh), *Ceratogastra ornata ornata* (Say) (fig. 40B), *Banchus femoralis* Thomson (fig. 40c), *B. flavescens* Cresson.

The following are figured in the literature: *Exetastes cinctipes* (Ratzeburg) (Beirne, 1941), *Exetastes* sp. (Snodgrass, 1935), *Banchus femoralis* Thomson (Beirne, 1941).

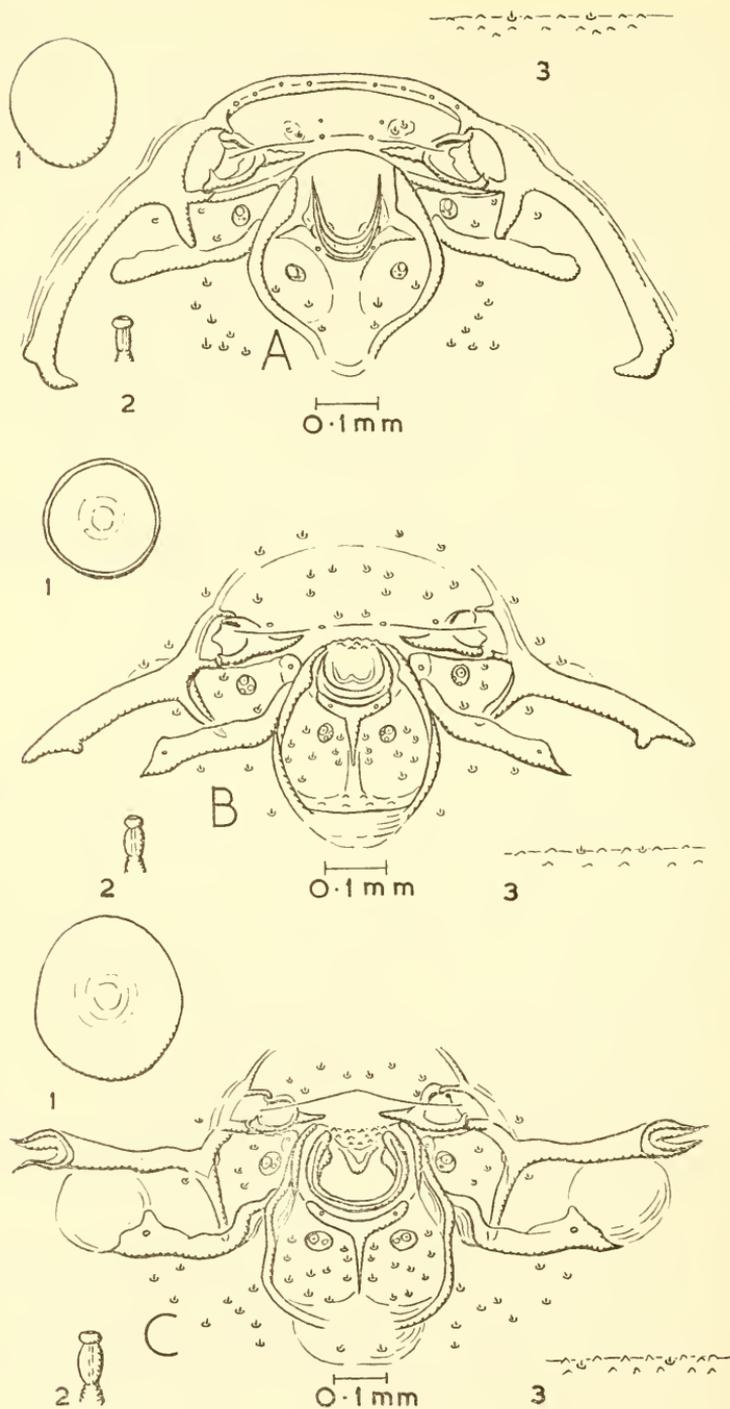


FIGURE 40.—Lissonotinae: Banchini, head sclerites: A, *Exetastes bifenestratus* Cushman; B, *Ceratogastra ornata* (Say); c, *Banchus femoralis* Thomson. (1, antenna; 2, spiracle; 3, skin.)

Subfamily Mesoleiinae

FIGURES 41-44

Members of this subfamily are internal parasites of Tenthredinoidea.²⁰

The dorsal part of the epistoma is unsclerotized or lightly sclerotized; the pleurostoma is usually lightly sclerotized: the hypostoma and hypostomal spur are well sclerotized, the hypostomal spur being relatively longer than in most Ophioninae; the stipital sclerite is well developed and a lightly sclerotized cardo is sometimes present; the labial sclerite is present and may be incomplete ventrally; in some genera the dorsal ends of the labial sclerite bear small bubble-like projections; a prelabial sclerite is present and two sensilla are usually present on the dorsal part of this sclerite; the maxillary and labial palps are relatively large and each bears two to three sensilla; the silk press is conspicuous; the labral sclerite is absent, except in *Opheltes* and *Protarchus*; there are two main types of mandible, one having a rounded and lightly sclerotized base with a relatively straight blade which may be short, the other having a rather square base and a curved blade; the antenna is disc-shaped; with the exception of *Euceros* and *Opheltes* where the closing apparatus of the spiracle is small, the spiracle has a thin-walled closing apparatus with a length which is two to three times the depth of the atrium; the skin bears very small setae and small projections which in *Lophyroplectus* are sufficiently sclerotized to be described as spines.

The Mesoleiinae have many features resembling the Ophioninae. In the key to the subfamilies it was found necessary to separate the Ophioninae into tribes in order to key out the Mesoleiinae from this subfamily. The larval characters of the Mesoleiinae do, however, indicate a fairly distinct group. The type of mandible of *Rhorus*, with its rounded base and very small blade, is distinctive. The mandible of *Hypsantyx* is basically similar although the blade is relatively larger. The mandible of *Hypsantyx*, in turn, resembles that of other Mesoleiini and that of the Euryproctini. The mandible of *Scolobates* and *Euceros* is similar to that of most of the Ophioninae in that there is a rather square base and a curved blade. But the shape of the labial sclerite of *Scolobates* connects this genus to the remaining Mesoleiinae. The labial sclerite of *Euceros*, with its plate-like expansion of the ventral part, resembles that of some genera in the Ophioninae, Campoplegini. In *Opheltes* (Mesoleiinae, Mesoleiini), however, there is a smaller plate-like expansion of the ventral part of the labial sclerite and this may connect to the condition in *Euceros*. The spiracle of *Euceros*, with its relatively small closing apparatus, resembles that

²⁰ *Euceros frigidus* Cresson has been recorded as an internal parasite of Lepidoptera.

of the Ophioninae, Campoplegini, and, with the exception of *Opheltes*, differs from that of the remaining Mesoleiinae.

It has not been found possible to separate the Mesoleiini and Euryproctini on larval characters. *Lamachus* and *Hypsantyx* with their incomplete labial sclerites, the dorsal ends of which have bubble-like projections, resemble the Euryproctini rather than *Opheltes*, *Mesoleius* and *Lophyproctus*.

Townes and Townes (1951) place *Opheltes* in a subtribe Perilissina and *Mesoleius* and *Lamachus* in a subtribe Mesoleiina of the Mesoleiini. The larval characters do not appear to support this grouping.

LARVAL KEY

1. Mandible with rounded and very lightly sclerotized base and very small sclerotized blade of length less than radius of base Pionini
Mandible not of this form 2
2. Labial sclerite with ventral part expanded into plate constituting almost half length of sclerite Euceratini
Labial sclerite not of this form 3
3. A lightly sclerotized plate is present across labrum, and the labral setae are situated on this plate Scolobatini
A lightly sclerotized plate not present on labrum 4
4. Labial sclerite with ventral part well sclerotized or, if not, then as well sclerotized as lateral parts.

Opheltes, *Mesoleius*, and *Lophyproctus* of Mesoleiini

Labial sclerite with ventral part unsclerotized or not as well sclerotized as lateral parts.

Euryproctini, and *Lamachus* and *Hypsantyx* of Mesoleiini

Tribe Scolobatini

FIGURE 41A

Members of this tribe are parasitic on argid sawflies.

Scolobates auriculatus (Fabricius) (CDA) was examined. The mandibles of this species resemble those of the Ophioninae, Campoplegini, but the remaining characters are similar to those of many Mesoleiinae.

Distinctive structures are the lightly sclerotized bar across the labrum and a lightly sclerotized plate which appears to be present on the dorsal surface of the food meatus. This may be the suspensorium of the hypopharynx (see Short, 1952, figs. 6-8) but, as seen in a cast skin, it appears to be present on the dorsal surface of the food meatus and therefore distinct from the suspensorium. Living material could not be obtained for sections to decide this point.

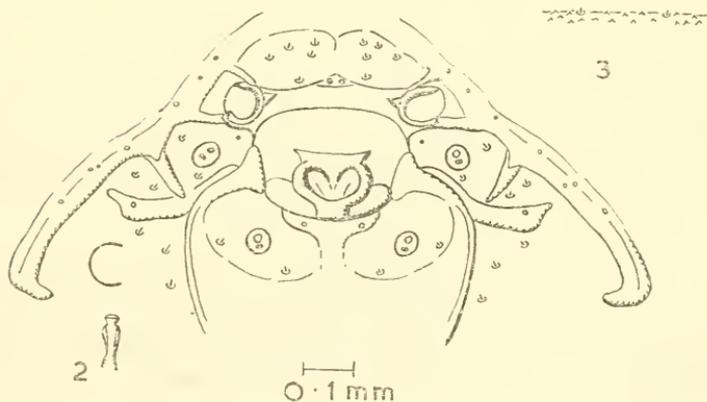
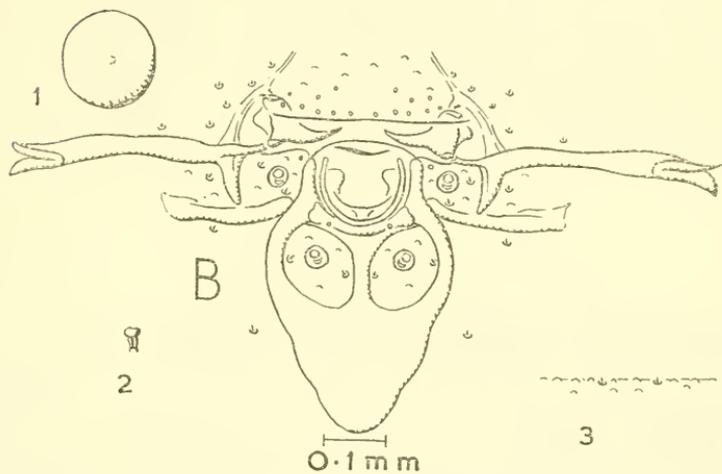
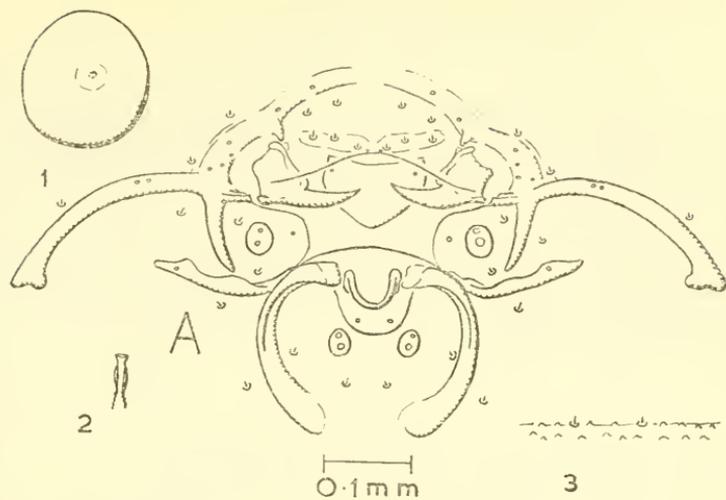


FIGURE 41.—Mesoleiinae, head sclerites: A, *Scolobates auriculatus* (Fabricius) (Scolobatini); B, *Euceros thoracicus* Cresson (Euceratini); C, *Rhorus clapini* (Provancher) (Pionini); antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

Tribe Euceratini

FIGURE 41B

Species of *Euceros* have been recorded mainly from Tenthredinoidea, but *E. fridigus* Cresson has been recorded from Lepidoptera.

Euceros thoracicus Cresson was examined. This species shows a strong resemblance to many Ophioninae, Campoplegini, but the mandibles also resemble those of the Scolobatini and the expansion of the ventral part of the labial sclerite is also seen, although to a lesser extent, in *Opheltes*. The small closing apparatus of the spiracle is also seen in *Opheltes*.

Tribe Pionini

FIGURE 41C

Rhorus clapini (Provancher) was examined.

This is a somewhat isolated form, but the labial sclerite, although very slender, does resemble that of most Mesoleiinae in being incomplete ventrally. The type of mandible is also found, in a modified form, in the Euryproctini and Mesoleiini.

Rhorus mesoanthus (Gravenhorst) is figured by Beirne (1941).

Tribe Mesoleiini

FIGURES 42, 43

LARVAL KEY

- | | |
|--|---------------------------------|
| 1. With labial sclerite complete ventrally | 2 |
| With labial sclerite very lightly sclerotized or unsclerotized ventrally | 4 |
| 2. Labral sclerite present ²¹ | Opheltes |
| | Protarchus ²² |
| Labral sclerite absent | 3 |
| 3. Six setae on prelabium | Mesoleius |
| Four setae on prelabium | Lophyprolectus |
| 4. Posterior end of hypostoma with small expansion | Hypsantyx |
| Posterior end of hypostoma without small expansion | Lamachus |

The broad ventral end of the hypostomal spur figured in *Lamachus virginianus* (Rohwer) appears to be present only in this species. In other species of *Lamachus* the ventral end of the hypostomal spur is slender. In most species of *Lamachus* examined the dorsal ends of the labial sclerite had pronounced bubble-shaped projections similar to those of *Hypsantyx* and the Euryproctini.

The following have been examined: *Opheltes glaucopterus flavipennis* (Provancher) (fig. 42A), *Mesoleius tarsilas* (Cresson), *M. tenthredinis* Morley (fig. 42B), *Lamachus albopictus* Cushman, *L.*

²¹ *Opheltes* differs from *Protarchus* in that the ventral part of the labial sclerite is less pointed.

²² Of Beirne (1941).

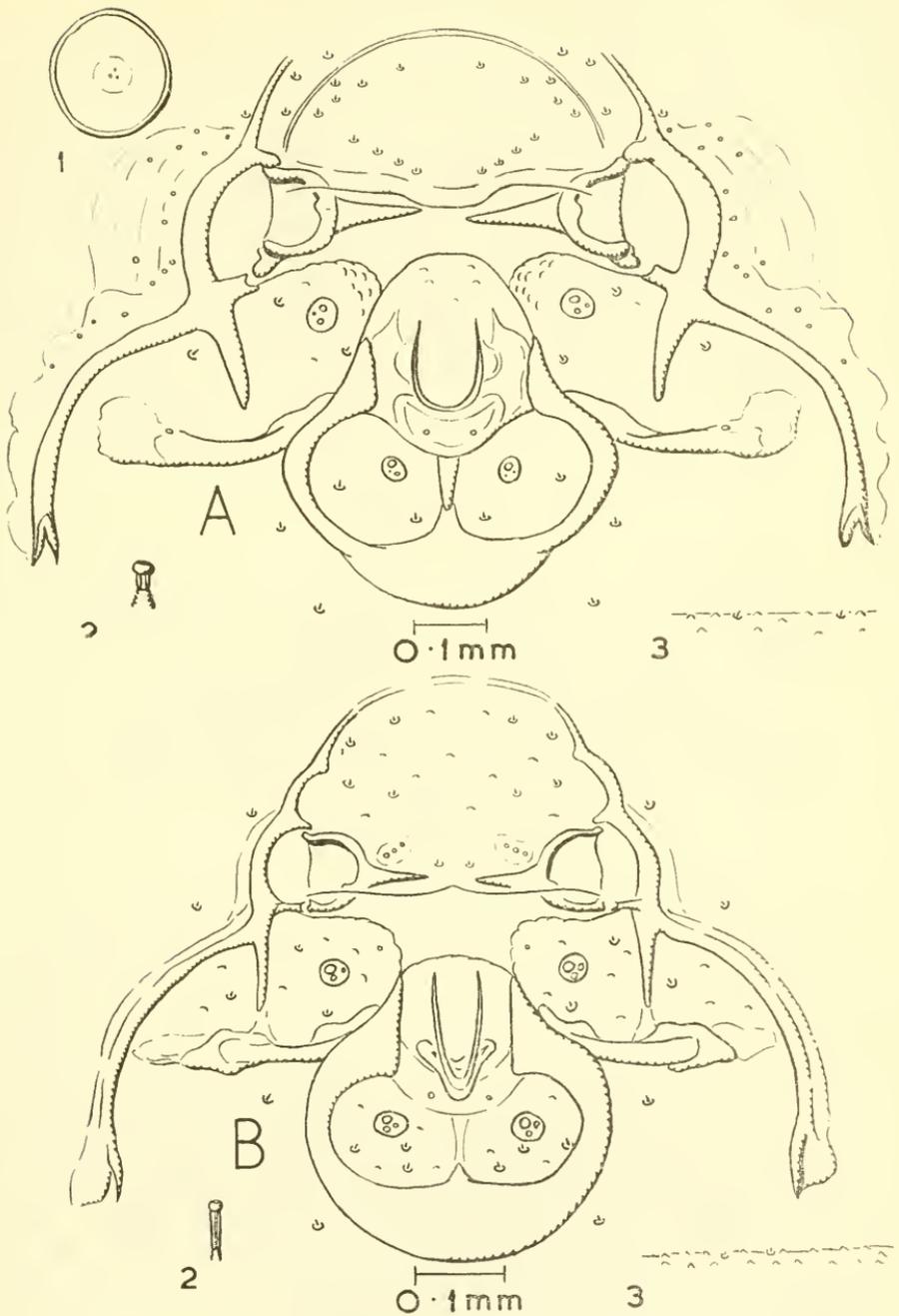


FIGURE 42.—Mesoleiinae: Mesoleiini, head sclerites: A, *Opheltes glaucopterus flavipennis* (Provancher); B, *Mesoleius tenthredinis* Morley, antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

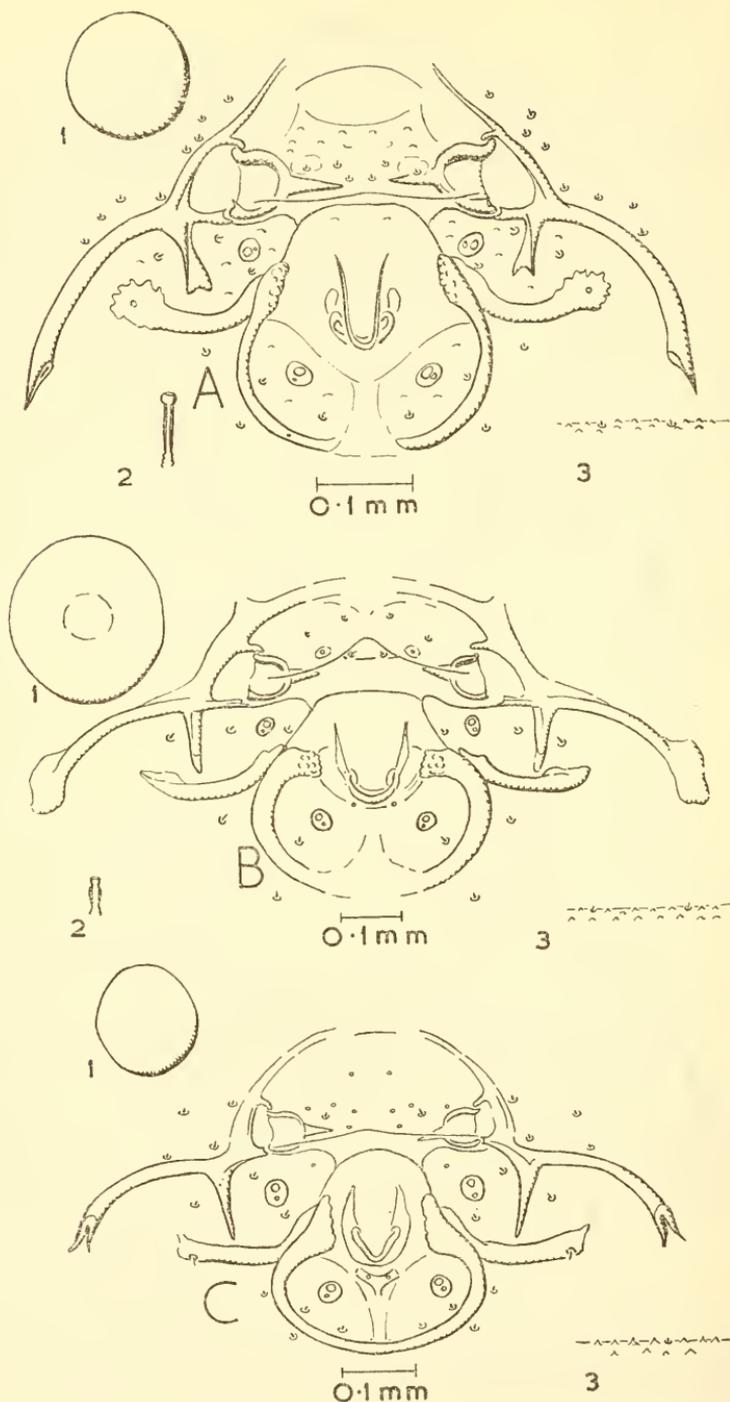


FIGURE 43.—Mesoleiinae: Mesoleiini, head sclerites: A, *Lamachus virginianus* (Rohwer), B, *Hypsantyx liturarius* (Linnaeus); c, *Lophyprolectus nipponensis* Cushman. (1 antenna; 2, spiracle; 3, skin.)

contortionis Davis, *L. eques* (Hartig), *L. lophyri* (Ashmead), *L. ruficoxalis* (Cushman), *L. tsugae* Cushman, *L. virginianus* (Rohwer) (fig. 43A), *Hypsantyx lituratorius* (Linnaeus) (fig. 43B), *Lophyroplectus nipponensis* Cushman (fig. 43C).

The following are figured in the literature: *Mesoleius tenthredinis* Morley (Beirne, 1941), *Protarchus testatorius* (Thunberg) (Beirne, 1941), *Lamachus* sp. (Morris, Cameron, and Jepson, 1937), *Hypsantyx lituratorius* (Linnaeus) (Beirne, 1941), *Lophyroplectus luteator* (Thunberg) (Beirne, 1941). Beirne (1941, pp. 151, 153) figures lateral projections on the labial sclerite in the region of the stipital sclerite in *Mesoleius* and *Lophyroplectus*. These structures were not seen. It is probable that lobes on the median end of each stipital sclerite were mistaken for lobes on the labial sclerite.

Tribe Euryproctini

FIGURE 44

LARVAL KEY

- | | |
|--|--------------------|
| 1. Ventral part of prelabial sclerite absent | Synomelix |
| Ventral part of prelabial sclerite lightly sclerotized | 2 |
| 2. Three sensilla on each labial palp | Ipoctoninus |
| Two sensilla on each labial palp | Polyterus |

These three genera are very similar.

The following were examined: *Synomelix* sp. (fig. 44A), *Polyterus olympiae* (Ashmead) (fig. 44B), *Ipoctoninus striatus* (Davis) (fig. 44C).

Subfamily Collyriinae

FIGURE 45A

Collyria calcitrator (Gravenhorst) was examined. This is a very isolated species with the larval characters showing no relationship to those of any other ichneumonid. It is endoparasitic in the sawfly *Cephus*.

The lateral parts of the epistoma are very lightly sclerotized and broad, forming plates on the lateral parts of the clypeus; each pleurostoma is lightly sclerotized and bears about five sensilla; there are no other head sclerites: the maxillary and labial palps are represented by small sensilla; there is no sclerotized silk press; about 12 sensilla are present on the labrum; the mandibles are unsclerotized and are without teeth; they can be detected in specimens cleared in Faure's fluid, but must be stained in order to be seen clearly; the antenna is disc-shaped; the spiracle has a long, thin-walled closing apparatus with a length which is five to six times the depth of the atrium; the skin is very smooth with small projections and small setae.

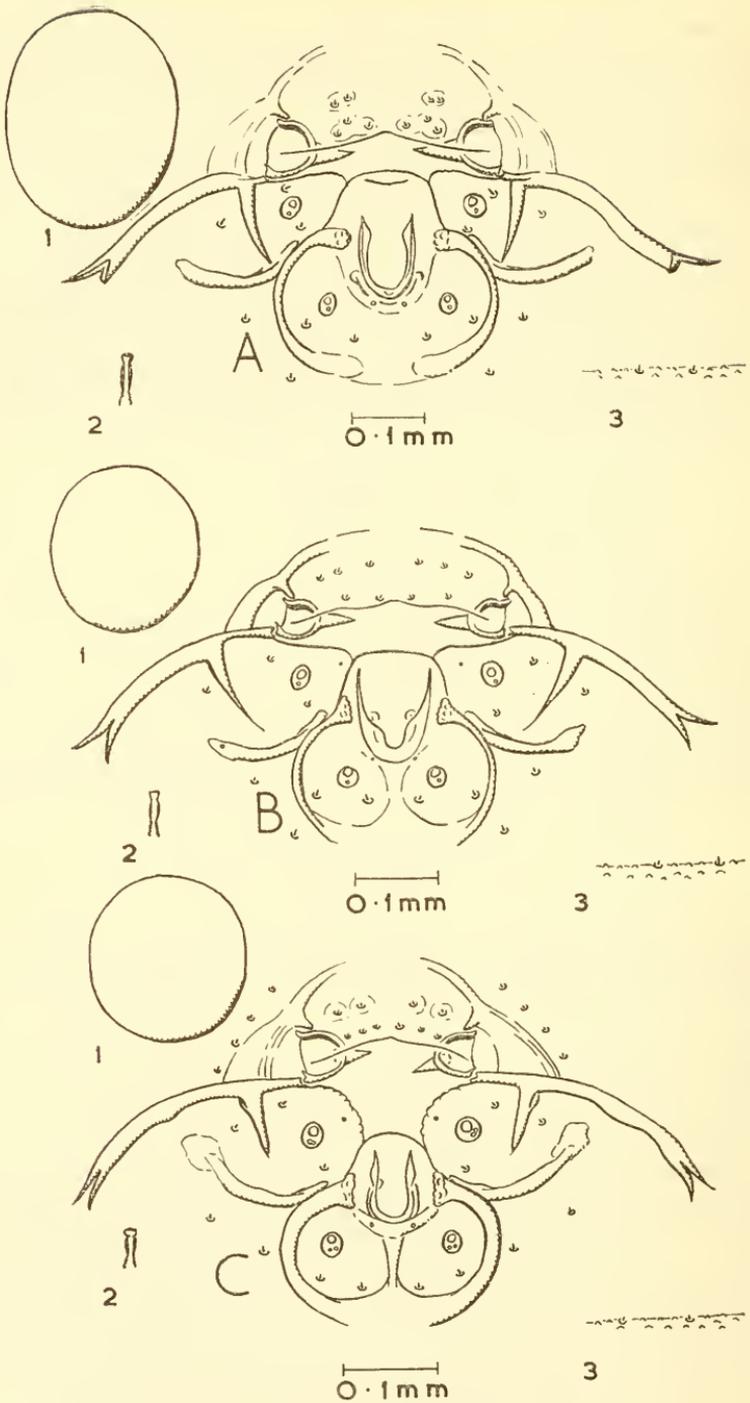


FIGURE 44.—Mesoleiinae: Euryproctini, head sclerites: A, *Synomelix* sp.; B, *Polyterus olympiae* (Ashmead); c, *Ipoctoninus striatus* (Davis). (1, antenna; 2, spiracle; 3, skin.)

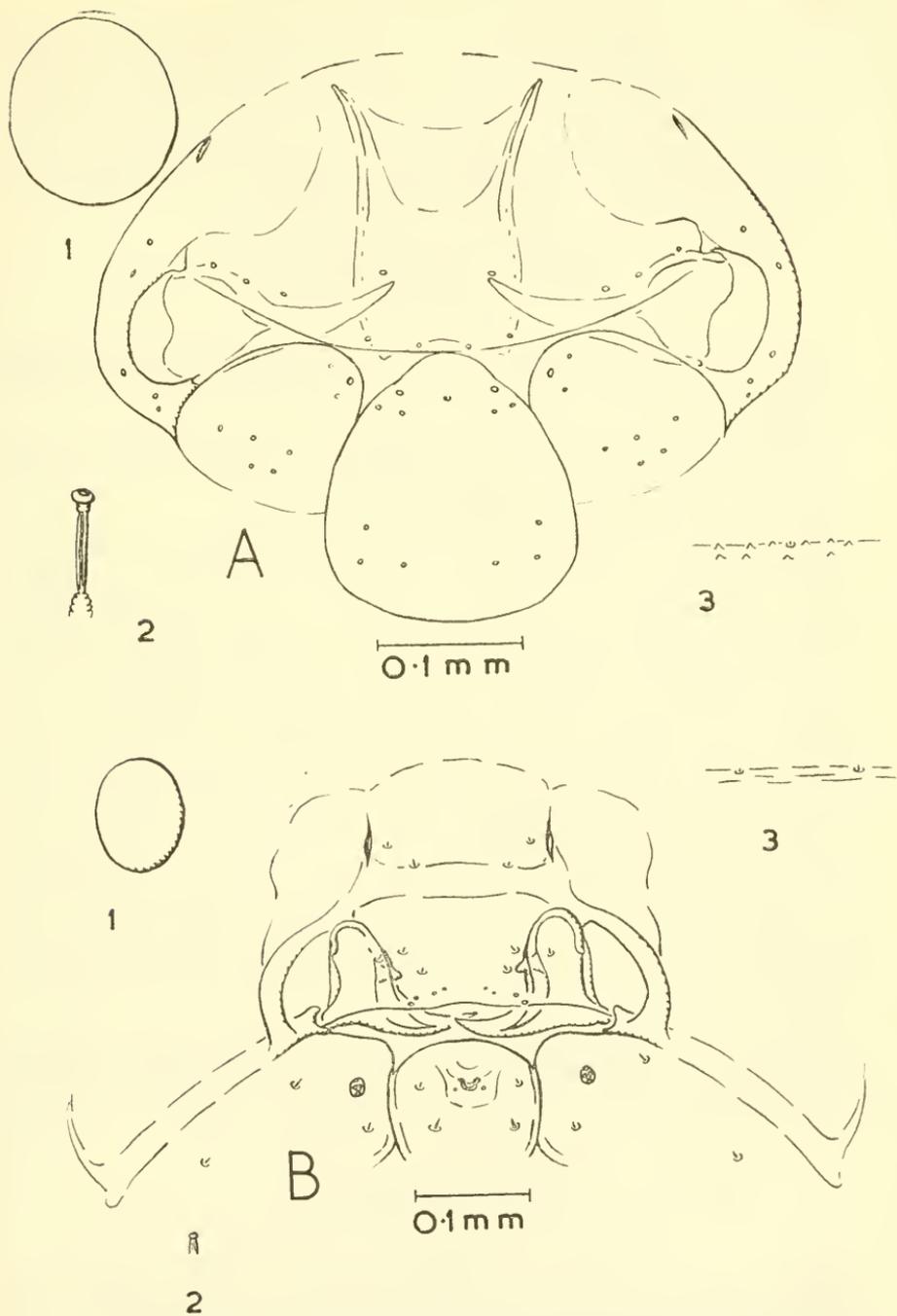


FIGURE 45.—Head sclerites: A, *Collyria calcitrator*^F (Gavenhorst) (Collyriinae); B, *Orthopelma mediator* (Thunberg) (Orthopelmatinae). (1, antenna; 2, spiracle; 3, skin.)

C. calcitrator is figured by Salt (1931) and a large sclerotized plate is shown underlying the labial area. This plate is the suspensorium of the hypopharynx (see Short, 1952), and is figured here, although in a different position (fig. 45A). The suspensorium is an internal skeletal structure forming part of the ventral wall of the cibarial part of the stomodaeum, and the position in which it is seen depends on the position into which it is forced during mounting.

Subfamily Orthopelmatinae

FIGURE 45B

Orthopelma mediator (Thunberg) was examined. The members of this genus are endoparasitic in the cynipoids *Diastrophus* on *Rubus* and *Diplolepis* on *Rosa*.

The larval characters resemble those of the Ichneumoninae, although the form of the mandible is different, the hypostoma is more lightly sclerotized, and disc-shaped labial palps are absent.

The epistoma and pleurostoma are moderately sclerotized and very lightly sclerotized areas are present dorsal to the epistoma and dorso-lateral to the pleurostoma; the hypostoma is very lightly sclerotized; the lateral parts of the labial sclerite are very faintly sclerotized and folds along the median part of the ventral edge of each maxilla may appear as faintly sclerotized bands; the remaining head sclerites are absent; the maxillary palps are represented by flat discs but the labial palps are represented by setae; a lightly sclerotized silk press is visible; the mandible is relatively large and well sclerotized and has a curved blade containing a deep groove on the inner wall of which is situated a prominent tooth; the anterior tentorial pits are prominent; the antenna is disc-shaped; the spiracle is relatively very small with an oval atrium and the closing apparatus, which adjoins the atrium, is equal in length to twice the depth of the atrium; the skin is smooth with small setae and no projections.

Orthopelma mediator as figured by Beirne (1941) shows a toothless mandible, disc-shaped labial palps, and a well-sclerotized hypostoma. These structures have not been seen in any specimen of *O. mediator* examined in the present study.

Subfamily Plectiscinae

FIGURE 46

This is a very isolated subfamily and little is known about its biology. The usual hosts are believed to be Fungivoridae. The larval characters suggest that the group is endoparasitic.

Megastylus sp. (fig. 46A) and *Plectiscus varius* (Haliday) (GCV) (fig. 46B) were examined.

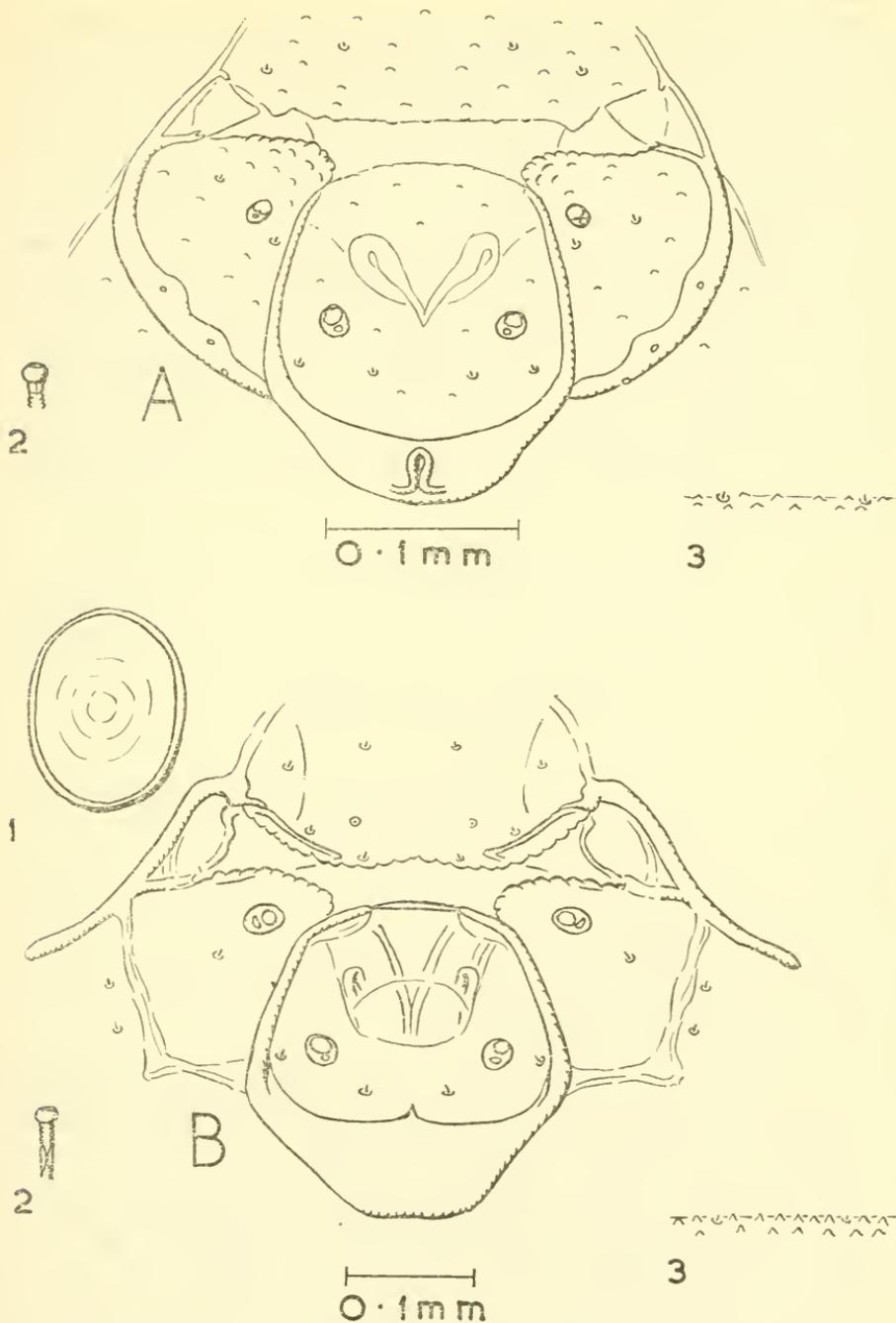


FIGURE 46.—Plectiscinae, head sclerites: A, *Megastylus* sp., antenna not visible on preparation; B, *Plectiscus varius* (Haliday). (1, antenna; 2, spiracle; 3, skin.)

The epistoma is unsclerotized; the pleurostoma is lightly sclerotized; the hypostoma is short and lightly or very lightly sclerotized; the hypostomal spur and stipital sclerite are fused, the stipital sclerite not extending laterally beyond its point of meeting with the hypostomal spur; the labial sclerite is somewhat square in shape and the ventral part is relatively broad; each maxillary and labial palp is large and each bears two sensilla, one of which is relatively large; the silk press is lightly sclerotized; the labral sclerite is absent; the mandibles are relatively small and are triangular in shape; they are very lightly sclerotized and are without teeth; the antenna is disc-shaped; in *Megastylus* the closing apparatus of the spiracle is slightly smaller than the atrium and adjoins the atrium; in *Plectiscus* the closing apparatus of the spiracle is longer than the depth of the atrium and is separated from the atrium by a length of trachea equal to the length of the closing apparatus; the skin bears small spines and small projections.

LARVAL KEY

1. Hypostomal spur and stipital sclerite as well sclerotized as labial sclerite. **Megastylus**
- Hypostomal spur and stipital sclerite not as well sclerotized as labial sclerite. **Plectiscus**

Subfamily Diplazoninae

FIGURE 47

Members of this subfamily are endoparasitic in Syrphidae. They oviposit into the egg or young larva of the host and emerge from the puparium. The subfamily is an isolated group.

The following were examined: *Diplazon laetatorius* (Fabricius) (fig. 47A), *D. orbitalis* (Cresson), *D. scutellaris* (Cresson), *Zootrephus rufiventrus* (Gravenhorst) (fig. 47B) (the head parts other than the labium were damaged in this specimen), *Syrphoctonus agilis* (Cresson), and *S. maculifrons* (Cresson) (fig. 47C).

The epistoma is unsclerotized; the pleurostoma is lightly sclerotized; a small part of the hypostoma is very lightly sclerotized as is a small part of the hypostomal spur; the stipital sclerite is absent; the labial sclerite is well sclerotized and of characteristic shape with a ventral spine-like projection; the maxillary and labial palps are present, but setae appear to be absent from the maxillae and labium; there is a faintly sclerotized area at the dorsal end of the labial sclerite which may represent the silk press; the labral sclerite is absent; groups of sensilla are present on raised areas of the labrum; the mandibles are usually very lightly sclerotized although the blade is lightly sclerotized in some species; the antenna was not seen in any cast skin and is

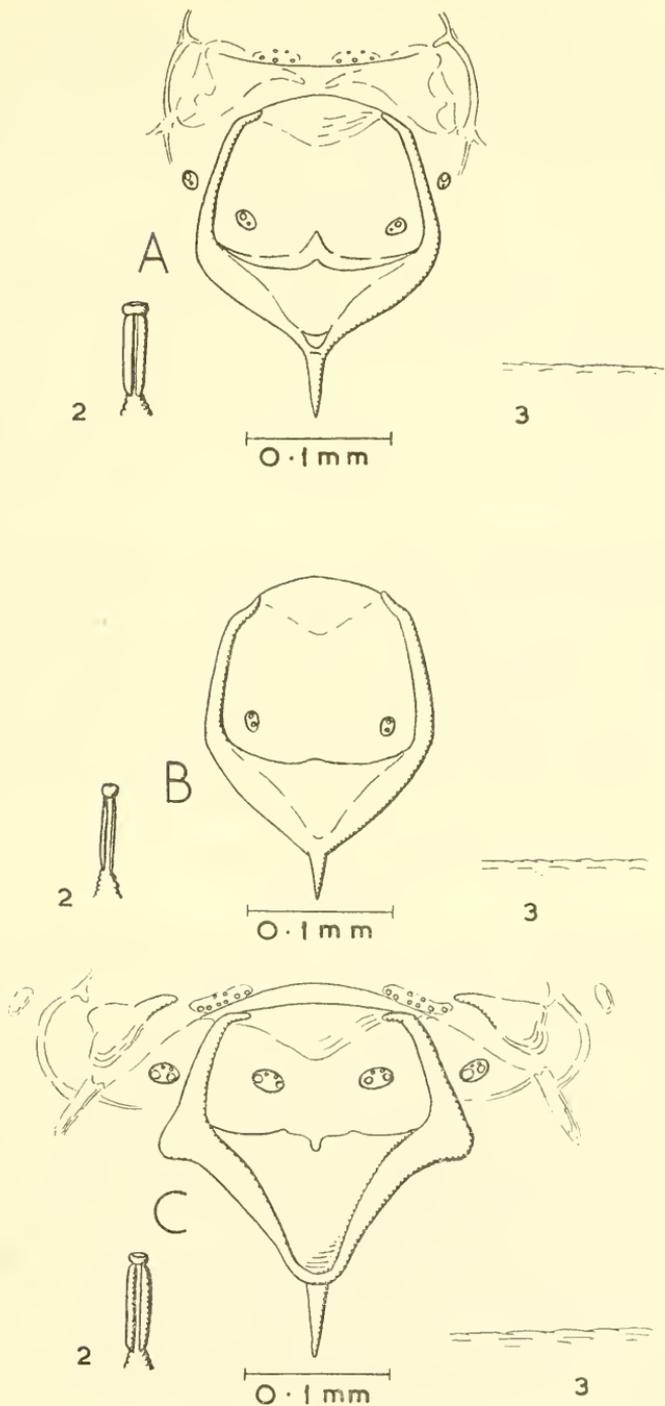


FIGURE 47.—Diplazoninae, head sclerites: A, *Diplazon laetatorius* (Fabricius); B, *Zootrephus rufiventris* (Gravenhorst); C, *Syrphoctonus maculifrons* (Cresson). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

presumably disc-shaped with an unsclerotized circumference; the spiracle has an oval atrium and the closing apparatus, which has thin walls, adjoins the atrium in some genera but not in others; the closing apparatus has a length equal to five to seven times the depth of the atrium; the skin is very smooth and appears to lack setae and projections.

LARVAL KEY

1. Lateral parts of labial sclerite produced into relatively sharp angles and not rounded **Syrphoctonus**
 Lateral parts of labial sclerite less sharp and more rounded 2
2. Labial palps lobed **Promethus**²³
 Labial palps oval 3
3. Length of labial spine approximately equal to depth of main ventral part of labial sclerite **Diplazon**
 Length of labial spine shorter than depth of main ventral part of labial sclerite. **Zootrephus**

The following are figured in the literature: *Diplazon fissorius* (Gravenhorst) (Schneider, 1950), *D. laetatorius* (Fabricius) (Scott, 1939), *D. tetragonus* (Thunberg) (Beirne, 1941), *Promethus monticola* (Vollenhoven) (Scott, 1939), *Syrphoctonus signatus* (Gravenhorst) (Scott, 1939), *S. tarsatorius* (Panzer) (Scott, 1939; Beirne, 1941).

The figures of Scott are particularly good. Schneider figures a labral sclerite in *Diplazon fissorius* (Gravenhorst). This has not been seen in any specimen of *Diplazon* examined in the present study and neither Scott nor Beirne figure this structure.

Subfamily Metopiinae

FIGURES 48, 49

Members of this subfamily are endoparasitic in Lepidoptera. The parasites emerge from the pupae of the hosts.

The epistoma is well sclerotized except in *Triclistus*; the pleurostoma and hypostoma are well sclerotized; the hypostomal spur is absent and the stipital sclerite extends dorsally to meet the hypostoma; the labial sclerite is incomplete ventrally; on each maxillary and labial palp there is one large sensillum and one or several smaller sensilla; the silk press is well sclerotized; there is a lightly sclerotized plate ventral to the press containing two sensilla; this plate may represent the dorsal part of the prelabial sclerite but is more probably the ventral part of the silk press; the labral sclerite is absent; the mandibles are relatively large and do not have teeth on the blade; the antenna is disc-shaped; the atrium of the spiracle is shallow; the closing apparatus of the spiracle is thin-walled and with a length approximately equal

²³ Of Scott (1939).

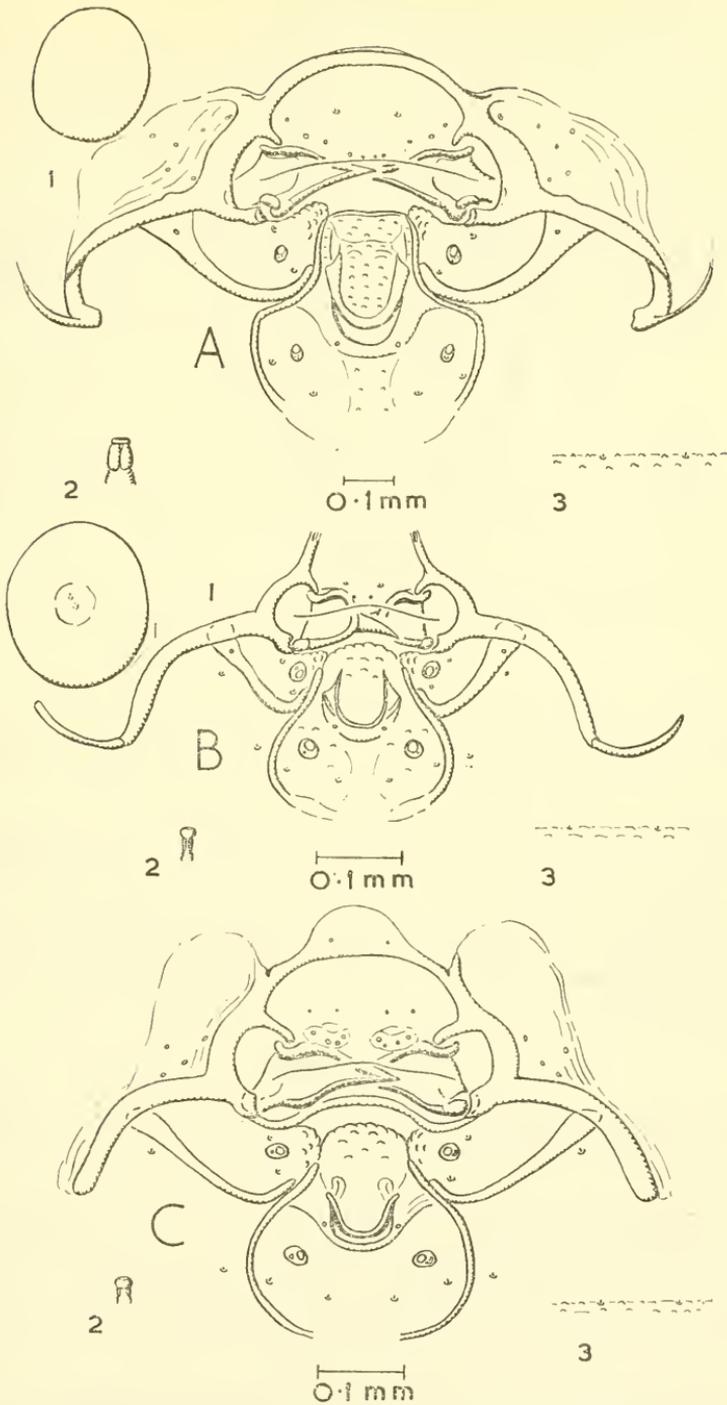


FIGURE 48.—Metopiinae, head sclerites: A, *Metopius micratorius* (Fabricius); B, *Triclistus curvator* (Fabricius); C, *Exochus scitulus* Provancher, antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

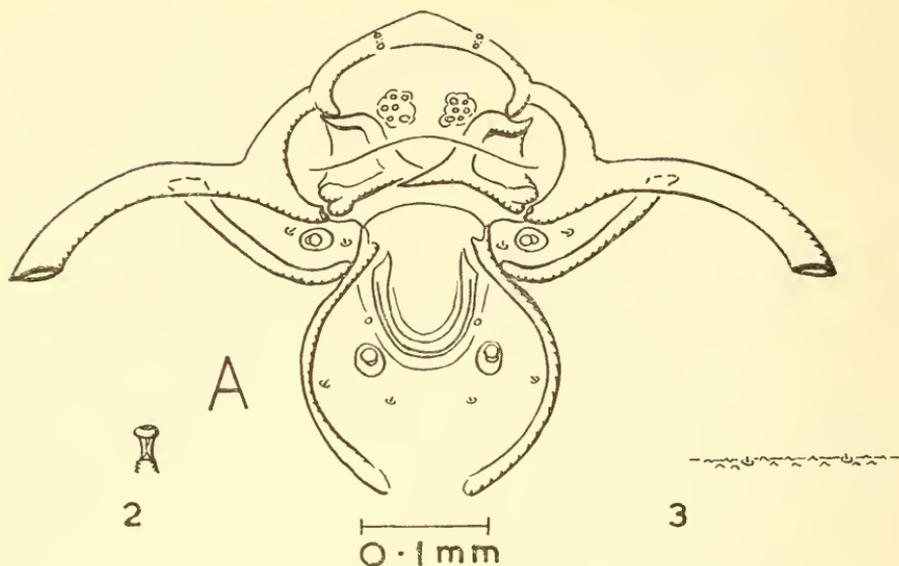


FIGURE 49.—Metopiinae, head sclerites: *Chorinaeus* sp. (antenna not visible on preparation; 2, spiracle; 3, skin.)

to the depth of the atrium, except in *Metopius* where the closing apparatus is thick-walled and with a length three to four times the depth of the atrium; the skin is smooth with small spines and small projections.

The head sclerites of the subfamily show a strong resemblance to those of the Anomalinae. They also resemble the Pimplini and the Ichneumoninae in having large toothless mandibles and a well-sclerotized epistoma and pleurostoma. These resemblances are possibly associated with similar habits since all these groups emerge from the pupae of Lepidoptera.

LARVAL KEY

1. Epistoma incomplete dorsally **Triclistus**
Epistoma complete dorsally 2
2. A lightly sclerotized plate is present lateral to each pleurostoma and hypostoma 3
A lightly sclerotized plate is not present lateral to each pleurostoma and hypostoma **Chorinaeus**
3. A lightly sclerotized bar is present connecting the posterior pleurostomal processes across the dorsal surface of the food meatus **Exochus**
A lightly sclerotized bar connecting the posterior pleurostomal processes not present **Metopius**

The following were examined: *Metopius micratorius* (Fabricius) (fig. 48A), *Triclistus curator* (Fabricius) (fig. 48B), *Exochus albifrons*

Cresson, *E. scitulus* Provancher (fig. 48c), *Chorinaeus* sp. (GCV) (fig. 49).

Beirne (1941) figures *Metopius anxius* Wesmael and *Triclistus podagricus* (Gravenhorst).

Subfamily Ophioninae

This subfamily has many characters resembling those of the Lissonotinae and Mesoleiinae. As stated in the introductory keys to subfamilies, it was found necessary to break up the Ophioninae into tribes in order to differentiate these from the two related subfamilies.

Tribe Campoplegini

FIGURES 50-56

This tribe includes many important endoparasites of economic pests. Most of the species attack lepidopterous larvae. Exceptions include those of the genus *Olesicampe* parasitic on Tenthredinidae and Diprionidae, of *Biolybia* and *Bathyplectes* parasitic on Curculionidae, and of *Pyracmon* parasitic on wood-boring Coleoptera.

The dorsal part of the epistoma is unsclerotized and the lateral parts are lightly sclerotized; the pleurostoma is lightly sclerotized; the hypostoma is long and well sclerotized; the hypostomal spur is short; the stipital sclerite is present and its lateral end has a plate-like expansion in many genera; the labial sclerite is longer than wide in most genera and the ventral part is lightly sclerotized in many genera; the prelabial sclerite is present and is Y-shaped in most genera; the labial sclerite and the prelabial sclerite differ in shape in different genera; the maxillary and labial palps each bear two sensilla, one large and one small, in most genera; the silk press is well sclerotized; the labral sclerite is absent; the mandible is of relatively moderate size and in most genera the base is rather square and the blade slender; in *Pyracmon* and *Prochas* the blade is broad; the antenna is disc-shaped; the closing apparatus of the spiracle is very lightly sclerotized and adjoins the atrium; the skin has small projections and small setae, except in *Prochas*, where the setae are equal in length to the blade of the mandible.

The following key to genera is not particularly satisfactory. Some genera have distinctive characters, but within certain genera, the larval characters of the species examined differ widely. This might indicate that the classification of the adults is greatly in need of revision. One solution for the present study would have been to group the species examined on larval characters only, ignoring the relationships indicated by the U.S. Department of Agriculture's synoptic catalog. This has been done to a very limited extent. For example

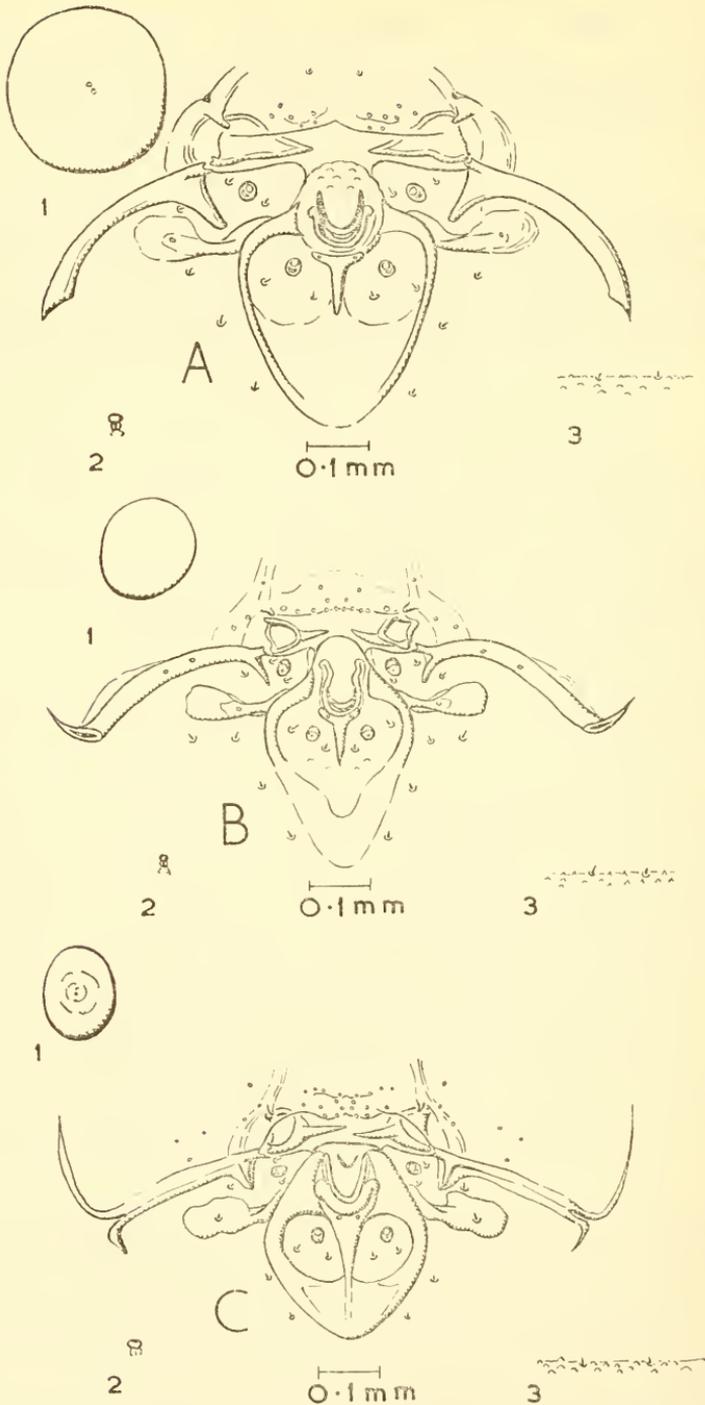


FIGURE 50.—Ophioninae: Campoplegini, head sclerites: A, *Pyracmon xanthognatha* (Rohwer); B, *Campoplex validus* (Cresson); c, *Xanthocampoplex nigromaculatus* (Cameron). (1, antenna; 2, spiracle; 3, skin.)

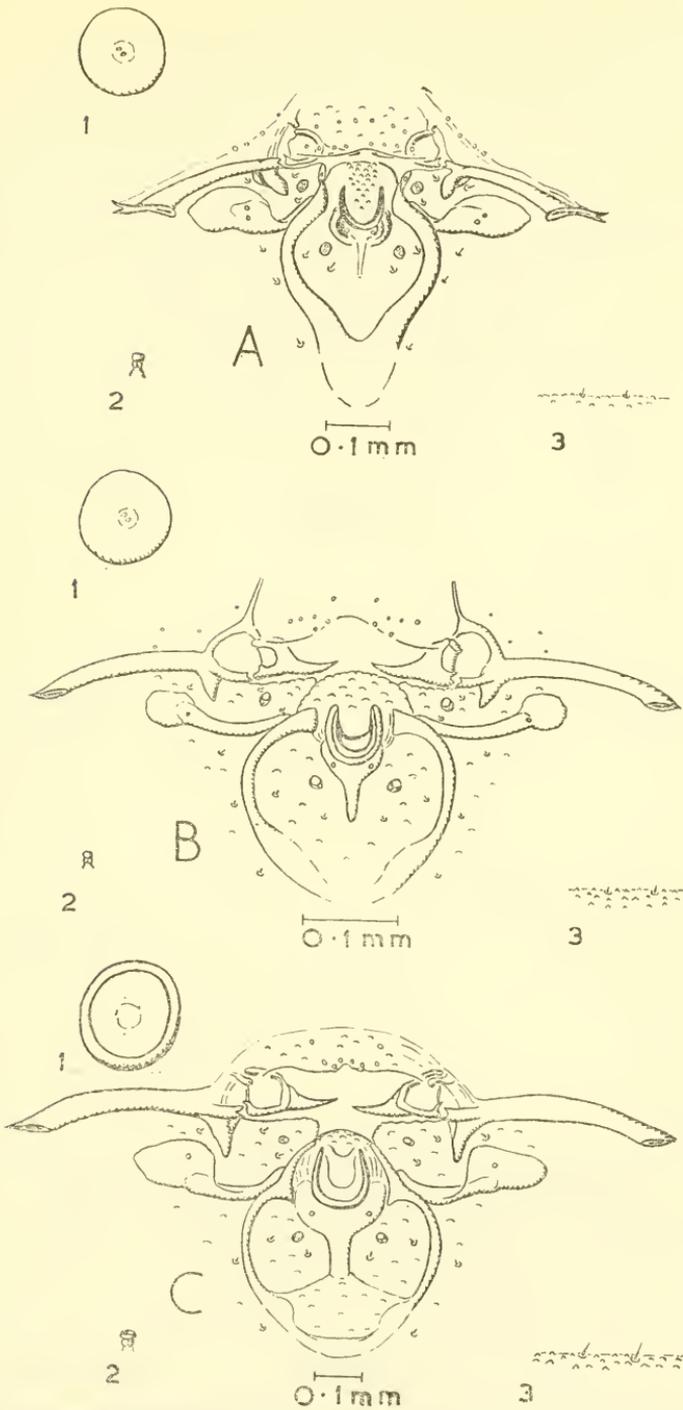


FIGURE 51.—Ophioninae:Campoplegini, head sclerites: A, *Idechthis nigriscapus* Viereck; B, *Casinaria eupitheciae* Viereck; c, *Charops papilionis* Ashmead. (1, antenna; 2, spiracle; 3, skin.)

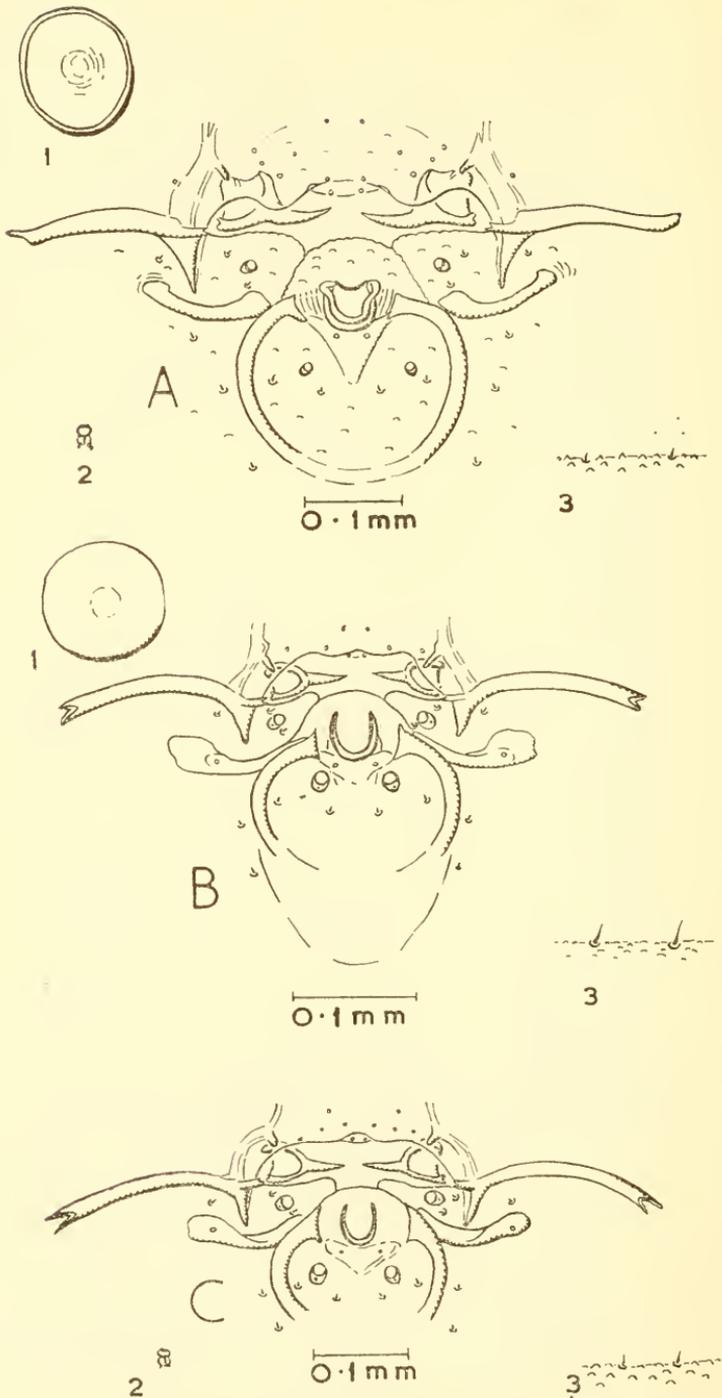


FIGURE 52.—Ophioninae: Campoplegini, head sclerites: A, *Charops narangae* (Cushman); B, *Bathyplectes curculionis* (Thomson); C, *Biolysia tristis* (Gravenhorst), antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

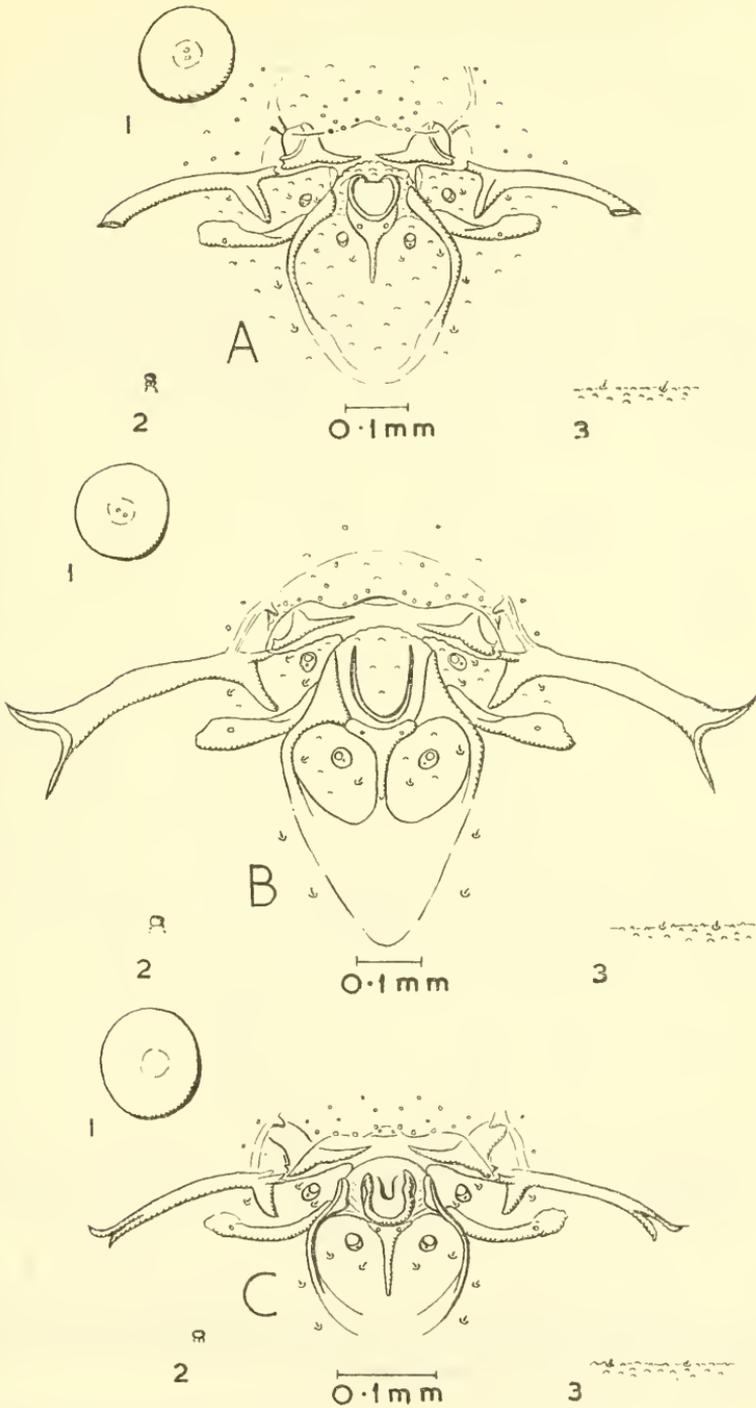


FIGURE 53.—Ophioninae:Campoplegini; head sclerites: A, *Campoletis oxylus* (Cresson); B, *Dusona vitticollis vitticollis* (Norton); c, *Nepiera benevola* Gahan. (1, antenna; 2 spiracle; 3, skin.)

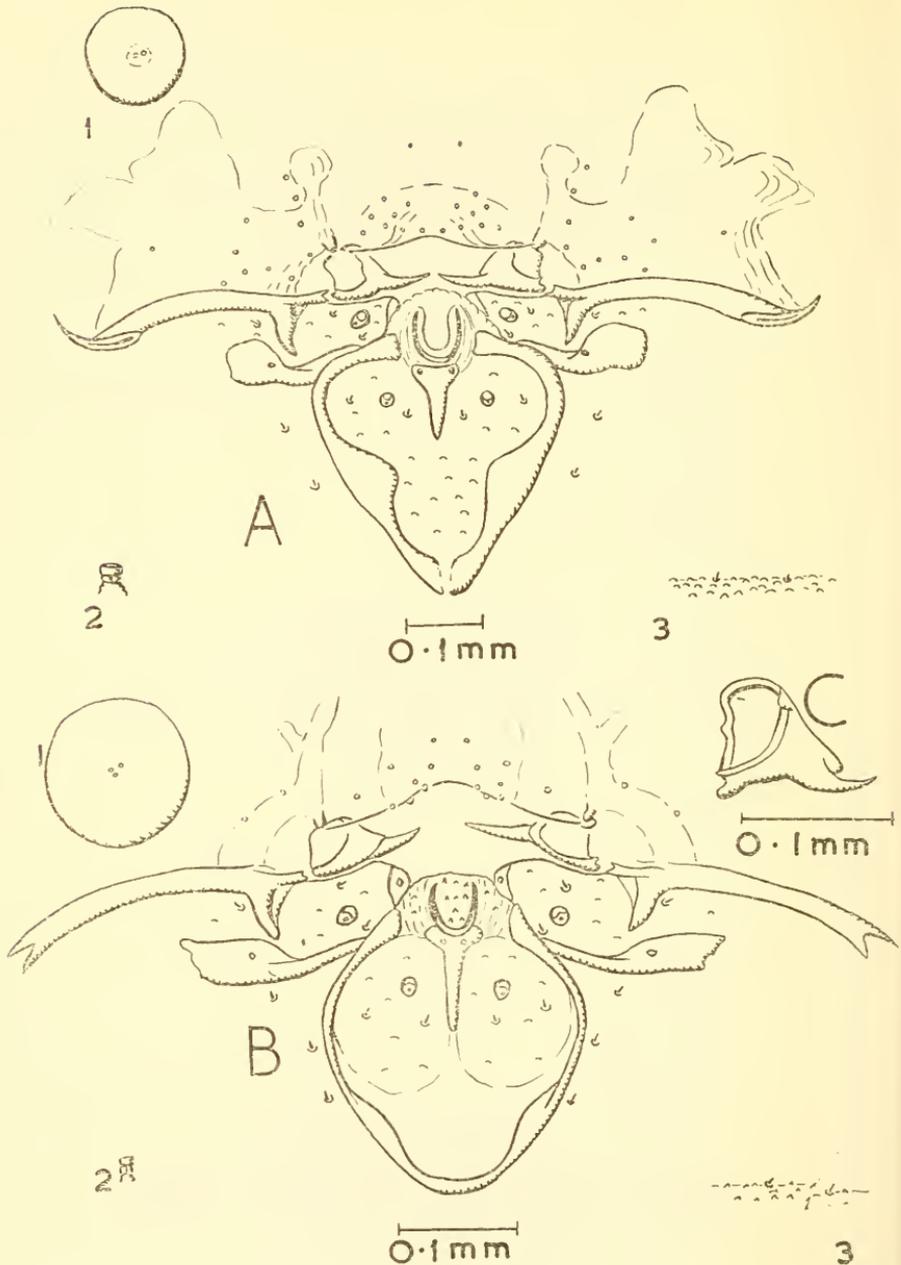


FIGURE 54.—Ophioninae: Campoplegini. A, *Phobocampe disparis* (Viereck), head sclerites; B, *Horogenes comptoniellae* (Viereck), head sclerites; c, *Hyposoter pilosulus* (Provancher), mandible. (1, antenna; 2, spiracle; 3, skin.)

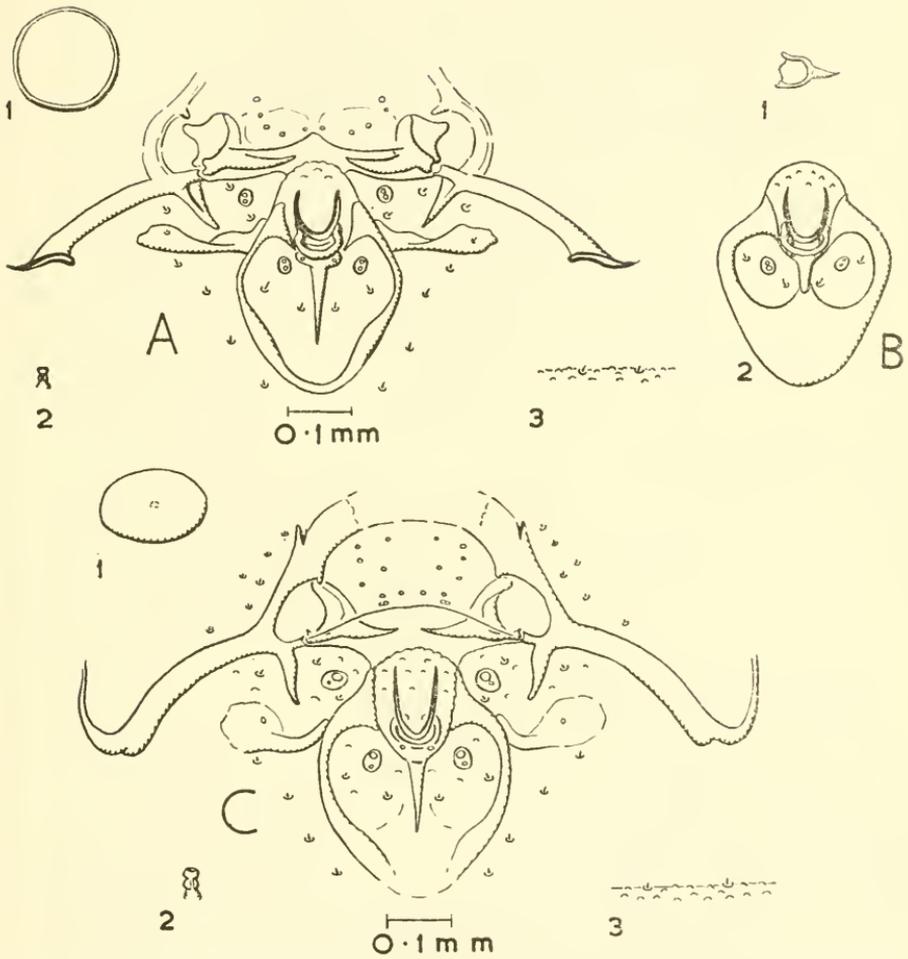


FIGURE 55.—Ophioninae:Campoplegini. A, *Olesicampe pikonemae* Walley, head sclerites (1, antenna; 2, spiracle; 3, skin); B, *Olesicampe lophyri* (Riley) (1, mandible; 2, labium); C, *Holocremnus clandestinus* (Holmgren), head sclerites (1, antenna; 2, spiracle; 3, skin.)

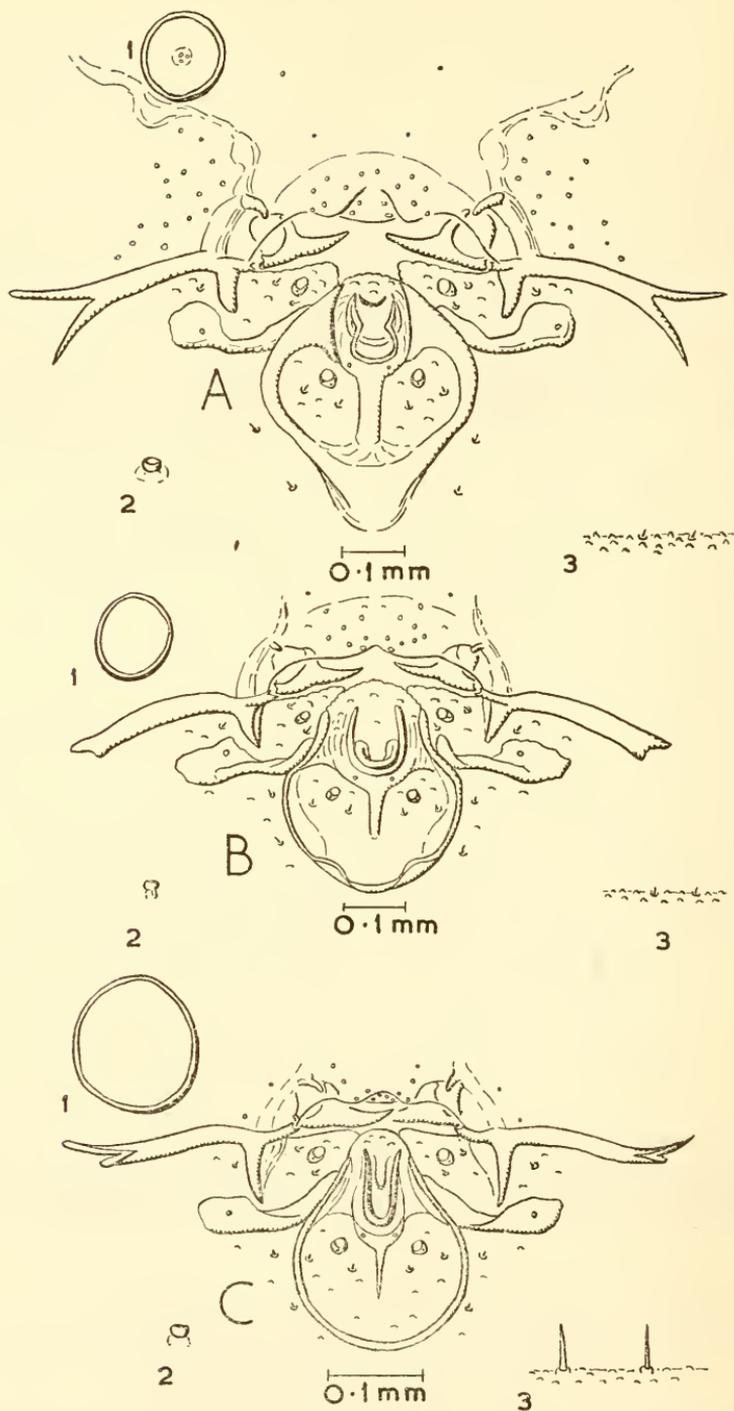


FIGURE 56.—Ophioninae: Campoplegini, head sclerites: A, *Benjaminia fuscipennis* (Provancher); B, *Charopsimorpha uncinata* (Ashmead); C, *Prochas theclae* Walkley, new genus, new species. (1, antenna; 2, spiracle; 3, skin.)

some species of *Hyposoter* are listed in a different part of the key from others. But the key is largely a compromise in that an attempt has been made to fit the larval characters into a scheme of classification based on adult characters. A revision of the tribe in the light of both larval and adult characters would be the only satisfactory solution.

LARVAL KEY

1. Setae on body approximately equal in length to blade of mandible.
 - Setae on body much shorter than blade of mandible 2
2. Mandible as in figure 50A with no marked differentiation between base and blade **Pyracmon**
 - Mandible with blade more slender than base 3
3. A lightly sclerotized plate is present lateral to each pleurostoma and hypostoma and extending dorsally to meet ventral half of antenna . **Spudastica**²⁵
 - A lightly sclerotized plate, if present, not of this shape 4
4. A lightly sclerotized and lobed plate as in figure 54A present lateral to each pleurostoma and hypostoma and not extending dorsally to meet ventral half of antenna **Phobocampe**
 - A lightly sclerotized plate of this shape not present 5
5. A lightly sclerotized plate extends dorsally from pleurostoma across to meet ventrolateral edge of antenna **Benjaminia**
 - A lightly sclerotized plate of this shape not present 6
6. Prelabial sclerite roughly triangular in shape with ventral part poorly developed 7
 - Prelabial sclerite Y-shaped with ventral part as well developed as dorsal parts 9
7. Ventral part of prelabial sclerite extending to point just ventrad of labial palps **Charops narangae** (Cushman)
 - Charops ganges** Cushman
 - Ventral part of prelabial sclerite not extending to point just ventrad of labial palps 8
8. A lightly sclerotized plate present beneath ventral part of labial sclerite.
 - Bathyplectes**
 - A lightly sclerotized plate not present beneath ventral part of labial sclerite.
 - Biolsia**

²⁴ In order that Dr. Short may refer to this genus by a valid name a brief description is given here. R. A. Cushman had set aside in the U.S. National Museum collection two black campoplegine specimens that he had labelled as *Prochas theclae*, a manuscript name.

Prochas theclae, new genus, new species

This new genus is closely related to *Charopsimorpha* Viereck, 1912 but may be easily distinguished from it by the broader postpetiole, different abdominal sculpture, fully areolated propodeum, and by unusual head characters for this group of the Campoplegini. The type species, *Prochas theclae*, has the occipital carina meeting the hypostomal carina at the base of the mandible; has non-emarginate eyes (the inner margin at most only slightly sinuate); has the clypeus (pale in the male) protruding just before the apex and with the apex slightly rounded, and mandibles with flange on only the basal half of lower margin.

Holotype female (USNM 64687), Trinidad, B.W.I., Aug. 6, 1943, Diego Martin. Allotype male (USNM), Trinidad, B.W.I., Nov. 14, 1941, Brasso. Both specimens were reared from *Thecla empusa* Hew. on cacao by E. McC. Callan.

Luella M. Walkley
Entomology Research Division
U.S. Department of Agriculture

²⁵ Of Beirne (1941).

9. Prelabial sclerite with ventral part broader than lateral parts of labial sclerite.
Charops papilionis Ashmead
 Prelabial sclerite with ventral part not as broad as lateral parts of labial sclerite 10
10. Lateral parts of epistoma broad and lightly sclerotized . . . **Holocremnus**
 Lateral parts of epistoma not of this form 11
11. Labial sclerite longer than wide²⁶ 12
 Labial sclerite as wide or wider than long 17
12. Ventral part of labial sclerite broad and well sclerotized . **Xanthocampoplex**
 Ventral part of labial sclerite not as above 13
13. Ventral part of labial sclerite forming broad, lightly sclerotized plate and not distinct from any lightly sclerotized membrane in ventral part of prelabial area 14
 Ventral part of labial sclerite not forming broad, lightly sclerotized plate and distinct from any sclerotized membrane in ventral part of prelabial area²⁷ 16
14. Prelabial sclerite not meeting broad ventral part of labial sclerite . . **Idechthis Campoplex**²⁸
 Prelabial sclerite meeting broad ventral part of labial sclerite 15
15. Ventral part of labial sclerite lightly sclerotized and pointed . . . **Dusona Hyposoter parogyiae** (Viereck)
 Ventral part of labial sclerite as well sclerotized as lateral parts and more rounded **Olesicampe lophyri** (Riley)
16. Ventral part of labial sclerite very lightly sclerotized; lateral part of stipital sclerite about 1½ times as broad as median part **Campoletis**
 Ventral part of labial sclerite moderately sclerotized; lateral part of stipital sclerite about twice as broad as median part **Hyposoter Horogenes**
Olesicampe pikonemae Walley,
Olesicampe euurae (Ashmead)
17. Labial sclerite complete ventrally **Charopsimorpha**
 Labial sclerite incomplete ventrally 18
18. Each lateral part of prelabial sclerite approximately equal in length to ventral part **Casinaria**
 Each lateral part of prelabial sclerite one-half to one-third length of ventral part **Nepiera**

The following have been examined: *Pyracmon xanthognatha* (Rohwer) (fig. 50A), *Campoplex crassifemur* (Thomson), *C. depressus* Viereck, *C. frustranae* Cushman, *C. hyalinus* (Provancher), *C. phthorimaeae* (Cushman), *C. polychrosidis* Viereck, *C. pyraustae* Smith, *C. rufifemur* (Thomson), *C. tosensis* (Uchida), *C. tricoloripes* (Schmiedeknecht), *C. validus* (Cresson) (fig. 50B), *Campoplex* sp. nr. *inaequalipes* Cresson, *Xanthocampoplex nigromaculatus* (Cameron) (fig. 50C), *Xanthocampoplex* sp., *Idechthis nigriscapus* Viereck (fig. 51A), *I.*

²⁶ In using this part of the key care should be taken to ensure that all of the prelabial region is fully visible in a preparation. In some species which have the ventral part of the labial sclerite lightly sclerotized this part may become folded under the rest of the prelabium during mounting, with the result that the labial sclerite appears to be much shorter than it really is.

²⁷ Except *Hyposoter parogyiae* (Viereck), where the prelabial sclerite meets the broad ventral part of the labial sclerite.

²⁸ Except *Campoplex tosensis* (Uchida), which can be recognized by the bubble-like appearance of the prelabial and labial sclerites.

canescens (Gravenhorst), *Casinaria eupitheciae* Viereck (fig. 51B), *C. indubia* (Morley), *C. infesta* (Cresson), *C. tenuiventris* (Gravenhorst), *Casinaria* sp., *Charops ganges* Cushman, *C. narangae* (Cushman) (fig. 52A), *C. papilionis* Ashmead (fig. 51c), *Bathyplectes corvina* (Thomson), *B. curculionis* (Thomson) (fig. 52B), *B. exiguus* (Gravenhorst), *Biolysia tristis* (Gravenhorst) (fig. 52c), *Campoletis oxylus* (Cresson) (fig. 53A), *Dusona glauca glauca* (Norton), *D. quebecensis* (Walley), *D. terebrator* (Foerster), *D. variabilis* (Franklin), *D. vitticollis vitticollis* (Norton) (fig. 53B), *Nepiera benevola* Gahan (fig. 53c), *Phobocampe disparis* (Viereck) (fig. 54A), *P. flavipes* (Provancher), *Horogenes acutus* (Viereck), *H. aestivalis* (Viereck), *H. compressus* (Cresson), *H. comptoniellae* (Viereck) (fig. 54B), *H. eureka* (Ashmead), *H. obliteratus* (Cresson), *H. pterophorae* (Ashmead), *H. punctorius* (Roman), *Horogenes* sp., *Hyposoter fugitivus fugitivus* Say, *H. fugitivus pacificus* Cushman, *H. nigrolineatus* (Viereck), *H. parorgyiae* (Viereck), *H. pilosulus* (Provancher) (fig. 54c), *H. rubiginosus* Cushman, *Olesicampe eurae* (Ashmead), *O. pikonemae* Walley (fig. 55A), *O. lophyri* (Riley) (fig. 55B), *Holocremnus clandestinus* (Holmgren) (fig. 55c), *H. ratzeburgi* (Tschek), *Benjaminia fuscipennis* (Provancher) (fig. 56A), *B. euphydryadis* (Viereck), *Charopsimorpha tibialis* (Cresson), *C. uncinata* (Ashmead) (fig. 56B), *Prochas theclae* Walkley, new genus, new species (fig. 56c):

Pyracon has a distinctive form of mandible with a relatively broad blade. Within the genus *Campoplex*, *C. pyraustae* Smith has a labial sclerite which is more rounded than in the other species examined, and in *Campoplex* sp. nr. *inaequalipes* Cresson the mandible has a curved but broad blade with a width equal to that of half the depth of the base. *C. tosensis* (Uchida) differs from the species figured in that the prelabial sclerite meets the broad ventral part of the labial sclerite. *Idechthis canescens* (Gravenhorst) is basically similar to the species figured, but the enlargement on the lateral end of the stipital sclerite is relatively smaller. The species of the genus *Charops* fall into two groups: *C. ganges* Cushman being very like *C. narangae* (Cushman) (fig. 52A), and *C. obtusus* Morley as figured by Beirne (1941) being similar to *C. narangae*. *Bathyplectes* and *Biolysia* are distinctive in the shape of the labial sclerite and in the triangular and lightly sclerotized prelabial sclerite. *Horogenes*, *Hyposoter*, and *Olesicampe* are basically similar. The labial sclerite is more rounded than in figure 54B in *Hyposoter fugitivus fugitivus* Say and *H. fugitivus pacificus* Cushman. Also, in these two subspecies the lightly sclerotized area between the base of the prelabial sclerite and the ventral part of the labial sclerite is not present. The mandible of *Hyposoter* has a small lobe dorsal to the blade. This is seen in a slight form in other *Campoplegini*, but is more pronounced in *Hyposoter*, especially

in *H. pilosulus* (Provancher) (fig. 54c). In *H. parorgyiae* (Viereck) the region between the prelabial sclerite and the ventral part of the labial sclerite has the form of a lightly sclerotized plate. In both *Horogenes* and *Hyposoter* the labial sclerite has a small infolding at each venterolateral edge. *Olesicampe euurae* (Ashmead) is very similar to *O. pikonemae* Walley in structure. In *O. lophyri* (Riley) the labial sclerite differs in shape from that of these two species in that the ventral part is broad; also the prelabial sclerite is short and the mandible is distinctive in form, being relatively small with a rounded base and a small, straight blade. *Prochas theclae* Walkley differs from other Campoplegini in the length of the setae of the skin and the shape of the mandible; however, the head sclerites in general resemble those of the Campoplegini.

The following are figured in the literature: *Nemeritis bicingulata* Gravenhorst (Beirne, 1941), *Campoplex alkae* (Ellinger and Sachtleben) (Baker, Bradley, and Clark, 1949; Goidanich, 1931), *C. borealis* (Zetterstedt) (Thorpe, 1930), *C. crassifemur* (Thomson) (Thompson and Parker, 1930), *C. cultrator* Gravenhorst (Beirne, 1941), *C. ensator* (Gravenhorst) (Thorpe, 1930), *C. mutabilis* (Holmgren) (Thorpe, 1930), *C. rufifemur* (Thomson) (Thorpe, 1930), *C. validus* (Cresson) (Timberlake, 1912), *Idechthis canescens* (Gravenhorst) (Daviaux, 1930), *Charops obtusus* Morley (Beirne, 1941), *Bathyplectes exiguus* (Gravenhorst) (Beirne, 1941), *Spudastica krieckbaumeri* (Bridgman) (Beirne, 1941), *Phobocampe uncinata* (Gravenhorst) (Beirne, 1941), *Horogenes armillata* (Gravenhorst) (Beirne, 1943), *H. exareolatus* (Ratzeburg) (Beirne, 1941), *H. macrostoma* (Thomson) (Roberti, 1947), *H. nana* (Gravenhorst) (Thorpe, 1933), *H. punctorius* (Roman) (Baker, Bradley, and Clark, 1949), *Horogenes* sp. (Cameron, 1938), *Horogenes* sp. (Beirne, 1942), *Hyposoter pilosulus* (Provancher) (Tothill, 1922), *H. tricolor* (Ratzeburg) (Beirne, 1941), *Holocremnus ratzeburgi* (Tschek) (Morris, Cameron, and Jepson, 1937), *Balcarcia bergi* Brethes (Griot and Icart, 1948).

Tribe Cremastini

FIGURES 57, 58

Members of this tribe are endoparasitic, mostly in microlepidopterous larvae in leaf rolls and tunnels. Many of them frequent drier habitats than is usual for the family.

The tribe closely resembles the Campoplegini, although the head sclerites are, in general, more lightly sclerotized. Also, the hypostomal spur is longer, the lateral part of the stipital sclerite is not expanded, except in *Eiphosoma* where the expansion is small, and the labial sclerite is broader than in most Campoplegini. In all species examined

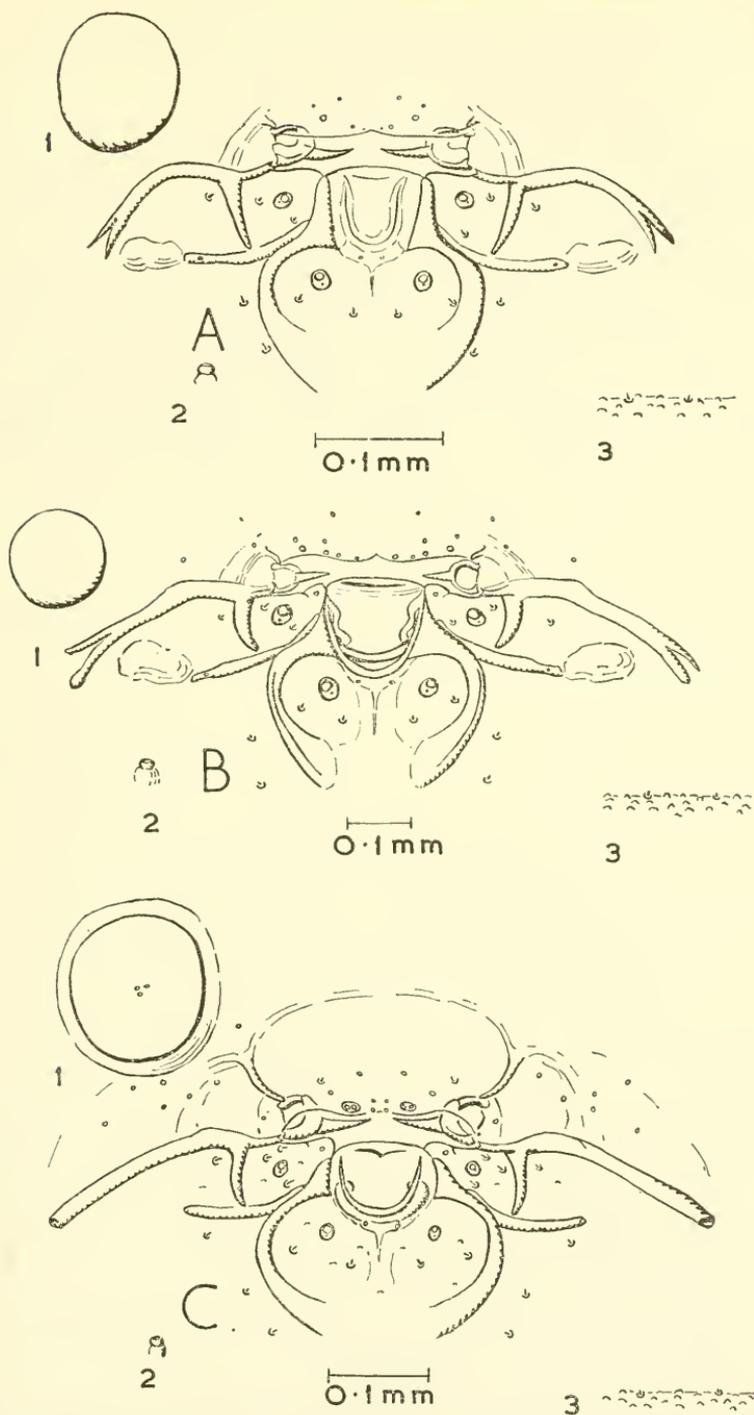


FIGURE 57.—Ophioninae: Cremastini, head sclerites: A, *Pristomerus vulnerator* (Panzer); B, *Xiphosomella stenomae* Cushman; C, *Zaleptopygus flavo-orbitalis* (Cameron). (1, antenna; 2, spiracle; 3, skin.)

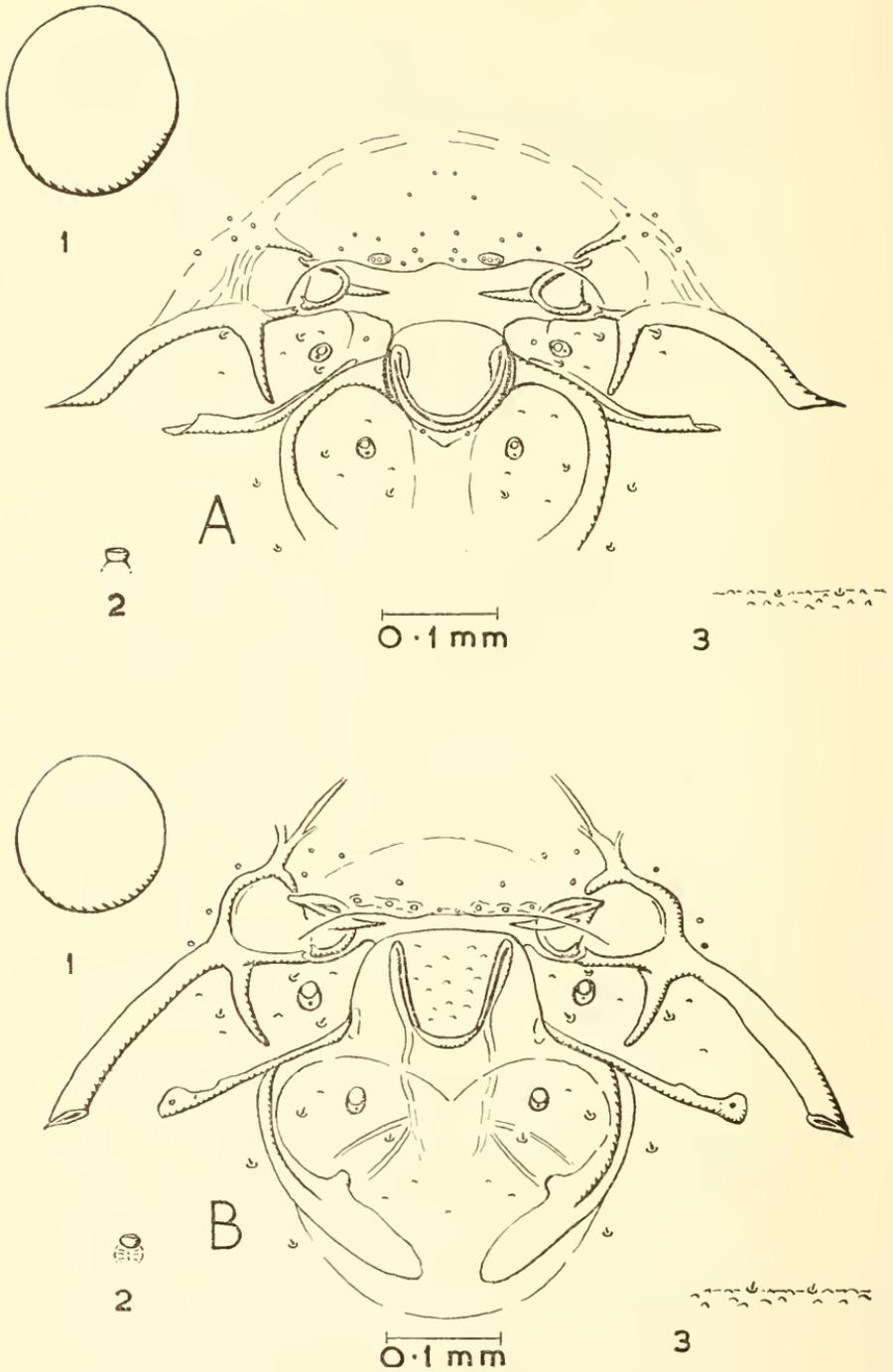


FIGURE 58.—Ophioninae: Cremastini, head sclerites: A, *Gremastus ferrugineus* Davis; B, *Eiphosoma batatae* Cushman. (1, antenna; 2, spiracle; 3, skin.)

the labial sclerite is incomplete ventrally. The skin is lightly sclerotized with small projections and small setae.

LARVAL KEY

1. Each lateral part of the labial sclerite with a small projection towards the median line **Eiphosoma**
 Each lateral part of labial sclerite without small projection towards median line 2
2. A very lightly sclerotized epistoma present . . . **Zaleptopygus, Cremastus**
 Epistoma not sclerotized 3
3. Hypostoma bent in the middle of its length **Pristomerus**
 Hypostoma bent at point one third of length from median end . **Xiphosomella**

Pristomerus euryptychiae Ashmead differs from the drawing in figure 57A in that there are two groups each of two sensilla on the labrum. *Cremastus minor* Cushman differs from the drawing in figure 58A in that the ventral part of the labial sclerite is lightly sclerotized.

It was not found possible to differentiate *Zaleptopygus* and *Cremastus* on larval characters.

The following have been examined: *Pristomerus austrinus* (Townes and Townes), *P. euryptychiae* Ashmead, *P. pacificus appalachianus* Viereck, *P. vulnerator* (Panzer) (fig. 57A), *Xiphosomella stenomae* Cushman (fig. 57B), *Zaleptopygus flavo-orbitalis* (Cameron) (fig. 57C), *Z. gallaecola* (Cushman), *Z. rosae* (Cushman), *Zaleptopygus* sp., *Cremastus carpocapsae* Cushman, *C. epagoges* Cushman, *C. facilis* (Cresson), *C. ferrugineus* Davis (fig. 58A), *C. forbesi* Weed, *C. minor* Cushman, *Eiphosoma annulatum* Cresson, *E. batatae* Cushman (fig. 58B), *E. insularis* (Viereck), *E. texanum* Cresson.

The following are figured in the literature: *Pristomerus vulnerator* (Panzer) (Goidanich, 1931; Rosenberg, 1934), *Zaleptopygus flavo-orbitalis* (Cameron) (Bradley and Burgess, 1934), *Cremastus interruptor* Gravenhorst (Thorpe, 1930; Beirne, 1941).

Tribe Tersilochini

FIGURE 59

This tribe, the larvae of which are endoparasites, resembles the Cremastini and many Campoplegini in essential structure, but the mandible is distinctive with its conical shape and small tooth at the apex. The head sclerites are slender and lightly sclerotized. As in most Cremastini, the stipital sclerite has no lateral expansion. The labial sclerite is broader than long and is incomplete ventrally. The ventral part of the prelabial sclerite is absent and several large sensilla are present on the ventral edge of this sclerite. The maxillary and labial palps are relatively large. The spiracle is of the usual shape in the Ophioninae with a lightly sclerotized closing apparatus adjoining

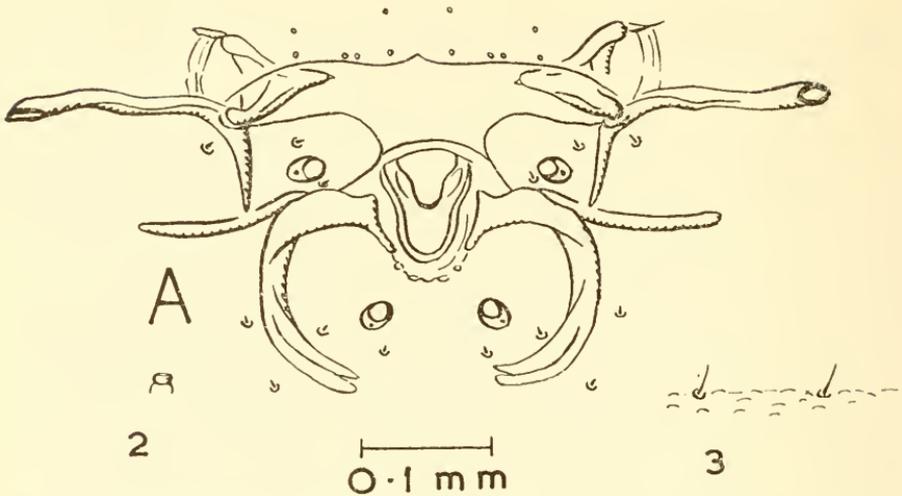


FIGURE 59.—Ophioninae:Tersilochini, head sclerites: *Tersilochus argentinensis* (Blanchard) (antenna not visible on preparation; 2, spiracle; 3, skin.)

the atrium. The skin has relatively long setae, approximately equal in length to one-third the length of the mandible, but the projections on the skin are small.

Tersilochus argentinensis (Blanchard) (fig. 59) and *T. conotracheli* (Riley) were examined. *T. conotracheli* is figured by Cushman (1916) and *Tersilochus* sp. by Beirne (1941).

Tribe Ophionini

FIGURE 60 A, B

Members of this tribe are endoparasitic in larger caterpillars, except that *Ophion bifoveolatus* Brullé is known to parasitize larvae of *Phyllophaga* (Scarabeidae). Species of *Ophion* and *Enicospilus* are nocturnal or crepuscular and are frequently attracted to lights.

This is a distinctive tribe although it resembles other tribes of the Ophioninae in many basic features. The head sclerites are broad and moderately sclerotized. The stipital sclerite has a small lateral expansion and a lightly sclerotized cardo is present. The ventral part of the labial sclerite forms a broad plate. The prelabial sclerite is triangular in shape with the ventral part reduced. Numerous setae are present on the labrum, on the maxilla lateral to the hypostomal spur and on the prelabial membrane and the labial sclerite. The mandibles are distinctive, being relatively small and with a rounded base and a slightly or strongly curved blade. The antenna is disc-shaped. The closing apparatus of the spiracle is lightly sclerotized and adjoins the atrium. The skin has very small setae and small projections.

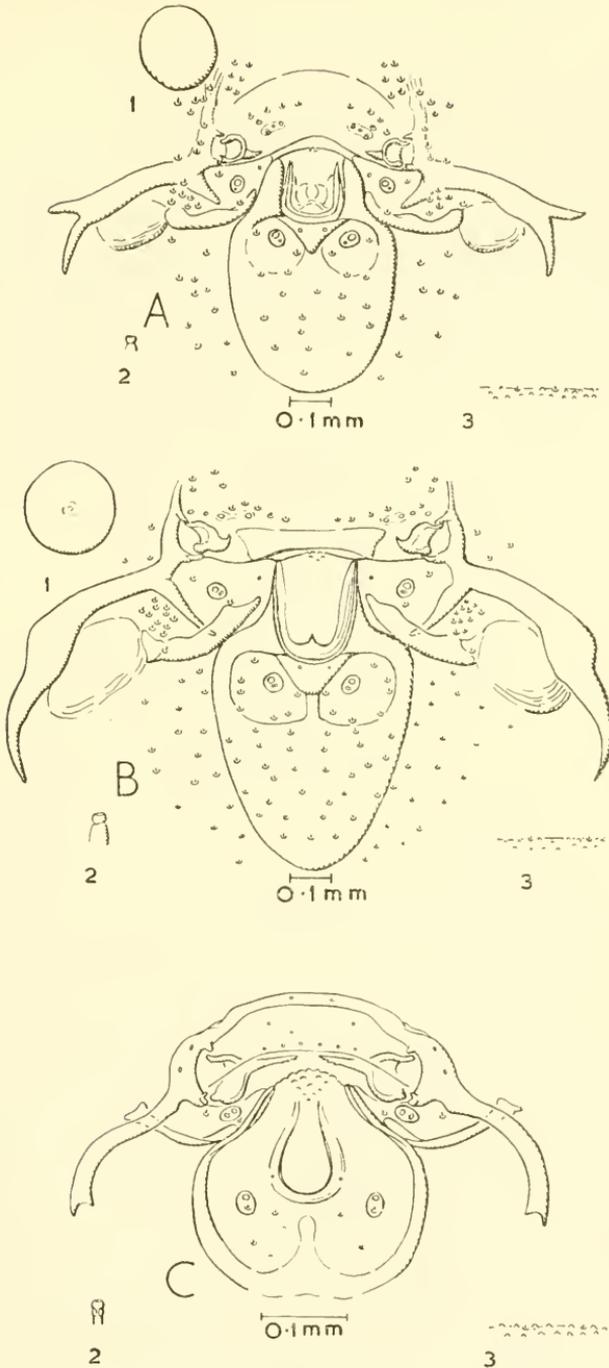


FIGURE 60.—A, B, Ophioninae:Ophionini, head sclerites: A, *Ophion idoneum* Viereck; B, *Enicospilus arcuatus* (Felt). C, Anomalinae:Anomalini, head sclerites, *Anomalon* sp., antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

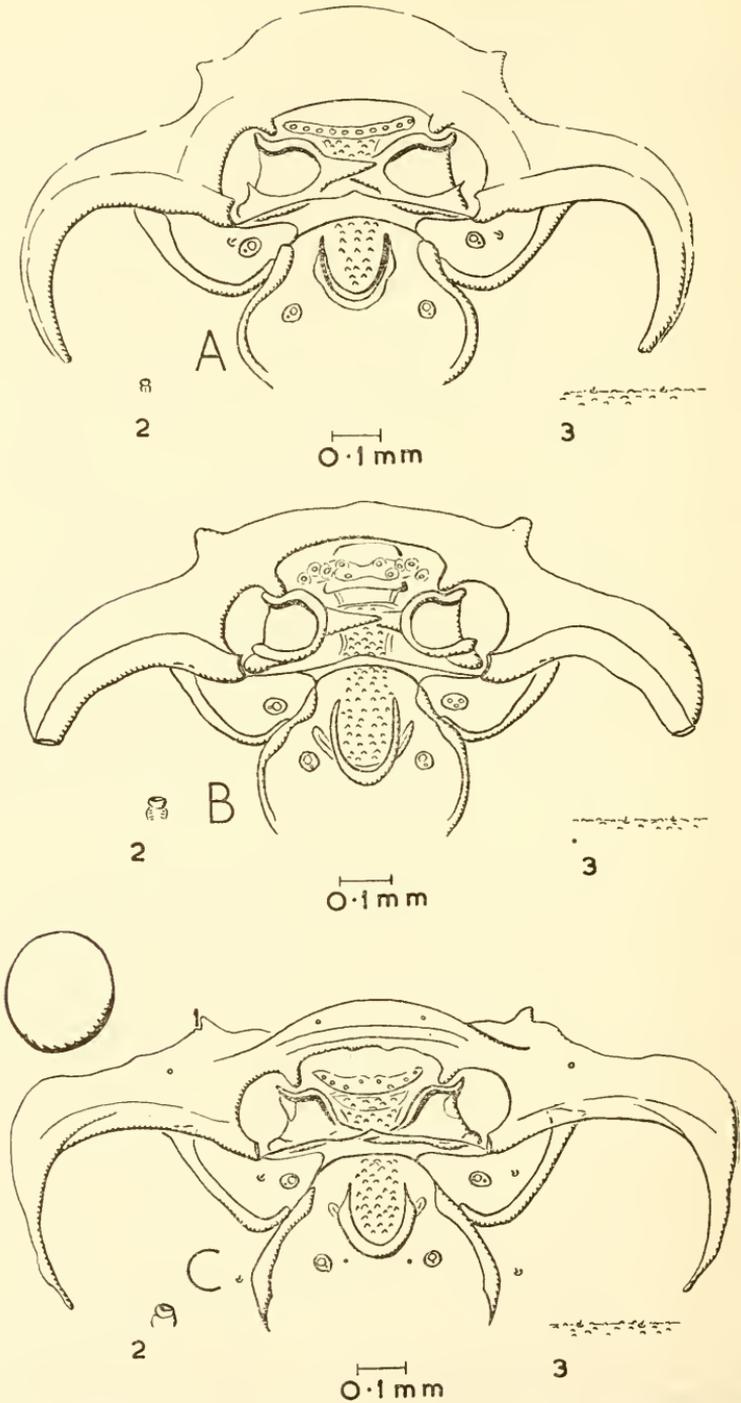


FIGURE 61.—Anomalinae:Gravenhorstiini, head sclerites: A, *Aphanistes hyalinus* (Norton), antenna not visible on preparation; B, *Barylypa insidiator* (Foerster), antenna not visible on preparation; C, *Labrorychus analis* (Say). (1, antenna; 2, spiracle; 3, skin.)

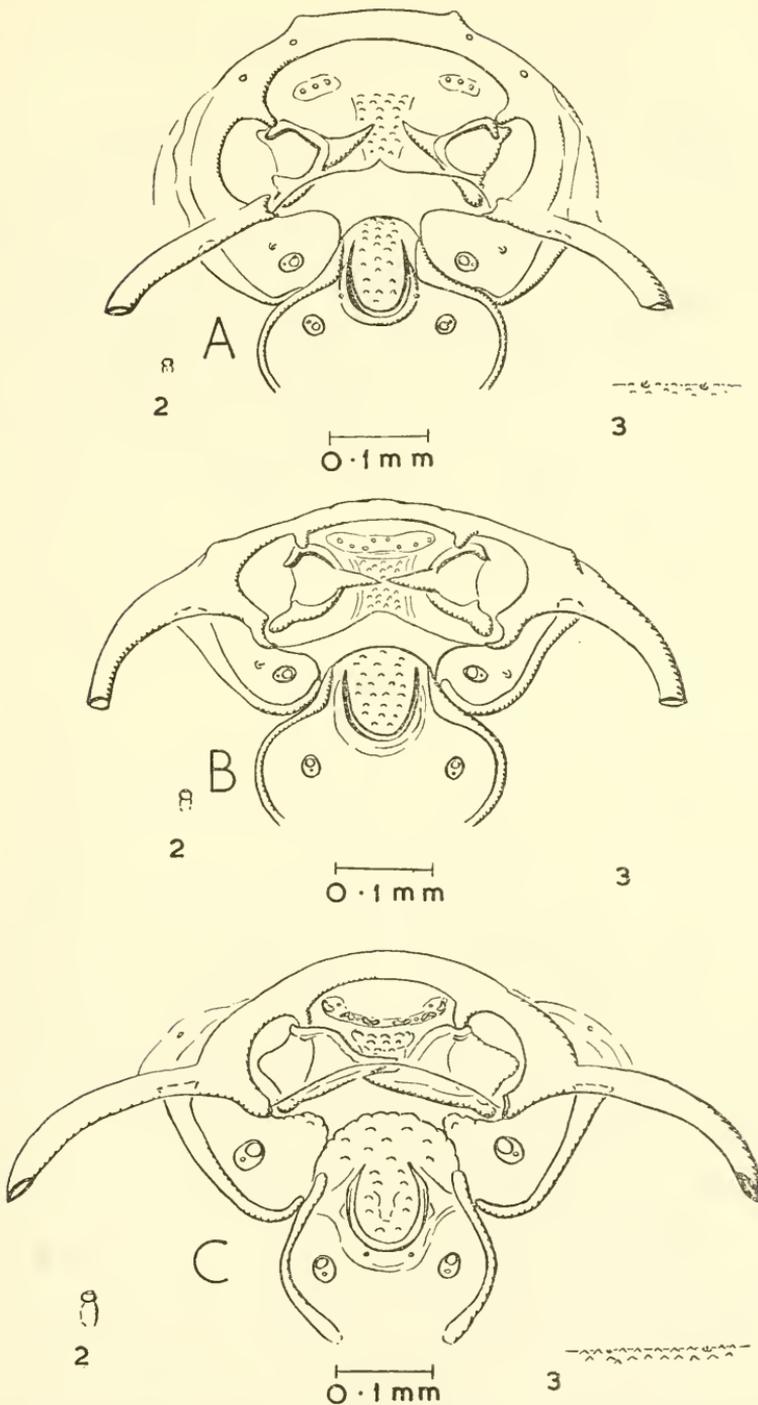


FIGURE 62.—Anomalinae: Gravenhorstiini, head sclerites: A, *Atrometus clavipes* (Davis); B, *Agrypon* sp.; C, *Blaptocampus nigricornis* (Wesmael). (Antenna not visible on preparation; 2, spiracle; 3, skin.)

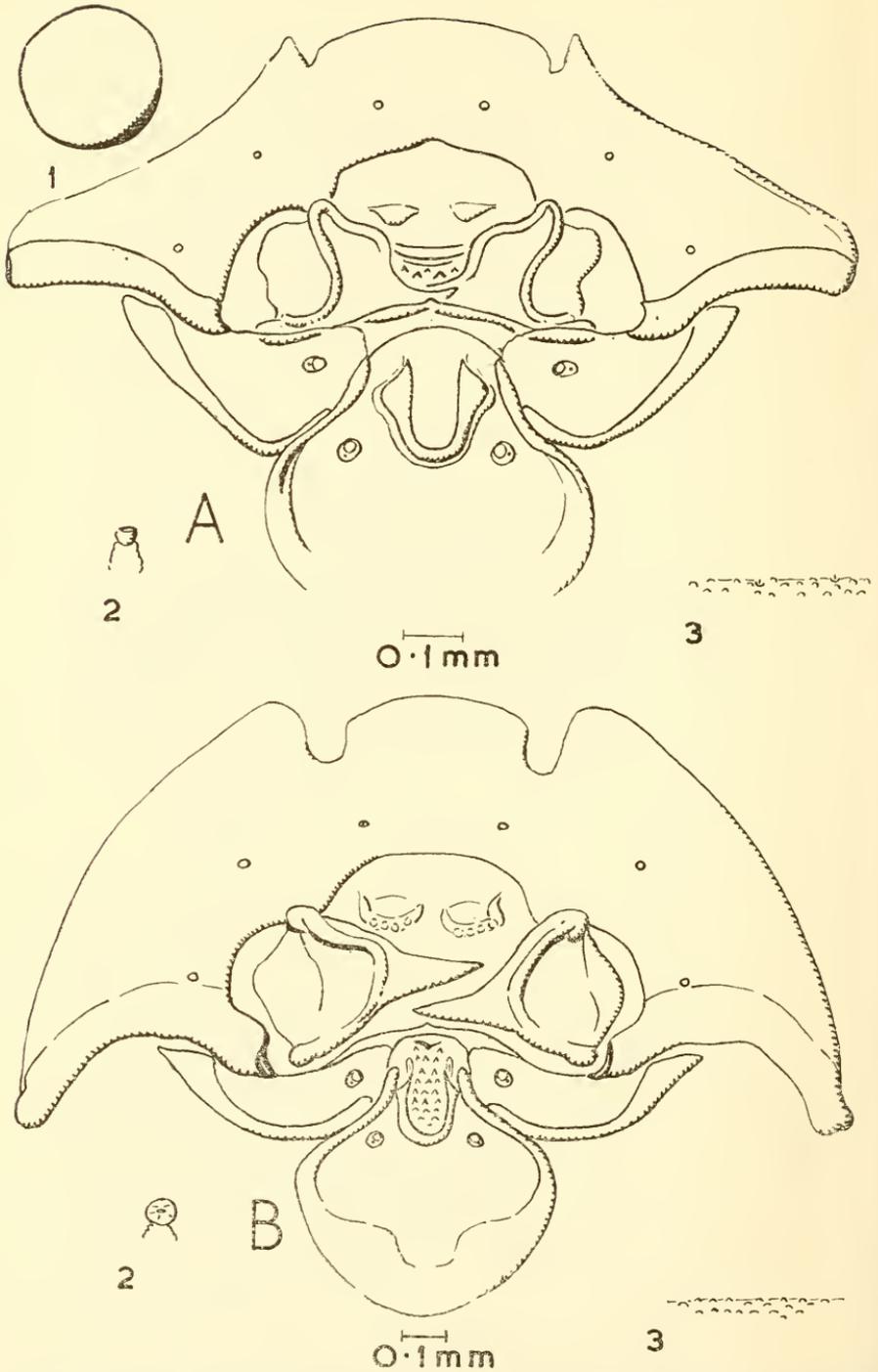


FIGURE 63.—Anomalinae: Therionini, head sclerites: A, *Therion circumflexum* (Linnaeus); B, *Heteropelma fulvicorne* Townes, antenna not visible on preparation. (1, antenna; 2, spiracle; 3, skin.)

LARVAL KEY

1. Mandible with blade slightly curved **Ophion**
 Mandible with blade strongly curved so that the tip points dorsally.
Enicospilus

The following were examined: *Ophion ancyloneura* Cameron, *O. bilineatus* Say, *O. idoneus* Viereck (fig. 60A), *O. tityri* Packard, *Enicospilus americanus* (Christ), *E. arcuatus* (Felt) (fig. 60B), *E. glabratus* (Say), *E. horsfeldi* Cameron, *E. purgatus* (Say), *E. texanus* (Ashmead), and *Enicospilus* spp.

In *Enicospilus americanus* the blade of the mandible, although of the *Enicospilus* form, is not so strongly curved as in figure 60B. A lightly sclerotized plate is present on the ventral edge of the labrum of some species of *Enicospilus*. This should not be confused with the suspensorium of the hypopharynx which is also visible in several species.

The following are figured in the literature: *Thyreodon atricolor* (Olivier) (Cushman, 1947), *Enicospilus macrurus* (Drury) (Beirne, 1941), *E. purgatus* (Say) (Cushman, 1947), *Enicospilus* sp. (Moutia and Courtois, 1952), and *Ophion idoneus* Viereck (Cushman, 1947).

Subfamily Anomalinae

FIGURES 60C-63

This endoparasitic group usually has been placed as a tribe of the Ophioninae. The larval characters of those species examined differ markedly from the characters of the Ophioninae and the group has therefore been treated as a separate subfamily. The form of the labial sclerite is generally similar in the Anomalinae and Ophioninae and, although this might indicate some sort of general relationship between the two groups, the form of the remaining sclerites and the mandibles differs sharply.

The epistoma, pleurostoma, and hypostoma are broad and well sclerotized; the hypostomal spur is absent; the stipital sclerite curves dorsally from the labial sclerite to meet the hypostoma; the labial sclerite is relatively slender and is incomplete ventrally except in *Anomalon* where the ventral part is moderately sclerotized, and in *Heteropelma* where the ventral part is very lightly sclerotized; the maxillary and labial palps each have two sensilla, one large and one small, except in *Anomalon* where the two sensilla are approximately equal in size, the dorsal being flat and the ventral peglike; the silk press is sclerotized; a lightly sclerotized prelabial sclerite which lacks a ventral projection is present in some genera; the labral sclerite is absent, but large sensilla which are grouped in various patterns are present on the labral area; setae are reduced and labral and prelabial setae appear to be absent except in *Anomalon*; the mandibles are large with relatively straight blades which lack teeth except in

Anomalon, and the blade of each mandible is well sclerotized; the antenna is disc-shaped; the closing apparatus of the spiracle is lightly sclerotized and adjoins the atrium; the skin has small projections and small setae.

The larval characters of the Anomalinae are strikingly like those of the Metopiinae. The larvae of the two subfamilies may be distinguished by the presence of setae on the prelabium of the Metopiinae and the absence of these setae in the Anomalinae except *Anomalon*, a genus having so many special features as to be readily recognizable.

The reduction of the labial sclerite and hypostomal spur in the Anomalinae, Metopiinae, and Ichneumoninae might be correlated with the relatively slight cocoon spun by these endoparasites. In the head of the final instar larva of *Xorides* muscles are present which insert on the labial sclerite (Short, 1952, p. 41, fig. 8A). The contraction of these muscles tilts forward the dorsal end of the prelabium with the opening of the silk glands. In this action the labial sclerite rotates on the extremities of the stipital sclerites. The labial sclerite is thus held so that movement can take place in only one plane. The spurs of the hypostomae, which articulate with the stipital sclerites, hold the maxillae rigid. The spinning of the cocoon has been observed in *Xorides* and the region of the prelabium containing the opening of the silk glands was tilted forward during this process. It is therefore possible that the reduction of a cocoon is accompanied by a reduction of the muscles which evert the dorsal end of the prelabium and a reduction of the labial sclerite and hypostomal spur. One objection to this suggestion is that the Pimplini, which emerge from the pupa of a lepidopterous host and have only a slight cocoon, have a well developed hypostomal spur and labial sclerite. However the stipital sclerite is reduced and this might be associated with the reduction of the cocoon since, when being everted, the labial sclerite rotates on the stipital sclerite.

LARVAL KEY

- | | |
|---|-----------------------------------|
| 1. Blade of mandible with teeth; setae on prelabium | Anomalini |
| Blade of mandible without teeth; setae absent from prelabium | 2 |
| 2. Width of epistoma along entire length and width of pleurostoma along entire length equal to at least half length of mandible | Therionini |
| Width of epistoma or part of width of pleurostoma less than length of mandible | Gravenhorstiini |
| | Ophionellini ²⁰ |

Tribe Anomalini

FIGURE 60C

The general form of the head sclerites, spiracles, and skin places *Anomalon* with the genera of the tribes Gravenhorstiini and Therionini;

²⁰ Of Cushman (1947).

but it does not appear to be a close relationship, a conclusion which Walkley (in litt.) has also reached from study of the adults. *Anomalon* differs from the other Anomalinae examined in that the blade of the mandible bears distinct teeth; there are setae on the prelabium; and the ventral part of the labial sclerite, although not as well sclerotized as the lateral parts, is nevertheless distinctly sclerotized. It is also possible that the hypostomal spur might be represented in *Anomalon* by a small projection from the anteroventral part of the hypostoma. *Anomalon* therefore can be considered to have an isolated position within the Anomalinae. The larval habits also distinguish this genus from other Anomalinae in that larvae of Elateridae appear to be the usual hosts, whereas the hosts of the other Anomalinae examined were lepidopterous.

Anomalon sp. (60c) was examined. *A. ejuncidum* Say is figured by Cushman (1947).

Tribe Ophionellini

Ophionellus foutsii (Cushman) is figured by Cushman (1947). This figure is not sufficiently detailed to allow the Ophionellini to be distinguished from the Gravenhorstiini.

Tribe Gravenhorstiini

FIGURES 61, 62

LARVAL KEY

1. Labral sensilla arranged in two separate groups **Atrometus**
 Labral sensilla arranged in single line 2
2. When head sclerites mounted flat on slide then posterior ends of hypostomae extend to point approximately level with ventral end of labial sclerite . . 3
 When head sclerites mounted flat on slide then posterior ends of hypostomae do not extend to point level with ventral end of labial sclerite 4
3. Width of pleurostoma at anterior pleurostomal process approximately equal to two-thirds length of mandible **Aphanistes**
 Width of pleurostoma at anterior pleurostomal process much less than two-thirds length of mandible **Labrorychus**
4. Hypostoma with sclerotized expansion along entire dorsal edge . . **Barylypa**
 Hypostoma without sclerotized expansion along entire dorsal edge 5
5. Length of blade of mandible less than half width of base and arising from ventral surface of base **Blaptocampus**
 Length of blade of mandible approximately equal to half width of base and arising from middle of base **Agrypon**

The following have been examined: *Aphanistes hyalinus* (Norton) (fig. 61A), *Barylypa insidiator* (Foerster) (fig. 61B), *Labrorychus analis* (Say) (fig. 61c), *L. prismaticus* (Norton), *Labrorychus* sp., *Atrometus clavipes* (Davis) (fig. 62A), *Agrypon* sp. (fig. 62B), *Blaptocampus nigricornis* (Wesmael) (GCV) (fig. 62c).

The following are figured in the literature: *Trichomma enecator* (Rossi) (Rosenberg, 1934), *Aphanistes armatus* (Wesmael) (Beirne, 1941), *Blaptocampus nigricornis* (Wesmael) (Beirne, 1941).

Tribe Therionini

FIGURE 63

LARVAL KEY

1. Ventral part of labial sclerite lightly sclerotized **Heteropelma**
 Ventral part of labial sclerite not sclerotized **Therion**

The following have been examined: *Therion morio* (Fabricius), *T. circumflexum* (Linnaeus) (fig. 63A), *Heteropelma fulvicorne* Townes (fig. 63B). *Therion morio* (Fabricius) is figured by Cushman (1947).

Interrelationships between the Subfamilies

Although in many cases the larval characters suggest interrelationships which are very similar to those which are believed to be shown by the characters of the adults, there are certain discrepancies.

Some similar adults, such as the Pimplini and Ephialtini, have very different larvae. These differences may be correlated with the fact that the larvae of the Pimplini are endoparasitic while those of the Ephialtini are ectoparasitic. The larval characters of the Ephialtini and similar tribes of the Pimplinae resemble those of other ectoparasites such as the Tryphoninae and Cryptinae rather than the Pimplini.

There are certain structural features which appear to be connected with whether the larva is an ectoparasite or an endoparasite. The antenna in most ectoparasites is papilliform. In most endoparasites it is reduced and disc-like. The mandible is toothed in most ectoparasites where teeth are necessary for holding on to the host and for piercing the host skin. In most endoparasites the mandible is without teeth. The labral sclerite is present in most ectoparasites and absent in most endoparasites. The epistoma and the labral sclerite are rarely present together, except in the Tryphoninae, where the epistoma is slender. It is difficult to suggest a reason for this. The anterior retractor muscles of the labrum insert on the median part of the labral sclerite (Short, 1952, p. 39, fig. 7B). It is not likely that the labral sclerite could brace the cranium in any way as a substitute for the epistoma. The epistoma is well developed in larvae with powerful mandibles.

The closing apparatus of the spiracle adjoins the atrium in most endoparasites, whereas in ectoparasites it may adjoin the atrium or be situated some distance from the atrium. There is no obvious explanation for this. It is generally assumed that the spiracles are open in endoparasites in the final instar larva, which is carnivorous, feeding on

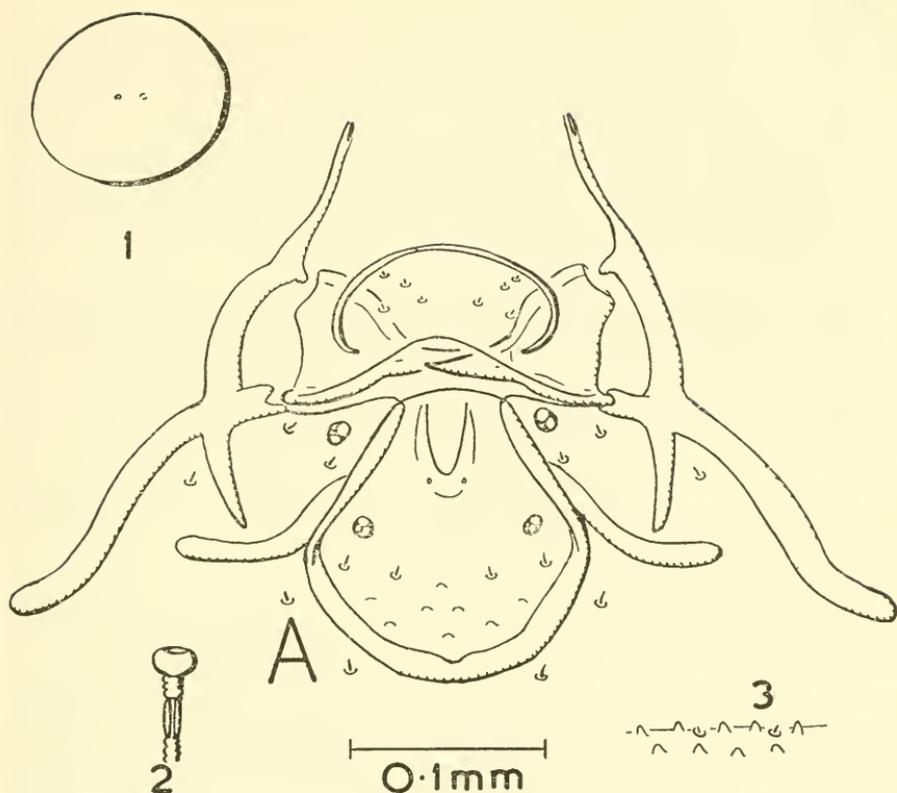


FIGURE 64.—Cryptinae:Hemiteiini, head sclerites: *Atractodes* sp. (1, antenna; 2, spiracle; 3, skin.)

the tissues of the host and liberating air from the tracheae. If the spiracle is open there is possibly some biological advantage in having the closing apparatus situated close to the atrium. If one function of the closing apparatus is to prevent the entry of body fluids of the host into the tracheal system, then it is best situated to perform this function when it adjoins the atrium. If, however, such a precaution were necessary, one would more readily expect to find hydrofuge structures at the opening of the tracheal system, as in many aquatic insects.

The setae of the skin of endoparasites are reduced.

It should be noted that the Cryptinae, which contain both ectoparasites and endoparasites of prepupae and pupae, show larval characters which are relatively uniform within the group.

Just as some similar adults have different larvae, so do some different adults, such as the Metopiinae and Anomalinae, have similar larvae. These similarities may be correlated with larval habits. The Metopiinae, Anomalinae,³⁰ Ichneumoninae, and Pimplini all have large,

³⁰ Except *Anomalon*.

toothless mandibles with a corresponding development of the epistoma and pleurostoma. In the Metopiinae, Anomalinae, and Ichneumoninae the hypostoma is also well developed. In the Pimplini the hypostoma is reduced, but the hypostomal spur is well developed. The hypostomal spur is absent in the Metopiinae, Anomalinae, and Ichneumoninae. The labial and stipital sclerites are, except in the Pimplini, relatively poorly developed. The reduction of these sclerites might be correlated with the relatively slight cocoons spun by these endoparasites (see section on Anomalinae).

In the species examined of the Metopiinae, Anomalinae,³¹ Ichneumoninae, and Pimplini, development takes place in, or is completed in, the pupa of a lepidopterous host. The Campoplegini, which are endoparasites of larvae, have a different type of head structure with the epistoma absent and the labial and stipital sclerite relatively well developed. With regard to the degree of development of these sclerites it is significant that many Campoplegini emerge from the host larva to spin a well developed cocoon, although some species of *Hyposoter* and *Benjaminia* pupate within the host larva.

It cannot be claimed that all Ichneumonidae which emerge from the pupa of the host, or even from the pupa of a lepidopterous host, will have a larval head of similar form. The Cryptinae have a head structure which is very different from that of the Metopiinae, Anomalinae, Ichneumoninae, and Pimplini. Also, larval habits are not constant. Mr. J. F. Perkins (in litt.) has directed my attention to some reared specimens of *Trichomma occisor* Habermehl with a quite well developed cocoon and to an *Ophion* in which the cocoon is spun within the host pupa, which remains adhering to the outside of the cocoon. Thorpe (1930) has observed that the ectoparasite *Ephialtes ruficollis* (Gravenhorst) spins a light and irregular cocoon, yet when reared in a gelatin capsule usually does not spin a cocoon. But it does appear that in most Metopiinae, Anomalinae, Ichneumoninae, and Pimplini there is some connection between the form of the larval head and the habits of the larva. It is thus possible that convergence in larval characters associated with a similarity in larval habits might explain the similarity of the Metopiinae and Anomalinae.

From the standpoint of larval characters alone, the following interrelationships are suggested among the subfamilies of the Ichneumonidae. The Metopiinae and Anomalinae are related. The Ophiioninae, Mesoleiinae, and Lissonotinae are also related subfamilies. Similarly, but to a lesser extent, there appears to be some degree of relationship between the Tryphoninae, Cryptinae, and the tribes of the Pimplinae other than the Pimplini and Acaenitini. The Ichneumoninae show some likeness to the Orthopelmatinae. The Adelognathinae, Collyriinae, Plectiscinae, Diplazoninae, and Mesochorinae are

³¹ Except *Anomalon*, which pupates within the larvae of Elateridae.

all isolated subfamilies. The Pimplini and Acaenitini are isolated tribes showing some degree of relationship to each other and to the remaining tribes of the Pimplinae.

There was thought to be no point in attempting to construct a family tree.

Relationship between the Ichneumonidae and Braconidae

The tribe Xoridini of the Pimplinae has a type of mandible which resembles that of the subfamily Braconinae of the Braconidae. The Braconinae possess the most generalized larval structure of the Braconidae. Since the larval structure of the Xoridini is also generalized, it is possible that this tribe connects the Ichneumonidae to the Braconidae. There is a similarity in larval habit as well as in larval structure since many primitive ichneumonids and braconids are parasites of woodboring insects (see Brues, 1921).

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