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AN ILLUSTRATED SYNOPSIS OF THE PRINCIPAL LARVAL FORMS OF THE ORDER COLEOPTERA*

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* This study was projected about 1915 when both authors who were working independently on separate families of coleopterous larvae realized that it was practically impossible to go far in descriptive work within these families without having a comparative knowledge of the characters throughout the order. During the following five years the material of all the families represented in the collections of the Bureau of Entomology and of the United States National Museum was examined, family characterizations were prepared, and typical larval characters were illustrated. By 1920 a general scheme of the classification presented herewith was drawn up, including the keys to families and family series, and most of the plates were completed. Since 1923 one of the authors (Craighead) has been able to devote very little time to the work; the other author (Böving) has continued to give much time to it, has remodeled many of the keys, and has introduced those portions treating the subfamilies and lesser groups.

PREFACE

The character of this publication is double, both graphic and descriptive. It displays a series of habitus-figures and detail-drawings of typical larvae pertaining to the different families and subfamilies of the beetle order and it presents keys for their determination and classification.

The figures are all original with the exception of one copied from Schiödte's paper on the buprestid larvae[1A] and two figures pertaining to *Hydrochus* from Avery Richmond's paper on the Hydrophilids,[1B] which are properly accounted for in the explanation to plates 22 and 80. All the figures on plates 84 to 86 and most of the figures on plate 69 were drawn by Mr. J. A. Hyslop, the remainder by Mr. R. A. St. George and by one or the other of the authors, from specimens in alcohol or from slides with microscopic details present in the collection of beetle larvae in the United States National Museum. There will be found only a few figures of larvae belonging to the suborder Adephaga and to some of the series of the Polyphaga, such as the Cerambycoidea and the Scarabaeoidea, because the larvae of these groups have been particularly well and completely illustrated by former authors in generally known and in most cases easily available publications.

The descriptions in the keys are based on original studies of larval material at hand.

These keys are intended to serve not only as a practical means for the determination of beetle larvae, but also as a contribution to the taxonomic discussion of the natural systematic grouping of the Coleoptera.

In the selection of the systematic characters for the single series, families, and subfamilies preference has been given to those which are most easily observed and least variable throughout the individual groups and which at the same time express the taxonomic relationship between associated groups, thus making it possible in most cases to list these groups in a natural systematic sequence. Only in the series key (pp. 10–15) has it not been possible or, rather, not practical to do this.

As a rule the classification of the larvae agrees with the commonly recognized classification of the imagines, and particularly

[1A] J. C. Schiödte: "De metamorphosi Eleutheratorum observationes," Naturhist. Tidssk. ser. III, vol. 6, 1869.

[1B] E. Avery Richmond: "Studies on the biology of the aquatic Hydrophilidae," Bull. Amer. Museum of Natural History, vol. 42, 1920.

well with the one followed in Leng's catalogue. In those cases, however, in which the characters of the larvae suggest a different systematic position of the group to which they belong than do the characters of their imagines, commentary remarks have been made in footnotes.

In a publication such as the present one in which the space limit must be a rather determining factor only a few characters can be used in the descriptions of the groups. As the field is new and rather uncultivated it is unavoidable that misleading or impracticable systematic characters have been introduced, or even that mistakes may have crept in. It is also realized that some of the figures, especially those which were prepared many years ago, when the authors were less familiar with the taxonomic value of the different characters, are not entirely satisfactory; in fact, scores of old figures have been discarded and new ones substituted. Frankly admitting the many shortcomings of the paper, of which nobody is more aware than the authors, it is nevertheless hoped that it may meet an evident desideratum in the entomological literature and encourage the taxonomic study of the beetle larvae, a study which still is in its beginning.

For obvious reasons no attempt has been made to compile a full bibliography, and such references to literature as are given will be found in footnotes. Neither has a complete explanation of terms been prepared, as the terms used in the keys as a rule are defined in the easily available "Glossary of Entomology" by John B. Smith, published by the Brooklyn Entomological Society in 1906, or have been defined and are in common use by modern entomological writers, the present authors included. The very few new terms found in the keys, such as "urogomphus," meaning a tail-projection, instead of "cercus" or "pseudocercus," and "raster," meaning a rake, designated for the spinose region on the ventral side of the last abdominal segments in Scarabaeidae, will readily be understood through the examination of the figures themselves and the corresponding explanations.

Besides the strictly alternative characters of the keys, others, guiding but not necessarily alternative, are given in parentheses.

The generic and specific nomenclature used in the keys, and particularly in the explanations of plates, follows the one applied in Leng's catalogue[1c] for the North American larvae, in Reitter's cata-

[1c] Charles W. Leng: Catalogue of the Coleoptera of America, North of Mexico. 1920, with suppl. 1927.

logue[1D] for the European larvae, and in Junk's catalogue[1E] for the larvae from other countries.

It is impossible to adequately acknowledge and express our appreciation of the great amount of assistance we have received from many colleagues and friends interested in our project. The late Dr. E. A. Schwarz followed our work with interest and generous assistance, and we are deeply indebted to Doctor Schwarz for his suggestions as to the systematic position of many forms. From time to time in the last more than fifteen years Messrs. E. C. Rosenberg, J. P. Kryger, and K. L. Henriksen have presented one of the authors with many important Danish larvae, now included in the collection of the National Museum, without which it would have been impossible to characterize and figure the larval types of several families and subfamilies. An important collection of larvae from Finland, acquired last year through Prof. Uunio Saalas, has been very useful for the final revision and completion of the keys. From the British Museum of Natural History a number of exceedingly interesting forms have been presented by Dr. C. J. Gahan and Dr. K. G. Blair. Dr. G. de Lapouge from France has donated a valuable collection of carabid larvae. Many meloid larvae and other larvae of great importance have come from Dr. A. Cros. Mr. J. C. M. Gardner has sent a great many named larvae from India; Dr. O. H. Swezey, larvae of Proterhinidae and other rare larval types from Honolulu; Dr. J. Bequaert, larvae of *Drilidae* and other remarkable larval types from Yucatan, Mexico, Liberia, and Belgian Congo; and Dr. J. G. Needham, a Chinese larva which appears as a transitional type between the Psephenidae and the Ptilodactylidae. Last but not least we have had available for daily study the large collection of beetle larvae in the United States National Museum, which gradually has been accumulated by numerous North American entomologists since the year 1896, when C. V. Riley transferred to the National Museum a small biological collection which he brought with him from Missouri. Now the collection contains invaluable systematic material from North and South America, collected and reared by E. A. Schwarz, H. G. Hubbard, H. S. Barber, A. D. Hopkins and his many associates, F. H. Chittenden, George Dimmock, C. C. Hamilton, J. A. Hyslop, J. J. Davis, A. B. Champlain, T. E. Snyder, R. T. Cotton, R. J. Sim, and many other entomologists, and it is also

[1D] L. v. Heyden, E. Reitter, J. Weise: Catalogus Coleopterorum Europae, Second edition. 1906.

[1E] E. W. Junk, editus a S. Schenkling: Coleopterorum Catalogus.

rich in material of European larvae which has been acquired by exchange between Prof. C. V. Riley and Dr. Fr. Meinert at the Zoological Museum in Copenhagen or has been bought, particularly from the collections of Wm. Schlick and K. W. Verhoeff.

Finally, the authors wish to extend their sincere thanks to Mr. R. A. St. George. For a number of years he has been giving a great deal of study to the larvae of the order, particularly the families of the Cucujoidea, and has assisted in the characterization of this series. At the same time he has made many of the drawings included in this paper.

INTRODUCTION

(pl. 125)

The coleopterous larvae belong to three fundamentally different types. Consequently, in the present synopsis the families are arranged into three different suborders, namely:

Suborder 1: Archostemata
Suborder 2: Adephaga
Suborder 3: Polyphaga

According to the views commonly held by entomologists,[2] only two major divisions of Coleoptera, the Adephaga and the Polyphaga, are recognized. However, the present studies, which intentionally stress larval characters and avoid consideration of imaginal structures, show the necessity of recognizing a third suborder for the inclusion of the Cupedidae and Micromalthidae, whose larval morphology isolates them from all other beetles. The term "Archostemata," first proposed by Kolbe, is here adopted as the subordinal name for these two families. Although very specialized they are nevertheless so ancient that they must be regarded as the representatives of an almost extinct larval type.

It is of great interest that several modern entomologists, working exclusively with the imagines, have realized the isolation of the Cupedidae and Micromalthidae; and Dr. Wm. T. M. Forbes, in his paper on wing-folding patterns of the Coleoptera (Jour. New York Ent. Soc., vol. 34, 1926), has, like the present authors, recognized those two families as forming a separate suborder which he, too, names Archostemata.

In contrast to the primitive and slightly specialized larval types to which the Polyphaga can be traced, the larvae of the Adephaga possess a complex of highly advanced and derivative characters which probably have been acquired through a long evolutionary process from an unknown primitive larval type somewhat different from the existing primitive Polyphaga larva. However, the well developed and well defined tarsus of the Adephaga carrying one or two distinct and movable claws may be a primitive character not altered through the course of their development into high specialization. The ancient Archostemata larvae also possess a distinct tarsus and claw and

[2] Consult the introduction "Essay on Classification" in C. W. Leng's Catalogue, pp. 3–37, in which a very clear and critical review is given of the different systems from the earliest one by Linnaeus to the one proposed and applied by Leng himself. The bibliography is prepared with the painstaking care so characteristic of the author.

certain Polyphaga larvae (though not necessarily of primitive families) likewise show an indication of a separate tarsus and claw (see footnote 5, p. 9). In neuropterous larvae, as *Raphidia, Sialis,* and *Corydalis,* a distinct tarsus and two claws are present and in many other respects the greatest similarity exists between them and the typical Caraboidea. Unquestionably, however, these neuropterous larvae are less primitive than the primitive polyphagous Staphylinoidea (p. 25). It would therefore be logical to place the Adephaga as the third suborder, as it is the more modern of the three, and the Polyphaga before it, because the suborder Polyphaga includes existing larvae of a primitive type from which its other larval types can be derived directly or indirectly. But for practical purposes it appears more advisable to rank the suborders in the commonly accepted sequence, and as no traceable phylogenetic connection exists between them, the sequence in which they are placed and treated is rather immaterial.

The primitive type of the Polyphaga is found in its most characteristic and original form in the series Staphylinoidea as limited in the present paper, more particularly in such families and subfamilies as the Limnebiidae, Leptinidae, and Anisotomidae; and it is from the larval type found in these families that are derived not only the more or less specialized larvae of the other staphylinoid families but also the different types of the hydrophiloid larvae (p. 31), possibly through larvae of such families as Hydrochidae and Spercheidae.

The larva of the series Byrrhoidea (p. 43) represents a second distinct polyphagous type which, while primitive, is in some respects less primitive than the larva of the primitive Staphylinoidea. Probably the two series have ancestors in common, but by no larval type known up to this time are they linked together. However, some of the derived families of the byrrhoid type and some belonging to a third distinct polyphagous type, the cucujoid type, approach one another, and about the direct affinities between the Cucujoidea and the Staphylinoidea there can be no doubt. Rather isolated as the series Byrrhoidea appears in the polyphagous suborder, it does not seem necessary to rank it and the families and series derived from it as a separate suborder. Two series, the Dascilloidea (p. 43) and the Cleroidea (p. 55), are descended directly from the Byrrhoidea, supposedly through heterocerid forms and dermestid forms, respectively.

From the byrrhoid family the Byrrhidae (p. 43), the Dryopoidea (p. 44) can be derived through the dryopoid family Ptilo-

dactylidae; from the dryopoid family Eurypogonidae, the Elateroidea (p. 49) may wholly or partly branch; from near this same dryopoid family, or more probably from different Dryopoidea, the Cantharoidea and very likely a minor part of the Elateroidea have come; and from the dascilloid family Dascillidae, the series Scarabaeoidea (p. 51) descends according to their larval forms through scarabaeoid families like the Trogidae and the Lucanidae.

With the cleroid family Ciidae (p. 55) may be associated the series Mordelloidea (p. 60), the series Bostrichoidea (p. 62), and the so-called phytophagous assemblage of different series, including the Cerambycoidea (p. 60), Chrysomeloidea (p. 63), Platystomoidea (p. 66), and Curculionoidea (p. 66). The Meloidea (p. 58) may also belong to the cleroid assemblage of families and series, attaching itself to the cleroid family Melyridae (p. 55), but there are on the other hand some reasons for considering the possibility that it might be related to the Cantharoidea.

The third distinct polyphagous larval type that is more primitive than the byrrhoid type and shows closer affinity with the staphylinoid leptinid association is found as mentioned in the series Cucujoidea, notably in the families Lathridiidae (p. 33), Derodontidae (p. 33), Silvanidae (p. 34), and Endomychidae (p. 38). Most of the cucujoid families are plainly derived from this type; a few, however, not so plainly, such as the larvae of the family Oedemeridae (p. 40), and the whole tenebrionid association (p. 42^{54-56}), which only indirectly can be traced to the primitive cucujoid larvae through rather advanced cucujoid types like the larvae of the Colydiidae or the Melandryidae.

SUBORDERS

The systematic characters defining the larvae of the three suborders, whose relative phylogenetic positions now have been discussed, are as follows:

A. *Archostemata.* Legs six-jointed with distinct tarsus and one or two distinct claws;[3] always a mandible possessing a strong molar part, and with hypopharyngeal and paragnathal structures fused with prementum into a strong, hard unit.

B. *Adephaga.* Legs six-jointed with a well defined tarsal joint and one or two distinct, movable claws;[4] mandible lacking a molar part; hypopharynx never united with prementum into a strong, hard unit.

C. *Polyphaga.* Legs five-jointed, the tarsal joint fused with a single claw into a tarsungulus; or less than five-jointed; or no legs present.[5]

[3] Except in the instars of *Micromalthus,* which are legless or have three-jointed legs.

[4] All, or some, of the larval instars of the carabid species *Brachinus janthinipennis* Dej. and *Lebia scapularis* Dej. are adapted to an ectoparasitic life to the extent that it is impossible to place them systematically by a mere examination of the body structures. In the series Paussoidea (p. 24), of which, however, only the last larval instar is known, the legs are three-jointed, but this myrmecophilous larva can be recognized by the unique development of the eighth abdominal segment into a large, terminal, glandular disk. Tibia and tarsus fused in a few cicindelid genera (p. 18).

[5] Several larvae as the staphylinid genera *Philonthus* and *Bledius,* the first instar of the staphylinid species *Aleochara bilineata* Gyllenhal, *Euplectus,* some genera of Histeridae, and the cerambycid genus *Nothorhina* have the tarsungulus divided by a faint suture into a proximal and distal portion which possibly correspond respectively to tarsus and claw. In several of the Bostrichoidea, particularly in *Ptilineurus marmoratus* Reitter, the tarsungulus has not the usual character of a claw but of a long, pointed, upward curved joint carrying many, strong, spinelike setae, the tarsal portion of the tarsungulus here being predominant.

SERIES OR SUPERFAMILIES

The *Archostemata* includes one family series: A, Cupesoidea.

The *Adephaga* includes three family series: B, Caraboidea; C, Gyrinoidea; and D. Paussoidea.

The *Polyphaga* includes eighteen family series: E, Staphylinoidea; F, Hydrophiloidea; G, Cucujoidea; H. Byrrhoidea; I, Dascilloidea; J, Dryopoidea; K, Cantharoidea; L, Elateroidea; M, Scarabaeoidea; N, Cleroidea; O, Meloidea; P, Mordelloidea; Q, Cerambycoidea; R, Bostrichoidea; S, Chrysomeloidea; T, Platystomoidea; U, Curculionoidea; and V, Lymexyloidea.

The sequence in which the different family series have been catalogued above and will be treated in the subsequent parts of the paper, except in the key to the series immediately following, intimates a natural arrangement of the series according to the presumed relationship of their larval types (pl. 125).

Key to Series

1. Leg six-jointed with tarsus distinct and one or two distinct, movable claws present[6] 2
   Leg either five-jointed with tarsus and claw fused into a single, claw-shaped, terminal tarsungular joint, or less than five-jointed, or vestigial, or absent[7] 4
2. Mandible with molar structure; hypopharyngeal sclerome fused with prementum and ligula into a strongly chitinized unit ..... *Cupesoidea* (p. 16)
   Mandible of the grasping type without molar structure, hypopharyngeal region membranous and not fused with prementum and ligula 3
3. Cardo of normal moderate size or small; prementum having stipites labii fused at least proximally. (Tenth abdominal segment usually not armed with large hooks; spiracles usually present) ..... *Caraboidea* (p. 16)
   Cardo very large; prementum having stipites labii completely separated. (Tenth abdominal segment armed with four long hooks; spiracles absent; lateral gills present; mandibles perforate) ..... *Gyrinoidea* (p. 24)

[6] Except in the instars of *Micromalthus* which are legless or have three-jointed legs.

[7] For further discussion and information see: Snodgrass, R. E., Morphology and Mechanism of the Insect. Smithsonian Miscellaneous Collections, vol. 80, no. 1, 1927, pp. 93–98.

4. Eighth abdominal segment glandular, discoidal, and terminal. (Ninth and tenth abdominal segments minute, leg three-jointed) ..... *Paussoidea* (p. 24)
   Eighth abdominal segment not glandular and not discoidal 5
5. Urogomphi jointed,[8] individually movable. (Often retracted into a terminal breathing pocket in eighth abdominal segment in the Hydrophilidae) 6
   Urogomphi solid or absent 7
6. Maxillary palpiger as a rule closely connected with stipes, not often carrying a finger-shaped galea; spiracles annular. *Staphylinoidea* (p. 25)
   Maxillary palpiger free and joint-like, usually carrying a finger-shaped galea; spiracles biforous *Hydrophiloidea* (p. 31)
7. Hypermetamorphosis present; mandible without molar part; maxillary mala short, thick, almost vestigial; gular area present; spiracles annuliform and often large; urogomphi absent[9] ..... *Meloidea* (p. 58)
   No hypermetamorphosis;[10] different combination of the five mentioned structural characters 8
8. Larva with mandible bearing an accessory ventral condyle and with either a free galea well separated from a distinct lacinia or with cribriform spiracles, or with both of these characters[11] 9
   Larva with a different combination of the characters. (A mandible with an accessory ventral condyle never occurring together with either a free galea or actually cribriform spiracles) 10

[8] Absent in some Pselaphidae, Scydmaenidae, termitophilous Histeridae, and the later instars of parasitic Staphylinidae.

[9] First larval instar, often named triungulin, triungulinid, or triunguloid, has frequently a pair of setae at the end of the body, and in one subfamily is the eighth abdominal pair of spiracles placed on projecting hooks or warts; the legs have a single, frequently spatulate claw which is provided with one or two setae at the base or at the middle, these setae so large and strong in many genera that they appear as extra claws and for a long time were considered as such; hence the name "triungulinus." Apparently three-clawed legs have occasionally been found in larvae of other series, for instance, in an undetermined lampyrid larva.

[10] *Drilus* has polymorphic metamorphosis and some members of the family Cantharidae have, according to *Verhoeff*, foetometamorphosis, that is, two free embryonic instars preceding the first larval instar.

[11] Accessory ventral condyle absent in the family Passalidae which, however, is readily distinguished by possessing atrophied metathoracic legs (pl. 87).

9. Median epicranial suture present; tenth abdominal segment well developed, usually about as large or larger than the well-developed ninth abdominal segment, sometimes fused with it dorsally, when shorter than ninth provided with a pair of large anal pads; spiracles cribriform[12] and all lateral. *Scarabaeoidea* (p. 51)

Median epicranial suture absent, frons reaching to the occipital foramen; tenth abdominal segment much smaller than the well-developed ninth and always without anal pads, or both ninth and tenth vestigial; spiracles either cribriform and all lateral, or not cribriform and the eighth abdominal pair terminal ..... *Dascilloidea* (p. 43)

10. Gular region or median gular suture present or absent; when absent, with mandibles having mola or prostheca or extraordinary structures[13] except a pseudomola 11

Gular region or gular suture absent; subfacial region of head and ventral region of prothorax contiguous; mandible with pseudomola or with no mola, except in Platystomoidea and Lymexyloidea. (Cardo never completely absent and never distinctly exceeding stipes in size; mala when divided having a lobe-shaped galea; paired urogomphi usually absent) 19

11. Maxillary articulating area either large or indistinct; when indistinct, mandible with mola, except in Catogenidae, Epilachninae and Lamiinae[14] 12

Maxillary articulating area absent, or very small, or concealed by mentum, not large and cushioned; mandible without molar part 13

12. Maxillary mala divided into a well-developed lacinia and a finger-shaped, one- or two-jointed galea; mandible without a distinct molar part but with a longitudinal series of hairs at the base. (Hypopharynx membranous) ... *Byrrhoidea* (p. 43)

[12] Except in some species of *Trox* in which the spiracles are biforous (pl. 87).

[13] The gular region is completely absent in the cerambycoid subfamily Disteniinae having simple mandibles without mola, in some genera of Lampyridae with perforate mandibles, of Phalacridae without cardo, of Byrrhidae with mala divided into a jointed, finger-shaped galea and prominent lacinia, and in a few others.

[14] The maxillary articulating area is indistinct in some Nitidulidae, Laemophloeidae, Smicripidae, and Lamiinae through fusion with or loss of cardo (pls. 31, 35–38). In some Phalacridae and in the Catogenidae the cardines, the maxillary articulating areas, the submentum, and the gular area are fused more or less completely into one large subfacial membranous region between the diverging hypostomal rods (pl. 33, 34).

Mala simple, or division either indicated by distal notch or present with lobelike galea; mandible with or without a molar part but without a longitudinal series of hairs at the base. (Hypopharynx membranous or with a sclerome) 18

13. Either with exposed gills below the entire abdomen, or with movable operculum usually covering retractile gills at the end of the body, or with mamillaeform appendices from the tenth abdominal segment;[15] mandible never perforate or deeply cleft. (Usually with one large ocellus on each side and without true urogomphi).

Dryopoidea (p. 44)

Gills or anal appendices usually absent; in larvae where present, mandibles either perforate or deeply cleft longitudinally 14

14. Ninth abdominal segment operculate, vertical, and terminal. (Spiracles biforous; body cylindrical and strongly chitinized; mental-submental area distinctly triangular.)

Elateroidea-Rhipiceridae (p. 49)

Ninth abdominal segment otherwise 15

15. Spiracles cribriform; tenth abdominal segment terminal; prothorax large and more or less depressed, usually covered with a plate both dorsally and ventrally.

Elateroidea-Buprestidae (p. 49)

Spiracles, tenth abdominal segment, and prothorax otherwise 16

16. Labrum present ..... *Cleroidea* (p. 55)

Labrum absent or included in nasale. (In Throscidae and Melasidae, head capsule or mouthparts very much reduced or abnormal; prothorax provided ventrally, or both dorsally and ventrally, with pairs of rod-shaped scleromes (pl. 81)) 17

17. Frontal sutures present, except in Throscidae and Melasidae in which head capsule and mouthparts are reduced or very much specialized. (Mandible of the biting labidomorphic type; head capsule with deep subfacial sinus for reception of ventral mouthparts) ..... *Elateroidea proper* (p. 50[7-12])

Frontal sutures absent, except in Brachypsectridae and Lampyridae; both with piercing mandibles. (Mandible of the biting labidomorphic type, or of the subulate type adapted for piercing and sucking; subfacial sinus present or absent[16])

Cantharoidea (p. 46)

[15] *Eurypogon*, a type intermediate between the Dryopoidea and the elateroid family Cebrionidae, has no gills or appendices (pl. 69).

[16] Sometimes with pseudocribriform spirales (pl. 78).

18. Ventral mouthparts retracted.[17] (Mandibular molar part usually present) ..... *Cucujoidea* (p. 33) and section 23 (p. 15)
Ventral mouthparts protracted. (Head capsule ventrally with a broad transverse bridge formed completely or mainly by the large hypostomata; mandible without molar part, often of the gouge-shaped coelate type; legs short or absent.) *Cerambycoidea* (p. 60)
19. Hypopharyngeal sclerome absent; mandible without a real molar structure 20
Hypopharyngeal sclerome present; mandible of the masticomorphic type with veritable molar structure. (Mentum and submentum well separated; head nutant) 23
20. Ninth abdominal tergum armed with a pair of urogomphi or an unpaired spine. (Tenth abdominal segment without a pair of large lobes separated by median longitudinal groove; legs short, soft, but jointed; terminal joint not claw-shaped; frons short and transverse) ..... *Mordelloidea* (p. 60)
Ninth abdominal tergum without a pair of urogomphi or an unpaired spine[18] 21
21. Tenth abdominal segment in front of anus provided with a pair of cushioned and adjacent lobes separated by a median, longitudinal groove often marked at the anterior end by a small, transverse sclerome. (Frons indistinct, short, and transverse; frontal sutures faint or absent; epicranial suture present and long, or absent through complete fusion of epicranial halves; mentum laterally free and separated from submentum, except in *Caenocara*; legs four- or five-jointed, usually with rather long, setose, distally pointed, and hard tarsungulus, except in *Caenocara* where legs are vestigial, two-jointed, and soft) (pl. 101) ..... *Bostrichoidea* (p. 62)
Tenth abdominal segment in front of anus without a pair of soft, oval lobes separated by a longitudinal groove 22
22. Hypopharyngeal bracon absent. (Frons usually distinct with converging frontal sutures; usually with distinct, four- or

[17] In some forms, as Phalacridae, Laemophloeidae, and possibly Catogenidae, the ventral mouthparts are apparently protracted as a result of elimination of cardines, or fusion of cardines, submentum, and gular area into a large common subfacial region (pls. 31, 32–34).

[18] In exception, paired urogomphi are present in the first larval instar of *Lyctus*, and an unpaired terminal spine is found on the minth abdominal segment of the first instar of the *Scobicia* larva, but both of the larvae possess in front of the anus a pair of adjacent lobes separated by a longitudinal groove (pls. 101, 102).

five-jointed legs with a tarsungular last joint;[19] mentum either free or joined with maxillary stipites; mala often separated into a galea and a lacinia hidden below the galea.)
Chrysomeloidea (p. 63) and *Disteniinae*

Hypopharyngeal bracon present. (Without jointed legs, except in Brenthidae where they are vestigial; mentum connected completely with maxillary stipites, except in Brenthidae; mala simple) ..... *Curculionoidea* (p. 66)

23. Legs vestigial, without pointed, tarsungular joint, or absent; maxillary mala divided into a lacinia terminating with a thorn, and a galea; body curved, fleshy, and with dorsal, transverse plicae; tenth abdominal segment small, in continuation of ninth ..... *Platystomoidea* (p. 66)

Legs normal, with strong tarsungulus; maxillary mala with only terminal indentation indicating a division into lacinia and galea; body elongate cylindrical, covered with tergal shields; tenth abdominal segment well-developed, asperate, and placed below base of large, chitinized ninth segment.
Lymexyloidea[20] (p. 67)

[19] Legs are weak or vestigial without a tarsungular joint in the older larvae of Bruchidae and absent in many of the leaf-mining larvae.

[20] The systematic position of this series is uncertain. Its larval form approaches in important characters the deviating larvae of the two cucujoid families Oedemeridae and Calopidae, but also greatly resembles the larval form of the ancient suborder Archostemata.

FAMILIES, SUBFAMILIES, AND OCCASIONALLY TRIBES

In the taxonomic arrangement of the larvae, each series includes usually a greater or smaller number of families, subfamilies, and minor subdivisions. In proper order, keys to the families, subfamilies, and occasionally tribes of each of the series listed on page 10 are given below.

A. CUPESOIDEA

Key to Families

1. Ninth abdominal segment extended terminally into a single, conical, straight process, ventrally with a simple, transverse, narrow sternal plate; leg short, conical; tarsus carrying one bifurcate claw with subequal tips. (Polymorphic larval metamorphosis lacking) ..... *Cupesidae* (pl. 1 A–G)

   Ninth abdominal segment with terminal process bent downward and directed toward a similar but upward bent process from the sternal plate; leg (in instar in which fully developed) provided with a long, slender tarsus carrying two claws of equal length. (Polymorphic larval metamorphosis present with partly paedogenetic cycle of larval generations.)[21] *Micromalthidae* (pl. 2 A–J)

B. CARABOIDEA

Key to Families

1. Labial palpi latent; prementum and ligual fused into an unpaired anteriorly bilobed piece. (Retracted ventral mouthparts; one claw.)[22a] *Rhysodidae* (pl. 3 A–J)

   Labial palpi distinct and jointed 2

2. Ninth abdominal segment present; eighth abdominal segment never terminal. (One or two claws) 3

   Ninth abdominal segment rudimentary; eighth long, conical, appearing as the terminal segment of the body. (Two claws) 7

3. Tenth abdominal segment developed as a pygopod for locomotory purpose 4

   Tenth abdominal segment not developed as a pygopod 6

[21] Barber, H. S., Proc. Biol. Soc. Wash., vol. 26, 1913, pp. 185–190.

[22a] Peyerimhoff, P. de, Rev. d'Ent. vol. 22, 1903, pp. 80–84, one plate.

4. Two or three pairs of hooks present on tergum of fifth abdominal segment ..... *Cincindelidae*[22b] (pl. 4 A–E)
   No hooks on fifth abdominal tergum 5
5. Terminal setae of tarsus much shorter than claws; retinaculum single or absent ..... *Carabidae*[23] (pl. 4 F–I)
   Terminal setae of tarsus much longer than claws; retinaculum bicuspidate ..... *Omophronidae* (pl. 5 A–E)
6. Thoracic and abdominal spiracles present, biforous, and all lateral; branchial prolongations absent; ninth and tenth abdominal segments separate; tenth abdominal segment long, bifurcate, and attenuate ..... *Haliplidae-Haliplinae* (pl. 5 F–H)
   Spiracles all absent; branchial prolongations present; ninth and tenth abdominal segments fused into a bifurcate, terminal segment ..... *Haliplidae-Peltodytinae*
7. Head nutant; mandible falcate and simple; eighth abdominal spiracle absent. (Gills present below anterior part of body.) *Hygrobiidae* (*Hygrobia*) (pl. 5 I, J, M)
   Head porrect; mandible not simple; eighth abdominal spiracle terminal. (Gills rarely present) 8
8. Mandible with distinct retinaculum, inner margin neither sulcate nor tubular; legs fossorial *Noteridae* (*Noterus*, *Hydrocanthus*, and *Canthydrus* (pl. 5 K, L, N–P)
   Mandible without distinct retinaculum, inner margin either sulcate or tubular; legs ambulatory or natatory 9
9. Prothoracic presternum large and subquadrate; gula[24] present, subquadrate or triangular; gular suture double or anteriorly bifurcate ..... *Dytiscidae*[25] (pl. 6 A–H)
   Prothoracic presternum transverse, narrow, and band-shaped; gula absent; gular suture median and simple. *Amphizoidae* (pl. 7 A–H)

B.I. CICINDELIDAE

Key to Main Types of Larvae

1. Each of the paired protuberances on fifth abdominal segment with two hooks 2

[22b] Key to the main types of cicindelid larvae on pages 17–18.

[23] Key to subfamilies of Carabidae on pages 18–23.

[24] The plate or area which appears as the gula may be a morphologically different structure, namely, a pair of medianly fused pieces separated from the gular margin of the epicranium. However, for practical purposes, it is referred to as the gula.

[25] Key to subfamilies of Dytiscidae on pages 23–24.

Each with three hooks 4

2. Exterior hook falcate and outwardly concave; basal joint of labial palpus with two or three spines.
Cicindelini (*Cincindela*)

Exterior hook straight or slightly concave toward the middle line; basal joint of labial palpus without spines 3

3. Dorsal pair of ocelli subequal in size
Tetrachini (*Tetracha*)

Posterior one of dorsal ocelli decidedly larger than anterior.
Amblycheilini (*Amblycheila*)
(pl. 4 B, D)

4. Exterior hook much smaller than the other two. (Tibia and tarsus small but separate) ..... *Omini* (*Omus*)

All three hooks of about the same size. (Tibia and tarsus separate (*Therates?*), or fused)
Collyrini (*Collyris, Ctenostoma,* and *Therates* (?))
(pl. 4 A)

B.II. CARABIDAE

Out of the nineteen subfamilies into which the Carabidae have been divided here according to the characters of the larvae, a single one, the Lebiinae, may not be natural. The evidence of a close relationship between the genera which have been included in it is not strong and, considered as a group, its affinities to other subfamilies, particularly to the Dromiinae, can hardly be traced. Furthermore, because of extreme adaptation to an ectoparasitic life in all or some of the larval instars, it is not always possible even to recognize the larvae of some of its species as carabid larvae. In the following key the main character common to the genera of the Lebiinae appears rather insignificant but it sets the subfamily off from all other carabid larvae. Two of the remaining subfamilies, namely, the Dromiinae and the Loricerinae, occupy an isolated position, but the rest intergrades either with one or with several of the other subfamilies. The Dromiinae is in itself a homogeneous and natural group, and the larval form of the subfamily Loricerinae, represented by a single genus only, is very characteristic and strikingly different from other carabid larvae. The larvae of the Odacanthinae show no close relationship to the larvae of the two other "Truncatipennes", the Lebiinae and the Dromiinae, but they approach the Nebriinae. The Driptinae are closely related to the Nebriinae which are rather distant from the Carabinae, according to their larvae. The Cychrinae are closely related both

to the Carabinae and to the Chlaeniinae, and between this latter subfamily and the Licininae is an unmistakable affinity. The Bembidiinae, as limited here according to the larvae, represent a natural and well defined subfamily, but the Sphodrinae, Broscinae, and Dyschiriinae, all of which have but one claw on each tarsus like the Bembidiinae, come near to this group. Regardless of a significant lack of similarity with the whole bembidiine association in the number of claws, the Scaritinae may join it, and the Elaphrinae which like the Scaritinae have two claws on each tarsus, are unquestionably related to this latter subfamily. Another association of subfamilies is formed by the Pterostichinae, Amarinae, and Harpalinae. Connected with this group is the subfamily Patrobinae, which in the larval stage has no connection whatsoever with the Bembidiinae but is difficult to separate from the Pterostichinae. The larvae of the genera *Glyptus* from Africa (pl. 4 I) and *Orthogonius* from India and Africa are termitophilous, blind, with a more or less bottle-shaped, fleshy, soft-skinned body, short legs with but one claw, and no urogomphi. According to the imagines, their systematic position is with the Amarinae and Harpalinae.

Key to Subfamilies

1. Ligula almost absent and entirely without setae. (Polymorphic metamorphosis; body often degraded because of parasitism) *Lebiinae* (*Lebia*, *Brachinus*, and possibly *Pheropsophus*)[26]

   Ligula with setae 2

2. Tenth abdominal segment with two protrusile prominences carrying a series of scansorial hooks; with a single exception, claws having a round or tooth-shaped enlargement at base. *Dromiinae* (*Dromius*, *Demetrias*, *Euproctus*, *Calleida*, *Philophuga*, *Plochionus*, *Cymindis*, and *Onota*)

[26] *Brachinus janthinipennis* Dejean is ectoparasitic in all larval stages on the pupa of *Dineutes americanus* Say (= *assimilis* Kirby) and pupates inside the mud cocoon of its host (Dimmock, G., and Knab, F., Springfield Museum of Natural History, Bul. 1, 1904). *Lebia scapularis* Fourcroy is ectoparasitic on the larva and pupa of *Galerucella luteola* Müller; while feeding, the parasite is inside a sort of capsule (Silvestri, F., Redia, vol. 2, 1904). *Lebia chlorocephala* Hoffman is not parasitic (Rosenberg, E., Entom. Medd., ser. 2, vol. 2, 1903—Larvae of Lebiini and Odacanthini). *Pheropsophus hispanicus* Dejean is probably not parasitic (Emden, F. von, Supplementa Entomologica, no. 8, 1919).

Tenth segment with no scansorial hooks; claws normal 3

3. Mandible falcate, at least three times as long as wide at base (Retinaculum placed at base or in the middle of the inner edge) 4

Mandible robust, about twice as long as wide at base, or shorter. (Retinaculum never placed at base; each leg often with claws of different sizes) 19

4. Mandible multiserrate in front of retinaculum; nasale not projecting but armed with a transverse series of several sharp teeth of the same size; two claws of equal size; urogomphi immovable ..... *Odacanthinae* (*Odacantha*, *Leptotrachelus*, and *Casnonia* (?))

Combination of the four characters different 5

5. Mandible not serrate in front of retinaculum and without groove for antenna; antenna inserted outside of mandible; urogomphi movable and long; head round and usually large; collum constricted and narrow (except in *Pelophila*) 6

Different combination of the characters 7

6. Prementum with lateral setae. (Coxa of front leg with inner margin of a groove for reception of femur armed with long spines; urogomphi multijointed) *Driptinae* (*Galerita*)

Prementum without lateral setae. (Urogomphi not jointed, finely nodose) ..... *Nebriinae* (*Notiophilus*, *Pelophila*, *Nebria*, and *Leistus*)

7. Dorsal shield of ninth abdominal segment very small; ligula broadly rounded and multisetose; mandible with distal part beset with appendices; retinaculum serrate; inner corner of mandible receding at base. (Stipes large, swollen; palpus shorter than galea) ..... *Loricerinae* (*Loricera*)

Dorsal shield of ninth abdominal segment distinct; ligula with a pair of setae; mandible without appendices and with inner corner projecting 8

8. Urogomphi fixed, short, strong, and pointed; prementum without lateral setae; stipes maxillaris subquadrate, depressed 9

Urogomphi different; prementum with lateral setae; stipes different 10

9. Retinaculum with posterior margin simple; urogomphi antler-like in mature larvae; labial palpus with apical joint simple and ovate, or terminally cleft. (Ligula distinct in *Calosoma*, minute in most species of *Carabus*) *Carabinae* (*Calosoma*, *Carabus*, *Damaster*, and *Procerus*)

Retinaculum with posterior margin serrate; urogomphi conical and simple; labial palpus with apical joint securiform. (Head small, body broad and oval)

Cychrinae (*Cychrus, Maronetes,* and *Sphaeroderus*)

10. Two claws of equal size 11
    One claw 13
11. Collum indistinct; epicranial suture absent or indistinct; mandible, except in *Rembus,* with serrations, crenulations, or with a few denticulations at least on retinaculum and often also on inner edge in front of retinaculum. (Urogomphi often of unusual shape; distal joint of labial palpus rather thick and conical 12
    Collum distinct and broad; epicranial suture distinct; retinaculum, and usually the whole inner edge of mandible, entire 16
12. Antenna not twice as long as mandible. (Urogomphi either thin and stiff with a few seta-bearing tubercles, or very long, rolled up like a spring, and divided into a large number of minute pseudojoints as in *Chlaenius prasinus* Dejean and other species of *Chlaenius*)

Chlaeniinae (*Oodes* and *Chlaenius*)

    Antenna at least twice as long as mandible. (Urogomphi either movable, long, straight, and pubescent as in *Panagaeus,* or immovable, slender, curved toward each other, and pubescent as in *Dicaelus,* or, immovable, nodose, and with a number of long setae as in several genera)

Licininae (*Rembus, Dicaelus, Licinus, Badister,* and *Panagaeus*)[27]

13. Galea with proximal joint shorter than, or as long as, the distal one. (Ocelli usually six on each side; in *Trechus,* only three, the two anterior coalescent; in *Anophthalmus,* none.)

Bembidiinae (*Asaphidion, Bembidion, Cillenus, Tachys, Tachyta, Anophthalmus,* and *Trechus*)[28]

    Galea with proximal joint longer than the distal one 14

[27] *Panagaeus* has been given many different places in the classification of the imagines, for instance, close to the Chlaeniinae or near the *Bembidiinae,* but according to the larva its systematic position is in the *Licininae.*

[28] *Anophthalmus* and *Trechus,* according to the larvae, definitely belong in this subfamily and have no connection with the larva of *Patrobus* which, as mentioned above, is very similar to *Pterostichus.*

14. Lacinia present. (Ocelli absent; urogomphi jointed, with basal joint very long, the five distal joints small.)
Sphodrinae (*Sphodrus*)[29]

Lacinia absent 15

15. Meso- and metathorax convex laterally; urogomphi much longer than tenth segment, terete, and nodose. (Galea with the proximal joint twice as large as the distal; six ocelli.)
Broscinae (*Broscus*)

Meso- and metathorax subparallel laterally; urogomphi as long as or shorter than tenth segment, rather flat and membranous beneath, either very short, almost triangular, and distant at base, in *Dyschirius*, or fairly long, with parallel sides, and united at base, in *Clivina*. (Six ocelli or none.)
Dyschiriinae (*Dyschirius* and *Clivina*)

16. Legs fossorial; body with subparallel sides; prothoracic spiracle very large, first abdominal spiracle large, the rest of normal size. (Sternal sclerites of abdomen closely adjacent; either six ocelli or none; urogomphi either smooth and curved toward each other, in *Pasimachus*, or nodose and straight, in *Scarites*) ..... *Scaritinae* (*Scarites and Pasimachus*)

Legs ambulatory or rasorial; body fusiform; prothoracic spiracles of normal size. (Six ocelli) 17

17. Urogomphi either with short, setose ramuli, in *Elaphrus*, or thick, cylindrical, and beset with numerous setae, in *Blethisa*; four anal prominences. (Nasale extended into a short horn; with or without lacinia.)
Elaphrinae (*Elaphrus* and *Blethisa*)

Urogomphi terete, nodose or with several setae; two or no anal prominences 18

18. Penicillus absent; lacinia absent; claws slender and not strong; setae of femora fine ..... *Patrobinae* (*Patrobus*)[30]

Penicillus present; lacinia present or at least represented by a strong seta; claws of normal strength; setae of femora moderately strong. (Anterior margin of nasale varying much according to genus; six ocelli, except in the blind *Sphodrop-*

[29] This subfamily differs considerably from the Pterostichinae in which, according to the characters of the imagines, its only genus, *Sphodrus*, has been placed between *Pterostichus* and *Laemostenus*, but it approaches, together with the Broscinae, the great and well-defined bembidiine association.

[30] See explanatory remarks on page 19.

sis from European caves; urogomphi short, terete, and curved toward each other in *Evarthrus*, in the other genera long and multinodose) ..... *Pterostichinae* (Genera as placed in Leng's Catalogue in tribes *Pterostichini* and *Platynini*) (pl. 4 F–H)

19. Each leg with two claws of equal length; stipes stout and more or less distinctly divided into a proxistipes and a dististipes of about the same size; lacinia with moderately strong, lateral or terminal seta. (Anterior margin of nasale varying much according to genus, in *Zabrus* produced into two conical teeth; retinaculum very small; urogomphi solid, nodose, usually of moderate length, short in *Zabrus* and *Percosia*.)
Amarinae (*Zabrus* and the genera placed by Leng in *Amarini*)

Each leg with two claws of different length; stipes normal, rather slender; lacinia with very strong, spinelike, terminal seta. (Anterior margin of nasale varying much according to genus, but never produced into a pair of strong, conical teeth; retinaculum well-developed; inner edge of mandible in front of retinaculum either entire, serrate, or with one to several teeth; urogomphi usually of moderate length, short in a few genera as *Cratacanthus* in which the pygopod is exceptionally short and thick; trochanter with one or two rows of spines on each side) ..... *Harpalinae* (genera as placed by Leng in his tribe *Harpalini*)

B.III. DYTISCIDAE

Key to Subfamilies

1. Head with anterior, distally notched prolongation; mandible turned upward with apex fitting into the notch of the prolongation; maxillary palpus three-jointed
Hydroporinae (*Hyphydrus*, etc.) (pl. 6 B–D, G)

Head without anterior prolongation; mandibles directed forward; maxillary palpus four-jointed or more 2

2. Maxillary stipes broad, suboval, with one or two strong hooks on inner margin 3

Maxillary stipes slender and long, no hooks on inner margin 5

3. Seventh and eighth abdominal segments laterally without series of swimming hairs; ligula absent.
Colymbetinae (*Agabus*, *Ilybius*, *Colymbetes*, *Rhantus*, and also *Laccophilus*)

Seventh and eighth abdominal segments with swimming hairs; ligula present 4

4. With a pair of long lateral gills on the six anterior abdominal segments ..... *Coptotominae* (*Coptotomus*)
   No gills ..... *Thermonectinae* (*Acilius, Thermonectes, Graphoderes,* and *Eretes*)

5. Head anteriorly without dentation; ligula either absent, or low and bilobed; urogomphi present
   Dytiscinae (*Hydaticus* and *Dytiscus*) (pl. 6 A, F, H)
   Head anteriorly dentate; ligula long; urogomphi absent.
   Cybistrinae

C. GYRINOIDEA

Key to Families and Subfamilies

1. Head subcircular with collum narrow and distinct; mandible falcate without retinaculum
   Gyrinidae-Enhydrini (*Dineutes*) (pl. 6 E, I–M)
   Head elongate with collum about as wide as rest of head and not distinct; mandible with retinaculum 2

2. Nasale without teeth ..... *Gyrinidae-Orectochilini* (*Orectochilus*)
   Nasale with two to four teeth in a transverse row.
   Gyrinidae-Gyrinini (*Gyrinus*)

D. PAUSSOIDEA

The Paussoidea approach the Caraboidea, especially the Rhysodidae and the Carabidae, in fundamental characters but apparently also the series Hydrophiloidea. In common with the first of the two series, the Paussoidea possess a normal maxillary palpiger, four-jointed antenna, and annular spiracles. In common with the second of the series, they have a three-jointed maxillary palpus and a single-jointed galea, characters, however, which also occur in the isolated caraboid family Haliplidae. The posterior part of the abdomen is unique as are also the legs which are only three-jointed and are curved upward. However, reduced legs but of a different type are found both in the Caraboidea, for instance, in stages of *Lebia scapularis,* and in the Hydrophiloidea, for instance, in *Sphaeridium.* It is for practical reasons mostly that the series Paussoidea has been established and placed at the end of the

Adephaga. This conception, however, is based on the knowledge of the mature larvae of only two genera, namely, *Paussus* (represented by three species) and *Pleuropterus* (one species), and may be altered by the eventual discovery of the earlier instars and of the larvae of the more primitive genera.

FAMILY

The series consists of a single family .....*Paussidae* (pl. 7 I–M)

E. STAPHYLINOIDEA

The series contains several fairly distinct associations of families or subfamilies. Two of these are outstanding, namely, the leptinid association containing very primitive larvae, and the staphylinine association with greatly mutated and advanced larval types. To the leptinid association belong the Limnebiidae, Leptinidae, Anisotomidae, and Ptiliidae; to the staphylinine association the very specialized subfamilies Staphylininae, Thinopininae, and Paederinae. The four families which constitute the association of primitive larvae have been placed differently in the classification of the imagines: The Limnebiidae, with genera *Limnebius*, *Ochthebius*, and *Hydraena*, were placed in the beginning of the Hydrophiloidea (auct.); the Anisotomidae, with subfamilies Cholevinae (auct.) and Anisotominae (auct.), and the Leptinidae were included in the beginning of the Staphylinoidea (auct.); the Ptiliidae at the end of this latter series. The Hydroscaphidae are closely related to the Limnebiidae.

From the four primitive staphylinoid families are directly derived the Scaphidiidae, the Platypsyllidae, and the Silphidae; the latter merely including *Necrophorus*, *Silpha*, and the few other genera usually listed as "Silphini." The entire family Staphylinidae, as here conceived, consists of a complex of many subfamilies linked together into one large unit.

There is a gradual transition from the Oxytelinae, which represents the nearest approach to the Silphidae, into the Paederinae, which is the most specialized group of all the Staphylinidae. The Pselaphidae and Scydmaenidae are here regarded as families branched off from the Staphylinidae much in the same way as the Hydroscaphidae are branched off from the Limnebiidae, and the Platypsyllidae from the Silphidae or Scaphidiidae. The larvae of the small families Brathinidae, Clambidae, Clavigeridae, Sphaeridae, and Sphaeritidae are either completely unknown or are at least not present in the United States National Museum. The Histeridae

has been included in our Hydrophiloidea (p. 31) and the Corylophidae placed in the Cucujoidea near the Phalacridae (p. 36) and Smicripidae (p.36). The Micropeplidae is listed in the Staphylinoidea according to an incomplete description by Lubbock (Trans. Ent. Soc. London, 1868, p. 275, one plate) but the larva may not belong in this series at all.

Key to Families and Subfamilies

1. Mandible with a, usually large, asperate or tuberculate molar part 2
   Mandible without asperate or tuberculate molar part, usually without molar part 7

Leptinid association:

2. Tenth abdominal segment provided with a pair of recurved hooks ..... *Limnebiidae* (*Ochthebius*, *Hydraena*, and *Limnebius*) (pl. 8 A–L)
   Tenth abdominal segment without terminal hooks but sometimes with a pair of long setae 3
3. Spiracles absent; balloonlike appendices on prothorax, first and eighth abdominal segments; antenna very short and two-jointed ..... *Hydroscaphidae* (pl. 9 A–F)
   Spiracles present; no balloonlike appendices; antenna three-jointed 4
4. Apex of mandible multiserrate; urogomphi short, one-jointed. *Ptiliidae* (*Nossidium*) (pl. 10 F–L)
   Apex of mandible bifid or trifid; urogomphi two-jointed, last joint often multiannulate 5
5. Mandible with vestigial retinaculum (r). *Leptinidae* (pl. 10 A–E)
   Mandible with distinct retinaculum (r), or prostheca (lm),[31] or both 6
6. Asperities on molar structure covering entire ventral surface, irregularly arranged; paraglossae as long as ligula. *Anisotomidae-Liodinae*[87] (pl. 11 A, B)
   Asperities on molar structure arranged in fine transverse (often few) rows; paraglossae absent or shorter than ligula. *Anisotomidae - Cholevinae*[87] (pl. 11 C–M)
7. Mala and stipes fused 8
   Mala jointlike, movable 23

[31] Except in *Aphaobius*, belonging to the Anisotomidae-Cholevinae but very similar to the Leptinidae. (L. Weber, Allg. Ztsch. f. Ent. vol. 7, 1902).

Silphid association:

8. Mandible with apex simple, recurved, and bent away from the sagittal plane of the larva. (Ligula rounded and entire.)
Platypsyllidae (pl. 12 E–I, K)
Mandible with apex differently shaped, never recurved 9
9. Galea present; often developed as a small, hairy lobe on top of lacinia. (Ligula bi- or trilobed) 10
Mala maxillaris simple. (Ligula either deeply bilobed, or entire, or absent)[32] 12
10. Lacinia with entire surface asperate; terminal joint of maxillary palpus subulate; ligula trilobed.
Scaphidiidae (pl. 12 A–D, J)
Lacinia not asperate or only along posterior margin; terminal joint of maxillary palpus not subulate; ligula bilobed 11
11. Dorsal shields small, the abdominal ones quadrispinose; ventral surface whitish and soft
Silphidae-Necrophorinae
Dorsal shields large, usually laterally produced with posterior angles acuminate; ventral surface with well sclerotized shields ..... *Silphidae-Silphinae*[87] (pl. 13 A–J)
12. Ligula either deeply bilobed anteriorly, or absent; nasale present 22
Ligula entire anteriorly; labrum distinct, often movable 13

Oxyporine association:

13. Mandible narrowed at the middle, apically bifid and finely mucronate. (Ligula small and quadrate.)
Staphylinidae-Oxyporinae[33]
Mandible different 14
14. Ligula broad, anteriorly either rounded, straight, or slightly emarginate 15
Ligula conical, often transversely bipartite at base 18
15. Mandible with suddenly dilated molarlike base. (Apically with three or four teeth and ocelli several in number) 16
Mandible with no molarlike base [34] 17

[32] The mala is crowned in several species of *Bledius* and in *Syntomium* with a hairy, rounded projection which might be interpreted as a vestigial galea, but the ligula is simple and rounded.

[33] The anatomical details of head and body have a primitive character; the systematic relationship to the oxyteline association is rather remote, and the systematic position somewhat isolated.

[34] In the aleocharine genera *Leptusa* and *Silusa* the base is somewhat dilated, but the apex is bifid or entire and only one ocellus is present.

Oxyteline association:

16. Larva elongate; anal segment conical, ventrally directed; with four ocelli on each side . *Staphylinidae-Piestinae*[35] (*Piestus* and *Lispinus*) (pl. 14 B, C, E, F, H)

Larva ovate, short, body capable of contraction into a globe; anal segment small, short, laminate, posteriorly directed; three ocelli on each side. *Staphylinidae - Syntomiinae* (*Syntomium*)[36]

17. Mandibles apically more or less widened, bifid or trifid, sometimes asymmetrical; number of ocelli on each side, three, one, or none ..... *Staphylinidae - Oxytelinae*[37] (*Bledius* with termitiform body and three ocelli, *Platystethus* and *Aploderus* with dark spots laterally on most segments, *Oxytelus, Coprophilus,* and *Trogophloeus*) (pl. 15 D, G, H, L)

Mandibles apically not widened, either slightly forked or entire; with one ocellus *Staphylinidae-Aleocharinae, part one*[37] (*Gyrophaena* with eighth abdominal segment terminally produced into a glandular process, *Microglotta, Maseochara,* and many other genera) (pls. 14 A, D, G, I and 16 F–I)

18. Ligula simple, conically pointed; one ocellus . *Staphylinidae-Aleocharinae, part two*[37] (*Leptusa and Silusa* with mandibles suddenly enlarged at base, *Atheta,* and many other genera).

Ligula transversely bipartite at base; three to six ocelli on each side 19

[35] The classification of the Piestinae as a subfamily conforms with the views of many European entomologists, and the larvae are easily recognized, but their subfamily characters are of disputable value. Bernhauer's and Schubert's conception of the group as a mere tribe of the Oxytelinae may prove to be the more satisfactory. It is with great hesitation that the Piestinae are placed here as a subfamily separate from the Oxytelinae.

[36] The larva of *Coprophilus* possesses falciform urogomphi shaped like the mandibles of a *Dytiscus* larva. It differs greatly in type from *Syntomium,* and has here been placed in the Oxytelinae.

[37] It is a very difficult taxonomic problem to find distinctive characters for the separation of the subfamilies Oxytelinae and Aleo-

Omaliine association:

19. Maxillary mala fanglike, smooth, and as long as entire head. (Three or six ocelli on each side).
Staphylinidae-Proteininae (*Proteinus* and *Megarthus*)[38] (pl. 16 J–M)
Maxillary mala shorter, with hairs. (Four to six ocelli on each side) 20
20. Mandible apically entire. Lacinia with or without pectinate inner edge; (ocelli six or less on each side).
Staphylinidae-Omaliinae (*Anthobium, Omalium, Olophrum,* and other genera) (pl. 17 B, D, F, G)
Mandible bifid. Lacinia with pectinate edge; (ocelli six) 21
21. Body biconvex; head nutant, laterally rounded; mala subtrapezoidal ..... *Staphylinidae-Tachyporinae* (pl. 15 C, E, I–K)

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charinae. In the Aleocharinae, the "part two" characterized by the presence of a simple, conical ligula is easily set off, thus causing no difficulties, but "part one" with a broad and rounded ligula isomorphous with the one found in the Oxytelinae is not separable from the latter subfamily by a single definite character as a comparison between the alternatives given in section 17 will show. However, in the general appearance of the larvae of the two subfamilies there is a lack of conformity that warns against any digression from the commonly accepted classification. In many aleocharine larvae, certain characteristic changes or radical adaptations to special biological conditions such as a fungicolous, myrmecophilous, termitophilous, or endoparasitic life make the determination to subfamily or even to series extremely difficult or impossible. The urogomphi, for instance, have disappeared in the myrmecophilous larvae of *Lomechusa, Xenodusa,* and *Atemeles*; and in *Aleochara bilineata* Gyllenhal only the first instar is built normally and is free living, but having found and gnawed its way into the puparium of a fly it changes into a very reduced endoparasitic second instar which is followed by a similarly reduced endoparasitic third instar. Other species of *Aleochara,* and *Maseochara valida* LeConte are also known to have endoparasitic larval instars in the puparia of flies or cocoons of sawflies. (See: N. A. Kemner: "Die Lebensweise und die parasitische Entwickelung der echten Aleochariden," Entom. Tidskrift, 1929, pp. 133–170, four plates.)

[38] The classification of the Proteininae as a subfamily is questionable. It is characterized by the extraordinary development of the mala, but is closely approached in this and other characters by genera such as *Lathrimaeum* belonging to the Omaliinae. (See important paper by N. A. Kemner concerning the larvae of the Proteininae; Entom. Tidsskrift, 1925, pp. 61–76, two plates.)

Body depressed; head porrect, laterally parallel; mala subtriangular ..... *Staphylinidae - Habrocerinae* (*Olisthaerus* and *Habrocerus*)[39]

Stenine association:

22. Urogomphi long and two-jointed; antenna more than twice as long as head; ligula bilobed; six ocelli on each side.
Staphylinidae-Steninae (pl. 17 A, C, E)

Urogomphi absent or small and immovable; antenna not longer than head; ligula absent; less than six ocelli, sometimes no ocelli 25

Staphylinine association:

23. Legs strong, fossorial; urogomphi one-jointed, thick, sausage-like ..... *Staphylinidae-Thinopininae* (pls. 15 B and 18 A, D, E, G, H–J)

Legs cursorial; urogomphi two-or three-jointed 24

24. Ocelli, four or less on each side.
Staphylinidae-Staphylininae (*Xantholinus* with one ocellus, *Othius* with none, *Quedius* in many species with club-shaped or capitulate setae, *Staphylinus*, *Philonthus*, and other genera.)

Ocelli, five or six ..... *Staphylinidae-Paederinae* (pl. 18 B, C, F)

Pselaphid association:

25. Terga expanded laterally, body oval 26

Terga not expanded. (Antenna not club-shaped.)
Pselaphidae[40] (*Batrisodes* and *Euplectus*) (pl. 19 E–J)

26. Tergal shields smooth, with simple hairs; antenna with second joint very large and club-shaped.
Scydmaenidae[40] (*Scydmaenus* and *Eumicrus*) (pls. 16 A–E and 19 A–D)

[39] The larvae of *Olisthaerus*, of which two European species are completely described and figured by Saalas (Uunio Saalas p. 69) agree in every character with *Habrocerus* (*schwarzi* Horn) and the two genera constitute together a subfamily that comes close to the staphylinine association having a porrect head and antennae inserted dorsally near the anterior margin of the head. The subfamily also approaches the Piestinae and Oxytelinae, thus forming a remarkable link between the more primitive and the highly transformed and advanced Staphylinidae.

Tergal shields tuberculate; with fan shaped hairs.
Micropeplidae (*?*)

F. HYDROPHILOIDEA

This series is not identical with the series named Hydrophiloidea in the classification of the imagines but it is considered expedient to retain the serial name Hydrophiloidea for the present association of families which according to their larvae constitute a homogeneous unit and to which the genus *Hydrophilus* belongs. The Histeridae are included in this series on account of an unquestionable conformity in the development of the fundamental systematic characters in the larvae of the Histeridae and Helophoridae. The Limnebiinae, Hydraeninae, and Hydroscaphidae of the authors belong in the series Staphylinoidea according to the form of their maxillary palpigers and spiracles.

Key to Families and Subfamilies

1. Nine complete abdominal segments; tenth small. (First to eighth abdominal spiracles lateral and well developed) 2
   Eight complete abdominal segments. (Ninth and tenth reduced; first to seventh abdominal spiracles lateral and small or apparently absent, eighth abdominal spiracle terminal, sometimes poorly developed; usually with a terminal breathing pocket; occasionally with gills) 3
2. Cardo fused with stipes; one ocellus (*Epierus*) or none; coxae small and widely separated. (Tarsus either short and falciform, or long, flexible and terminally filiform; urogomphi of moderate length and usually two-jointed, or short and two-jointed with proximal joints fused at base in *Plegaderus* and *Epierus*, or reduced to a pair of warts. Some termitophilous larvae from British Guiana with rather stiff, digitiform processes on the sides of the body, one pair to each segment) ..... *Histeridae*[41] (pls. 20 A–R and 21 I)
   Cardo distinct; six ocelli; coxae large, approximate. (Tarsus falciform; urogomphi diverging, long, three-jointed, tapering into a thread-shaped end; mandibular penicillus very

[40] The Pselaphidae and Scydmaenidae are very closely related, differing mainly from each other in the form of the antennae and the size of the abdominal spiracles in proportion to the size of the thoracic spiracles. According to the larvae, the Scydmaenidae may have some connection with the Scaphidiidae, but like the Pselaphidae they approach more closely to staphylinid genera like *Bledius*.

[41] The subfamily Hololeptinae with the genus *Hololepta* as type can not be retained in the classification of the larvae.

short ..... *Helophoridae* (*Helophorus*) (pl. 21 A, D, E)

3. Head slightly inclined; antenna inserted nearer the lateral margin of the head than is the mandible; ventral mouthparts retracted; gula well developed, quadrangular, and attaining the occipital foramen 4

Head elevated; antenna inserted farther from the lateral margin of the head than is the mandible; ventral mouthparts protracted; gula reduced to a triangular pregular plate and a single, median, posterior gular suture 5

4. Mandible apically bifid and without molar part; maxillary stipes with strong projecting lacinia; maxillary palpiger with long, conical galea; abdominal segments soft, with short conical gills(?); last three abdominal segments attenuate, not forming a breathing pocket.

Spercheidae (*Spercheus*) (pl. 21 B, C, F–H)

Mandible apically ending abruptly and with a terminal, short seta, molar part present; stipes with rudimentary lacinia; palpiger without galea; abdominal segments with well-developed plates; last three abdominal segments forming a breathing pocket ..... *Hydrochidae* (*Hydrochus*) (pl. 22 A, D)

5. Seven pairs of very long gills on sides of abdomen; no breathing pocket. (Ninth and tenth abdominal segments apparently absent) ..... *Hydrophilidae - Berosinae* (*Berosus*) (pl. 22 B, E)

Gills (?) of moderate size or absent; with breathing pocket 6

6 Maxillary stipes long and styliform; femora with fringes of long swimming hairs. (Gills(?) present or absent.)

Hydrophilidae - Hydrophilinae (*Hydrous*, *Hydrophilus*, and *Tropisternus*) (pls. 22 F, G and 23 A)

Stipes moderately or very broad; femora without fringes of swimming hairs. (Gills absent) 7

7. Ocellar group often large; ocelli equally developed and rather distant. (Legs generally of normal size and visible from above; abdomen more or less tapering posteriorly; nasale often with more than three teeth; nasale and anguli frontales often asymmetrical) *Hydrophilidae-Hydrobiinae* (pls. 22 H–S and 23 B, G, H)

Ocellar group small; ocelli of different size, or closely aggregate. (Legs poorly developed or absent; abdomen often truncate posteriorly; nasale with a single tooth or three small teeth; nasale and anguli frontales symmetrical).

Hydrophilidae-Sphaeridiinae (*Chaetarthria*, *Coelostoma* = *Cyctonotum*, *Cercyon*, etc.) (pls. 23 C–F, I–P and 24 A–T)

G. CUCUJOIDEA

Key to Families and Subfamilies

1. The back of the mandible either with two long, flagellate setae distally, and the body of the mandible partially fleshy or fully chitinized; or the back of the mandible without long setae distally, and the body of the mandible always fleshy, only with the base, or the tip and the base chitinized. (Maxillary mala entire) ..... *Lathridiidae*,[49] *major part* (pl. 25 A–J)

   The back of the mandible without long, flagellate setae distally, and the body of the mandible completely chitinized 2

2. Maxillary mala with distinguishable lacinia and galea 3

   Maxillary mala entire, sometimes bilobed anteriorly 5

3. Second antennal joint more than four times as long as the basal joint ..... *Lathridiidae*,[49] *minor part* (*Eufallia*) (pl. 25 K, L)

   Second antennal joint subcylindrical, three times, or less, as long as the basal joint 4

4. Spiracles annular, not on tubes; urogomphi not distinct ..... *Eucinetidae*[42] (pl. 26 A–H)

   Spiracles biforous, on tubes; urogomphi strong ..... *Derodontidae* (pl. 27 A–H)

5. Mala falciform 6

   Mala obtuse, or with inner margin irregularly jagged 14

6. Spiracles biforous 7

   Spiracles annular 11

7. Spiracles, at least some, borne on tubes; urogomphi terminating abruptly with two or three conical processes. (A paramedian process present in front of each urogomphus) 8

   Spiracles not on tubes; urogomphi terminally pointed and simple, or urogomphi absent. (Usually without paramedian processes) 9

8. Labial palpus one-jointed. (Tergal plates armed with series of chitinous tubercles with a small, fan shaped hair on the top) ..... *Monotomidae*[43] (*Europs* and *Hesperobaenus* but not *Smicrips*) (pl. 25 M–U)

   Labial palpus two-jointed ..... *Rhizophagidae* (pl. 28 A–G)

9. Mandible with three apical teeth. (Cutting edge between

[42] Apart from the lack of jointed urogomphi, the larva of the Eucinetidae agrees with the larval form of the leptinid association of the Staphylinoidea. Usually the family is placed as a subfamily of the Dascillidae.

[43] The genus *Smicrips*, usually placed in the Monotomidae, constitutes a separate family, Smicripidae (p. 36[20]), near the Phalacridae according to the characters of the larva.

apex and retinaculum entire and incurved; retinaculum short and broad; a fleshy lobe present behind mola; body cylindrical) ..... *Languriidae-Languriinae*[44] (pl. 28 H–J, L, N)

Mandible with two apical teeth. (Cutting edge between apex and retinaculum with one or many projections; body fusiform) 10

10. Cutting edge of mandible behind the apical teeth with a single rounded projection; retinaculum short and broad. (Urogomphi present) ..... *Languriidae-Cladoxeninae* (pl. 28 K, M, O–Q)

Cutting edge of mandible behind the apical teeth multiserrate; retinaculum long, slender and brittle. (With or without urogomphi ..... *Cryptophagidae* (pl. 29 A–U)

11. Urogomphi absent. (Ninth abdominal segment small or very small; tenth segment conical and often long) 12

Urogomphi present 13

12. Antenna with second joint large and clavate; apical joint minute ..... *Silvanidae-Silvaninae*[45] (pl. 30 A–J)

Antenna with three well-developed normal segments *Silvanidae - Telephaninae*[45] (pl. 30 K–O)

13. Tenth abdominal segment long and conical *Cucujidae - Brontinae* (= *Hyliotinae*)[45] (pl. 31 L)

Tenth abdominal segment short and wart-shaped *Cucujidae-Cucujinae*[45] (pl. 31 A–F)

14. Mentum with only apex free, or small, or indistinct by fusion with other areas. (Exceptionally, in the Sphindidae, mentum free to base and distinct, but appearing together with a mandible provided with retinaculum and a ninth abdominal segment without urogomphi) 15

Mentum with more than apex free, often free to base, always well developed and distinct. (Mandible, except in genus *Deretaphrus*, without retinaculum; urogomphi usually present) 35

15. Head swollen laterally, and much broader than thorax; cardo of normal shape and position; maxillary articulating area round and well developed; hypostomal inner margin concave between fossa for mandible and posterior end of cardo *Prostomidae*[45] (pl. 33 A–H)

Different development of some, or all, of the four characters 16

16. Maxillae appearing protracted in front of the mandibular

[44] The family Languriidae is usually considered as a subfamily of the Erotylidae. See also footnote[51].

articulations by a complete or partial elimination of the cardines 17

Maxillae deeply retracted. (Cardines distinct, or fused with stipites) 22

17. Urogomphi present; terga without glandular openings ("foramina" of Peyerimhoff) 18

Urogomphi absent; terga with paired glandular openings. (Labrum and clypeus fused with frons into a nasale; tarsungulus with a long adhesive hair) 21

18. Eighth abdominal segment distinctly longer than seventh. (Small ninth abdominal segment with comparatively large urogomphi; often developed as a springing apparatus) *Laemophloeidae*[45] (pls. 31 G–K, and 32 H, I, K, L, P, Q)

Eighth abdominal segment about as long as seventh or shorter 19

19. Larva parasitic and physogastric with slightly chitinized, white head and body. (Mandible without mola) *Catogenidae*[45] (pl. 33 I, J, L, M, O)

Larva not parasitic and not physogastric, head and body normally chitinized. (Mandible with, or, in single species, without mola) 20

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[45] All of the following families and subfamilies—

a. Cucujidae-Brontinae (including the genera *Brontes, Dedrophagus*, and *Psammoecus*),

b. Cucujidae-Cucujinae (including the genera *Cucujus, Pediacus,* and *Platisus*),

c. Prostomidae (including the genera *Prostomis* and *Dryocora*),

d. Laemophloeidae (including the genera *Prostominia, Narthecius, Lathropus, Laemophloeus, Dysmerus, Hemipeplus, Inopeplus,* and *Phloeostichus*), and

e. Catogenidae (including the genera *Scalidia* and *Catogenus*)—

are usually considered as one family, the Cucujidae, together with the genera *Oryzaephilus, Silvanus, Cathartus, Nausibius, Coccidotrophus, Eunausibius,* and *Telephanus.* These latter genera, according to the characters of the imagines, have lately been recognized by J. W. Wilson as constituting a separate family, the Silvanidae. (The Genitalia and Wing Venation of the Cucujidae and Related Families, Ann. Ent. Soc. Amer., June 1930, vol. 23, pp. 305–358). Doctor Wilson, however, does not find that the genitalia, wing venation, and body characters furnish a basis for a division of the Cucujidae (sensu Wilson) into four separate families, Cucujidae, Prostomidae, Laemophloeidae, and Catogenidae, as borne out by the characters of their larvae.

20. Apical joint of labial palpus normal; hypostomal rods diverging posteriorly. (Submental-gular plate absent, indistinct, or distinct) ..... *Phalacridae* (pls. 32 A–G, and 33 N, P–T)

Apical joint of labial palpus minute; hypostomal rods parallel. (Submental-gular plate present and distinct) *Smicripidae*[43] (pl. 32 J, M–O)

21. Body elongate elliptical; all of the setae normal; first to seventh abdominal segments dorsally with large glandular openings (or "foramina"); nasale transverse and subrectangular ..... *Corylophidae - Arthrolipinae* (*Arthrolips* and *Orthoperus*)[46] (pl. 34 A–C)

Body broadly elliptical; many of the setae fanlike, or flagellate, or clubshaped covered with spinulae; first and eighth abdominal segments with "foramina"; nasale forming an eyeshadelike structure which covers all of the mouthparts *Corylophidae - Corylophinae* (*Corylophodes, Sericoderus, Sacium, Molamba*)[46] (pl. 34 D–I)

22. Cardo either comparatively small, narrow, often spindle-shaped, and longitudinally directed, or large, about as long or longer than stipes, triangular, and immovable, without posterior condyle. (Labial palpus one-jointed) 23

Cardo either of moderate size, subtriangular, much shorter than stipes, and obliquely directed, or large, elongate-trapezoidal, movable, and with a posterior condyle, or fused with stipes to a large, movable structure with a posterior condyle. (Labial palpus one-jointed or two-jointed) 27

23. Cardo comparatively small, narrow and longitudinally directed 24

Cardo large and triangular 25

24. Mandible with lamellate, usually long, multiserrate projection from inner margin between apex and molar part; maxillary mala with uncus on middle of inner margin; adhesive tarsungular hair absent. (Spiracles biforous; urogomphi present) ..... *Nitidulidae-Nitidulinae* (pl. 35 A–H, J)

Mandible with large, lobe-shaped projection from inner margin between apex and molar part; maxillary mala subcylin-

[46] P. de Peyerimhoff, Études sur les larves des coléoptères, II. Corylophidae, Ann. Soc. Ent. France, vol. 90, 1921, pp. 99–106, pl. 3.—According to the imagines the family Corylophidae is usually placed as an aberrant family in the Silphid association, but the larvae indicate no relationship to this group.

drical, without uncus on middle of inner margin; adhesive tarsungular hair present and twice as long as tarsungulus itself. (Palpiger large, somewhat jointlike; labrum fused with clypeus; urogomphi reduced to a pair of wart-shaped tubercles) ..... *Nitidulidae - Meligethinae*[47] (pl. 36 A–I)

25. Urogomphi present, short, broad, flat, and shoe-shaped with tips horizontal and turned toward each other; mala with uncus on middle of inner margin; adhesive tarsungular hair absent. (Mandible without lamellate, multiserrate inner margin between apex and the long, strong molar part; spiracles annular) ..... *Nitidulidae - Prometopinae* (pl. 35 I, K–M)

Urogomphi absent; mala without uncus; adhesive tarsungular hair present 26

26. Mala well-developed and cylindrical; maxillary palpus three-jointed; cardo not longer than stipes; no projections from eighth and ninth abdominal segments. (Inner margin of mandible behind apex multiserrate but without lamellate, lobe-shaped projection) ..... *Nitidulidae-Cateretinae* (*Brachypterus, Amartus* and *Heterostomus*)[47] (pl. 36 J–P)

Mala vestigial or absent, maxillary palpus two-jointed; cardo longer than stipes, subtriangular, and separated from stipes by a fine suture, both pieces membranous; eighth and ninth abdominal segments with a pair of conical and membranous projections laterally ..... *Cybocephalidae*[48] (pl. 37 A–G)

27. Mentum well developed and free to base. (Mandibles symmetrical and with distinct retinaculum; urogomphi absent; spiracles annular, body with only fine and simple setae *Sphindidae*[49] (pl. 41 F, H–M)

Mentum not well developed, often fused with submentum, only free apically 28

28. Mandible with large, multituberculate or multicarinate molar structure; cardo proper distinct and subtriangular. (Body

[47] K. V. Verhoeff has proposed a new family, the Brachypteridae, including the two subfamilies, the Meligethinae and the Cateretinae, on larval characters. (Beiträge zur Kenntnis der Coleopteren-Larven mit besondere Berücksichtigungen der Clavicornia, Archiv. für Naturgeschichte, vol. 89, A. Heft 1, 1928, pp. 1–109, seven plates).

[48] The Cybocephalidae are usually considered as a tribe or a subfamily of the Nitidulidae. Larva described and figured by F. Silvestri (Metamorfosi del *Cybocephalus rufifrons* Reitter, Bol. Lab. Zool. Gen. e Agr. R. Scuola Super. Agr. Portici, vol. 4, 1910, pp. 221–227; 13 figures referring to the larva).

often with numerous fan-shaped, spinulose, or otherwise uncommonly formed, small hairs; juxta-cardo present) 29
Mandible without large, multituberculate or multicarinate molar structure 31

29. Body cheloniform, similar to body of a scale insect; along the sides with flat projections carrying spinulose setae. (Head not visible from above; distal end of maxillary mala provided with a brush of long, club-shaped hairs)
Murmediidae[49] (pl. 27 I–L)
Body different. (Maxillary mala with or without a terminal brush) 30

30. Distal end of maxillary mala with a brush consisting of a few, about four, long, stiff, curved and pointed setae; mandible with distinct apical part.....*Endomychidae - Mycetaeinae*[49] (Pl. 39 A–G)
Distal end of maxillary mala with a differently shaped, often large brush, or without a brush, or with a brush with few setae but then with a mandible without apical part.
Endomychidae-Endomychinae[49] (pls. 39 H–V, and 40 A–T)

31. Mandible with reduced, smooth, and usually condyliform molar (mola like?) structure; distinct hypopharyngeal sclerome present. (With or without cardo; juxtacardo absent; with or without lacinia mandibulae; three ocelli present on each side of head, except in the blind termitophilous larva of *Ortalistes rubidus* Gorham, from Barro Colorado island, Canal Zone, Panama)
Coccinellidae-Coccinellinae (pls. 37 H–L and 38 A–I)

[49] The larva of the different endomychid genera are remarkably distinct from each other, strongly emphasizing the compound character of the family. On the other hand, the family is closely linked both with the Lathridiidae and the Murmediidae, notably through the endomychid *Rhymbus*. The larva of this genus occupies a remarkable central position, approaching the specialized larvae of the major part of the lathridiid genera in the unique development of their mandibles, the primitive larva of the lathridiid genus *Eufallia* in having an almost separate lacinia and galea, and the Murmidiidae in the possession of tufted pleural projections. Through this larva the Endomychidae and all of the families which are closely or more remotely related to them may be traced to primitive ancestors, in reality to near the leptinid association of the Staphylinoidea.

The larva of the Sphindidae, interpolated here before the endomychid association, represents unquestionably a simple, primitive cucujoid type, but its more precise systematic position is rather uncertain. (Compare pp. 109 and 110 in the paper by Peyerimhoff, quoted in footnote number 46).

Mandible without molar structure; hypopharyngeal sclerome weak or absent 32

32. Body armed with many long, often branched, setiferous dorsal and lateral processes 33

Body without long setiferous dorsal and lateral processes 34

33. Three ocelli on each side; urogomphi absent; lacinia mandibulae absent ..... *Coccinellidae-Epilachninae* (pl. 38 J–N)

Five ocelli on each side; urogomphi well developed, often as long as body; lacinia mandibulae large *Erotylidae*[50] (pl. 41 A–E, G)

34. Mentum and submentum not fused *Dacnidae*[50] (pl. 42 A–T)

Mentum and submentum fused. (Prementum, mentum, submentum, and gula with a common, hourglass-shaped plate toward which anterior part of hypostoma sends a bridge as in Staphylinini) ..... *Melandryidae*[50] (pl. 43 A–Z, AE)

35. Body terminating in a deciduous ovate appendix *Scraptidae*[50] (pl. 44 A–E)

Body not so 36

36. Mandible with a taillike, hairy appendix or a fleshy, hairy lobe behind the base of mola. (Right and left mandibles only slightly different) 37

Mandible without such appendix or lobe 38

37. Hypopharyngeal sclerome strong and ring-shaped; three large and two or three small ocelli present on each side of the head; appendix of mandible tail-shaped *Byturidae*[51] (pl. 45 A–N)

Hypopharyngeal sclerome small and shaped like a cup on top of a large, slightly chitinized dome; one ocellus present on each side of head; appendix of mandible lobe-shaped ..... *Anthicidae - Euglenidae - Anaspidae*[51] (pls. 46 A–W and 47 A–I)

[50] From the family Melandryidae are excluded the genera *Eustrophus* and *Penthe* which are placed in the family *Dacnidae*, the genus *Scraptia* which forms a separate family, Scraptidae, and the genus *Synchroa* which also forms a separate family, Synchroidae.

[51] In *Anthicus heroicus* Casey the cup-shaped top of the hypopharynx is very thinly chitinized and is recognized only by careful examination. The genus *Anaspis*, usually considered as belonging to the Mordellidae, can by no character be distinguished from the Anthicidae; neither can the euglenid genus *Hylophilus* according to the larva of *Hylophilus populneus* Panzer which has been reared by E. C. Rosenberg in Denmark. The mandibles of the family

38. Abdominal spiracles located in disklike scleromes. (Urogomphi branched, with the inner prong directed toward the sagittal line) ..... *Eurystethidae* (= *Aegialitidae*) (pl. 48 A–F)
Abdominal spiracles not located in disklike scleromes 39
39. Mandible without molar structure. (Larva parasitic and physogastric) ..... *Bothrideridae* (*Deretaphrus* and *Bothrideres*) (pl. 44 F–N)
Mandible with molar structure 40
40. Larva elongate, cylindrical or subcylindrical, or more fusiform. (Body well chitinized or fleshy; urogomphi present and corniform, or absent) 41
Larva elongate and strongly depressed with parallel sides. (Body smooth and shining; urogomphi always present and often of very distinctive shape) 49
41. Cardo simple 42
Cardo divided into two parts 44
42. Hypopharynx only slightly or not chitinized; mandibles symmetrical. (Mola of mandible depressed with a ventral grinding surface; presternum of prothorax subtriangular; often with a small pit between bases of urogomphi) *Colydiidae* (*Colydiini, Synchitini* and, probably, *Monoedini*) (pl. 49 A–M)
Hypopharynx with a sclerome at base; mandible asymmetrical 43
43. Mola of mandible depressed, and with a grinding surface on the ventral side or on both the dorsal and ventral sides. (Presternum of prothorax usually elliptical and transverse) ..... *Mycetophagidae* (pl. 50 A–T)
Mola not depressed, and with a grinding surface facing the buccal cavity 53
44. Urogomphi present 45
Urogomphi absent. (Paired ambulatorial warts usually well-developed dorsally and ventrally on anterior body segments; mandibles asymmetrical) ..... *Oedemeridae-Oedemerinae* (pl. 51 A–F)
45. Ambulatorial warts present ventrally on second to fifth abdominal segments. (Mandibles symmetrical; urogomphi simple and curved upward, a pit present between their bases;

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group Anthicidae and the mandibles and hypopharyngeal sclerome in the Byturidae are rather similar to the same structures of the Languridae (pl. 28 I, J, N) indicating close affinity between these families.

ninth abdominal segment ventrally with two to three points on each side; maxillary mala with terminal incision)
Oedemeridae - Calopodinae (pl. 51 G–M)

Ambulatorial warts absent 46

46. Ninth abdominal venter simple, without conical points 47
Ninth abdominal venter with a conical point on each side 48

47. Submentum and gula fused and heavily chitinized. (Urogomphi well-developed, but white and rather soft)
Cephaloidae (pl. 52 J–L, N, O)
Submentum and gula fleshy. (Urogomphi corniform, strongly chitinized and curved upward)
Zopheridae (*Zopherus*, *Zopherodes*, *Phellopsis* and *Phloeodes*)[52a] (pl. 52 F–I, M)

48. Urogomphi simple, corniform, and curved upward; spiracles annular-biforous ..... *Synchroidae* (*Synchroa*)[50] (pl. 52 A–E)
Urogomphi with a branch at base; spiracles annular
Pedilidae (*Eurygenius*) (pl. 53 A–H)

49. Venter of ninth abdominal segment with transverse row of asperities, or of small plates 50
Venter of ninth abdominal segment not so armed. (Hypopharynx fleshy; each urogomphus broadly bifurcate; spiracle biforous) ..... *Salpingidae* (*Rhinosimus*)[52b] (pl. 54 A–H)

50. Eighth abdominal segment at least twice as long as ninth, urogomphi excluded; a pair of pits in margin between urogomphi 51
Eighth and ninth abdominal segments subequal, urogomphi excluded; a single pit present in margin between urogomphi. (Asperities of ninth abdominal venter in a broken arch) 52

51. Ninth abdominal venter bearing asperities arranged in a continuous arch ..... *Pyrochroidae* (pl. 53 I–K and L–O)
Ninth abdominal venter bearing small plates in place of asperities ..... *Boridae* (Boros unicolor)[53] (pl. 48 G–K and 55 A–I)

[52a] The genera of the family Zopheridae are usually placed in the tribes Zopherini and Nosodermini of the family Tenebrionidae.

[52b] Usually considered as a separate subdivision of the family Pythidae.

[53] According to the characters of the imago the genus *Boros* has been placed either in the Tenebrionidae or in the Pythidae by most of the authors, but according to the characters of the larva it is considered by R. A. St. George (Proc. Ent. Soc. Wash., vol. 33,

52. Ninth abdominal segment dorsally with a continuous row of small dark tubercles on the urogomphi and on the space between them. (Each urogomphus with or without a toothlike spine on innerside) ..... *Pythidae* (pl. 54 I–O)

Ninth abdominal segment without a continuous row of tubercles; only with two small tubercles proximally on dorsal side of each urogomphus. (Each urogomphus with a large, toothlike spine medianly on innerside)
Othniidae (= *Elacatidae*) (pl. 47 J–R)

53. Antenna contiguous to mouth frame. (Prothoracic legs frequently larger and thicker than those of meso-and metathorax, prothoracic coxae usually contiguous) 54

Antenna inserted some distance in from mouth frame. (Prothoracic legs not larger and thicker than the other legs, and coxae not contiguous) 56

54. Back of mandible opposite the cutting edge with sharp margin; opposite the mola, excavate and without a spinose-setose elevation. (Hypopharyngeal sclerome tricuspidate with median portion bifid and strongly projecting; ninth abdominal segment without urogomphi, except in *Omophlus proteus* Kirsch, from Russia) 55

Back of mandible not as described above. (Hypopharyngeal sclerome variable in form; ninth abdominal segment with or without urogomphi) ..... *Tenebrionidae* (pls. 57 A–U and 58 A–K)

55. Ventro-lateral suture distinct
Alleculidae-Alleculinae (pl. 56 A–L)

Ventro-lateral suture absent .... *Alleculidae-Omophlinae* (pl. 56 M, N)

56. Molar part of mandible with the grinding surface transversely multicarinate; antenna short and two-jointed, second joint dome shaped and almost completely membranous
Nilionidae (pl. 59 A–M)

Molar part of mandible with the grinding surface either smooth, or bearing obtuse tubercles; antenna elongate and two- or three-jointed, second joint usually clavate, distal joint minute and dome-shaped, or absent. (Presternum large and triangular; with or without strong, straight, pointed urogomphi) ..... *Lagriidae* (including the heterotarsine genera *Anaedus*, *Paratenetus* and *Lyprops*) (pl. 60 A–P)

1931, pp. 103–113; 2 plates) as the type of a separate family Boridae, thus substantiating the view of Thomson who in 1859 established this family on adult characters.

H. BYRRHOIDEA

The series contains only one family, the Byrrhidae. The genus *Nosodendron* is often placed in this family but belongs, according to the larval characters, in the subsequent series Dascilloidea, constituting a special family, Nosodendridae (p. 44).

Key to Subfamilies

1. Distal half of the mandibular inner edge entire between the tip and a low tooth at the middle of the edge
   Byrrhidae-Byrrhinae (pls. 61 A–K, 62 A–B, D–H)
   Distal half of the mandibular inner edge multidentate 2
2. Tenth abdominal segment with a pair of hooks
   Byrrhidae - Amphicyrtinae (pl. 62 C, I–L)
   Tenth abdominal segment without hooks. (Labrum with anterior margin deeply emarginate sagittally)
   Byrrhidae - Liooninae (pl. 62 M–R)

I. DASCILLOIDEA

This series does not conform with the series named Dascilloidea in the classification of the imagines but it has been considered expedient to retain the old serial name in the present tabulation of families which according to the larvae seem properly associated with the genus *Dascillus*. The larval characters of the Eucinetidae indicate that this family belongs in the series Cucujoidea (p. 33), or possibly in the leptinid association of the Staphylinoidea near the family Ptiliidae (p. 26).

Key to Families and Subfamilies

1. Eighth abdominal segment of normal form and not terminal; ninth abdominal segment large; spiracles cribriform. (Nine pairs of spiracles always present and all lateral) 2
   Eighth abdominal segment large and terminal; ninth abdominal segment vestigial; spiracles annuliform or biforous. (Either with nine pairs of spiracles present and well developed, or with all vestigial except those on eighth abdominal segment; the latter large and close together below posterior end of eighth tergite) 3
2. Tenth abdominal segment almost obliterated and without soft, terminal prolongation; ocelli absent; antenna long; maxil-

lary articulating area large and cushioned; hypopharyngeal scleromes asymmetrical, strong, and much differentiated
Dascillidae (*Dascillus*) (pl. 63 A–I)

Tenth abdominal segment well-developed, with soft, terminal, unpaired, two-jointed, and retractile prolongation (anus placed immediately below ninth abdominal tergite); five ocelli on each side; antenna short; maxillary articulating area rather small and indistinct; hypopharyngeal scleromes symmetrical, of moderate strength, and not very much differentiated ..... *Heteroceridae*[54] (pl. 64 A–M)

3. Spiracles vestigial or absent, except an annuliform pair on eighth abodminal segment; three terminal tufts of gills retractile into a pocket without an operculum; antenna multiarticulate and very long; one large ocellus and one small ocellus on each side (Mandible dimorph)
Helodidae (pl. 65 A–H)

Spiracles all present and biforous; gills absent; antenna three-jointed and of moderate length; five ocelli on each side
Nosodendridae[55] (pl. 66 A–P)

J. DRYOPOIDEA

This series does not conform with the series named Dryopoidea in the classification of the imagines but it has been considered expedient to retain the old serial name in the present tabulation of several families which according to the larvae are associated with the genus *Dryops*.

Key to Families and Subfamilies

1. Terminal cloacal chamber and movable operculum absent 2
Terminal cloacal chamber present and furnished with three tufts of retractile gills and with a movable operculum below ninth abdominal tergum 5
2. Body cylindrical; without ventral gills (except in an Asiatic larva probably belonging to the Ptilodactylidae); spiracles biforous 3
Body flat, broadly oval, limpetlike; with five pairs of ventral gills freely exposed from second to sixth abdominal segments; spiracles annuliform 4
3. Antenna comparatively long; tenth abdominal segment with a pair of large lobes usually carrying spinose diverticles. (In

[54] The family Heteroceridae is usually placed, according to the characters of the imagines, in the series Dryopoidea.

[55] The taxonomic position of this family is much debated but, according to the characters of the imagines, it is usually placed in the series Byrrhoidea.

Anchytarsus with, and in *Ptilodactyla* without, gills from tenth abdominal segment) *Ptilodactylidae*[56] (pls. 67 A–J, 68 A–H, 69 A–H)

Antenna short; tenth abdominal segment without diverticles. (Gills lacking) ..... *Eurypogonidae*[56] (pl. 69 I–S)

4. Lateral expansions of eighth abdominal segment present *Psephenidae - Eubrianacinae*[57] (pl. 70 A–E, G)

Lateral expansions of eighth abdominal segment absent (Mandible dimorphic in the same species, either simple, rather short, and terminally truncate, or composed of a basal and a terminal, pointed portion) *Psephenidae - Psepheninae* (pl. 70 F, H–P)

5. Nine pairs of spiracles present, all projecting and either cribriform, or biforous but of a deviating sinuous type. (One ocellus on each side; ninth abdominal segment conical, or subconical and terminally bifurcate; appendix from operculum short and broad) ..... *Chelonariidae*[58] (pl. 71 A–J)

Spiracles present in a number varying from one to nine pairs, either annuliform or regularly biforous, never sinuous 6

6. Five ocelli on each side. (Body subcylindrical; mandible apically bidentate; ninth abdominal tergite terminally emarginate) ..... *Dryopidae-Larinae* (*Lara*) (pl. 72 A–I)

One large ocellus on each side 7

7. Head concealed beneath prothoracic dorsal shield; ninth abdominal segment dorsally flattened, more or less semicircular, or subrectangular. (Mandibles either simple and terminally obtuse, or terminally tridentate, or composed of a basal and a terminal pointed portion) *Dryopidae-Pelonominae* (*Pelonomus, Helichus,* and *Psephenoides*) (pls. 70 Q–V, 72 J–K, 73 F–O)

Head exserted and visible from above; ninth abdominal segment subconical, often distally furcate. (Mandibles termi-

[56] According to the characters of the imagines, the Ptilodactylidae, including *Anchytarsus* and *Ptilodactyla,* and the Eurypogonidae, including *Eurypogon,* are usually placed in the series Dascilloidea.

[57] The subfamily Eubrianacinae, based on the genus *Eubrianax,* is usually placed in the Dascilloidea.

[58] The family Chelonariidae is usually placed in the series Dascilloidea.

nally bidentate or tridentate, alternating in some dimorphic species with rather short and terminally truncate ones) ..... *Dryopidae - Helminae* (*Dryops, Helmis, Limnius, Ancyronyx,* etc.) (pls. 71 K–Z, 73 A–E)

K. CANTHAROIDEA

Key to Families and Subfamilies

1. Ninth abdominal segment posteriorly with unpaired pointed prolongation, or paired urogomphi; body with featherlike or spinose processes. (Nasale posteriorly limited by a faint line; epicranial halves meeting ventrally; subfacial sinus of epicranium for the reception of the ventral mouthparts present; mandibles inserted well apart, falciform, canaliculate and without retinaculum; galea one-jointed) 2

   Ninth abdominal segment without unpaired posterior prolongation and without paired urogomphi; body without conspicuous processes 3

2. Frontal sutures present; cardo present; gular suture long; second antennal joint enlarged; ninth abdominal segment posteriorly tapering into a long, spinose prolongation; body dorsally with spinose warts, laterally with featherlike prolongations ..... *Brachypsectridae* Blair[59] (pls. 74 A–F, 75 A)

   Frontal sutures absent; cardo absent or completely membranous; gular area very short; second antennal joint not enlarged; ninth abdominal segment with paired urogomphi; body with spinose, dorsal, or dorsal and lateral, prolongations. (Spiracles in small separate epipleural projections or plates) ..... *Drilidae* (*Drilus* and *Silasia*)[60] (pls. 74, G–N, 75 B–E, 77 A)

[59] Blair, K. G., Brachypsectra, Lec.—The Solution of an Entomological Enigma, Trans. Ent. Soc. London, June 30, 1930, vol. 78, pp. 45–50, one plate.

The family Brachypsectridae, Blair, is considered a valid family according to the characters of the larva but, following H. S. Barber, it is here placed in the series Cantharoidea. It has close affinities to the larvae of *Drilus* and *Silasia*. The suggestion of Blair to join it with the Elateroidea has not been followed even if it unquestionably has close affinities with this latter series and particularly with the subfamily Cardiophorinae. In agreement with Blair, the usual conception of *Brachypsectra* as dascilloid is here disregarded.

[60] *Drilus* has polymorphic metamorphosis, the last instar of this snail-eating larva being maggotlike with a white, soft body and

3. Epicranial halves meeting ventrally forming a transverse bridge 4

   Epicranial halves not meeting ventrally. (Subfacial sinus incomplete or not present; tenth abdominal segment bearing retractile appendices) 8

4. Nasale long, spatulate, distally with median emargination; ventral epicranial bridge narrow and band-shaped; cardo absent; body segments with dorsal shields[61] *Homolisidae*

   Nasale short; ventral epicranial bridge broad, sagittally about half as long as cranium; cardo present; body segments fleshy, with velvety pubescence interspersed with fine setae. (Thoracic and most of abdominal segments with a pair of dorsal glands; subfacial sinus deep)[62] 5

5. Mandible entirely without retinaculum; mandibular canal almost closed longitudinally, and distally having an oval opening. (Anterior margin of nasale projecting, substriangular, but without median grainlike tooth between a pair of longitudinal grooves ..... *Cantharidae-Malthinae* (pl. 77 B–G)

   Mandible with a large retinaculum (except in *Podabrus,* where it is small and tuberculiform); mandibular canal open longitudinally and without a special distal opening 6

6. Maxilla without free, jointlike galea; anterior nasal margin multi-serrate without a median grainlike tooth visible from above ..... *Cantharidae - Chauliognathinae* (pl. 78 A–I)

   Maxilla with free, conical, one- or two-jointed galea; anterior nasal margin straight with a projecting median grainlike tooth between a pair of short longitudinal grooves 7

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very reduced membranous antennae, mouthparts and legs. The characterization given above refers to the larval instars prior to the last one. See article by E. C. Rosenberg (Ent. Medd. Ser. 2, vol. 3, 1909, two plates).

[61] Bertkau, P., Deut. Ent. Ztschr., 1891, pp. 37–42, one plate.

Verhoeff, K. W., Zur Kenntnis der Cantharidae-Larven, Archiv für Naturgeschichte, vol. 89, A, Heft 1, 1923, pp. 110–137, one plate.

[62] According to Verhoeff, K. W. (Zur Entwicklung, Morphologie und Biologie der Vorlarven und Larven der Cantharidae, Archiv. für Naturgeschichte, vol. 83, A, Sept. 2, 1917, pp. 102–140, one plate), foetometamorphosis occurs in members of the family Cantharidae, two free-living foetal instars with vestigial antennae, mouthparts and legs appearing before the first real larval instar. This first instar itself differs only in minor characters, for instance in the proportional length of the joints of the antennae and the maxillary palpi, from the rest of the larval instars.

7. Second antennal joint prolonged distally on the inner side into a cylindrical process carrying the apical joint; cylindrical process of second joint of about the same length or longer than basal portion of joint; sensory appendix large; inner margin of mandible without a longitudinal series of setae ... *Cantharidae-Malthodinae* (pl. 77 I, K, L)

Second antennal joint without a distinct cylindrical process; inner margin of mandible ventrally and medianly with a longitudinal series of short, densely set setae. (Retinaculum either with (in *Silis*) or without (in *Cantharis* and *Podabrus*) a small tooth posteriorly at base) *Cantharidae-Cantharinae* (pl. 77 H, J, M–U)

8. Frontal sutures present; abdominal spiracles placed in the epipleural plates. (Mandibles separate at base, perforated by a longitudinal canal, and often associated proximally with an ear- or tooth-shaped hairy enlargement; retinaculum present, but very small in a few forms as *Photinus;* luminous organs usually present; saclike gills from sides of first to eighth abdominal segments present in some aquatic Lampyrid larvae ..... *Lampyridae*[63] (pls. 74 O-V, 75 F–H)

Frontal sutures absent; abdominal spiracles placed in the parascutal areas above the epipleura. (Mandibles either separate or meeting at base; retinaculum absent) 9

9. Stipes and mentum separate; cardo present; galea palplike and two-jointed; mandibles separate, perforated by a longitudinal canal; antenna three-jointed with apical joint and disk shaped appendix. (Luminous organs usually present) *Phengodidae* (pls. 74 W–X, 75 I–K)

Stipes and mentum fused; cardo vestigial or absent; galea one-jointed; mandibles meeting sagittally at base; each mandible cleft from tip to base, with the inner part dagger-shaped and sliding into an open canal in outer part; antenna one- or two-jointed, distally covered with a large, dome-shaped appendix (*Caeniella* with inflated, tubular dorsal projections) ... *Lycidae* (pl. 76 A–K)

[63] Vogel, R., *Lampyris noctiluca* L., Ztschr. f. wiss. Zool., vol. 112, 1915, pp. 291–432, four plates, many figures in text.

Bugnion, E., *Phausis delarouzeei* Duv. and *Luciola lucitanica* Charp., Mem. Suppl. au Riviera Scientifique, 1929, pp. 1–131, figs. 1–61.

Blair, K. G., Aquatic Lampyrid larva from S. Celebes, Trans. Ent. Soc. Lond., 1927, pp. 43–45, one figure.

L. ELATEROIDEA

Key to Families and Subfamilies

1. Labrum distinct. (Headcapsule and mouthparts neither reduced nor abnormal) 2
   Labrum and clypeus fused, forming a nasale immovably united with frons. (Spiracles biforous) 6
2. Spiracles biforous; ninth abdominal segment opercular; body cylindrical and strongly sclerotized; legs distinct
   Rhipiceridae (*Zenoa*) (pl. 79 A–H)
   Spiracles cribriform; ninth abdominal segment well-developed and not opercular; body fleshy, with a dorsal and a ventral plate of the same shape, more or less covering a flattened and enlarged prothorax; legs absent or very much reduced. (Chordotonal organs often very distinctly indicated laterally on many of the segments by a deep auditory pit) 3
3. Prothorax only slightly broader or even slightly narrower than the first abdominal segments; larva either spindle-shaped (*Pachyschelus*), or wedge-shaped and with transverse anus (*Brachys* and the european *Trachys*). (Leaf miners)
   Buprestidae-Pachyschelinae (pl. 80 A–D)
   Prothorax distinctly broader than the first abdominal segments; larva clublike and somewhat flattened; anus a longitudinal slit 4
4. Tenth adbominal segment large, terminating with a pair of pointed and hard prolongations
   Buprestidae-Agrilinae (*Agrilus*, *Eupristocerus*) (pl. 80 E)
   Tenth abdominal segment rounded, often with a pair of soft warts but without strong, hard prolongations 5
5. Dorsal plate of prothorax with or without asperities, medianly marked with an inverted Y- or V-shaped groove
   Buprestidae-Buprestinae (*Chalcophorini*, *Buprestini*, *Chrysobothrini*) (pl. 80 F–K)
   Dorsal plate of prothorax without asperities and marked medianly with an I-shaped groove
   Buprestidae-Polycestinae (*Polycestini*, *Thrincopygini*)
6. Headcapsule and mouthparts very much reduced or extremely specialized. (Prothorax ventrally, or both dorsally and ventrally, with a pair of separate, rod-shaped, longitudinal scleromes often of a form suggesting a figure 7 or a letter T) 7

Headcapsule and mouthparts slightly reduced or entirely normal 8

7. Legs short but with normal joints
Throscidae[67] (pl. 81 A–D)
Legs vestigial or absent ..... *Melasidae* (= *Eucnemidae*) (pl. 81 H–Q)

8. Gular area well-developed and quadrangular 9
Gular area small and indistinct, or represented only by a median, long or short gular suture 10

9. Larva strongly sclerotized; dorsal and ventral prothoracic scleromes united into a solid cylinder; cervical membrane very large and eversible forming a balloon-shaped sack below the head when raised ..... *Cebrionidae* (including former family *Plastoceridae*[64]) (pl. 79 I–P)
Larva white and soft-skinned; dorsal and ventral prothoracic parts not forming a cylinder; cervical membrane not eversible. (Antenna and labial palpus one-jointed; legs small and three-jointed). (Parasitic in immature stages of cicadas) ..... *Sandalidae*[65] (pl. 82 A–G)

10. Abdomen entirely soft-skinned; typical abdominal segments transversely divided into three, ring-shaped portions of almost equal length; median portion subglobular, bearing ampullae and spiracles. (Tenth abdominal segment with three digitate or palmate and retractile appendices; mandible deeply cleft into a dorsal, dentate, and a ventral, simple part) ..... *Elateridae - Cardiophorinae* (pl. 83 A–O)
Abdomen completely or partially sclerotized; abdominal segments not divided into three ring-shaped portions of almost equal length 11

11. Ninth abdominal segment in front of terminal urogomphi with a pair of dorsal, distantly placed, curved prongs with concavities facing either toward each other (*Drapetes*) or backward and downward (*Oestodes*). (Nasale bilobed; frons broadly attaining the occipital foramen)[66]
Elateridae - Oestodinae (pl. 83 P–Y)

[64] Hyslop, J. A., Proc. Ent. Soc. Wash., vol. 25, 1923, pp. 156–160, one plate.

[65] The family is distinctly different from the family Rhipiceridae.
Craighead, F. C., Proc. Ent. Soc. Wash., vol. 23, 1921, pp. 44–48, one plate.
Emden, F. von, 3 Wanderversammlung deutscher Entomologen in Giessen, 1929, p. 115.

[66] *Drapetes* is usually placed in the family Throscidae. An unidentified elateroid larva, found in a decayed red oak log from

Ninth abdominal segment without dorsal prongs in front of urogomphi 12

12. Body dorsoventrally flattened; ninth abdominal tergite either with a pair of well-separated urogomphi or a single biramous process (pls. 84 G, 85 O); tenth abdominal segment more or less produced and often bearing hooks or other armature ..... *Elateridae - Pyrophorinae* (pls. 84 A–S, 85 A–R, 86 A–E)

Body more or less cylindrical; ninth abdominal tergite without urogomphi; tenth abdominal segment small, not produced, and never bearing armature *Elateridae - Elaterinae* (pl. 86 F–U)

M. SCARABAEOIDEA

Key to Families and Subfamilies

1. Stridulating organs present on second and third pairs of legs (pl. 87 E, I); abdominal terga not plicate. (Lacinia and galea separate (pl. 87 B, F)) 2

Stridulating organs absent, or present as teeth on dorsal inner margin of maxillary stipites, usually working against a granulate or striped area on ventral side of mandibles; (pl. 88 M, P) abdominal terga plicate. (Lacinia and galea separate or fused (pl. 87 V)) 7

2. Anus longitudinal between two large, oval, often sclerotized pads at end of body (pl. 87 J); third pair of legs normal 3

Anus transverse; end of body different; third pair of legs reduced and much shorter than second pair 6

3. Dorsal shield of prothorax anteriorly on each side with a triangular, forwardly directed process *Lucanidae - Sinodendrinae* (pl. 87 I, J)

Dorsal shield of prothorax without process 4

4. Left mandible in front of molar part with two (*Nicagus*) or three teeth (*Ceruchus*) ..... *Lucanidae-Aesalinae* (pl. 87 K)

Left mandible in front of molar part with four or five teeth .. 5

5. Tenth abdominal segment slightly hairy dorsally; claw somewhat curved; left mandible either with four (*Platycerus*) or five teeth (*Dorcus*) ..... *Lucanidae-Dorcinae*

Tenth abdominal segment hairy dorsally; claw strong and straight; left mandible with five teeth *Lucanidae - Lucaninae* (pl. 87 A–D)

North Carolina, probably belongs in or near the Oestodinae but it also possesses characters, present in the ventral mouthparts and the sternal region of prothorax, which approach it to the Throscidae (pl. 81 E–G).

6. Mandible without ventral accessory condyle; antenna and maxillary palpus two-jointed; abdominal terga without numerous spines or hairs; dorsal and ventral anal lobes small, ventral lobe with a pair of elongate lanceolate pads
Passalidae (pl. 87 E–H)

Mandible with accessory ventral condyle; (pl. 88 J) antenna and maxillary palpus more than two-jointed; abdominal terga with numerous spines or hairs; dorsal anal lobe semicircular, ventral anal lobe laterally grooved and much broader than dorsal ..... *Geotrupidae*

7. Lacinia and galea separate 8
Lacinia and galea fused 16

8. Stridulating organs absent (pl. 87 X) 9
At least maxillary stridulating teeth present (pl. 87 V) 10

9. Labrum sometimes anteriorly bilobed with a median emargination, usually subtriangular with rounded corners; anal lobes swollen, the dorsal entire, the ventral with median groove; (pl. 87 M, T) raster[67] without longitudinal or transverse series of setae; some species with biforous spiracles, as found in Trox scaber L. from Europe (pl. 87 Q, R) *Trox unistriatus* Beauvois and *Trox aequalis* Say, others with cribriform spiracles, as found in *Trox oligonus* Loomis (pl. 87 S); claw long and pointed, antenna with three joints, two normal and the terminal minute
Trogidae (pl. 87 L–T)

Labrum with distinctly multiserrate anterior margin; anal lobes normal; raster[67] with a single transverse row of spatulate setae; spiracles cribriform; claw normal; antenna four-jointed ..... *Acanthoceridae* (*Cloeotus*)

10. Dorsal and ventral anal lobes swollen. (Ventral lobe medianly divided by a longitudinal groove) 11
Anal lobes not particularly swollen. (Anus transverse and straight, or V-shaped) 15

11. Legs incomplete, claws absent or minute on all legs; abdomen strongly humped dorsally 12
Legs complete, with normal claws; abdomen not humped 14

12. Legs distinctly two-jointed (consisting of a long coxa and a still longer, strongly pointed joint with a terminal seta; terminal joint with shallow, annulate constrictions but not bent at the middle) ..... *Scarabaeidae-Coprinae, part one* (*Onthophagus*)
Legs distinctly or indistinctly three-jointed 13

13. Coxa, femur, and tibia distinct and all of the same length; tibia conical and ending bluntly; no claw
Scarabaeidae-Coprinae, part two (*Canthon*)

[67] The term "raster," meaning a rake, applies to a spinose area on the ventral side of the tenth abdominal segment (pl. 88 A, C, H).

Coxa distinct, femur and tibia apparently fused but forming an angle with each other; claw minute (no terminal seta)
Scarabaeidae - Coprinae, part three (Copris)

14. Raster with a longitudinal series of strong, simply pointed or tricuspidate spines on each side of middle line
Scarabaeidae - Aphodiinae, part one (Aphodius rufipes group)
Raster without paramedian series of spines
Scarabaeidae - Aphodiinae, part two (Aphodius fossor group)

15. Claw very long and pointed, longer than tibia; head flat above; body woolly; anus transverse
Scarabaeidae - Glaphyrinae (Lichnanthe)
Claw moderately long, shorter than tibia; head convex above; dorsal areas densely beset with short, strong, dark setae; anus angulate ..... *Scarabaeidae-Pleocominae*

16. Anus obtusely or acutely angulate, usually V- or Y-shaped (pl. 88 H). (Mandibular stridulating area without distinct outline and formed by minute granulations (pl. 88 J); sometimes entirely absent) 17
Anus transverse, not angulate (pl. 88 C). (Mandibular stridulating area oval and formed by transverse striae; absent in *Valgus*) 21

17. Raster with two longitudinal rows of pointed setae
Scarabaeidae - Melolonthinae-Melolonthini
Raster without two longitudinal rows of pointed setae 18

18. Raster with transversely arranged setae 19
Raster with setae placed without order 20

19. Setae arranged in a transverse mustachelike patch
Scarabaeidae - Melolonthinae-Diplotaxini
Setae spinelike, arranged in a single transverse, curved row
Scarabaeidae-Sericinae (pl. 88 H–L, N)

20. With large patch of closely set asperities on each side of raster
Scarabaeidae - Macrodactylinae - Dichelonycini
Without patch of asperities on each side of raster
Scarabaeidae - Macrodactylinae - Hopliini (Macrodactylus and *Hoplia)*

21. Epipharynx without a curved single row of small spines parallel with and behind the median part of the anterior

margin of labrum. (Stridulating organs present, terga of ninth and tenth abdominal segments distinguishable; labrum usually asymmetrical and not trilobed) 22

Epipharynx with a curved single row of small spines behind the median part of the anterior margin of labrum (pl. 87 Z) (except in *Valgus* which, however, has no stridulating organs). (Terga of ninth and tenth abdominal segments usually fused completely; labrum symmetrical, often trilobed) 24

22. Lateral margin of labrum on buccal side with a series of transverse striae (pl. 88 D) ..... *Scarabaeidae-Rutelinae-Anomalini* (pl. 88 B–D, F, G)

Lateral margin of labrum on buccal side without striae (pl. 87 U) 23

23. Stridulating teeth of maxillary stipes pointed and curved (pl. 87 V). (Distal joint of maxillary palpus usually without a setaceous sensory area) ..... *Scarabaeidae-Rutelinae-Rutelini* (pls. 87 U, V, 88 A)

Stridulating teeth of maxillary stipes truncate, as broad as long, not curved (pl. 88 M). (Distal joint of maxillary palpus often ending in a setaceous sensory area) *Scarabaeidae-Dynastinae* (pl. 88 E, M, O–R)

24. Anterior margin of labrum not distinctly trilobed, almost straight or slightly emarginate in the middle (pl. 87 W, Y); ninth and tenth abdominal terga separated; tarsungulus long and pointed 25

Anterior margin of labrum distinctly trilobed (pl. 87 Z); ninth and tenth abdominal terga fused into a single dorsal unit; tarsungulus different 26

25. Raster present, with numerous, minute, dark spinulae between the longer setae; epipharynx with triangular callus and a curved transverse series of small spines behind the anterior margin of labrum (pl. 87 Y) *Scarabaeidae-Trichiinae* (*Trichiotinus, Trichius, Trigonopeltastes, Gnorimella*) (pl. 87 Y)

Raster absent, end of abdomen with long, soft hairs; epipharynx without a triangular callus and without a curved series of spines behind the anterior margin of labrum. (Labrum strictly symmetrical, slightly emarginate in the middle) ..... *Scarabaeidae-Valginae* (*Valgus*) (pl. 87 W, X)

26. Tarsungulus cylindrical, distally obtuse (except in *Euphoria*); raster with median pair of distinct, longitudinal series of spines ..... *Scarabaeidae - Cetoniinae, part one* (*Gymnetini* and *Cetonini*) (pl. 87 Z)

Tarsungulus short, thick, conical; raster without a pair of longitudinal series of spines

Scarabaeidae - Cetoniinae, part two, (*Cremastocheilini* and *Osmodermini;* the latter tribe usually placed in the *Trichiinae*)

N. CLEROIDEA

Key to Families and Subfamilies

1. Frontal sutures present 2
   Frontal sutures absent. (Apex of mandible with two or more teeth; endoparasitic, physogastric larvae) 16
2. Lacinia distally armed with one or more spurs. (Body covered with long or short barbed hairs) 3
   Lacinia without spurs 4
3. Paired urogomphi present; submentum and gular areas united; mandible with a stiff process and a hair brush at base

   Dermestidae - Dermestinae (pl. 89 A–Q)

   Urogomphi absent; submentum and gular areas usually separated; mandible without spur and brush at base. (Larvae often with conspicuous hair tufts)

   Dermestidae - Attageninae (pl. 90 A–Z)
4. Ventral mouthparts retracted. (Distance between posterior ends of cardines and occipital foramen usually shorter than frons) 5
   Ventral mouthparts protracted. (Distance between ends of cardines and occipital foramen as long as frons) 8
5. Mandible with a long, stiff prosthecal process near the middle or at the base of the inner margin. (Median epicranial suture well developed) ..... *Melyridae* (pls. 91 A–N, 92 A–J)
   Mandible with a short or no prosthecal process. (Median epicranial suture usually not well developed, or entirely absent) 6
6. Antenna with the sensory appendix longer than the distal joint. (Distal joint carrying a very long and strong terminal seta ..... *Ciidae*[68] (pl. 92 K–R)
   Antenna with sensory appendix shorter than distal joints, or absent 7

[68] According to the characters of the imagines, the systematic position of this family is not clear, but usually it is placed in the series Bostrichoidea. In the larvae, the division of the mala into a lobe-like galea and a smaller lacinia hidden below the galea sug-

7. Prothorax with well-separated presternal plates and with a well-defined lanceolate median sternal plate
Ostomatidae-Tenebroidinae (pls. 93 A–Q, 94 A–I)

Prothorax without well-defined presternal plates and without a median lanceolate sternal plate
Ostomatidae - Ostomatinae (pl. 93 D, 94 J–U)

8. Frons posteriorly with straight, transversal margin
Cleridae-Hydnocerinae (pl. 95 B–H)

Frons posteriorly angulate 9

9. Epicranial suture well developed
Cleridae-Thaneroclerinae (pl. 95 V)

Epicranial suture not well developed 10

10. Antenna with second joint larger than basal joint; ninth abdominal segment conical, bifid. (One ocellus)
Cleridae-Priocerinae (pl. 95 P)

Antenna with second joint shorter than basal; ninth abdominal segment otherwise 11

11. All spiracles large and biforous; two ocelli present on each side. (Prothorax with separated presternal plates and a median sternal plate) ..... *Cleridae-Korynetinae* (*Necrobia* and *Korynetes*)

Anterior or all spiracles annuliform or pseudo-annuliform; never with two ocelli present on each side. (Prothorax with or without presternal plates and median sternal plate) 12

12. Ocelli one (*Monophylla*) or three (*Cymatodera* and *Tillus*)
Cleridae-Tillinae (pl. 95 K, N, R, X)

Ocelli absent, or four, or five 13

13. Ocelli absent. (Body tumid; without ambulatorial ampullae)
Cleridae-Orthopleurinae (pl. 95 S)

Ocelli four or five 14

14. Two or more of abdominal segments with paired protruding dorsal ambulatorial ampullae; cardo with narrow, band-like basal sclerome 15

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gests bostrichoid relationship, but a similar division is also found in some of the Cleroidea; and the presence of long and converging frontal sutures, a distinct gular area, paired urogomphi, and the absence of paired oval lobes in front of anus speak strongly against a taxonomic position within the Bostrichoidea and for the association with the Cleroidea.

Paired ambulatorial ampullae absent; cardo with extensive sclerome ..... *Cleridae-Clerinae* (*Opilo, Trichodes, Thanasimus, Enoclerus, Placopterus*) (pl. 95 A, I, J, M, Q, T, U)

15. Ocelli five; more than two of abdominal segments with dorsal ambulatorial ampullae ..... *Cleridae-Enopliinae* (*Neichnea, Phyllobaenus, Chariessa, Cregya*) (pl. 95 O)

Ocelli four; only two abdominal segments with ambulatorial ampullae ..... *Cleridae-Tarsosteninae* (pl. 95 L)

16. Antenna with sensory appendix absent; ventral mouthparts apparently protracted; ventral surface of head apparently formed by fusion of the gular region and the cranial capsule; hypostomata rod-shaped and diverging posteriorly from the fossae for the mandibles ..... *Catogenidae*[69] (pl. 33 I, J, L, M, O)

Antennae with sensory appendix present, dilated, and as long as distal and median joints together; ventral mouthparts retracted; gular area distinct, not fused with head capsule; hypostomata not rod-shaped, and not diverging, but curved toward each other..... *Bothrideridae*[70] (pl. 44 F–W)

[69] The family Catogenidae, composed of the genera *Scalidia* and *Catogenus*, is placed by most authors, and probably correctly, near genera as *Laemophloeus* and *Hemipeplus* in the series Cucujoidea. The characters defining the larvae as belonging to the series Cleroidea are probably not fundamental but result from adaptation to a parasitic life. The straight, pointed, rod-shaped hypostomata which diverge from the mandibular fossae in a posterior direction are similar to the ones found in *Laemophloeus, Hemipeplus,* and the Phalacridae, and this similarity indicates strongly that the large subfacial region between the rod-shaped hypostomata in the Catogenidae is homologous with the region between the rod-shaped hypostomata in the above-mentioned cucujoid larvae and particularly with the one in the Phalacridae. Thus the ventral surface of the head in the Catogenidae is probably formed by a fusion of the ventral sides of the cranial capsule, a pair of cardines, the submental region between them, and a gular area posteriorly. The family Catogenidae has therefore been tabulated also on page 35 in the series Cucujoidea.

[70] The relationship of this family is problematic. It has also been tabulated near the Colydiidae on page 40 in the series Cucujoidea where it most likely has its proper systematic place. However, the larvae are quite different from the larvae of the typical Colydiidae. Their head structures, at least, suggest cleroid affin-

O. MELOIDEA

Key to Families and Subfamilies[71]

1. Gula well-developed; maxillae inserted considerable at a distance in from anterior margin of prosternum; labial palpi two-jointed 2

   Gular area short; maxillae extending posteriorly to near the anterior margin of prosternum; labial palpi not jointed, reduced to warts, or entirely absent. (Antenna with terminal joint (tj pl. 97 D) long and slender, and distal sensory appendix (sj pl. 97 D, E) either long, slender and conical, or long and sausage-shaped 5

2. Head capsule subquadrate, with ocelli usually in anterior third; labrum small, visible from above; integument on ventral side of body thin. (All thoracic and abdominal spiracles usually of about the same size and sometimes very large; larva elongate, dorsoventrally flattened; mandible extending well beyond anterior margin of labrum; abdomen with subparallel sides or posteriorly attenuate; ninth abdominal segment terminally with one, rarely two pairs of long bristles). (Fifth instar coarctate, not enclosed in exuvium of previous instars; the free-living instars eating grasshoppers' eggs or carnivorous on bee larvae, rarely honey feeders; first instars not carried by bees) ..... *Meloidae-Lyttinae* (pl. 96 A–I)

   Head capsule broadly oval (pl. 96 Q) or subtriangular (pl. 96 M) with ocelli in or behind its transverse middle line; labrum as a rule not visible from above; integument on ventral side of body firm. (First pair of abdominal spiracles usually larger than the others and as large as the mesothoracic). (Instars as a rule feeding on honey; first larval instar climbing flowers and carried by bees) 3

3. One ocellus on each side; ninth abdominal segment carrying terminally one or more pairs of long bristles (term. s. pl. 96 M); body elongate, dorsoventrally flattened with suboval or posteriorly attenuate abdomen. (Fifth larval instar coarctate, not eveloped in exuvia of preceding instars; sixth instar moving freely around) ..... *Meloidae-Meloinae* (pl. 96 J, K, M, P, Q)

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ities. (See Craighead, F. C., Proc. Ent. Soc. Wash., vol. 22, 1920, pp. 1–13, 2 plates. This paper contains a discussion of the taxonomic position of the Bothrideridae, Colydiidae and Monoedidae (auct.). The Monoedidae are not recognized as a family on the larval characters, but placed as a genus in the family Colydiidae.)

[71] The key deals exclusively with the first larval instars of the series, except in a few cases in which it is definitely stated to which instars, different from the first, the references apply.

Two ocelli on each side (second ocellus small or even absent in species of Horiinae); ninth abominal segment carrying terminally one pair of small bristles, or no bristles; body either fairly elongate with posteriorly attenuate abdomen, or more often, navicular. (Fifth larval instar enveloped in exuvia of the two preceding instars; sixth instar as well as pupa inside of case formed by the exuvia of the three preceding larval instars) 4

4. Spiracles of eighth abdominal segment placed normally
Meloidae-Horiinae[72]

Spiracles of eighth abdominal segment placed terminally on hook- or wartlike projections (spw. pl. 96 N, O)
Meloidae-Nemognathinae (pl. 96 L, N, O, R, S)

5. One ocellus on each side of head; spiracle of first abdominal segment very large and placed on a laterally projecting, flat lobe (pl. 97 B and D); claw falciform, with a single bristle at base; labial palpi vestigial and wart-shaped[73]
Tetraonycidae (Based on *Tetraonyx quadrimaculatus*) (pl. 97 A–D)

Several ocelli placed closely together on each side of head; spiracle of first abdominal segment normal and not placed on a projecting lateral lobe; claw rather short, at base with a large pulvillus (pon. pl. 97 F) and a very short, conical, thick seta; labial palpus absent. (Median dorsal suture absent on all body segments). (Either with the first larval instar carried by wasps and in all the feeding stages devouring wasp larvae in their cells, or parasitic on cockroaches)
Rhipiphoridae[74] (pl. 97 E–J)

[72] According to the imagines, the Horniiae are usually placed as a tribe of the subfamily Zonitinae.

[73] According to the imagines, *Tetraonyx* is usually placed in the subfamily Lyttinae. According to the first instars reared from eggs laid by *Tetraonyx quadrimaculatus* Fab., this larva forms an intermediate type between the larvae of the family Meloidae and the family Rhipiphoridae but differs so distinctly from both of them that the creation of a new family, Tetraonycidae, is deemed advisable.

[74] The first instar of *Rhyzostylops*, described by F. Silvestri (Descrizione di un nuovo genere di Rhipiphoridae, Redia, vol. III, 1906, pp. 315–324, one plate) looks superficially like a *Stenus* larva, has long legs, said to be tipped by two extremely minute claws. several ocelli on each side of head, and is heavily bristled. It is considered by Silvestri as a very aberrant rhipiphorid larva, intermediate between the first instar of *Rhipidius* and the degenerate first instar of the Strepsiptera. Probably the Strepsiptera are to be classified in the Coleoptera and close to the Rhipiphoridae.

P. MORDELLOIDEA

In the Introduction to his Catalogue (p. 32) Leng proposed, with great hesitation however, a series Mordelloidea composed of the following groups: the Mordellidae-Mordellini, the Mordellidae-Anaspidini, the Anthicidae, the Euglenidae, the Eurystethidae (= Aegialitidae), the Pedilidae, the Pyrochroidae, the Pythidae (with the two genera *Salpingus* and *Rhinosimus* included), the Cephaloidae, the Oedemeridae, and, with proper reservation, the Meloidae and the Rhipiphoridae. Here only the Mordellidae-Mordellini with the main genera *Tomoxia, Mordella,* and *Mordellistena* have been retained in this series, and it is even questionable whether these really may constitute a series as their larvae seem rather closely related to the larvae of several of the melandryid genera. The Mordellidae-Anaspidini together with all of the above mentioned families from the Anthicidae to the Oedemeridae have been placed in the colydiid association of the Cucujoidea; and in this association are also placed the Othniidae with the genus *Othnius* and the Boridae with the genus *Boros* which are closely related to the Pyrochroidae and Pythidae. It is however, possible that the Anaspidinae, Anthicidae, and Euglenidae might better be associated with the Languriidae. The Rhipiphoridae and the Meloidae constitute, according to the larvae, a separate series, the Meloidea. (See also: Introduction p. 8, line 9).

Key to Family

1. Body without dorsal ambulatorial warts; ninth abdominal segment terminating with a single, conical, truncate spine ..... *Mordellidae, part one* (*Tomoxia, Mordella,* and the larva of *Mordellistena picipennis*) (pl. 98 A–E)

   Body with dorsal ambulatorial warts; ninth abdominal segment with a pair of short, upward curved, pointed urogomphi ..... *Mordellidae, part two* (*Mordellistena*) (pl. 98 F–J)

Q. CERAMBYCOIDEA

The series Cerambycoidea contains only one family, the Cerambycidae, which is divided into six subfamilies. Of these the subfamily Disteniinae should probably be given family rank because its larva, except in its general appearance, is very aberrant from the larval types of all of the other Cerambycidae. In fact the

Disteniinae might possibly with equal justification be placed in either of the two series, the Bostrichoidea or the Chrysomeloidea, both closely associated with the Cerambycoidea, rather than in the latter series. The larva of the Disteniinae differs from all other cerambycoid larvae in the development of the ventral structures of the head and chiefly in the lack of a distinct gula, but the presence of a short gula lying on top of the median part of a broad, well-defined hypostomal bridge and fused with it is just the essential character by which the larvae of the Cerambycoidea can be separated from the ones of the Bostrichoidea and Chrysomeloidea.[75]

Key to Subfamilies

1. Head oblong, sides parallel or converging behind. (Epistoma never projecting; tentorial cross-arm internal; epipleurum protuberant on several or all abdominal segments; legs usually absent) ..... *Lamiinae* (pls. 99 I, J, 100 A)
   Head transverse, wider behind the middle 2
2. Epistoma projecting over clypeus, except in *Parandra;* frons projecting over epistoma, dentate or carinate, except in *Parandra.* (Tentorial cross-arm in the same plane as the hypostoma and forming a bridge behind it; legs present) ..... *Prioninae*[76] (pls. 99 A, B, 100 B–F)
   Neither epistoma nor frons projecting 3
3. Mandible with oblique, straight cutting edge, except in *Opsimus* 4
   Mandible with rounded, gougelike cutting edge (pl. 100 G). (Tentorial cross-arm in the same plane as hypostoma and forming a bridge behind it; clypeus filling space between dorsal articulations of mandibles; epipleurum protuberant only on last three abdominal segments; legs present or absent) ..... *Cerambycinae* (pls. 99 E, F, 100 G)
4. Dorsal margins of epicranial halves partly fused behind frons. (Tentorial cross-arm internal; legs present) *Aseminae* (pl. 99 C, D)
   Dorsal margins of epicranial halves separated behind frons 5

[75] Craighead, F. C., North American Cerambycid Larvae, Canada Dept. Agr., Bul. 27, New Series, Technical, Ottawa, 1923, pp. 6, 26, and 99–101 with figures.

[76] Craighead, F. C., Larvae of Prioninae, U. S. Dept. Agr., Off. Sec., Report 107, 1915, pp. 1–24, eight plates.

5. Tentorial cross-arm internal. (Palpiger large, bearing lacinia and palpus; epipleurum protuberant on all abdominal segments; legs present) ..... *Lepturinae* (pls. 99 G, H, 100 H–L)

Tentorial cross-arm (tb pl. 100 M) in the same plane as the hypostoma, bridging the ventral surface of the head. (Larva very elongate and slender; legs present) *Disteniinae* (pl. 100 M)

R. BOSTRICHOIDEA

Key to Families

1. Head protracted; mandible dentate. (Terga hairy or not, often with rows or patches of asperities) 2

Head retracted; mandible not dentate, usually with gouge-shaped distal end. (Terga without asperities) 3

2. Thoracic spiracle pushed forward to anterior margin of prothorax. (Spiracles bearing a single spoutlike prolongation (prl pl. 101 E); a small, often curved, transverse sclerome present at the end of a median groove between the longitudinally placed anal lobes (ats pl. 101 G); terga without asperities) ..... *Ptinidae* (pl. 101 A, B, E)

Thoracic spiracle not reaching anterior margin of prothorax. (Spiracles without single spoutlike prolongations, except in *Anobium*, where they are large; with or without a small, transverse sclerome at the end of a longitudinal, median anal groove; straight, curved, or hook-shaped tergal asperities on all or some of the segments, except in *Ozognathus* and *Lasioderma*) ..... *Anobiidae* (pl. 101 C, D, F–N, X, Ae, Oe)

3. Mandible without a dorsal, molarlike process; epipharynx without a large sclerome; lacinia mandibulae absent *Bostrichidae*[77] (pl. 101 O–W, Y, Z)

Mandible with a dorsal, molarlike process, grinding against a large sclerome in epipharynx; lacinia mandibulae present and fleshy 4

4. Abdominal spiracles subequal in size *Psoidae*[78] (pl. 102 A–E)

[77] The family includes all the genera usually placed in the family Bostrichidae, except the genera which are here tabulated in the family Psoidae.

[78] The family Psoidae includes the following genera, usually placed in the Bostrichidae: *Stephanopachys* (Saalas, U., Die Fichtenkäfer Finlands, part 2, 1923, pp. 179 and 700, figs. 115–120), *Rhizopertha*, *Dinoderus*, and *Dinoderopsis* (Lesne, P., Les coléoptères Bostrychides de l'Afrique tropical française, Paris, 1924, pp. 47 and 77), *Polycaon*, and *Psoa*.

Last abdominal spiracle much larger than the others
Lyctidae (pl. 102 F–K)

S. CHRYSOMELOIDEA

Key to Families and Subfamilies

1. Mandible simple, distally either with a broad, transverse, gougelike cutting edge, or with a simple apex 2
   Mandible dentate, distally with from two to five teeth 5
2. Prementum and mentum fused, bearing a common, median, escutcheonlike sclerome with a pair of light, circular areas anteriorly. (Labial palpi either (in Pachymerinae) rudimentary, one-jointed, and placed in the light, circular areas of the escutcheon (pl. 103 D), or (in Bruchinae) completely absent; mandible short, strong, gouge-shaped, with rounded, distal edge; body curved and plump; legs vestigial except in the first larval instar (pl. 103 N). Ocelli three in Pachymerinae, one in Bruchinae)
   Bruchidae (= *Mylabridae*) (pl. 103 A–N)
   Prementum and mentum without escutcheonlike sclerome. (Labial palpi present, except in a few Halticinae as *Dibolia* and *Sphaeroderma* (pl. 114 H, and N)) 3
3. Legs present and fully developed; body curved and plump. (Mandible with excavated inner side and single, pointed apex; prementum distinct and covered with an unpaired subtriangular sclerite; mentum distinct, free laterally; labial palpi inserted well apart) ..... *Sagridae* (pl. 104 A–H)
   Legs absent; body straight. (Leaf miners with distinct ninth abdominal segment) 4
4. Prementum and mentum not fused; labial palpi inserted well apart at the base of ligula; mandible with excavated inner side and single, pointed apex
   Orsodacnidae-Orsodacninae (pl. 105 A–E)
   Prementum, mentum, and submentum fused; labial palpi close together; ligula absent; mandible with transverse, approximately gouge-shaped, and slightly scalloped distal edge
   Orsodacnidae-Zeugophorinae (pl. 105 F–H)
5. Spiracles of eight abdominal segment biforous, terminal, and projecting like a pair of spurs. (Mentum free laterally and fused posteriorly with submentum; galea and lacinia adapted for sucking of plant juice; larva club-shaped and curved, feeding on submerged parts of fresh-water plants and swamp plants) ..... *Donaciidae* (pl. 106 A–R)
   Spiracles of eighth abdominal segment not projecting like spurs 6

6. Labrum small, or indistinct and fused with frons and clypeus. (Legs very long, slender, and without pulvillus; abdomen swollen posteriorly, doubled back upon itself, and adapted for carrying a case made either from the excrement of the larva, or, in *Lamprosoma*,[79] from fine particles of wood glued together with the excrement of the larva and with resin from the host tree) 7

Labrum well-developed and free 9

7. Tarsungulus short, strongly hamate, with a large heel. (Antenna two-jointed, with conical sensory appendix (sj pl. 107 G); third joint represented only by a strong seta)
Camptosomatidae - Chlamydinae (pl. 107 G, H)

Tarsungulus slender, somewhat curved and awl-shaped; heel absent or insignificant 8

8. Antenna two-jointed, with a broad, pillbox-shaped sensory appendix (sj pl. 107 A, B); third joint represented only by a seta ..... *Camptosomatidae-Clytrinae* (pl. 107 A–F)

Antenna three-jointed, with a conical sensory appendix; third joint seta-bearing and shorter than the appendix. (Frons almost circular in outline and flat)
Camptosomatidae-Cryptocephalinae and *Camptosomatidae-Lamprosominae*

9. Maxillary palpus three- or four-jointed, excluding palpiger;[80] eighth abdominal pair of spiracles present and laterally placed; eighth abdominal segment not terminal, its hind margin connected with the front margin of the ninth abdominal segment 10

Maxillary palpus two-jointed or less; eighth abdominal pair of spiracles either present, but dorsally placed, or absent; eighth abdominal segment terminal with free hind margin 15

10. Tarsungulus long, slender, and without pulvillus; mandible compressed, with two to three distal teeth; epicranial suture long; ocelli absent. (Larva white; abdominal segments without dorsal scleromes and ventrally often with rounded, projecting lobes with many stiff setae)
Eumolpidae (pl. 108 A–M)

Tarsungulus of moderate length, curved, and usually with puvillus (pon pl. 109 M); mandible palmate, with four to five distal teeth; combination of a long epicranial suture and lack of ocelli not found 11

[79] The larva of *Lamprosoma bicolor* Kirby and its pointed, hood-shaped case are described by Carlos Moreira (Ann. Soc. Ent. France, vol. 82, 1913, pp. 743–745, one plate).

[80] Very rarely two-jointed, as in *Sphaeroderma* (pl. 114 N).

11. More than one ocellus on each side of head, usually five or six ocelli; antenna three-jointed 12
One ocellus on each side, or none; antenna two-jointed or less 13

12. First eight abdominal segments with a transverse, ventral region with ambulatory warts (pl. 109 G); anal opening dorsal; labial palpus one-jointed. (Spiracles annular or biforous; larva covered with excrement or slimy exudation) ... *Crioceridae* (pl. 109 A–G)
First eight abdominal segments without any ambulatory warts; anal opening ventral and placed in the middle of the sucking disk of the tenth abdominal segment; labial palpus two-jointed ..... *Chrysomelidae* (pl. 109 H–M)

13. With a combination of the three following characters: Epicranial suture well-developed or long; one ocellus on each side of head; dorsal region of each of first to seventh abdominal segments distinctly subdivided into two or three transverse areas (pl. 110 C and G)
Galerucidae - Galerucinae[81] (pl. 110 A–M)
With a different combination of the three characters 14

14. Epicranial suture present, but usually short; ocelli absent; dorsal region of each of first to seventh abdominal segments subdivided into three transverse areas. (Intersegmental membranes often large; spiracles annular, except in *Exosoma*, (pl. 111 M), where they are biforous)
Galerucidae - Diabroticinae[82] (*Diabrotica, Cerotoma, Phyllobrotica,* and *Exosoma lusitanica*) (pl. 111 A–M)
Different combination. (Spiracles always annular)
Galerucidae - Halticinae[83] (pls. 112 A–R, 113 A–X, 114 A–O)

[81] In the present subfamily Galerucinae are included all of the genera which usually are placed in the subfamily Galerucinae, with the exception of the ones tabulated in the following subfamily, Diabroticinae.

[82] This subfamily, which probably includes more genera than the ones listed above, but whose larvae are unknown, is more closely connected with the Halticinae tribes, Crepidoderini, Chaetocnemini, Systenini, and Psylliodini than with the subfamily Galerucinae, as here conceived.

[83] The subfamily Halticinae includes genera with remotely related larvae such as *Blepharida,* (112 L, O, Q, R), *Oedionychis* (113 A–E), *Haltica* (112 A, B), *Psylliodes* (112 M, N), and *Sphaeroderma* (114 I–O). When better studied, the classification of the entire family Galerucidae will unquestionably be changed.

15. Eighth pair of abdominal spiracles well-developed and dorsal, in some genera biforous, in others annular, eighth abdominal segment terminal, with free hind margin
Hispidae (pl. 115 A–K)

Eighth pair of abdominal spiracles vestigial; tergum of eighth abdominal segment often provided with an upright fork bearing the cast skins or the excrement of the larva (pl. 116 G) ..... *Cassididae* (pl. 116 A–I)

T. PLATYSTOMOIDEA

Key to Subfamilies

1. Legs present, one-, two-, or three-jointed, always without a claw-shaped tarsungular joint. (Spiracles annular, uniforous, or biforous) ..... *Platystomidae - Brachytarsinae* (pl. 117 A–K)

Legs absent, semiglobular pedal lobes occupying their place. (Mesothoracic spiracle biforous (pl. 117 O, N); abdominal spiracles uniforous; body profusely covered with long hairs) ..... *Platystomidae-Choraginae* (*Araecerus*) (pl. 117 L–Q)

U. CURCULIONOIDEA

Key to Families and Subfamilies

1. Mentum-portion of fused subfacial region free laterally; legs present, but small, and usually two-jointed
Brenthidae (pl. 118 A–G)

Mentum connected laterally with maxillary stipes; legs absent; pedal lobes, occupying their place, often bulging 2

2. Head capsule elongate, broadening posteriorly, and with straight sides. (Head deeply retracted; spiracles uniforous with the mouthpiece equipped with a spoutlike prolongation (pl. 119 A) ..... *Proterhinidae* (pl. 119 A–H)

Head capsule narrowing posteriorly, and with curved sides 3

3. Abdominal hypopleurum subdivided into at least two lobes, one superposed upon the other 7

Abdominal hypopleurum not subdivided 4

4. Abdominal segments with no more than two transverse, dorsal plicae 5

Abdominal segments with three or four transverse, dorsal plicae 6

5. More than two ocelli on each side; head retracted; frons indistinct; mentum bearing a median, unpaired plate more or less completely fused with a subtriangular, unpaired plate borne by prementum; labial palpus distinctly two-jointed ..... *Attelabidae - Rhynchitinae* and *Attelabidae - Attelabinae* (pl. 118 H–M)

One ocellus on each side; head protracted; frons distinct; mentum without a plate and prementum without a subtriangular, unpaired plate; basal joint of labial palpus reduced or absent, distal joint distinct

Apionidae (not including *Cylas*) pl. 120 A–D)

6. Spiracles on second to seventh abdominal segments not projecting and not placed dorsally

Curculionidae and *Scolytidae*[84] (pls. 120 E–G, 121 A–U, 123 A–E)

Spiracles on second to seventh abdominal segments projecting, hook-shaped, and placed dorsally. (Larva submerged, living between the leaves of rice) ... *Curculionidae - Lissorhoptrinae* (*Lissorhoptrus simplex*) (pl. 122 A–V)

7. Maxillary palpus two-jointed; spiracles either biforous with large, oval spiracular opening, or, in the single genus *Rhynchophorus,* bilabiate ... *Calendridae* (pl. 123 F–H)

Maxillary palpus one-jointed with the dome-shaped, soft end covered with fine, short hairs; spiracles uniforous, with spoutlike prolongation from a ring-shaped mouthpiece. (Prothoracic tergum armed in the middle with a transverse ridge composed of a series of ring-shaped scleromes of different sizes) ..... *Platypodidae*[85] (pl. 123 I–P)

V. LYMEXYLOIDEA

The systematic position of this series has been discussed in a footnote[20]. It contains only the one family Lymexylidae which is

[84] The larvae of the Curculionidae and Scolytidae can not be separated. In most of the larvae of these two families, the body is whitish, fleshy, subcylindrical, more or less curved, without abdominal prolegs, and not clothed with long hair. However, in the leaf-mining genera *Orchestes* and *Prionomerus,* (pl. 120 E, F), the body is rather straight and either flat both on the dorsal and ventral side, or only flat ventrally but projecting laterally into broad, rounded processes on most of the segments (Trägårdh, Ivar, Arkiv for Zoologi, vol. 6, No. 7, 1910, pp. 1–22, English text, two plates); in the slimy larva of *Cionus solani* Fab. (pl. 120 G), which is free-living on the leaves of *Verbascum*, and in larvae of Hyperini paired prolegs are found on the underside of the abdominal segments; and in the hyperine species *Phelypera distigma* Boheman, from Guatemala, (pl. 121 U), the body is beset on the back with dark hairs as long or considerably longer than the width of the larva.

[85] Hubbard, H. G., The Ambrosia Beetles of the United States, U. S. Dept. Agr., Div. Ent., Bul. 7, New Series, 1897, pp. 14–16 with figures.

distinguished by the same characters by which the series is defined and in addition by the following characters: Labrum elongate, conical, fitting into a groove on the dorsal side of the mandibles; molar structure of mandible present but rather indistinct; maxillary articulating area well-developed; maxillary palpus three-jointed, palpiger excluded; cardo bipartite; ligula large and broad; prothorax hood-shaped, somewhat swollen dorsally and ventrally; ninth abdominal segment terminal and heavily sclerotized; spiracles bilabiate.

Key to Subfamilies

1. Ninth abdominal segment cylindrical, obliquely truncate posteriorly, armed with a raised rim and with rugosities or tubercles on the disk inside of the rim; abdominal epipleural lobes with a hard, tubercled or shagreened surface ..... *Lymexylidae - Lymexylinae* (*Melittomma* and *Atractocerus*) (pl. 124 A–G, J–K, M)

   Ninth abominal segment elongate conical, thorn-shaped, terminally with upward bent, bicuspidate apex; epipleural lobes glabrous. (First larval instar with a more disklike ninth abdominal segment) ..... *Lymexylidae - Hylecoetinae* (*Hylecoetus*) (pl. 124 H, L)

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CONSPECTUS

ARCHOSTEMATA

ADEPHAGA

[86] Larval stage unknown, or not examined by the present authors.

[87] See: (a) Peyerimhoff, P. de; Sur quelques larves de coléoptères cavernicoles;
1906, Bull. Soc. Ent. France, pp. 112–118. (With figures)

(b) Peyerimhoff, P. de: Deux types nouveaux de larves Silphidae;
1907, Ann. Soc. Ent. France; vol. 76, pp. 83–88. (With figures)

SERIES			PAGE	PLATE
Staphylinoidea	"	Cholevinae (Catopini)[87]	26	11
	(")	(Bathysciinae)[86, 87]	—	—
	(")	(Coloninae)[86]	—	—
"	(Clambidae)[86, 87]		—	—
"	Platypsyllidae[87]		27	12
"	(Brathinidae)[86]		—	—
"	Scaphidiidae		27	12
"	(Sphaeritidae)[86]		—	—
"	(Sphaeriidae)[86]		—	—
"	Silphidae[87]			
	"	Necrophorinae	27	—
	"	Silphinae	"	13
"	Staphylinidae			
	"	Oxyporinae	27	—
	"	Piestinae	28	14
	"	Syntomiinae	"	—
	"	Oxytelinae	"	15
	"	Aleocharinae	28	14, 16
	"	Proteininae	29	16
	"	Omaliinae	"	17
	"	Tachyporinae	"	15
	"	Habrocerinae (+ Phloeocharinae)	30	—

(c) Jeannel, R.: Revision des Bathysciinae;
1911, Arch. Zool. expérimentale et générale; Ser. 5, vol. 7, pp. 1–641. (With many figures and extensive bibliography. On page 95 the author separates the larvae of the two subfamilies Bathyschiinae and Cholevinae as follows:
Antenna inserted anteriorly, at the exterior margin of the mandible; apex of mandible enlarged.
Bathysciinae (*Leptoderus*, *Pholeuon*, *Oryotus*, *Aphaobius*, etc.)
– Antenna inserted posteriorly, at the transverse diameter of the head; apex of mandible attenuate and fine ..... Cholevinae)

(d) Hatch, Melville H.: Studies of the carrion beetles of Minnesota;
1927, Tech. Bull. No. 48, University of Minnesota, Agric. Exp. St. (With keys to the larvae)

SERIES		PAGE	PLATE
Cucujoidea	Scraptiidae	39	44
"	Anthicidae (Connection with Languriidae)		
	" Anthicinae	39	46
	" Eugleninae	"	—
	" Anaspidinae	"	47
"	Byturidae	39	45
	—·—		
"	Bothrideridae	40	44
"	Colydiidae (Colydiini, Synchitini, Monoedini)	40	49
"	Mycetophagidae	"	50
	—·—		
(")	(Lymexylidae)	68	124
"	Oedemeridae		
	" Oedemerinae	"	51
	" Calopodinae (= Calopinae)	41	"
"	Cephaloidae	"	52
	—·—		
"	Zopheridae (Zopherini, Nosodermini)	"	52
"	Synchroidae	"	52
"	Pedilidae (Eurygeniini, Pedilini)	41	53
	—·—		
"	Eurystethidae (= Aegialitidae)	40	48
"	Salpingidae	41	54
"	Pyrochroidae	"	53
"	Boridae	"	48, 55
"	Pythidae (Pythini, Cononotini,[86] Lacconotini,[86] Mycterini[86])	42	54
"	Othniidae (= Elacatidae)	"	47
	—·—		
"	Alleculidae (Alleculinae, Omophlinae	"	56
"	Tenebrionidae[88]	"	57, 58

[88] Modern systematists have divided the family into more than a score of subfamilies on the characters of the adults. Recent studies of the larvae seem to substantiate the correctness of this classification. Much work, however, is still needed before a separation of the larvae into subfamilies and tribes can be established. See: [1]St. George, R. A.: "Studies on the larvae of North American beetles of the subfamily Tenebrioninae" . . . (Proc. U. S. Nat.

SERIES		PAGE	PLATE
Cucujoidea	Nilionidae	42	59
"	Lagriidae (Heterotarsini, Lagriini, Statirini[86])	"	60
"	(Monommatidae)[86]	—	—
Byrrhoidea	Byrrhidae		
	" Byrrhinae	43	61, 62
	" (Limnichinae)[86]	—	—
	" Amphicyrtinae	43	62
	" Liooninae	"	62
Dascilloidea	Dascillidae (with the single genus *Dascillus*)	44	63
"	Heteroceridae	"	64
"	Helodidae (= Cyphonidae)	"	65
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	" Psepheninae	"	70
	" Eubrianacinae	"	70
"	Chelonariidae	"	71
"	Dryopidae		
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	" Pelonominae	"	70, 72, 73
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"	Homalisidae	47	—
"	Cantharidae		
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	" Chauliognathinae	"	78
	" Malthodinae	48	77
	" Cantharinae	"	77
"	Lampyridae	"	74, 75
"	Phengodidae	"	74, 75
"	Lycidae	"	76
Elateroidea	Rhipiceridae	49	79

Mus., vol. 65, pp. 1–22, pls. 1–4, 1924) [2]Oglobin, D. A., and Kolobova, A. N.; "Tenebrionidae and their larvae injurious to agriculture" (Proc. Poltava Agricultural Experiment Station, Entomological Division, vol. XV, 1927; No. 61, pp. 1–49, with 41 figures) (Entirely in Russian)

To be Continued

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ENTOMOLOGICA AMERICANA

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AN ILLUSTRATED SYNOPSIS OF THE PRINCIPAL LARVAL FORMS OF THE ORDER COLEOPTERA

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(Continued from page 80.)

ABBREVIATIONS USED ON THE FIGURES

1–10, first to tenth abdominal segments.
a, arm of the spiracular closing apparatus.
abs, annular-biforous type of spiracle (an apparently annular spiracle but provided with two small air-tubes).
ac, accessory ventral condyle of mandible.
al, anal lobe.
alr, alar area (= pasc, parascutal area; a tergal area immediately above the epipleural area; in the abdominal segments usually carrying the spiracle).
am, basal articulating membrane of antenna.
amb, ambulatory wart (sometimes named "ampulla" or "scansorial wart").
an, anus.
ans, annular type of spiracle (ringlike with a simple opening and no accessory tubes or chamber).
ant, antenna.
ap, appendage of tenth abdominal segment.
at, atrium of spiracle (a part between the spiracular mouthpiece and the trachea).
b, bulla of spiracle.
bls, bilabiate type of spiracle (an elongate, annular spiracle with a pair of projecting lips interior to the spiracular frame).
bis, biforous type of spiracle (spiracle provided with a pair of distinct airtubes).
c, cardo (with jca, pc, sca; pls. 40 T, 89 G*).
cl, claw (or "ungulus") from distal end of tarsus.
cly, clypeus.
cn, canal or sulcus in the mandible or in other buccal structures.
co, membrane between head and prothorax.
col, collum (necklike constriction of head around the occipital foramen).
crs, cribriform spiracle (spiracle provided with a sievelike plate).
cx, coxa.
cxl, coxal lobe (= parasternum, an abdominal, usually triangular area extending from hypopleurum toward the sagittal line of sternum; often separating laterally eusternum and sternellum).
da, dorsal articulation of mandible (= mandibular fossa).
dis, dististipes (an anterior portion of the maxillary stipes).
dl, dorso-lateral suture (a frequently rather indistinct groove immediately below the spiracle-bearing parascutal area;

in abdomen parallel with the ventro-lateral suture, in thorax more oblique).

e, epidermis (= hypodermis).

ecr, epicranium.

ecrs, epicranial suture (median suture between the two epicranial halves and behind the posterior end of frons).

em, epimeron.

ep, epistomal margin (the anterior margin of the cranium between the two dorsal articular projections for the mandibular fossae).

epp, epipleurum (term introduced by Hopkins for the lateral area immediately above the ventro-lateral suture and below the alar area; dorsally limited in thoracic segments by a normally oblique, in abdominal segments always horizontal dorso-lateral suture; pl. 95 Q).

epr, epipharyngeal rod.

eps, episternum.

epx, epipharynx.

est, eusternum (anterior sternal area in front of the suture between the furcal pits).

f, frons.

fe, femur.

fl, flexor of the mandible.

fs, frontal suture (paired suture between frons and one or other of epicranial halves; usually dividing the ring-shaped sclerome to which the antenna is attached).

ga, galea.

gl, glossa (dorsal surface of ligula).

gld, gland.

gs, gular suture (either a paired suture between gular plate and one or other of epicranial halves, or, when pregular plate is present, an unpaired, median longitudinal suture behind this plate and between the ventrally adjacent epicranial halves, or, when the gular area is entirely absent, an unpaired median longitudinal suture behind submentum and between the ventrally adjacent epicranial halves.

gu, gula (area behind submentum, separated from this by a real or imaginary suture between posterior articulations of the two cardines).

hb, hypopharyngeal bracon (a term introduced by A. D. Hopkins for a transverse brace between hypopharynx and the anterior part of the hypostomal margin).

hc, hypopharyngeal sclerome.

hp, hypopleurum (a term introduced by A. D. Hopkins for the lateral area immediately below the ventro-lateral

suture; in thorax usually carrying the two scleromes episternum, anterior to the articulation of the coxa, and epimeron, posterior to this articulation).

hr, hypopharyngeal rod.

hx, hypopharynx.

hy, hypostomal margin (the ventral marginal thickening of each of the epicranial halves between the articulation of the ventral mandibular condyle and the ventral tentorial pit, tp; pls. 3 F, 31 F, 99, 107 B).

is, intersegmental membrane.

jca, juxtacardo (a separate part of cardo extending from cardo proper toward submentum).

jx, juxta stipes (a separate part of stipes extending from stipes proper toward mentum).

lab, labrum.

lac&la, lacinia.

lb, labium (the unit consisting of submentum, mentum, prementum, ligula and labial palpi).

lg, leg.

li, ligula and in some figures glossa.

lm, lacinia mandibulae (= prostheca = lacinia mobilis, a fleshy or membranous process from the interior face of the mandible; see: r, retinaculum).

lp, labial palpus (never more than two-jointed in coleopterous larvae).

lpg, labial palpiger (in a few coleopterous larvae appearing as a free joint; see: pm, prementum).

ls, labial stipes (see: pm, prementum).

lt, median line on the free surface of the airtubes of the biforous spiracle.

m, mentum (a labial area limited anteriorly by the posterior margin of the premental area and posteriorly by a transverse suture running approximately between the front margins of the maxillary cardines).

ma, mala (a single maxillary lobe not differentiated into an outer lobe, or galea, and an inner lobe, or lacinia).

md, mandible.

mo, the molar or grinding structure of the mandible.

mpf, maxillary palpiger.

mst, mesothorax.

mtt, metathorax.

mx, maxilla.

mxl, maxillula (= pgn).

mxp, maxillary palpus.

mxs, maxillary articulating area (between stipes maxillae and cardo maxillae, exteriorly, and mentum and submentum, interiorly).

n, nasale (an anterior and median projection from frons, formed either by a fusion of frons, clypeus and labrum, or sometimes by frons and clypeus alone; in this latter case labrum is small and hidden below the nasal projection).
o, ocellus.
oe, oesophagus.
of, occipital foramen.
or, orifice of the spiracle.
p, maxillary palpiger.
pag, paragula (a paired, usually elongate, sclerome on either side of gula; found in ostomid, clerid and some other larvae).
pasc, parascutal area (= alr, alar area).
pc, precardo (anterior part of bipartite cardo).
pg, pregula (an anterior part of the gular plate found in front of a median gular suture; present, for instance, in many hydrophiloid and staphylinoid larvae).
pgl, paraglossa (paired lobe on either side of glossa (gl); not to be confused with the maxillulae (pgn; pl. 11, fig. E).
pgn, maxillula (= superlingua, a single or bidivided, lobe-shaped mouthpart on either side of the hypopharyngeal region).
ph, pharynx.
plb, pedal lobe (a fleshy, bumplike, non-segmented rudiment of a leg).
pm, prementum (= ls plus lpg, term used by K. L. Henriksen for the area lying in front of mentum in coleopterous larvae and consisting of the fused labial stipites with the labial palpigera included but with the ligula and labial palpi excluded).
po, pleurostomal margin (the lateral marginal thickening of each epicranial half between the dorsal and ventral mandibular articulations).
pon, paronychial appendix (= pulvillus).
pos, postscutellum.
post, poststernellum.
pr, prostheca (= lm, lacinia mandibulae).
prt, prothorax.
psc, prescutum.
pst, presternum.
pxs, proxistipes (a posterior portion of maxillary stipes).
r, retinaculum (a hard, pointed, and tooth shaped process usually near or at the middle of the inner edge of the mandible; never jointed).
re, retractor mandibulae.

s, seta.
sc, scutum.
sca, subcardo (posterior part of bipartite cardo).
scl, scutellum.
scler, sclerome.
sj, supplementary joint of antenna (="tactile papilla" or "sensory appendix").
sm, submentum (an unpaired median area lying approximately between the maxillary cardines on the underside of the head).
sp, spiracle.
srp, stridulatory plate.
srt, stridulatory teeth.
st, maxillary stipes.
stl, sternellum.
su, the sucking portion of the last abdominal segment.
sty, stylus.
t, tarsungulus (here regarded as a terminal joint of the leg formed by fusion of the tarsus and the claw; modern authors, however, maintain that in coleopterous larvae with legs having five or less joints this clawlike terminal structure which they call "pretarsus" or "dactylopodite" is a simple joint, that there is no claw ("unguluS"), and that tarsus is eliminated or united with tibia).
ta, tentorial arm.
tb, tentorial bridge (bridge within head between the posterior ends of the hypostomata).
tg, tergum.
ti, tibia.
tp, ventral tentorial pit.
tr, trochanter.
tu, the usually fingershaped, paired airtubes of a biforous spiracle.
u, uncus.
ur, urogomphus (a process, usually paired, projecting from the posterior end of tergum of the ninth abdominal segment; may be jointed and movable by muscles, or unjointed and immovable; urogomphus is commonly known as "cercus" or "pseudocercus").
vc, ventral condyle of mandible.
vf, fossa in anterior end of hypostoma for the ventral articulation of the mandible.
vl, ventro-lateral suture (or merely the "lateral suture" when a distinction between this important suture and the rather insignificant dorso-lateral suture is not necessary:

it is a continuous, longitudinal groove, in the thorax running immediately above the two scleromes episternum and epimeron or, when these are indistinct or absent, above the hypopleural area to which they belong, in the abdomen running above hypopleural area and between the pitlike impressions where the ventral and dorsal wedges of the intersegmental membranes meet when these are present).

vr, scansorial wart (="tuber scansorium" Schiödte).

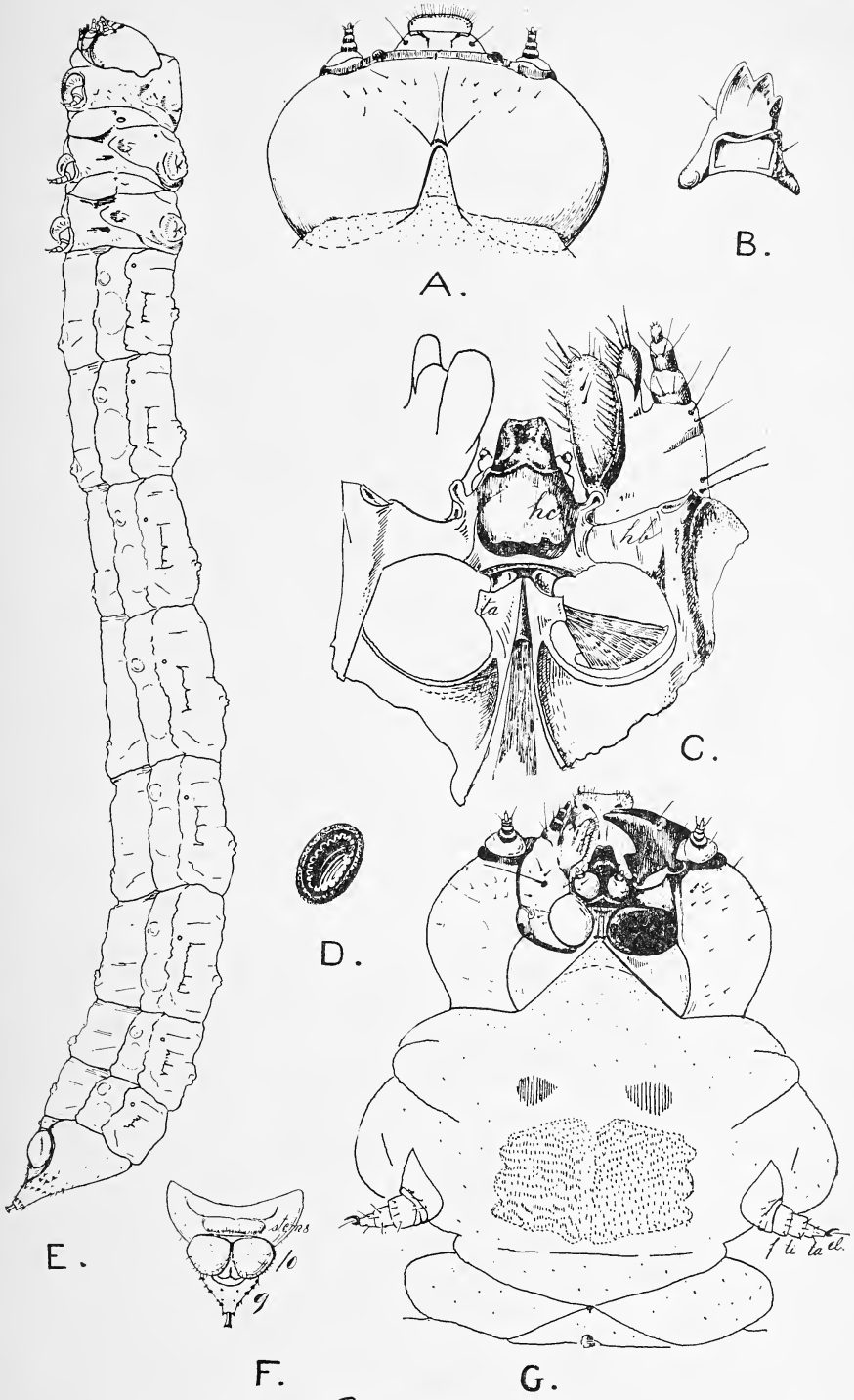
*, jointlike appendix of galea (=bl, bladelike appendix in Donaciidae; pls. 106 G and K, 110 I, 111 G).

PLATES 1-125

Plate 1.

Cupesidae

A. Cupes concolor Westw.: Head. Dorsal view.
B. " " : Right mandible. Inner face.
C. " " : Buccal structures, hypopharynx, bracon, tentorial arm, and maxilla. Dorsal view.
D. " " : Spiracle.
E. " " : Larva. Lateral view.
F. " " : Ninth and tenth abdominal segments. Ventral view.
G. " " : Head and prothorax. Ventral view.

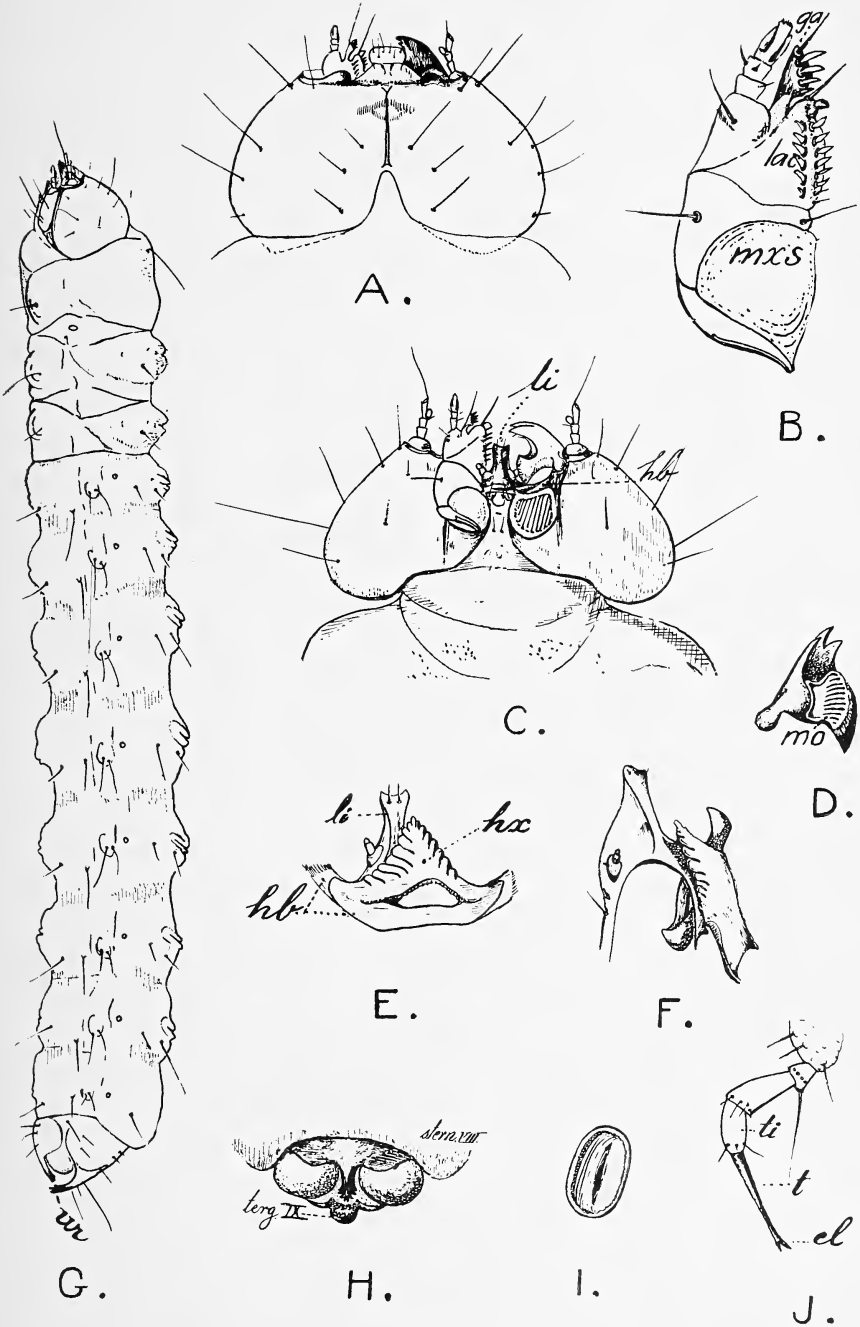


Cupes

Plate 2

Micromalthidae

A. Micromalthus debilis Lec.: Legless larva; head. Dorsal view.
B. " " : Right maxilla. Ventral view.
C. " " : Head. Ventral view.
D. " " : Right mandible. Ventral view.
E. " " : Hypopharyngeal sclerome, hypopharyngeal bracon, and ligula. Dorsal view.
F. " " : Hypopharyngeal sclerome, hypopharyngeal bracon, and ligula. Lateral view.
G. " " : Larva. Lateral view.
H. " " : Tip of abdomen. Ventral view.
I. " " : Spiracle.
J. " " : First larval instar; leg with tibia, tarsus and two claws.

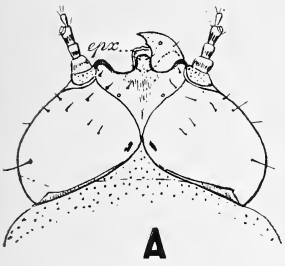


Micromalthus

Plate 3

Rhysodidae

A. Clinidium sculptile Newn.: Head. Dorsal view.
B. " " : Right mandible. Ventral view.
C. " " : Right mandible. Dorsal view.
D. " " : Head; lp, read: li, ligula. Ventral view.
E. " " : Larva. Lateral view.
F. " " : Ventral mouthparts; lp, read: pgl, paraglossal(?). Dorsal view.
G. " " : Details of abdominal tergum.
H. " " : Leg and its attachment to hypopleurum.
I. " " : Head and prothorax. Ventral view.
J. " " : Spiracle with closing apparatus and spiracular trachea.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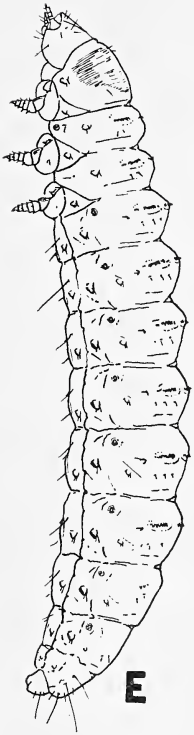
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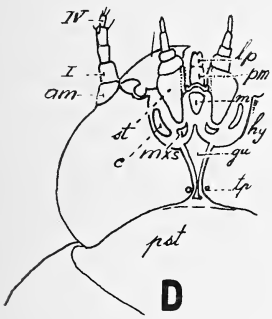
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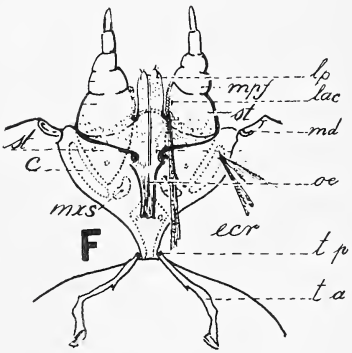
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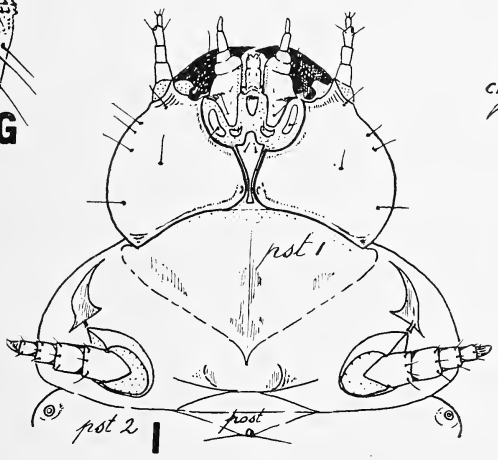
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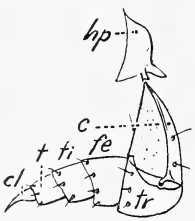
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Clinidium

Plate 4

Cicindelidae, Carabidae

A. (Therates sp.?) (In rotten wood. British Solomon Isl.) : Larva. Lateral view.
B. Amblycheila cylindriformis Say : Part of head. Dorsal view.
C. Cicindela limbalis Klug : Leg.
D. Amblycheila cylindriformis : Part of head. Ventral view.
E. Omus californicus Esch. : Abdominal segment. Lateral view.
F. Laemostenus terricola Herbst (Denmark) : Anterior part of larva. Ventral view.
G. " " " " : Anterior Part of larva. Lateral view.
H. " " " " : Larva. Dorsal view.
I. Glyptus sculptilis Brullé (Sierra Leone) : Larva. Lateral view.

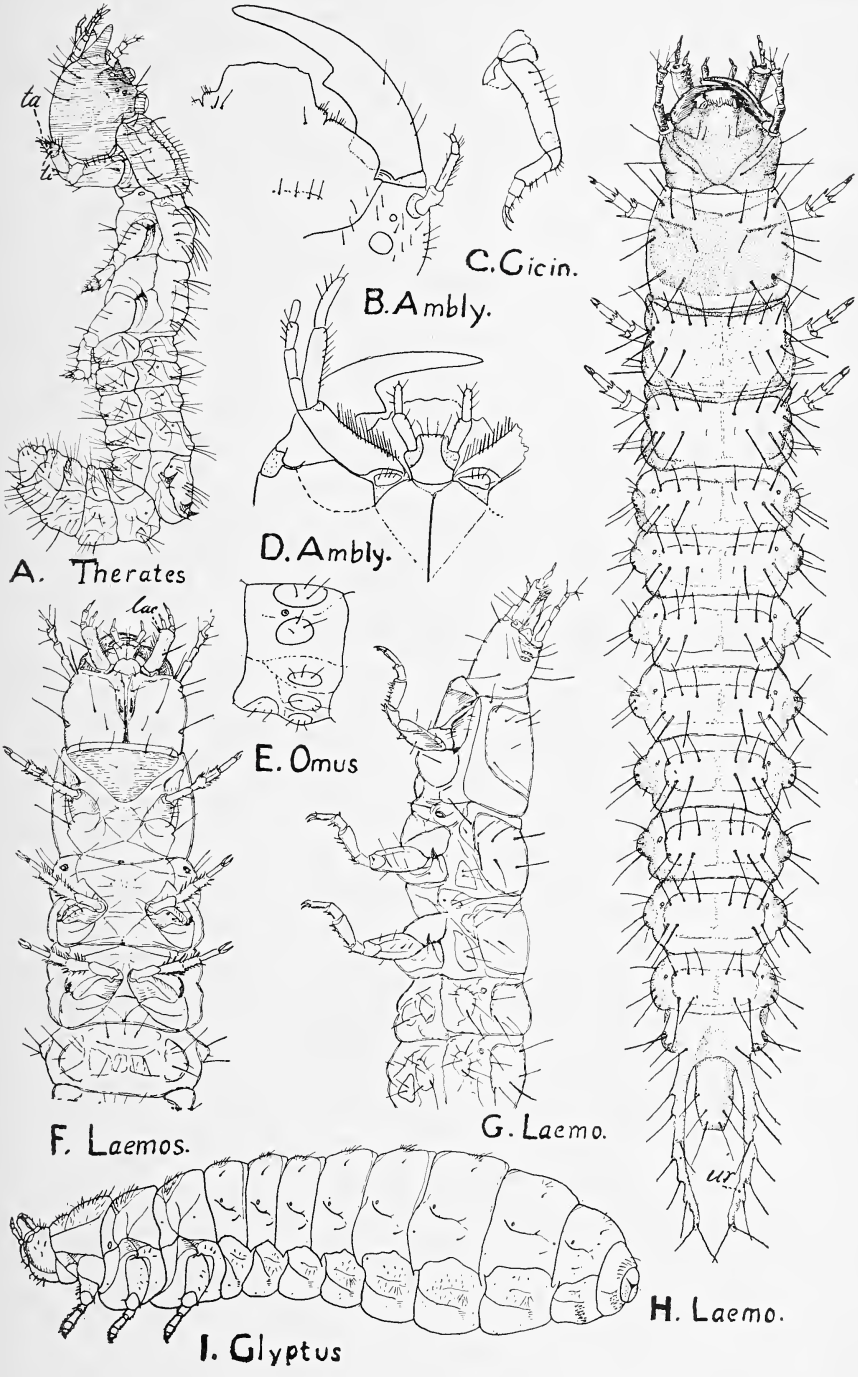

ta
A. Therates
B. Ambly.
C. Cicin.
D. Ambly.
E. Omus
F. Laemos.
G. Laemo.
H. Laemo.
I. Glyptus

Plate 5

Omophronidae, Haliplidae, Hygrobiidae, Noteridae

A. Omophron (nitidum Lec?) (Texas) : Larva. Dorsal view.
B. " " : Leg.
C. " " : Labium. Ventral view.
D. " " : Anterior part of head. Ventral view.
E. " " : Anterior part of head. Dorsal view.
F. Haliplus confinis Steph. (Denmark) : Third leg.
G. " " : Larva. Dorsal view.
H. " " : Head. Dorsal view
I. Hygrobia tarda Herbst. (Denmark) : End of body. Ventral view.
J. " " : Larva. (Natural position of head more nutant; notice the very long eighth abdominal segment.)
K. Noterus clavicornis Deg. (=N. sparsus Marsh.) (Denmark) : Right mandible. Ventral view.
L. " " : Antenna.
M. Hygrobia tarda : Head. Dorsal view.
N. Noterus clavicornis : Ventral mouthparts. Ventral view.
O. " " : End of body. Ventral view.
P. " " : Larva. Lateral view.

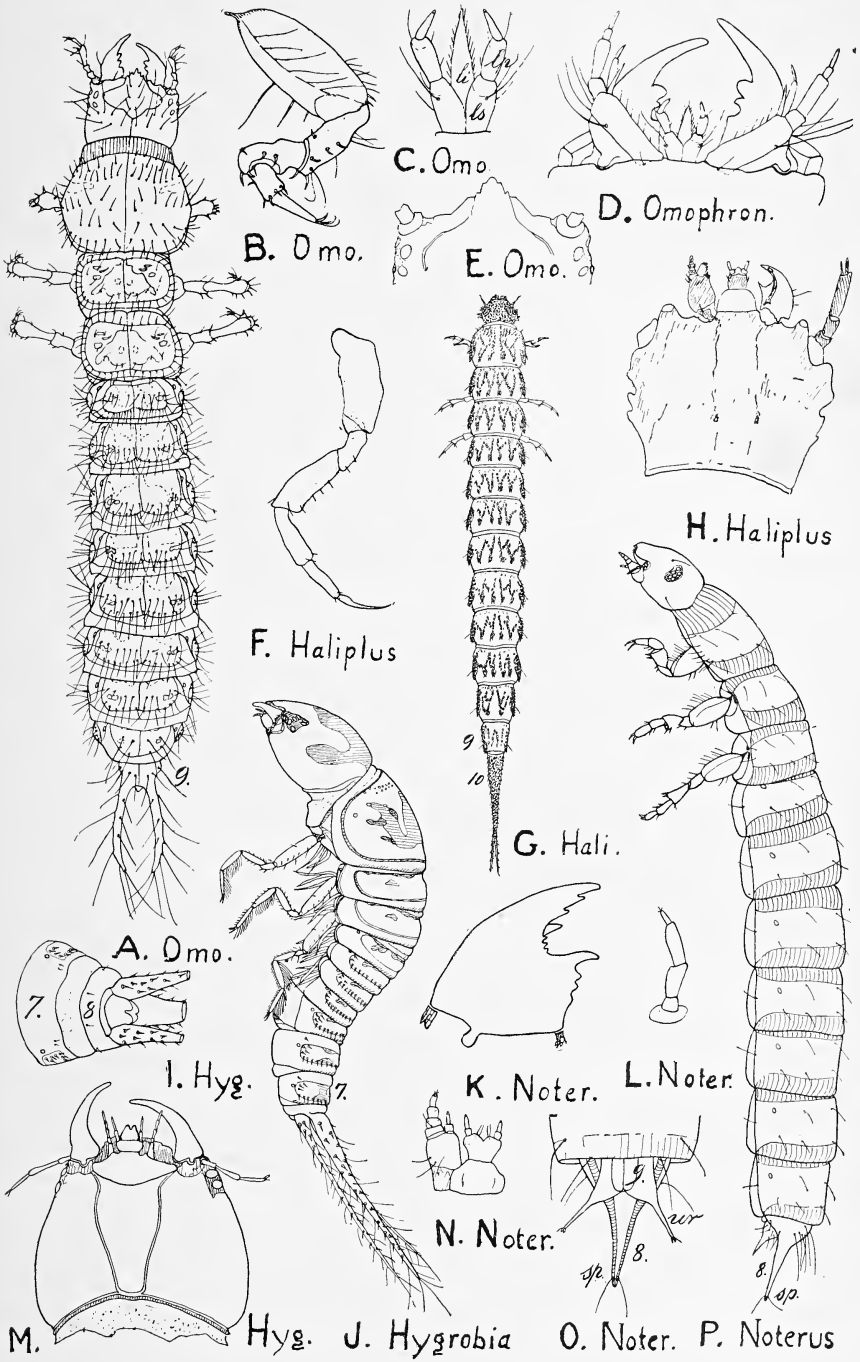
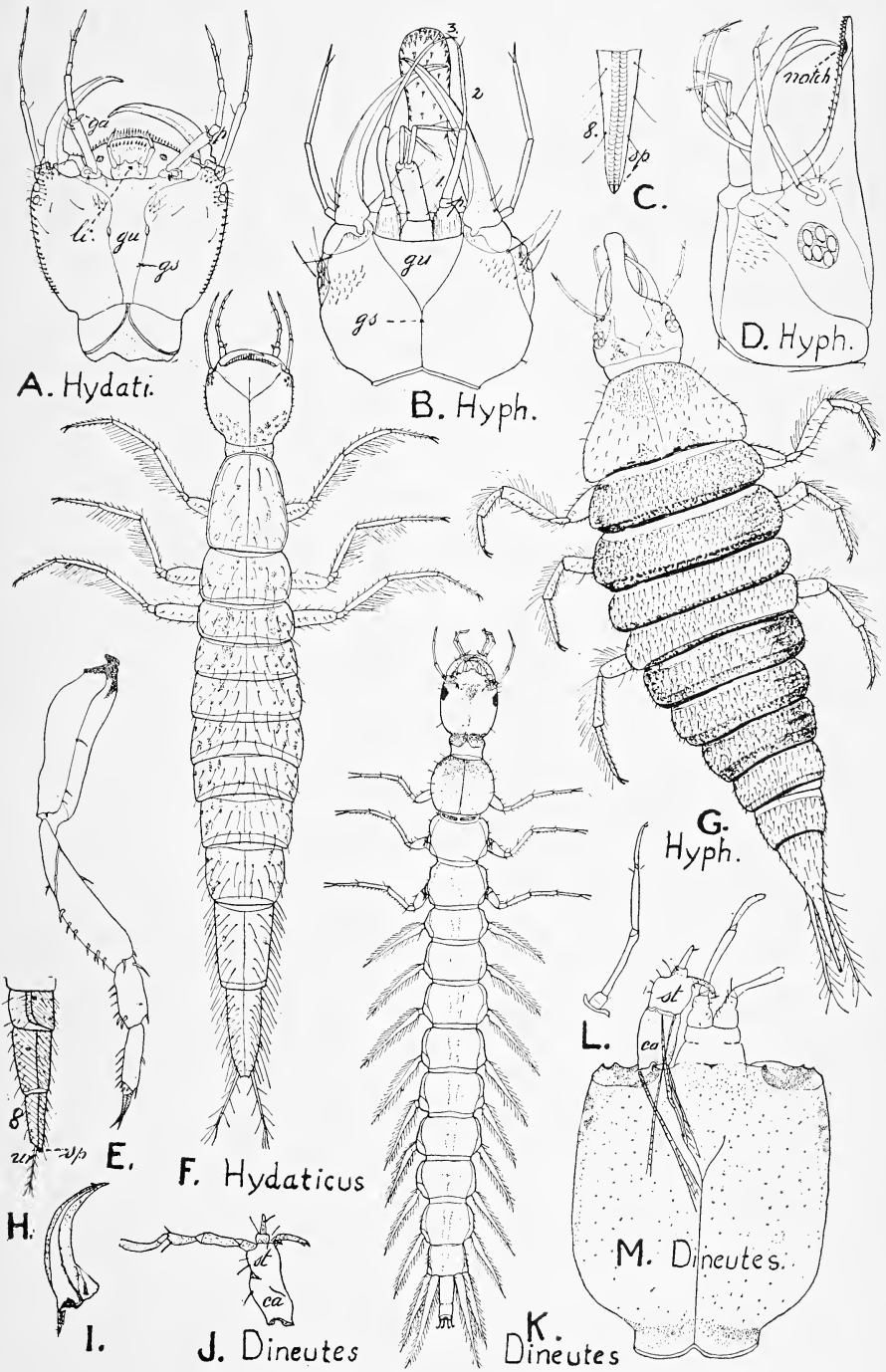

B. Omo.
C. Omo
D. Omophron.
E. Omo.
H. Haliplus
F. Haliplus
G. Hali.
A. Omo.
I. Hyg.
K. Noter.
L. Noter.
N. Noter.
M. Hyg.
J. Hygrobia
O. Noter.
P. Noterus

Plate 6

Dytiscidae, Gyrinidae

A. Hydaticus transversalis Pontopp. (Denmark) : Head. Ventral view.
B. Hyphydrus ovatus L. (Denmark) : Head. Ventral view.
C. " " : Tip of eighth abdominal segment.
D. " " : Head. Lateral view.
E. Dineutes americanus Say : Leg.
F. Hydaticus transversalis : Larva. Dorsal view.
G. Hyphydrus ovatus : Larva. Dorsal view.
H. Hydaticus transversalis : End of abdomen. Lateral view.
I. Dineutes americanus : Mandible.
J. " " : Maxilla.
K. " " : Larva. Dorsal view.
L. " " : Antenna.
M. " " : Head. Ventral view.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F. Hydaticus
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J. Dineutes
K.
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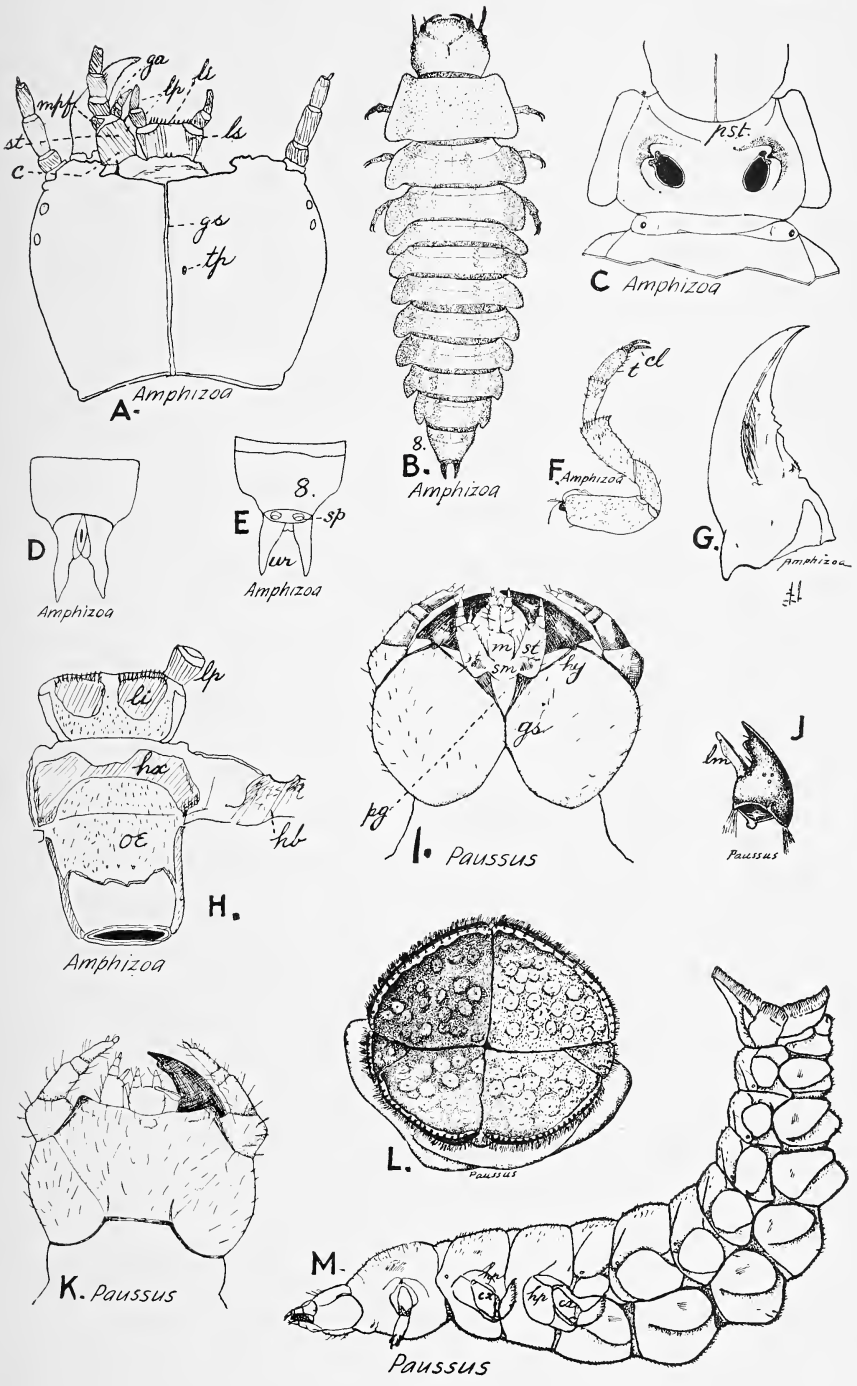
L.
M. Dineutes.

Plate 7

Amphizoidae, Paussidae

A. Amphizoa lecontei Matth.: Head. Ventral view.
B. " " : Larva. Dorsal view.
C. " " : Prothorax. Ventral view.
D. " " : End of abdomen. Ventral view.
E. " " : End of abdomen. Dorsal view.
F. " " : Metathoracic leg.
G. " " : Left mandible. Dorsal view.
H. " " : Hypopharynx, etc. Dorsal view.
I. Paussus kannegieteri Wasm. (Java) : Head. Ventral view.
J. " " : Right mandible. Dorsal view.
K. " " : Head. Dorsal view.
L. " " : Eighth abdominal segment. Dorsal view.
M. " " : Larva. Lateral view.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I. Paussus
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Paussus
lp
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hac
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hb
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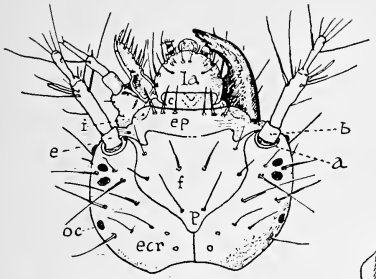
H.
Amphizoa
K. Paussus
L.
Paussus
M.
Paussus

Plate 8

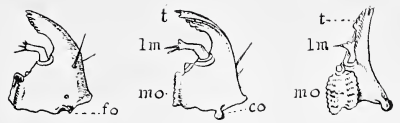
Limnebiidae

A. Ochthebius impressus Marsh. (Denmark) : Head. Dorsal view.*
B. " " : Mandible.
C. " " : Leg.
D. " " : Head. Ventral view.*
E. " " : Larva. Ventral view.
F. " " : Larva. Dorsal view.
G. Limnebius papposus Muls. (Denmark) : Larva. Dorsal view.
H. " " : Head. Dorsal view.
I. " " : Spiracle.
J. Limnebius sp. (Denmark) : Larva. Lateral view.
K. Limnebius papposus : Mandible.
L. " " : Anterior part of body. Lateral view.

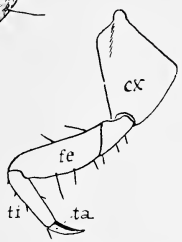
* Special abbreviations applied.



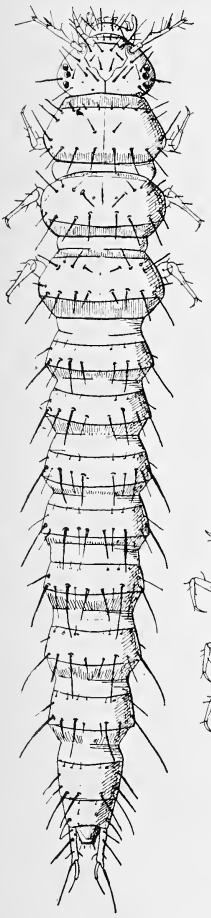
A. Ochthebius

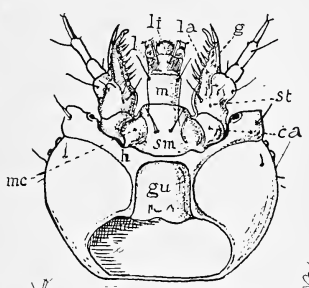


B. Ochthebius

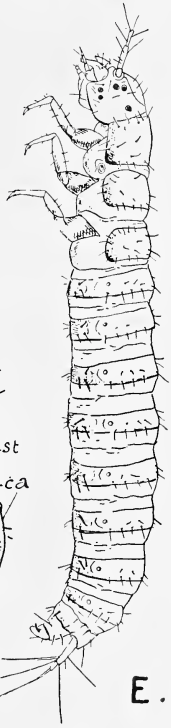


C. Ochthebius

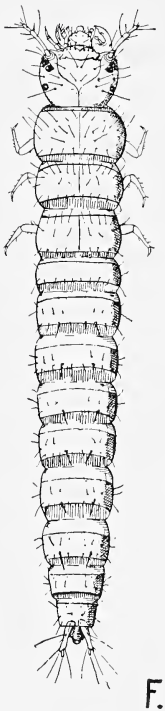




D. Ochth.

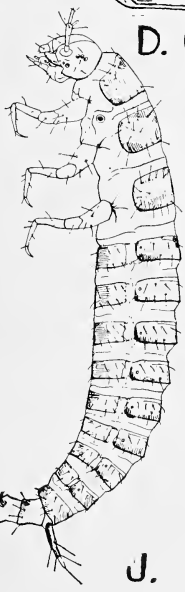


E.

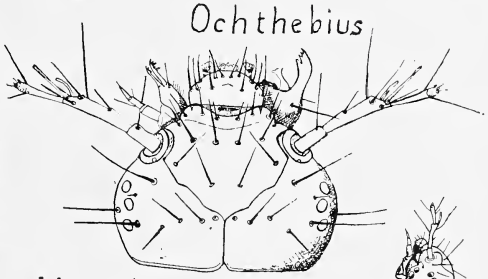


F.

Ochthebius



G. Limn.



H. Limnebius

I.

J.

K.

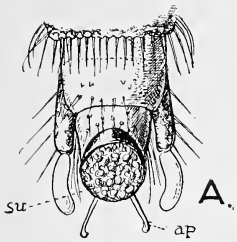
L.

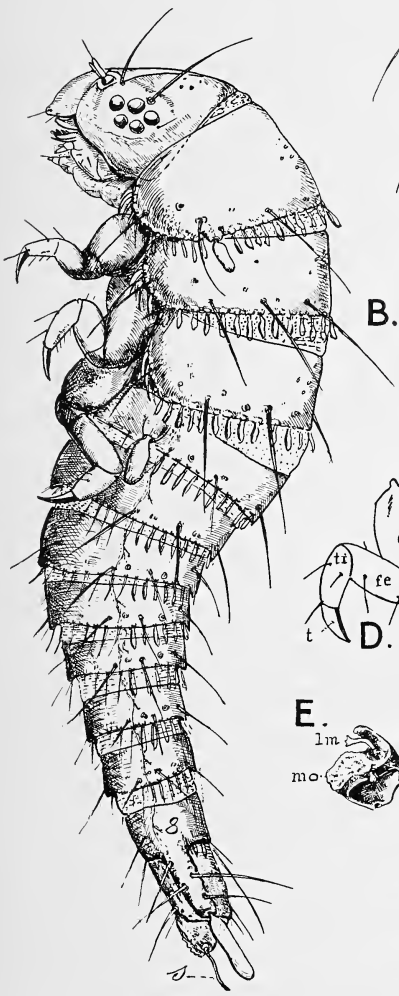
Limnebius

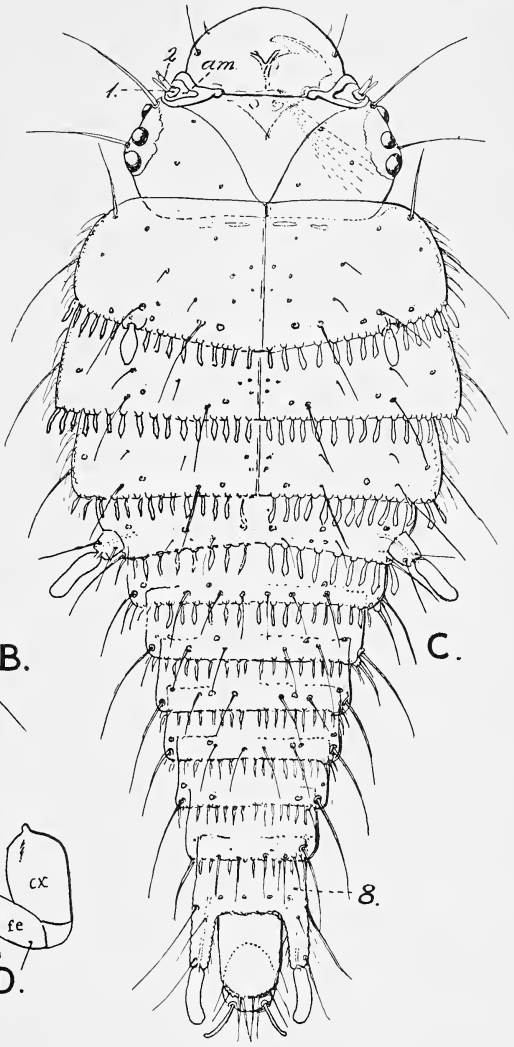
Plate 9

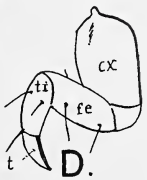
Hydroscaphidae

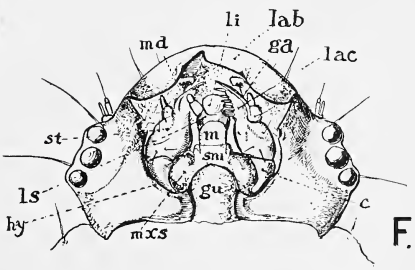
A. Hydroscapha natans Lec.: Last abdominal segments. Ventral view.
B. " " : Larva. Lateral view.
C. " " : Larva. Dorsal view.
D. " " : Right leg of mesothorax.
E. " " : Left mandible. Ventral view.
F. " " : Head. Ventral view.









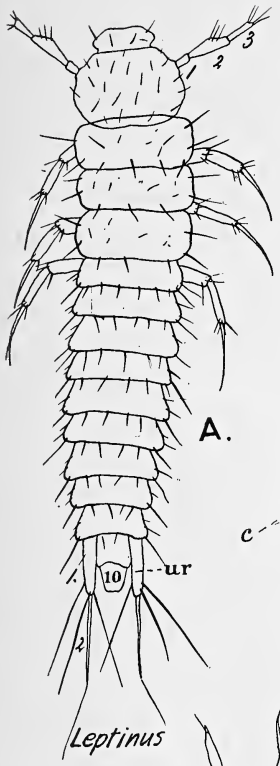


A-F *Hydroscapha*

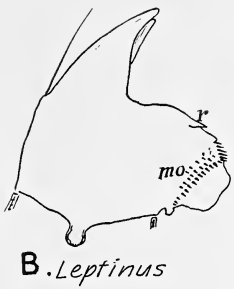
Plate 10

Leptinidae, Ptiliidae

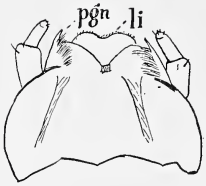
A. Leptinus testaceus Müll. : Larva. Dorsal view.
B. " " : Right mandible. Ventral view.
C. " " : Hypopharynx; pgn, paraglossa.
D. " " : Head. Dorsal view.
E. " " : Head. Ventral view.
F. Nossidium americanum Mots. : Right mandible. Ventral view.
G. " " : Leg.
H. " " : Antenna.
I. " " : Head. Ventral view.
J. " " : End of left maxilla. Ventral view.
K. " " : Larva. Lateral view.
L. " " : Epipharynx.



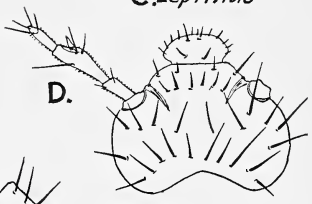
A.



B. Leptinus

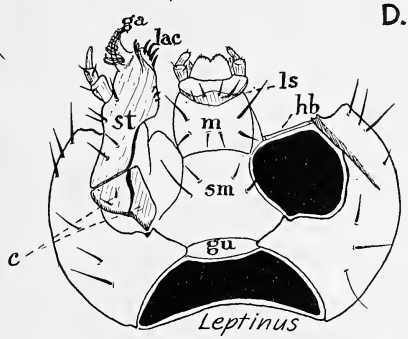


C. Leptinus



D.

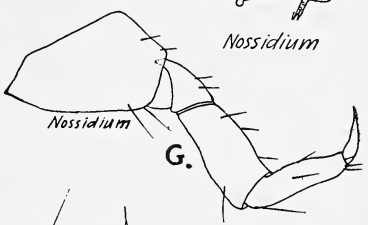
Leptinus



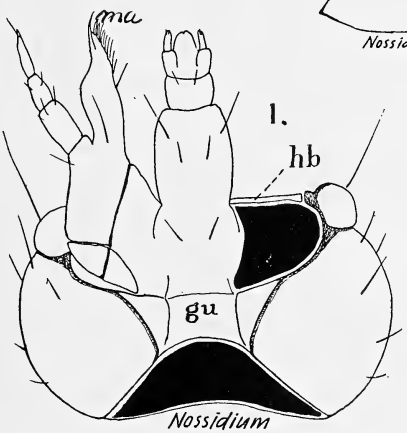
E.

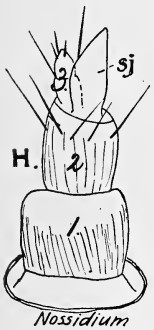
F.

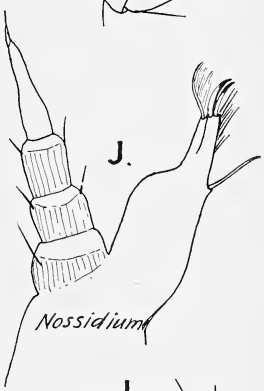
Nossidium

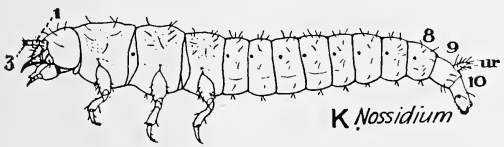


G.









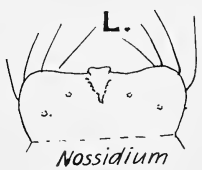
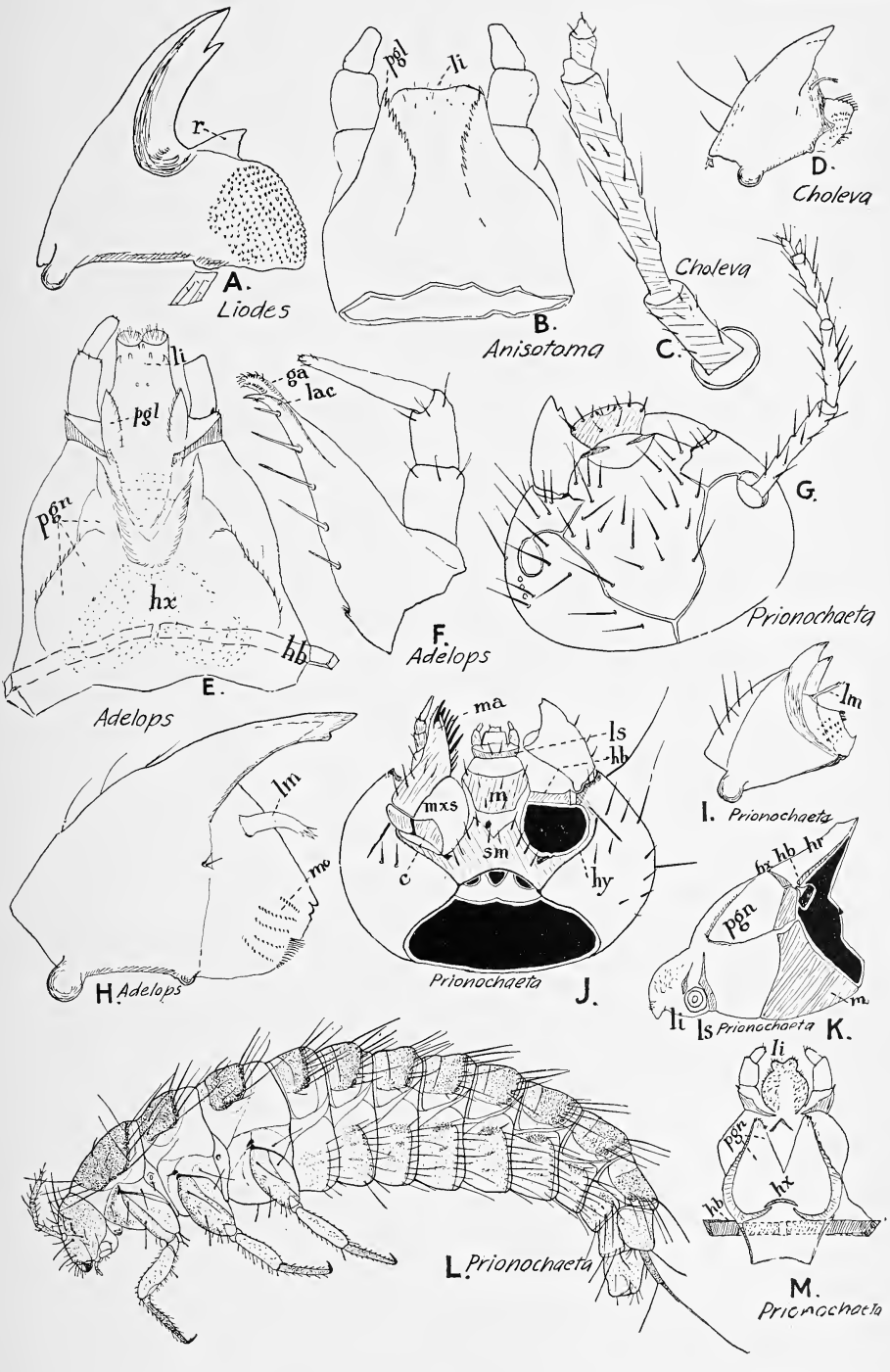


Plate 11

Anisotomidae-Liodinae (A, B)

Anisotomidae-Cholevinae (C–M)

A. Liodes humeralis F. (Denmark) : Right mandible. Ventral view.
B. Anisotoma glabra Kugel. (Denmark) : Ligula and paraglossa.
C. Choleva sp. (Denmark) : Antenna.
D. " " : Right mandible. Ventral view.
E. Adelops hirtus Tellk. : Ligula, paraglossa, maxillula, hypopharynx, and hypopharyngeal bracon.
F. " " : Tip of maxilla.
G. Prionochaeta opaca Say : Head. Dorsal view.
H. Adelops hirtus : Right mandible. Ventral view.
I. Prionochaeta opaca : Right mandible. Ventral view.
J. " " : Head. Ventral view.
K. " " : Labium and ventral buccal structures. Lateral view.
L. " " : Larva. Lateral view.
M. " " : Ligula, maxillula, hypopharynx, and hypopharyngeal bracon.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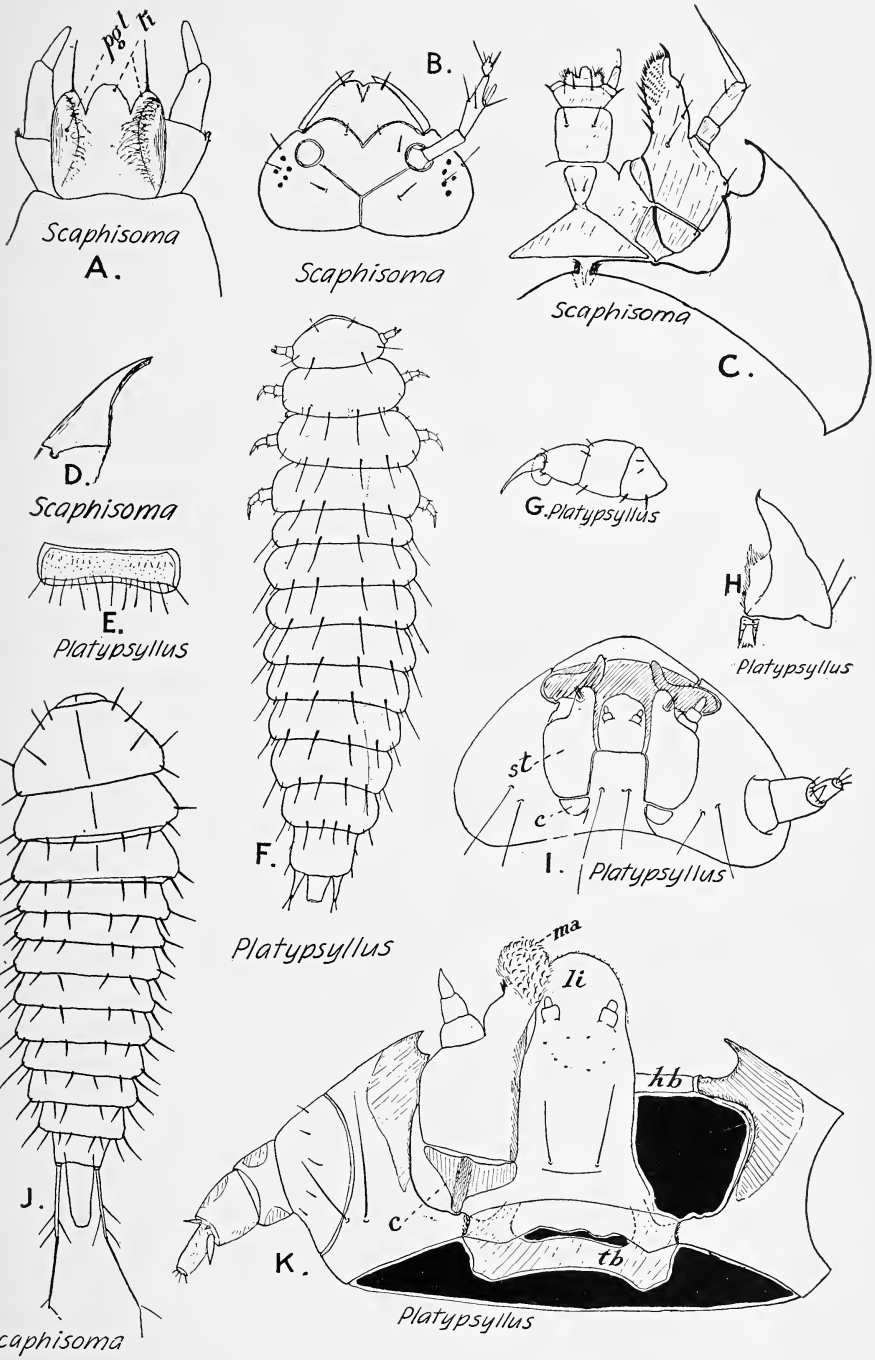
Prionochaeta
L.
Prionochaeta

Plate 12

Scaphidiidae, Platypsyllidae

A. Scaphisoma convexum Say : Ligula and paraglossa. Buccal view.
B. " " : Head. Dorsal view.
C. " " : Head. Ventral view.
D. " " : Right mandible. Ventral view.
E. Platypsyllus castoris Rits. : Abdominal segment. Dorsal view.
F. " " : Mature larva. Dorsal view.
G. " " : Leg of first instar.
H. " " : Right mandible of mature larva. Dorsal view.
I. " " : Head of first instar. Ventral view.
J. Scaphisoma convexum : Larva. Dorsal view.
K. Platypsyllus castoris : Head of mature larva. Ventral view.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Scaphisoma
C.
D.
Scaphisoma
E.
Platypsyllus
F.
Platypsyllus
G. Platypsyllus
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Scaphisoma
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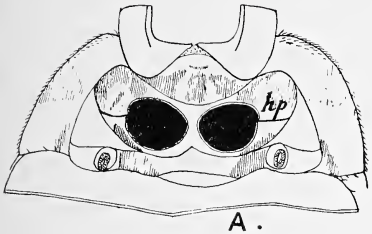
tb
K.
Platypsyllus

Plate 13

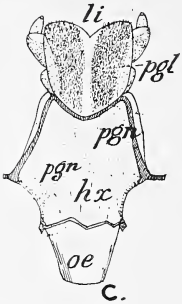
Silphidae-Silphinae

A. Silpha (noveboracensis Forst.?) : Prothorax. Ventral view.
B. " " : Labium and hypopharynx. Lateral view.
C. " " : Hypopharyngeal structures. Dorsal view.
D. " " : Right mandible. Dorsal view.
E. " " : Head. Ventral view.
F. " " : Larva. Dorsal view.
G. " " : Left maxilla. Dorsal view.
H. " " : Head. Dorsal view.
I. " " : Tenth abdominal segment.
J. Necrodes littoralis L. (Denmark) : Larva. Lateral view.

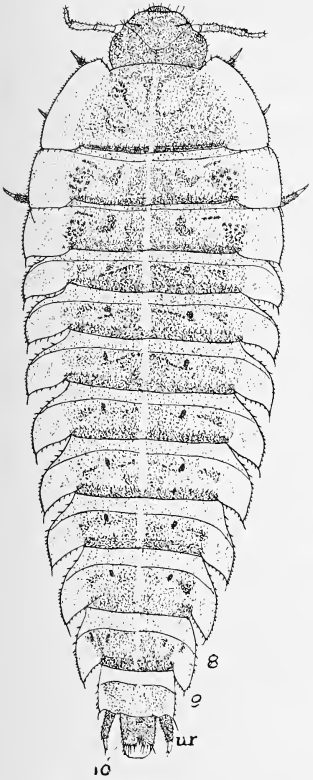


A.
Silpha

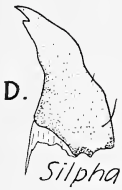
B.
Silpha



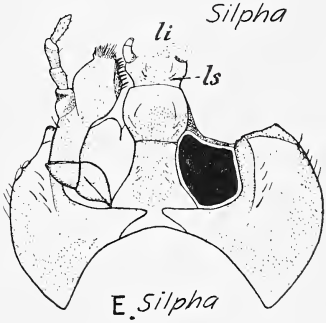
C.
Silpha



F. Silpha

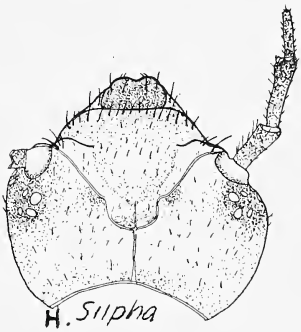


D.
Silpha



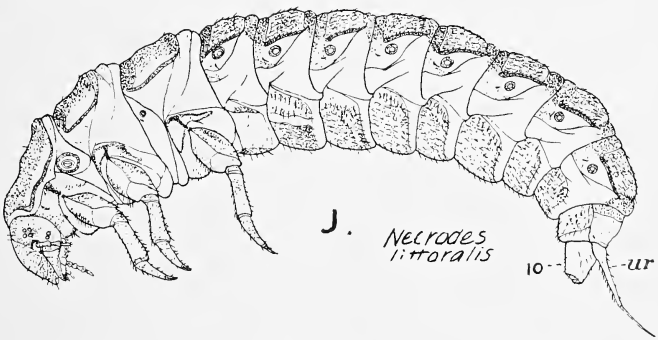
E. Silpha

G.
Silpha



H. Silpha

I. Silpha

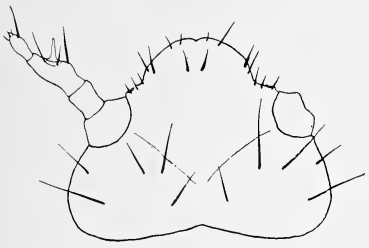


J.
Necrodes
littoralis

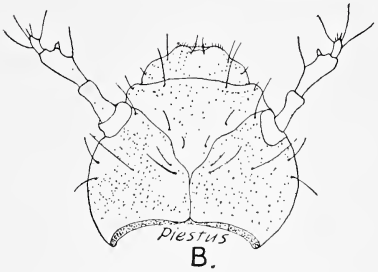
Plate 14

Staphylinidae-Piestinae,
Staphylinidae-Aleocharinae

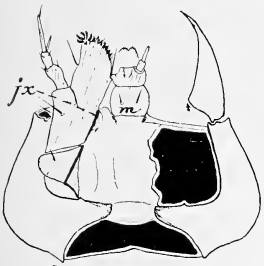
A. Gyrophaena sp. : Head. Dorsal view.
B. Piestus pygmaeus Casteln. (Brazil) : Head. Dorsal view.
C. " " : Larva. Lateral view.
D. Gyrophaena sp. : Head. Ventral view.
E. Piestus pygmaeus : Hypopharyngeal structures. Dorsal view.
F. " " : Head. Ventral view.
G. Gyrophaena sp. : Diagram illustrating abdominal sclerotes.
H. Piestus pygmaeus : Diagram illustrating abdominal sclerotes.
I. Gyrophaena sp. : Larva. Lateral view.



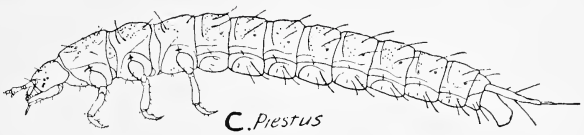
A.
Gyrophaena



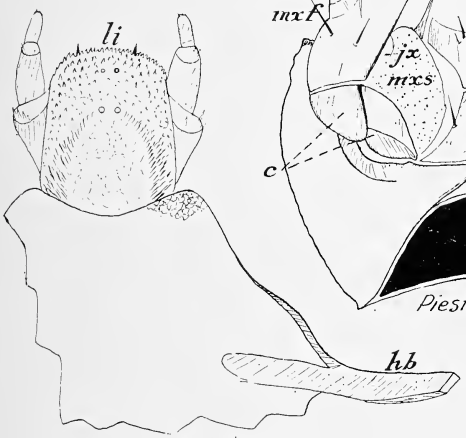
B.



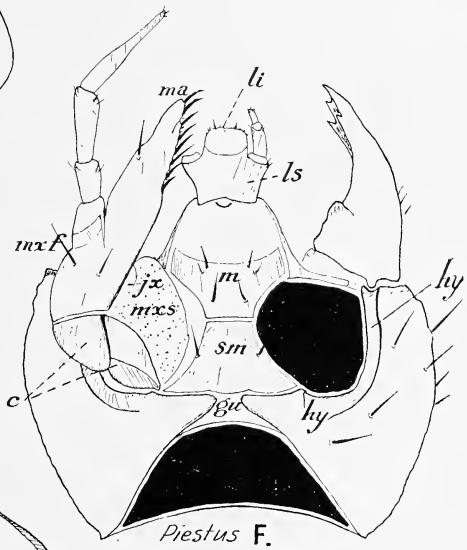
Gyrophaena D.



C. *Piestus*



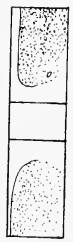
E. *Piestus*



Piestus F.

G.
Gyrophaena

H.



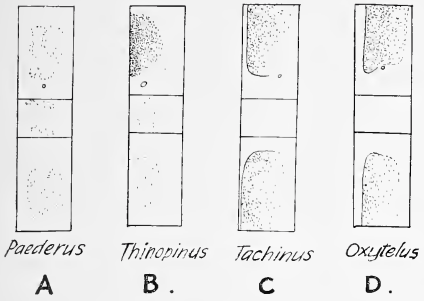
Piestus

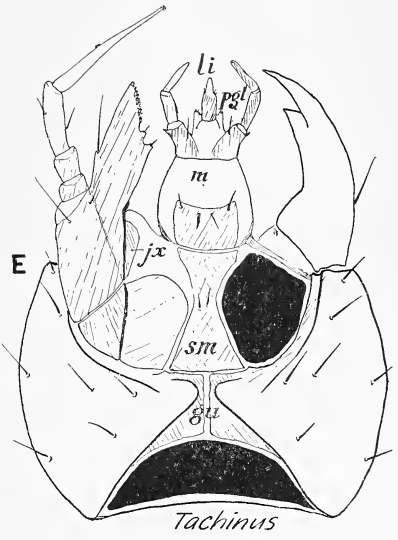
I. *Gyrophaena*

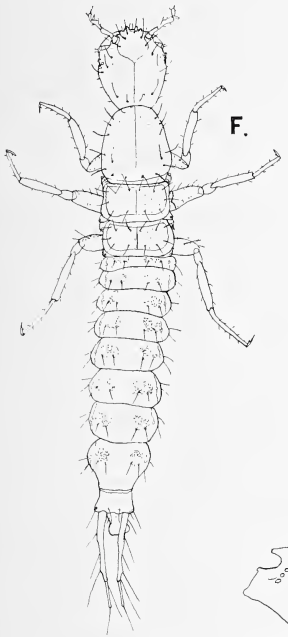
Plate 15

Staphylinidae-Oxytelinae,
Staphylinidae-Tachyporinae,
Staphylinidae-Thinopininae,
Staphylinidae-Paederinae

A. Paederus riparius L. (Denmark) : Diagram illustrating abdominal scleromes.
B. Thinopinus pictus Lec. : Diagram illustrating abdominal scleromes.
C. Tachinus fumipennis Say : Diagram illustrating abdominal scleromes.
D. Oxytelus insignitus Grav. : Diagram illustrating abdominal scleromes.
E. Tachinus fumipennis : Head. Ventral view.
F. Paederus riparius : Larva. Dorsal view.
G. Oxytelus insignitus : Head. Lateral view.
H. " " : Head. Ventral view.
I. Tachinus fumipennis : Head. Lateral view.
J. " " : Head. Dorsal view.
K. " " : Posterior end of abdomen. Lateral view.
L. Oxytelus insignitus : Head. Dorsal view.

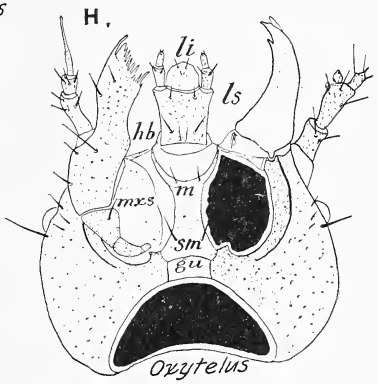

Paederus
Thinopinus
Tachinus
Oxytelus
A
B.
C
D.

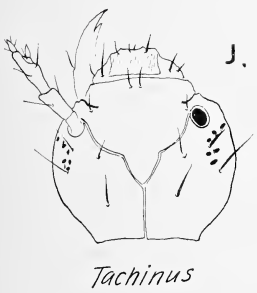

li
pal
m
jx
E
sm
gu
Tachinus

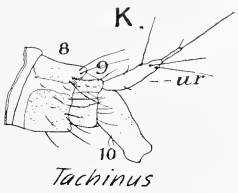

F.
Paederus


G.
Oxytelus


I. Tachinus


H.
li
ls
hb
m
mxs
sm
gu
Oxytelus


J.
Tachinus


K.
8
9
ur
10
Tachinus

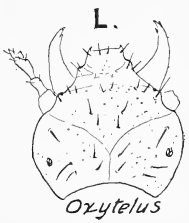
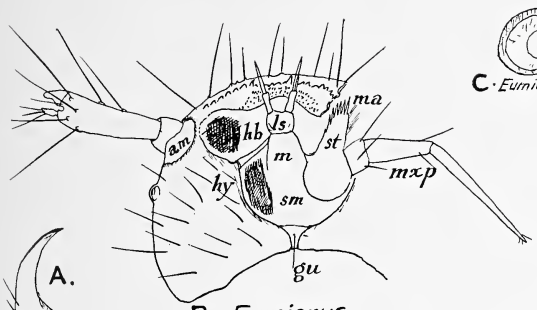

L.
Oxytelus

Plate 16

Staphylinidae-Aleocharinae (F–I),
Staphylinidae-Proteininae (J–M),
Scydmaenidae (A–E)

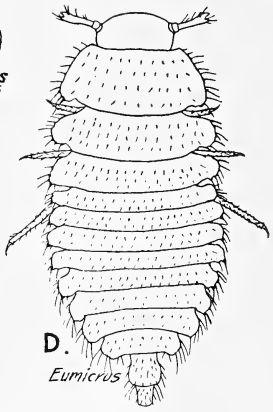
A. Eumicrus longicollis Csy. : Right mandible. Ventral view.
B. " " : Head. Ventral view.
C. " " : Spiracle.
D. " " : Larva. Dorsal view.
E. " " : Leg.
F. Maseochara sp. (Arizona) : Leg.
G. " " : Mature larva. Lateral view.
H " " : Head. Dorsal view.
I. " " : Head. Ventral view.
J. Proteinus atomarius Er. : Head. Lateral view.
K. " " : Mesothoracic leg.
L. " " : Head. Ventral view.
M. " " : Larva. Dorsal view.



B. Eumicrus

A. Eumicrus

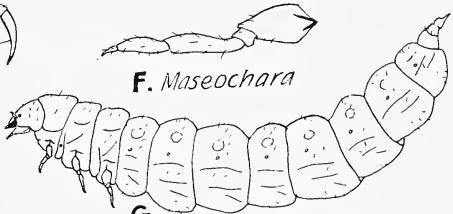
C. Eumicrus



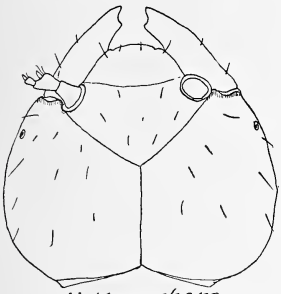
D. Eumicrus

E. Eumicrus

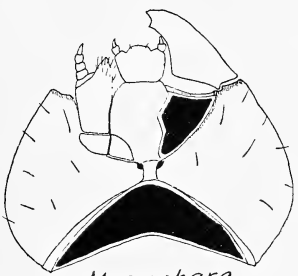
F. Maseochara



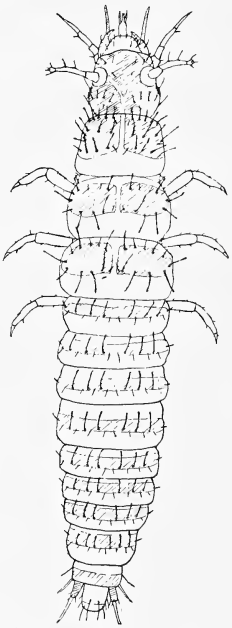
G. Maseochara



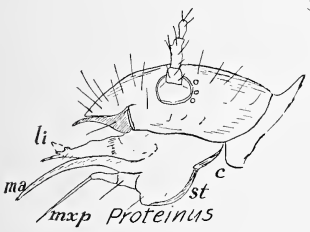
H. Maseochara



I. Maseochara

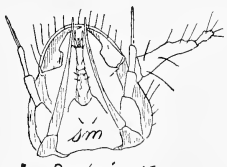


M. Proteinus



J. Proteinus

K. Proteinus

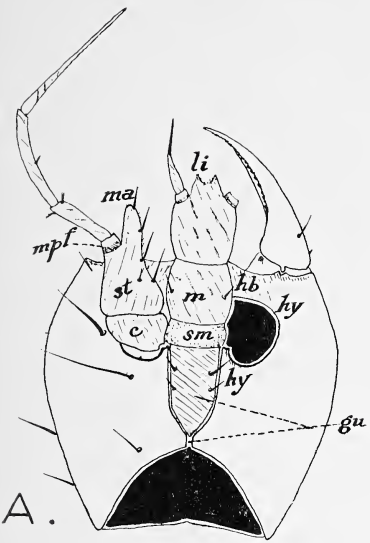


L. Proteinus

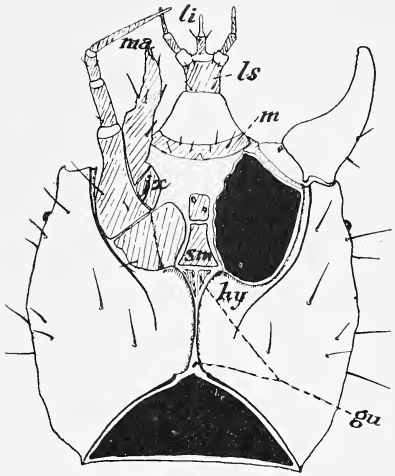
Plate 17

Staphylinidae-Omaliinae,
Staphylinidae-Steninae

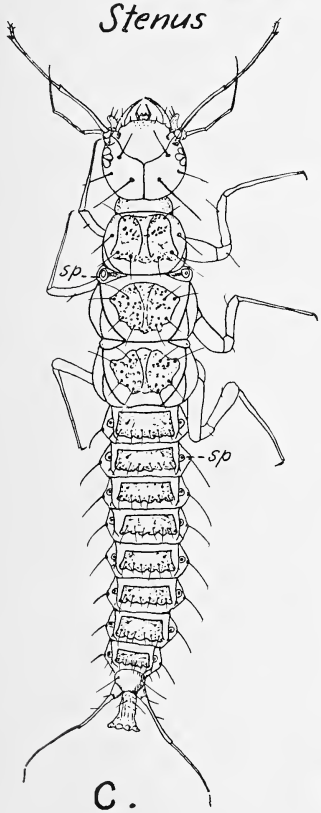
A. Stenus sp. : Head. Ventral view.
B. Omalium rivulare Payk. (Denmark) : Head. Ventral view.
C. Stenus sp. : Larva. Dorsal view.
D. Omalium rivulare : Head. Dorsal view.
E. Stenus sp. : Head. Lateral view.
F. Omalium rivulare : Diagram illustrating abdominal scleromes.
G. " " : Larva. Lateral view.



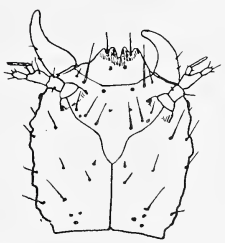
A. *Stenus*



B. *Omalium*



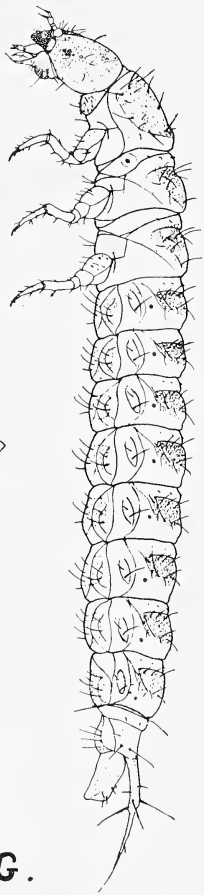
C. *Stenus*



D. *Omalium*

E. *Stenus*

F. *Omalium*

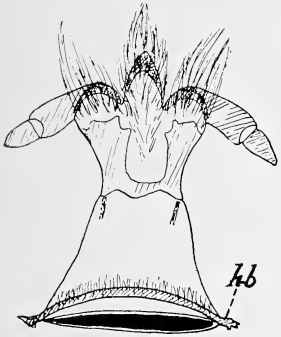


G. *Omalium*

Plate 18

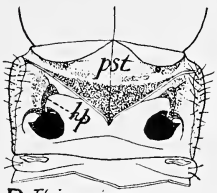
Staphylinidae-Thinopininae,
Staphylinidae-Paederinae

A. Thinopinus pictus Lec. : Hypopharynx.
B. Paederus riparius L. (Denmark) : Hypopharynx.
C. " " : Head. Ventral view.
D. Thinopinus pictus : Prothorax. Ventral view.
E. " " : Head. Dorsal view.
F. Paederus riparius : Head. Lateral view.
G. Thinopinus pictus : Diagram illustrating position of antennae and mouthparts.
H. " " : Abdominal spiracle.
I. " " : Head. Ventral view.
J. " " : Head. Lateral view.

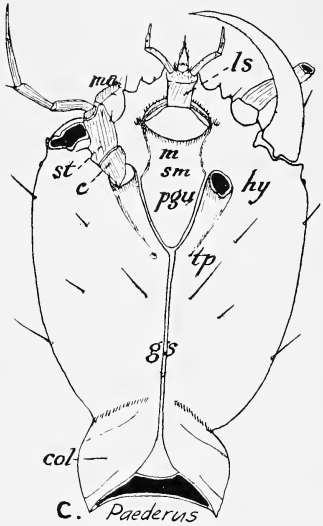


A. Thinopinus

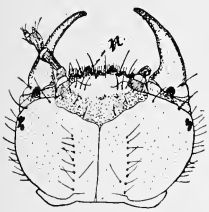
B. Paederus



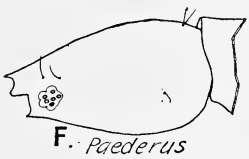
D. Thinopinus



C. Paederus

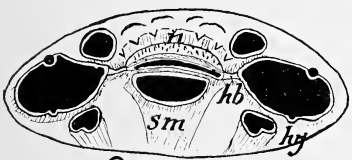


E. Thinopinus

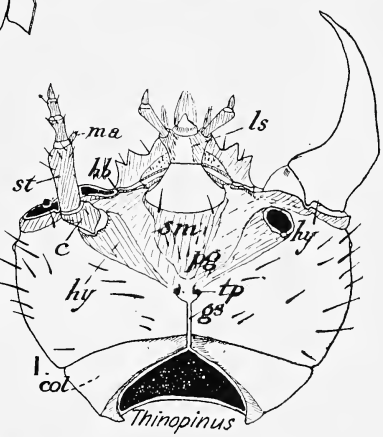


F. Paederus

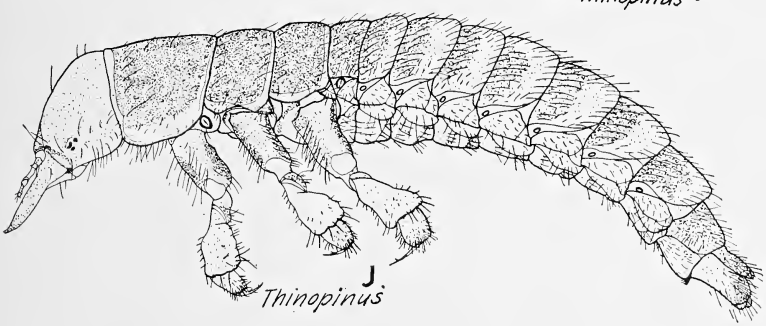
H. Thinopinus



G. Thinopinus



I. Thinopinus



J. Thinopinus

Plate 19

Scydmaenidae (A–D). Pselaphidae (E–J)

A. Scydmaenidae (Plummers Isl., Maryland): Head. Ventral view.
B. " : Larva. Dorsal view.
C. " : Larva. Lateral view.
D. " : Head. Dorsal view.
E. Batrisodes monstrosus Lec. : Head. Dorsal view.
F. Euplectus confluens Lec. : Head. Ventral view.
G. Batrisodes monstrosus : Larva. Ventral view.
H. " " : Ventral mouth-parts. Ventral view.
I. " " : Larva. Lateral view.
J. Euplectus confluens : Larva. Dorsal view.

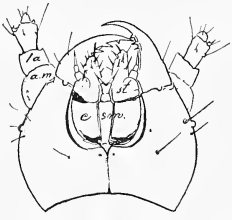
A. Scyd.

B. Scyd.

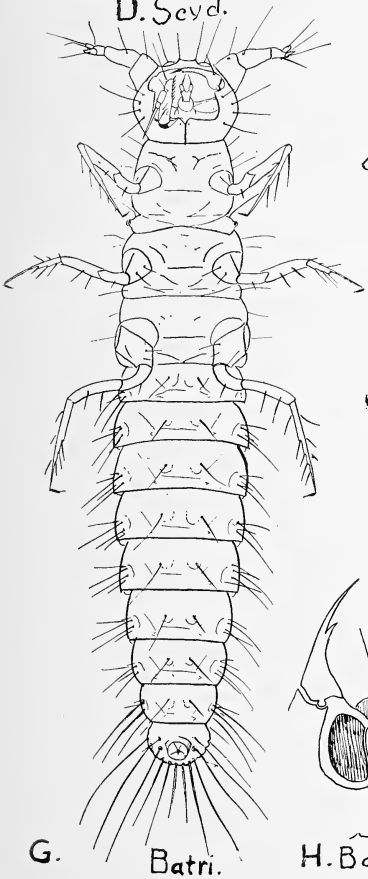
C. Scyd.

D. Scyd.

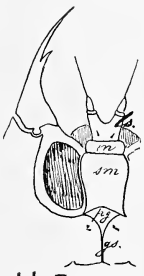
E. Batri.



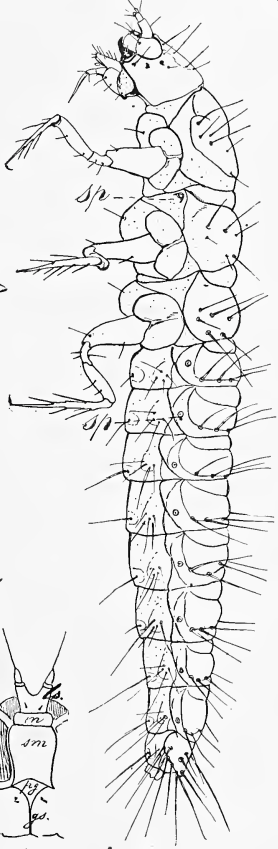
F. Euplectus



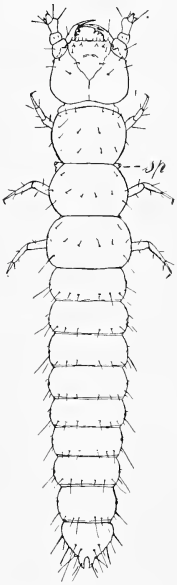
G. Batri.



H. Batri.



I. Batri.



J. Euplectus

Plate 20

Histeridae

A. Platysoma sp. : Right mandible. Dorsal view.
B. Saprinus estriatus Lec. : Right mandible. Dorsal view.
C. " " : Head. Dorsal view.
D. " " : Ventral mouthparts. Ventral view.
E. Teretrius sp. : Tibia and tarsungulus.
F. " " : Ventral mouthparts. Ventral view.
G. " " : Head. Dorsal view.
H. " " : Right mandible. Dorsal view.
I. Hololepta yucateca Mars. : Larva. Dorsal view.
J. " " : Ventral mouthparts with muscles (Diagram).
K. Paromalus aequalis Say. : Leg.
L. Hister unicolor L. (Denmark) : Vertical longitudinal section of spiracle, closing apparatus, and the epidermal tissues which form these parts in the following larval stage. (Notice the barrel shaped layer of one of the tubes of the next spiracle).
M. Hololepta yucateca : Thorax. Ventral view.
N. Hister unicolor : Closing apparatus of spiracle.
O. " " : Cross section of tubes of biforous spiracle.
P. " " : Spiracle cut horizontally to show the inner lumen of tubes.
Q. " " : Spiracle from above.
R. Hololepta yucateca : Larva. Lateral view.

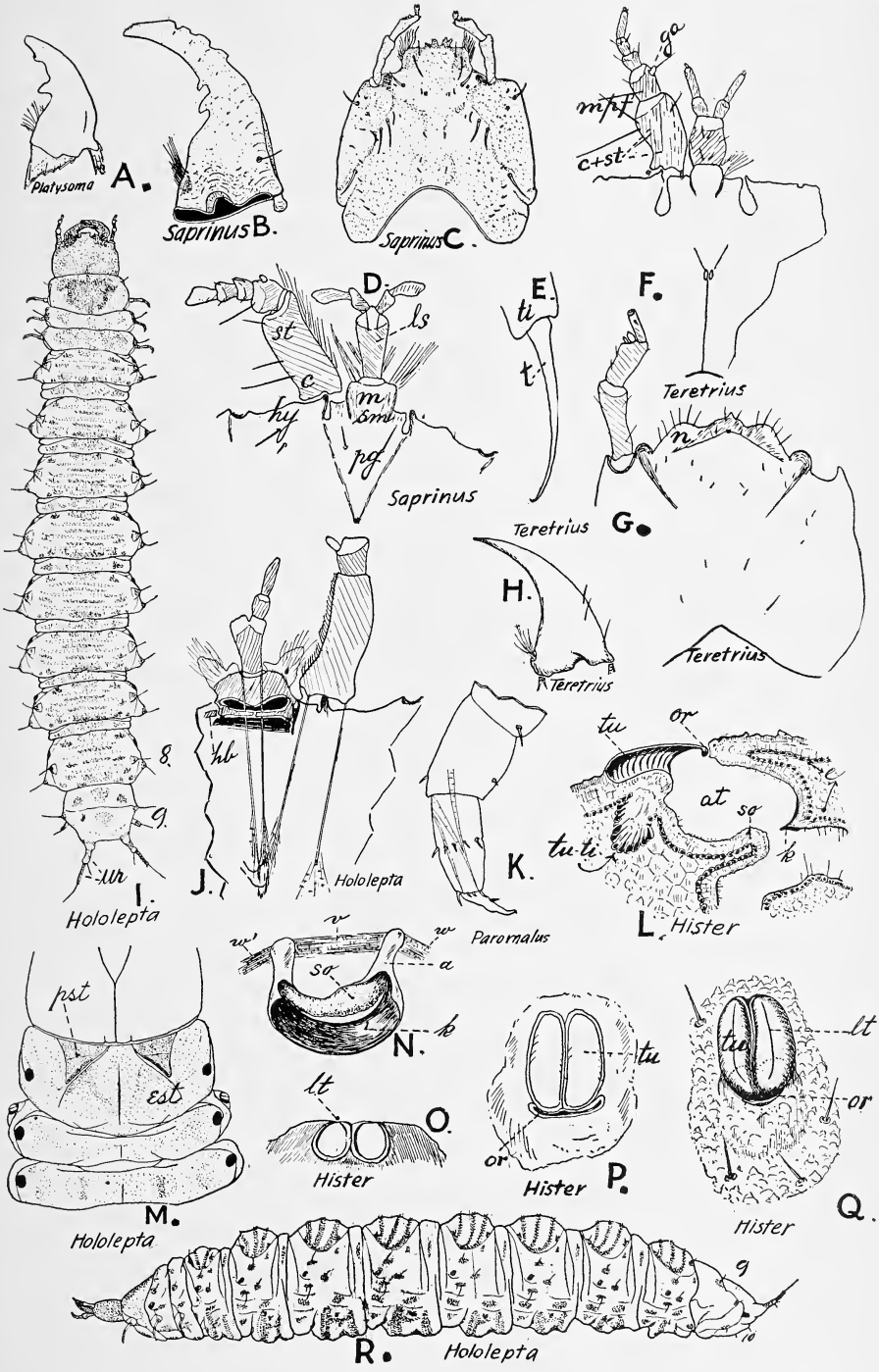

Platysoma
A.
Saprinus B.
Saprinus C.
go
m+t
c+st
D.
st
ls
c
m
sm
hy
pg
Saprinus
E.
tl
t
Teretrius
F.
Teretrius
n
G.
Teretrius
H.
Teretrius
8.
9.
ur
I.
Hololepta
hb
J.
Hololepta
K.
tu
or
at
so
tu-tl
L.
Hister
Paromalus
v
w
a
b
N.
pst
est
M.
Hololepta
lt
O.
Hister
tu
or
P.
Hister
lt
tu
or
Q.
Hister
9
10
R.
Hololepta

Plate 21

Histeridae, Helophoridae, Spercheidae

A. Helophorus aquaticus L. (Denmark) : Head. Dorsal view.
B. Spercheus emarginatus Schall (Denmark) : Maxilla. Ventral view.
C. " " : Head. Ventral view.
D. Helophorus aquaticus : Larva. Ventral view.
E. " " : Larva. Ventral view.
F. Spercheus emarginatus : Leg.
G. " " : Mandible.
H. " " : Larva. Dorsal view.
I. Histeridae (British Guiana. Termitophilous larva of unknown genus collected by Dr. E. A. Emerson) : Larva. Lateral view.

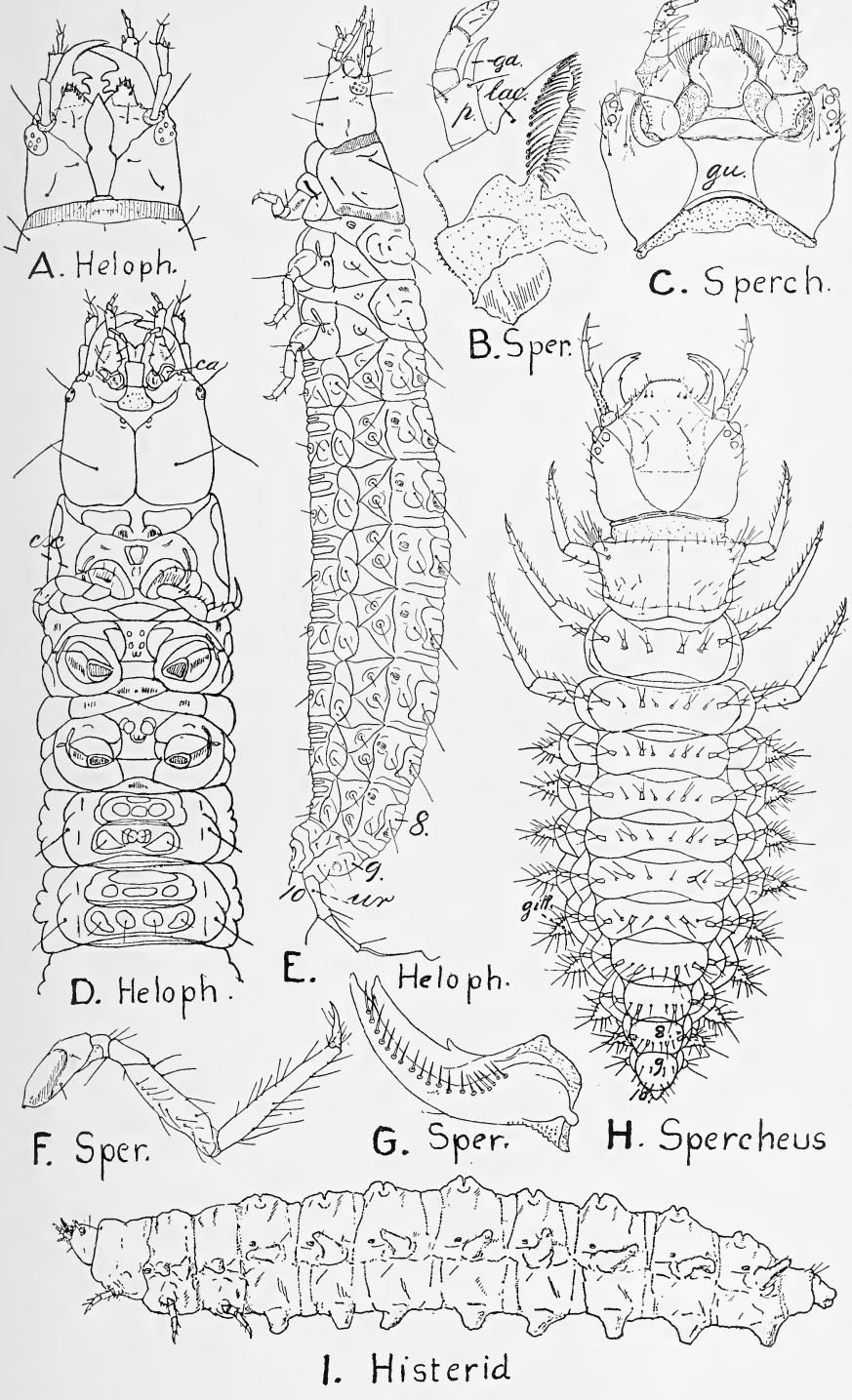

A. Heloph.
ga.
lac.
p.
B. Sper.
gu.
C. Sperch.
ca.
cx.
D. Heloph.
8.
9.
10
ur
E. Heloph.
gill
8.
9.
10
H. Spercheus
F. Sper.
G. Sper.
I. Histerid

Plate 22

Hydrochidae, Hydrophilidae-Berosinae, Hydrophilidae-Hydrophilinae, Hydrophilidae-Hydrobiinae

A. Hydrochus squamifer Lec. (After E. A. Richmond) : Ventral mouthparts. Ventral view.
B. Berosus signaticollis Charp. (Denmark) : Anterior part of head. Dorsal view.
C. Laccobius minutus L. (Denmark) : Head. Dorsal view.
D. Hydrochus squamifer (After E. A. Richmond) : Larva. Dorsal view.
E. Berosus spinosus Stev. (Denmark) : Larva. Dorsal view.
F. Hydrophilus caraboides L. (Denmark) : Larva. Dorsal view.
G. " " : End of body. Lateral view.
H. Laccobius minutus : Anterior part of body. Ventral view.
I. " " : Larva. Lateral view.
J. Hydrobius fuscipes L. (Denmark) : Larva. Dorsal view.
K. " " : Head. Dorsal view.
L. Paracymus aeneus Germ. (Denmark) : Head. Ventral view.
M. " " : Head. Dorsal view.
N. Helochares lividus Forster (Denmark) : First instar. Dorsal view.
O. Enochrus melanocephalus Od. (= E. bicolor Payk.) (Denmark) : End of body. Dorsal view.
P. " " : Head. Dorsal view.
Q. " " : Proleg. Ventro-lateral view.
R. Philydrus sp. (Denmark) : Proleg. Ventro-lateral view.
S. Enochrus melanocephalus : Larva. Dorso-lateral view.

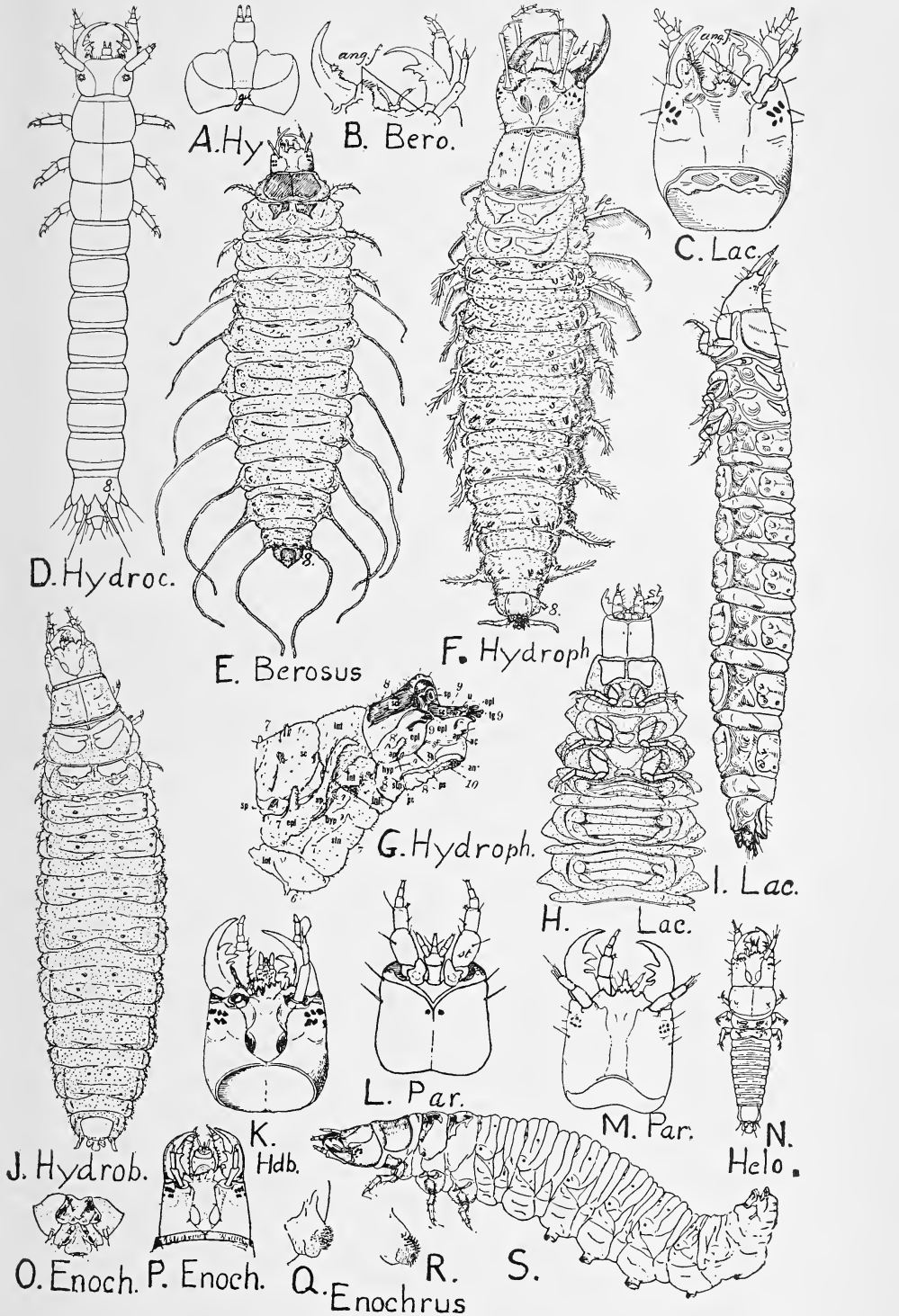

A. Hy.
B. Bero.
C. Lac.
D. Hydroc.
E. Berosus
F. Hydroph.
G. Hydroph.
H. Lac.
I. Lac.
J. Hydrob.
K.
L. Par.
M. Par.
N. Helo.
O. Enoch.
P. Enoch.
Hdb.
Q. Enochrus
R.
S.

Plate 23

Hydrophilidae-Hydrophilinae (A),
Hydrophilidae-Hydrobiinae (B, G, H),
Hydrophilidae-Sphaeridiinae (C–F, I–P)

A. Hydrous piceus L. (Denmark) : Larva. Dorsal view.
B. Paracymus aeneus Germ. (Denmark) : Anterior part of larva. Dorsal view.
C. Chaetartria seminulum Herbst (Denmark) : Larva. Lateral view.
D. " " : Larva. Dorsal view.
E. " " : Head. Dorsal view.
F. " " : Head. Ventral view.
G. Paracymus aeneus : Posterior part of larva. Dorsal view.
H. " " : Leg.
I. Chaetartria seminulum : End of body. Dorsal view.
J. " " : Leg.
K. Coelostoma orbiculare F. (Denmark) : Anterior part of head. Dorsal view.
L. " " : Head. Dorsal view.
M. " " : Head. Ventral view.
N. " " : Larva. Dorsal view.
O. " " : Anterior part of larva. Lateral view.
P. " " : Prothorax and mesothorax. Ventral view.

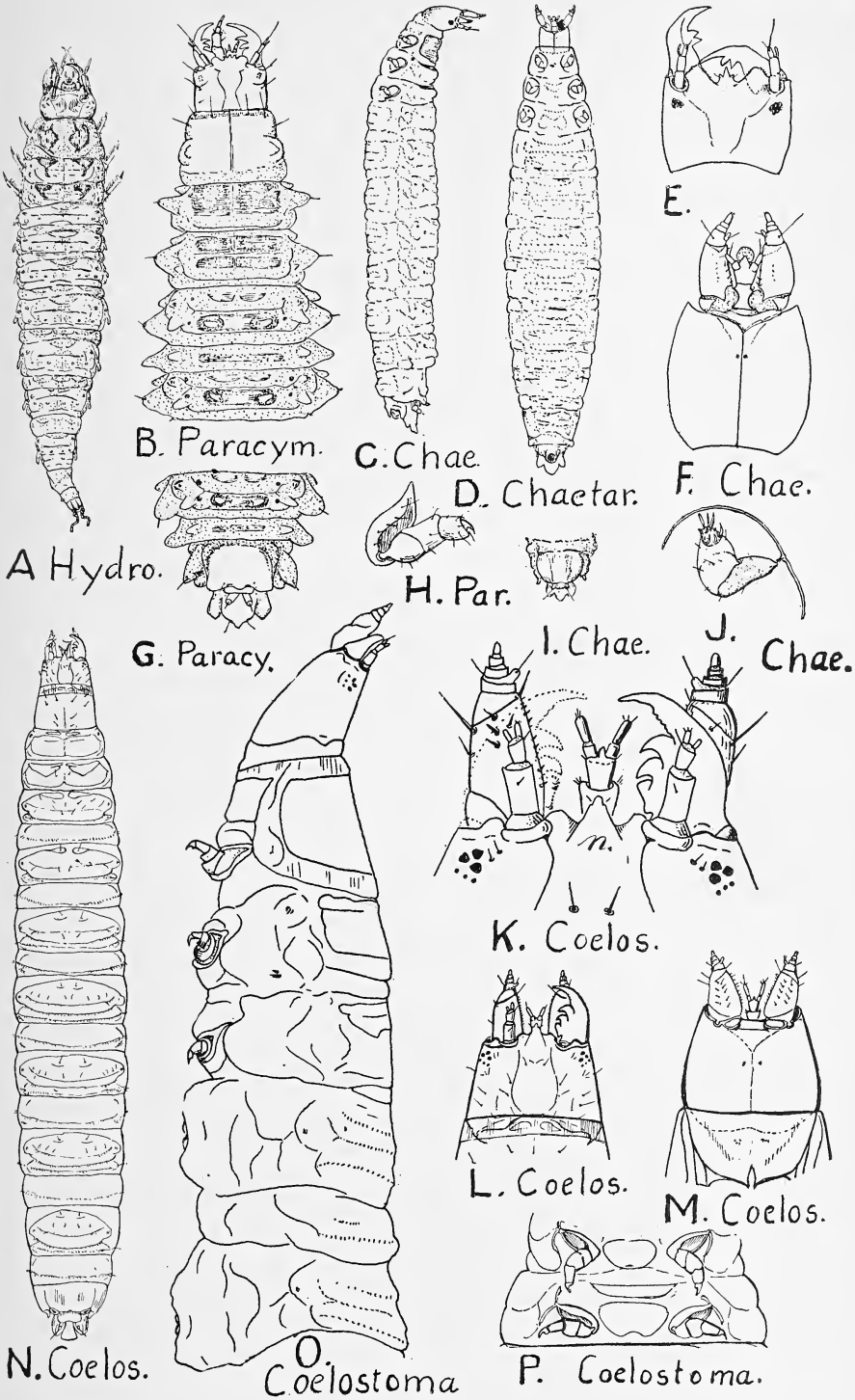

A Hydro.
B. Paracym.
C. Chae.
D. Chaetar.
E.
F. Chae.
G. Paracy.
H. Par.
I. Chae.
J. Chae.
K. Coelos.
L. Coelos.
M. Coelos.
N. Coelos.
O. Coelostoma
P. Coelostoma.

Plate 24.

Hydrophilidae-Sphaeridiinae

A. Undetermined larva (Cryptopleurum (?), Megasternum (?), or Cercyon (?) 3mm. long) (Ireland) : Left mandible.
B. " : Anterior part of head. Dorsal view.
C. " : Right mandible.
D. " : Larva. Ventral view.
E. " : Ventral mouthparts. Ventral view.
F. " : Larva. Dorsal view.
G. Sphaeridium bipustulatum F. (Denmark) : Spiracle of eighth abdominal segment.
H. " " : Leg.
I. Undetermined larva (Cryptopleurum? etc. as above) : Legs and part of abdomen. view.
J. Sphaeridium bipustulatum : Anterior part of head. Dorsal view.
K. " " : Maxilla. Ventral view.
L. Paracercyon flavipes Thunbg. (= Cercyon analis Payk.) (Denmark) : Right mandible.
M. Sphaeridium bipustulatum : Larva. Ventral view.
N. " " : Right mandible.
O. " " : Left mandible.
P. Paracercyon flavipes : Left mandible.
Q. Sphaeridium bipustulatum : End of body. Dorsal view.
R. Sphaeridium scarabaeoides L. (Denmark) : End of body. Dorsal view.
S. Sphaeridium bipustulatum : Labium. Ventral view.
T. Paracercyon flavipes : Larva. Dorsal view.
U. " " : Ventral mouthparts. Ventral view.

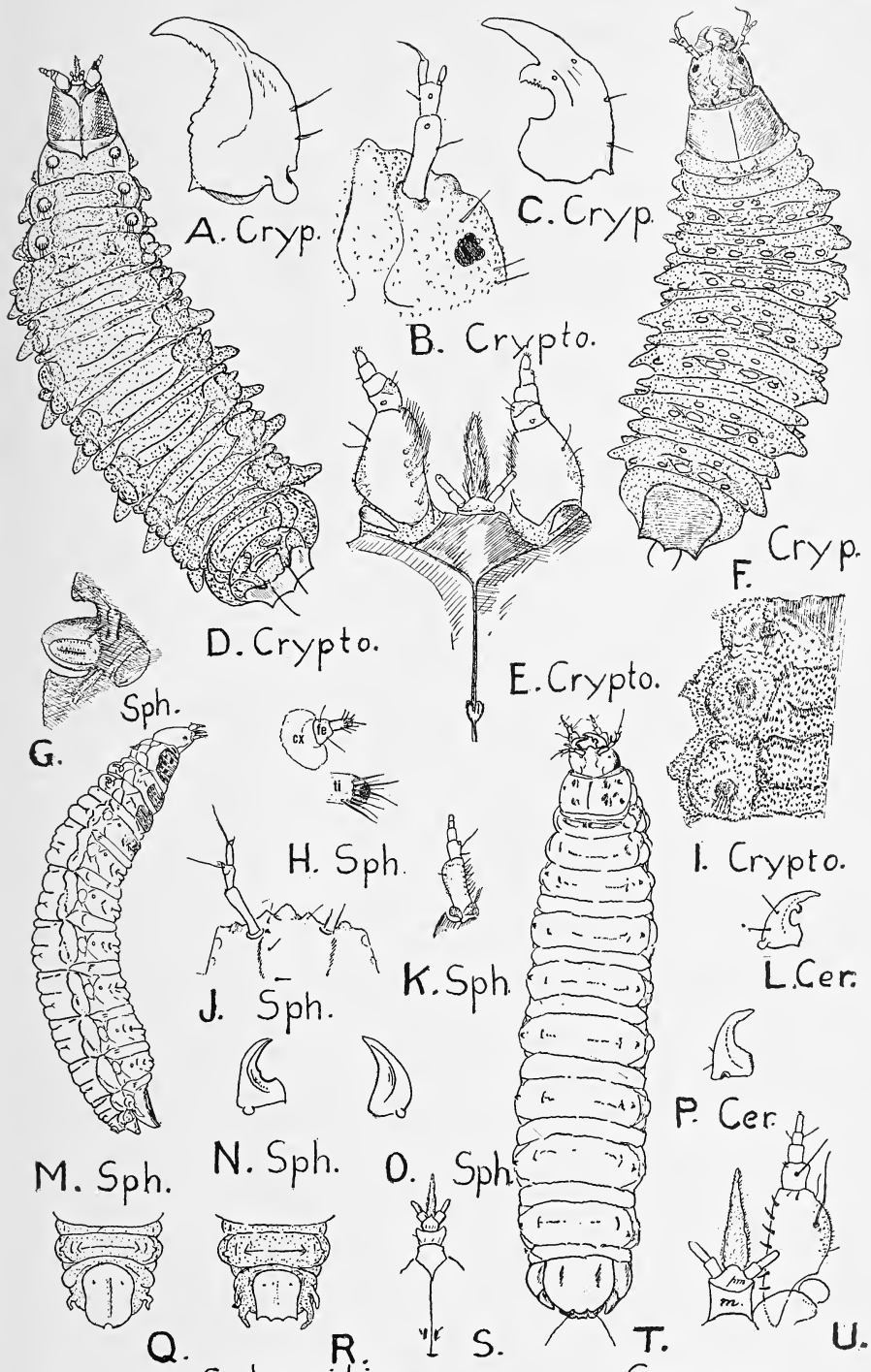

A. Cryp.
B. Crypto.
C. Cryp.
D. Crypto.
E. Crypto.
F. Cryp.
Sph.
G.
H. Sph.
I. Crypto.
J. Sph.
K. Sph.
L. Cer.
P. Cer.
M. Sph.
N. Sph.
O. Sph.
Q.
R.
S.
T.
U.
Sphaeridium
Cercyon

Plate 25

Lathridiidae, Monotomidae

A. Cartodere costulata Reit. : Anterior part of head. Ventral view.
B. " " : Mandible. Extero-dorsal view.
C. Melanophthalma chamaeropis Fall. : Mandible, labial palpi, hypopharynx.
D. Cartodere costulata : Mandible. Buccal view.
E. " " : Larva. Lateral view.
F. " " : Eighth and ninth abdominal segments. Dorsal view.
G. Melanophthalma chamaeropis : Ocelli, antenna.
H. " " : End of maxilla.
I. Corticaria dentigera Lec. : Mandible. Ventral view.
J. Lathridiidae (genus?) : Mandible. Dorsal view.
K. Eufallia seminiveus Mots. : Larva. Dorsal view.
L. " " : Head. Ventral view.
M. Hesperobaenus n. sp. (Florida) : Head. Dorsal view.
N. " " : Tip of mala.
O. " " : Spiracle.
P. " " : Hypopharynx.
Q. " " : Head. Ventral view.
R. " " : Seventh, eighth, and ninth abdominal segments. Dorsal view.
S. " " : Larva. Lateral view.
T. " " : Tip of leg.
U. " " : Mandible.

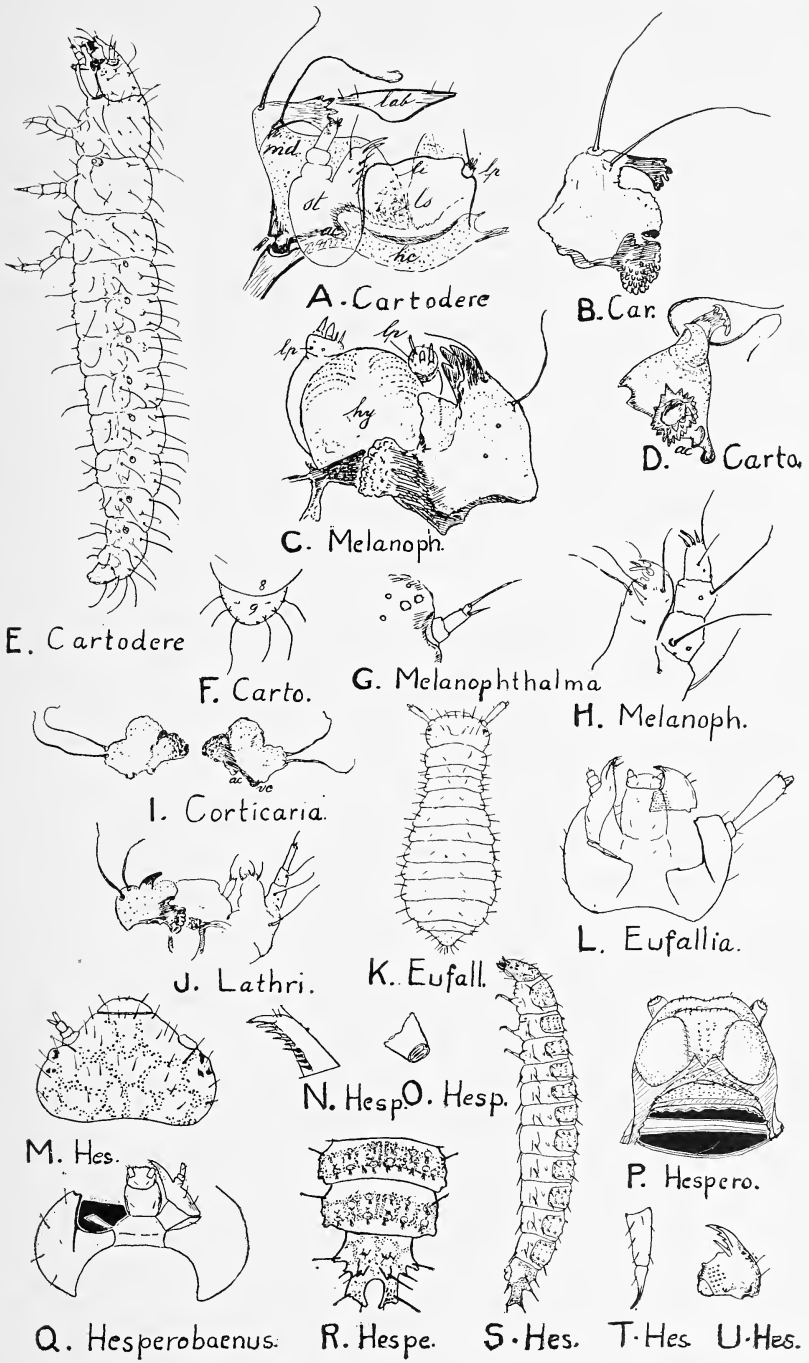
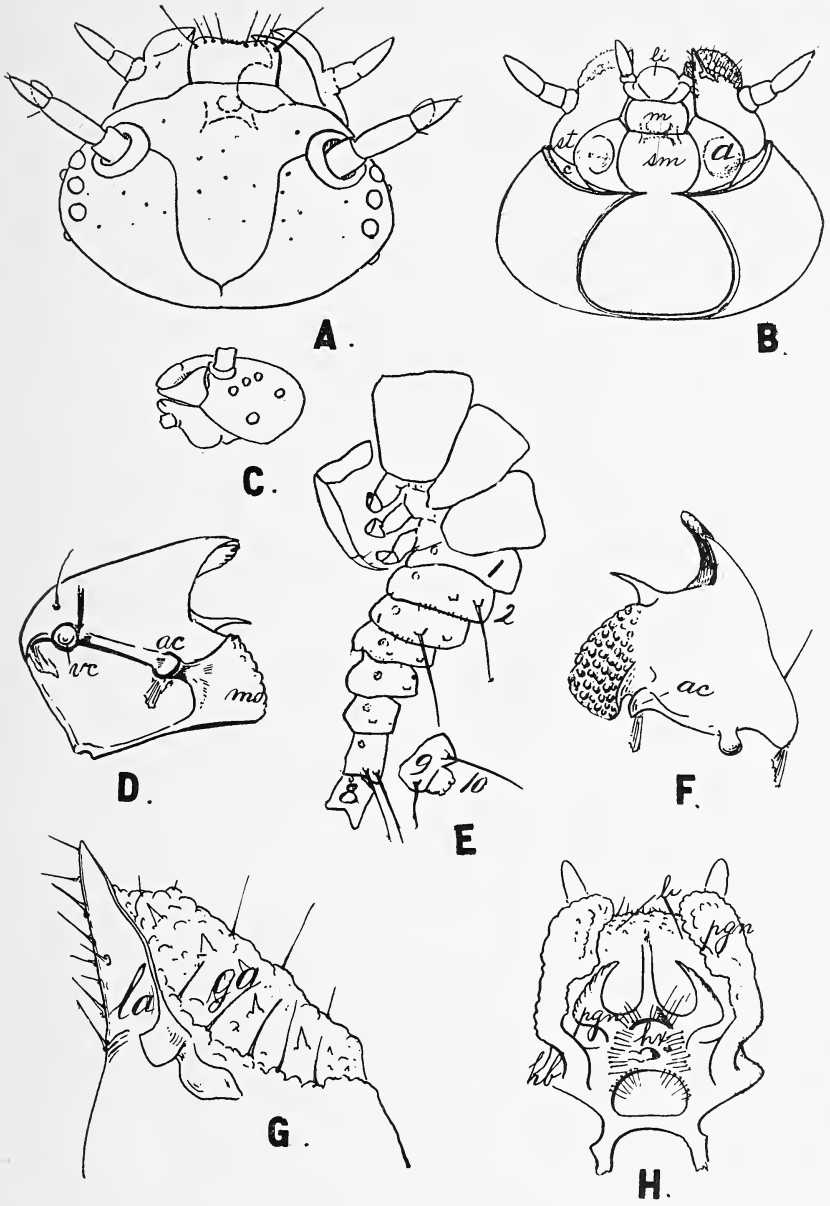

lab
mid
st
fe
lb
fp
hc
A. Cartodere
B. Car.
hy
lp
C. Melanoph.
D. Carto.
E. Cartodere
F. Carto.
G. Melanophthalma
H. Melanoph.
I. Corticaria
K. Eufall.
L. Eufallia.
J. Lathri.
M. Hes.
N. Hesp.
O. Hesp.
P. Hespero.
Q. Hesperobaenus.
R. Hespe.
S. Hes.
T. Hes.
U. Hes.

Plate 26

Eucinetidae

A. Eucinetus (morio Lec.?) (Florida) : Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Head. Lateral view.
D. " " : Right mandible. Ventro-basal view.
E. " " : Larva; notice annular spiracles. (From cast skin on slide). Lateral view.
F. " " : Left mandible. Ventral view.
G. " " : Tip of maxilla.
H. " " : Hypopharynx; pgn to the right, read: pgl.



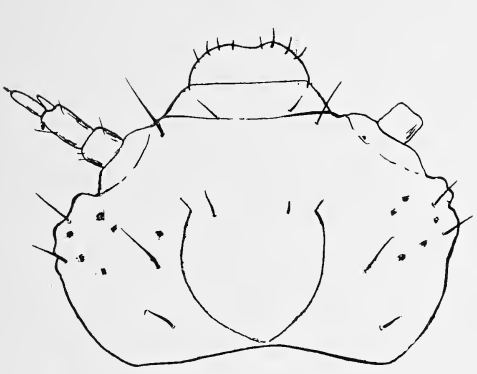
Cicinetus (morio Lec.?)

Plate 27

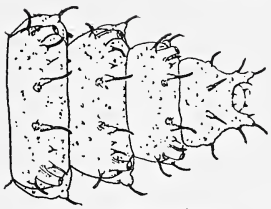
Derodontidae, Murmidiidae

A. Derodontus maculatus Melsh. (?)* : Head. Dorsal view.
B. " " : End of abdomen. Dorsal view.
C. " " : Abdominal biforous spiracle on process.
D. " " : Hypopharynx.
E. " " : Larva. Lateral view.
F. " " : Head. Ventral view.
G. " " : Leg.
H. " " : Left mandible. Ventral view.
I. Murmidius ovalis Beck. : Head. Ventral view.
J. " " : Hypopharyngeal structure.
K. " " : Left mandible. Ventral view.
L. " " : Larva. Dorsal view.

* Larva not reared but collected together with imago from slimy fungus below bark of dying tulip tree.

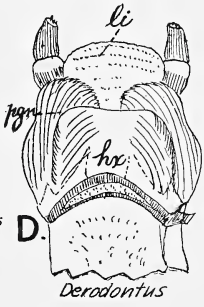


A. Derodontus

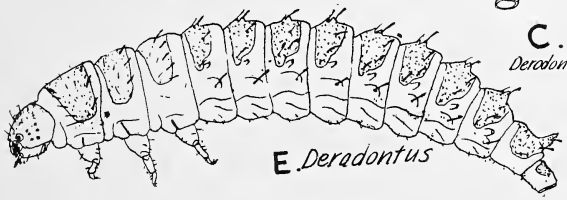


B. Derodontus

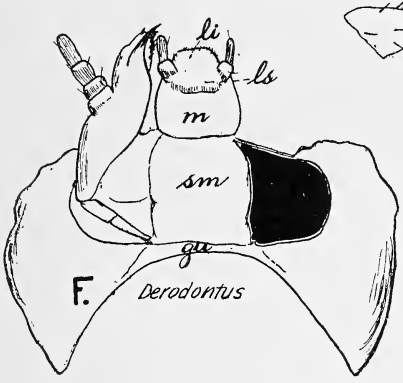
C. Derodontus



D. Derodontus



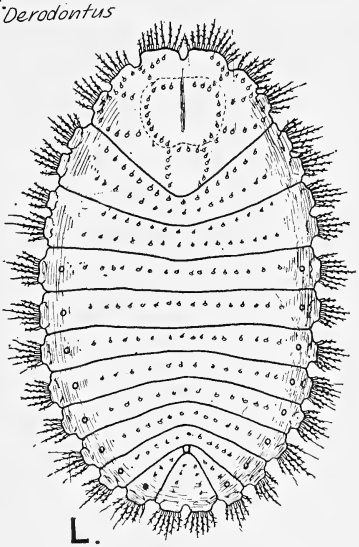
E. Derodontus



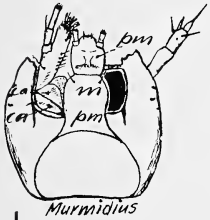
F. Derodontus

G. Derodontus

H. Derodontus



L. Murmidius



I. Murmidius

J. Murmidius

K. Murmidius

Plate 28

Rhizophagidae, Languriidae-Languriinae

Languriidae-Cladoxeninae (K, M, O, Q)

A. Rhizophagus grandis Gyll. (Finland) : Head. Ventral view.
B. " " : Head. Dorsal view.
C. " " : Ninth abdominal segment. Dorsal view.
D. " " : Mandible.
E. " " : Spiracle. Lateral view.
F. " " : Spiracle. Exterior view.
G. " " : Larva. Lateral view.
H. Languria angustata Beauv. : Head. Dorsal view.
I. " " : Right mandible. Ventral view.
J. " " : Left mandible. Ventral view.
K. Pharaxonotha kirschi Reit. : Left mandible. Ventral view.
L. Languria angustata : Larva. Lateral view.
M. Pharaxonotha kirschi : Larva. Lateral view.
N. Languria angustata : Hypopharynx, maxilla.
O. Pharaxonotha kirschi : Head. Dorsal view.
P. " " : Larva. Dorsal view.
Q. " " : Hypopharynx, maxilla.

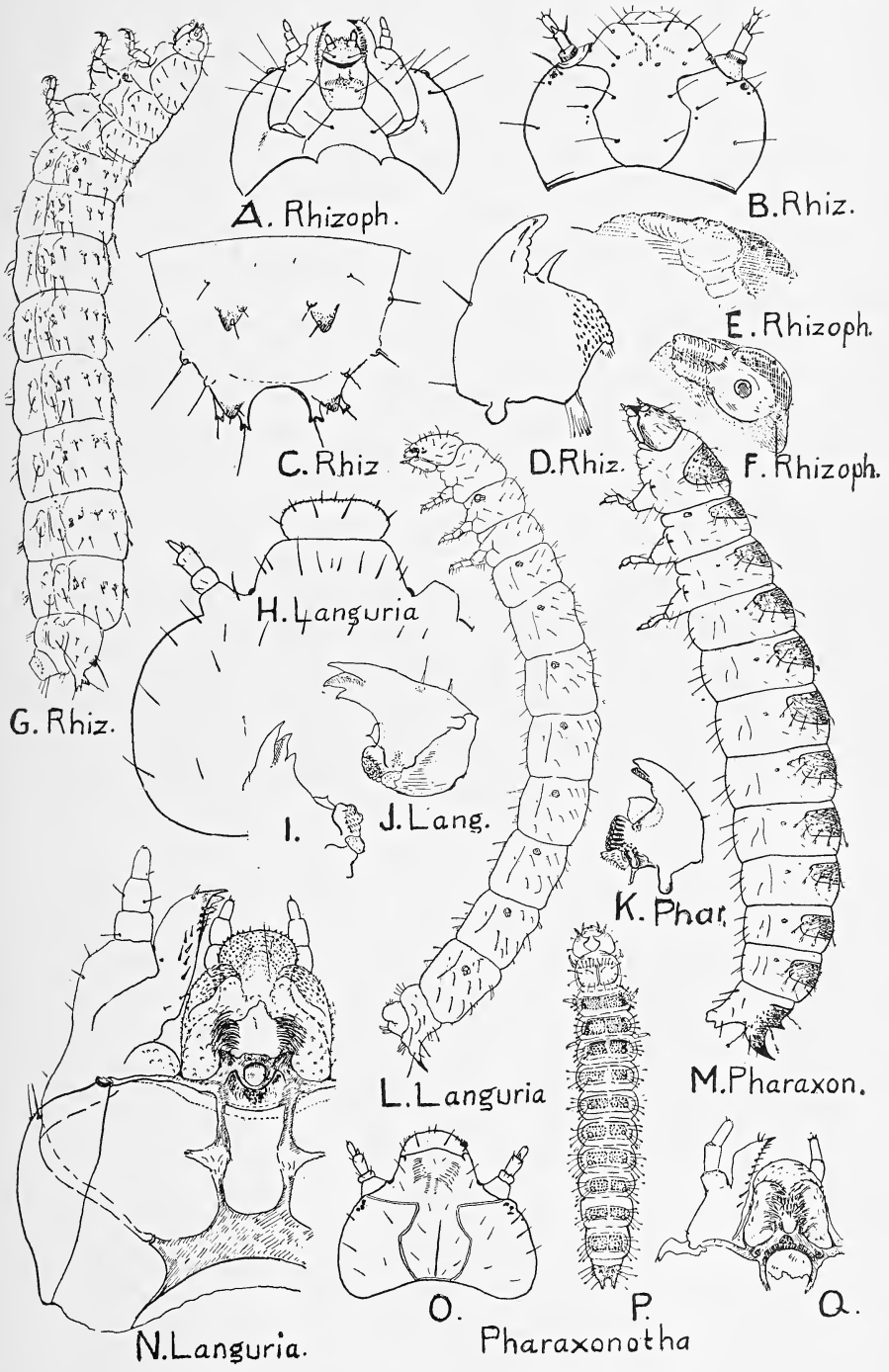
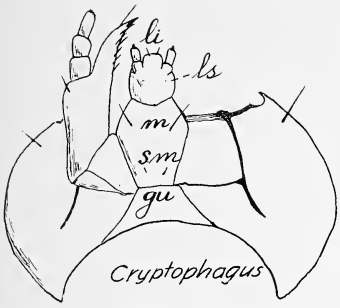

A. Rhizoph.
B. Rhiz.
E. Rhizoph.
C. Rhiz
D. Rhiz.
F. Rhizoph.
H. Languria
G. Rhiz.
I.
J. Lang.
K. Phar.
L. Languria
M. Pharaxon.
N. Languria.
O.
P.
Q.
Pharaxonotha

Plate 29

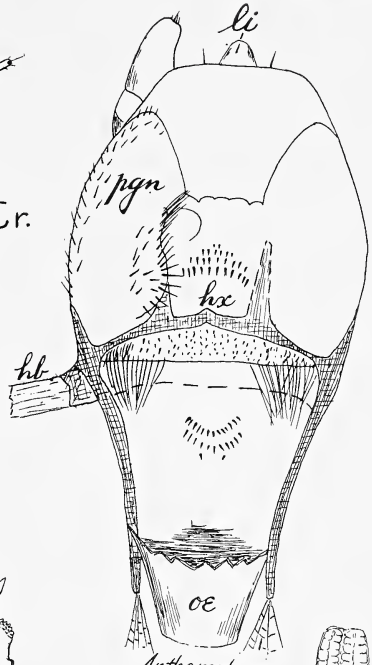
Cryptophagidae

A. Cryptophagus saginatus Sturm. : Head. Ventral view.
B. " " : Antenna, ocelli. Lateral view.
C. " " : Epipharynx.
D. " " : Larva. Dorsal view.
E. " " : Mandible. Ventral view.
F. " " : Mandible. Exterior view.
G. Antherophagus sp. : Hypopharynx.
H. Cryptophagus saginatus : Spiracle.
I. Telmatophilus typhae Fall. (Denmark) : Antenna, ocellus. Lateral view.
J. " " : Mandible. Ventral view.
K. " " : Thoracic spiracle.
L. " " : Third abdominal spiracle.
M. " " : Larva. Dorsal view.
N. " " : End of abdomen. Lateral view.
O. " " : Tip of mandible.
P. Henoticus germanicus Reit. (London; in jam) : Part of mandible. Ventral view.
Q. " " : Third abdominal spiracle.
R. " " : Anterior part of larva. Dorso-lateral view.
S. " " : Antenna.
T. " " : Ocelli. Lateral view.
U. " " : End of body. Dorsal view.

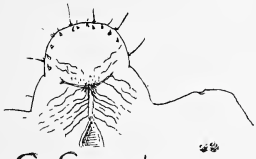


A.

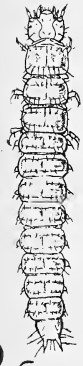
B. Cr.



G.



C. Crypto.



D. Cryp.

E. Cryp.

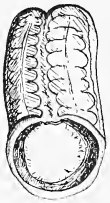
F. Cryp.

H. Cryp.

M. Tel.

I. Telm.

J. Telm.



K. Telm.

L. Telm.

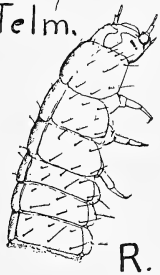
N. Telm.

O. Telm.

T. He.

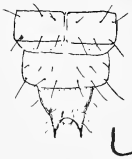
P.

Q.



R.

S.



U.

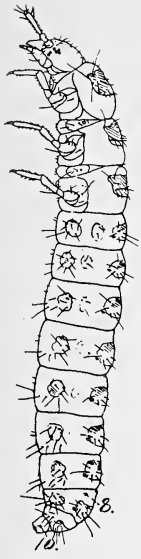
Henoticus

Plate 30

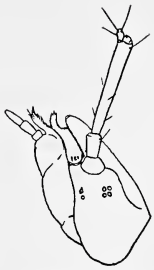
Silvanidae-Silvaninae,

Silvanidae-Telephaninae

A. Oryzaephilus surinamensis L. : Antenna.
B. Cathartus advena Waltl. : Head. Lateral view.
C. Oryzaephilus surinamensis : Ventral mouthparts. Ventral view.
D. Coccidotrophus socialis Schwarz and Barber (British Guiana) : Spiracle.
E. Oryzaephilus surinamensis : Larva. Lateral view.
F. Coccidotrophus socialis : Posterior part of left mandible; fil. pr, stiff chitinous filaments. Ventral view.
G. Nausibius clavicornis Kug. : Head and prothorax. Dorso-lateral view.
H. Coccidotrophus socialis : Anterior part of head. Dorsal view.
I. " " : Epipharynx.
J. " " : Maxilla, hypopharynx, maxillular area and glossa. (Special abbreviations.)
K. Telephanus (pallidus Schauf.?) (On cane, Porto Rico, reared) : Larva. Dorsal view.
L. " " : Head. Lateral view.
M. " " : End of abdomen. Lateral view.
N. " " : Mandible.
O. " " : Ventral mouthparts. Buccal view.



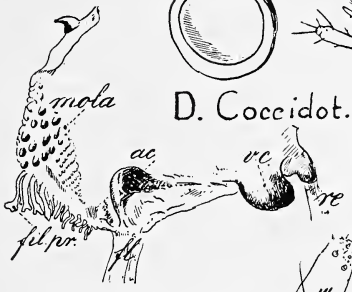
A. Oryzae.



B. Cath.

C. Oryzaephilus

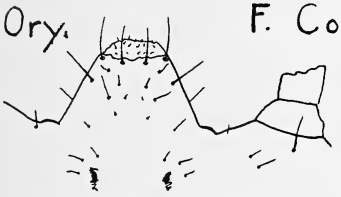
D. Coccidot.



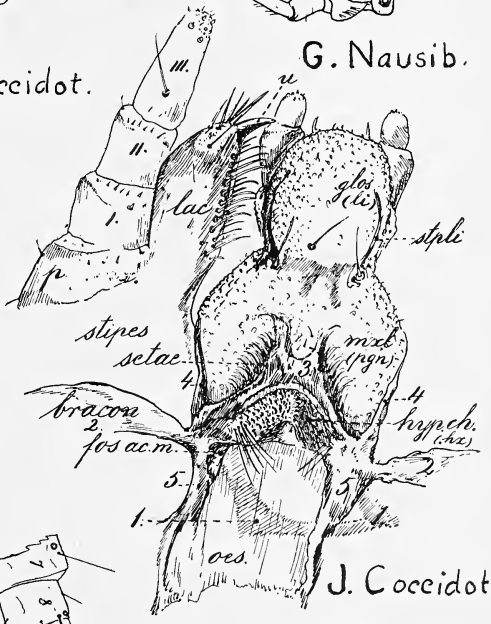
F. Coccidot.

G. Nausib.

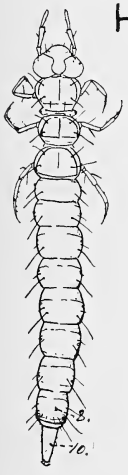
E. Ory.



H. Coccidot



J. Coccidot.



I. Coccidot.

L.

M.

N.

O.

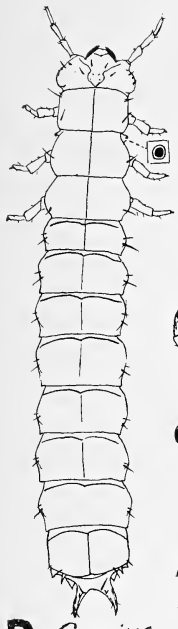
K.

Telephanus.

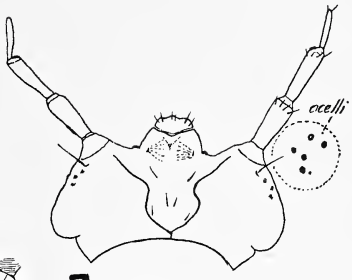
Plate 31

Cucujidae-Cucujinae,
Cucujidae-Brontinae (L),
Laemophloeidae (G–K)

A. Cucujus clavipes F. : Right mandible. Ventral view.
B. " " : Head (Ocelli inset). Dorsal view.
C. " " : Prothorax. Ventral view.
D. " " : Larva. Dorsal view.
E. " " : Hypopharyngeal region.
F. " " : Head. Ventral view.
G. Hemipeplus sp. (Cuba) : Left mandible. Dorsal view.
H. " : Epipharynx.
I. " : Ocelli. Lateral view.
J. " : Ventral mouthparts. Ventral view.
J.* " : Hypopharynx.
K. " : Posterior end of abdomen; sp. spiracle. Ventral view.
L. Brontes sp. : Posterior end of abdomen. Dorsal view.

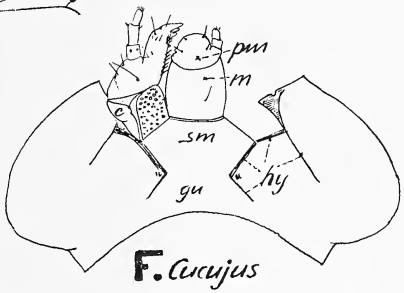


A. Cucujus



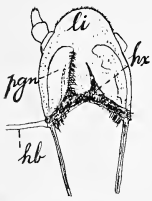
B. Cucujus

C. Cucujus



F. Cucujus

D. Cucujus



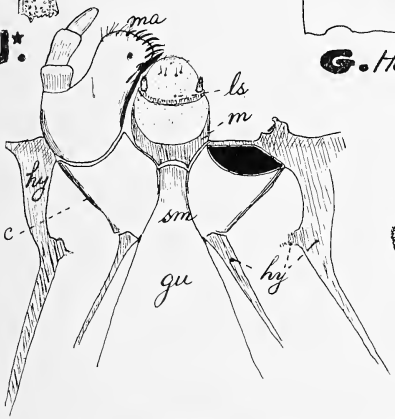
E. Cucujus

G. Hemipeplus

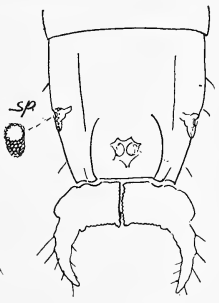
H. Hemipepl.

I. Hemipeplus

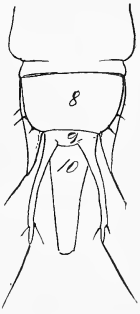
J*.



J. Hemipeplus



K. Hemipeplus



L. Brontes

Plate 32

Laemophloeidae,

Phalacridae (A–G), *Smicripidae*

A. Olibrus aeneus F. (Denmark) : Head. Dorsal view.
B. " " : Mandible. Dorsal view.
C. " " : Leg.
D. " " : Ventral mouthparts. Ventral view.
E. " " : Ocelli. Lateral view.
F. " " : Spiracle.
G. " " : Eighth and ninth abdominal segments. Dorsal view.
H. Laemophloeus biguttatus Say : Head. Dorsal view.
I. " " : Ventral mouthparts. Ventral view.
J. Smicrips palmicola Lec. (Florida) : Mandible. Ventral view.
K. Laemophloeus biguttatus : Mandible. Dorsal view.
L. " " : Larva; thoracic and abdominal spiracles inset. Dorsal view.
M. Smicrips palmicola : Larva; annular thoracic spiracle inset. Lateral view.
N. " " : Ventral mouthparts. Ventral view.
O. " " : Hypopharyngeal sclerome.
P. Laemophloeus biguttatus : Ninth abdominal segment. Dorsal view.
Q. " " : End of leg.

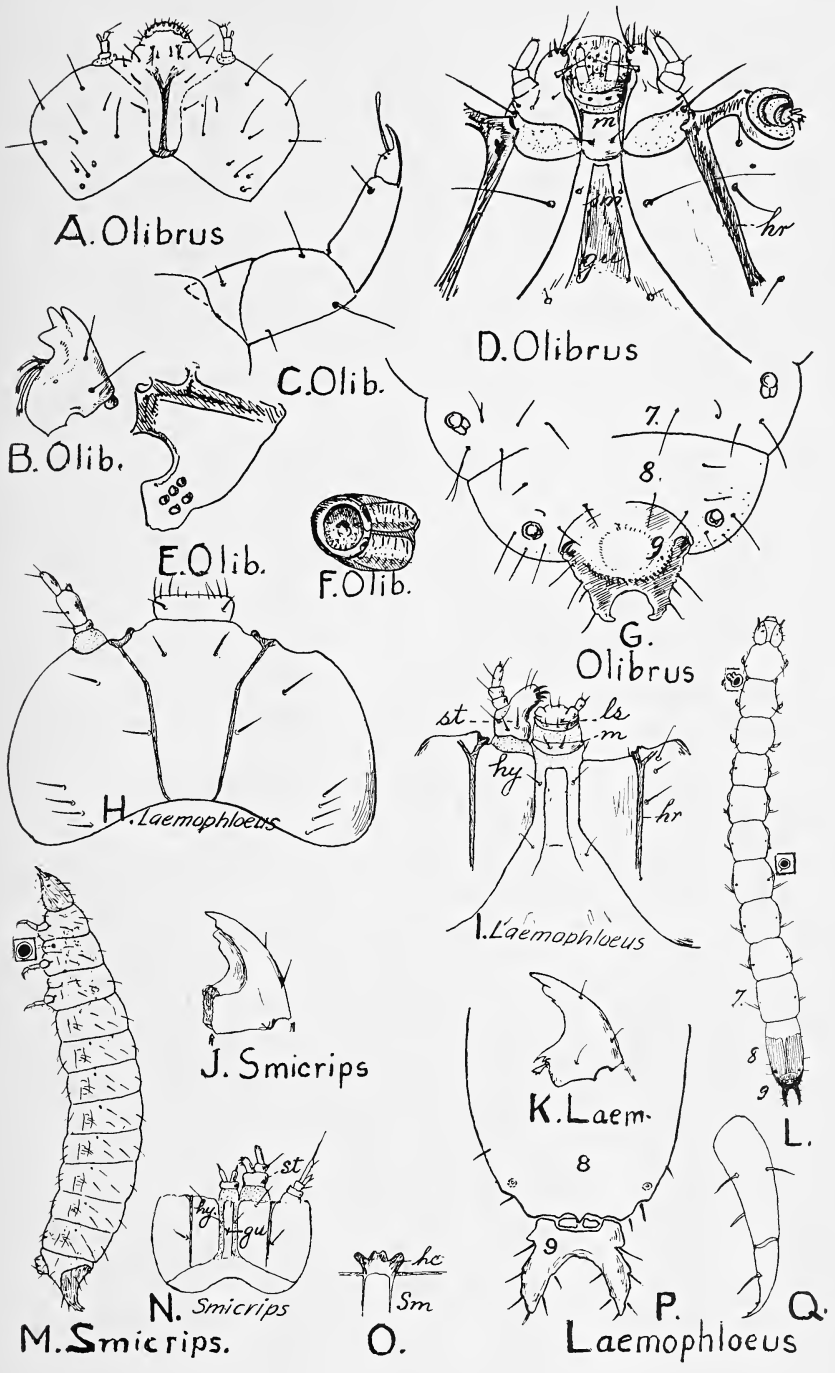

A. Olibrus
D. Olibrus
C. Olib.
B. Olib.
E. Olib.
F. Olib.
G. Olibrus
H. Laemophloeus
I. Laemophloeus
J. Smicrips
K. Laem.
L.
M. Smicrips.
N. Smicrips
O.
P.
Q.
Laemophloeus

Plate 33

Prostomidae (A–H),
Catogenidae, Phalacridae

A. Prostomis mandibularis F. (Denmark) : End of abdomen. Ventral view.
B. " " : Mandible.
C. Dryocora howitti Pasc. (New Zealand) : Ninth abdominal segment. Dorsal view.
D. Prostomis mandibularis : Head and prothorax; thoracic spiracle inset. Ventral view.
E. " " : Larva. Dorsal view.
F. " " : Maxilla. Ventral view.
G. Dryocora howitti : Head and prothorax. Dorsal view.
H. " " : Maxilla.
I. Scalidia linearis Lec. : Head. Dorsal view.
J. " " : Mandible. Dorsal view.
K. Phalacrus sp. : Hypopharyngeal region.
L. Scalidia linearis : Head. Ventral view.
M. " " : Leg.
N. Phalacrus sp. : Larva. Lateral view.
O. Scalidia linearis : Larva. Lateral view.
P. Phalacrus sp. : Head. Ventral view.
Q. Phalacrus politus Melsh. : Spiracle.
R. " " : Sixth to ninth abdominal segments. Dorsal view.
S. " " : Mandible. Dorsal view.
T. Phalacrus sp. : Mandible. Ventral view

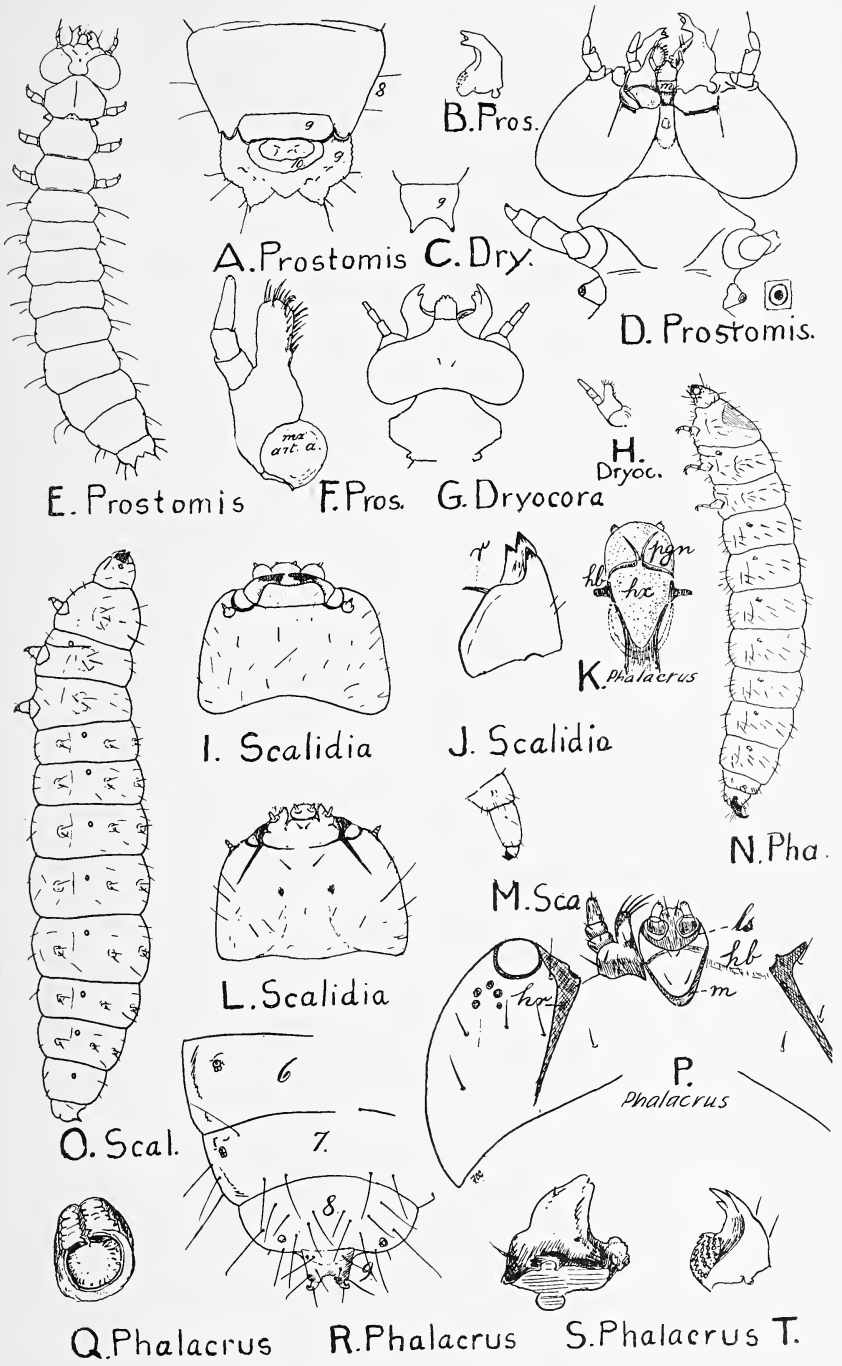

B. Pros.
A. Prostomis
C. Dry.
D. Prostomis.
E. Prostomis
F. Pros.
G. Dryocora
H. Dryoc.
I. Scalidia
J. Scalidia
K. Phalacrus
N. Pha.
M. Sca
L. Scalidia
O. Scal.
P. Phalacrus
Q. Phalacrus
R. Phalacrus
S. Phalacrus
T.

Plate 34

Corylophidae-Arthrolipinae

Corylophidae-Corylophinae

A. (Arthrolips sp., or possibly: Orthoperus sp.) (?): Larva; fo, glandular opening or "foramen, Peyerimhoff." Dorsal view.

B. " " : Mandible.

C. " " : Head and prothorax. Ventral view.

D. Corylophodes marginicollis Lec. : Head; na, nasale. Ventral view.

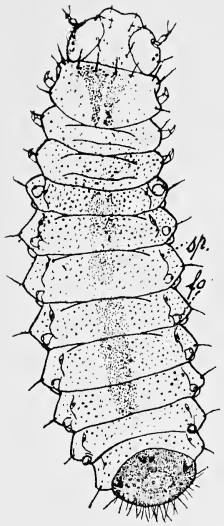
E. Molamba lunata Lec. : Head; na, nasale. Ventral view.

F. Corylophodes marginicollis : Larva; fo, foramen. Dorsal view.

G. Sacium sp. : Right side of posterior part of body. Dorsal view.

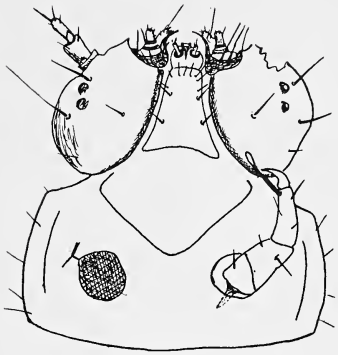
H. " " : Leg.

I. Molamba lunata : Larva; fo, foramen. Dorsal view.

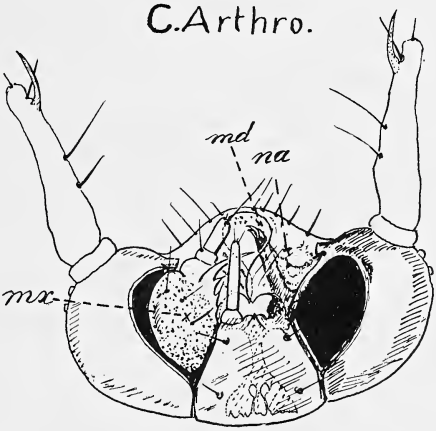


A. Arthrolips

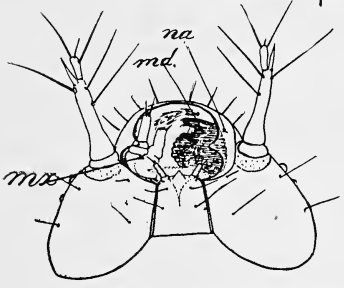
B. Arthro.



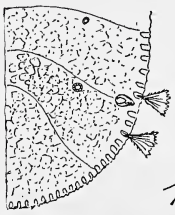
C. Arthro.



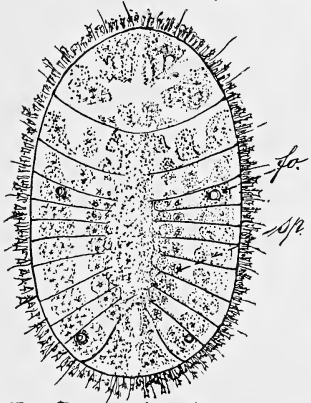
E. Molamba



D. Corylophodes.

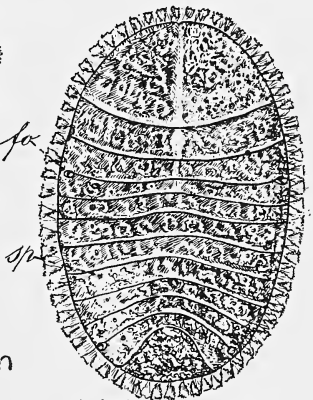


G. Sacium



F. Corylophodes

H. Sacium



I. Molamba

Plate 35

Nitidulidae-Nitidulinae,

Nitidulidae-Prometopiinae

A. Glischrochilus obtusus Say : Head. Dorsal view.
B. " " : Head. Ventral view.
B.* Epuraea sp. : Hypopharyngeal region.
C. Glischrochilus obtusus : Spiracle.
D. " " : Mandible.
E. " " : Leg.
F. " " : Prothorax and mesothorax. Ventral view.
G. Lobiopa insularis Cast. : Mandible.
H. Glischrochilus obtusus : Larva. Lateral view.
I. Prometopia sexmaculata Say : Antenna and ventral mouthparts. Ventral view.
J. Unknown genus near Epuraea : Larva. Dorsal view.
K. Prometopia sexmaculata : Mandible (possibly worn apically). Ventral view.
L. " " : Larva. Mostly a ventro-lateral view.
M. " " : Ninth abdominal segment. Dorsal view.

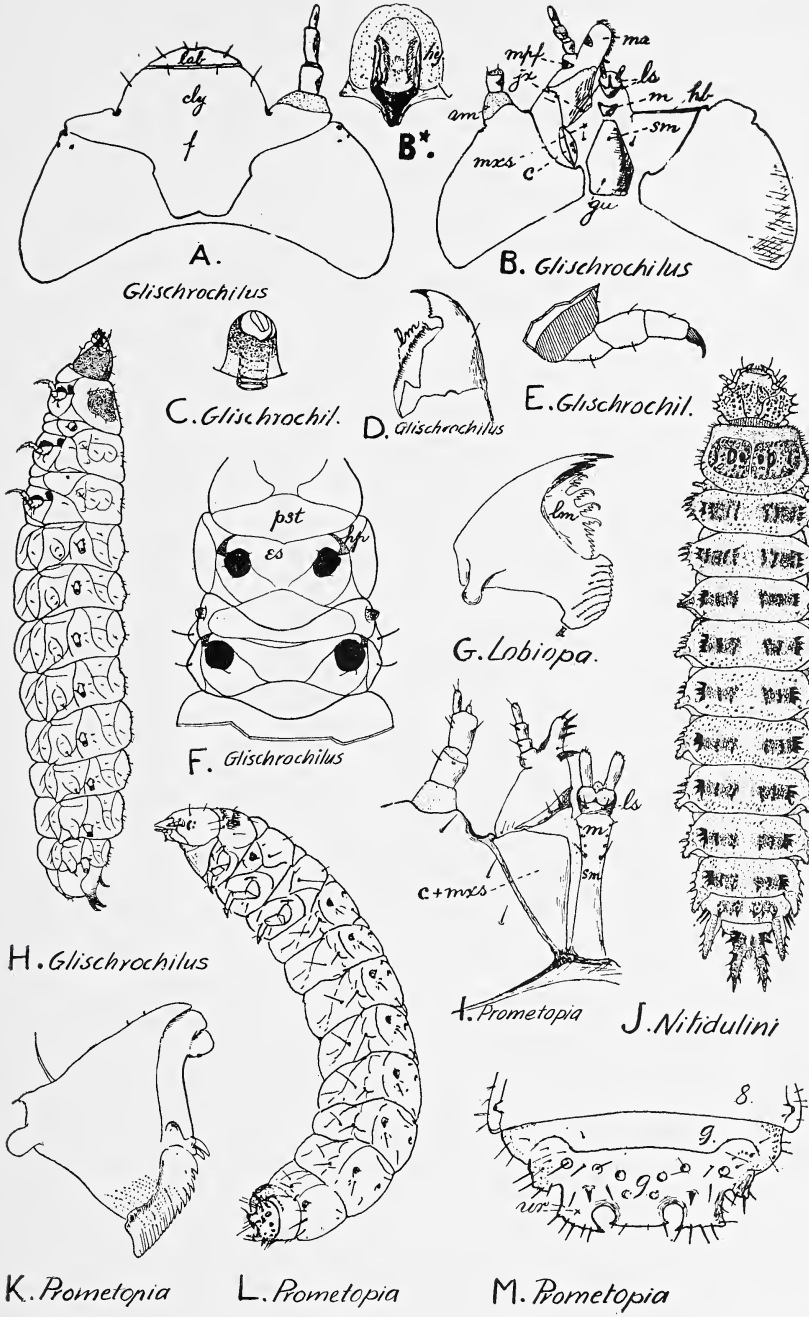
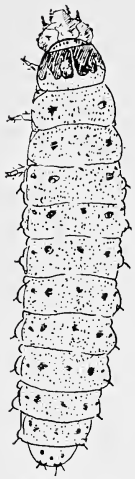

lab
cly
f
hy
B*.
mpf
ma
ls
m
hf
sm
am
mxs
c
gu
A.
Glischrochilus
B. Glischrochilus
C. Glischrochil.
D. Glischrochilus
E. Glischrochil.
pst
es
hp
F. Glischrochilus
G. Lobiopa.
H. Glischrochilus
c+mxs
I. Prometopia
J. Nitidulini
K. Prometopia
L. Prometopia
M. Prometopia

Plate 36

Nitidulidae-Meligethinae

Nitidulidae-Cateretinae

A. Meligethes aeneus F. (Denmark) : Head. Dorsal view.
B. " " : Leg.
C. " " : Mandible. Ventral view.
D. " " : Larva. Dorsal view.
E. " " : Spiracle.
F. " " : Antenna and ventral mouthparts. Ventral view.
G. " " : Eighth and ninth abdominal segments. Dorsal view.
H. " " : Antenna.
I. " " : Distal parts of maxilla and labium. Ventral view.
J. Heterostomus pulicarius L. (= Brachypterus gravidus Ill.) : Antenna, ocelli. Dorsal view.
K. " " : Tip of mala.
L. " " : Mandible.
M. " " : Larva. Dorsal view.
N. " " : Larva. Lateral view.
O. " " : Distal end of leg.
P. " " : Ventral mouthparts. Ventral view.



A. Meligethes

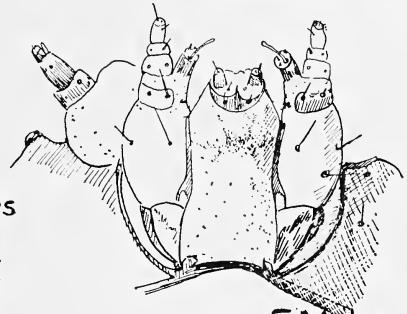
B. Meligethes

C. Meligethes

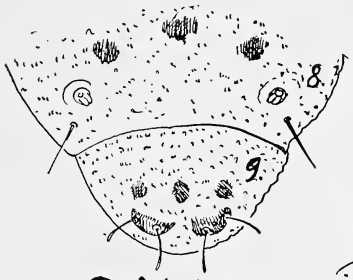
D. Meligethes

E. Melig.

F. Melig.

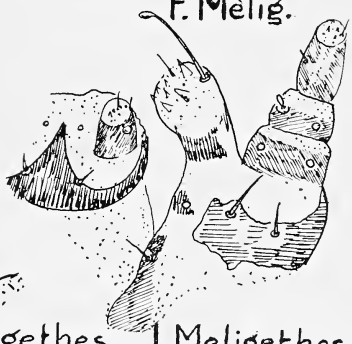


G. Meligethes

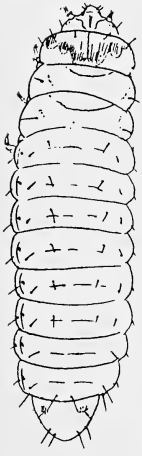


H. Meligethes

I. Meligethes



M. Brachypterus



N.

O.

J. Brac.

K.

L. Bra.

P. Brachypterus

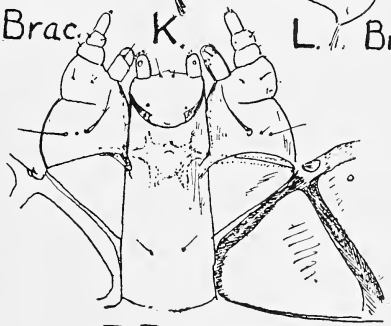


PLATE 37

Cybocephalidae,

Coccinellidae-Coccinellinae

A. Cybocephalus californicus Horn : Head. Dorsal view.
B. " " : Antenna.
C. " " : Mandible.
D. " " : Head. Ventral view.
E. " " : Distal end of leg.
F. " " : Head. Anterior view.
G. " " : Larva. Dorsal view.
H. Hyperaspis signata Oliv. : Anterior part of larva. Lateral view.
I. " " : Mandible. Dorsal view.
J. " " : Head. Ventral view.
K. " " : Larva; fo, glandular opening, or "foramen" of Peyerimhoff. Dorsal view.
L. " " : Head. Antero-dorsal view.

(To be continued)

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AN ILLUSTRATED SYNOPSIS OF THE PRINCIPAL LARVAL FORMS OF THE ORDER COLEOPTERA

BY ADAM G. BÖVING,

SENIOR ENTOMOLOGIST, U. S. BUREAU OF ENTOMOLOGY

AND

F. C. CRAIGHEAD,

IN CHARGE OF FOREST INSECT INVESTIGATIONS, U. S. BUREAU OF ENTOMOLOGY

(Continued from page 160.)

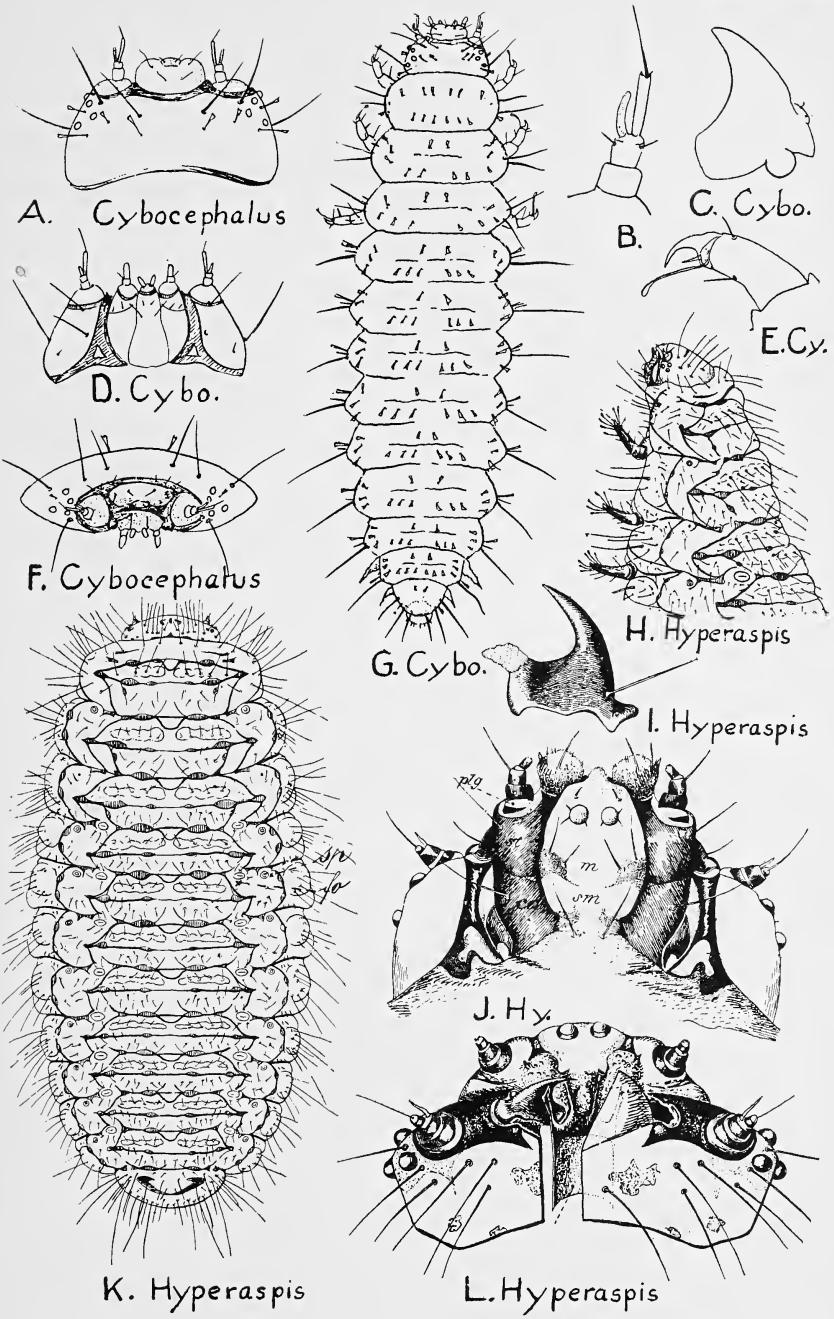

A. Cybocephalus
B.
C. Cybo.
D. Cybo.
E. Cy.
F. Cybocephalus
G. Cybo.
H. Hyperaspis
I. Hyperaspis
J. Hy.
K. Hyperaspis
L. Hyperaspis

Plate 38

Coccinellidae-Coccinellinae,

Coccinellidae-Epilachninae

A. Coccinella novemnotata Hbst. : Spiracle.
B. " " : Head. Dorsal view.
C. " " : Buccal structures; diagrammatic. Lateral view.
D. " " : Mandible. Ventral view. (Compare: Plate 40, fig. B).
E. " " : Larva. Lateral view.
F. " " : Tibia and tarsungulus.
G. " " : Hypopharyngeal bridge and bracon.
H. " " : Head. Ventral view.
I. " " : Prothorax and mesothorax. Ventral view.
J. Epilachna borealis F. : Head. Dorsal view.
K. " " : Larva. Lateral view.
L. " " : Mandible of first larval instar.
M. " " : Mandible of last larval instar.
N. " " : Hypopharynx, maxillulae, and glossa.

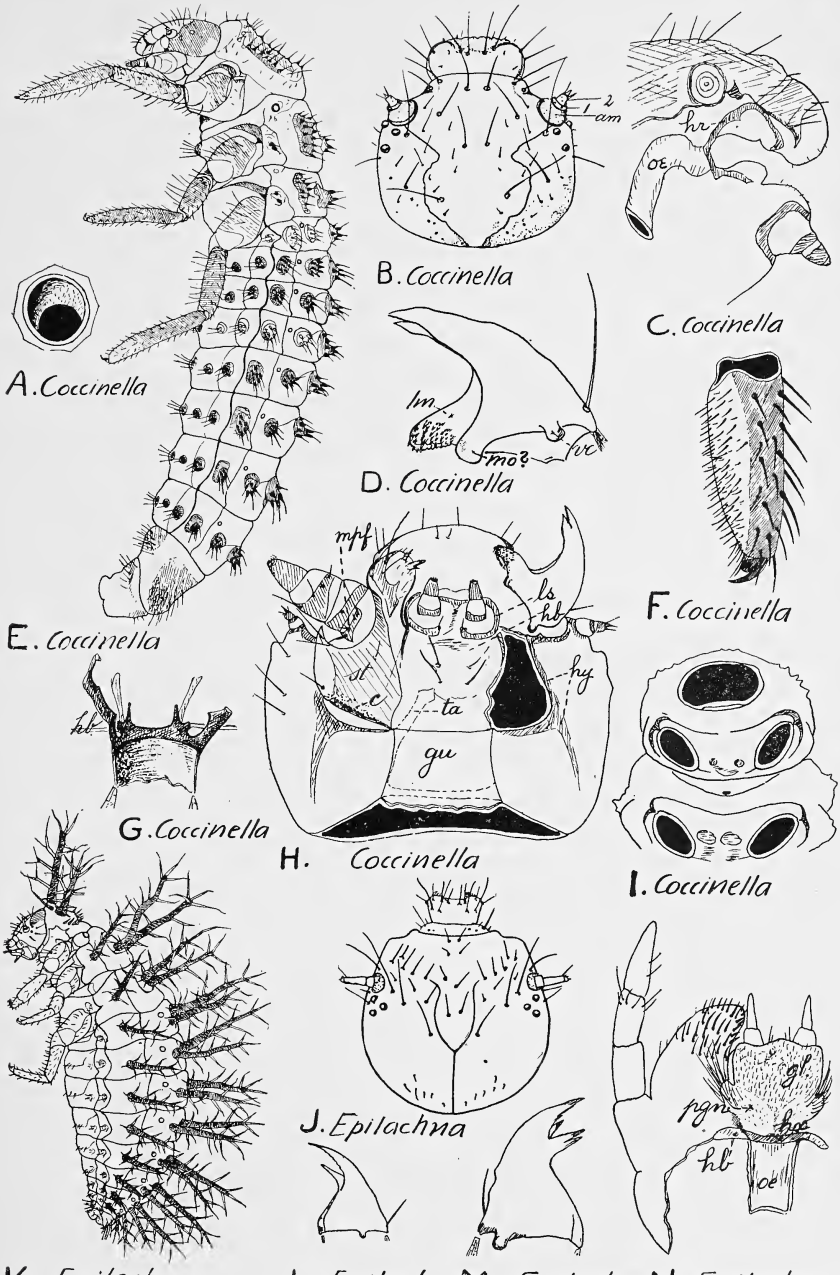

A. Coccinella
B. Coccinella
1
2
am
C. Coccinella
hr
oe
D. Coccinella
lm
mo?
vc
E. Coccinella
F. Coccinella
mpf
ls
hb
st
c
ta
hy
gu
G. Coccinella
H. Coccinella
I. Coccinella
J. Epilachna
K. Epilachna
L. Epilach
M. Epilachna
N. Epilachna
gl
pgn
hyo
hb
oe

Plate 39

Endomychidae-Mycetaeinae (A–G),
Endomychidae-Endomychinae (H–V)

A. Mycetaea hirta Marsh. : Outline of larva. Dorsal view.
B. " " : Head. Dorsal view.
C. " " : Distal end of maxillary mala.
D. " " : Larva. Lateral view.
E. " " : Mandible. Dorsal view.
F. " " : Head. Ventral view.
G. " " : Hypopharyngeal structures.
H. Amphix laevigatus Gerst. (= Corymalus castanicolor Gorham) (Panama) : Mandible. Dorsal view.
I. " " : Mesothoracic spiracle on ventral side of body.
J. " " : Distal end of maxillary mala. Ventral view.
K. " " : Larva. Dorsal view.
L. Aphorista vittata F. : Head. Dorsal view.
M. " " : Fan-shaped hair.
N. " " : Mandible. Dorsal view.
O. " " : Larva. Ventral view.
P. " " : Larva. Dorsal view.
Q. " " : Head. Ventral view.
R. " " : Hypopharyngeal structures.
S. Stenotarsus hispidus Hbst. : Mandible. Ventral view.
T. " " : Hypopharyngeal region.
U. Endomychus coccineus L. (Denmark) : Lateral part of head.
V. " biguttatus Say : Spiracle.

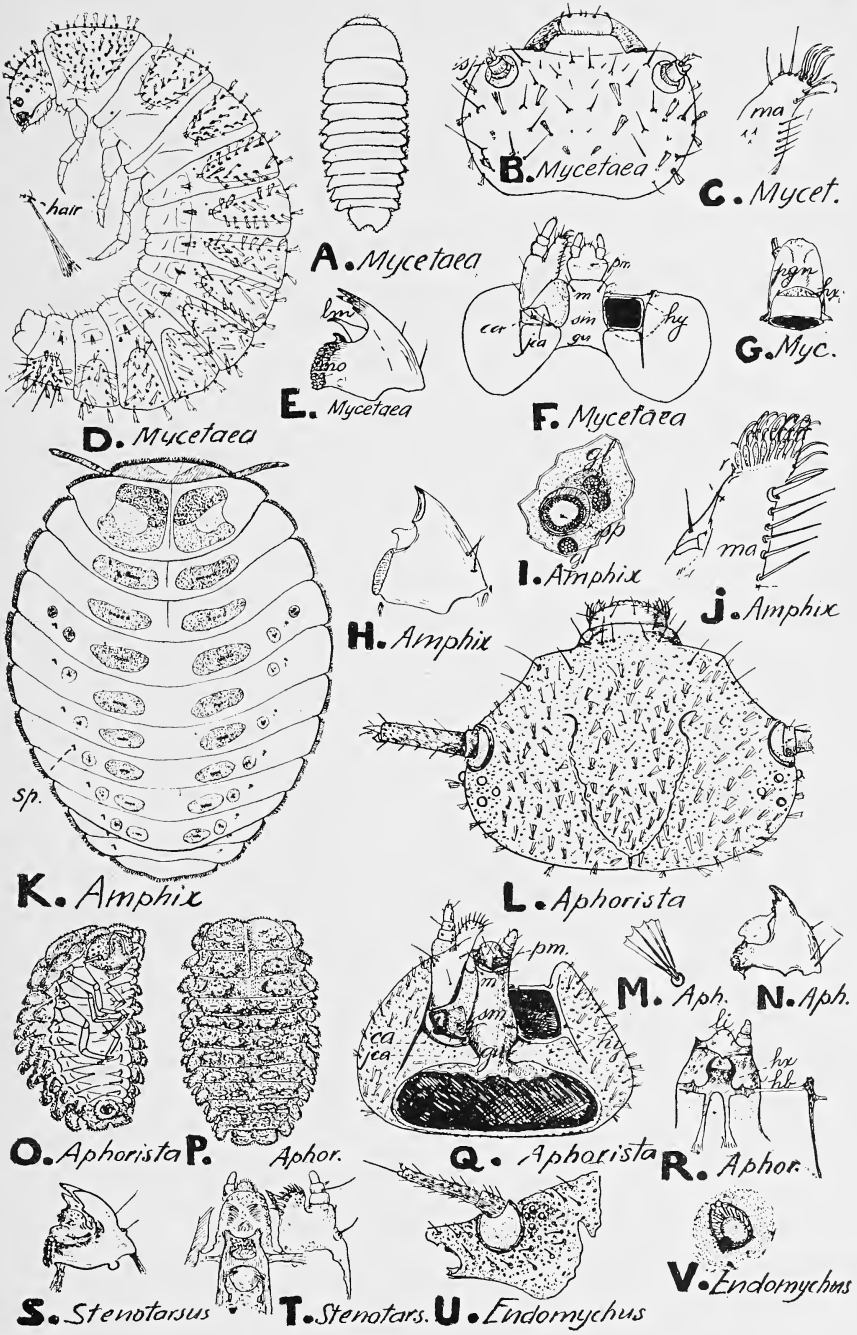

hair
A. Mycetaea
B. Mycetaea
C. Mycet.
D. Mycetaea
E. Mycetaea
F. Mycetaea
G. Myc.
H. Amphix
I. Amphix
J. Amphix
K. Amphix
sp.
L. Aphorista
M. Aph.
N. Aph.
O. Aphorista
P. Aphor.
Q. Aphorista
R. Aphor.
S. Stenotarsus
T. Stenotars.
U. Endomychus
V. Endomychus

Plate 40

Endomychidae-Endomychinae

A. Endomychus coccineus L. (Denmark) : Mandible. Dorsal view.
B. " " : Hypopharyngeal structures and mandible; mo (?), molar part or possibly irregularly placed accessory ventral condyle (compare: plate 39, figs. E and S, plate 40, fig. J, and also plate 38, fig. D.)
C. " " : Left and median part of head.
D. " " : Posterior part of head.
E. " " : Distal end of maxilla. Ventral view.
F. " " : Tip of maxillary mala. Dorsal view.
G. Lycoperdina ferruginea Lec. : Head. Dorsal view.
H. Lycoperdina succincta L. (Denmark) : Maxilla and tip of labium.
I. " " : Hypopharyngeal region and maxillary mala.
J. " " : Epipharynx and mandible.
K. Rhymbus ulkei Cr. : Larva. Dorsal view.
L. " " : Larva. Ventro-lateral view.
M. " " : Epipharynx.
N. " " : Leg, except the coxa.
O. " " : Head. Dorsal view.
P. " " : Head. Lateral view.
Q. " " : Spiracle.
R. " " : Molar part of mandible. Facial view from base of mandible.
S. " " : Mandible. Ventral view.
T. " " : Maxilla and labium.

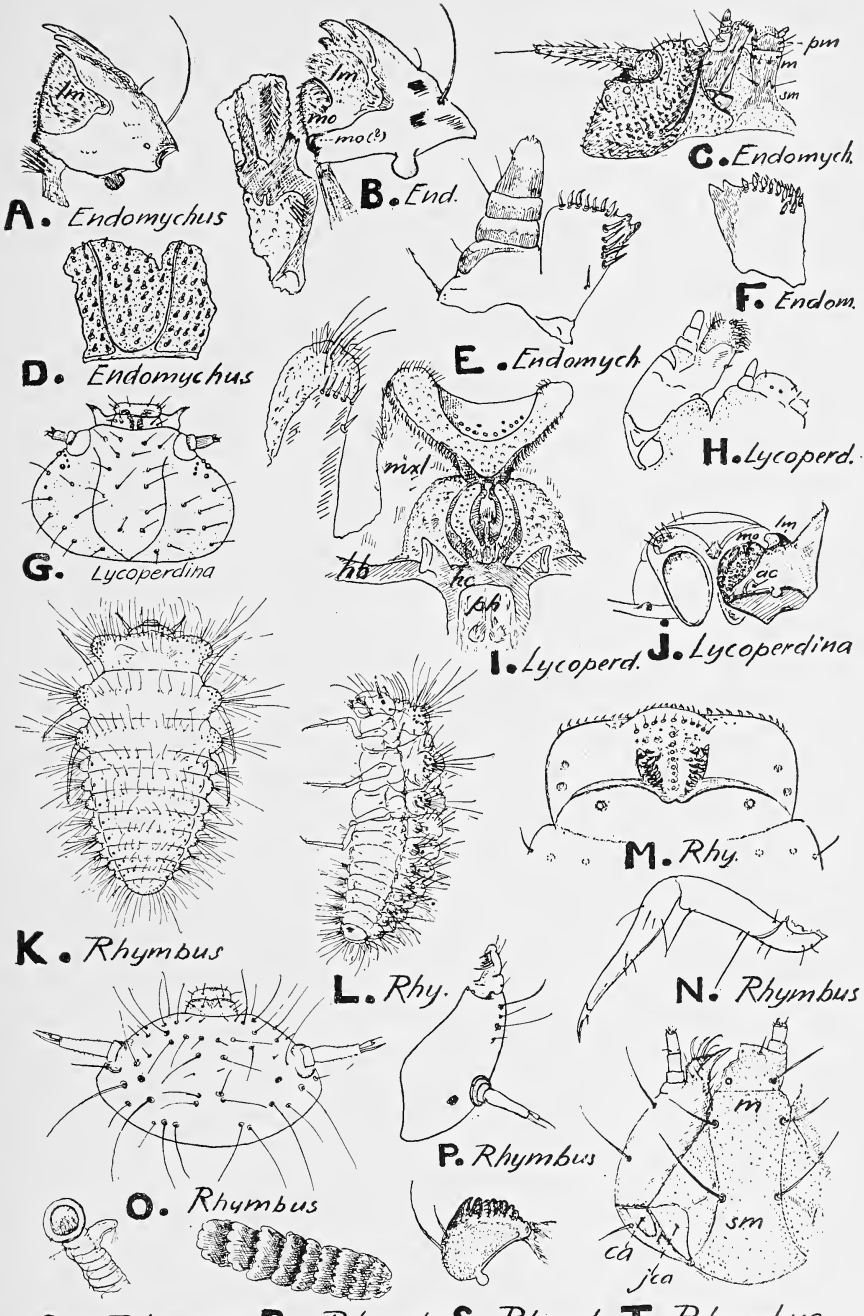

A. Endomychus
B. End.
C. Endomych.
D. Endomychus
E. Endomych
F. Endom.
G. Lycoperdina
H. Lycoperd.
I. Lycoperd.
J. Lycoperdina
K. Rhymbus
L. Rhy.
M. Rhy.
N. Rhymbus
O. Rhymbus
P. Rhymbus
Q. Rhymbus
R. Rhymb.
S. Rhymb.
T. Rhymbus
lm
mo
mx
hb
hc
pb
pm
m
sm
ca
jca

Plate 41

Erotylidae, Sphindidae

A. Cypherotylus aspersus Gorh. : Mandible. Ventral view.
B. " " : Mesothoracic spiracle.
C. " " : Head and prothorax. Ventral view.

D. Homoeotelus confusus Crotch. (Panama) : Larva. Lateral view.
E. Cypherotylus aspersus : Hypopharyngeal region, tip of labium and dorsal side of maxilla.

F. Sphindus americanus Lec. : Spiracle.
G. Cypherotylus aspersus : Head. Dorsal view.
H. Sphindus americanus : Leg.
I. " " : Hypopharyngeal region.
J. " " : Larva. Lateral view.
K. " " : Head. Ventral view.
L. " " : Mandible. Ventral view.
M. " " : Head. Dorsal view.

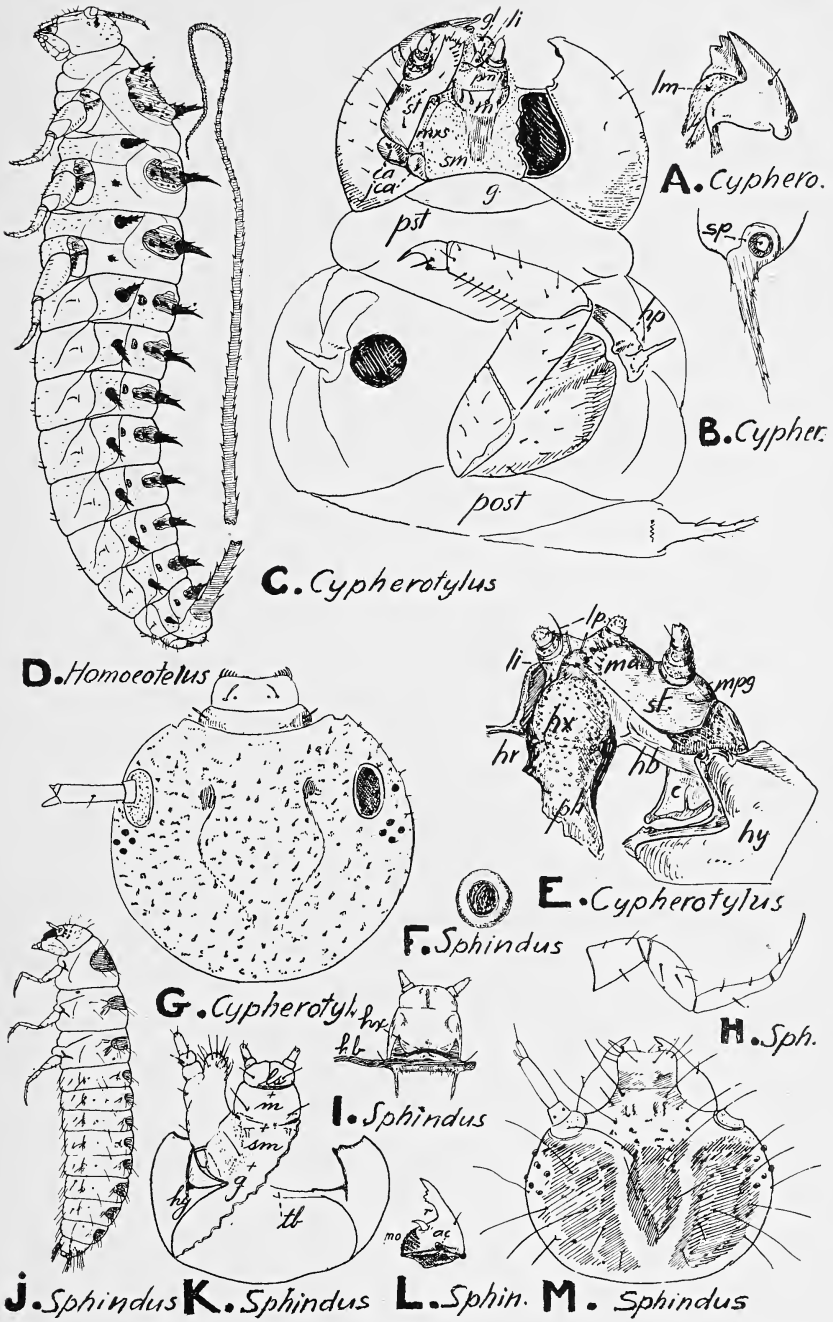

gf
li
lm
A. Cyphero.
sp
B. Cypher.
C. Cypherotylus
D. Homoeotelus
lp
ma
mpg
hx
hr
hb
hy
E. Cypherotylus
F. Sphindus
G. Cypherotyl.
H. Sph.
I. Sphindus
J. Sphindus
K. Sphindus
L. Sphin.
M. Sphindus

Plate 42

Dacnidae

A. Megalodacne (fasciata F. ?) : Head. Lateral view.
B. " " : Mandible. Ventral view.
C. " " : End of maxilla.
D. " " : Spiracle.
E. " " : Head. Dorsal view.
F. " " : Head. Ventral view.
G. " " : Larva. Lateral view.
H. " " : Antenna.
I. " " : Leg.
J. " " : Hypopharynx and ligula. Lateral view.
K. Penthe pimelia F. : Hypopharynx and ligula. Lateral view.
L. Tritoma unicolor Say : Mandible. Ventral view.
M. " " : Larva. Lateral view.
N. Penthe pimelia : Mandible. Ventral view.
O. " " : Antenna.
P. " " : Distal end of mala. Dorsal view.
Q. " " : Larva. Lateral view.
R. " " : Head. Dorsal view.
S. " " : Head. Ventral view.
T. " " : Spiracle.

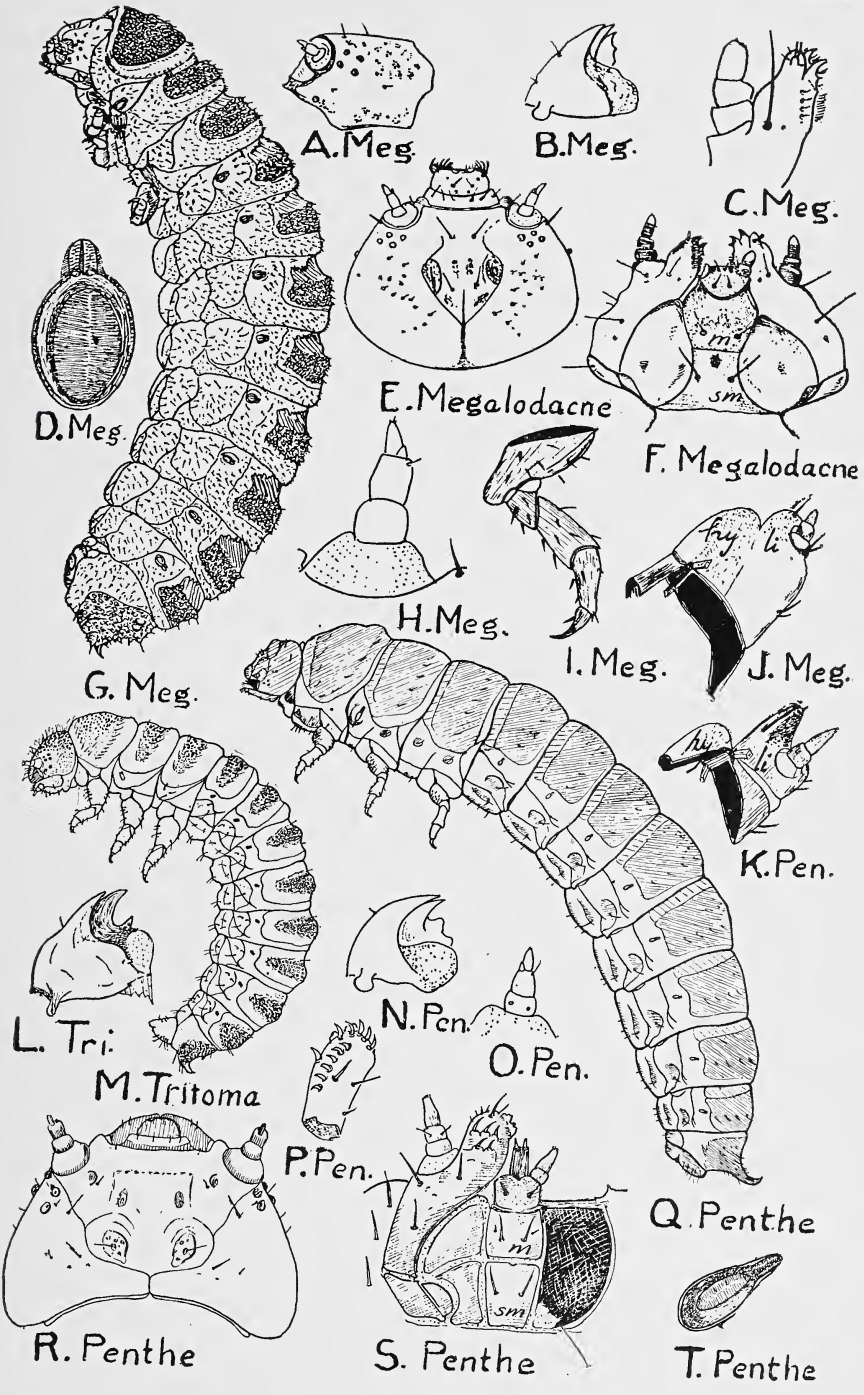
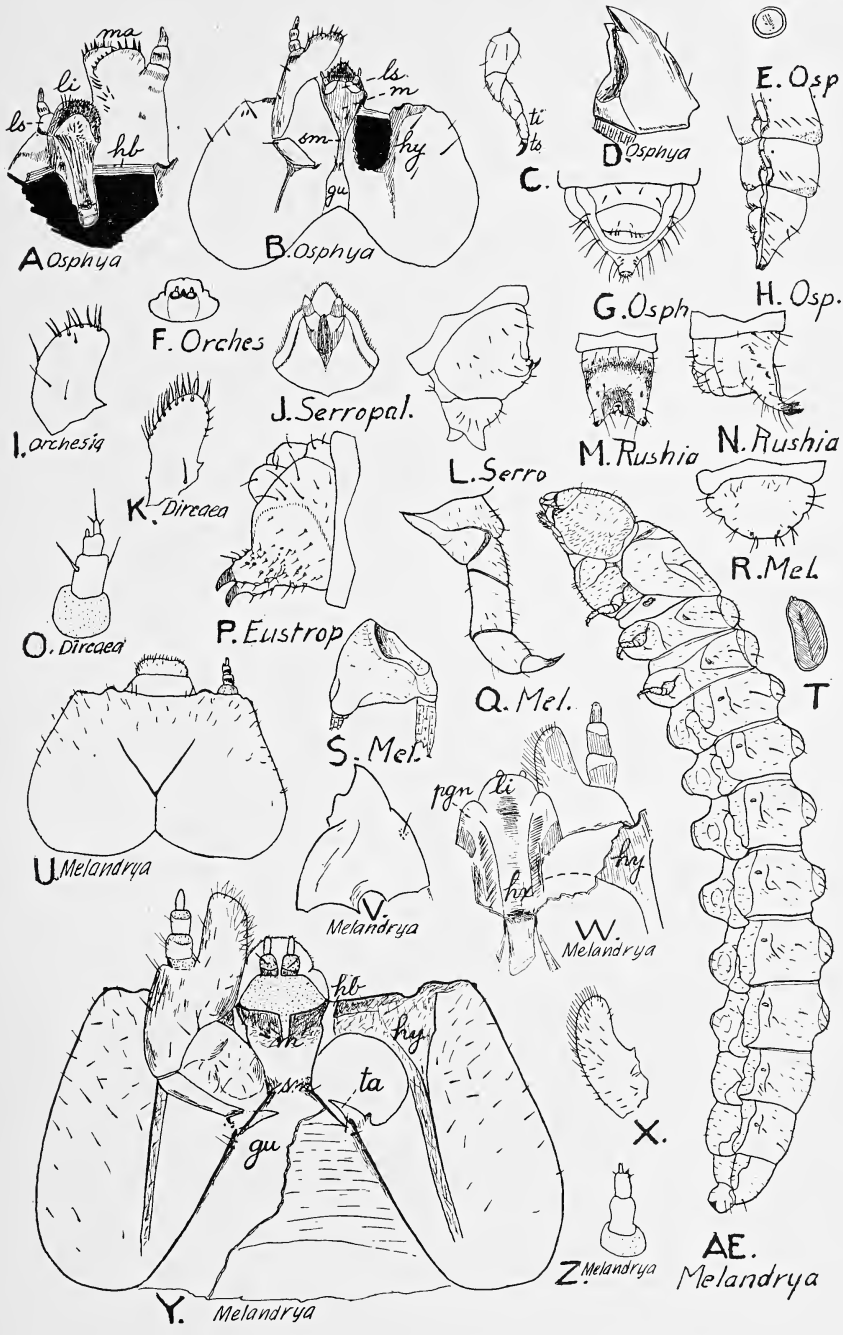

A. Meg.
B. Meg.
C. Meg.
D. Meg.
E. Megalodacne
F. Megalodacne
m.
sm.
G. Meg.
H. Meg.
I. Meg.
J. Meg.
hy
li
K. Pen.
L. Tri.
M. Tritoma
N. Pen.
O. Pen.
P. Pen.
Q. Penthe
R. Penthe
S. Penthe
T. Penthe

Plate 43

Melandryidae

A. Osphya luteus Horn : Ventral mouthparts.
B. " " : Head. Ventral view.
C. " " : Leg.
D. " " : Mandible.
E. " " : Spiracle.
F. Orchesia castanea Melsh. : Prementum, labial palpi and ligula.
G. " " : Posterior end of body. Ventral view.
H. " " : Posterior end of body.
I. " " : Mala.
J. Serropalpus barbatus Schall. : Prementum, labial palpi and ligula.
K. Dircaea quadrimaculata Say : Mala.
L. Serropalpus barbatus : Posterior end of body.
M. Rushia longula Lec. : Ninth abdominal segment. Dorsal view.
N. " " : Ninth abdominal segment. Lateral view.
O. Dircaea quadrimaculata : Antenna.
P. Eustrophinus bicolor F. : Posterior end of abdomen. Lateral view.
Q. Melandrya striata Say : Leg.
R. Melandryidae (Genus not determined) : Ninth abdominal segment. Dorsal view.
S. " " : Mandible.
T. " " : Spiracle.
U. Melandrya striata : Head. Dorsal view.
V. " " : Mandible. Dorsal view.
W. " " : Ventral mouthparts.
X. " " : Mala. Ventral view.
Y. " " : Head. Ventral view.
Z. " " : Antenna.
AE. " " : Larva. Lateral view.


ma
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A Osphya
ls
m
sm
hy
gu
B. Osphya
ti
ts
C.
D Osphya
E. Osp.
G. Osph
H. Osp.
F. Orches
J. Serropal.
I. Orchesia
K. Direaea
L. Serro
M. Rushia
N. Rushia
R. Mel.
O. Dircaea
P. Eustrop
Q. Mel.
T
S. Mel.
U. Melandrya
pgn
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W. Melandrya
V. Melandrya
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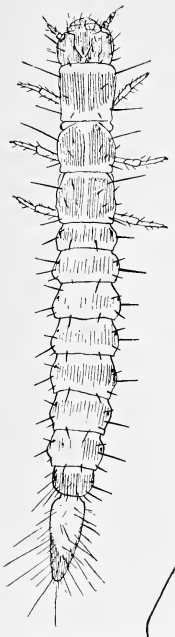
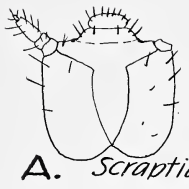
X.
Z. Melandrya
AE. Melandrya
Y. Melandrya

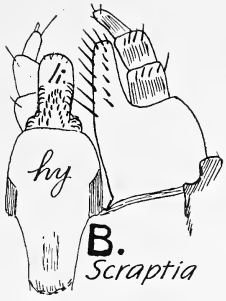
Plate 44

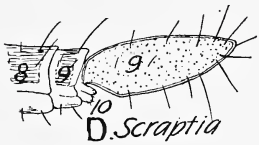
Scraptiidae, Bothrideridae

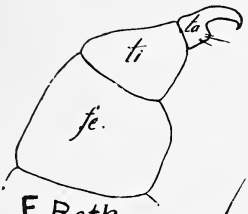
A. Scraptia sericea Melsh. : Head. Dorsal view.
B. " " : Ventral mouthparts. Dorsal view.
B.* " " : Ventral mouthparts. Ventral view.
C. " " : Mandible. Dorsal view.
D. " " : Posterior end of abdomen. Lateral view.
E. " " : Larva. Dorsal view.
F. Bothrideres geminatus Say : Distal part of leg.
G. " " : Anterior portion of ventral mouthparts. Ventral view.
H. " " : Antenna.
I. " " : Mandible.
J. Deretaphrus oregonensis Horn : Mandible.
K. " " : Spiracle.
L. " " : Head and thorax. Ventral view.
M. " " : Head. Ventral view.
N. " " : Larva. Lateral view.

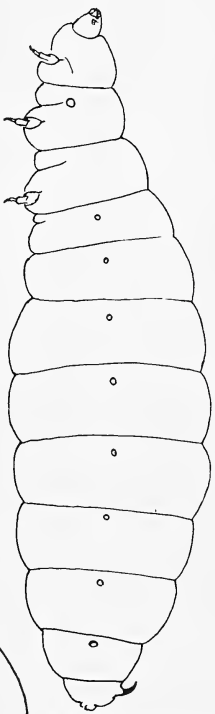


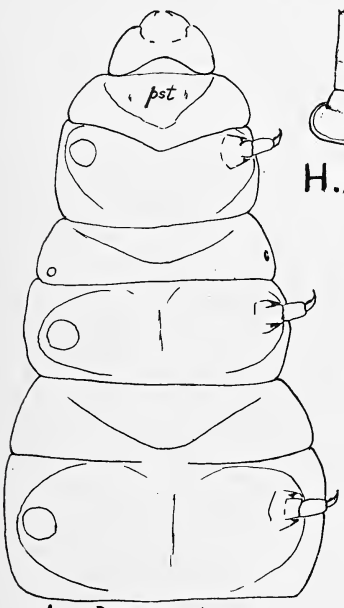










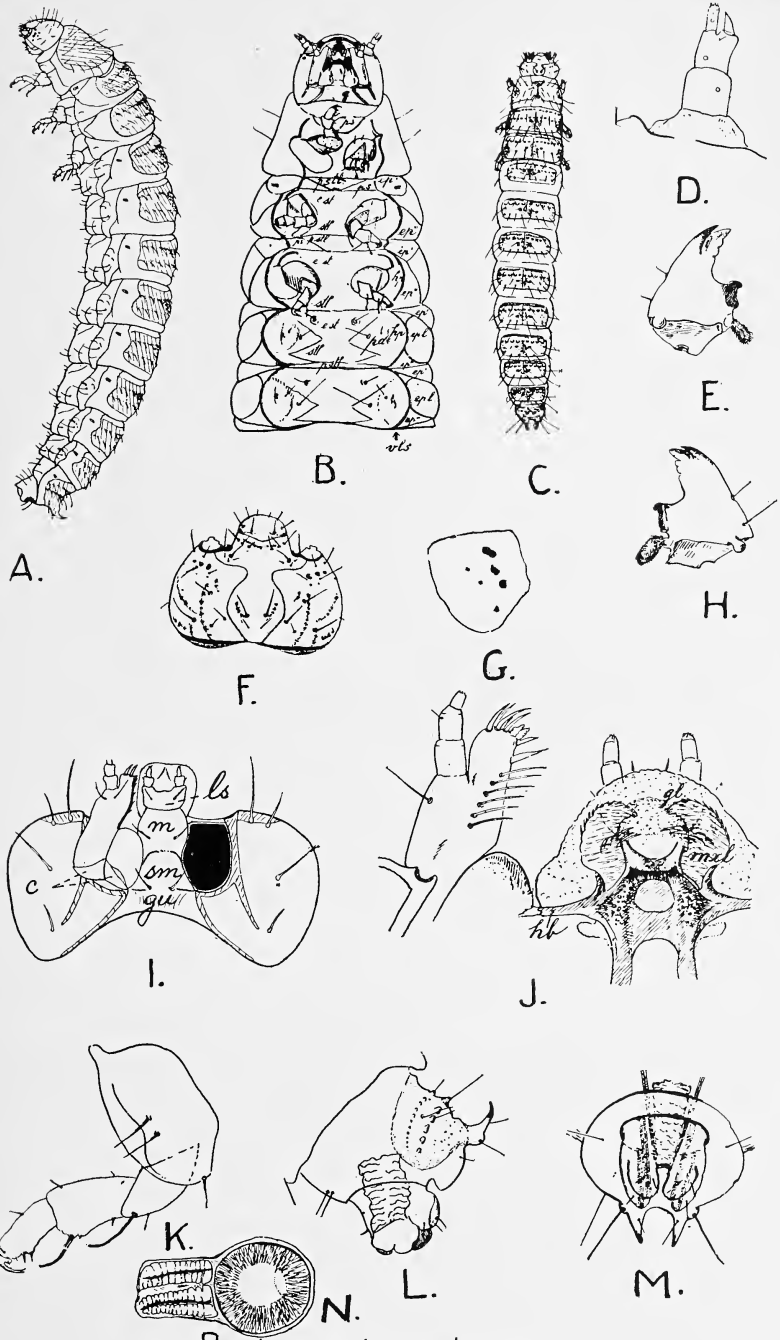


J. Deretaphrus

Plate 45

Byturidae

A. Byturus unicolor Say : Larva. Lateral view.
B. Byturus tomentosus F. (Denmark) : Anterior part of larva. Ventral view.
C. " " : Larva. Dorsal view.
D. " " : Antenna.
E. " " : Right mandible.
F. " " : Cranium. Dorsal view.
G. Byturus unicolor : Ocelli. Lateral view.
H. Byturus tomentosus : Left mandible.
I. Byturus unicolor : Head. Ventral view.
J. Byturus tomentosus : Hypopharyngeal region.
K. Byturus unicolor : Leg.
L. Byturus tomentosus : Ninth and tenth abdominal segments. Lateral view.
M. " " : Ninth and tenth abdominal segments. Ventral view.
N. Byturus unicolor : Spiracle.



Byturus tomentosus

Plate 46

Anthicidae

A. Anthicus heroicus Csy. : Right mandible. Interoventral view.
B. " " : Left mandible; le, linear elevation. Ventral view.
C. Anthicus sp. (Denmark) : Spiracle.
D. " " : Spiracle. Longitudinal section.
E. " " : Head. Dorsal view.
F. " " : Posterior end of abdomen.
G. " " : Ninth and tenth abdominal segments. Ventral view.
H. " " : Hypopharyngeal region.
I. " " : Prothoracic leg.
J. " " : Ventral mouthparts.
K. Anthicus heroicus : Larva. Lateral view.
L. Anthicus sp. (Denmark) : Larva. Dorsal view.
M. Anthicus heroicus : Hypopharyngeal region and maxilla.
N. " " : Urogomphi. Dorsal view.
O. Notoxus monoceros L. (Denmark) : Spiracle. Lateral section.
P. " " : Right mandible; le, linear elevation. Ventral view.
Q. " " : Left mandible.
R. " " : Hypopharyngeal region and maxilla.
S. " " : Urogomphi. Ventral view.
T. Mecynotarsus candidus Lec. : Mandible; le, linear elevation. Ventral view.
U. " " : Ninth and tenth abdominal segments. Lateral view.
V. " " : Ninth abdominal segment. Dorsal view.
W. " " : Ninth abdominal segment. Ventral view.

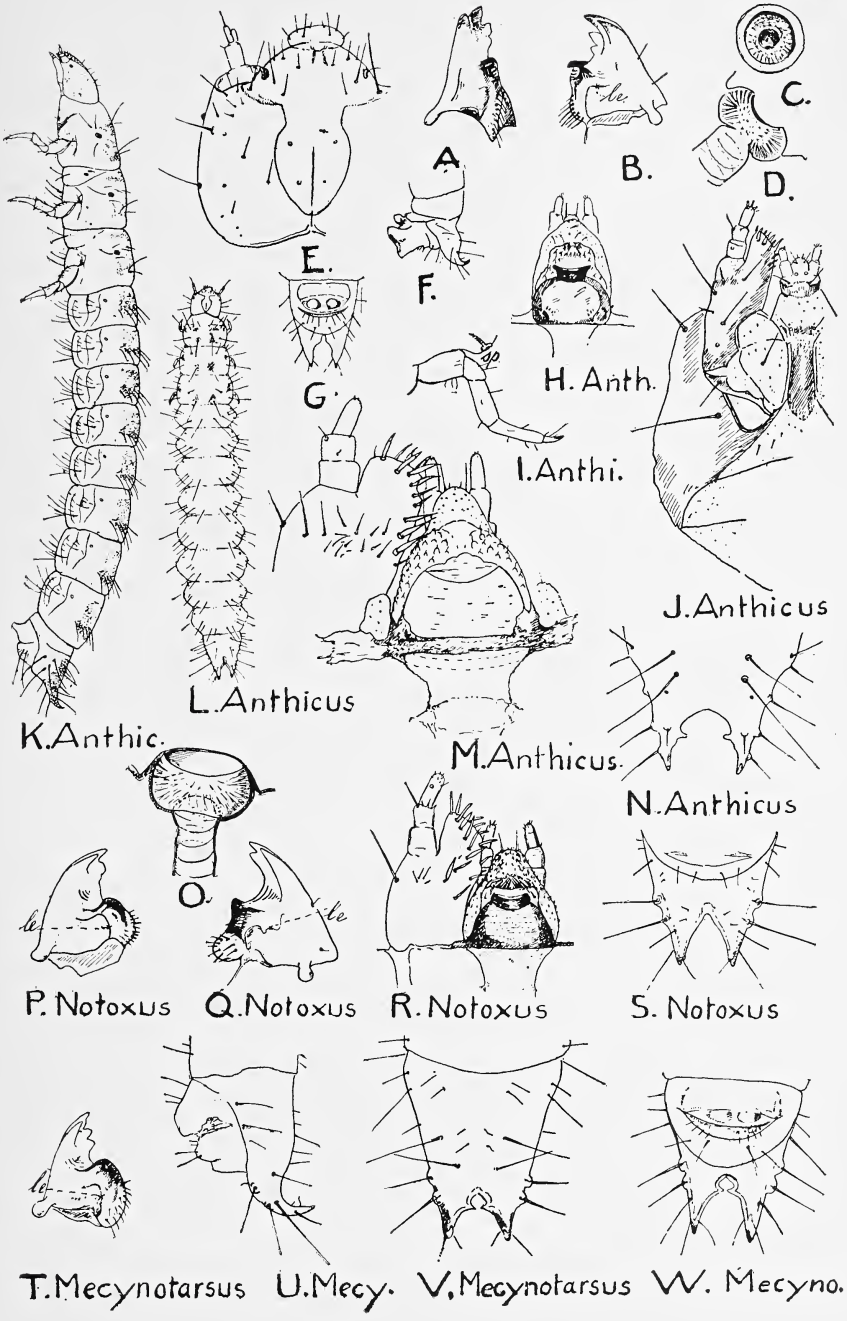
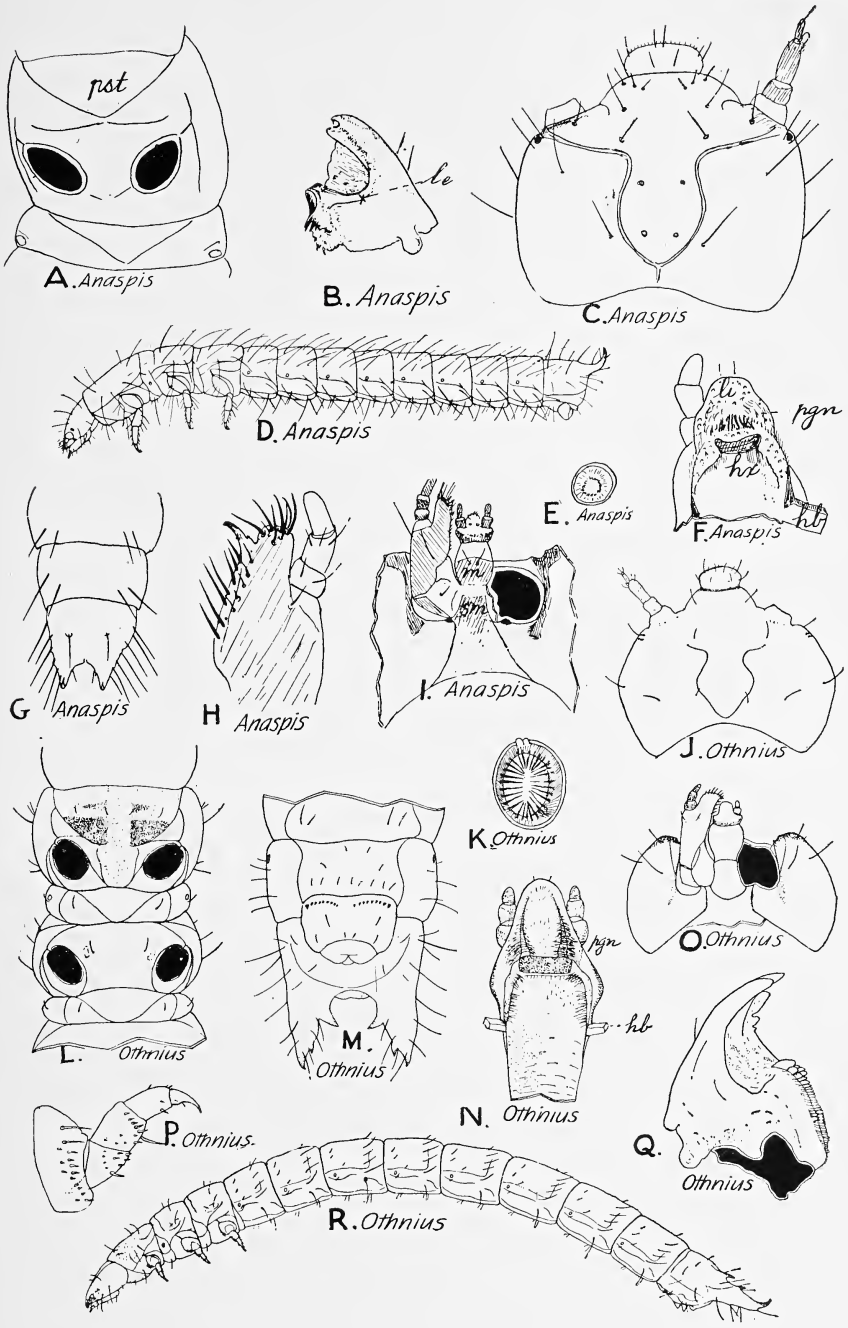

A.
B.
C.
D.
E.
F.
G.
H. Anth.
I. Anthi.
J. Anthicus
K. Anthic.
L. Anthicus
M. Anthicus.
N. Anthicus
O.
P. Notoxus
Q. Notoxus
R. Notoxus
S. Notoxus
T. Mecynotarsus
U. Mecy.
V. Mecynotarsus
W. Mecyno.

Plate 47

Anaspidae, Othniidae

A. Anaspis sp. : Prothorax and part of mesothorax. Ventral view.
B. Anaspis frontalis L. (Denmark) : Left mandible; le, linear elevation. Ventral view.
C. Anaspis sp. : Head. Dorsal view.
D. Anaspis frontalis : Larva. Lateral view.
E. Anaspis sp. : Spiracle.
F. " " : Hypopharyngeal region.
G. " " : Eighth and ninth abdominal segments. Dorsal view.
H. " " : Distal part of maxilla. Ventral view.
I. " " : Ventral mouthparts. Ventral view.
J. Othnius umbrosus Lec. : Head. Dorsal view.
K. " " : Spiracle (annular-biforous).
L. " " : Prothorax and mesothorax. Ventral view.
M. " " : Posterior end of abdomen. Ventral view.
N. " " : Hypopharyngeal region.
O. " " : Head. Ventral view.
P. " " : Leg.
Q. " " : Mandible.
R. " " : Larva. Lateral view.


pst
A. Anaspis
le
B. Anaspis
C. Anaspis
D. Anaspis
li
pgn
hy
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F. Anaspis
E. Anaspis
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stm
I. Anaspis
G Anaspis
H Anaspis
J. Othnius
K. Othnius
L. Othnius
M. Othnius
pgn
hl
N. Othnius
O. Othnius
Q. Othnius
P. Othnius.
R. Othnius

Plate 48

Eurystethidae, Boridae

A. Eurystethus californicus Melsh. (= Aegialites debilis Mann.) : Spiracle surrounded by oval sclerome.

B. " " " : Head. Dorsal view.

C. " " " : Mandible. Ventral view.

D. " " " : Larva. Dorsal view.

E. " " " : Head. Ventral view.

F. " " " : Hypopharyngeal region.

G. Boros unicolor Say : Hypopharyngeal region.

H. " " : Metathorax and first abdominal segment. Lateral view.

I. " " : Leg.

J. " " : Labrum. Dorsal view.

K. " " : Epipharynx.

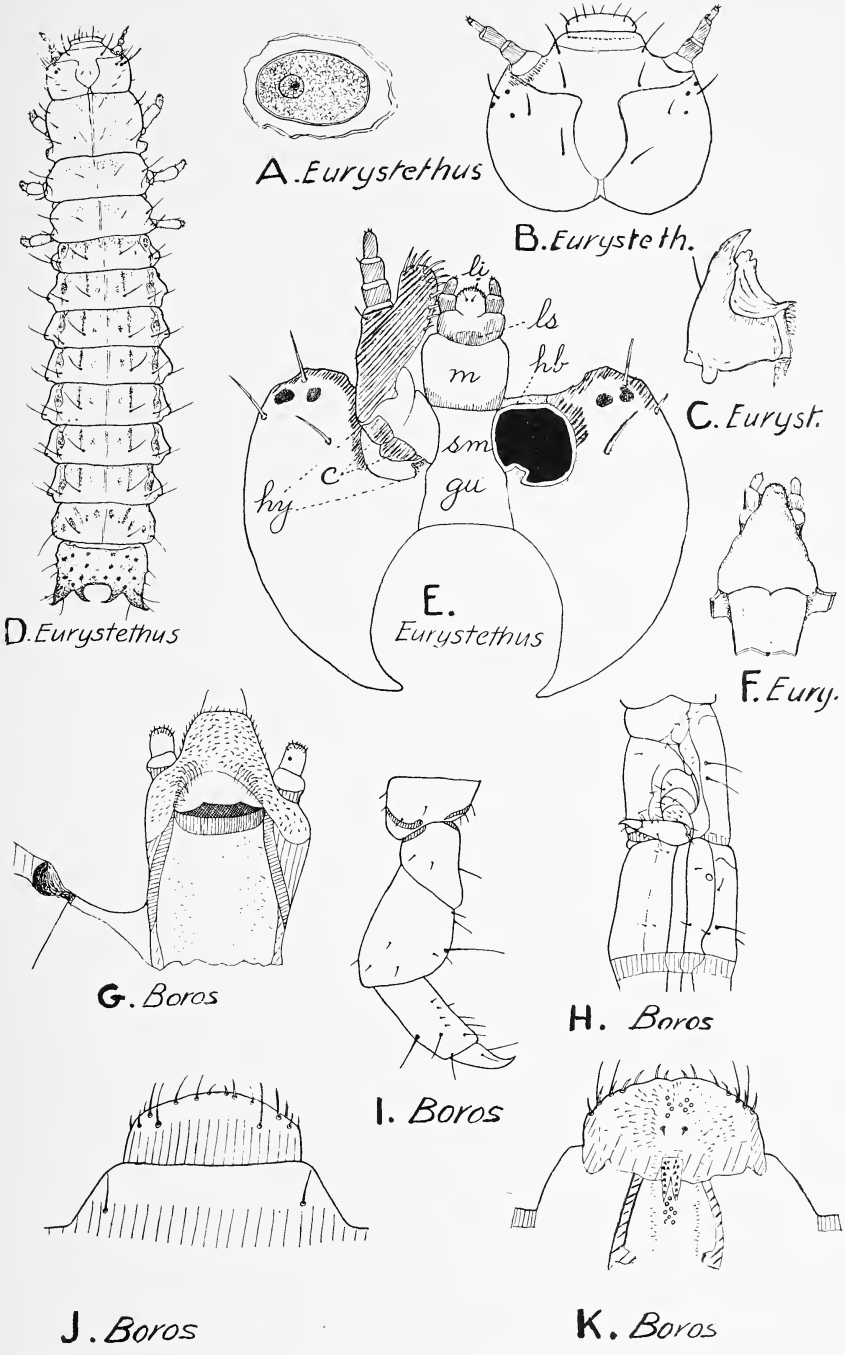

A. Eurystethus
B. Eurysteth.
C. Eurysth.
D. Eurystethus
E. Eurystethus
F. Eury.
G. Boros
H. Boros
I. Boros
J. Boros
K. Boros
li
ls
m
hb
sm
c
hy
gu

Plate 49

Colydiidae

A. Bitoma crenata F. (Denmark) : Ninth abdominal segment. Dorsal view.
B. Synchita fuliginosa Melsh. : Head. Dorsal view.
C. " " : Head. Ventral view.
D. Phloeonemus catenulatus Horn : Spiracle.
E. Synchita fuliginosa : Thorax. Ventral view.
F. Phloeonemus catenulatus : Right mandible.
G. Nematidium filiforme Lec. : Head. Dorsal view.
H. " " : Head. Ventral view.
I. Aulonium tuberculatum Lec. : Ventral mouthparts. Ventral view.
J. " " : Spiracle.
K. " " : Larva. Lateral view.
L. " " : Right mandible.
M. Nematidium filiforme : Posterior end of abdomen. Lateral view.

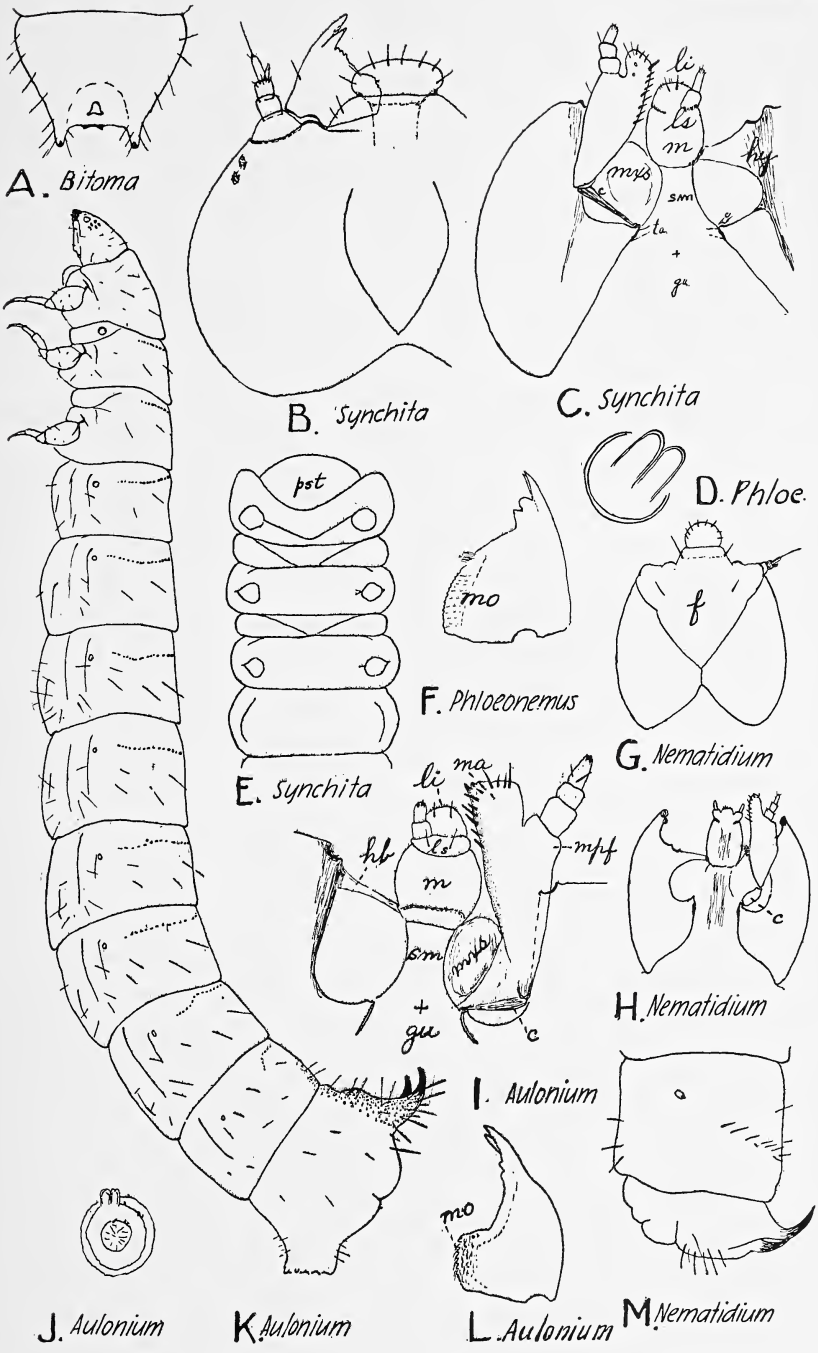

A. Bitoma
B. Synchita
C. Synchita
li
la
m
hy
mxs
sm
la
+
ga
D. Phloe
pst
E. Synchita
mo
F. Phloeonemus
f
G. Nematidium
ma
li
mxs
hb
la
m
mxf
sm
mxb
+
ga
c
I. Aulonium
H. Nematidium
c
mo
J. Aulonium
K. Aulonium
L. Aulonium
M. Nematidium

PLATE 50

Mycetophagidae

A. Mycetophagus punctatus Say : Larva. Lateral view.
B. " " : Head and prothorax. Ventral view.
C. Mycetophagus obsoletus Melsh. : Ninth abdominal segment. Ventral view.
D. " " : Third abdominal spiracle.
E. Typhaea fumata L. : Left mandible. Ventral view.
F. " " : Left mandible. Dorsal view.
G. " " : Right mandible. Dorsal view.
H. " " : Mesothoracic spiracle.
I. " " : Hypopharyngeal region.
J. " " : Head. Dorsal view.
K. " " : Larva. Dorsal view.
L. Thrimolus duryi Csy. : Antenna.
M. Litargus sexpunctatus Say : Posterior end of abdomen. Dorsal view.
N. Litargus connexus Geoffr. (Denmark) : Third abdominal spiracle.
O. Alitargus balteatus Lec. : Larva. Ventral view.
P. Thrimolus duryi : Left mandible. Ventral view.
Q. " " : Right mandible. Ventral view.
R. " " : Spiracle.
S. " " : Larva. Dorsal view.
T. " " : Larva. Lateral view.

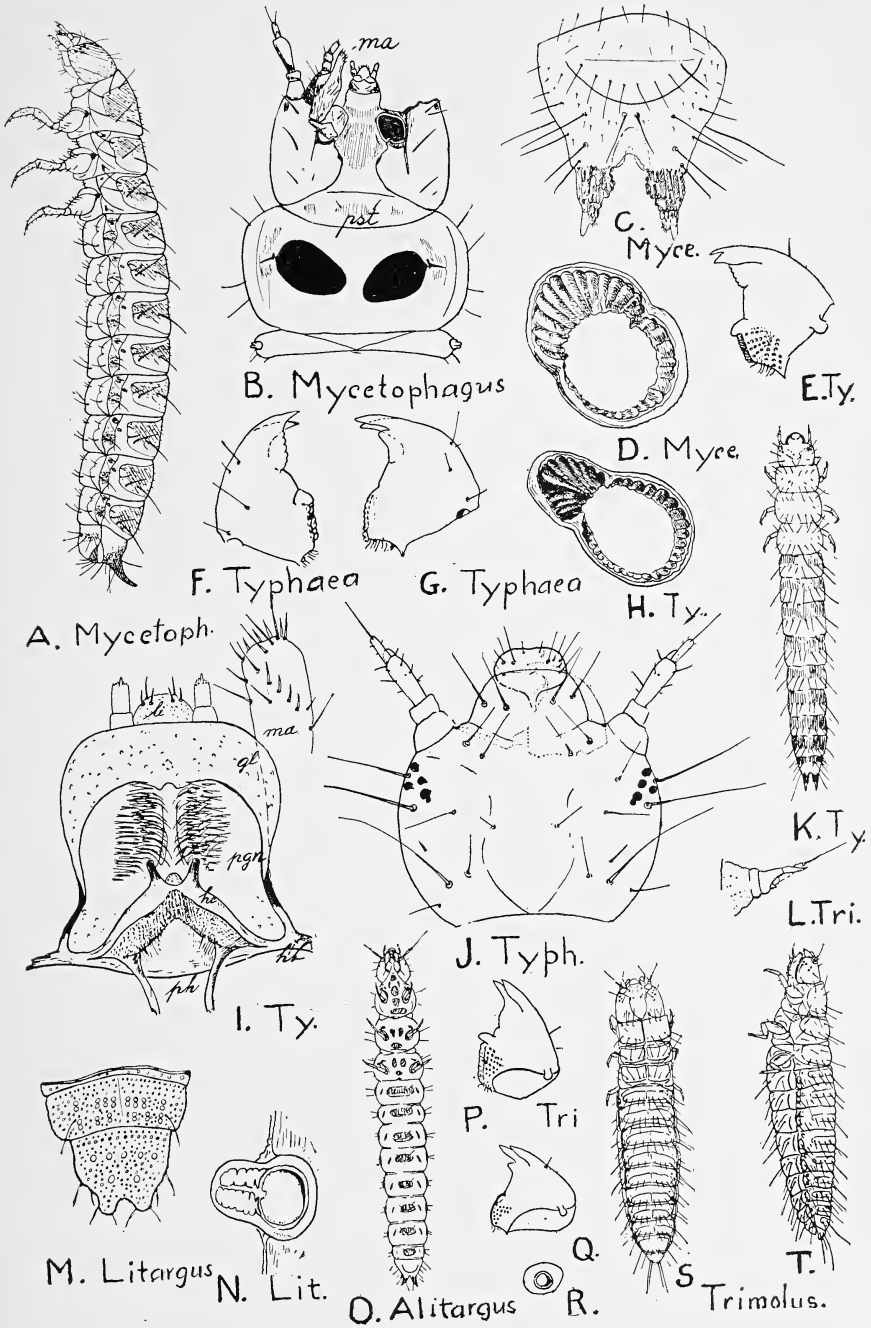
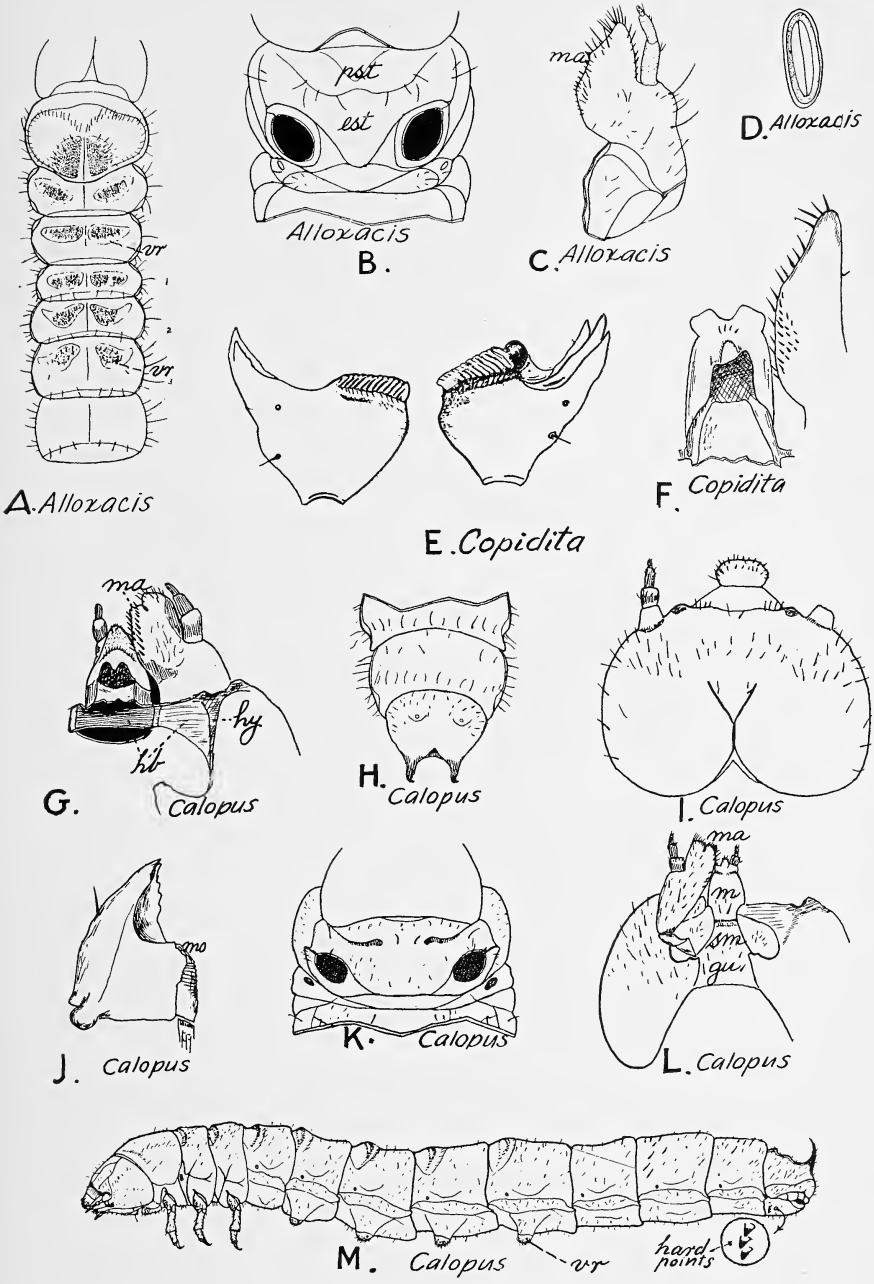

ma
pst
B. Mycetophagus
C. Myce.
E. Ty.
D. Myce.
F. Typhaea
G. Typhaea
H. Ty.
A. Mycetoph.
K. Ty.
L. Tri.
J. Typh.
I. Ty.
P. Tri
Q.
R.
M. Litargus
N. Lit.
O. Alitargus
S
Trimolus.
T.

Plate 51

Oedemeridae-Oedemerinae (A–F), *Oedemeridae-Calopodinae*

A. Alloxacis dorsalis Melsh.: Anterior part of body; vr, verruca scansoria or ambulatory wart (= tuber scansorium, Schiödte).
B. " " : Prothorax. Ventral view.
C. " " : Maxilla. Ventral view.
D. " " : Spiracle.
E. Copidita thoracica F. : Right and left mandibles. Dorsal view.
F. " " : Hypopharyngeal region and mala.
G. Calopus angustus Lec. : Hypopharyngeal region and maxilla. Dorsal view.
H. " " : Eighth and ninth abdominal segments. Dorsal view.
I. " " : Head. Dorsal view.
J. " " : Right mandible.
K. " " : Prothorax. Ventral view.
L. " " : Head. Ventral view.
M. " " : Larva; vr, scansorial verruca; enlargement of the three hard points of right abdominal segment shown separately in the circular inset. Lateral view.


A. Alloxacis
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Alloxacis
B.
ma
C. Alloxacis
D. Alloxacis
E. Copidita
F. Copidita
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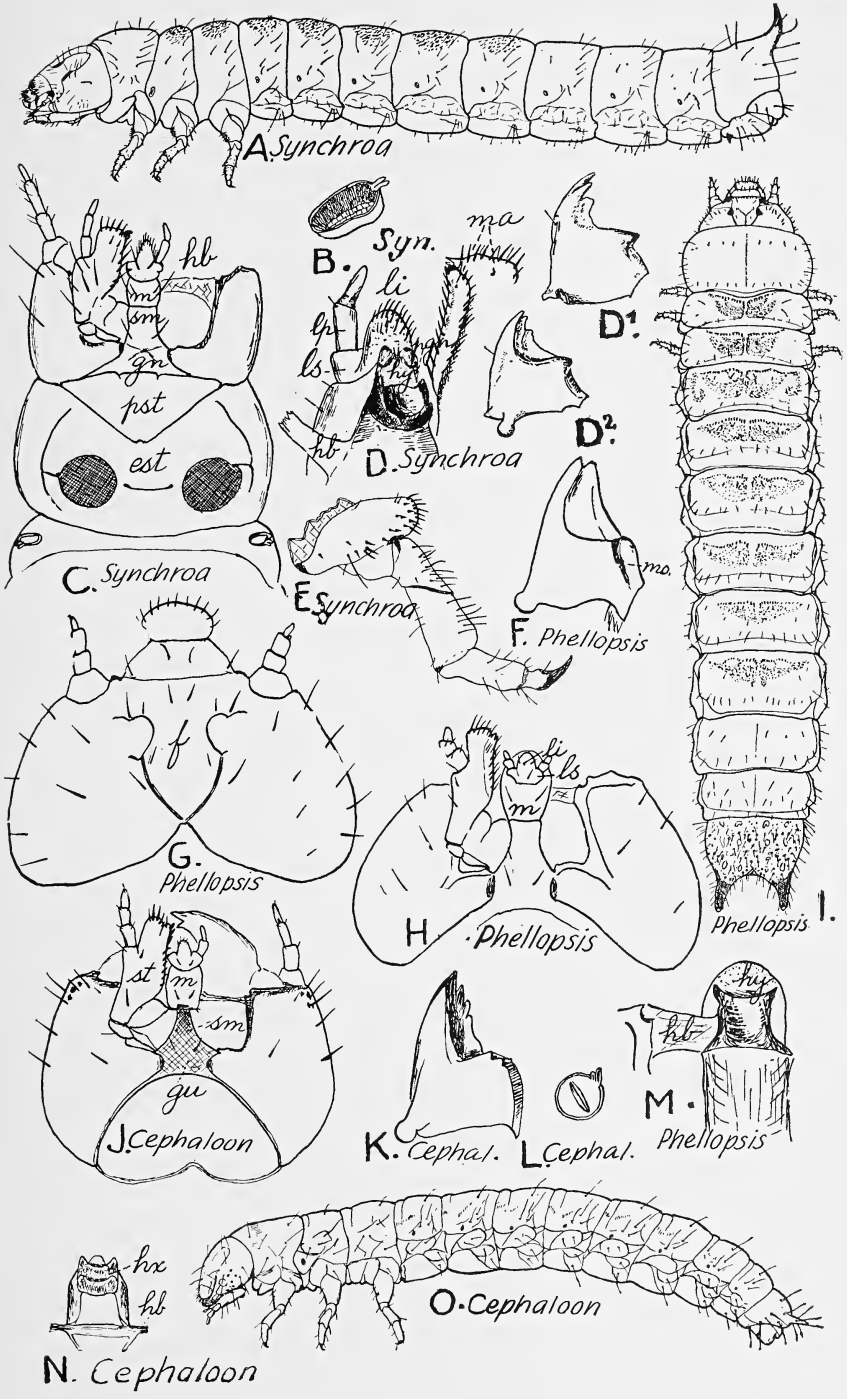
G. Calopus
H. Calopus
I. Calopus
J. Calopus
mo
K. Calopus
ma
m
sm
gu
L. Calopus
M. Calopus
vr
hard points

Plate 52

Synchroidae, Zopheridae (F–I and M), *Cephaloidae*

A. Synchroa punctata Newn. : Larva. Lateral view.
B. " " : Spiracle.
C. " " : Head and prothorax. Ventral view.
D. " " : Hypopharyngeal region and maxilla.
D^1. " " : Left mandible. Dorsal view.
D^2. " " : Right mandible. Ventral view.
E. " " : Leg.
F. Phellopsis obcordata Kby. : Mandible.
G. " " : Head. Dorsal view.
H. " " : Head. Ventral view.
I. " " : Larva. Dorsal view.
J. Cephaloon lepturides Newn. : Head. Ventral view.
K. " " : Mandible.
L. " " : Spiracle.
M. Phellopsis obcordata : Hypopharynx.
N. Cephaloon lepturides : Hypopharynx.
O. " " : Larva. Lateral view.


A. Synchroa
B. Syn.
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lp
ls
hy
hb
D. Synchroa
D¹.
D².
hb
m
sm
gn
pst
est
C. Synchroa
E. Synchroa
F. Phellopsis
mo.
I.
Phellopsis
f
G.
Phellopsis
li
ls
m
H. Phellopsis
st
m
sm
gu
J. Cephaloon
K. Cephal.
L. Cephal.
hy
hb
M.
Phellopsis
hx
hb
N. Cephaloon
O. Cephaloon

Plate 53

Pedilidae (*Eurygeniidae*), *Pyrochroidae*

A. Eurygenius campanulatus Lec. : Labrum and antenna. Dorsal view.
B. " " : Mandible. Ventral view.
C. " " : Hypopharyngeal region.
D. " " : Ninth abdominal segment. Dorsal view.
E. " " : Tibia and tarsungulus.
F. " " : Ninth and tenth abdominal segments. Ventral view.
G. " " : Maxilla. Ventral view.
H. " " : Larva. Lateral view.
I. Neopyrochroa femoralis Lec. : Head. Dorsal view.
J. " " : Right mandible. Ventral and dorsal views.
K. " " : Spiracle.
L. " " : Larva. Dorsal view.
M. " " : Eighth, ninth and tenth abdominal segments. Ventral view.
N. " " : Leg.
O. " " : Head and prothorax. Ventral view.

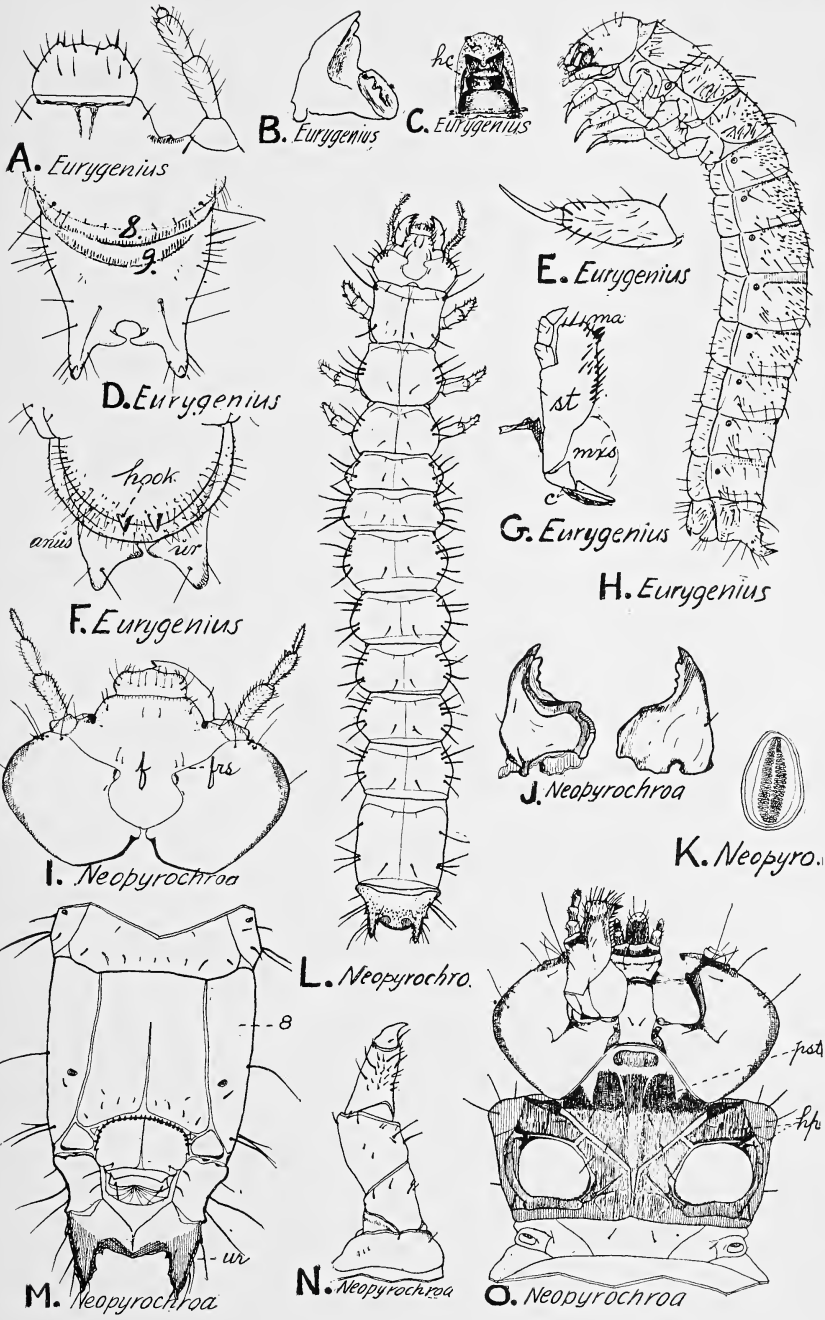

A. Eurygenius
B. Eurygenius
C. Eurygenius
hc
D. Eurygenius
8.
9.
E. Eurygenius
G. Eurygenius
urona
st
mxs
c
H. Eurygenius
F. Eurygenius
hpok
antis
ur
I. Neopyrochroa
f
frs
J. Neopyrochroa
K. Neopyro.
L. Neopyrochro.
M. Neopyrochroa
8
ur
N. Neopyrochroa
O. Neopyrochroa
post
hp

Plate 54

Salpingidae (*Rhinosimus*), *Pythidae*

A. Rhinosimus ruficollis L. (Denmark) : Right mandible. Ventral view.
B. " " : End of tibia, and tarsungulus.
C. " " : Hypopharynx, hypopharyngeal bracon, and maxilla.
D. " " : Spiracle.
E. " " : Left mandible. Ventral view.
F. " " : Larva. Dorsal view.
G. " " : Eighth, ninth, and tenth abdominal segments. Ventral view.
H. " " : Ventral mouthparts. Ventral view.
I. Pytho niger Kby. : Spiracle.
J. " " : Right mandible. Dorsal view.
K. " " : Head. Dorsal view.
L. " " : Left maxilla. Dorsal view.
M. " " : Posterior end of abdomen. Ventral view.
N. " " : Head. Ventral view.
O. " " : Hypopharyngeal region.

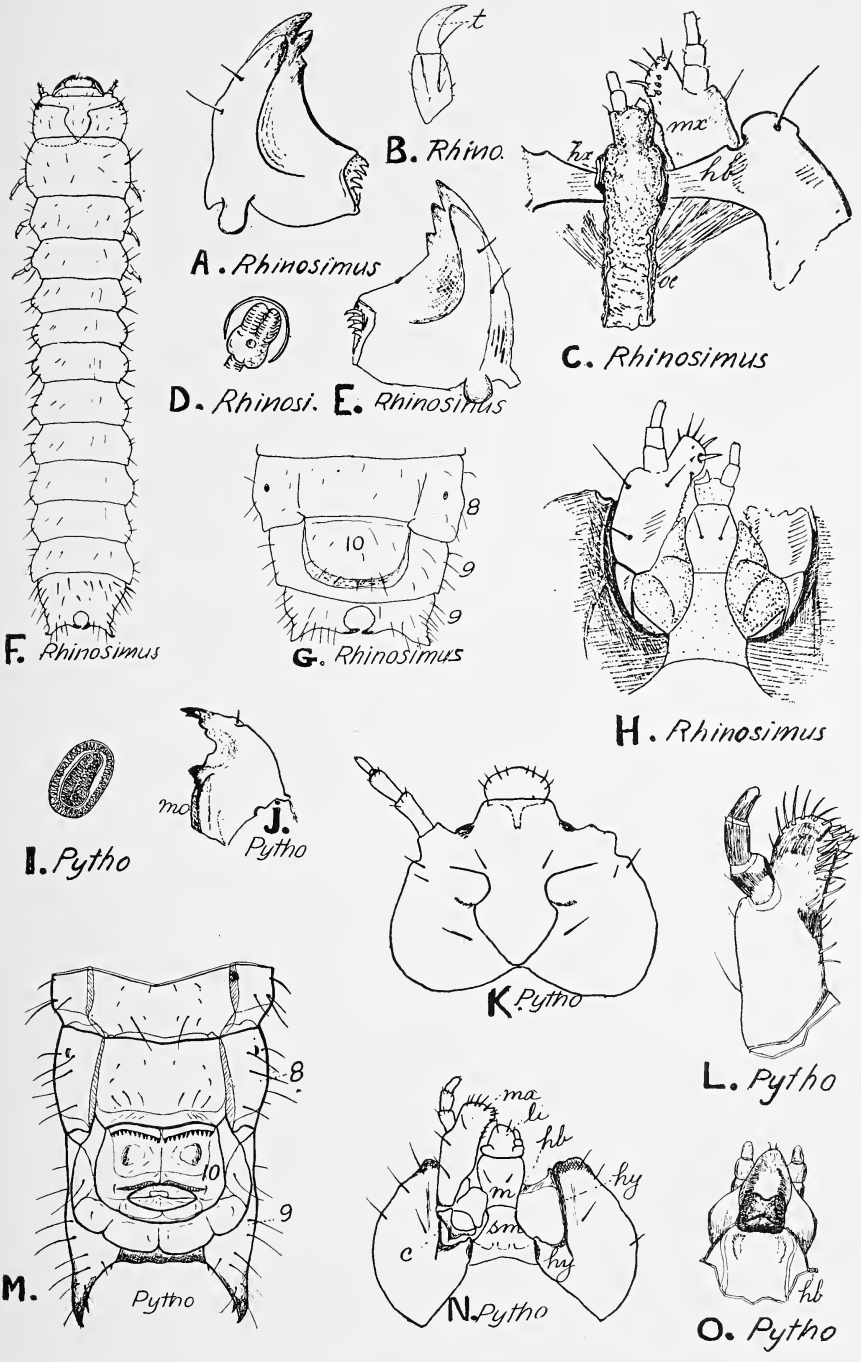
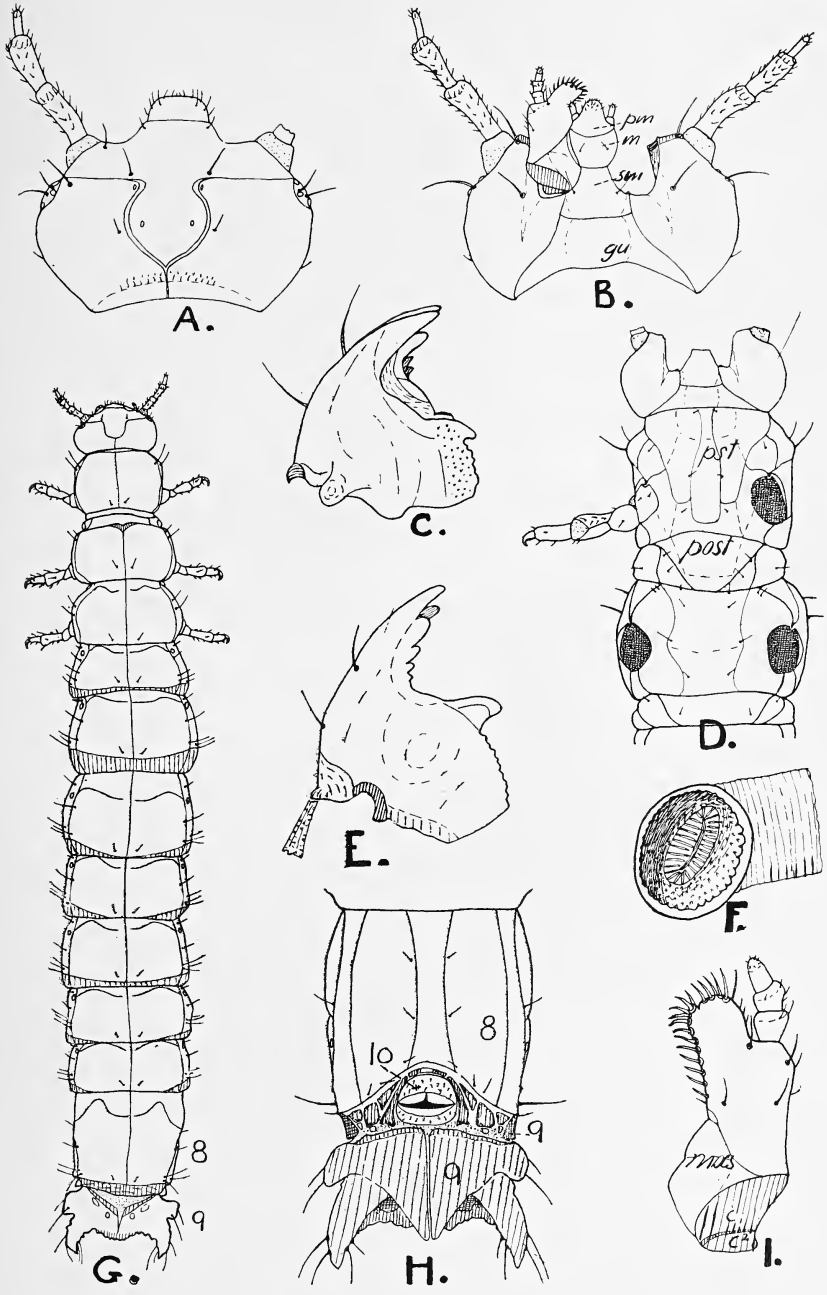

t
B. Rhino.
mx
hs
hb
oe
C. Rhinosimus
A. Rhinosimus
D. Rhinosi.
E. Rhinosimus
F. Rhinosimus
8
10
9
9
G. Rhinosimus
H. Rhinosimus
I. Pytho
mo
J. Pytho
K. Pytho
L. Pytho
8
10
9
M. Pytho
ma
li
hb
hy
m
sm
c
hy
N. Pytho
hb
O. Pytho

PLATE 55

Boridae

A. Boros unicolor Say : Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Right mandible. Ventral view.
D. " " : Prothorax and mesothorax. Ventral view.
E. " " : Left mandible. Dorsal view.
F. " " : Spiracle.
G. " " : Larva. Dorsal view.
H. " " : Eighth, ninth, and tenth abdominal segments. Ventral view.
I. " " : Maxilla; C^1, anterior part of cardo; C^2, posterior part of cardo. Ventral view.



Boros unicolor.

Plate 56

Alleculidae-Alleculinae (A–L)

Alleculidae-Omophlinae (M–N)

A. Capnochroa fuliginosa Melsh. : Head. Dorsal view.
B. " " : Prothorax and anterior part of mesothorax. Ventral view.
C. " " : Ventral mouthparts. Ventral view.
D. " " : Right mandible. Interodorsal view.
E. Mycetochara fraterna Say : Posterior end of abdomen. Lateral view.
F. Hymenorus pilosus Melsh. : Mandible. Ventral view.
G. Capnochroa fuliginosa : Larva. Lateral view.
H. Hymenorus pilosus : Head. Dorsal view.
I. " " : Leg.
J. " " : Hypopharyngeal region and maxilla.
K. " " : Head. Ventral view.
L. " " : Posterior end of abdomen; vl, ventro-lateral suture. Lateral view.
M. Cteniopus sulphureus L. (Denmark) : Posterior end of abdomen. Ventro-lateral view.
N. Omophlus proteus Kirsch (Russia) : Larva. Ventro-lateral view.

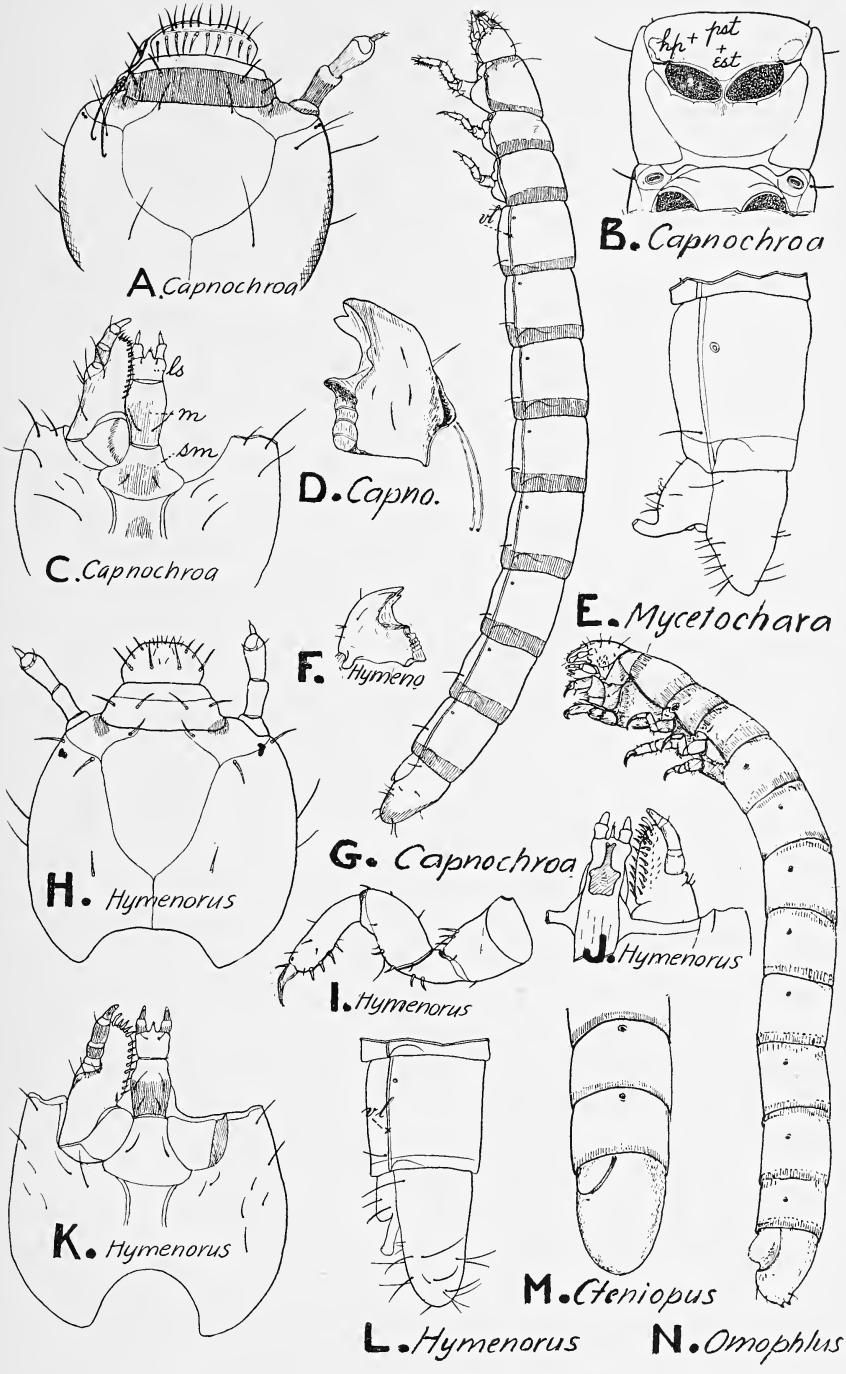

A. Capnochroa
B. Capnochroa
hp+ pst + est
C. Capnochroa
ls
m
sm
D. Capno.
E. Mycetochara
F. Hymeno
G. Capnochroa
H. Hymenorus
I. Hymenorus
J. Hymenorus
K. Hymenorus
L. Hymenorus
M. Cteniopus
N. Omophlus

Plate 57

Tenebrionidae

A. Eleodes suturalis Say : Ninth abdominal segment. Dorsal view.
B. Embaphion muricatum Say : Right and left mandibles and hypopharyngeal sclerome. Dorsal view.
C. " " : Ventral mouthparts. Ventral view.
D. Eleodes suturalis : Larva. Lateral view.
E. Hoplocephala ferruginea Lec. : Head. Dorsal view.
F. " " : Hypopharyngeal region and anterior part of labium. Dorsal view.
G. " " : Right mandible. Ventral view.
H. " " : Antenna.
I. " " : Right mandible. Dorsal view.
J. " " : Head. Ventral view.
K. Gnathocerus cornutus F. : Right mandible. Ventral view.
L. " " : Antenna.
M. " " : Hypopharyngeal region.
N. " " : Posterior part of abdomen. Lateral view.
O. Hypophloeus parallelus Melsh. : Right mandible. Ventral view.
P. " " : Right mandible. Dorsal view.
Q. " " : Antenna.
R. " " : Hypopharyngeal region.
S. Meracantha contracta Beauv. : Seventh to ninth abdominal segments. Dorsal view.
T. Strongylium tenuicolle Say : Eighth and ninth abdominal segments. Dorsal view.
U. " " : Eighth and ninth abdominal segments. Lateral view.

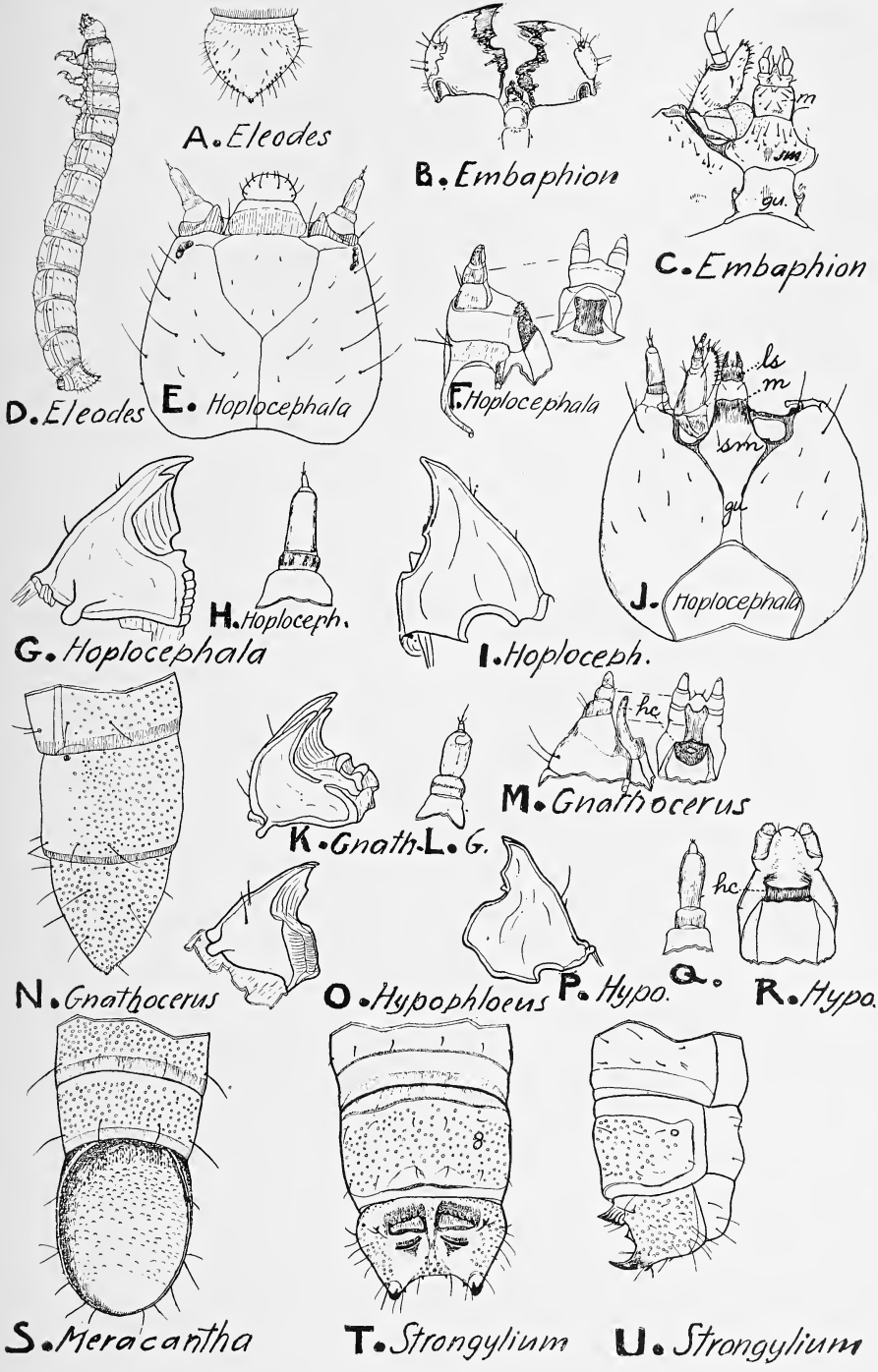
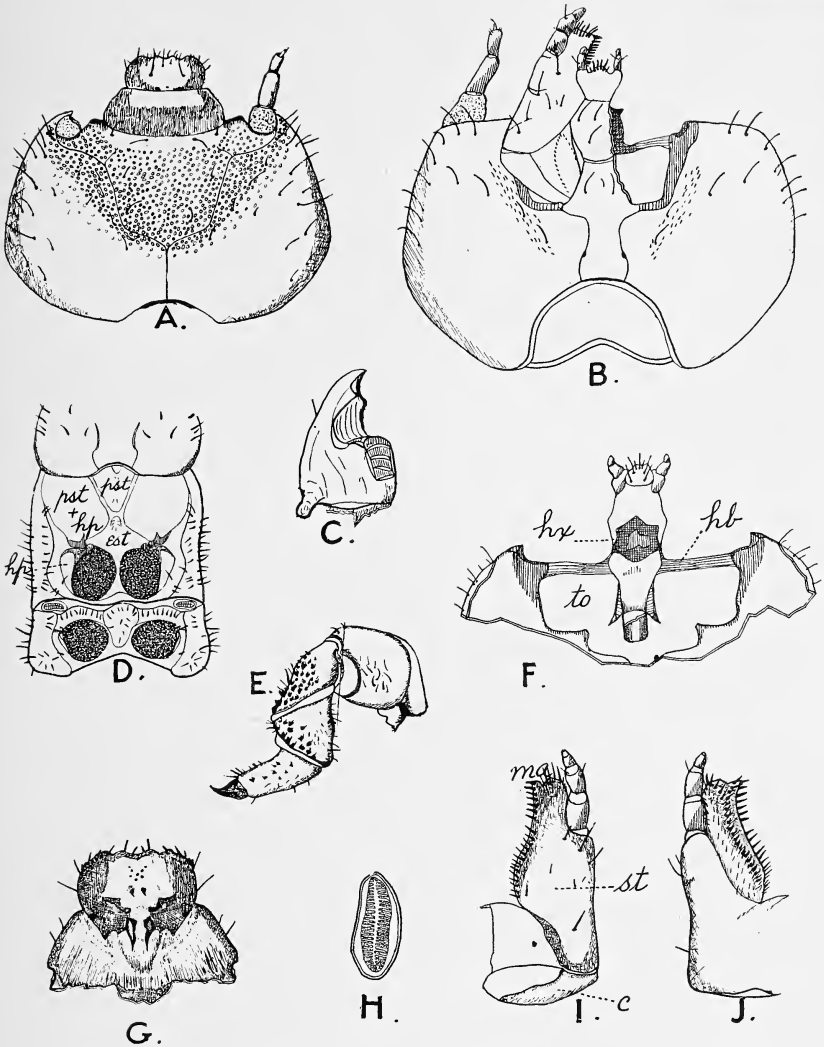

A. Eleodes
B. Embaphion
C. Embaphion
m
sm
gu.
D. Eleodes
E. Hoplocephala
F. Hoplocephala
ls
m
sm
gu
J. Hoplocephala
G. Hoplocephala
H. Hoploceph.
I. Hoploceph.
hc
M. Gnathocerus
K. Gnath.
L. G.
N. Gnathocerus
O. Hypophloeus
P. Hypo.
Q.
hc
R. Hypo.
S. Meracantha
T. Strongylium
U. Strongylium

Plate 58

Tenebrionidae

A. Alobates pennsylvanica DeG. : Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Mandible. Ventral view.
D. " " : Prothorax and mesothorax. Ventral view.
E. " " : Prothoracic leg.
F. " " : Labium, hypopharynx and bracon.
G. " " : Epipharynx.
H. " " : Abdominal spiracle.
I. " " : Left maxilla. Ventral view.
J. " " : Left maxilla. Dorsal view.
K. " " : Larva. Lateral view.

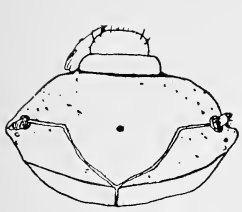


Alobates

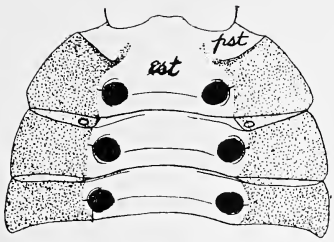
Plate 59

Nilionidae

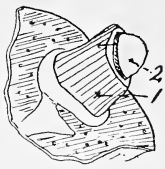
A. Leiochrodes sp. (Larva with pupae and imagines from China): Head. Dorsal view.
B. " " : Thorax. Ventral view.
C. " " : Antenna.
D. " " : Right mandible. Ventral view.
E. " " : Left mandible. Ventral view.
F. " " : Anterior end of labium. Ventral view.
G. " " : Maxilla. Ventral view.
H. " " : Hypopharyngeal region; gl, glossa.
I. " " : Larva. Dorsal view.
J. " " : Ventral mouthparts. Ventral view.
K. " " : Anterior end of labium and hypopharyngeal region. Lateral view.
L. " " : Larva. Lateral view.
M. " " : Leg.



A.



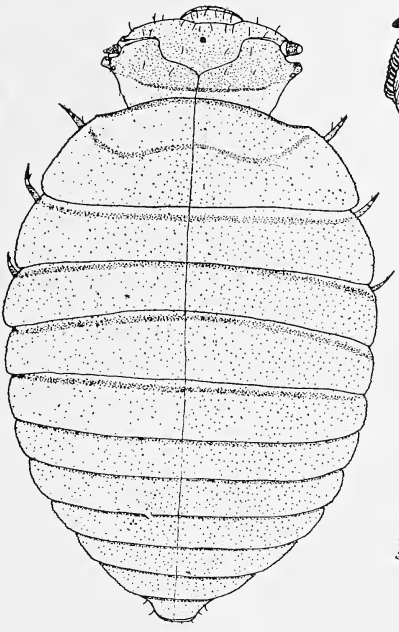
B.



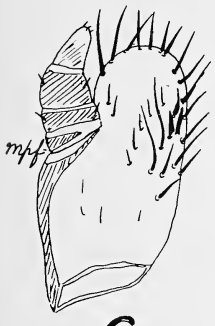
C.

D.

E.



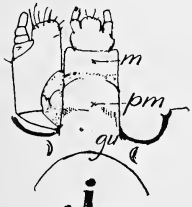
I.



G.

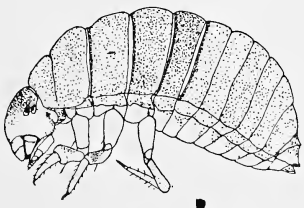
F.

H.



J.

K.



L.

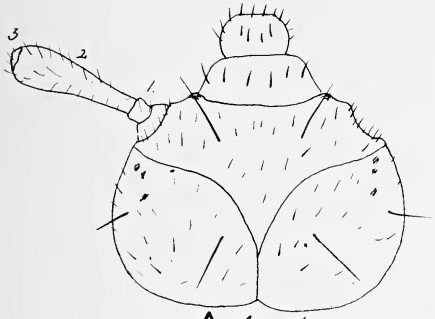
M.

Leiochrodes

Plate 60

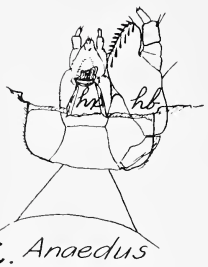
Lagriidae

A. Anaedus brunneus Ziegl. : Head. Dorsal view.
B. " " : Spiracle.
C. " " : Ventral mouthparts. Dorsal view.
D. " " : Leg.
E. " " : Left mandible. Ventral view.
F. " " : Right mandible. Dorsal view.
G. Paratenetus punctatus Spin. : Antenna.
H. Not determined Lagriid (Panama) : Antenna.
I. Paratenetus punctatus : Anterior end of labium and hypopharynx. Lateral view.
J. Arthromacra aenea Say : Anterior end of labium and hypopharynx. Lateral view.
K. " " : Prothorax. Ventral view.
L. Anaedus brunneus : Gland, covered by overlapping hairs; from tergal shield of an abdominal segment. Exterior view.
M. " " : Abdominal gland with overlapping hairs removed.
N. Arthromacra aenea : Eighth and ninth abdominal segments. Dorsolateral view.
O. " " : Ninth abdominal segment. Dorsal view.
P. Lagria sp. : Larva. Lateral view.

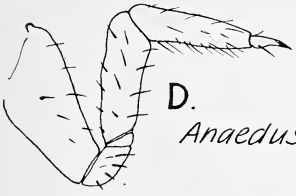


A. Anaedus

B. Anaedus

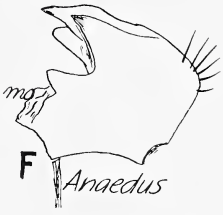


C. Anaedus

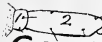


D. Anaedus

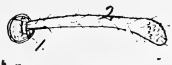
E. Anaedus



F Anaedus



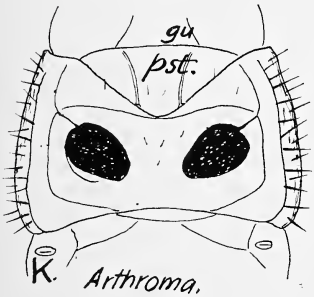
G. Paratenetus



H. Lagriid

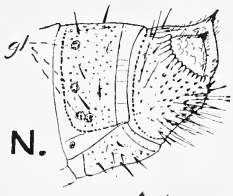
I. Paratenetus

J. Arthroma.



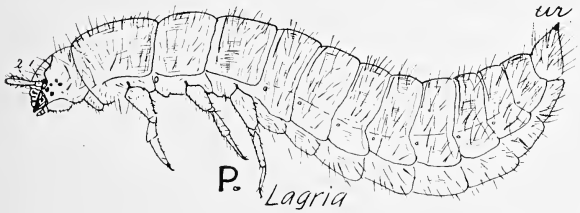
K. Arthroma.

L. Anaedus



N. Arthroma.

M. Anaedus



P. Lagria

O. Arthroma.

Plate 61

Byrrhidae-Byrrhinae

A. Byrrhus fasciatus Forst. (Denmark): Right mandible; notice the lack of a lacinia mandibulae and the presence of a row of hairs exclusively at the base of the mandible. Ventral view.

B. " " : Head. Dorsal view.

C. " " : Right mandible. Dorsal view.

D. " " : Head (partial). Ventral view.

E. " " : Innerside of the ventral portion of the head; nc, ganglion. Dorsal view.

F. " " : Portion of head showing epipharynx, antenna and the dorsal and ventral articulations of the mandible.

G. " " : Antenna. Dorsal view.

H. " " : Larva. Lateral view.

I. " " : Left maxilla. Dorsal view.

J. " " : Gula, submentum, mentum, prementum, labial palpiger, labial palpus, ligula, hypopharynx and other structures. Lateral view.

K. " " : Left maxilla; a, maxillary articulating area. Ventral view.

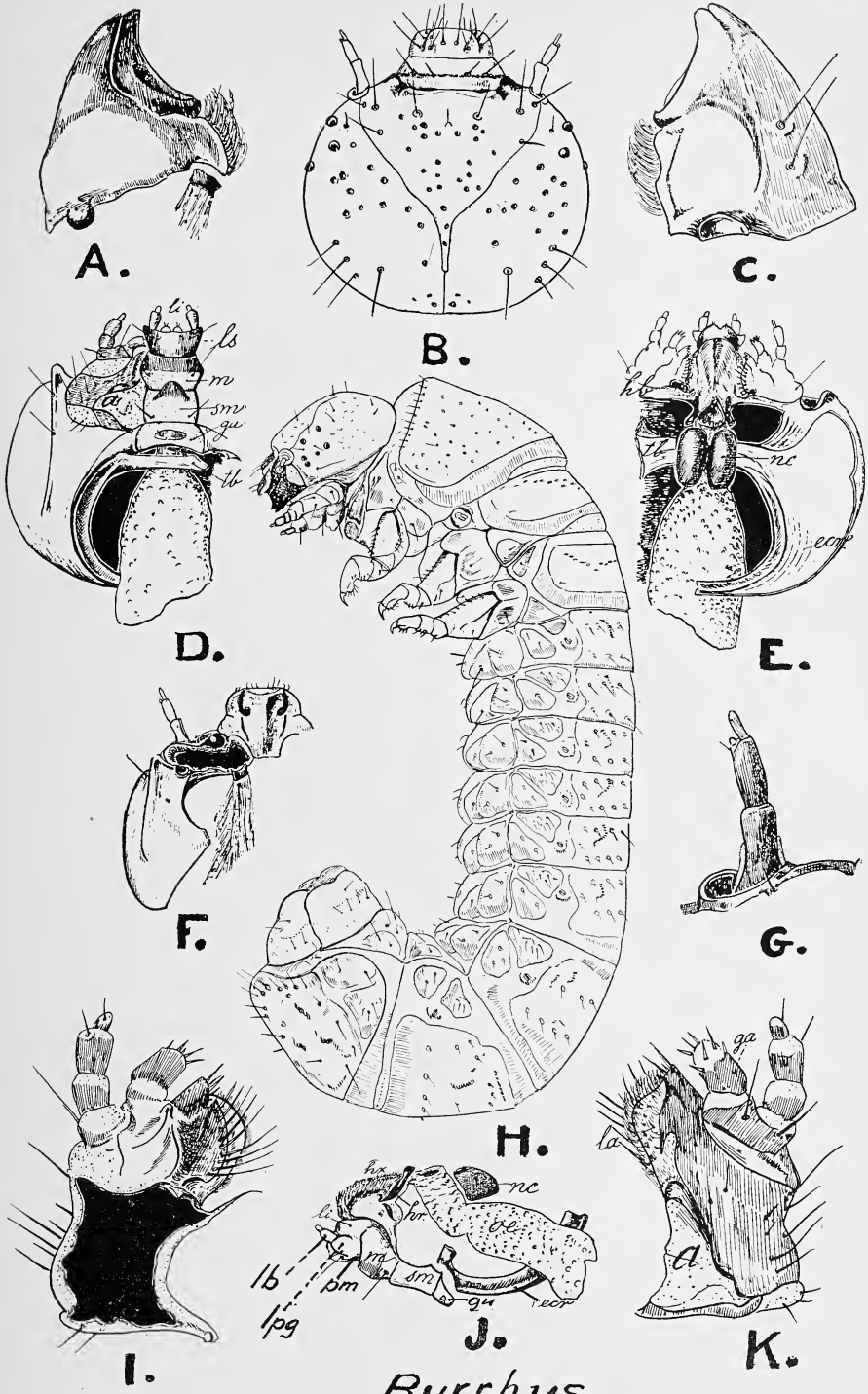

A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
K.
Byrrhus

Plate 62

Byrrhidae-Byrrhinae (A–B, D–H)

Byrrhidae-Amphicyrtinae (C, I–L)

Byrrhidae-Liooninae (M–R)

A. Cytilus sericeus Forster (Denmark): Antenna.
B. " " : Right maxilla. Ventral view.
C. Amphicyrta chrysomelina Er.: Head. Lateral view.
D. Cytilus sericeus : Left mandible. Dorsal view.
E. " " : Spiracle.
F. " " : Larva. Ventro-lateral view.
G. " " : Tibia and tarsungulus.
H. " " : Labial palpi.
I. Amphicyrta chrysomelina : Left mandible. Ventral view.
J. " " : Epipharyngeal, hypopharyngeal, labial and maxillary parts. Lateral view.
K. " " : Ventral mouthparts.
L. " " : Ninth and tenth abdominal segments; 9d, margin of dorsum of ninth abdominal segment; 9v, venter of ninth abdominal segment; 10d, margin of dorsum of tenth; 10v, venter of tenth; anus and anal hooks figured.
M. Lioon simplicipes Mann. : Frons, clypeus, labrum and antenna. Dorsal view.
N. " " : Left mandible. Ventral view.
O. " " : Epipharyngeal, hypopharyngeal, labial and maxillary parts. Dorso-lateral view.
P. " " : Spiracle.
Q. " " : Ventral mouthparts.
R. " " : Larva; gld, gland.

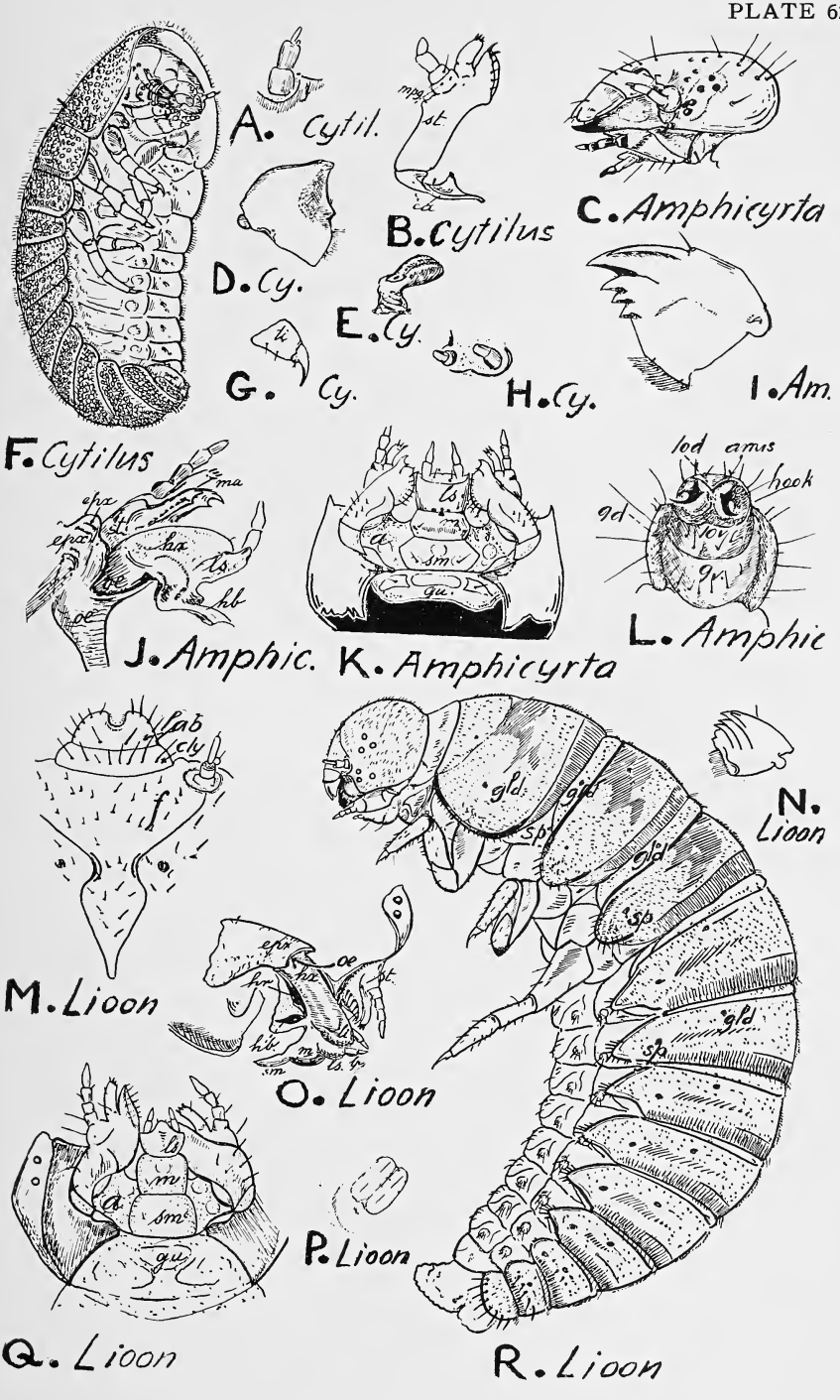
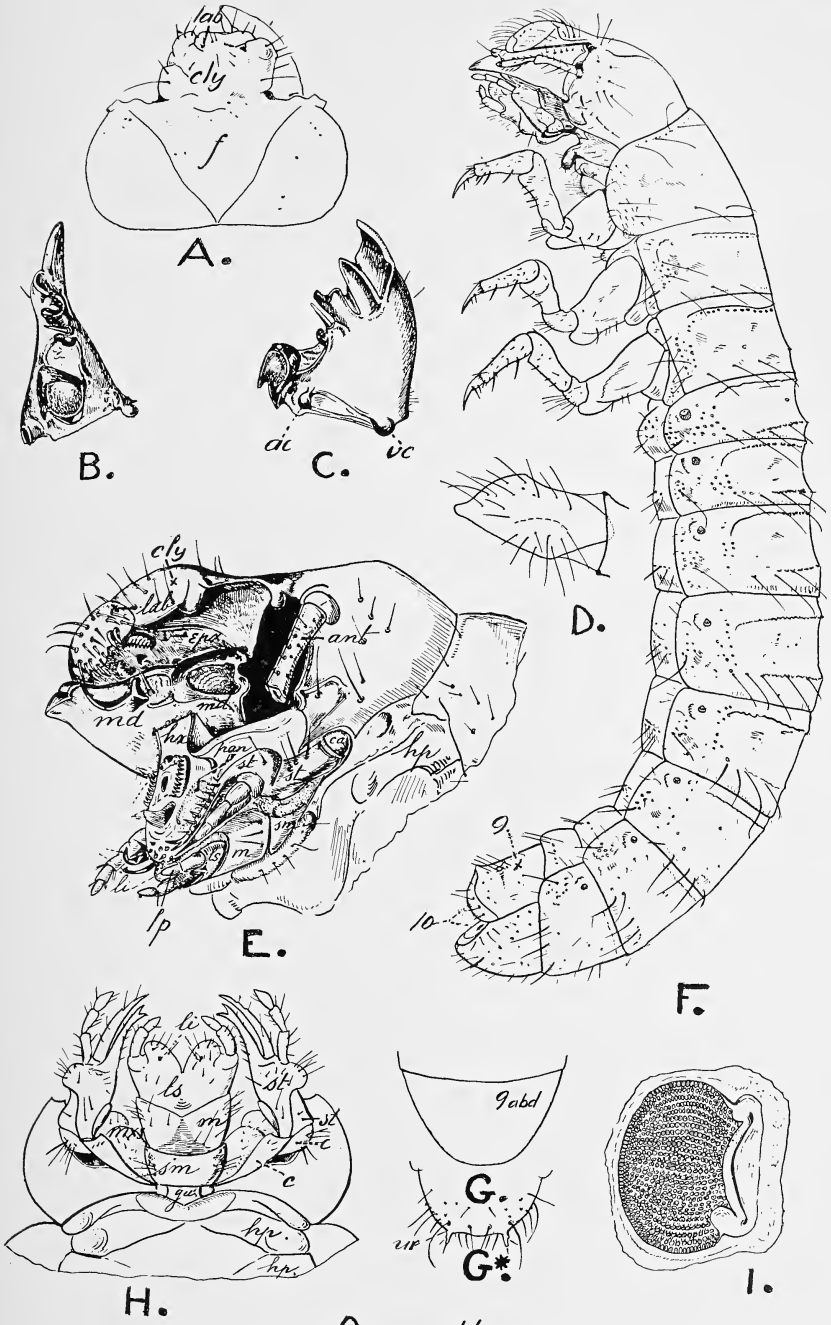

A. Cytil.
B. Cytilus
C. Amphicyrta
D. Cy.
E. Cy.
G. Cy.
H. Cy.
I. Am.
F. Cytilus
J. Amphic.
K. Amphicyrta
lod
anus
hook
L. Amphic
M. Lioon
N. Lioon
O. Lioon
P. Lioon
Q. Lioon
R. Lioon

PLATE 63

Dascillidae

A. Dascillus davidsoni Lec. : Head. Dorsal view.
B. " " : Left mandible. Facing the buccal cavity.
C. " " : Left mandible. Ventral view.
D. " " : Trochanter from inside.
E. " " : Split head showing clypeus, labrum, epipharynx, mandible, hypopharynx, and ventral mouthparts.
F. " " : Larva. Lateral view.
G. " " : Outline of ninth abdominal segment. Dorsal view.
G.* Dascillus cervinus L. (Denmark) : Tip of ninth abdominal segment. Dorsal view.
H. Dascillus davidsoni : Underside of head, ventral mouthparts, and anterior part of prothorax; hp, hypopleural lobe. Ventral view.
I. " " : First abdominal spiracle.


lab
cly
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lp
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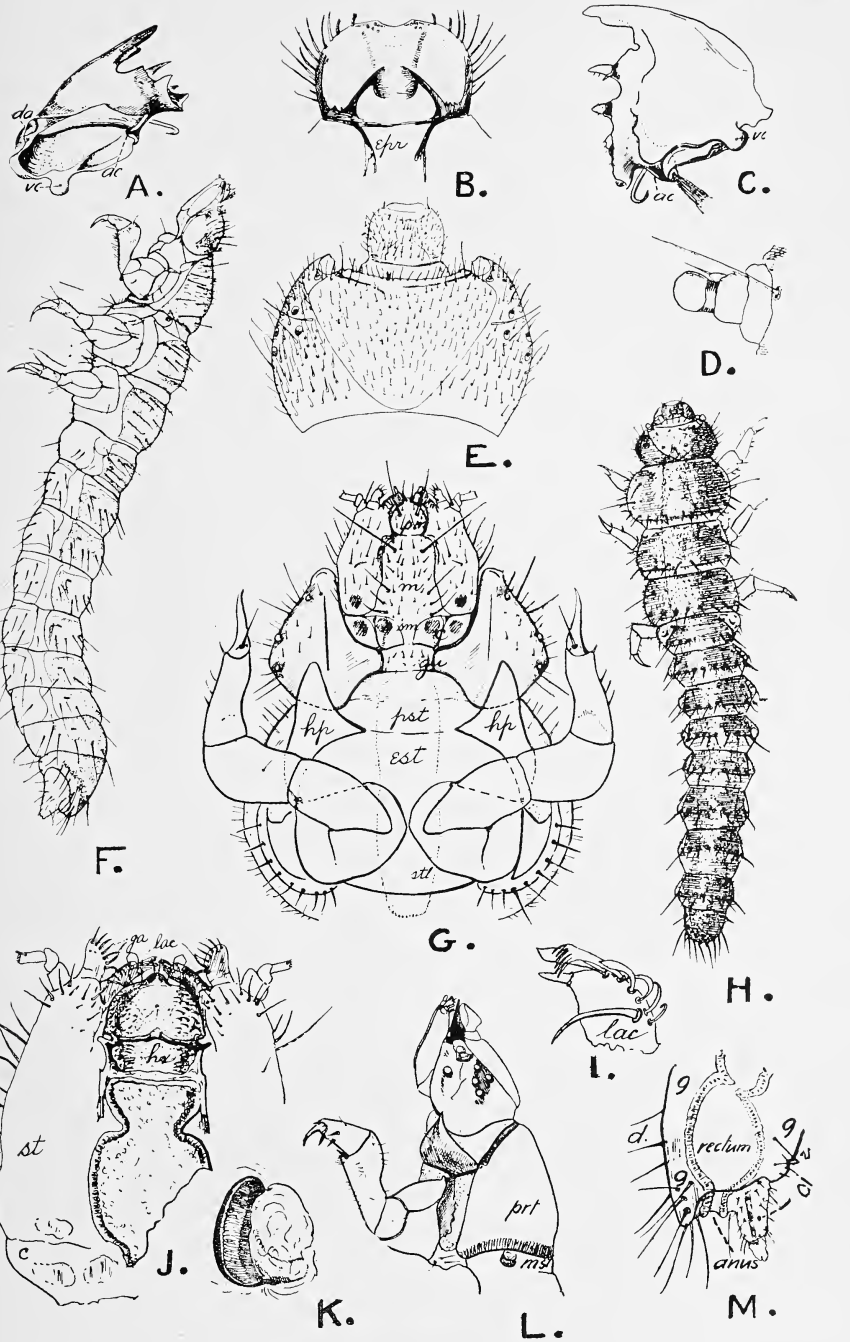
mx
sm
c
gu
hpr
H.
9abd
G.
anl
G*
I.

Dascillus

Plate 64

Heteroceridae

A. Heterocerus ventralis Melsh.: Left mandible showing dorsal and ventral articulations.
B. " " : Epipharynx.
C. " " : Left mandible. Ventral view.
D. " " : Antenna.
E. " " : Headcapsule. Dorsal view.
F. " " : Larva. Lateral view.
G. " " : Head and prothorax. Ventral view.
H. " " : Larva. Dorsal view.
I. " " : Tip of lacinia. Ventral view.
J. " " : Hypopharynx and maxilla.
K. " " : Spiracle of mesothorax. Exterior view.
L. " " : Head, prothorax, and anterior part of mesothorax with the spiracle. Lateral view.
M. " " : Sagittal section of end of abdomen; d, dorsal side; v, ventral side.



Heterocerus

Plate 65

Helodidae

A. Prionocyphon discoideus Say. : Mandible and epipharynx; i.s., not branched inner seta of the marginal front row of long epipharyngeal setae.

A.* Helodes marginata F. (Denmark) : Epipharyngeal marginal setae; i.s., branched inner seta.

B. Prionocyphon discoideus : Ventral mouthparts and part of prothorax.

B.* " " : Apical and postapical joints of maxillary palpus; 3, subapical joint; 4, apical joint; spl, sensory papillae; notice the indication of a subdivision of the postapical joint.

C. " " : Innerside of mouth with large maxillulae.

D. " " : Tassels of gills.

E. " " : Larva; aj, multiarticulated apical joint of antenna; sj, supplementary joint of antenna. Lateral view.

F. " " : Larva; aj and sj as in figure E. Dorsal view.

G. " " : End of abdomen; AC, alimentary canal with anus; 8 sp, spiracle of eighth abdominal segment. Diagram; lateral view.

H. " " : End of abdomen. Ventral view.

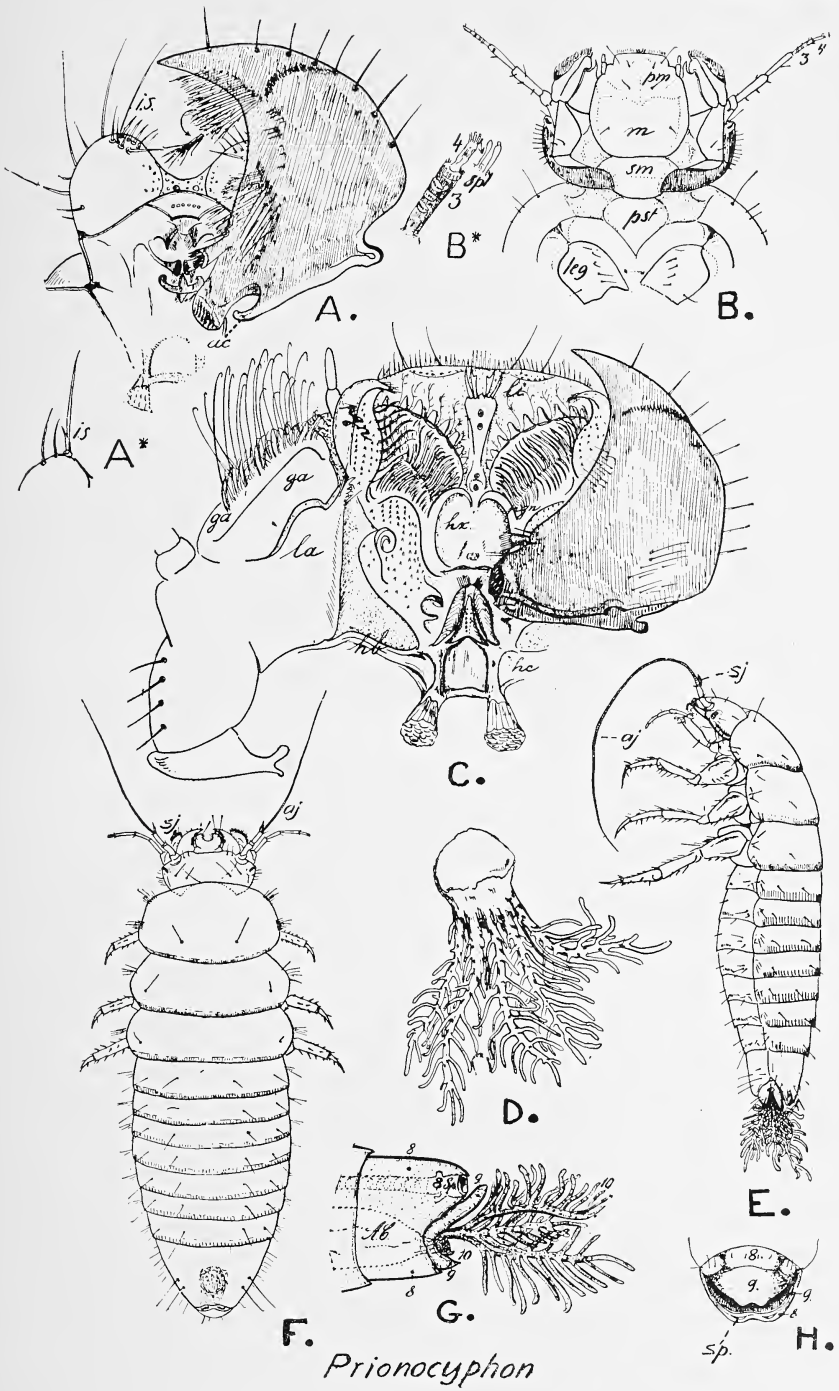

A.
B*
B.
A*
C.
D.
E.
F.
G.
H.
Prionocyphon

Plate 66

Nosodendridae

A. Nosodendron californicum Horn : End of abdomen. Dorsal view.
B. " " : End of abdomen; anal s., anal segment. Ventral view.
C. " " : Tip of eighth abdominal segment showing the terminal spiracles. Dorsal view.
D. " " : Head, prothorax and mesothorax; notice the position of the mesothorax spiracle as compared with that of *Nosodendron unicolor* on figure P. Lateral view.
E. " " : Third abdominal spiracle.
F. Nosodendron unicolor Say : Right mandible. Oblique view.
G. " " : Right mandible. Dorsal view.
H. " " : Anterior part of head with buccal roof removed. Dorsal view.
I. " " : Epipharynx and ventral surface of mandible.
J. " " : Cross-section of base of mandible.
K. " " : Glossa, maxillula, and hypopharynx. Dorsal view.
L. " " : Inside of the integument of parts shown on figure K.
M. " " : Glossa, maxillula, and hypopharynx. Lateral view.
N. " " : Head, prothorax, and mesothorax. Ventral view.
O. " " : Right maxilla. Ventral view.
P. " " : Larva; notice position of mesothoracic spiracle. Dorsal view.

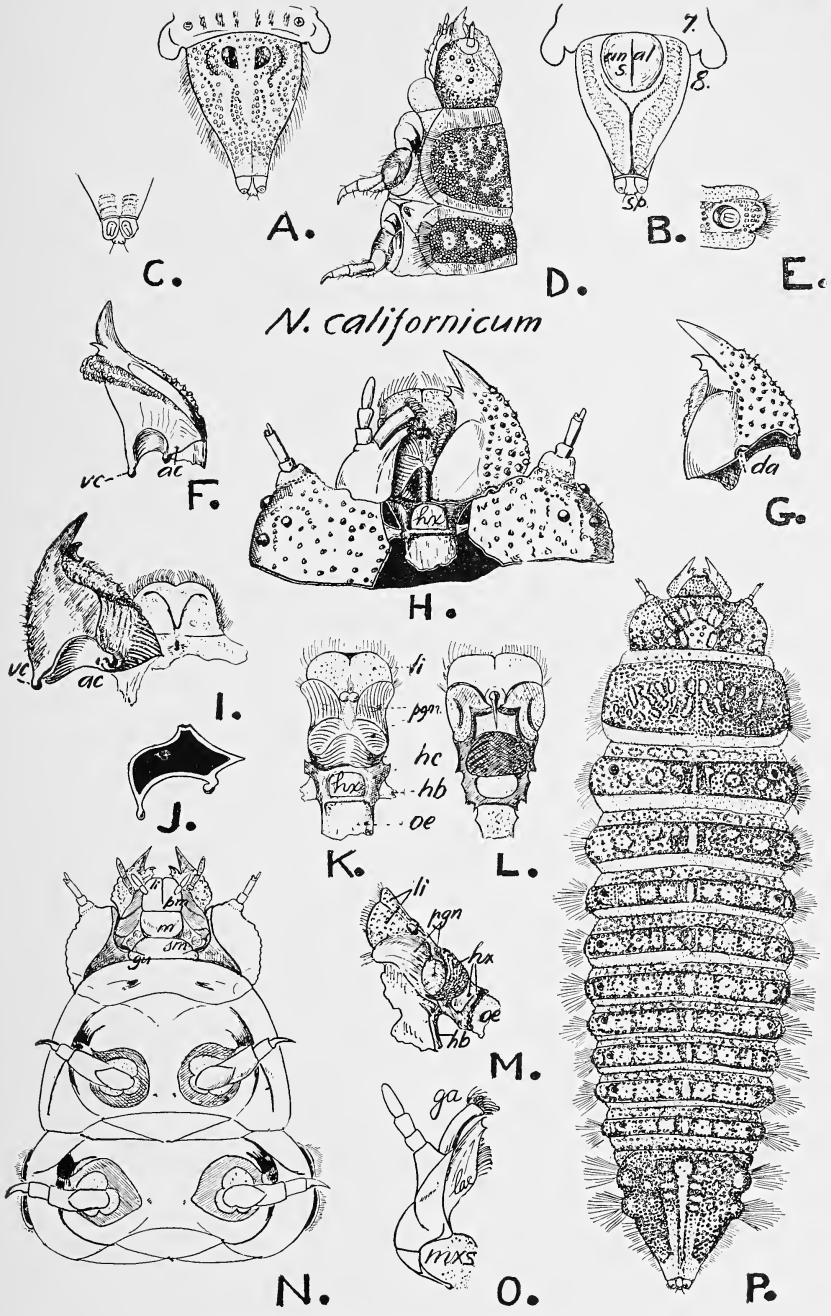
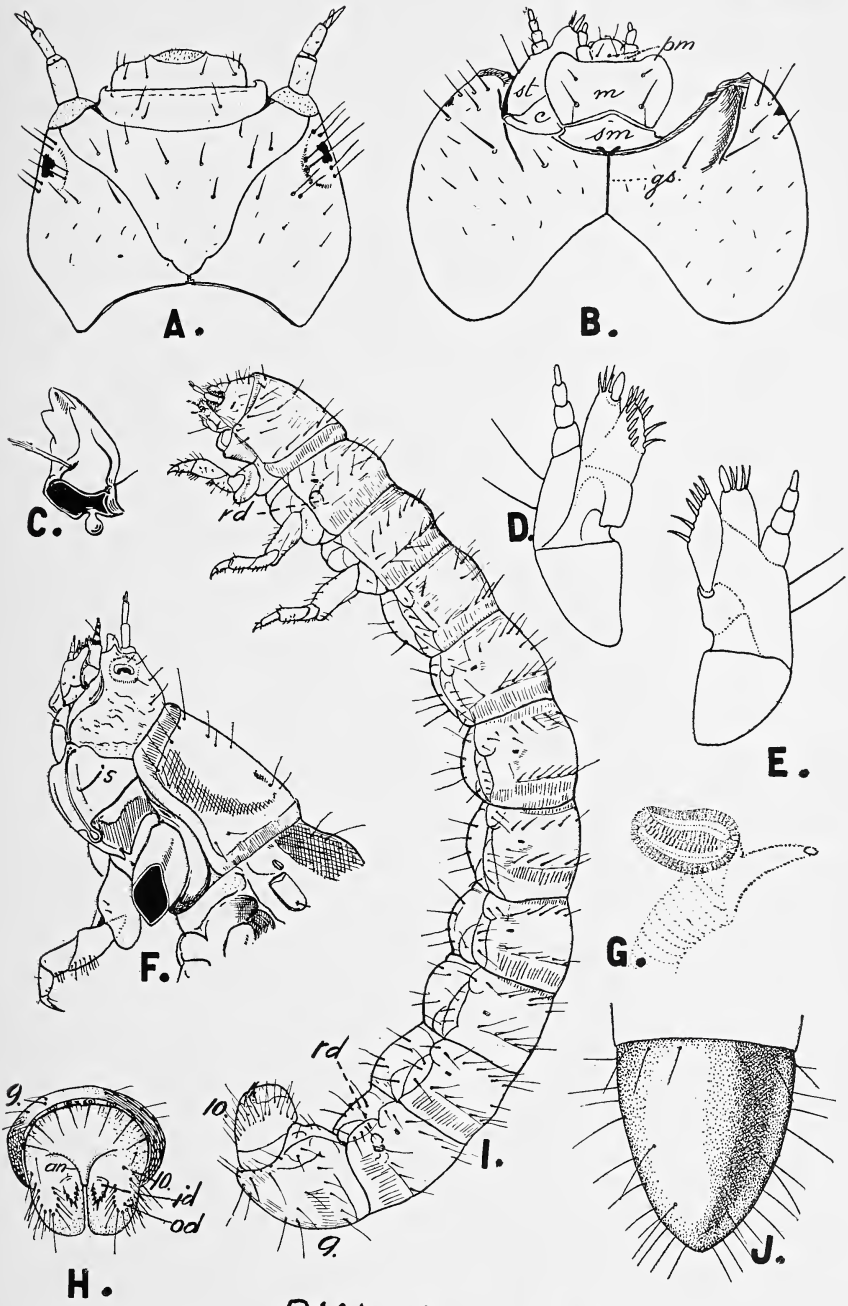

A.
B.
C.
D.
E.
N. californicum
F.
G.
H.
I.
J.
K.
L.
M.
N.
O.
P.
Nosodendron unicolor

PLATE 67

Ptilodactylidae

A. Ptilodactyla serricollis Say: Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Right mandible. Dorsal view.
D. " " : Right maxilla. Dorsal view.
E. " " : Right maxilla. Ventral view.
F. " " : Anterior part of larva; j.s, distended jugular skin; note retractile diverticle. Lateral view.
G. " " : Spiracle.
H. " " : Tenth abdominal segment; an, anus; id, spinose inner diverticle; od, hairy outer diverticle. Dorsal view.
I. " " : Larva; rd, retractile diverticle. Lateral view.
J. " " : Ninth abdominal segment. Dorsal view.

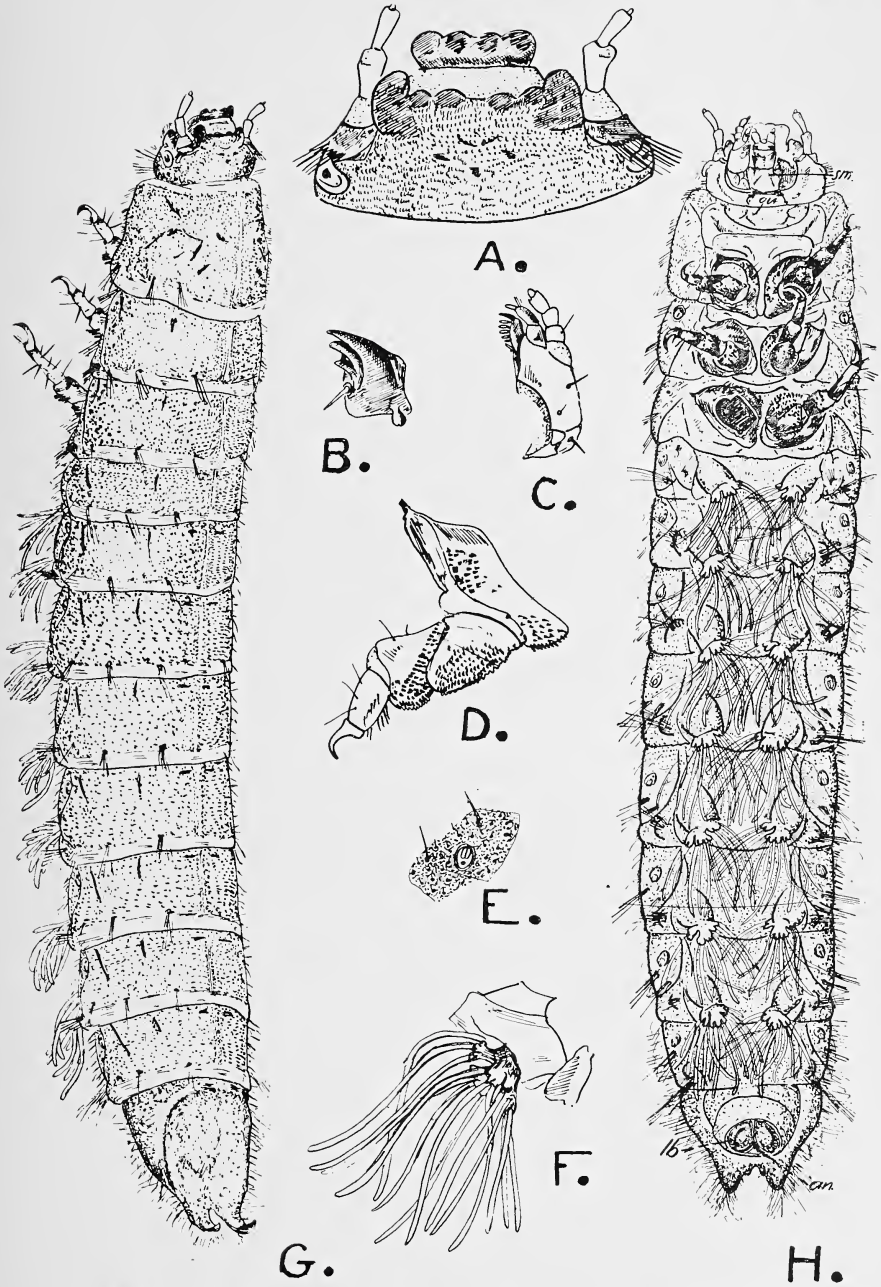


Ptilodactyla

Plate 68

Ptilodactylidae

A. Ptilodactylid larva from Asia. (Hang Chow): Anterior part of head. Dorsal view.
B. " " : Left mandible. Ventral view.
C. " " : Left maxilla. Ventral view.
D. " " : Leg.
E. " " : Spiracle.
F. " " : Tassel of gill-threads.
G. " " : Larva. Dorso-lateral view.
H. " " : Larva; notice large submentum, distinct gular area and longitudinally grooved anal lobes without spiny diverticles or gills; an, anus; lb, lobe.



Asiatic Ptilodactylid Larva

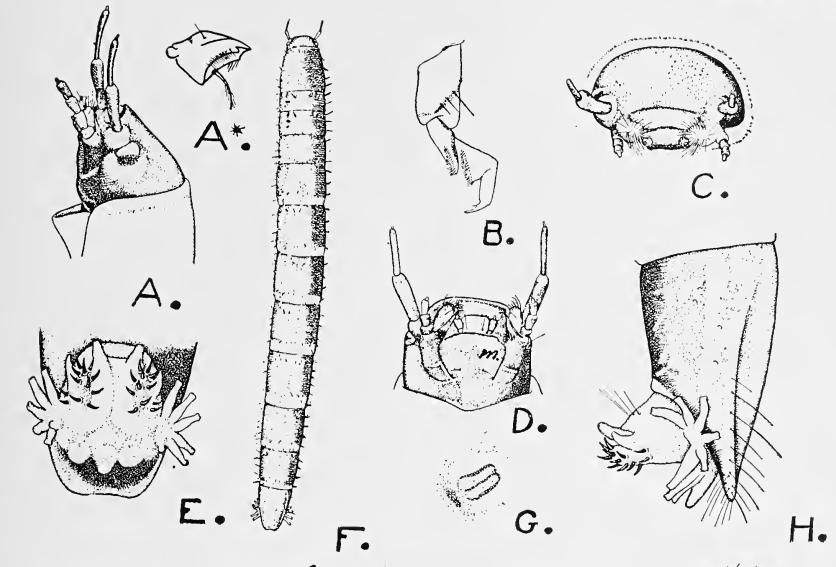
Plate 69

Ptilodactylidae

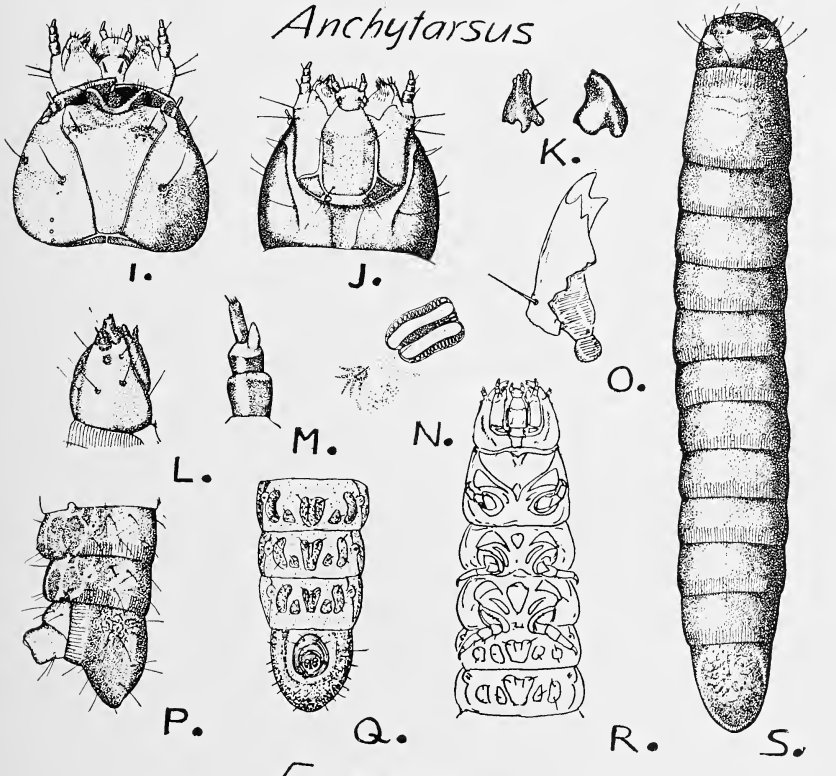
Eurypogonidae

(All the figures drawn by J. A. Hyslop, except figures A*, O, Q and R)

A.	Anchytarsus bicolor Melsh.	: Head. Lateral view.
A.*	" "	: Right mandible; notice hairs along the sides but not at the base, and the presence of a lacinia mandibulae; compare Byrrhidae figured on plate 61.
B.	" "	: Legs.
C.	" "	: Head. Front view.
D.	" "	: Head. Ventral view.
E.	" "	: End of abdomen. Ventral view.
F.	" "	: Larva. Dorsal view.
G.	" "	: Spiracle.
H.	" "	: End of abdomen. Lateral view.
I.	Eurypogon niger Melsh.	: Head; notice free labrum, no nasale as in Elateridae. Dorsal view.
J.	" "	: Head. Ventral view.
K.	" "	: Mandibles; worn apically.
L.	" "	: Head. Lateral view.
M.	" "	: Antenna.
N.	" "	: Spiracle.
O.	" "	: Tip of mandible; not worn.
P.	" "	: End of abdomen. Lateral view.
Q.	" "	: End of abdomen. Ventral view.
R.	" "	: Larva. Dorsal view.



Anchytarsus



Eurypogon

Plate 70

Psephenidae-Eubryanacinae

Psephenidae-Psepheninae

Dryopidae-Pelonominae (Q–V)

A. Eubrianax edwardsi Lec. : Left mandible. Dorsal view.
B. " " : Left mandible. Ventral view.
C. " " : Larva. Dorsal view.
D. " " : Right maxilla. Ventral view.
E. " " : Part of head. Ventral view.
F. Psephenus lecontei Lec. : Head. Dorsal view.
G. Eubrianax edwardsi : Larva. Ventral view.
H. Psephenus lecontei : Left mandible, pointed type. Oblique dorsal view.
I. " " : Left mandible, truncate type.
J. " " : Left mandible, pointed type.
K. " " : Larva. Dorsal view.
L. " " : Right maxilla. Ventral view.
M. " " : Epipharynx; o, eye from inside.
N. " " : Head. Ventral view.
O. " " : Maxilla and bottom of mouth cavity.
P. " " : Larva. Ventral view.
Q. Psephenoides gahani Champ : Head and prothorax.
R. " " : Distal end of leg.
S. " " : Larva. Dorsal view.
T. " " : Sucking disks from underside of body; a, in face view; b, in lateral view.
U. " " : Mandible, exterior face, and right antenna; D, dome-shaped tactile papilla; s, supplementary appendix; 1, 2, 3, the three antennal joints.
V. " " : Posterior part of body. Ventral view.

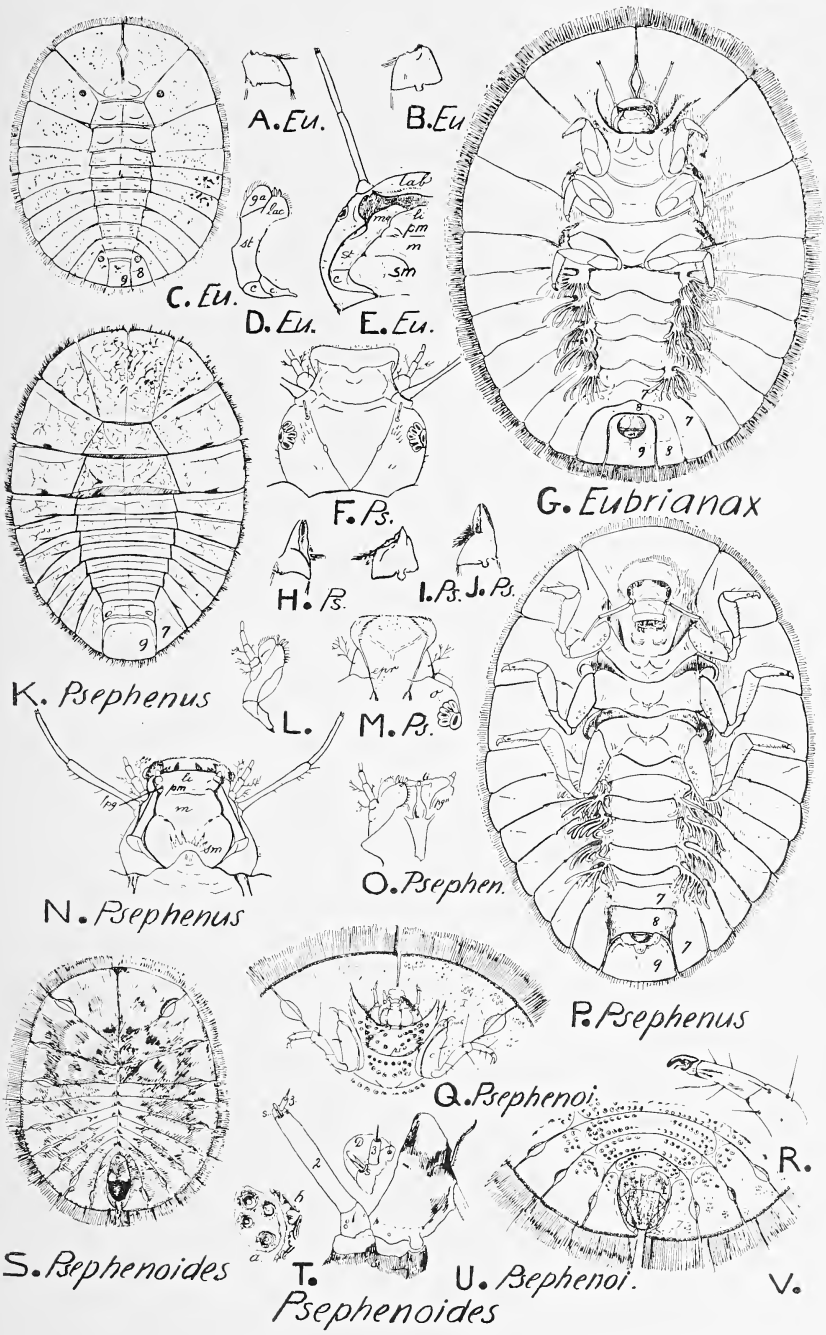

A. Eu.
B. Eu
C. Eu.
D. Eu.
E. Eu.
F. Ps.
G. Eubrianax
H. Ps.
I. Ps.
J. Ps.
K. Psephenus
L.
M. Ps.
N. Psephenus
O. Psephen.
P. Psephenus
Q. Psephenoi
R.
S. Psephenoides
T.
U. Psephenoi.
V.
Psephenoides

Plate 71

Chelonariidae

Dryopidae-Helminae (K–Z)

A. Chelonarium sp. : Operculum (= 10th abdominal sternum) with appendices; ap, right appendix dissected loose and turned over. Dorsal view.
B. " " : Rectum and retractile gills.
C. " " : Anterior part of head.
D. " " : Spiracular trachea and spiracle. From within the body.
E. " " : Spiracle of mesothorax.
F. " " : End of ninth abd. segment.
G. " " : Left mandible. Ventral view.
H. " " : Ventral mouthparts.
I. " " : Spiracle of eighth abdominal segment.
J. " " : Larva. Lateral view.
K. Stenelmis crenata Say : Left mandible. Ventral view.
L. " " : Left mandible. Dorsal view.
M. " " : Maxilla.
N. " " : End of body. Sideview.
O. " " : Head. Dorso-lateral view.
P. Ancyronyx variegatus Germar. (Determined by elimination and locality, not reared) : Larva. Lateral view.
Q. " " : Spiracle of mesothorax and of the first abdominal segment.
R. " " : Head. Lateral view.
S. " " : Leg.
T. Helmis pusilla Lec. : Larva. Dorsal view.
U. Helmis aeneus Müller : Larva. Dorsal view.
V. Dryops auriculatus Geoffr. (Denmark) : Larva. Lateral view.
W. " " : Leg.
X. " " : Antenna.
Y. " " : Maxilla.
Z. " " : Inner face of left mandible.

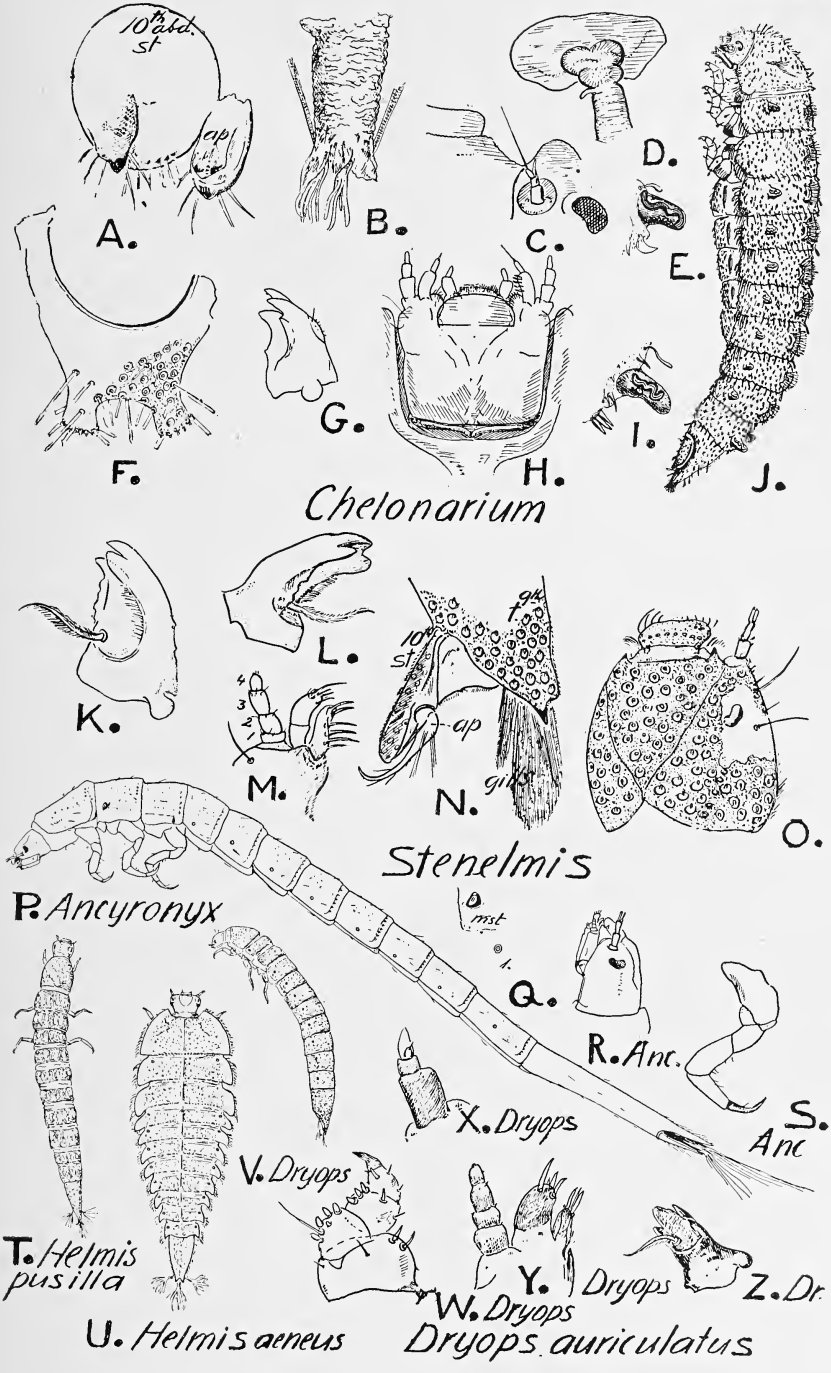

10th Abd. St
ap
A.
B.
C.
D.
E.
F.
G.
H.
I.
J.
Chelonarium
K.
L.
M.
10th St
ap
gills
N.
O.
Stenelmis
P. Ancyronyx
mst
Q.
R. Anc.
S. Anc
X. Dryops
V. Dryops
T. Helmis pusilla
U. Helmis aeneus
W. Dryops
Y.
Dryops
Z. Dr.
Dryops auriculatus

Plate 72

Dryopidae-Larinae

Drypidae-Pelonominae

A. Lara avara Lec. : Left maxilla. Dorsal view.
B. " " : Right mandible. Dorsal view.
C. " " : Spiracle.
D. " " : Larva. Lateral view.
E. " " : End of body; ap, appendix from operculum; st, operculum. Lateral view.
F. " " : Operculum with appendices. Ventral view.
G. " " : Three tassels of gills, and the appendices. Inner view.
H. " " : Larva. Dorsal view.
I. " " : Larva. Ventral view.
J. Pelonomus palpalis Schwn. (Panama) : Larva. Dorsal view.
J.* " " : Maxilla. Dorsal view.
K. " " : Larva. Ventral view.
K.* " " : Mandible.

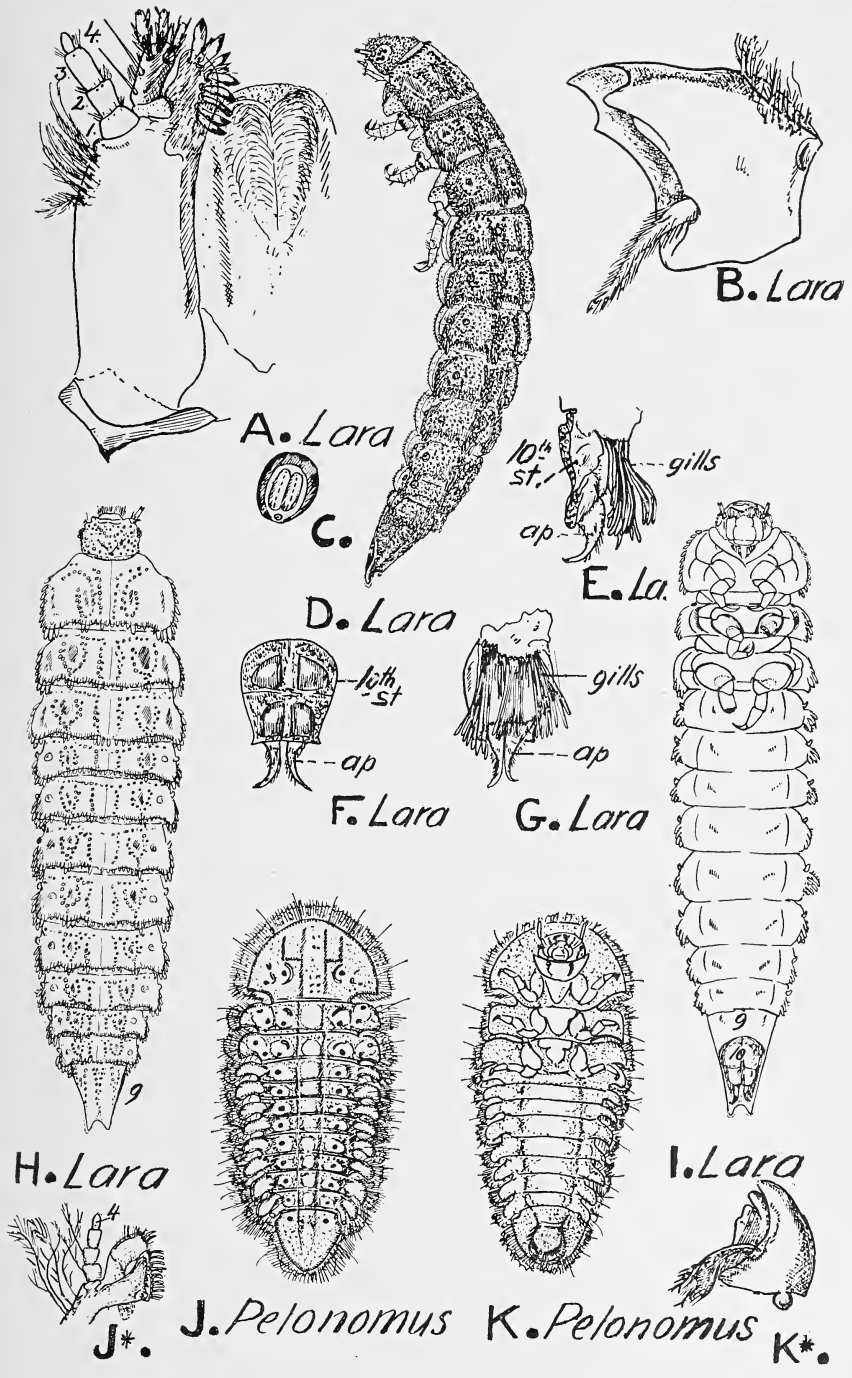

4
3
2
1
A. Lara
B. Lara
C.
D. Lara
10th st.
gills
ap
E. La.
11th st
ap
F. Lara
gills
ap
G. Lara
9
H. Lara
9
I. Lara
4
J*.
J. Pelonomus
K. Pelonomus
K*.

Plate 73

Dryopidae-Helminae (A–E),
Dryopidae-Pelonominae (F–O)

A. Limnius troglodytes Gyll. (Denmark) : Anterior part of head. Dorsal view.
B. " " : Right mandible, old and worn apically. Dorsal view.
C. " " : Ends of right maxilla and labium.
D. " " : Left mandible. Ventral view.
E. " " : Larva. Lateral view.
F. Helichus sp. : Larva. Dorsal view.
G. " " : Larva. Lateral view.
H. " " : Left mandible. Ventral view.
I. " " : Head. Dorsal view.
J. " " : Parts of lacinia and galea. Dorsal view.
K. " " : Leg.
L. " " : Head. Ventral view.
M. " " : End of abdomen with ninth abdominal segment and operculum removed. Ventral view.
N. " " : Same as figure M, but with ninth abdominal tergite present. Ventral view.
O. " " : End of abdomen. Ventral view.

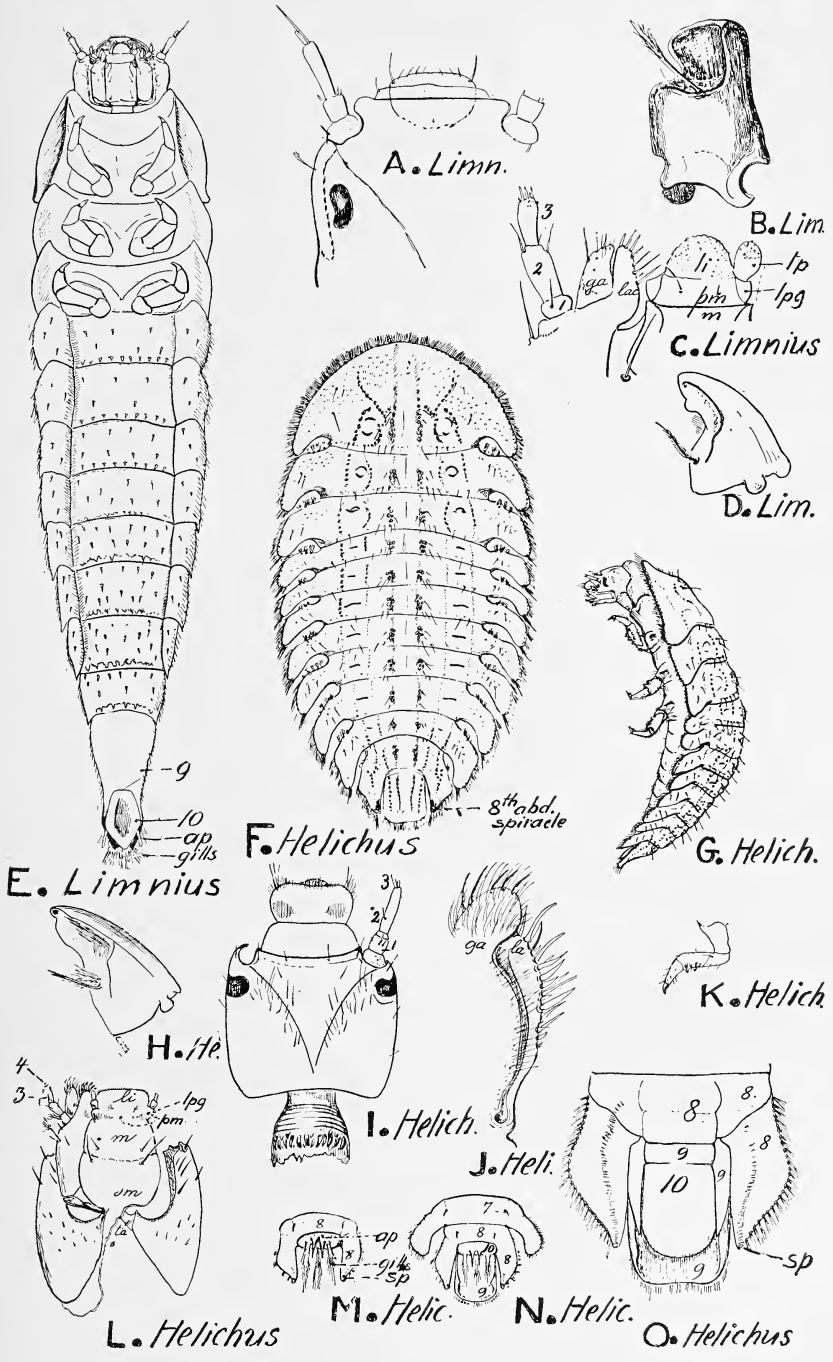

A. Limn.
B. Lim.
C. Limnius
D. Lim.
E. Limnius
F. Helichus
G. Helich.
H. He.
I. Helich.
J. Heli.
K. Helich
L. Helichus
M. Helic.
N. Helic.
O. Helichus
8th abd. spiracle
gills
ap
sp
lp
lpg
li
pm
m
ga
la

Plate 74

Brachypsectridae, Drilidae,
Lampyridae (O–V), *Phengodidae*

A. Brachypsectra fulva Lec. : Fringes of mesothorax and metathorax. Dorsal view.
B. " " : Leg and part of lateral fringe.
C. " " : Larva. Dorsal view.
D. " " : Fringes of first and second abd. segments. Dorsal view.
E. " " : Spiracle and two glandular spots.
F. " " : Ventral mouthparts.
G. Drilus concolor Ahr., first larval instar (Denmark) : Mandible. Dorsal view.
H. " " : Tarsungulus and appendix.
I. Silasia (unicolor Guér. (?)) (Gold Coast) : Tarsungulus (adhesive appendix probably lost by accident in specimen drawn).
J. " " : Mouthparts. Lateral view.
K. Silasia (unicolor (?)) : Mouthparts. Dorsal view.
L. Drilus concolor : Mesothoracic spiracle.
M. Silasia (unicolor (?)) : Mouthparts. Ventral view.
N. Drilus concolor : Ventral mouthparts; mb. c, membranous cardo.
O. Lampyris noctiluca L. (Denmark) : Larva. Lateral view.
O.* " " : Anal appendices with rings of minute hooks.
P. " " : Larva. Dorsal view.
P.* " " : Luminous organs on ventral side of eighth abd. segment.
Q. Photinus pyralis L. : Left mandible; r, retinaculum.
R. " " : Head; fs, frontal suture.
S. Photuris pennsylvanica DeG. : Head. Dorsal view.
T. " " : Head. Ventral view.
U. " " : Right mandible. Dorsal view.
V. " " : Left mandible.
W. Phengodes laticollis Lec. : End of larva. Lateral view.
X. " " : Larva. Dorsal view.

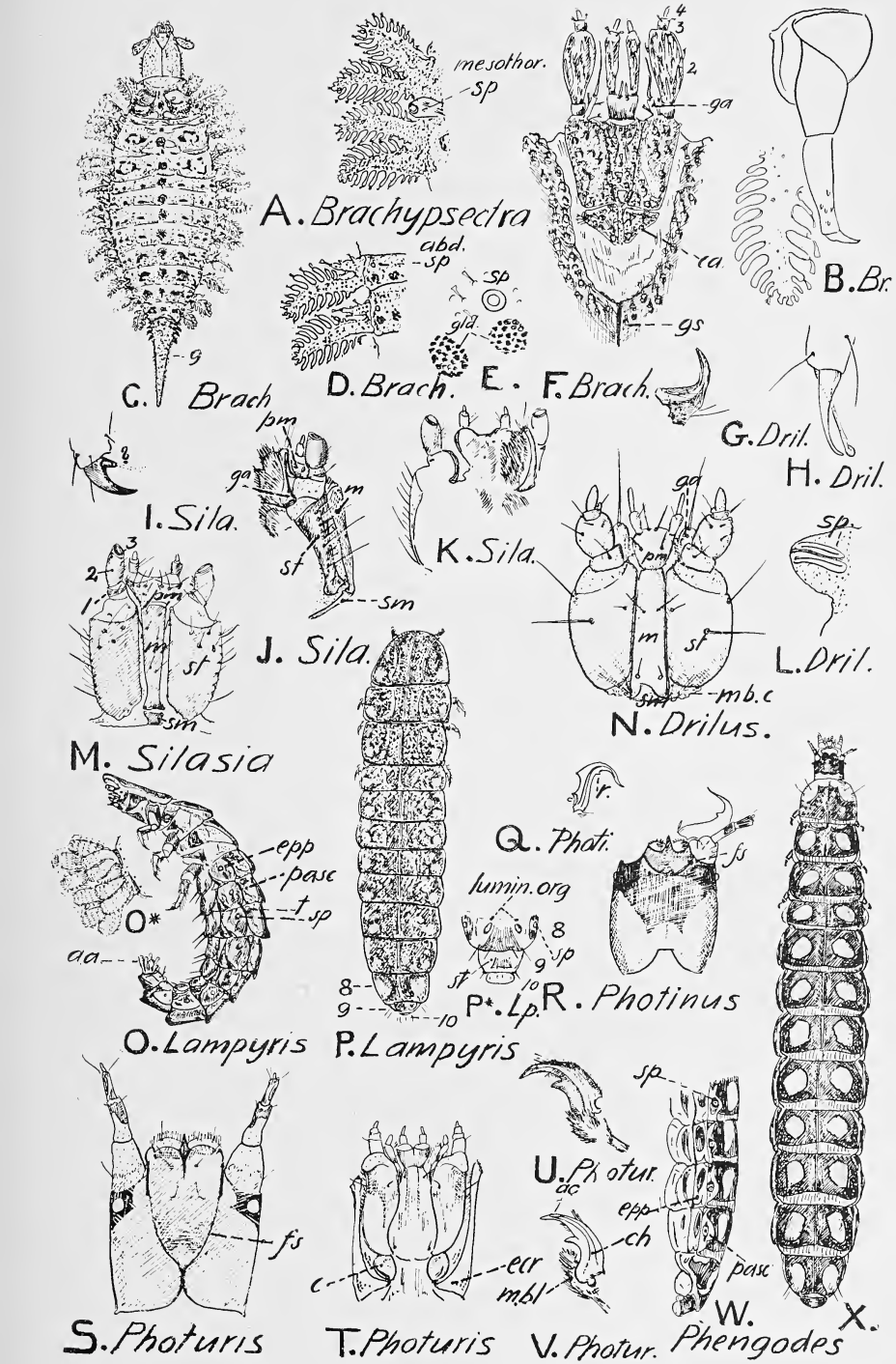

mesothor.
sp
A. Brachypsectra
abd.
sp
sp
gld.
ga
ra
gs
B. Br.
g
C. Brach
D. Brach.
E.
F. Brach.
G. Dril.
H. Dril.
pm
ga
m
st
sm
I. Sila.
J. Sila.
K. Sila.
ga
pm
m
st
sm
mb.c
N. Drilus.
sp
L. Dril.
M. Silasia
epp
pasc
t sp
aa
O*
O. Lampyris
8
9
10
P. Lampyris
lumin. org
sp
st
P*. Lp.
ir
Q. Phati.
fs
R. Photinus
fs
S. Photuris
c
ecr
mbl
T. Photuris
dc
U. Photur.
sp
epp
ch
pasc
V. Photur.
W. Phengodes
X.

Plate 75

Brachypsectridae, Drilidae,

Lampyridae, Phengodidae

A. Brachypsectra fulva Lec. : Head; eers, epicranial suture; fs, frontal suture.

B. Silasia (unicolor Guér. (?)) (Aburia, Gold Coast) : Urogomphi. Dorsal view.

C. " " : Head and presternum; ao, apical opening of the mandibular canal; bo, basal opening of the canal; ch, mandibular canal; epx, epipharynx; ga, galea with rudiment of lacinia at base; gu, gular plate; sfs, subfacial sinus.

D. " " : End of abdomen; an, anus; dorsal pr, dorsal spinose process; epp, epipleural plate; lateral pr, lateral spinose process; ur, urogomphus. Lateral view.

E. Drilus concolor Ahr., first larval instar (Denmark) : Larva. Dorsal view.

F. Photuris pennsylvanica DeG. : Larva. Dorsal view.

G. " " : Larva; epp, epipleural plate.

H. Photinus pyralis L. : Larva. Dorsal view.

I. Phengodes laticollis Lec. : Head; hx, hypopharyngeal elements; n, nasale. Dorsal view.

J. " " : Head; sd, sensory disk. Ventral view.

K. " " : Distal end of leg.

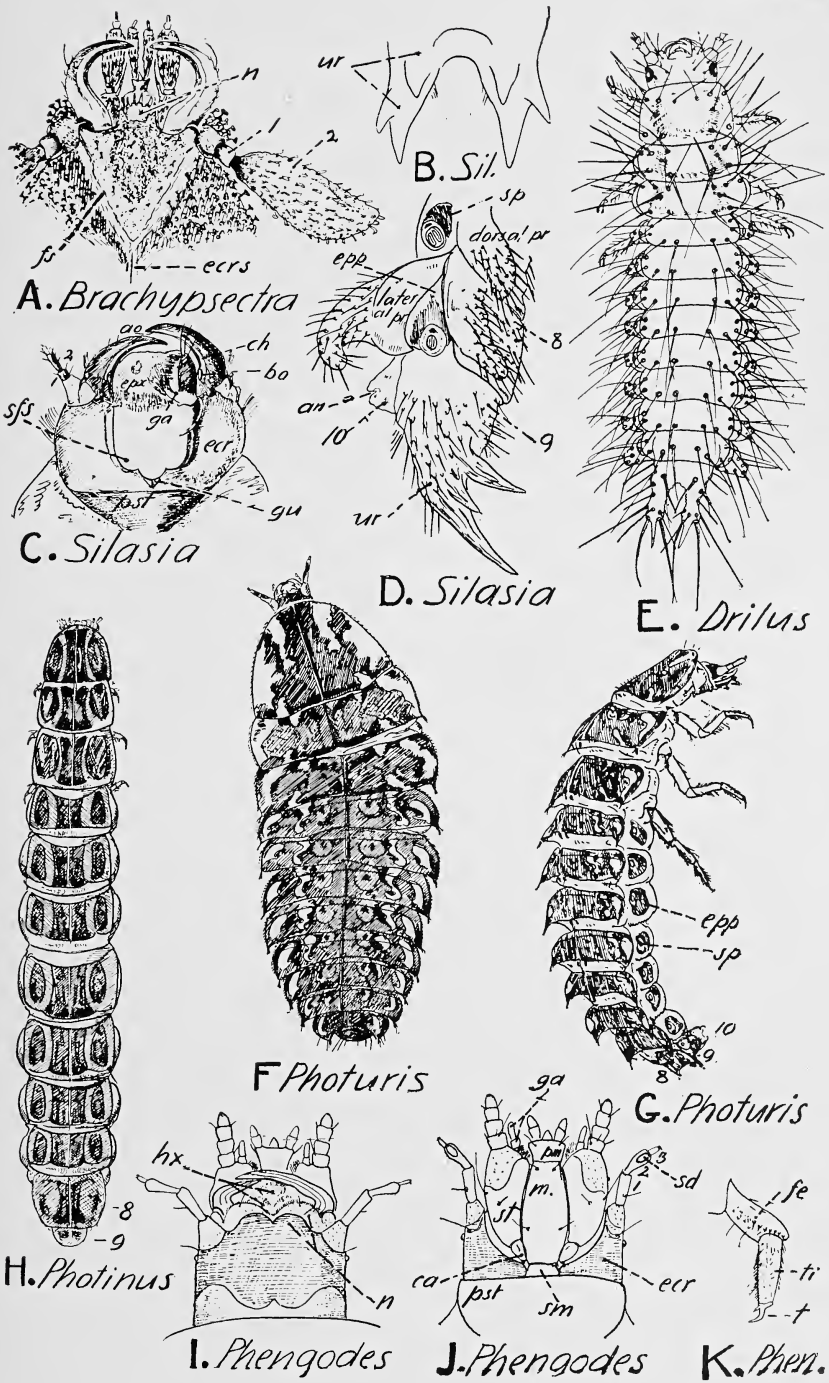
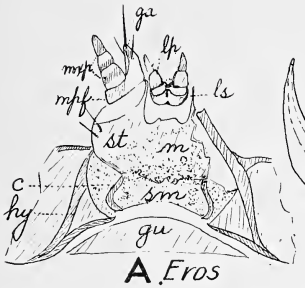

n
1
2
fs
ecrs
A. Brachypsectra
ur
B. Sil.
sp
dorsal pr
epp
lateral pr
8
an
10
9
ur
D. Silasia
E. Drilus
ao
ch
bo
3
spr
ga
sfs
ecr
pst
gu
C. Silasia
F Photuris
epp
sp
10
9
8
G. Photuris
-8
-9
H. Photinus
hx
n
I. Phengodes
ga
bm
m.
st
ca
pst
stm
ecr
sd
J. Phengodes
fe
ti
t
K. Phen.

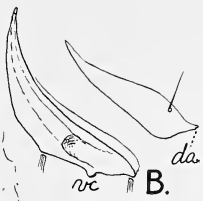
Plate 76

Lycidae

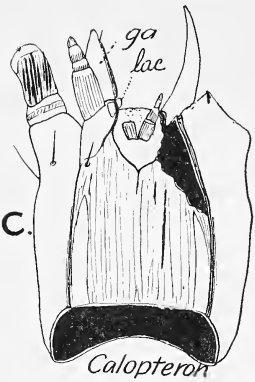
A. Eros humeralis F. : Ventral mouthparts. Ventral view.
B. " " : Right mandible showing separation into two portions. Ventral view.
C. Calopteron reticulatum F.: Head. Ventral view.
D. " " : Head. Dorsal view.
E. " " : Diagrammatic illustration showing position of trophi.
F. " " : Details of mandible. Dorsal view.
G. " " : Thoracic segments. Ventral view.
H. Caeniella dimidiata F. : Larva. Dorsal view.
I. Calopteron reticulatum : Abdominal spiracle in parascutal area above epipleural plate.
J. " " : Leg.
K. " " : Larva. Lateral view.



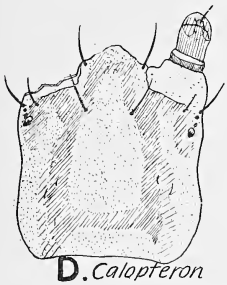
A. *Eros*



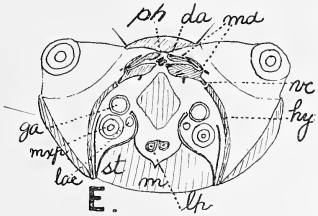
B.



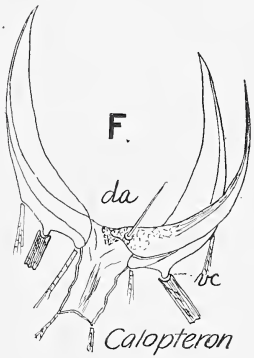
C. *Calopteron*



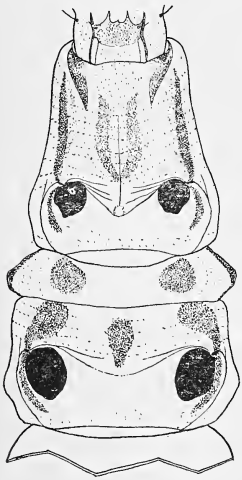
D. *Calopteron*



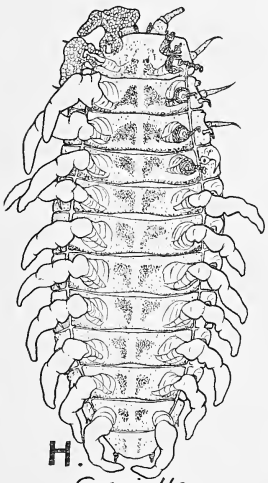
E. *Calopteron*



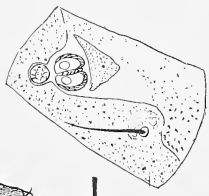
F. *Calopteron*



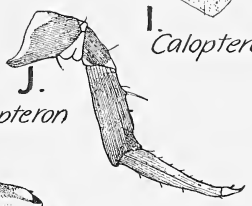
G. *Calopteron*



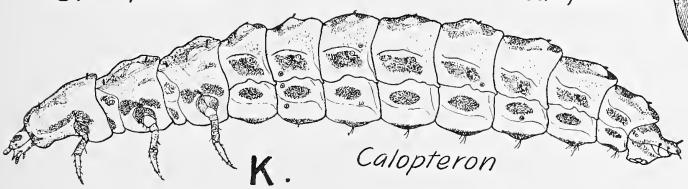
H. *Caeniella*



I. *Calopteron*



J. *Calopteron*



K. *Calopteron*

Plate 77

Drilidae, Cantharidae-Malthinae,
Cantharidae-Malthodinae, Cantharidae-Cantharinae

A. Drilus concolor Ahr. (Denmark) : Last larval instar; mandible membranous, except tip. Larva twisted, fitting inside of snail-shell of *Helix*.
B. Malthinus flaveolus Payk. (Germany) : Left mandible. Ventral view.
C. " " : Tibia and tarsungulus.
D. " " : Epipharynx and half part of hypopharyngeal sclerome.
E. " " : Larva. Dorsal view.
F. " " : Ventral mouthparts. Dorsal view left; ventral view right.
G. " " : Part of head; do, distal opening of mandibular canal; po, proximal opening.
H. Silis nitidula F. (Europe) : Mandible. ls, longitudinal series of hairs. Ventral view.
I. Malthodes marginatus Latr. (Denmark) : Part of head. Ventral view.
J. Cantharis sp. : Mandible and antenna.
K. Malthodes marginatus : Larva. Dorsal view.
L. " " : Ventral mouthparts. Ventral view.
M. Cantharis sp. : Outline of head. Dorsal view.
N. " " : Ventral mouthparts.
O. Rhagonycha fulva Scop. (Denmark) : Dorsal gland.
P. " " : Metathorax and two abdominal segments. Dorsal view.
Q. " " : First abdominal spiracle.
R. Podabrus tomentosus Say : Mandible and antenna.
S. " " : Mandible. Dorsal view.
T. " " : Mandible. Buccal view.
U. " " : Outline of head. Dorsal view.

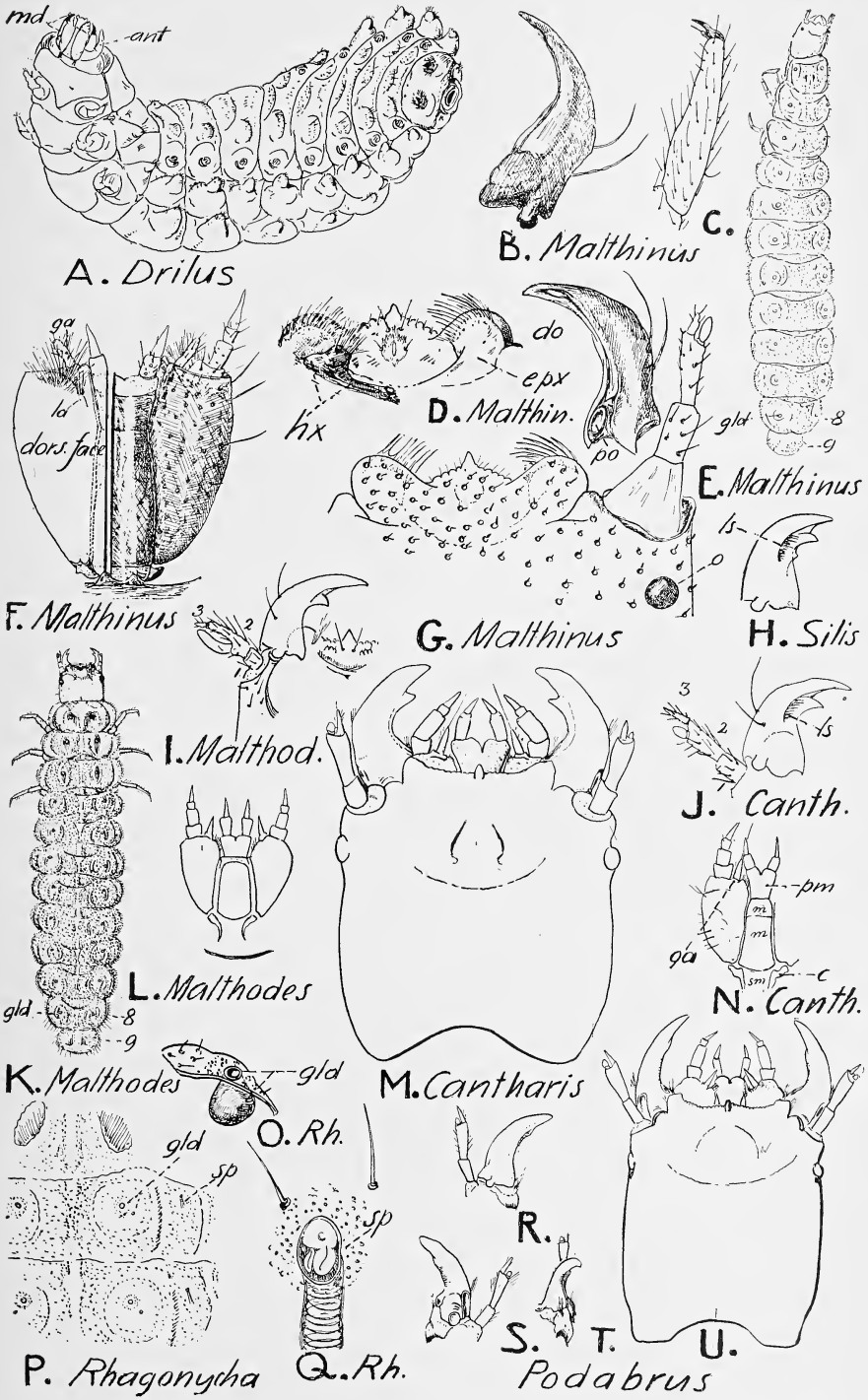

md
ant
A. Drilus
B. Malthinus
C.
ga
la
dors. face
F. Malthinus
do
epx
hx
D. Malthin.
gld
8
9
po
E. Malthinus
ls
o
G. Malthinus
H. Silis
3
2
1
I. Malthod.
J. Canth.
ls
pm
m
m
ga
sm
c
N. Canth.
L. Malthodes
gld
8
9
K. Malthodes
M. Cantharis
gld
O. Rh.
sp
R.
P. Rhagonycha
Q. Rh.
S.
T.
U.
Podabrus

Plate 78

Cantharidae-Chauliognathinae

A. Chauliognathus scutellaris Lec.: Subnasal region (uncertain whether labrum or epipharynx); snl, subnasal lobe; snsc, subnasal sclerite.

B. " " : Mesothoracic spiracle; so, spiracular opening furnished with marginal hairs; tb, possibly the reduced airtubes.

C. " " : Anterior part of head; n, nasale; snl, subnasal lobe. Dorsal view.

D. " " : Larva. Dorsal view.

E. " " : Head opened; hx, hypopharyngeal middle area with dark median triangular spot; hy, hypostome; sh, straining hairs from maxillulae. Dorsal view.

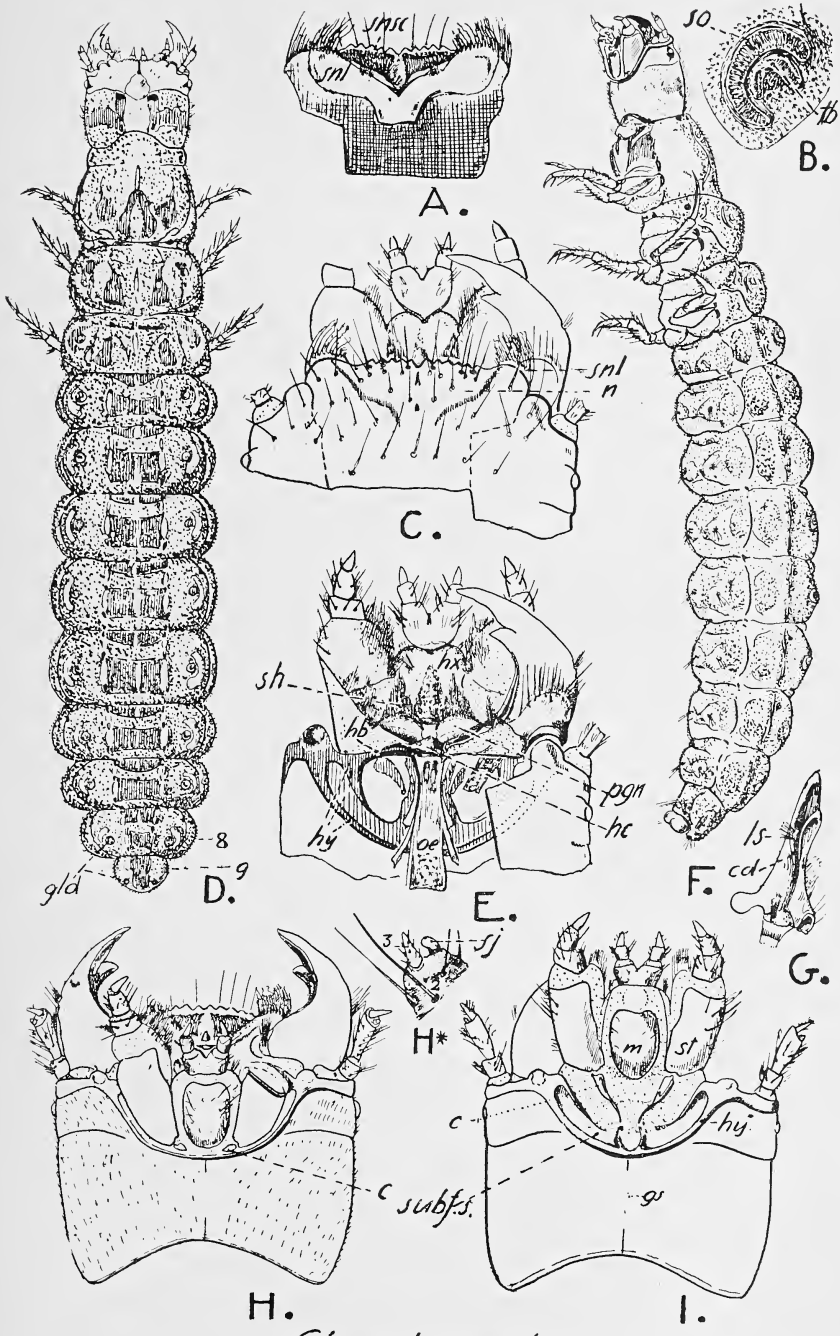
F. " " : Larva. Ventro-lateral view.

G. " " : Mandible; cd, main conduit for juice; ls, lateral series of fine hairs. Buccal view.

H. " " : Underside of head; ventral mouthparts drawn back.

H.* " " : Tip of antenna.

I. " " : Underside of head; ventral mouthparts drawn forth; subf. s, subfacial sinus.



Chauliognatus

Plate 79

Rhipiceridae, Cebrionidae

A. Zenoa picea Beauv. : Head. Dorsal view.
B. " " : Mesothorax, metathorax, and part of first abdominal segment; gr, groove. Lateral view.
C. " " : Ligula, hypopharynx and part of maxilla. Dorsal view.
D. " " : Left mandibles. Lateral view and exterior view.
E. " " : Head. Ventral view.
F. " " : Right mandible. Buccal view.
G. " " : Head. Ventro-frontal view.
H. " " : End of abdomen. Lateral view.
I. Cebrio antennatus Schfr. : Nasal region; snl, subnasal lobe. Ventral view.
J. " " : Head, prothorax, and mesothorax; cmb, cervical membrane expanded. Lateral view.
K. " " : Head. Ventral view.
L. " " : Right mandible. Ventral view.
M. " " : Maxilla and labial parts; dst, dististipes. Ventral view.
N. " " : Abdominal spiracle; or, spiracular opening; tub, airtubes. Exterior view.
O. " " : Abdominal spiracle; atr, atrium; or, opening; tub, airtube. Interior view.
P. " " : Larva. Lateral view.

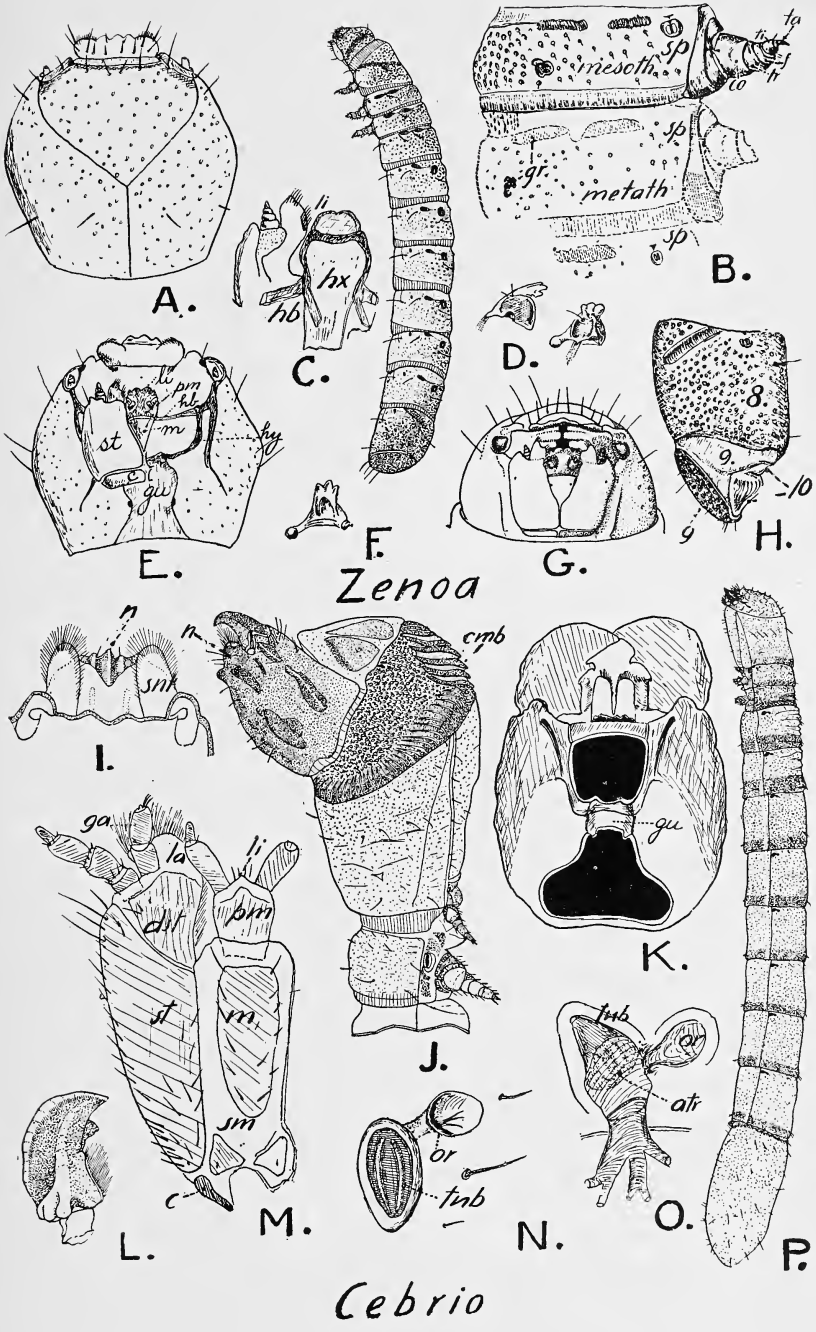

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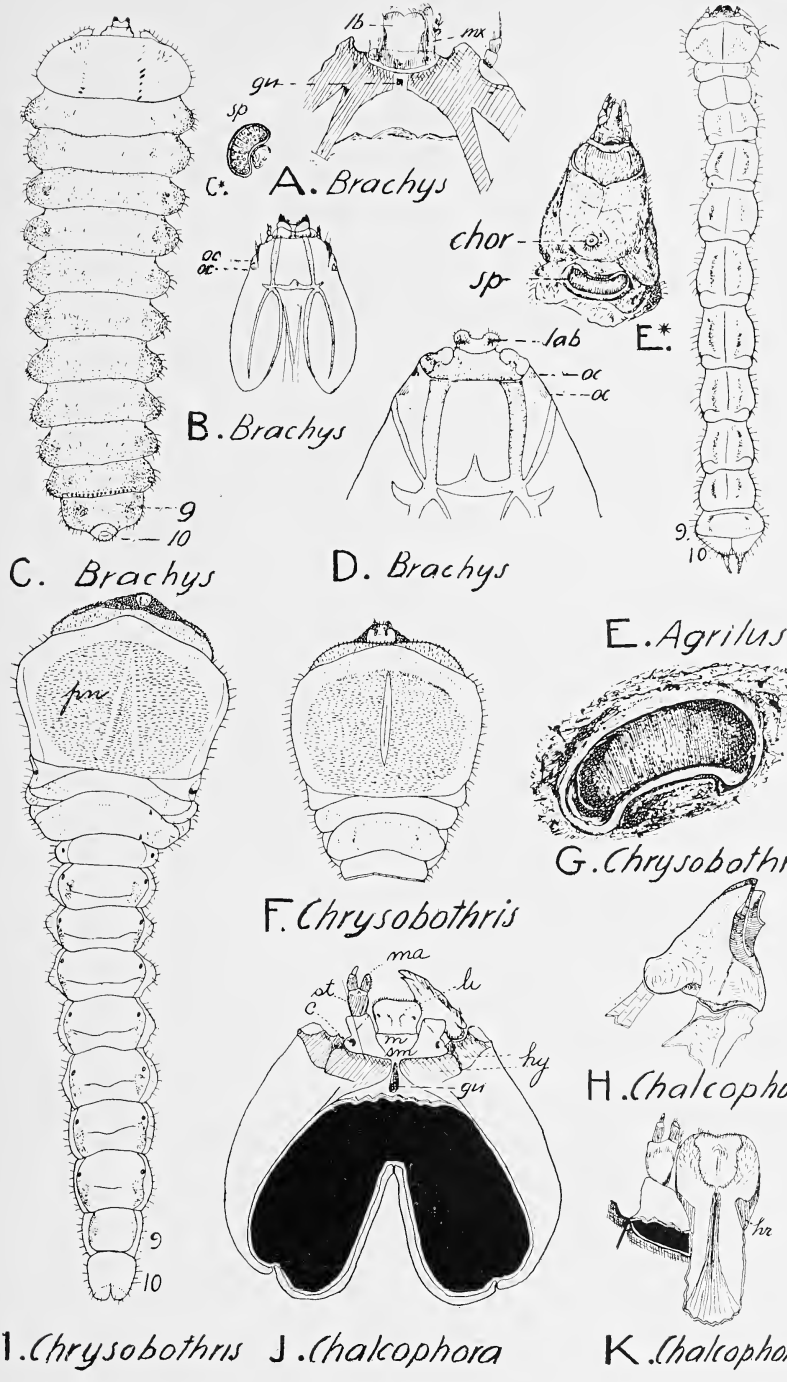
Plate 80

Buprestidae-Pachyschelinae (A–D)
Buprestidae-Agrilinae (E),
Buprestidae-Buprestinae (F–K)

A. Brachys ovatus Web. : Head; gu, gular plate; lb, undifferentiated labium; mx, maxilla. Ventral view.
B. " " : Head; oc, ocelli. Dorsal view.
C. " " : Larva. Dorsal view.
C.* " " : Spiracle enlarged.
D. " " : Dorsal side of head. Ventral view.
E. Agrilus politus Say : Larva. Dorsal view.
E.* Euchroma columbicum Mannerh. : Head, prothorax and anterior part of mesothorax; chor, chordotonal organ; sp, spiracle. (Figure copied from Schiödte).*
F. Chrysobothris octocola Lec. : Head and thorax. Ventral view.
G. Chrysobothris sp. : Abdominal spiracle.
H. Chalcophora virginiensis Drury : Right mandible. Ventral view.
I. Chrysobothris octocola : Larva. Dorsal view.
J. Chalcophora virginiensis : Head. Ventral view.
K. " " : Hypopharynx and maxilla. Buccal view.

* Schiödte, J. C., De metamorphosi Eleutheratorum observationes; Naturhistorisk Tidsskrift, ser. III, vol. 6, 1869, p. 336, pl. I, fig. 4. (Schiödte is the first entomologist who has discovered and described the chordotonal organs in coleopterous larvae. He named them (l. c) "foveae auditoriae").


lb
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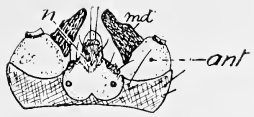
I. Chrysobothris
J. Chalcophora
K. Chalcophora

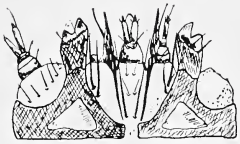
Plate 81

Throscidae (A–D), *Melasidae* (H–Q)

A. Throscus sp. (possibly Aulonothroscus constrictor Say) : Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Larva. Lateral view.
D. " " : Head and thorax. Ventral view.
E. Unidentified larva combining characters of Oestodinae and Throscidae. (In decayed red oak from Bent Creek, Asheville, North Carolina) : Head and prothorax. Dorsal view.
F. " " : End of abdomen. Lateral view.
G. " " : Head and prothorax; st, sternellum. Ventral view.
G.* " " : Right mandible. Ventral view.
H. Melasis rufipennis Horn. : Antenna.
I. " " : Left mandible. Ventral view.
J. " " : Left mandible. Dorsal view.
K. " " : Ventral mouthparts. Ventral view.
L. " " : Head and thorax. Dorsal view.
M. " " : Larva. Dorsal view.
N. " " : Mesothoracic spiracle; duct, ductus from spiracular opening to the atrium of the spiracle; or, spiracular opening; peritr, peritrema; tu, airtube. Exterior view.
O. " " : Head, prothorax, and mesothorax. Ventral view.
P. " " : Larva. Lateral view.
Q. Palaeoxenus dohrni Horn. : Larva. Ventral view.



A. *Throscus*



B. *Throscus*

D. *Throscus*

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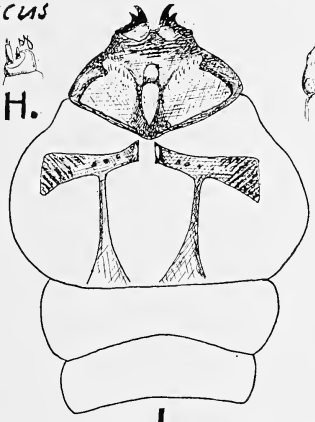
G.

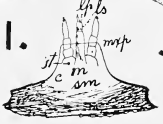
(*Oestodinae? Throscidae?*)

C. *Throscus*



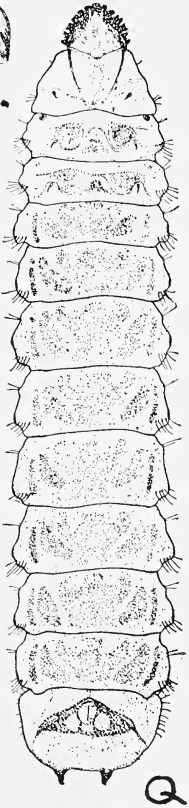
H.

I.

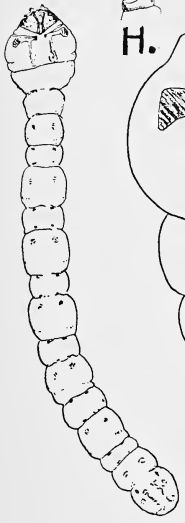


K.

J.



Q. *Palaeoxenus*



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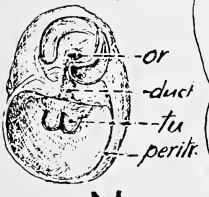

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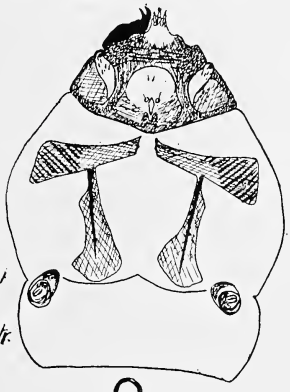
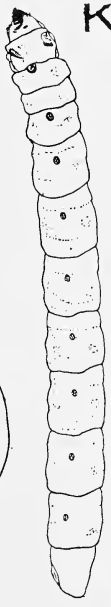


O. *Melasis*

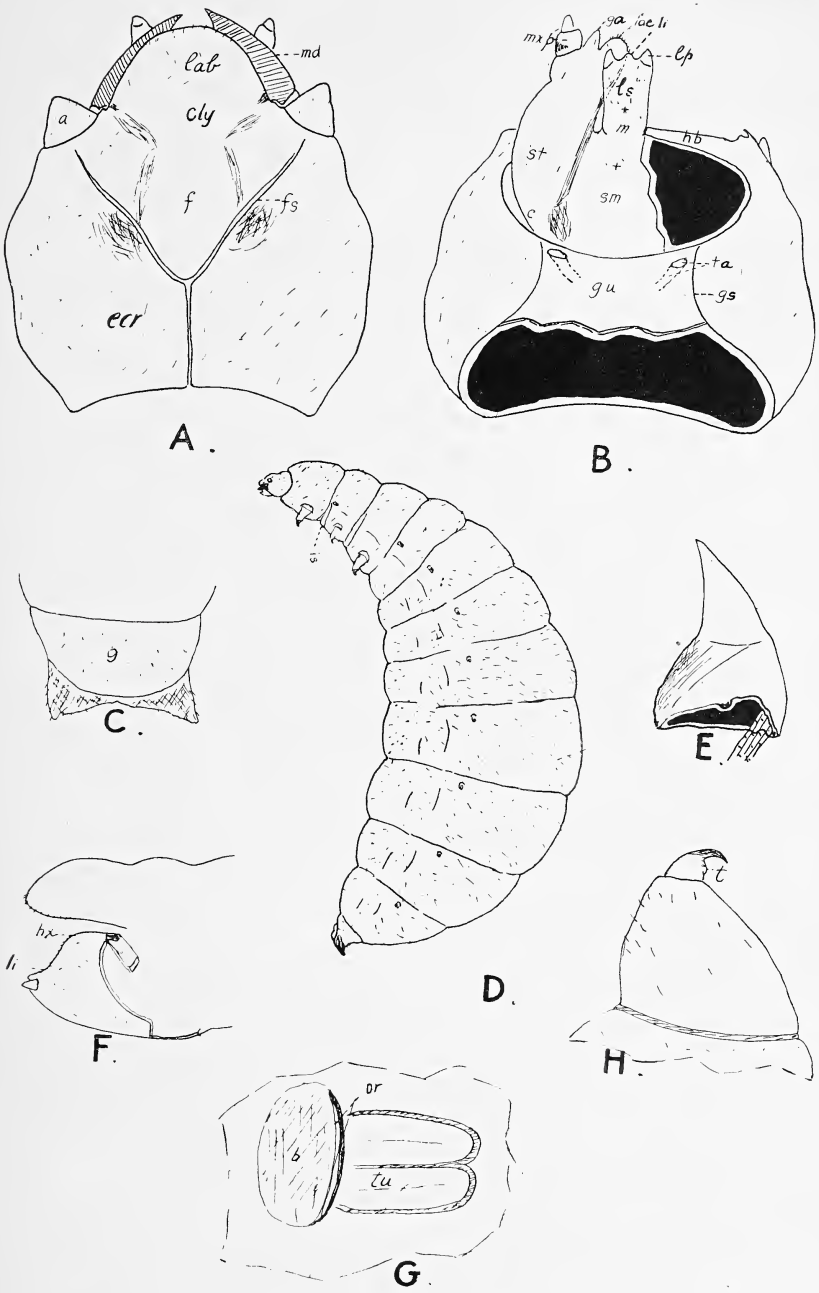


P.

Plate 82

Sandalidae

A. Sandalus niger Knoch: Head. Dorsal view.
B. " " : Head. Ventral view.
C. " " : Ninth abdominal segment. Dorsal view.
D. " " : Larva. Lateral view.
E. " " : Left mandible. Ventral view.
F. " " : Labrum and hypopharynx. Lateral view.
G. " " : Abdominal spiracle.
H. " " : Right leg.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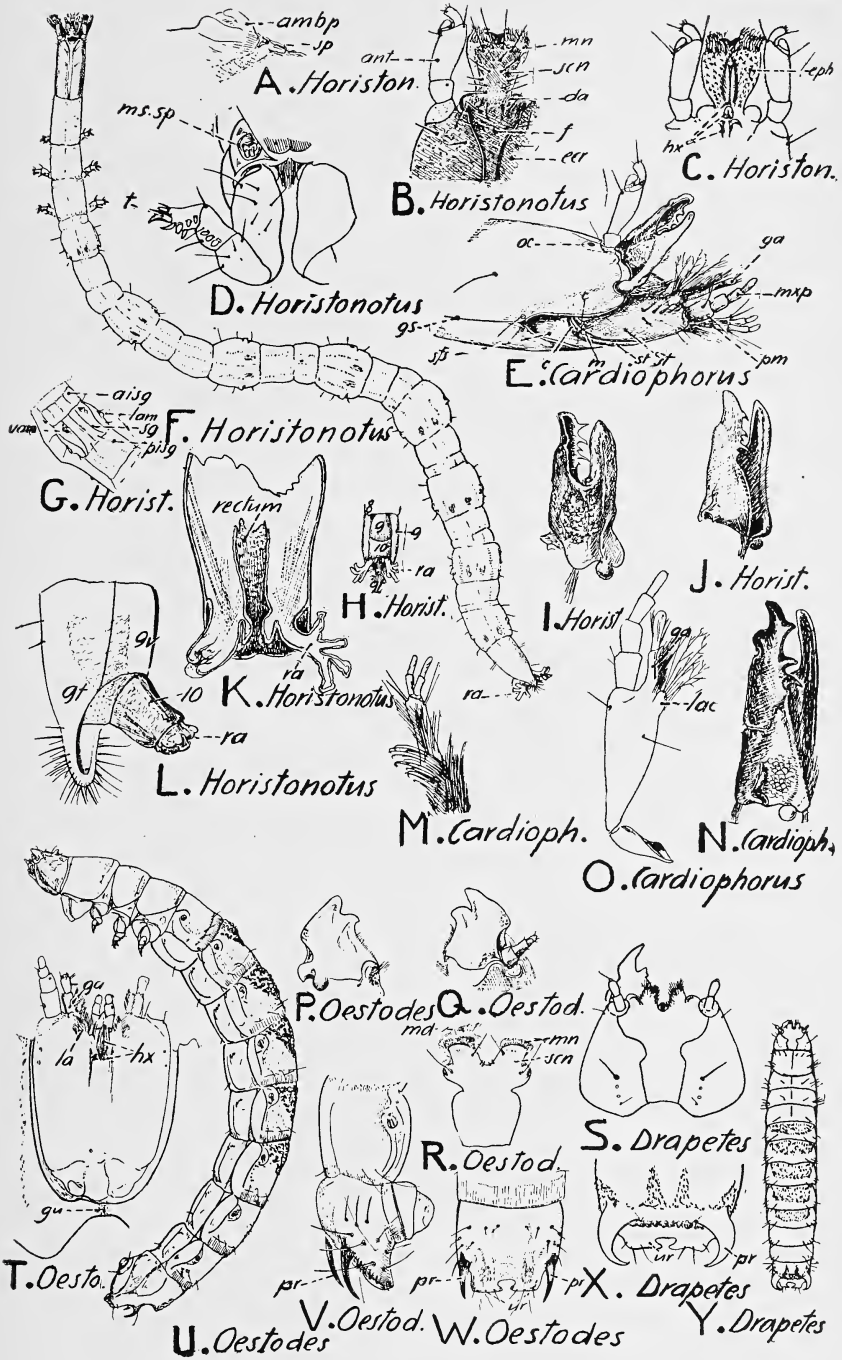
Sandalus

Plate 83

Elateridae-Cardiophorinae (A–O),

Elateridae-Oestodinae (P–Y)

A. Horistonotus uhleri Horn : Lateral wart; spiracle behind.
B. " " : Part of head; mn, membranous margin of nasale; scn, sclerotized part. Dorsal view.
C. " " : Anterior part of head; eph, epipharyngeal structures.
D. " " : Mesothoracic leg and spiracle.
E. Cardiophorus ruficollis L. (Denmark) : Head; sfs, subfacial sinus.
F. Horistonotus uhleri : Larva. Dorsal view.
G. " " : Fourth abdominal segment; aisg, anterior intersegmental membrane; lam, lateral ambulatory papilla; pisg, posterior intersegmental membrane; sg, segment proper; vam, ventral ambulatory papilla. Ventral view.
H. " " : End of abdomen; ra, retractile appendix. Ventral view.
I. " " : Right mandible. Exterior view.
J. " " : Left mandible. Buccal view.
K. " " : Retractile appendices. Diagram.
L. " " : End of abdomen.
M. Cardiophorus ruficollis : Labium. Buccal view.
N. " " : Left mandible. Buccal view.
O. " " : Right maxilla. Ventral view.
P. Oestodes tenuicollis Rand. : Right mandible. Ventral view.
Q. " " : Right mandible and antenna.
R. " " : Frons with nasale. Dorsal view.
S. Drapetes (geminatus Say?) : Head. Dorsal view.
T. Oestodes tenuicollis : Head. Buccal view.
U. Oestodes sp. (Cuba) : Larva. Lateral view.
V. Oestodes tenuicollis : End of abdomen. Lateral view.
W. " " : Vertical prongs. Dorsal view.
X. Drapetes (geminatus?) : Horizontal prongs. Dorsal view.
Y. " " : Larva. Dorsal view.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E. Cardiophorus
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F. Horistonotus
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O. Cardiophorus
P. Oestodes
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V. Oestod.
W. Oestodes
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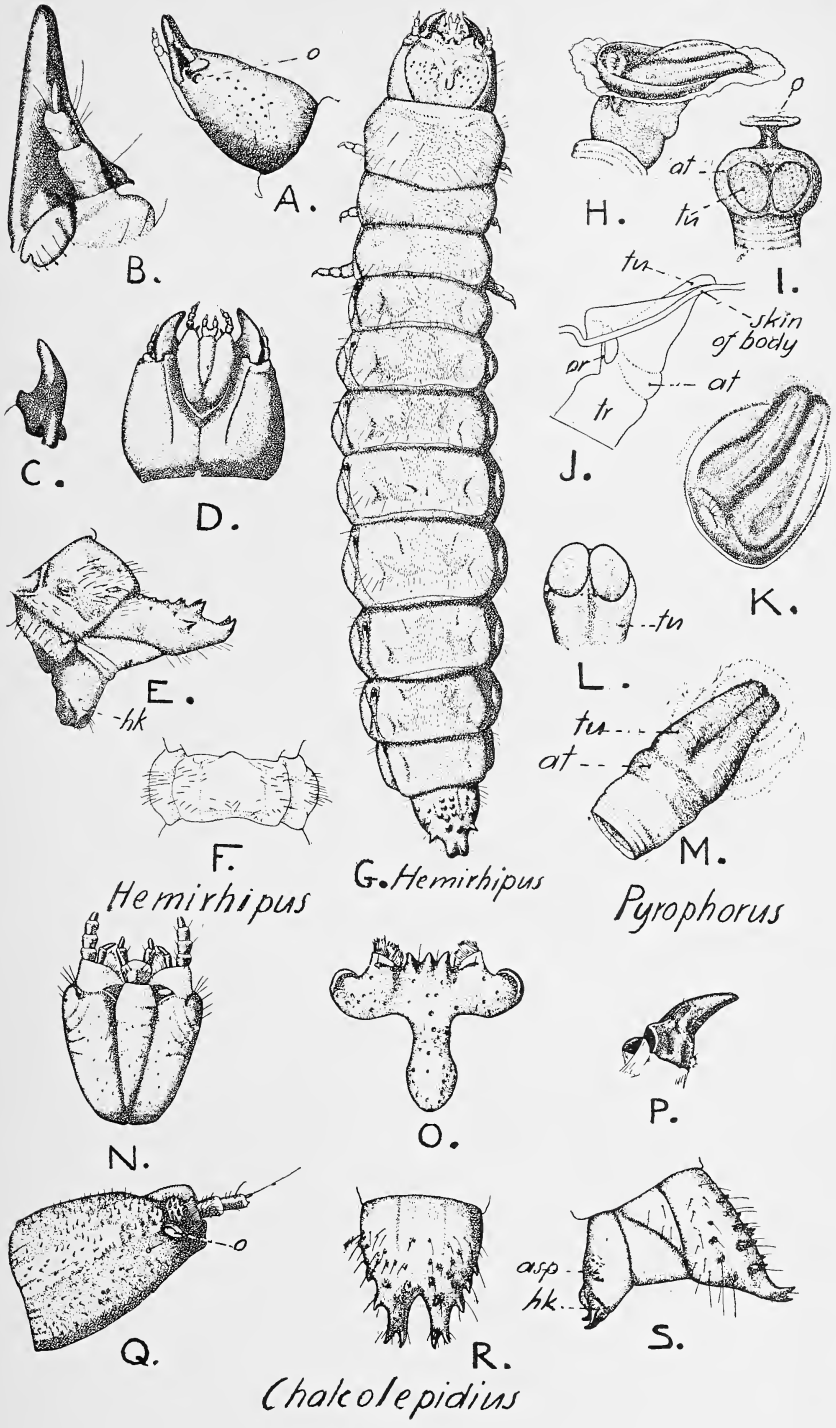
X. Drapetes
Y. Drapetes

PLATE 84 (Drawn by J. A. Hyslop)

Elateridae-Pyrophorinae

A. Hemirhipus fascicularis F. : Head. Lateral view.
B. " " : Antenna and mandible. Exterior view.
C. " " : Left mandible. Ventral view.
D. " " : Head. Ventral view.
E. " " : Eighth, ninth and tenth abdominal segments; hk, hook on tenth segment.
F. " " : Seventh abdominal segment. Ventral view.
G. " " : Larva. Dorsal view.
H. Pyrophorus luminosus Illig. : Mesothoracic spiracle. Lateral view.
I. " " : Section of spiracle, showing opening, atrium and entrance to airtubes.
J. " " : Mesothoracic spiracle; diagrammatic. Lateral view.
K. " " : Spiracle. Exterior view.
L. " " : Section of airtubes.
M. " " : Spiracle. View from inside of body.
N. Chalcolepidius viridipilis Say : Ventral mouthparts; cardo concealed. Ventral view.
O. " " : Frons with nasale.
P. " " : Left mandible. Dorsal view.
Q. " " : Head; mandible removed. Lateral view.
R. " " : Ninth abdominal segment.
S. " " : Ninth and tenth abdominal segments; asp, asperites on each side of tenth abdominal segment; hk, pair of hooks at the end of tenth abdominal segment.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L.
tu
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M.
Pyrophorus
N.
O.
P.
o
Q.
R.
Chalcolepidius
asp
hk
S.

PLATE 85 (Drawn by J. A. Hyslop)

Elateridae-Pyrophorinae

A. Monocrepidius auritus Hbst. : Right mandible. Ventral view.
B. " " : Frons with nasale.
C. " " : Ventral mouthparts; cardo concealed. dis, dististipes; st, proxistipes.
D. " " : Ninth abdominal segment.
E. " " : Ninth and tenth abdominal segments. Lateral view.
F. Monocrepidius lividus DeG. : Left mandible. Ventral view.
G. " " : Frons with nasale.
H. " " : Seventh abdominal segment. Ventral view.
I. Monocrepidius vespertinus F. : Left antenna.
J. Monocrepidius lividus : Ventral mouthparts; cardo concealed; m, triangular mentum. Ventral view.
K. Monocrepidius vespertinus : Frons with nasale.
L. " " : Left mandible. Ventral view.
M. Monocrepidius lividus : Ninth abdominal segment of last larval instar.
N. Monocrepidius vespertinus : Head. Ventral view.
O. Monocrepidius lividus : First larval instar; notice the form of the ninth abdominal segment. Dorsal view.
P. " " : Ninth and tenth abdominal segments of last larval instar. Lateral view.
Q. Monocrepidius vespertinus : Ninth and tenth abdominal segments of last larval instar. Lateral view.
R. " " : Last larval instar.

(*To be continued*)

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ENTOMOLOGICA AMERICANA

VOL. XI (n. s.) MARCH, 1931 No. 4

AN ILLUSTRATED SYNOPSIS OF THE PRINCIPAL LARVAL FORMS OF THE ORDER COLEOPTERA

BY ADAM G. BÖVING,

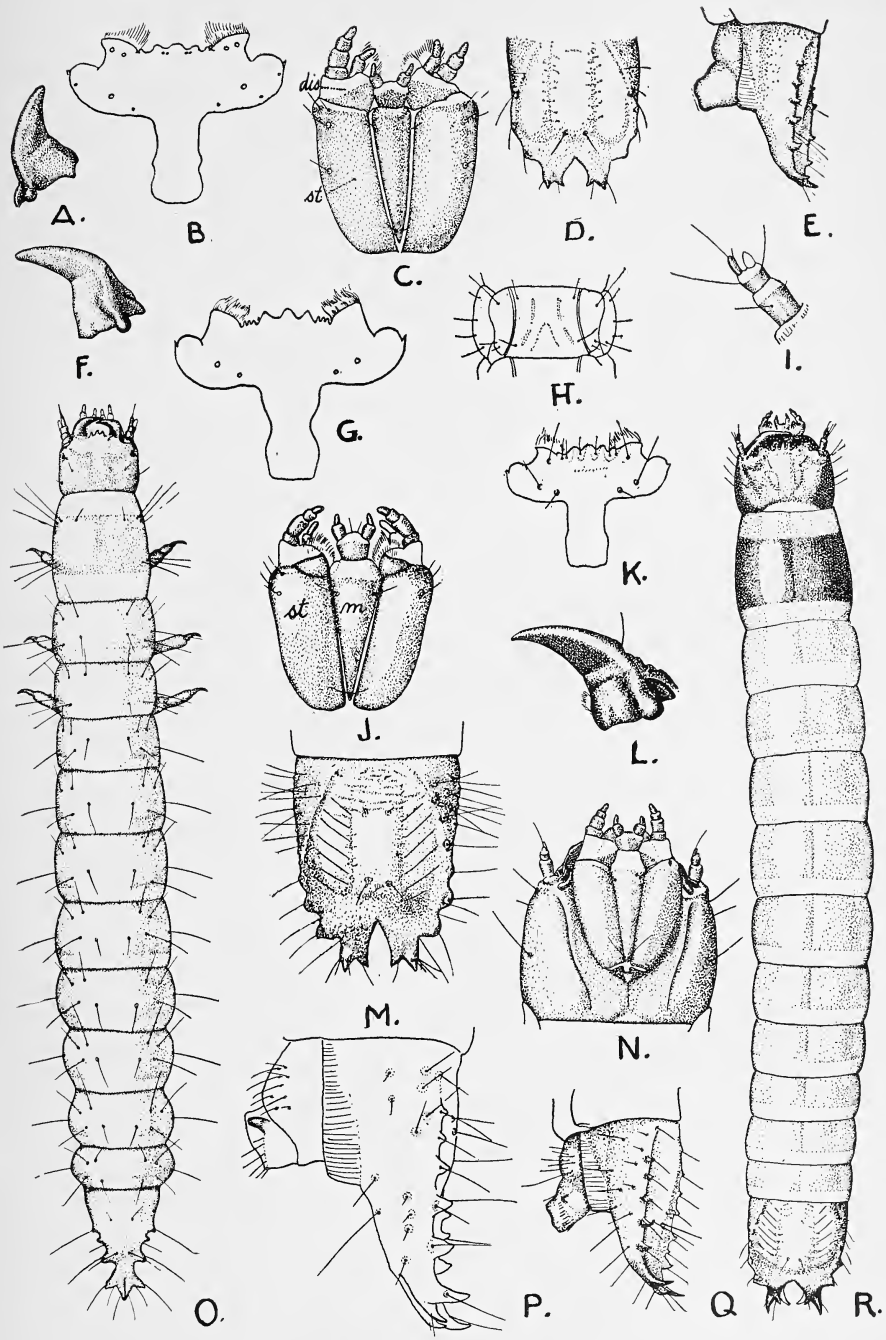
SENIOR ENTOMOLOGIST, U. S. BUREAU OF ENTOMOLOGY

AND

F. C. CRAIGHEAD,

IN CHARGE OF FOREST INSECT INVESTIGATIONS, U. S. BUREAU OF ENTOMOLOGY

(Continued from page 256.)



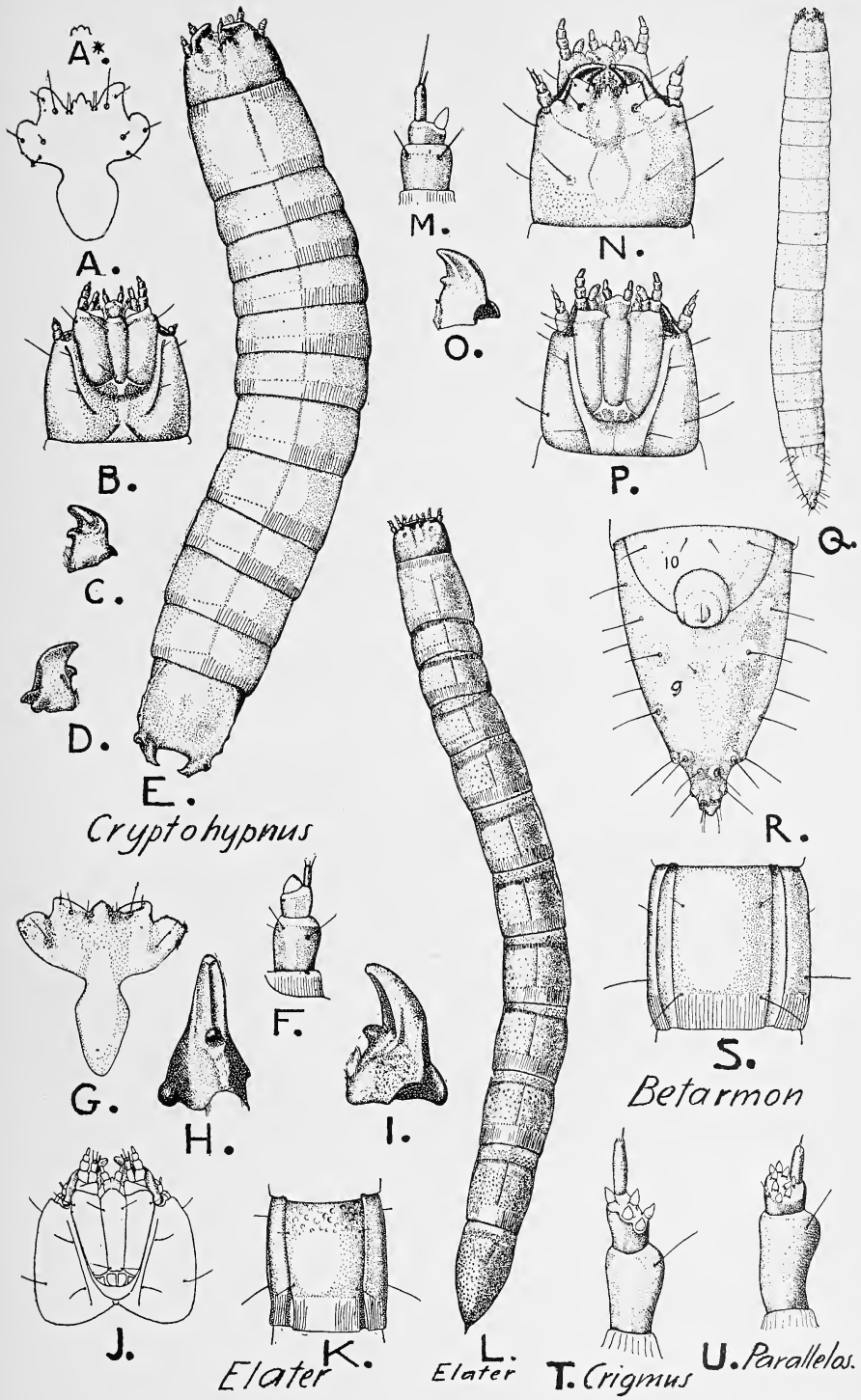
Monocrepidius

PLATE 86 (Drawn by J. A. Hyslop)

Elateridae-Pyrophorinae (A–E)

Elateridae-Elaterinae (F–U)

A. Cryptohypnus abbreviatus Say: Frons with nasale.
A.* " " : Worn tip of nasale.
B. " " : Head. Ventral view.
C. " " : Right mandible. Dorsal view.
D. " " : Right mandible. Ventral view.
E. " " : Larva. Dorsal view.
F. Elater rubricollis Hbst. : Left antenna; notice one tactile papilla.
G. " " : Frons with nasale.
H. " " : Inner surface of right mandible.
I. " " : Right mandible. Dorsal view.
J. " " : Head. Ventral view.
K. " " : Seventh abdominal segment. Ventral view.
L. " " : Larva. Dorsal view.
M. Betarmon bigeminatus Rand. : Right antenna; notice one tactile papilla.
N. " " : Head. Dorsal view.
O. " " : Right mandible. Dorsal view.
P. " " : Head. Ventral view.
Q. " " : Larva. Dorsal view.
R. " " : Ninth and tenth abdominal segment. Ventral view.
S. " " : Seventh abdominal segment. Ventral view.
T. Crigmus abruptus Say : Left antenna; notice six tactile papillae.
U. Parallelostethus attenuatus Say: Right antenna; notice numerous tactile papillae.


A*.
A.
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E.
Cryptohypnus
M.
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R.
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Betarmon
F.
G.
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I.
J.
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Elater
L.
Elater
T. Crigmus
U. Parallelos.

Plate 87

Lucanidae-Sinodendrinae, Lucanidae-Aesalinae (K),
Lucanidae-Lucaninae, Passalidae, Trogidae,
Scarabaeidae-Rutelinae-Rutilini (U, V),
Scarabaeidae-Trichiinae (Y),
Scarabaeidae-Valginae, Scarabaeidae-Cetoniinae (Z)

A. Lucanus sp. : Outline of head. Dorsal view.
B. " " : Ventral view.
C. " " : Section of spiracle on line indicated by arrow fig. D.
D. " " : Mesothoracic spiracle.
E. Passalus cornutus F. : Meso- and metathoracic legs.
F. " " : Mouthparts. Dorsal view.
G. " " : Right mandible. Buccal view.
H. " " : Head. Ventral view.
I. Sinodendron rugosum Mann. : Mesothoracic leg.
J. " " : Tenth abd. segment; ap, anal pad; d.al, dorsal anal lobe; v.al, ventral anal lobe.
K. Ceruchus piceus Web. : Tenth abd. segment; ap, anal
L. Trox scaber L. (Denmark) : Right mandible. Buccal view.
M. " " : Larva. Lateral view.
N. " " : Mandibles. Ventral view.
O. " " : Head. Ventral view.
P. " " : Hypopharyngeal region.
Q. " " : Biforous abdominal spiracle.
R. " " : Section of biforous spiracle on line indicated in figure Q.
S. Trox oligonus Loomis : Cribriform abdominal spiracle.
T. " " : Tenth abdominal segment.
U. Pelidnota punctata L. : Epipharynx; mp, median round patch of claw-shaped spines.
V. " " : Maxilla; srt, stridulating teeth. Dorsal view.
W. Valgus canaliculatus F. : Epipharynx.
X. " " : Maxilla; notice the lack of stridulating teeth. Dorsal view.
Y. Trichiotinus piger F. Epipharynx.
Z. Osmoderma eremicola Knoch : Epipharynx; ms, curved median series of small teeth.

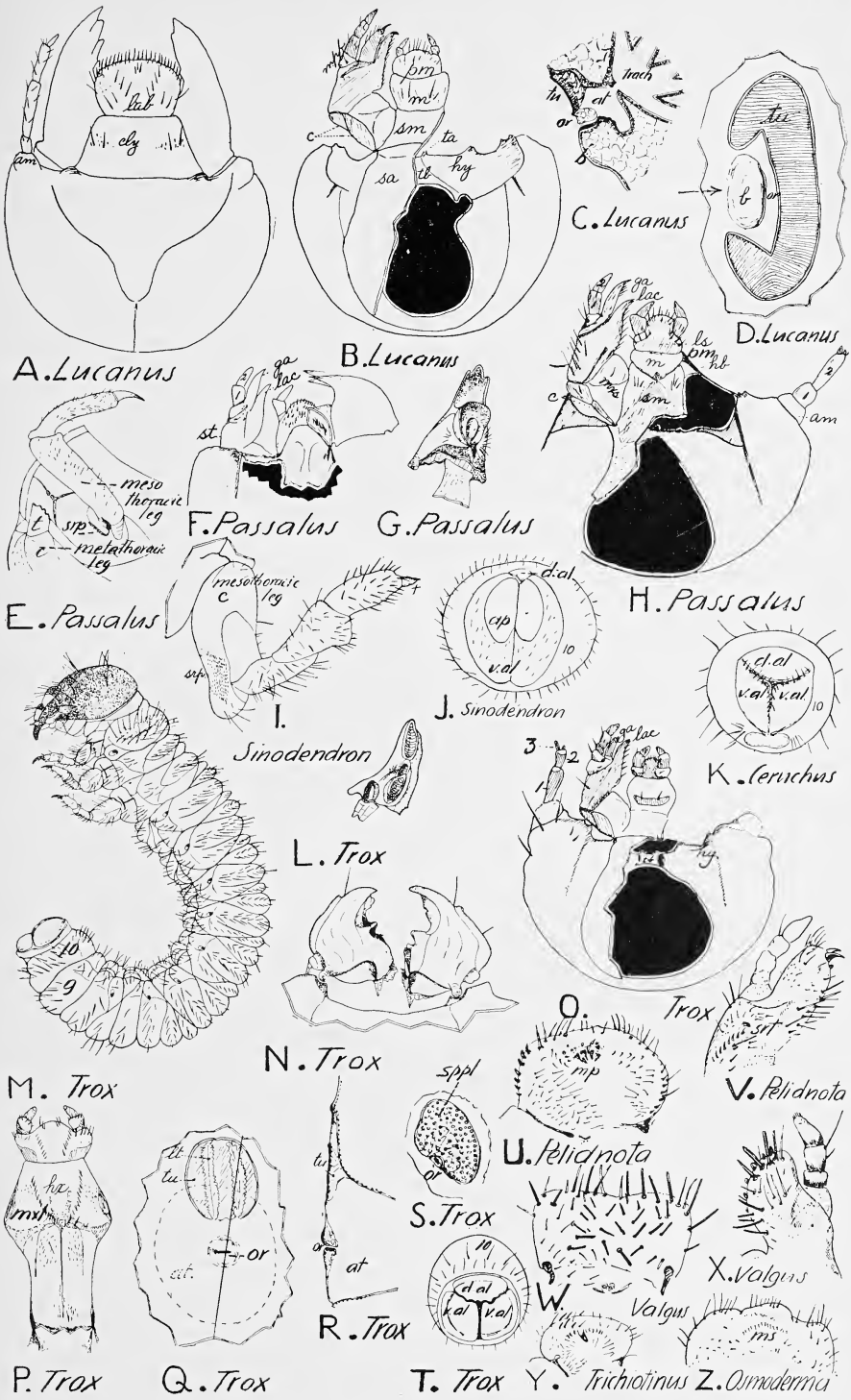
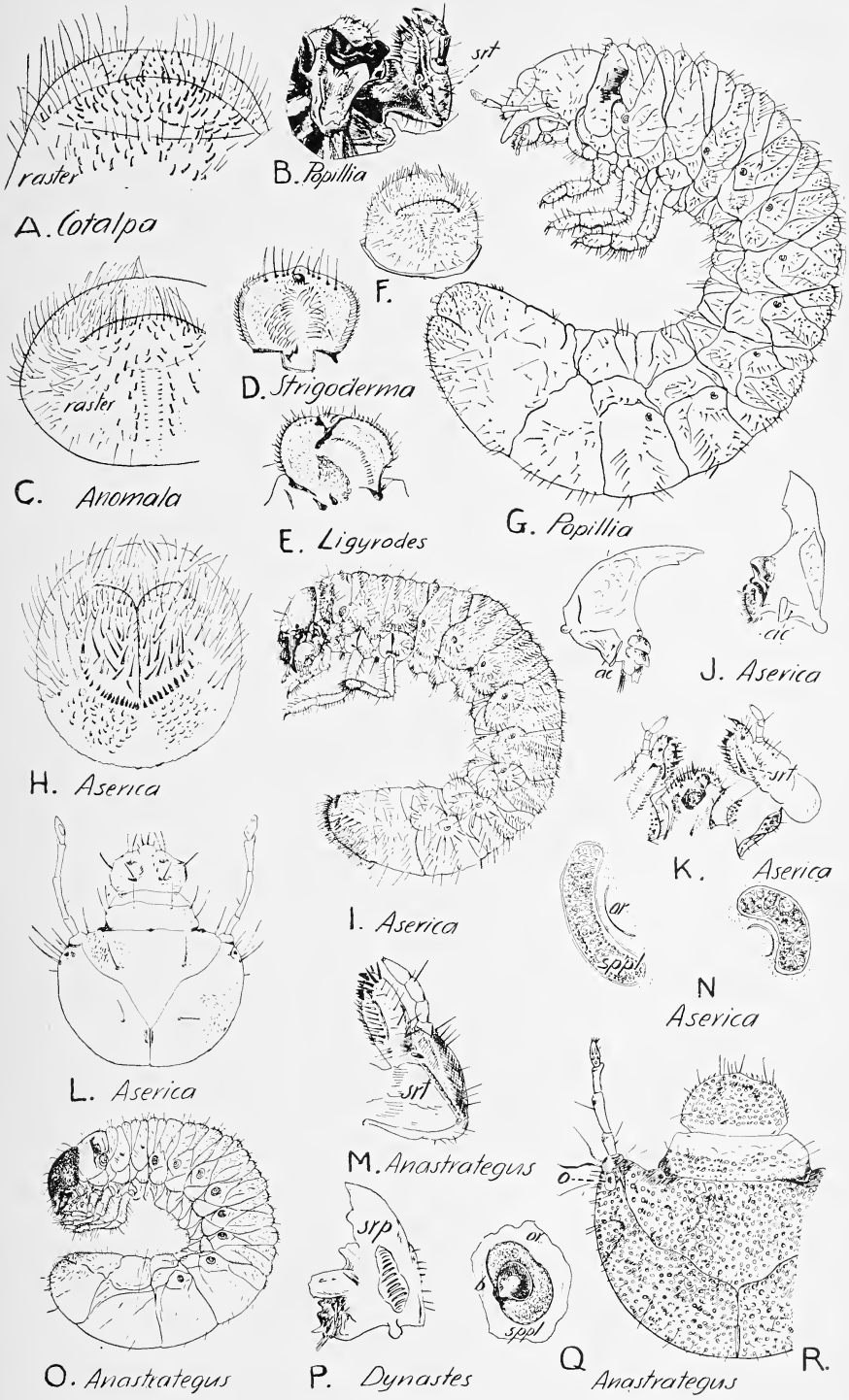

A. Lucanus
B. Lucanus
C. Lucanus
D. Lucanus
E. Passalus
F. Passalus
G. Passalus
H. Passalus
I. Sinodendron
J. Sinodendron
K. Cerrichus
L. Trox
M. Trox
N. Trox
O. Trox
P. Trox
Q. Trox
R. Trox
S. Trox
T. Trox
U. Pelidnota
V. Pelidnota
W. Valgus
X. Valgus
Y. Trichiotinus
Z. Osmoderma

Plate 88

Scarabaeidae-Rutelinae-Rutelini (A),
Scarabaeidae-Rutelinae-Anomalini (B–D, F, G),
Scarabaeidae-Sericinae (H–L, N),
Scarabaeidae-Dynastinae (E, M, O–R)

A. Cotalpa lanigera L. : End of body with raster. Ventral view.
B. Popillia japonica Newm. : Hypopharynx, maxilla.
C. Anomala orientalis Waterh. : End of body with raster. Ventral view.
D. Strigoderma arboricola F. : Epipharynx.
E. Ligyrodes relictus Say : Epipharynx.
F. Popillia japonica. : End of body with raster.
G. " " : Larva. Lateral view.
H. Aserica (= Autoserica) castanea Arrow : End of body with raster. Ventral view.
I. " " " : Larva. Lateral view.
J. " " " : Right and left mandible.
K. " " " : Maxilla and hypopharynx.
L. " " " : Head. Dorval view.
M. Anastrategus splendens Beauv. : Right maxilla. Dorsal view.
N. Aserica castanea : Mesothoracic and third abdominal spiracle; sppl, spiracular plate.
O. Anastrategus splendens : Larva. Lateral view.
P. Dynastes tityus L. : Left mandible; srp, stridulating plate. Ventral view.
Q. Anastrategus splendens : Cribriform spiracle; b, bulla; sppl, spiracular plate; or, spiracular opening.
R. " " : Head; o, ocellus.


raster
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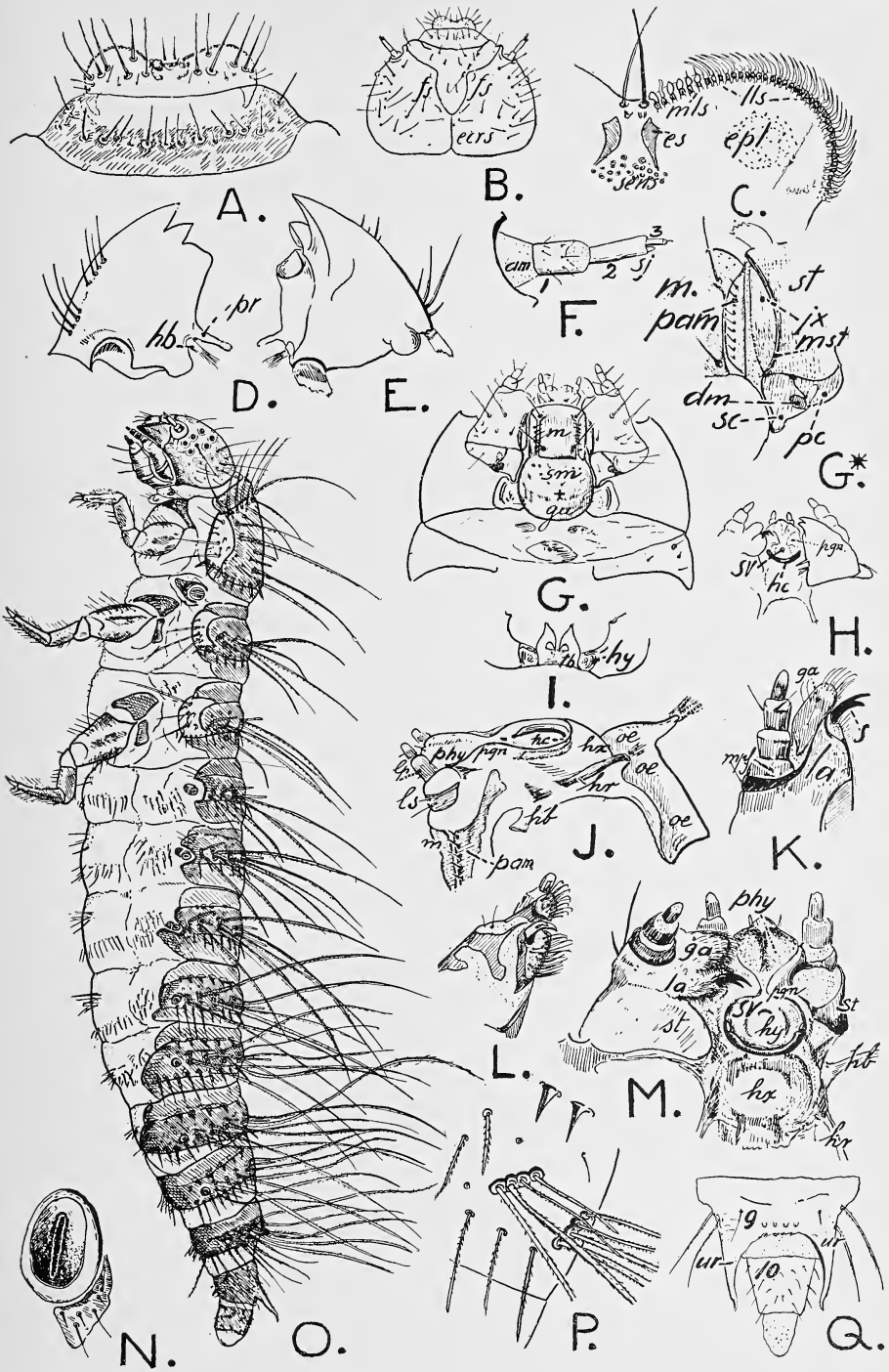
L. Aserica
srt
M. Anastrategus
srp
or
sppl
O. Anastrategus
P. Dynastes
Q
Anastrategus
R.

Plate 89

Dermestidae-Dermestinae

A. Dermestes nidum Arrow : Labrum and clypeus.
B. " " : Head. Dorsal view.
C. " " : Epipharynx; epl, epipharyngeal lobe; es, epipharyngeal sclerome; lls, lateral lobe-setae; mls, median lobe-setae; sens, sensory punctures.
D. " " : Left mandible; hb, hair brush; pr, stiff process. Dorsal view.
E. " " : Left mandible. Ventral view.
F. " " : Antenna.
G. " " : Ventral mouthparts. Ventral view.
G.* " " : Details of figure G; dm, bifurcate sclerite at the dividing suture between subcardo and precardo; jx, juxtastipes; m, mentum; mst, sclerotized margin of stipes; pam, paramentum with longitudinal series of hairs.
H. " " : Mandible, maxilla, and hypopharynx; sv, opening for salivary glands. Dorsal view.
I. " " : Tentorium.
J. " " : Labium, hypopharynx, and oesophagus; pam, paramentum; phy, glossa. Lateral view.
K. " " : Maxilla; s, spur. Ventral view.
L. " " : Maxilla. Buccal view.
M. " " : Hypopharyngeal region and maxilla; sv, opening for salivary glands. Dorsal view.
N. " " : Mesothoracic spiracle.
O. " " : Larva. Lateral view.
P. " " : Details of abdominal tergum.
Q. " " : Ninth and tenth abdominal segments. Dorsal view.


A.
B.
C.
D.
E.
F.
G.*
G.
H.
I.
J.
K.
L.
M.
N.
O.
P.
Q.
hb
pr
cm
sj
m.
pam
st
ix
mst
dm
sc
pc
sm
ga
hc
hy
phy
hgn
hx
oe
hr
fst
ls
pam
ga
s
la
phy
ga
la
st
hy
hx
hr
fst
9
10
ur

Dermestes

Plate 90

Dermestidae-Attageninae

A. Thylodrias contractus Mots. : Head. Dorsal view.
B. " " : Antenna.
C. " " : Tip of labium.
D. " " : Epipharynx.
E. " " : Mandible.
F. " " : Ventral mouthparts.
G. " " : Tip of maxilla.
H. " " : Larva.
I. Attagenus piceus Oliv. : Annular spiracle.
J. " " : Labrum, clypeus, and antenna.
K. " " : Right mandible.
L. " " : Left front leg.
M. " " : Ventral mouthparts.
N. " " : Larva. Lateral view.
O. Ctesias serra F. (Denmark) : Tip of maxilla.
P. Trogoderma ornata Say : Larva. Dorsal view.
Q. " " : Abdominal segments. Ventro-lateral view.
R. Ctesias serra : Ventral mouthparts.
S. " " : Larva. Lateral view.
T. Anthrenus verbasci L. : Mandible. Exterior view.
U. " " : Larva. Lateral view.
V. " " : Distal end of tibia and tarsungulus.
W. Aspectus hispidus Melsh. : Right mandible.
X. " " : Tips of maxilla and labium, and hypopharynx. Dorsal view.
Y. " " : Larva. Ventral view.
Z. " " : Larva. Lateral view.
Z.* " " : Three abdominal terga. Dorsal view.

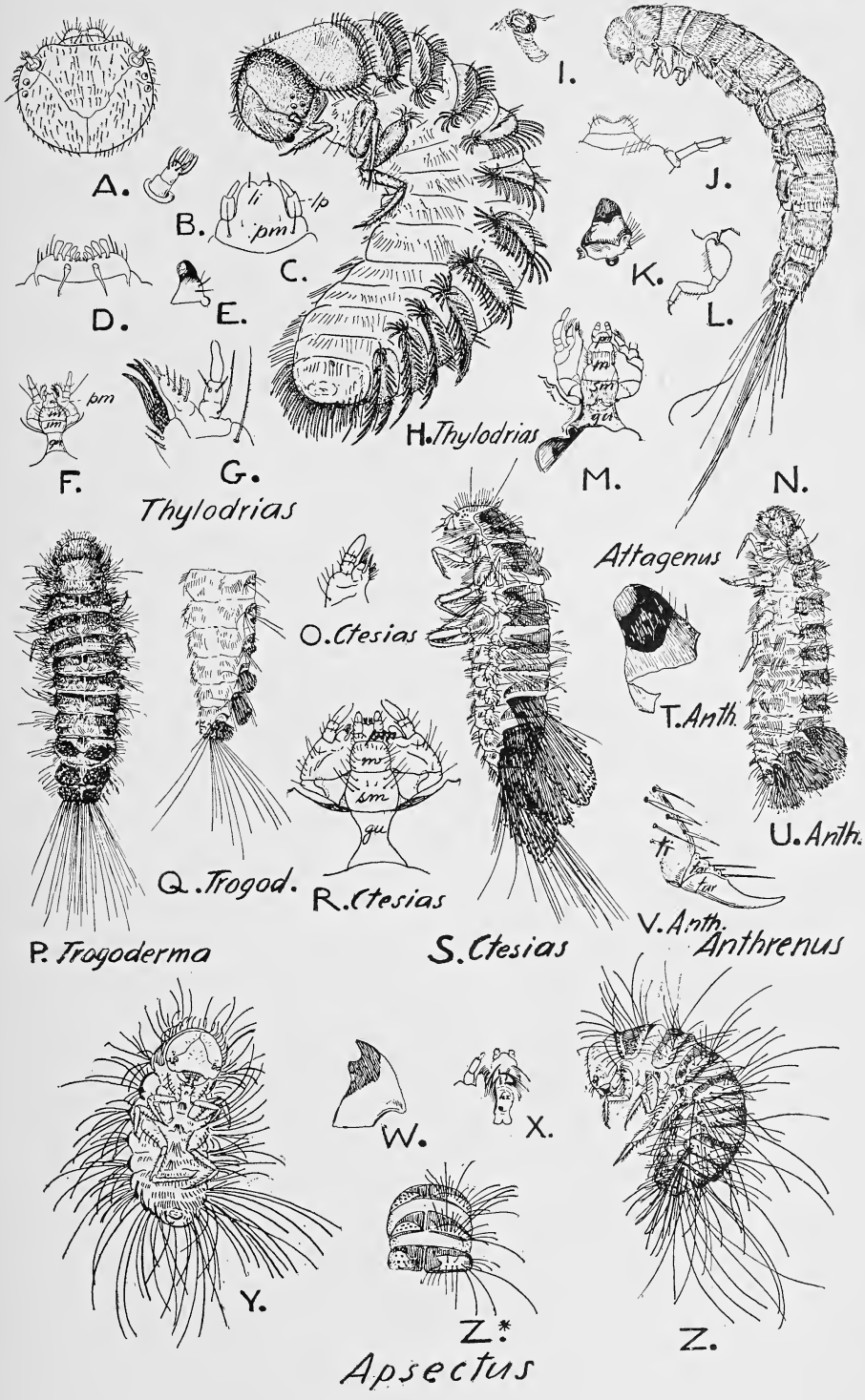

A.
B.
li
lp
pm
C.
D.
E.
F.
pm
sm
m
gu
G.
Thylodrias
H. Thylodrias
I.
J.
K.
L.
M.
N.
Attagenus
O. Ctesias
T. Anth.
U. Anth.
Q. Trogod.
R. Ctesias
S. Ctesias
V. Anth.
Anthrenus
P. Trogoderma
W.
X.
Y.
Z.*
Apsectus
Z.

Plate 91

Melyridae

A. Malachius bipustulatus L. (Denmark) : Head and prothorax. Lateral view.
B. " " : Left mandible; lm, lacinia mandibulae. Dorsal view.
C. " " : Left mandible. Buccal view.
D. " " : Left mandible. Ventral view.
E. " " : Ventral mouthparts. Ventral view.
F. " " : Dorsal side of head from within; ecrs, epicranial suture; fs, frontal suture.
G. " " : Ninth and tenth abdominal segments. Ventral view.
H. " " : Urogomphus. Lateral view.
I. " " : Hypopharynx and ventral mouthparts. Dorsal view.
J. " " : Larva. Dorsal view.
K. Malachius auritus Lec. : Larva. Dorsal view.
L. Melyridae (undetermined larva from Alaska) : Left mandible. Ventral view.
M. " " : Head and prothorax. Ventral view.
N. " " : Larva. Dorsal view.

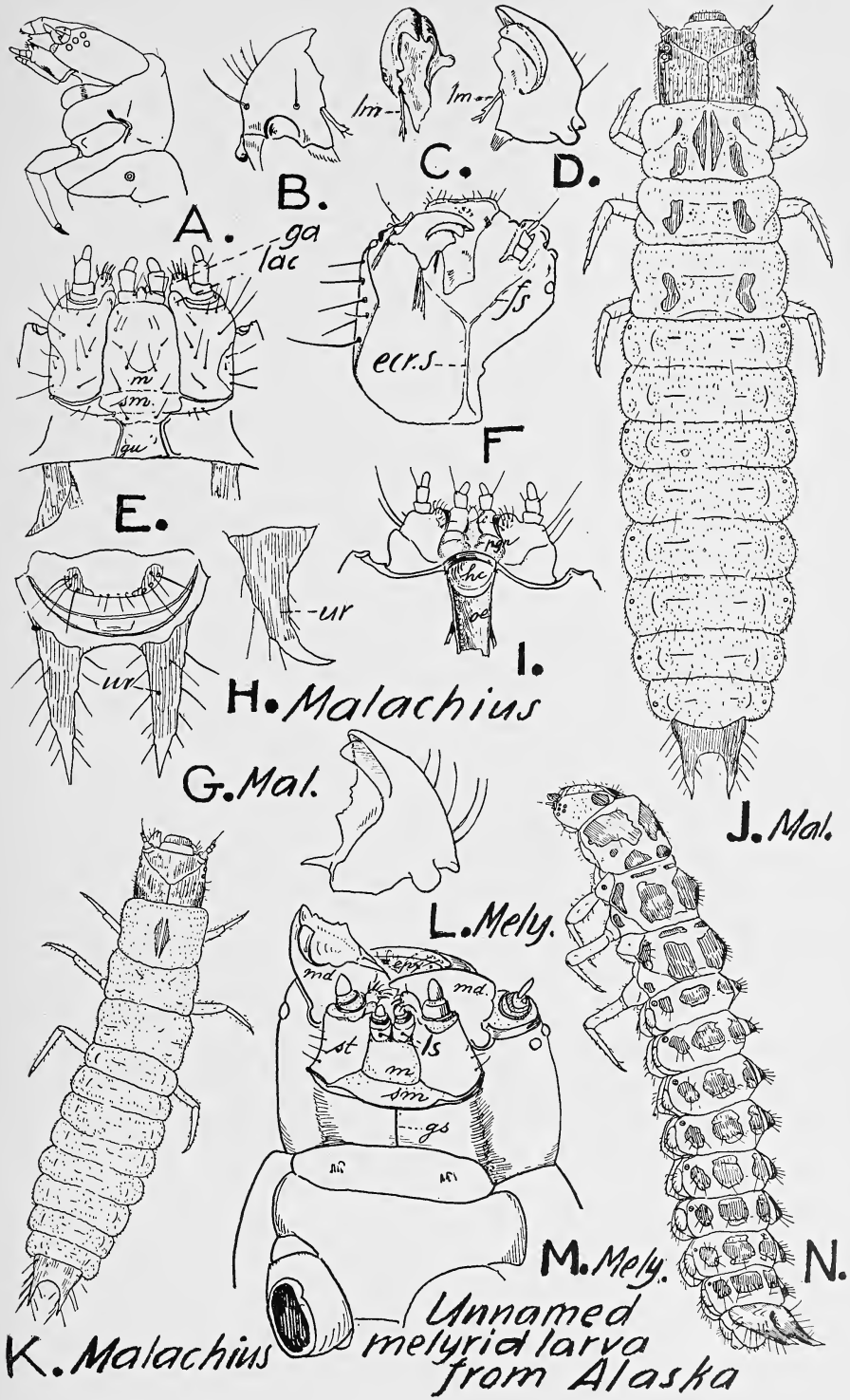

A.
B.
C.
D.
ga
lac
lm
lm
m
sm
gu
fs
ecr.s
F
E.
ur
ur
H. Malachius
hyp
hc
oe
I.
G. Mal.
J. Mal.
L. Mely.
epi
md
md
st
ls
m
sm
gs
M. Mely.
N.
K. Malachius
Unnamed
melyrid larva
from Alaska

Plate 92

Melyridae (A–J)

Ciidae (K–R)

A. Collops nigriceps Say : Larva. Dorsal view.
B. " " : Larva. Lateral view.
C. " " : Larva. Ventral view.
D. " " : Left mandible. Ventral view.
E. Dasytes coeruleus Deg. (Denmark) : Left mandible. Ventral view.
F. " " : Tarsungulus. One lateral and one ventral view.
G. " " : Head. Ventral view.
H. " " : Annular spiracle.
I. " " : Larva. Dorso-lateral view.
J. " " : Ninth abdominal tergum. Dorsal view.
K. Cis fuscipes Mellié : Head. Ventral view.
L. " " : Leg.
M. " " : Annular spiracle.
N. " " : Right maxilla. Dorsal view.
O. Ennearthron sp. (Hopk. U. S. 10086 t) : Larva. Lateral view.
O.* " " : Outline of posterior part of ninth abdominal segment. Dorsal view.
P. " " : Left mandible. Ventral view.
Q. " " : Antenna.
R. Ennearthron thoracicorne Ziegl. : Head. Dorsal view.

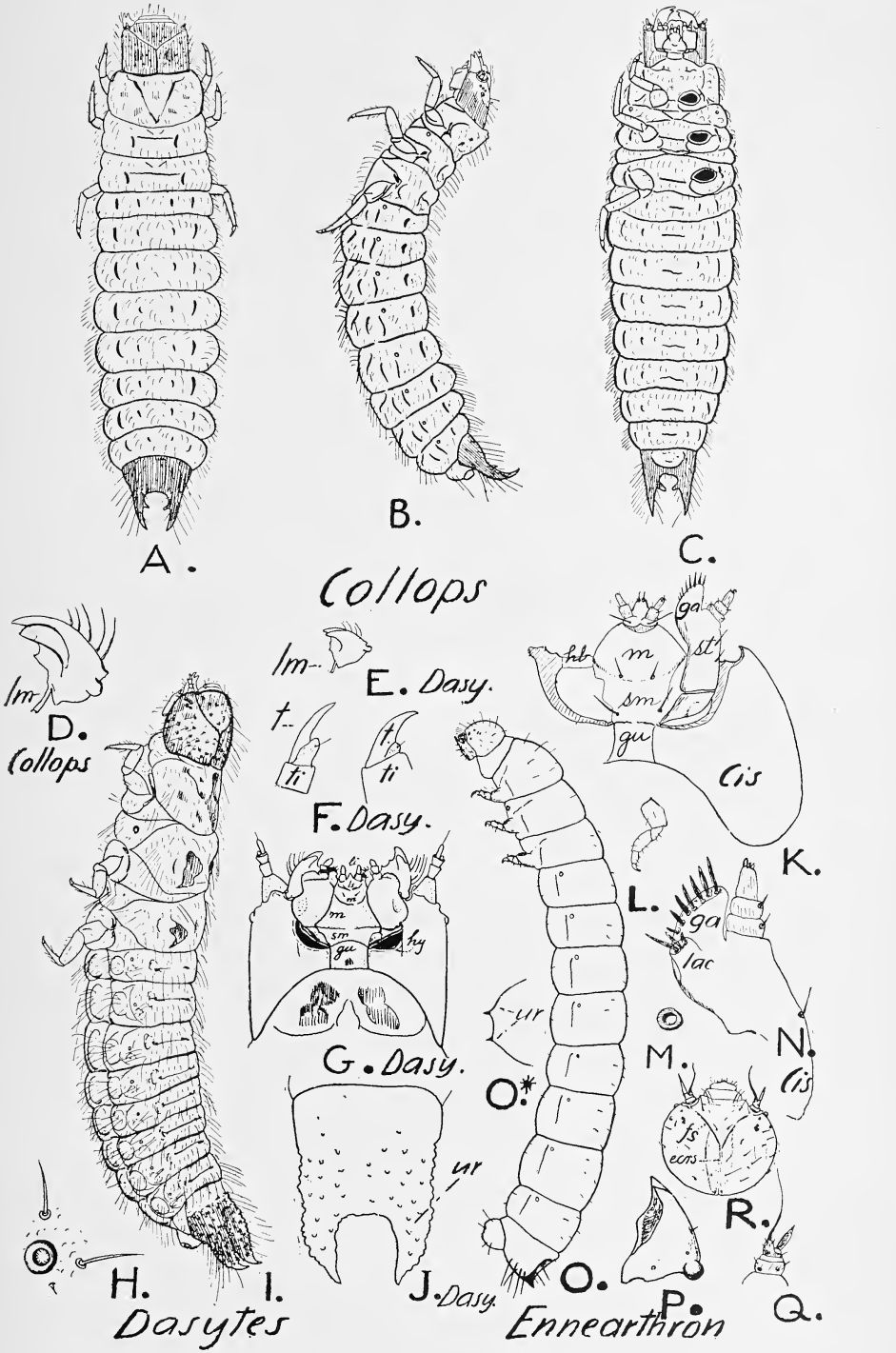

A.
B.
C.
Collops
D.
Collops
lm
E. Dasy.
lm
F. Dasy.
t
ti
ti
G. Dasy.
m
sm
gu
hy
ga
st
hb
m
sm
gu
Cis
K.
L.
ga
lac
M.
N.
Cis
O*
ur
J. Dasy.
ur
H.
I.
Dasytes
O.
P.
Q.
Ennearthron
fs
eons
R.

Plate 93

Ostomidae-Tenebroidinae,

Ostomidae-Ostominae (D)

A. Airora cylindrica Serv. : Left mandible; without lacinia mandibulae. Dorsal view.

B. Corticotomus cylindricus Lec. : Right mandible; lm, lacinia mandibulae. Ventral view.

C. Airora cylindrica : Part of head with ocellar group and antenna. Lateral view.

D. Ostoma ferrugineum L. (Canada) : Larva. Dorso-lateral view.

E. Corticotomus cylindricus : Larva; pst, presternal plate; stpl, sternal plate.

F. Airora cylindrica : Larva. Dorso-lateral view.

G. " " : Head and prothorax; pst, presternal plate; stpl, sternal plate; sp, annular spiracle.

H. Corticotomus cylindricus : Ninth abdominal segment with paired urogomphi.

I. Temnochila virescens F. : Ninth abdominal segment with one of the two urogomphi. Lateral view.

J. " " : Left mandible. Ventral view.

K. " " : Dorsal (d) and ventral (v) sclerites of thoracic segments.

L. " " : Biforous spiracle.

M. " " : Biforous spiracle and closing apparatus.

N. " " : Closing apparatus.

O. Tenebroides nanus Melsh. : Ninth abdominal segment with one of the two urogomphi. Lateral view.

P. " " : Right mandible. Dorsal view.

Q. " " : Dorsal (d) and ventral (v) sclerites of thoracic segments.

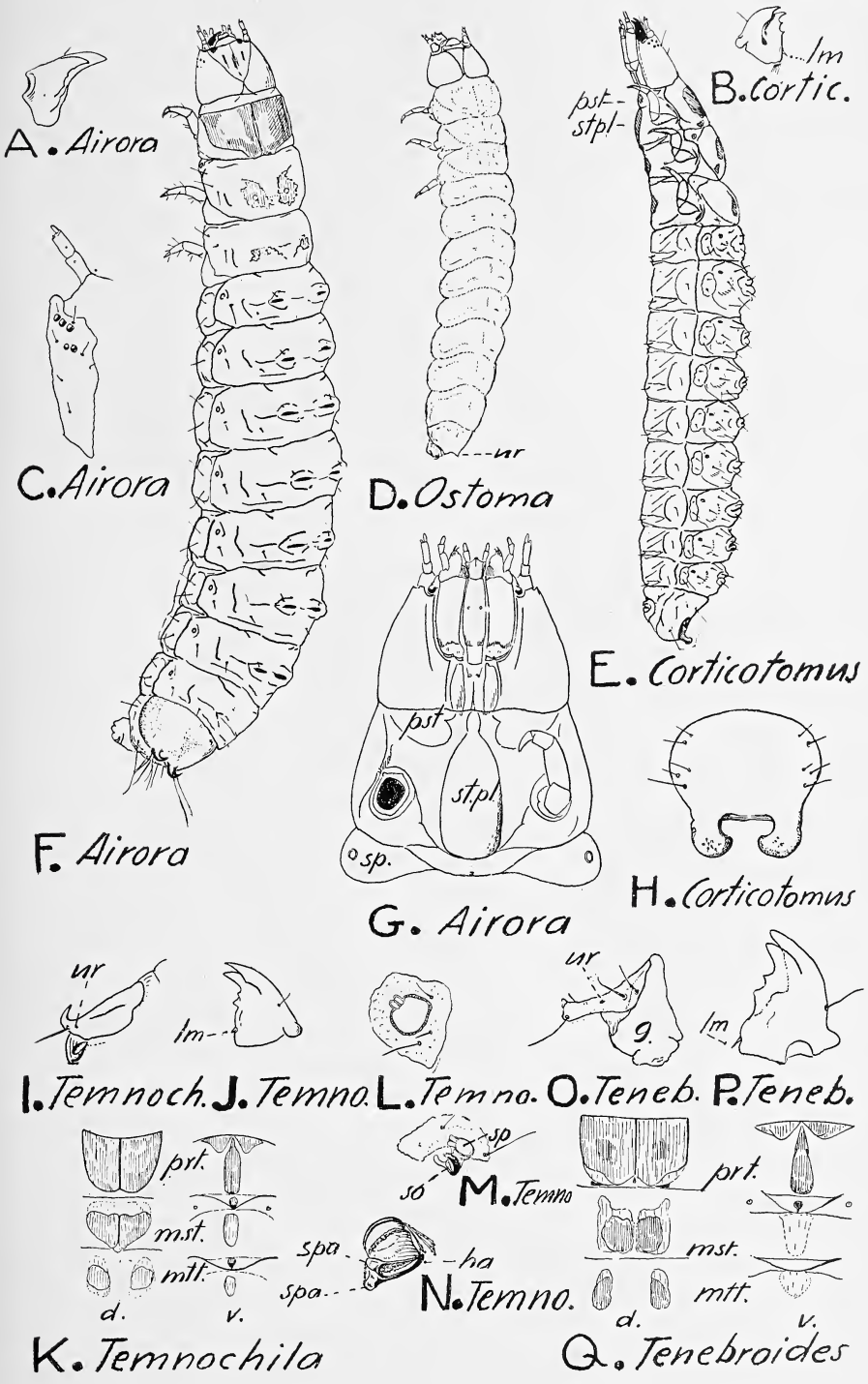

A. Airora
B. Cortic.
lm
pst.
stpl.
C. Airora
D. Ostoma
ur
E. Corticotomus
F. Airora
pst.
stpl.
sp.
G. Airora
H. Corticotomus
ur
lm
I. Temnoch.
J. Temno.
L. Temno.
ur
g.
lm
O. Teneb.
P. Teneb.
prt.
m.st.
mtt.
d.
v.
K. Temnochila
sp
so
M. Temno
spa.
ha
N. Temno.
prt.
m.st.
mtt.
d.
v.
Q. Tenebroides

Plate 94

Ostomidae-Tenebroidinae (A–I),

Ostomidae-Ostominae (J–U)

A. Temnochila virescens F. : Labrum.
B. " " : Epipharynx.
C. " " : Ventral mouthparts; pag, paragular plate; pm, prementum (fusion of the two stipites labii and the two palpigers).
D. " " : Head; fs, frontal sutures; ecrs, epicranial suture.
E. " " : Head and prothorax.
F. " " : Antenna, mouthparts and hypopharynx. Dorsal view.
G. " " : Ninth abdominal segment with urogomphi. Dorsal view.
H. " " : Abdominal segment; amb, ambulatory wart. Dorsal view.
I. " " : Larva. Ventro-lateral view.
J. Calitys scabra Thunb. : Abdominal segment; amb, ambu-
K. " " : Antenna, ventral mouthparts and hypopharynx; hb, hypopharyngeal bracon; pgn, maxillulae. Dorsal view.
L. " " : Larva. Dorsal view.
M. " " : Head, thorax and first abdominal segment. Ventral view.
N. " " : Left mandible. Ventral view.
O. " " : Left mandible. Buccal view.
P. Thymalus marginicollis Chev. : Larva. Dorso-lateral view.
Q. " " : Head and prothorax.
R. Thymalus limbatus F. (Denmark) : Leg.
S. " " : Right maxilla. Ventral view.
T. " " : Left mandible. Ventral view.
U. " " : Ninth abdominal segment with urogomphi. Dorsal view.

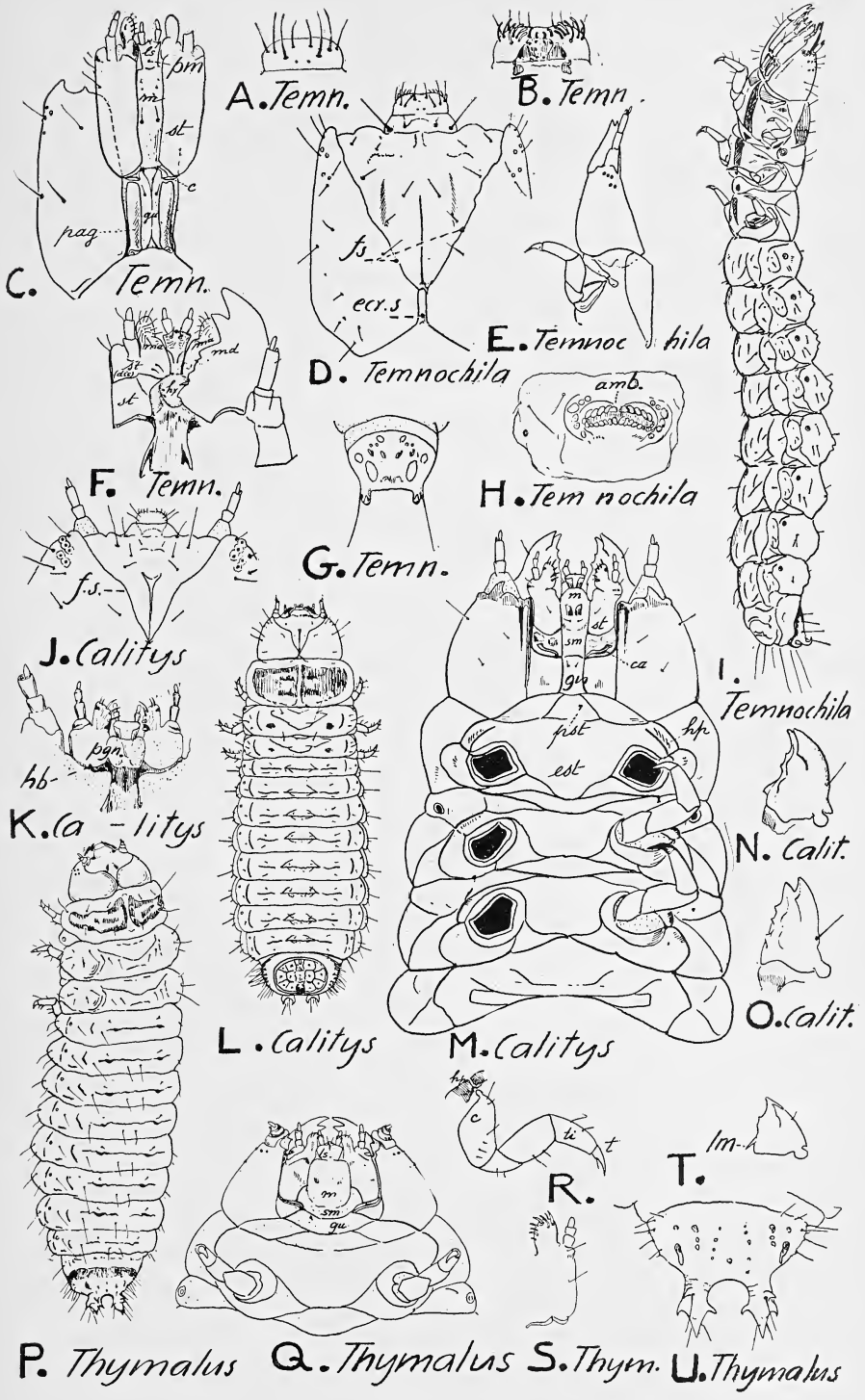
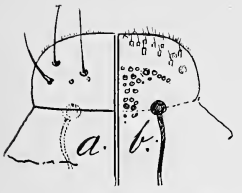

A. Temn.
B. Temn.
C. Temn.
D. Temnochila
E. Temnochila
F. Temn.
G. Temn.
H. Temnochila
I. Temnochila
J. Calitys
K. Ca - litys
L. Calitys
M. Calitys
N. Calit.
O. Calit.
P. Thymalus
Q. Thymalus
R.
S. Thym.
T.
U. Thymalus

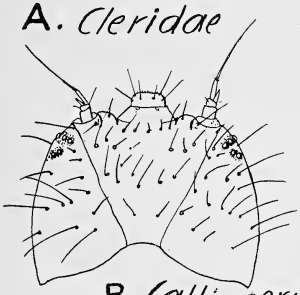
Plate 95

Cleridae-Hydnocerinae (B–M),
Cleridae-Clerinae (I, J, M, Q, T, U &c.)

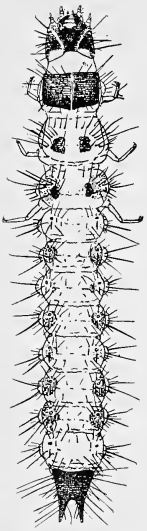
A. Cleridae : Labrum (a) and epipharynx (b).
B. Callimerus arcufer Chapin : Head. Dorsal view.
C. " " : Larva. Dorsal view.
D. " " : Head and prothorax; ga, galea enlarged; pst, presternum; stpl, sternal plate.
E. Hydnocera verticalis Say : Ninth abdominal segment.
F. Callimerus arcufer : Spiracle with short airtubes.
G. " " : Spiracle. Exterior view.
H. " " : Tip of leg showing tarsungulus (t) and paronychial appendix (pon).
I. Enoclerus ichneumoneus F. : Biforous spiracles of thorax, third and eighth abdominal segments, showing different development of airtubes.
J. Enoclerus lecontei Wolcott : Head. Dorsal view.
K. Monophylla terminata Say : Head, showing one ocellus.
L. Tarsostenus univittatus Rossi : Head with four ocelli.
M. Enoclerus lecontei : Leg (without paronychial appendix).
N. Cymatodera morosa Lec. : Annular spiracle.
O. Neichnea laticornis Say : Ninth abdominal segment; no urogomphi. Dorsal view.
P. Priocera castanea Newm. : Head with one ocellus on each side and projecting frons.
Q. Thanasimus formicarius L. (Denmark) : Larva. Lateral view.
R. Cymatodera inornata Say : Ninth abdominal segment.
S. Orthopleura damicornis F. : Head without ocelli.
T. Enoclerus lecontei : Right mandible.
U. " " : Ninth abdominal segment.
V. Thaneroclerus girodi Chev. : Head with five ocelli on each side and an unpaired ventral bump. Lateral view.
X. Cymatodera morosa : Head with three ocelli on each side. Lateral view.



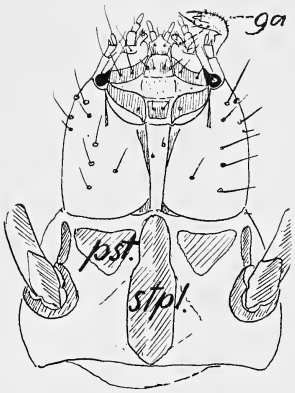
A. Cleridae



B. Callimerus



C. Callimerus



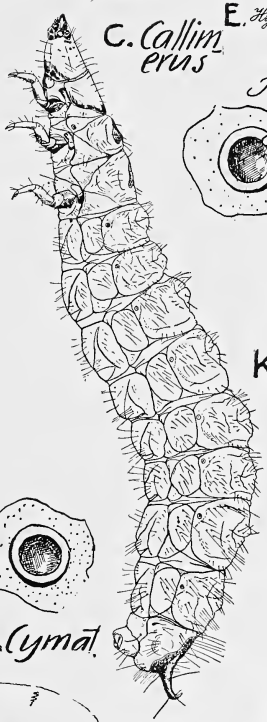
D. Callimerus

E. Hydnocera

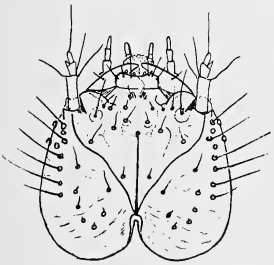
F. Call. G.

H. Callimerus

I. Enoclerus



K. Monophylla L. Tarsostenus



J. Enoclerus

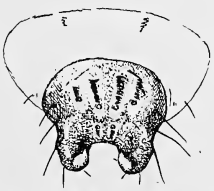
O. Nuchnea P. Prionera

M. Enocl.

N. Cymat.

R. Cymatodera inornata

S. Orthopleura



Q. Thanasimus

T. Enoclerus

U. Enoclerus

V. Thanerocleris

X Cymatodera morosa

PLATE 96

Meloidae-Lyttinae (A–I),
Meloidae-Meloinae, (J–K, M, P, Q)
Meloidae-Zonitinae (L, N, O, R, S)

A. Macrobasis immaculata Say; first instar : Larva. Dorsal view.
B. Epicauta vittata F; first instar : Head. Dorsal view.
C. Macrobasis immaculata; first instar : Head. Ventral view.
D. " " " " : Tarsungulus and two setae on it.
E. Epicauta pennsylvanica DeG.; first instar : Larva.
F. Epicauta vittata; scarabaeoid instar : Mandible. Dorsal view.
G. " " " " : Larva. Lateral view.
H. " " " " : Head. Dorsal view.
I. " " " " : Ventral mouthparts.
J. Meloe variegatus Donov. (Denmark); first instar : Mandible.
K. Meloe proscarabaeus L. (Denmark); first instar : Tip of leg with spatulate tarsungulus (t) and two setae at its base.
L. Zonitis bilineata Say; first instar : Head. Ventral view.
M. Meloe variegatus; first instar : Larva; term.s, terminal setae of the abdomen. Dorsal view.
N. Tricrania sanguinipennis Say; first instar : End of abdomen; spw, wart carrying the eighth abdominal spiracle. Lateral view.
O. Zonitis bilineata; first instar : Parts of seventh and eighth abdominal segments. Lateral view.
P. Meloe variegatus; first instar : Larva. Ventral view.
Q. Meloe proscarabaeus; first instar : Head; compare labrum in Meloe variegatus, figure P.
R. Zonitis bilineata; first instar : Larva.
S. " " " " : End of a leg.

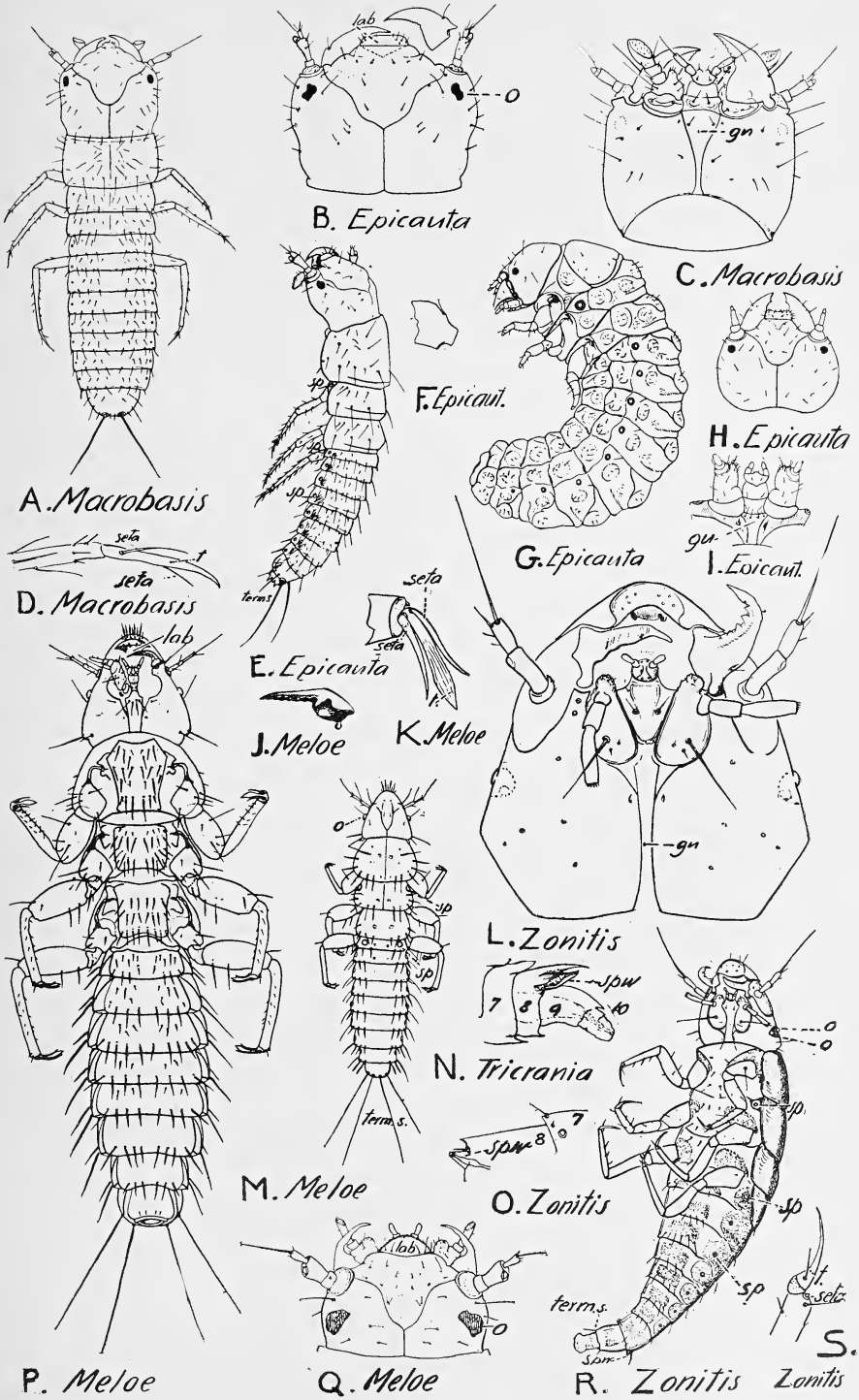

A. Macrobasis
B. Epicauta
lab
o
C. Macrobasis
gn
D. Macrobasis
seta
E. Epicauta
sp
terms
F. Epicaut.
G. Epicauta
H. Epicauta
I. Epicaut.
gu
J. Meloe
K. Meloe
seta
L. Zonitis
gn
M. Meloe
term.s.
N. Tricrania
spw
O. Zonitis
spw
P. Meloe
lab
Q. Meloe
R. Zonitis
term.s.
S. Zonitis
Zonitis

Plate 97

Tetraonycidae,

Rhipiphoridae

A. Tetraonyx quadrimaculata F.; first instar: Left mandible. Ventral view.

B. " " " " : Spiracle of first abdominal segment borne by a lateral projection from the segment. Exterior view.

C. " " " " : Head and prothorax; lp, labial palpus; s, single seta at base of tarsungulus; sj, tactile papilla of antenna; tj, terminal joint of antenna. Ventral view.

D. " " " " : Larva. Dorsal view.

E. Rhipiphorus solidaginis Pierce; first instar: Anterior part of larva; pon, paronychial appendix (= pulvillus). Ventral view.

F. " " " " : Tip of a leg; pon, paronychial appendix; s, short and thick seta at the base of tarsungulus. (Compare pl. 96 S).

G. " " " " : Larva. Dorso-lateral view.

H. " " " " : Posterior end of tenth abdominal segment.

I. Rhipiphorus stylopides Newm.; last larval instar : Anterior part of larva. Fronto-ventral view.

J. Rhipiphorus stylopides Newm.; last larval instar : Larva. Lateral view.

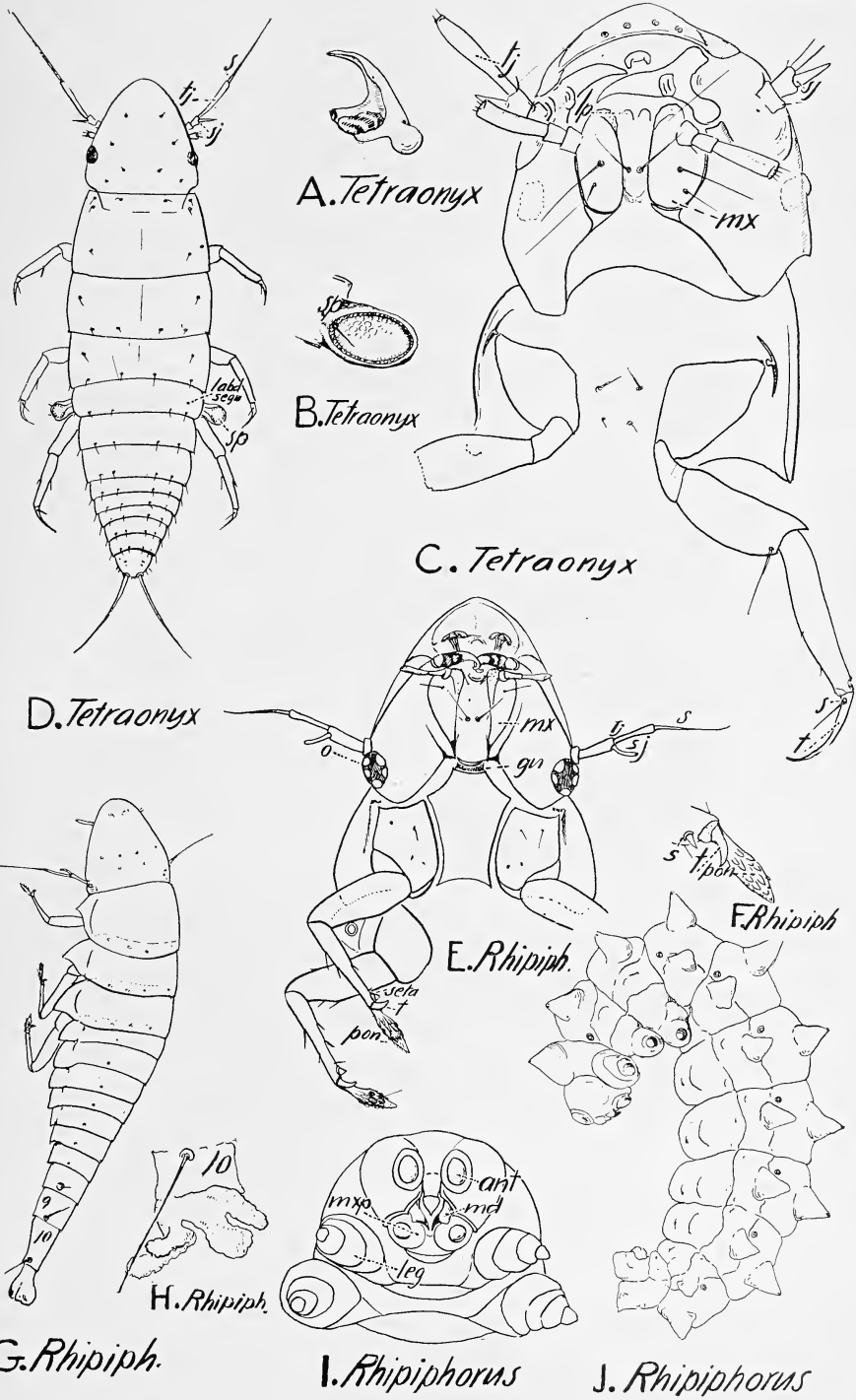

A. Tetraonyx
B. Tetraonyx
C. Tetraonyx
D. Tetraonyx
E. Rhipiph.
F. Rhipiph
G. Rhipiph.
H. Rhipiph.
I. Rhipiphorus
J. Rhipiphorus
mx
ant
md
leg
mxp
pon

Plate 98

Mordellidae

A. Tomoxia bidentata Say : Head. Dorsal view.
B. " " : Hypopharynx and bracon.
C. " " : Head, prothorax and mesothoracic spiracles. Ventral view.
D. " " : Larva. Lateral view.
E. " " : Right mandible. Dorsal view.
F. Mordellistena sp. (Hopk. U. S. 1009v) : Right mandible. Dorsal view.
G. " " : Left maxilla. Ventral view. Dorsal view shows a rudimentary lacinia with long spiny hairs at the base of the large galea (comp. pl. 92, fig. N).
H. " " : Annular spiracle.
I. " " : Mesothoracic leg.
J. " " : Larva. Lateral view.

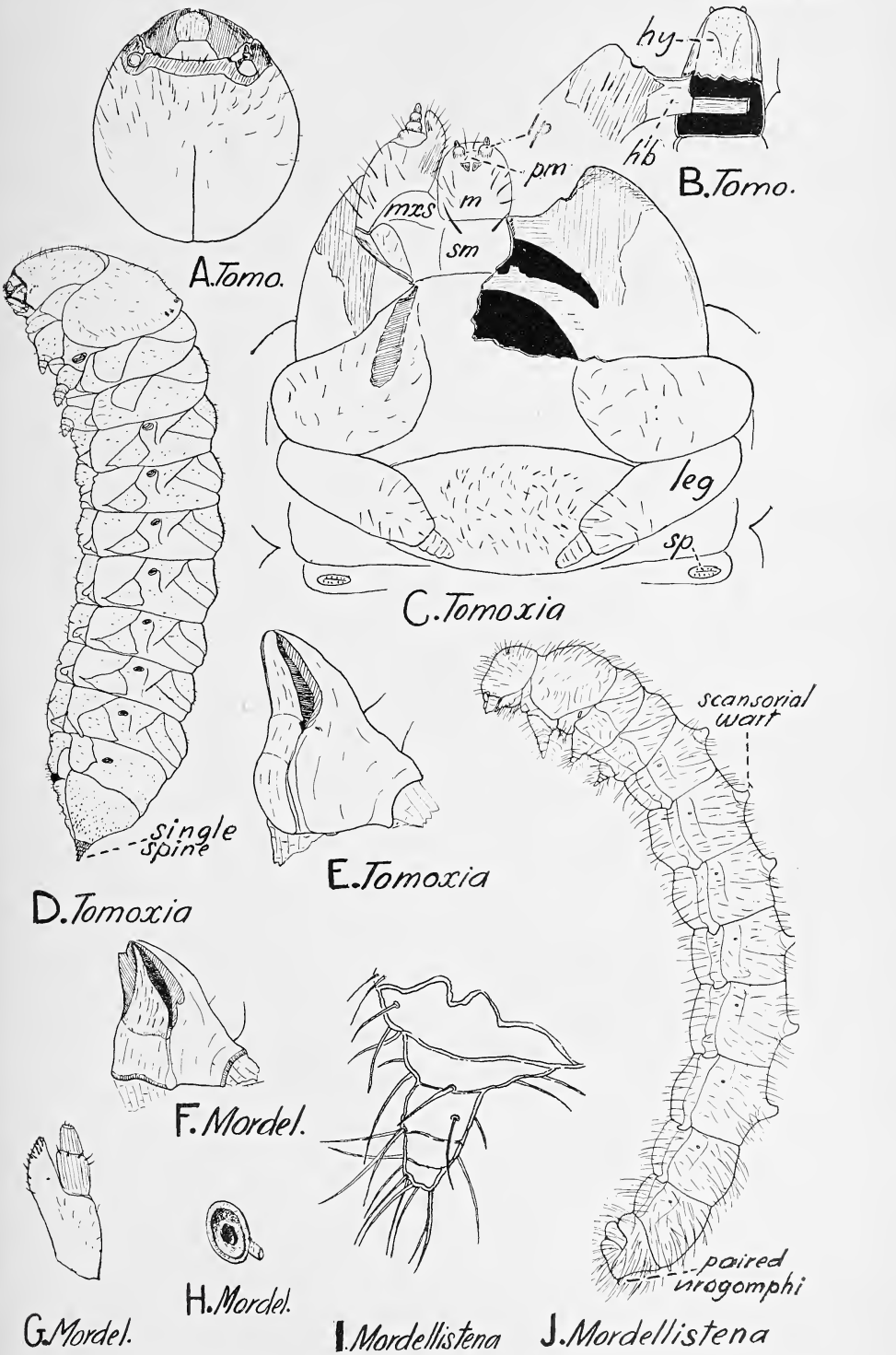

hy
hb
B. Tomo.
lp
pm
mxs
m
sm
A. Tomo.
leg
sp.
C. Tomoxia
single spine
D. Tomoxia
E. Tomoxia
scansorial wart
paired urogomphi
F. Mordel.
H. Mordel.
G. Mordel.
I. Mordellistena
J. Mordellistena

PLATE 99

Cerambycidae-Prioninae,

Cerambycidae-Aseminae,

Cerambycidae-Cerambycinae,

Cerambycidae-Lepturinae,

Cerambycidae-Lamiinae

(Diagrammatic illustration of the heads of subfamilies of Cerambycidae)

A. Genus Orthosoma : Head; ant, antenna; asrm, attachment of superior retractor muscles of head; cly, clypeus; ep, epistoma; epic, epicranium; frs, frontal suture; lab, labrum; M, median line of head; md, mandible; pcca, post-condylar carina. Dorsal view.

B. " " : Head; c, cardo; epic, epicranium; gu, gula; hs, hypostomal suture; hy, hypostoma; lac, lacinia; li, ligula; lp, labial palpus; lst, stipites labii; m, mentum; md, mandible; mpalp, maxillary palpiger; mxp, maxillary palpus; mxsc, maxillary articulating area; occ.for, occipital foramen; sfsp, subfossal spine; sm, submentum; st, stipes maxillae; tb, tentorial bridge; vrm, attachment of ventral retractor muscles of head; I, occipital foramen pars minor; II, occipital foramen pars major. Ventral view.

C. Genus Asemum : Head; eps, epistomal setae; gs, genal setae. Dorsal view.

D. " " : Head; tp, tentorial pit; I and II, occipital foramen, pars minor and pars major united. Ventral view.

E. Genus Xylotrechus : Head. Dorsal view.

F. " " : Head. Ventral view.

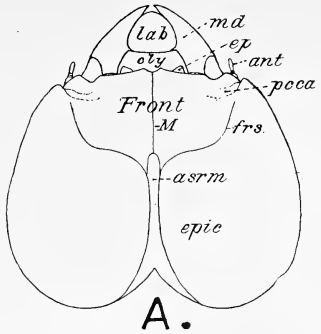
G. Genus Rhagium : Head; ar, antennal ring. Dorsal view.

H. " " : Head. Ventral view.

I. Genus Graphisurus : Head. Dorsal view.

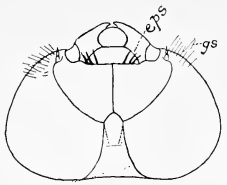
J. " " : Head. Ventral view.

Prioninae



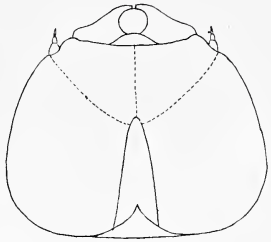
A.

Aseminae



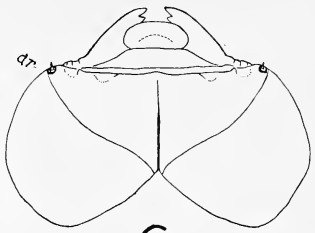
C.

Cerambycinae



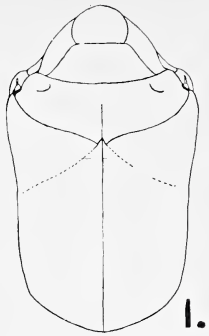
E.

Lepturinae

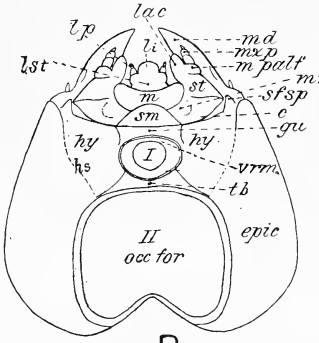


G.

Lamiinae

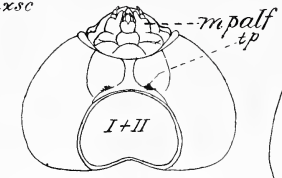


I.



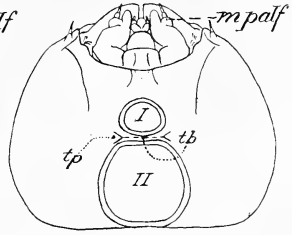
B.

Orthosoma



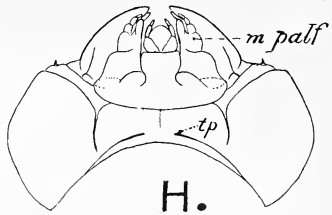
D.

Asemum



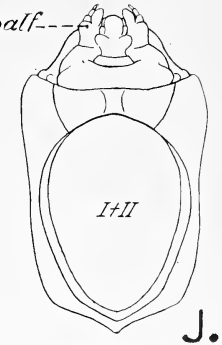
F.

Xylotrechus



H.

Rhagium



J.

Graphisurus

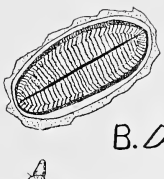
PLATE 99

Plate 100

Cerambycidae-Lamiinae (A),
Cerambycidae-Prioninae (B–F),
Cerambycidae-Cerambycinae (G),
Cerambycidae-Lepturinae (H–L),
Cerambycidae-Disteniinae (M)

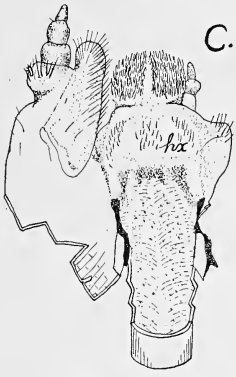
A. Lamiinae : Head, mpf, maxillary palpiger; st, stipes. Ventral view.
B. Derobrachus (= Orthosoma) brunneus Forst. : Spiracle.
C. " " " : Labium. Lateral view.
D. " " " : Head. Ventral view.
E. " " " : Maxilla, ligula, hypopharynx. Dorsal view.
F. " " " : Right mandible. Dorsal view.
G. Romaleum atomarium Drury : Right mandible. Dorsal view.
H. Undetermined lepturine larva (Siam) : Head. Ventral view.
I. " " " : Leg.
J. " " " : Abdominal segment. Dorsal view.
K. " " " : Larva. Dorsal view.
(Figure K drawn by J. A. Hyslop)
L. Lepturine larva, more typical of the family than figure H.
M. Distenia undata F. : Head. Ventral view.

A. Lamiinae



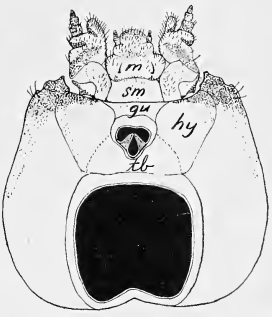
B. Dero.

C. Dero.



E. Derobrachus

F. Derobrachus

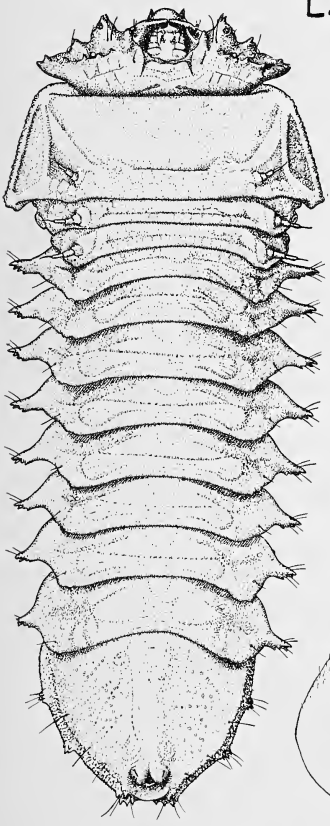


D. Derobrachus

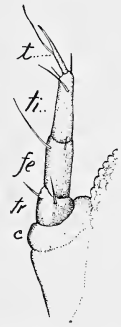
G. Romaleum

Prioninae

Cerambycinae



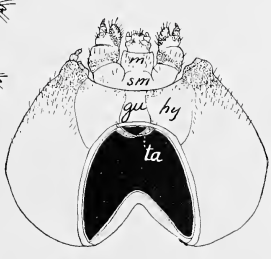
K. Lepturinae



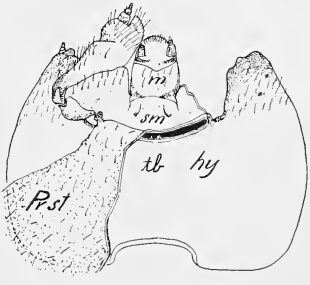
I. Leptur

H. Lepturinae

J. Lepturin.



L. Lepturinae



M. Disteniinae

PLATE 101

Ptinidae (A, B and E),
Anobiidae (C, D, F–N, X, Ae and Oe),
Bostrichidae (O–W, Y, Z)

A. Niptus sp. (Larvae, pupae and imagines in *Desfontinea ilicifolia* Chili): Larva; ats, anal transverse sclerome.
B. Ptinus fur L. : Ventral mouthparts.
C. Nevermannia dorcatomoides Fisher (Costa Rica): Mesothoracic spiracle.
D. " " : Right mandible.
E. Ptinus fur : Mesothoracic spiracle.
F. Nevermannia dorcatomoides : Head. Dorsal view.
G. " " : Anal pad.
H. " " : Larva. Lateral view.
I. Lasioderma serricorne F. : Mandible.
J. " " : Epipharynx (eph); labrum; clypeus, epistoma, and antenna.
K. " " : Head. Dorsal view.
L. " " : Ventral mouthparts.
M. Hedobia imperialis L. (Denmark) : Left maxilla; ma, undivided mala.
N. Trichodesma klagesi Fall. : Left maxilla with mala divided into lacinia and galea.
O. Scobicia declivis Lec., last instar : Epipharynx.
P. " " " " : Longitudinal cut of inner wall of mandible.
Q. " " first instar : Antenna, epipharynx and mouthparts.
R. " " last instar : Left mandible.
S. " " " " : Head. Dorsal view.
T. " " first instar : Larva. Lateral view.
U. " " " " : Tip of ninth abdominal segment. Dorsal view.
V. " " last instar : Prothoracic spiracle.
W. " " " " : Ventral mouthparts.
X. Caenocara oculata Say : Left maxilla.
Y. Scobicia declivis, last instar : Larva. Lateral view.
Z. " " " " : Right maxilla.
AE. Caenocara oculata : Right mandible.
OE. " " : Larva. Lateral view.

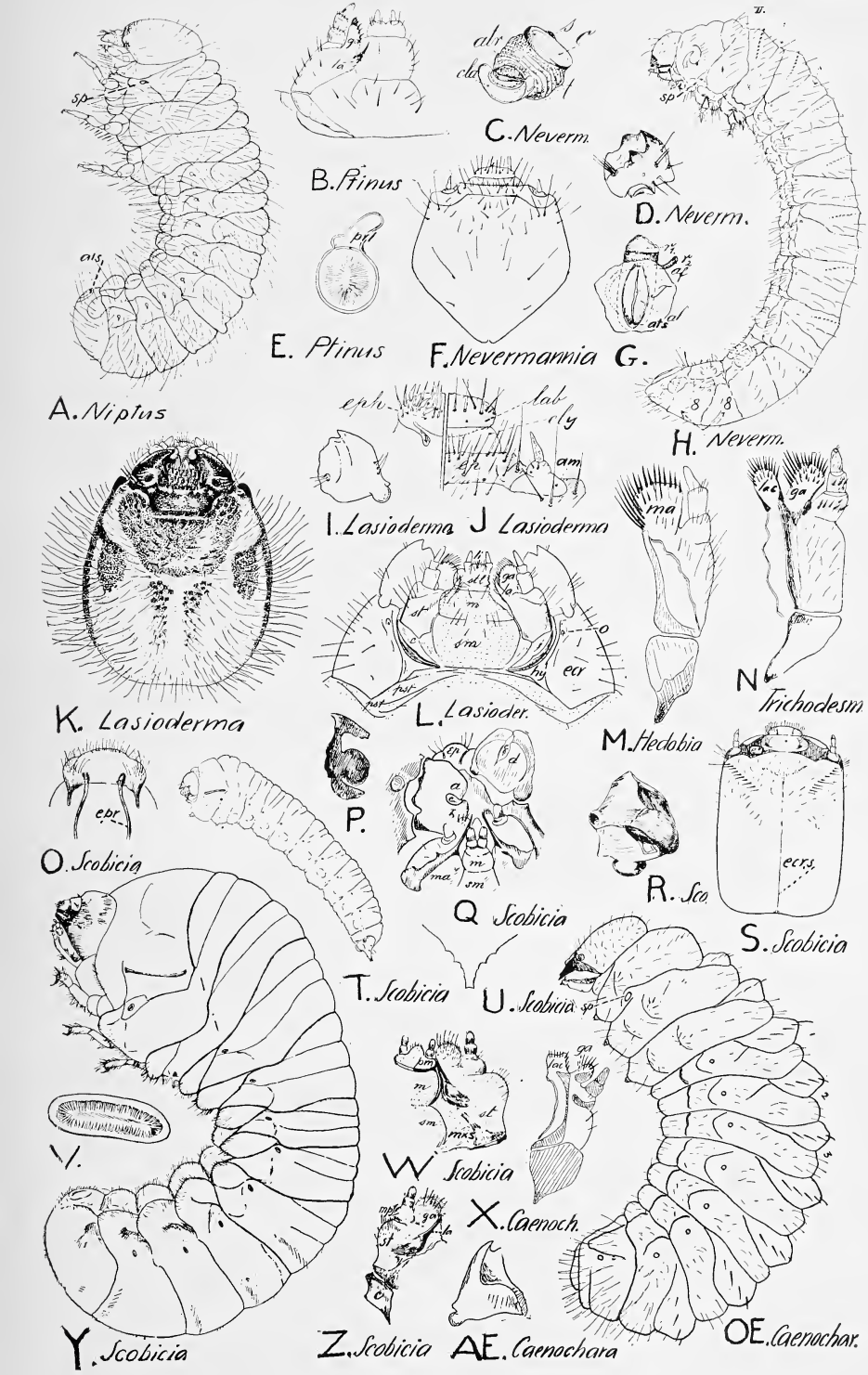

A. Niptus
B. Pinus
C. Neverm.
D. Neverm.
E. Ptinus
F. Nevermannia
G.
H. Neverm.
I. Lasioderma
J. Lasioderma
K. Lasioderma
L. Lasioder.
M. Hedobia
N. Trichodesm.
O. Scobicia
P.
Q. Scobicia
R. Sco.
S. Scobicia
T. Scobicia
U. Scobicia
V.
W. Scobicia
X. Caenoch.
Y. Scobicia
Z. Scobicia
AE. Caenochara
OE. Caenochar.

Plate 102

Psoidae (A–E),

Lyctidae (F–K)

A. Stephanopachys pacificus Csy.: Labrum, clypeus, and antenna.
B. Polycaon stouti Lec. : Labrum and clypeus.
C. " " : Head capsule. Ventral view.
D. " " : Interior of buccal region; epsc, epipharyngeal sclerome; epx, epipharynx; lm, lacinia mandibulae; md, mandible; pmo, pseudomola, a big molar-like process from dorsal side of mandible.
E. " " : Ventral mouthparts.
F. Lyctus cavicollis Lec. : Right mandible; lm, lacinia mandibulae; pmo, pseudomola. Dorsal view (left); buccal view (right).
G. " " : Antenna.
H. " " : Eighth abdominal spiracle (left figure); first abdominal spiracle (right figure).
I. " " : Larva. Lateral view.
J. Lyctus cavicollis, first instar : Ninth abdominal segment with a pair of small urogomphi. Dorso-lateral view.
K. " " , mature larva: Head and ventral mouthparts.

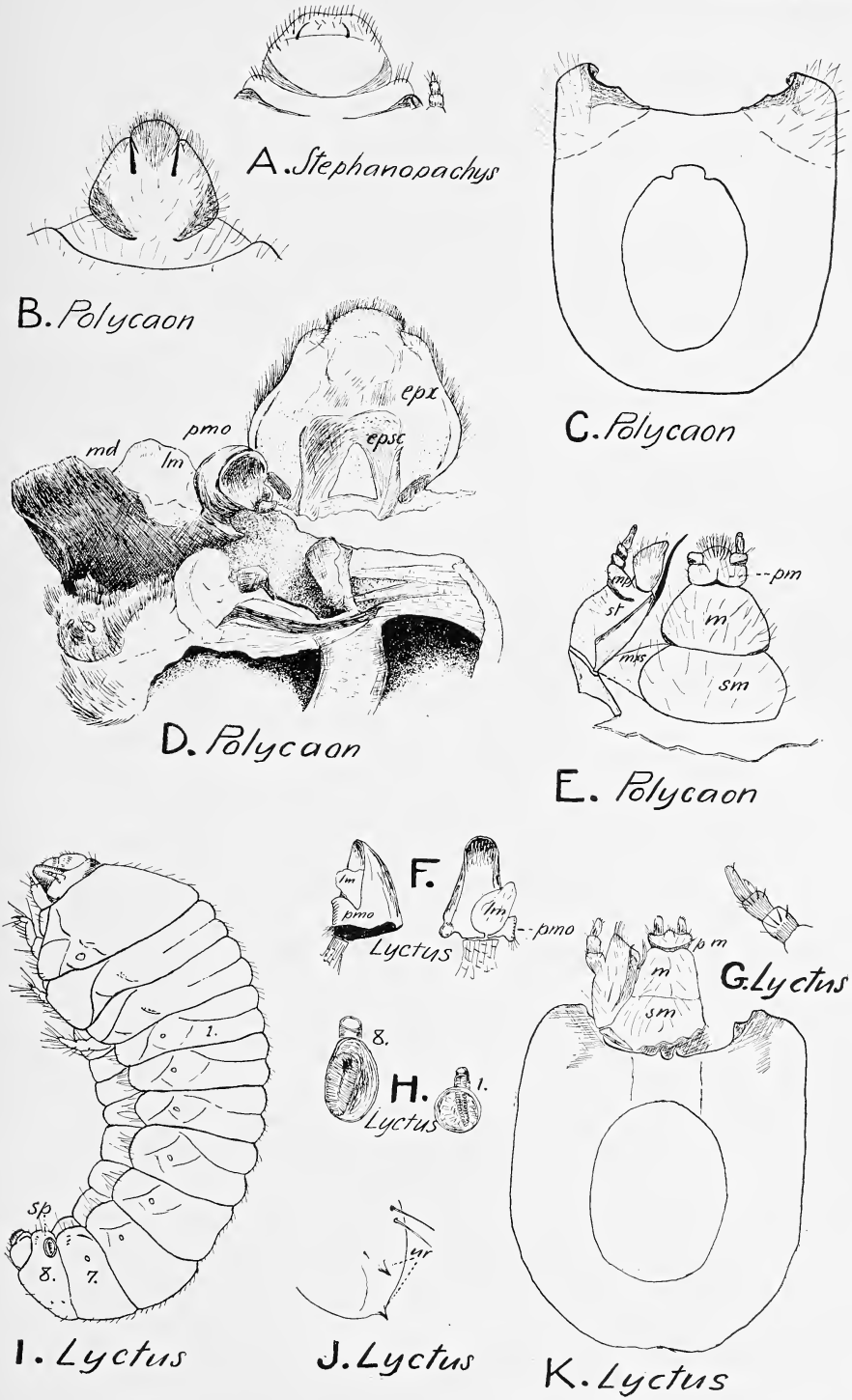
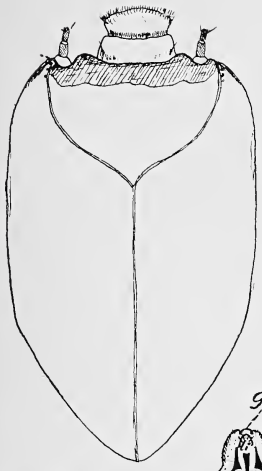
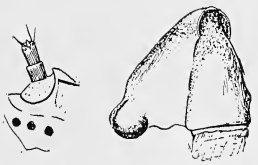

A. Stephanopachys
B. Polycaon
C. Polycaon
epi
epsc
pmo
md
lm
D. Polycaon
--pm
mx
st
m
mxs
sm
E. Polycaon
F.
lm
pmo
Lyctus
lm
--pmo
G. Lyctus
pm
m
sm
8.
H.
1.
Lyctus
1.
sp
8.
7.
I. Lyctus
ur
J. Lyctus
K. Lyctus

Plate 103

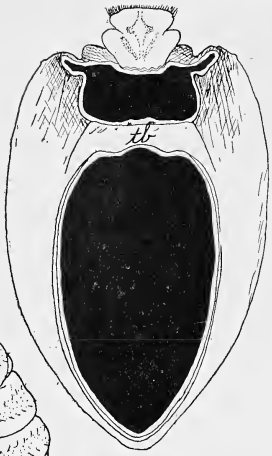
Bruchidae (= *Mylabridae*)

A. Caryedon fuscus (Goeze) (= Bruchus or Pachymerus gonagra F.) (Philippine Isl.) : Ocelli and antenna.
B. Pachymerus nucleorum F. (Brazil) : Right mandible.
C. Caryedon fuscus : Head. Dorsal view.
D. " " : Ventral mouthparts; gl, glossa; li, ligula; lp, labial palpus; pgl, paraglossa; sm, submentum. Ventral view.
E. " " : Head. Ventral view.
F. " ", first instar : Tibia and tarsus.
G. Pachymerus nucleorum : Larva. Lateral view.
H. Bruchus (= Mylabris) obtectus Say : Spiracle; atrium separately to the right.
I. " " : Labrum, clypeus and epistoma.
J. Spermophagus hoffmanneggi Gyll. : Anterior part of head. Dorsal view.
K. " ", first instar : Prothoracic dorsal X-shaped plate in the first bruchid instar assisting it in entering the seeds of leguminous plants.
L. " ", mature larva : Leg.
M. " ", mature larva : Ventral mouthparts.
N. " ", first instar : Leg.





A. Pach. B. Pach.

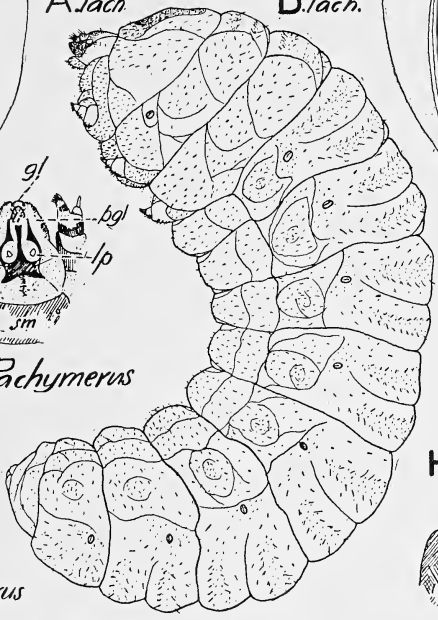


E. Pachymerus

C. Pachymerus

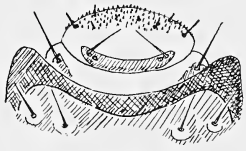
D. Pachymerus

F. Pachymerus



G. Pachymerus

H. Bruchus



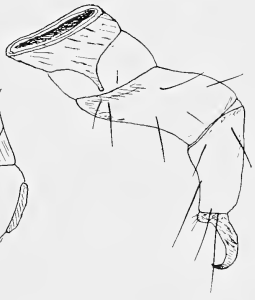
I. Bruchus

J. Spermophagus

K. Spermophagus

L. Spermoph.

M. Spermophagus

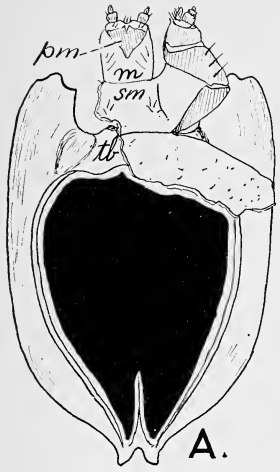


N. Spermophagus

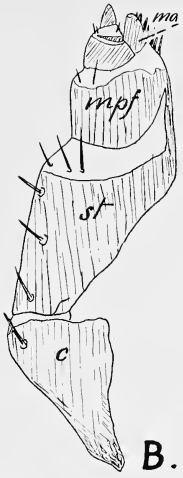
Plate 104

Sagridae

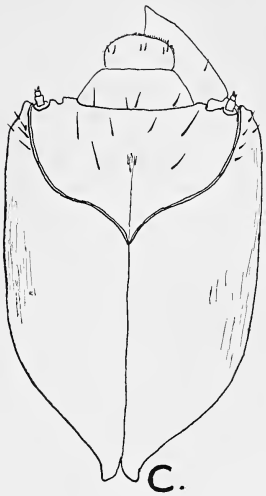
A. Sagra femorata Jac. (Malleswar, Mysore State, India) : Head. Ventral view.
B. Sagra femorata Jac. : Right maxilla. Ventral view.
C. " " : Head. Dorsal view.
D. " " : Hypopharynx and labium. Lateral view.
E. " " : Abdominal spiracle, bilabiate type.
F. " " : Leg.
G. " " : Larva. Lateral view.
H. " " : Right mandible. Ventral view.



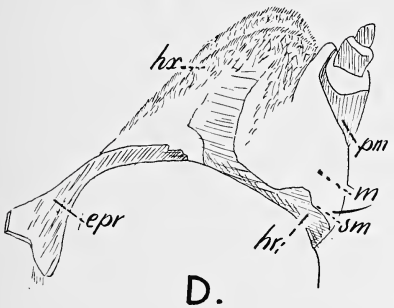
A.



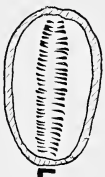
B.



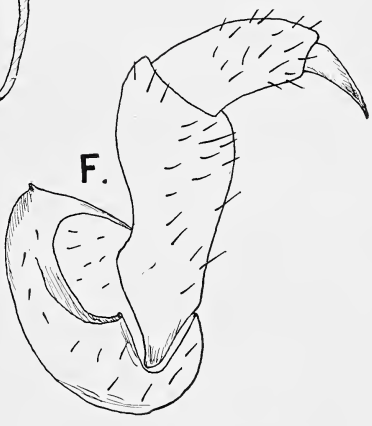
C.



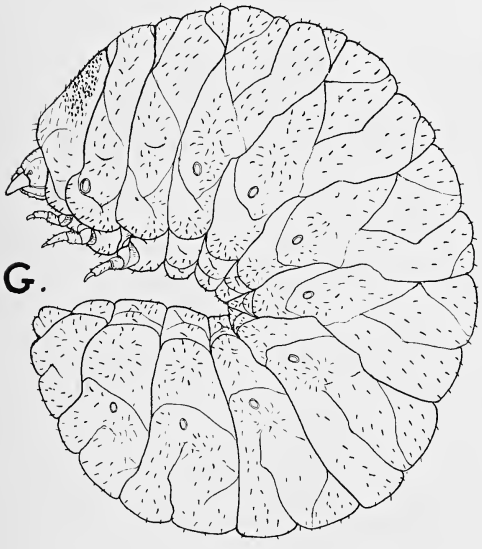
D.



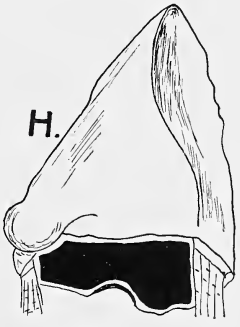
E.



F.



G.



H.

Sagra

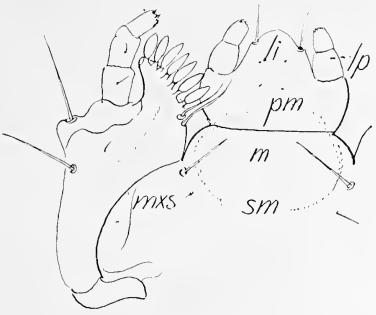
Plate 105

Orsodacnidae-Orsodacninae,

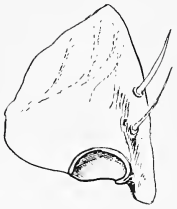
Orsodacnidae-Zeugophorinae

A. Orsodacne sp. (Not reared; determined by the method of elimination and locality) : Right mandible. Ventral view.
B. Orsodacne sp. : Ventral mouthparts. Ventral view.
C. " " : Right mandible. Dorsal view.
D. " " : Head. Dorsal view.
E. " " : Larva. Lateral view.
F. Zeugophora scutellaris Suffr. : Larva. Dorsal view.
G. " " : Head. Ventral view.
H. " " : Left mandible. Ventral view.

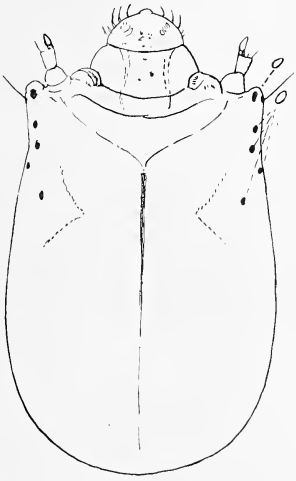
A. *Orsodacne*



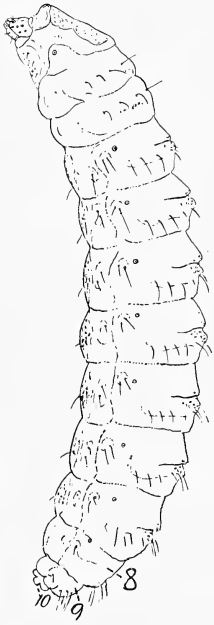
B. *Orsodacne*



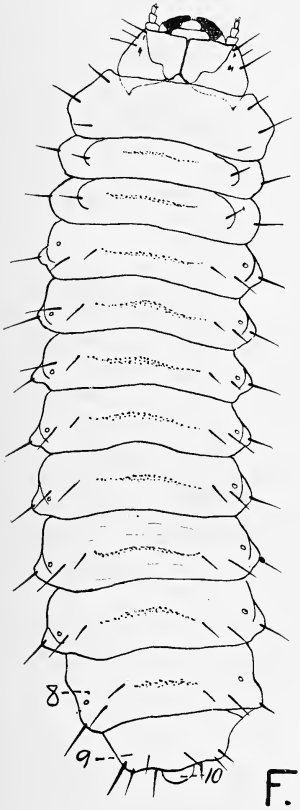
C. *Orsodacne*



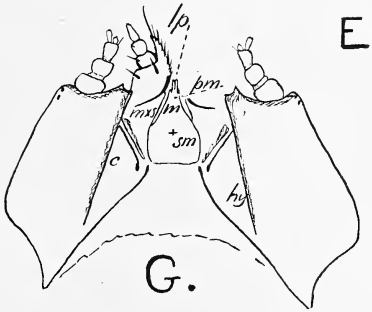
D. *Orsodacne*



E. *Orsodacne*



F.



G.

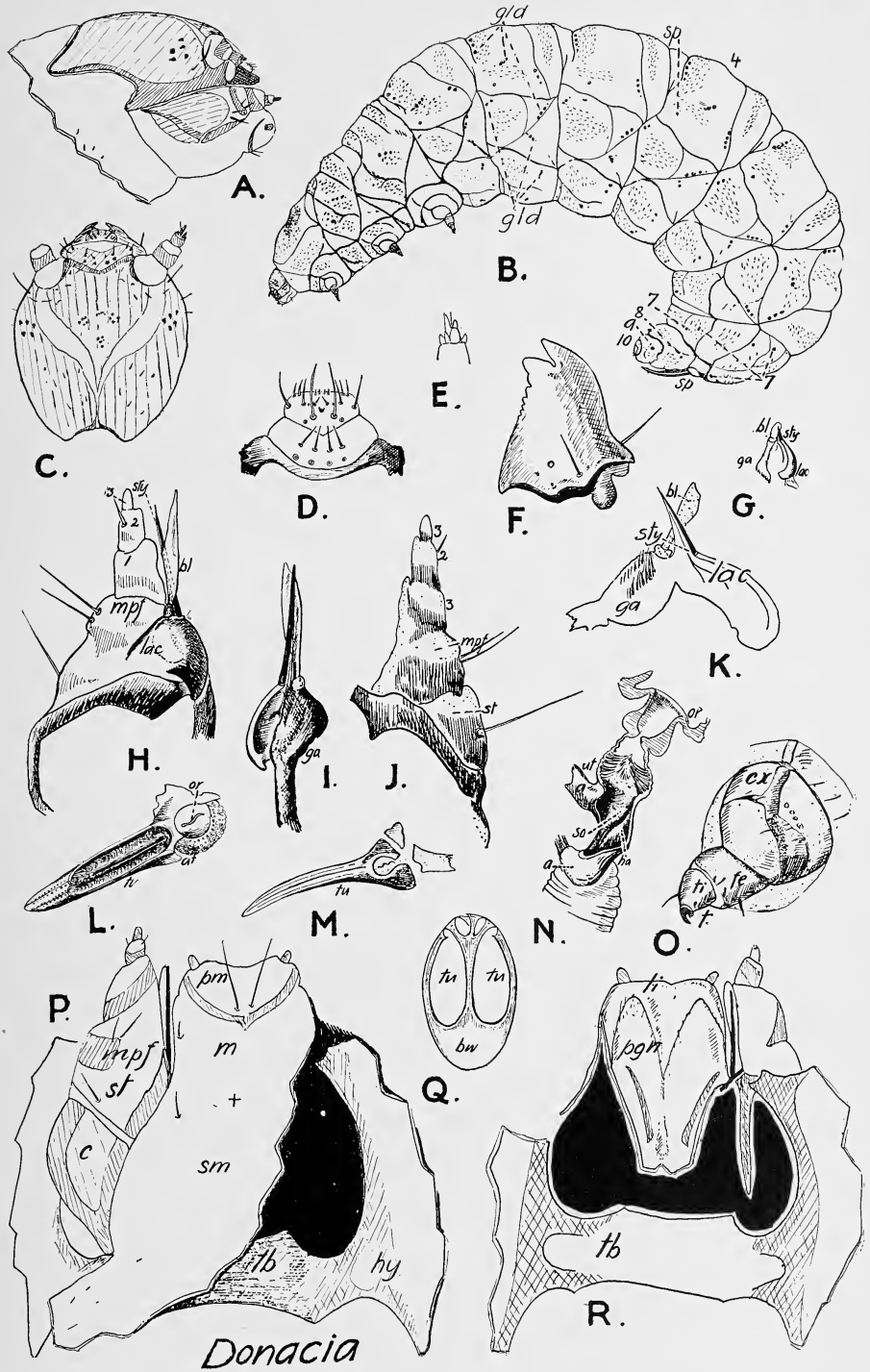
H.

Zeugophora

Plate 106

Donaciidae

A. Donacia sp. : Head. Lateral view.
B. " " : Larva. Lateral view.
C. " " : Head. Dorsal view.
D. Donacia marginata Hoppe (Denmark) : Labrum, clypeus, epistoma.
E. " " : Tip of antenna.
F. " " : Right mandible. Dorsal view.
G. Plateumaris braccata Scop. (Denmark) : Tip of maxilla. Dorsal view.
H. Donacia crassipes F. (Denmark) : Distal part of maxilla; bl, blade; lac, lacinia; sty, stylus. Dorsal view. (Compare pl. 111 G; bl = *; sty = long seta).
I. " " : Lacinia with stylus, and galea with blade. Ventral view.
J. " " : Maxillary stipes with palpus.
K. Donacia marginata : Mala; split open.
L. Donacia marginata : Hook shaped eighth abdominal spiracle; showing opened tubes and atrium.
M. " " : Hook shaped eighth abdominal spiracle; intact.
N. " " : Longitudinal section of annular fourth abdominal spiracle and closing apparatus; ha, hard fold of closing apparatus against which soft fold from opposite wall of trachea is pressed when the closing muscle between the arms is contracted.
O. Donacia sp. : Leg.
P. " " : Ventral mouthparts.
Q. " " : Cross-section of hook of eighth abdominal spiracle; bw, prolongation from body wall.
R. " " : Ventral mouthparts. Dorsal view.


A.
gld
sp
4
gld
B.
7
8
9
10
sp
7
C.
E.
D.
F.
bl
sty
ga
lac
G.
sty
bl
lac
ga
K.
sty
bl
mpf
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H.
ga
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st
J.
or
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+
sm
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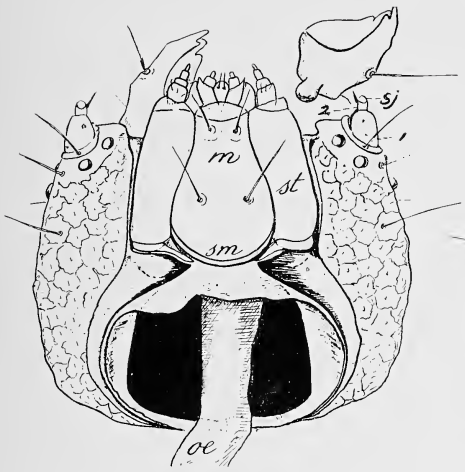
ti
pgm
tb
R.
Donacia

Plate 107

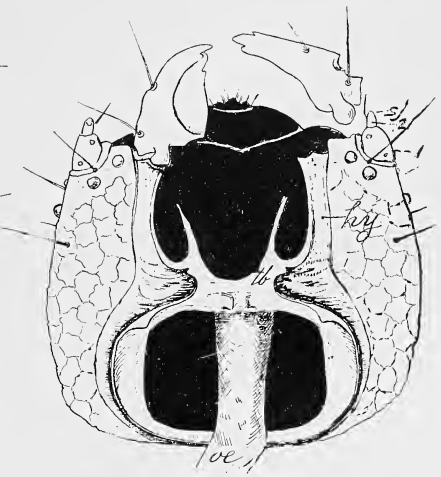
Camptosomatidae-Chlamydinae (G, H)

Camptosomatidae-Clytrinae (A–F)

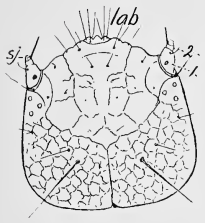
A. Clytra quadripunctata L. (Denmark) : Head. Ventral view.
B. " " : Head with ventral mouthparts removed. Ventral view.
C. " " : Head; sj, pillbox shaped sensory appendix of antennal tip. Dorsal view.
D. " " : Hypopharynx and ventral mouthparts. Lateral view.
E. " " : Hypopharynx and ventral mouthparts. Dorsal view.
F. " " : Larva. Lateral view.
G. Chlamys gibbosa F. : Anterior portion of head; sj, conical sensory appendix of antenna. Dorsal view.
H. " " : Head and prothorax. Lateral view.



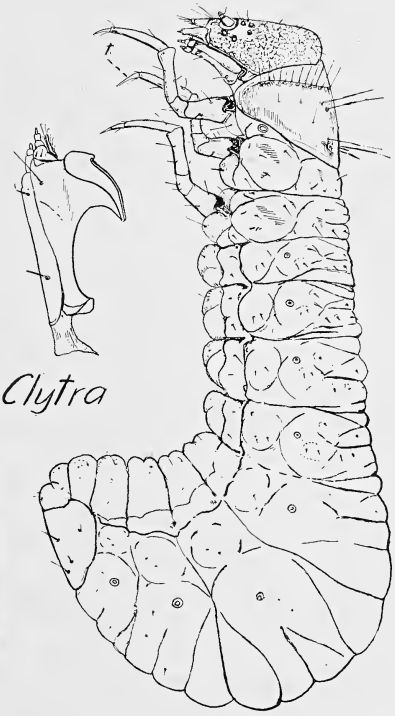
A. *Clytra*



B. *Clytra*



C. *Clytra*

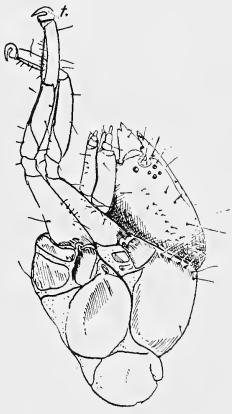


D. *Clytra*

G. *Chlamys*

E. *Clytra*

F. *Clytra*

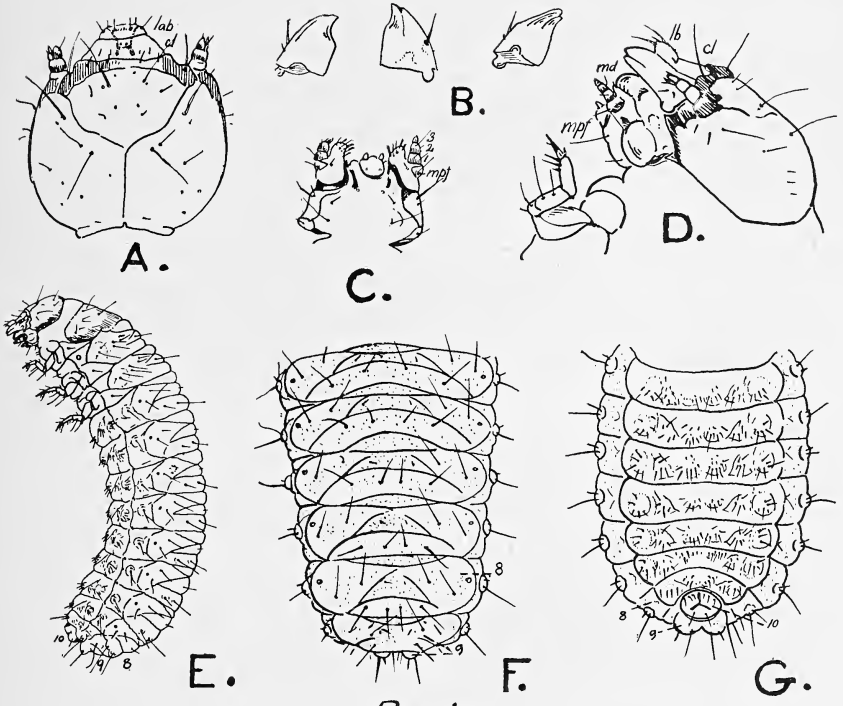


H. *Chlamys*

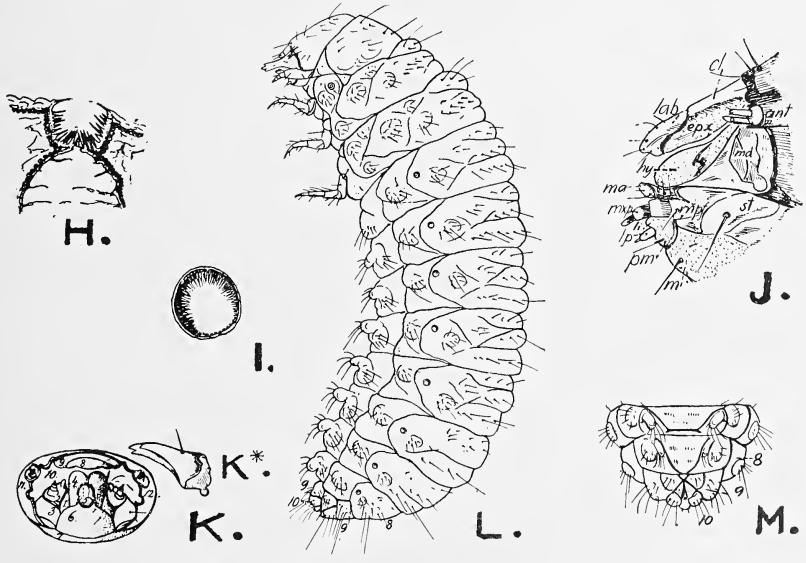
Plate 108

Eumolpidae

A. Paria canella F. : Head. Dorsal view.
B. " " : Left mandible. Dorsal, ventral, and tilted for basi-dorsal view.
C. " " : Ventral mouthparts. Ventral view.
D. " " : Head and prothorax. Lateral view.
E. " " : Larva. Lateral view.
F. " " : Abdomen. Dorsal view.
G. " " : Abdomen. Ventral view.
H. Chrysochus auratus F.: Annular spiracle. Longitudinal section.
I. " " : Annular spiracle. Exterior view.
J. " " : Anterior portion of head; distal end of mandible removed to show epipharynx, hypopharynx, and maxillary mala.
K. " " : Diagram of buccal structures; 1, membrane between maxilla and hypopharynx; 2, maxillary palpiger; 3, stipes; 4, hypopharynx; 5, prementum; 6, mentum; 7, body; 8, labrum; 9, clypeus; 10, place of the removed mandible; 11, antenna; 12, epicranium.
K.* " " : Mandible.
L. " " : Larva. Lateral view.
M. " " : End of abdomen. Ventral view.



Paria



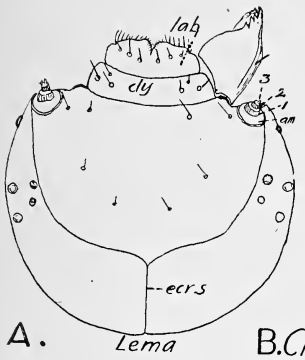
Chrysochus

Plate 109

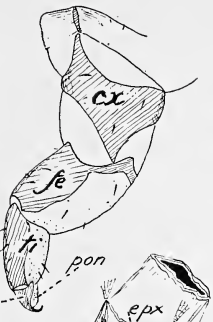
Crioceridae (A–G)

Chrysomelidae (H–M)

A. Lema sp. : Head. Dorsal view.
B. Crioceris asparagi L. : Leg.
C. " " : Thoracic biforous spiracle.
D. " " : Buccal cavity with epipharynx above, and hypopharynx and the ventral mouthparts below. Anterior view.
E. " " : Head capsule. Ventral view.
F. " " : Ventral mouthparts. Ventral view.
G. " " : Larva. Lateral view.
H. Gastroidea cyanea Melsh. : Head. Dorsal view.
I. " " : Head. Ventral view.
J. " " : Left mandible. Ventral view.
K. " " : Right maxilla. Ventral view.
L. " " : Larva. Lateral view.
M. " " : Leg.

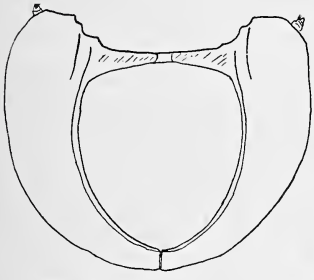


A. Lema

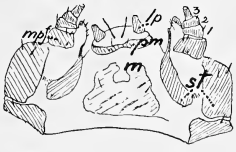


B. Crioceris

D. Crioceris

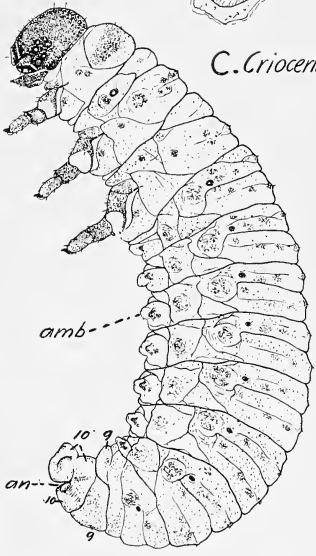


E. Crioceris

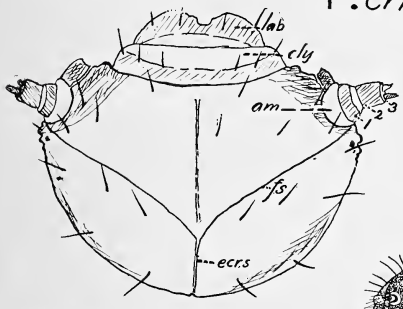


F. Crioceris

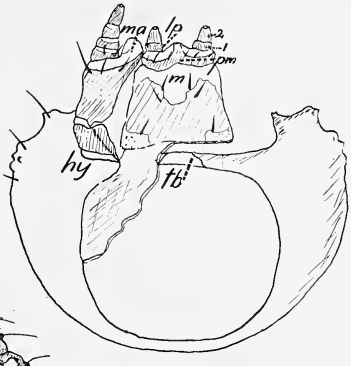
C. Crioceris



G. Crioceris



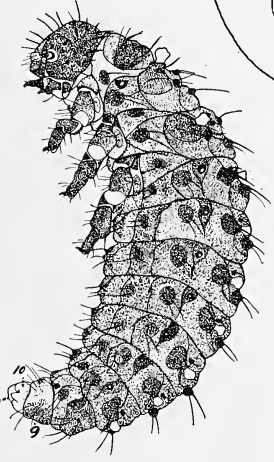
H. Gastroidea



I. Gastroidea

K. Gastroidea

J. Gastroidea



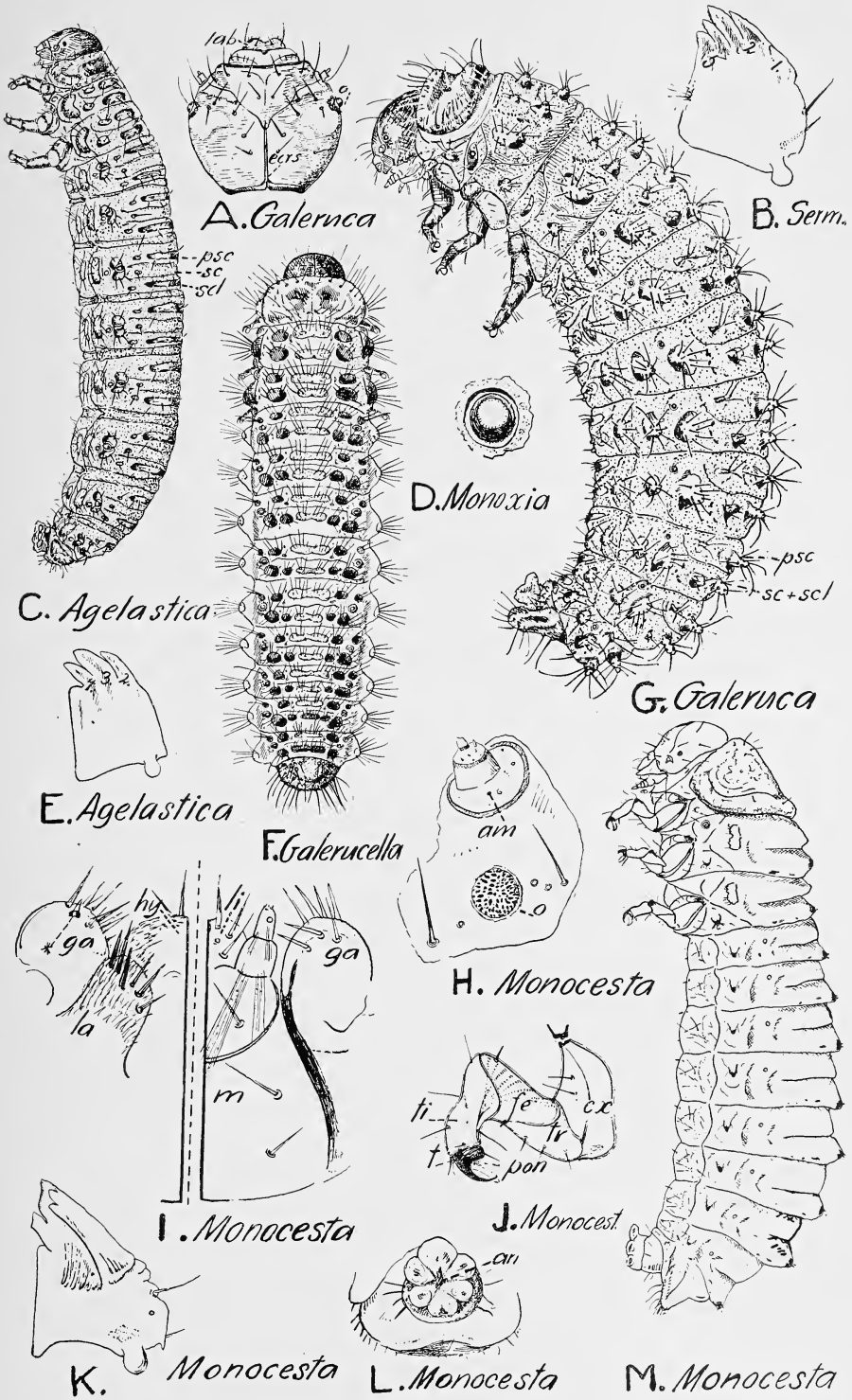
L. Gastroidea

M. Gastroidea

Plate 110

Galerucidae-Galerucinae

A. Galeruca tanaceti L. (Denmark) : Head. Dorsal view.
B. Sermylassa halensis L. (Denmark) : Left mandible. Ventral view.
C. Agelastica alni L. (Denmark) : Larva. Lateral view.
D. Monoxia consputa Lec. : Spiracle.
E. Agelastica alni : Left mandible. Ventral view.
F. Galerucella luteola Müller : Larva. Dorsal view.
G. Galeruca tanaceti : Larva. Lateral view.
H. Monocesta coryli Say : Antenna and ocellus.
I. " " : Left figure, showing lacinia, galea and hypopharynx facing the buccal cavity; right figure, showing galea, mentum, and labium viewed from below.
J. " " : Leg.
K. " " : Left mandible. Ventral view.
L. " " : Tenth abdominal segment from below, showing anus in center and six anal lobes.
M. " " : Larva. Lateral view.


lab.
ecrs
A. Galeruca
B. Serm.
psc
sc
scl
C. Agelastica
D. Monoxia
psc
sc+scl
G. Galeruca
E. Agelastica
F. Galerucella
am
o
H. Monocesta
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I. Monocesta
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J. Monocest
an
K. Monocesta
L. Monocesta
M. Monocesta

Plate 111

Galerucidae-Diabroticinae

A. Phyllobrotica quadrimaculata L. (Denmark) : Head, prothorax and mesothorax. Dorsal view.

B. " " : Larva. Lateral view.

C. Diabrotica duodecimpunctata Fab. : Left mandible. Ventral view.

D. " " : Head capsule. Dorsal view.

E. Phyllobrotica quadrimaculata : End of abdomen. Dorsal view.

F. Diabrotica duodecimpunctata : Pulvillus on posterior side of tarsungulus.

G. " " : Ventral mouthparts. Dorsal view (left figure); ventral view (right figure).

H. Diabrotica longicornis Say : End of abdomen. Dorsal view.

I. Diabrotica duodecimpunctata : End of abdomen. Dorsal view.

J. Diabrotica vittata F. : End of abdomen. Lateral view.

K. Diabrotica duodecimpunctata : Anterior part of larva. Lateral view.

L. Diabrotica vittata : End of abdomen. Dorsal view.

M. Exosoma lusitanica L. (Marocco) : Anterior part of larva. Lateral view.

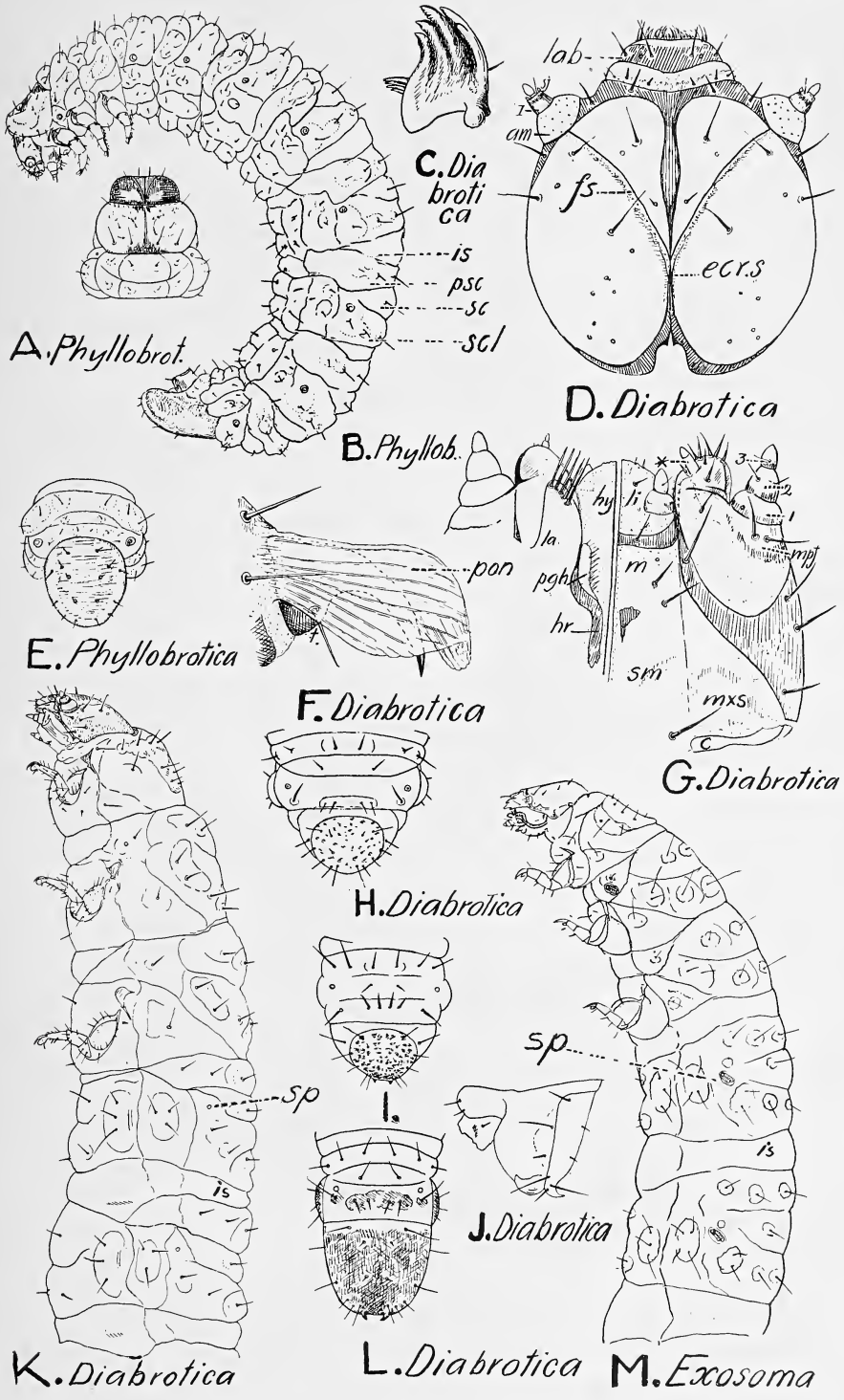
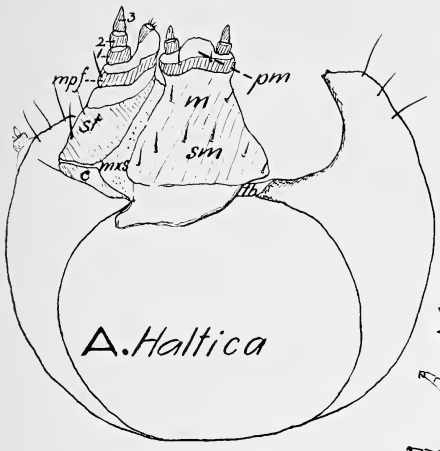

A. Phyllobrot.
is
psc
sc
scl
C. Diabrotica
lab
am
fs
ecrs
D. Diabrotica
B. Phyllob.
hy
li
la
pgh
m
hr
stm
mxs
mpl
pon
E. Phyllobrotica
F. Diabrotica
G. Diabrotica
H. Diabrotica
sp
is
I.
J. Diabrotica
K. Diabrotica
L. Diabrotica
M. Exosoma

Plate 112

Galerucidae-Halticinae

A. Haltica bimarginata Say : Head. Ventral view.
B. " " : Left maxilla.
C. Longitarsus menthaphagus Gentner : Antenna.
D. " " : Left mandible.
E. " " : Peglike appendix of galea.
F. " " : Distal end of maxilla.
G. Chaetocnema (denticulata Ill.?) : Anterior part of larva.
H. Longitarsus menthaphagus : Anterior part of larva.
I. " " : Larva. Dorsal view.
J. Phyllotreta armoraciae Koch (Denmark) : Anterior part of larva.
K. Chaetocnema (denticulata?) : Larva. Dorsal view.
L. Blepharida rhois Forst. : Spiracle.
M. Psylliodes chrysocephala L. : Head. Dorsal view.
N. " " : Larva. Lateral view. (Copy from figure by George H. Carpenter, 1906).
O. Blepharida rhois : Right maxilla.
P. Phyllotreta armoraciae : Posterior end of body. Dorsal view.
Q. Blepharida rhois : Mandible.
R. " " : Larva; notice the dorsal position of anus as in Crioceris (pl. 109G).
R.* " " : Sucking disk; without an anal opening in the center.



A. *Haltica*

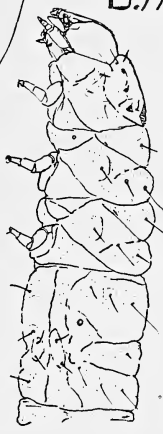
B. *Halt.*

C. *Longit.*

D. *Longitars.*

E. *Lon.*

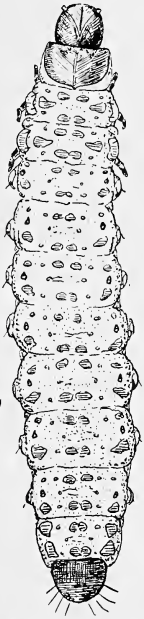
F. *Long.*



H. *Longitarsus*

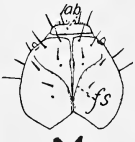
I. *Longitars.*

G. *Chaetocnema*



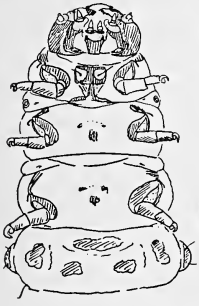
K. *Chaeto.*

N.



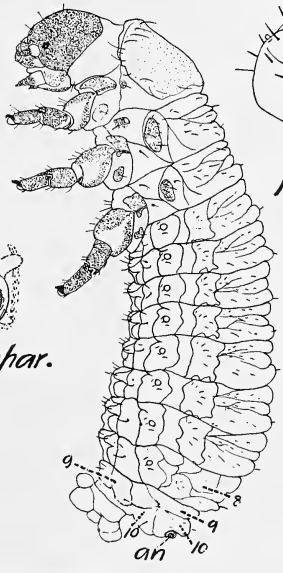
M.

Psylliodes



J. *Phyll.*

L. *Blephar.*



O. *Blep.*

P. *Phyllotreta*

Q. *Blepharida*

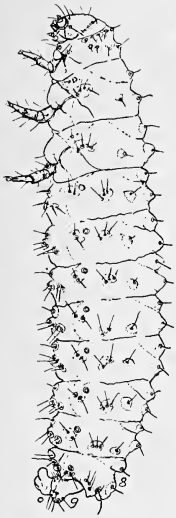
R. *Blepharida*

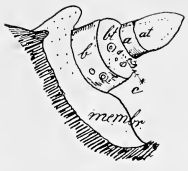
R*.

Plate 113

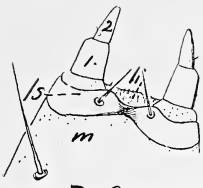
Galerucidae-Halticinae

A. Oedionychis gibbitarsa Say : Antenna; a, ring shaped sclerome at base of the tactile appendix; at, membranous part of tactile appendix; b, first antennal joint; c, rudiment of second joint.
B. " " : Tip of labium.
C. " " : Distal part of maxilla.
D. " " : Eighth and ninth abdominal segments. Dorsal view.
E. " " : Larva. Lateral view.
F. " " : Mandible. Ventral view.
G. " " : Last abdominal segments. Ventral view.
H. Disonycha xanthomelaena Dalm. : End of body. Lateral view.
I. Phydanis bicolor Horn. : Head. Dorsal view.
J. Mantura floridana Cr. : Left mandible.
K. " " : Tip of maxillary mala with peg indicating galea, lacinia absent.
L. Phydanis bicolor : Eighth and ninth abdominal segments. Dorsal view.
M. Mantura filoridana : Tip of leg.
N. Phydanis bicolor : Larva. Lateral view.
O. Mantura floridana : Larva. Lateral view.
P. " " : Ventral mouthparts.
Q. " " : Larva. Dorsal view.
R. Argopistes scyrtoides Lec. : Mandible. Buccal view.
S. " " : Head. Dorsal view.
T. " " : Thorax and first abdominal segment. Dorsal view.
U. " " : Thorax and first abdominal segment. Ventral view.
V. " " : End of body. Ventral view.
X. " " : Ventral mouthparts.

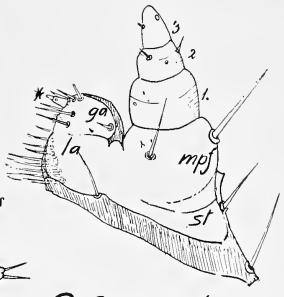




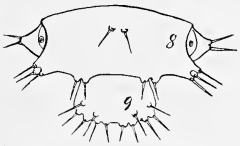
A. *Oedionychis*



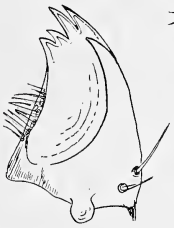
B. *Oedionychis*



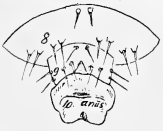
C. *Oedionychis*



D. *Oedionychis*



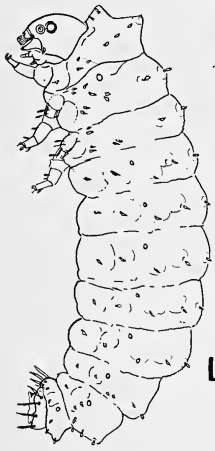
F. *Oedionychis*



G. *Oedionychis*

E. *Oedionychis*

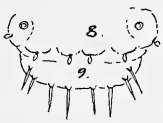
H. *Disonycha*



I. *Phydanis*

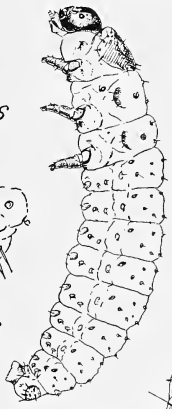
J.

K. *Mant.*



L. *Phydanis*

M.



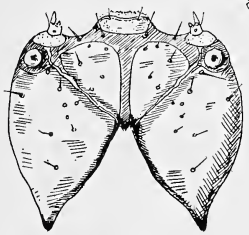
N. *Phydanis*

O. *Mantura*

Q. *Mant.*

P. *Mantura*

R. *Argo*



S. *Argopistes*

T. *Argopistes*

U.

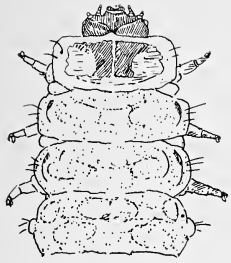
V.

X. *Argopistes*

Plate 114

Galerucidae-Halticinae

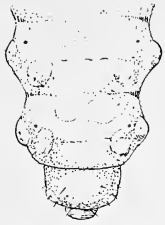
A. Dibolia cynoglossi Koch (Denmark) : Antenna.
B. " " : Anterior part of body. Dorsal view.
C. " " : Left mandible. Ventral view.
D. " " : Posterior end of body. Dorsal view.
E. Dibolia borealis Chev. : Posterior end of body. Dorsal view.
F. Dibolia cynoglossi : Anterior end of body. Ventral view.
G. " " : Head. Dorsal view.
H. Dibolia borealis : Head. Ventral view.
I. Sphaeroderma testaceum F. (Denmark) : Head; notice shape of frons and large ocelli. Dorsal view.
J. Sphaeroderma testaceum F. : Leg.
K. " " : Antenna.
L. " " : Larva. Dorsal view.
M. " " : Left mandible. Ventral view.
N. " " : Ventral mouthparts. Ventral view.
O. " " : Mala maxillaris.



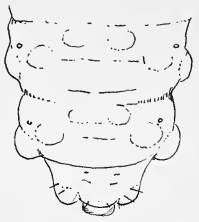
B. *Dibolia*

A. *Dibol.*

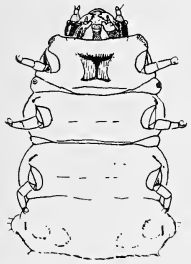
C. *Dibolia*



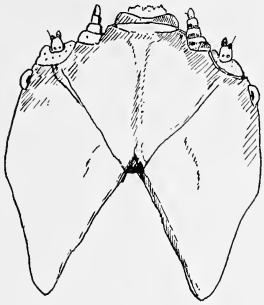
D. *Dibolia*



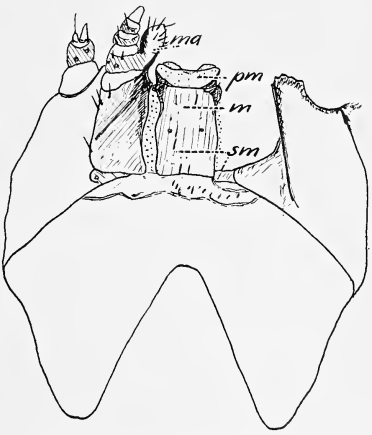
E. *Dibolia*



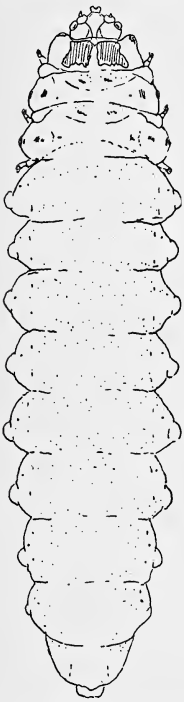
F. *Dibolia*



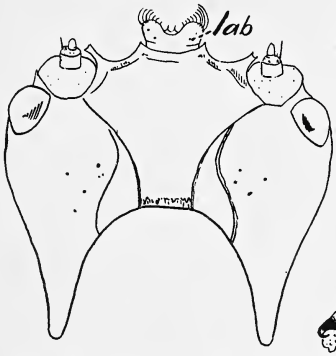
G. *Dibolia*



H. *Dibolia*

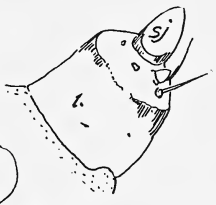


L. *Sphaeroderma*



I. *Sphaeroderma*

J. *Sphaeroderma*



K. *Spaeroderma*

M. *Sphaer.*

N. *Sphaer.*

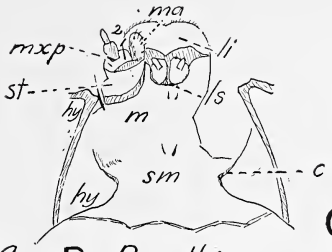
O. *Sphaer.*

Plate 115

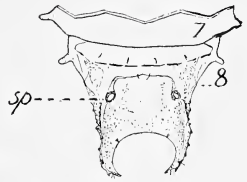
Hispidae

A. Bronthispa frogatti Sharp (Solomon Isl.) : Right mandible. Ventral view.
B. " " : Ventral mouthparts. Ventral view.
C. " " : Posterior end of abdomen. Dorsal view.
D. Chalepus ater Weise : Eighth abdominal spiracle.
E. Bronthispa frogatti : Head. Dorsal view.
E.* " " : Ocelli. Lateral view.
F. Chalepus ater : Mesothoracic leg.
G. " " : Larva. Dorsal view.
G.* " " : Ocelli. Lateral view.
H. " " : Distal end of leg.
I. Octotoma plicatula F. : Head. Dorsal view.
I.* " " : Ocelli. Lateral view.
J. Arescus monoceros Oliv. (Porto Bello, Panama) : Larva. Dorsal view.
K. Octotoma plicatula : Ventral mouthparts. Ventral view.

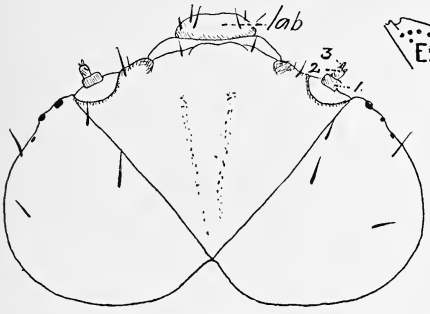
A. *Bronthispa*



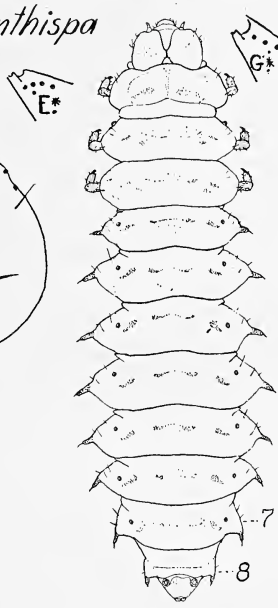
B. *Bronthispa*



C. *Bronthispa*

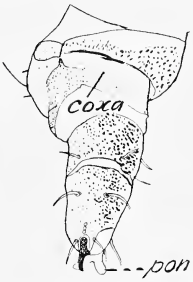


E. *Bronthispa*



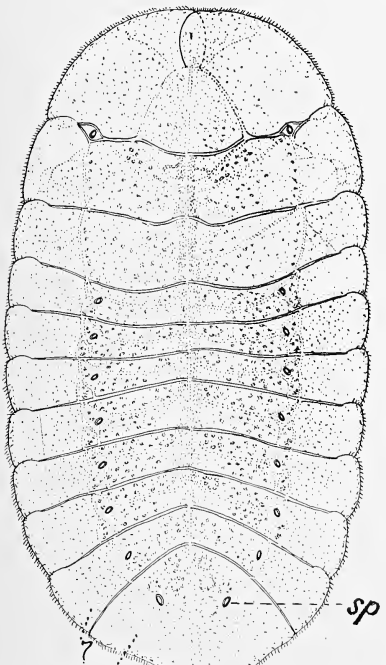
G. *Chalepus*

D. *Chalepus*

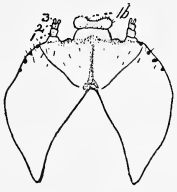


F. *Chalepus*

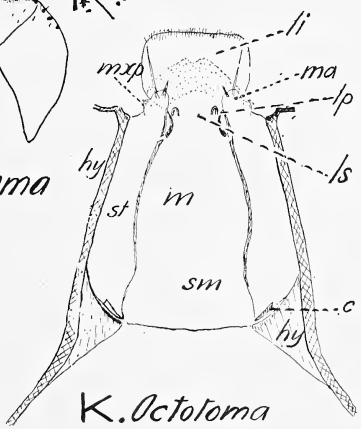
H. *Chalepus*



J. *Arescus*



I. *Octotoma*

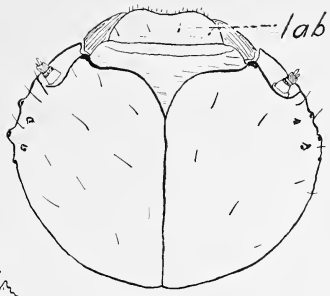


K. *Octotoma*

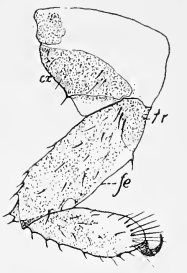
PLATE 116

Cassididae

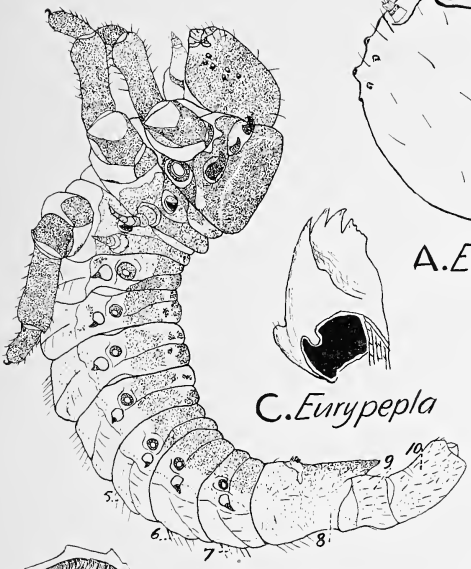
A. Eurypepla jamaicensis L. : Head. Dorsal view.
B. " " : Leg.
C. " " : Right mandible. Ventral view.
D. " " : Larva. Lateral view.
E. " " : Spiracle.
F. " " : Ventral mouthparts. Ventral view.
G. Cassida nebulosa L. : Larva. Lateral view.
H. Porphyraspis cyanea Say : Ball of excrement covering larva.
I. " " : Detail of excrement strand.



A. *Eurypepla*



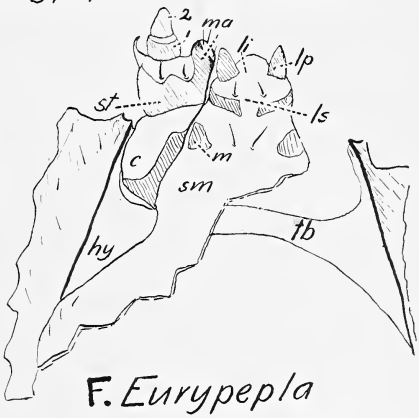
B. *Eurypepla*



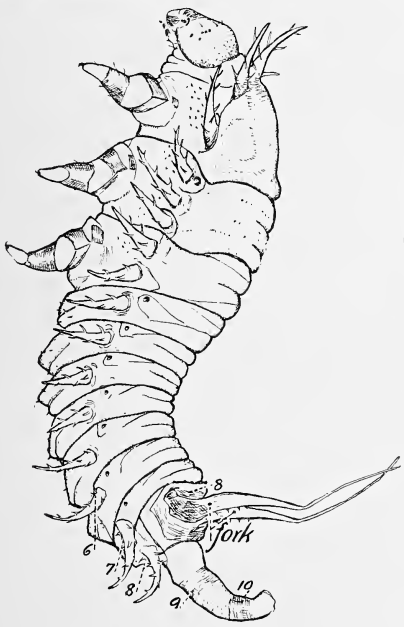
C. *Eurypepla*

D. *Eurypepla*

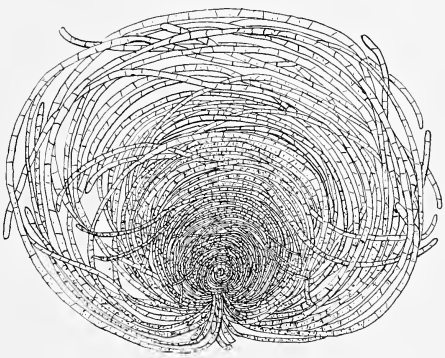
E. *Eurypepla*



F. *Eurypepla*



G. *Cassida*



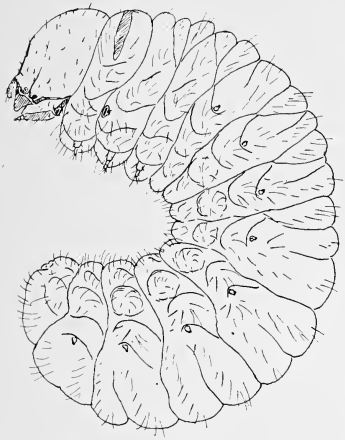
H. *Porphyraspis*

I. *Porphyraspis*

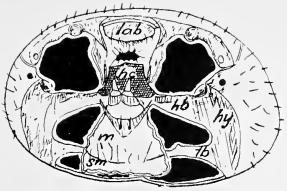
Plate 117

Platystomidae-Brachytarsinae (A–K),
Platystomidae-Choraginae (L–Q)

A. Euparius marmoreus Oliv. : Head. Front view.
B. " " : Abdominal spiracle.
C. " " : Larva. Lateral view.
D. " " : Head. Ventral view.
E. " " : Epipharyngeal and hypopharyngeal regions. Lateral view.
F. " " : Right mandible. Ventral view.
G. " " : Right mandible. Dorsal view.
H. Brachytarsus limbatus Say : Left mandible. Ventral view.
I. Eurymycter fasciatus Oliv. : Antenna.
J. " " : Distal end of maxilla.
K. Brachytarsus limbatus : Right maxilla. Ventral view.
L. Araecerus fasciculatus DeG. : Epipharynx.
M. " " : Distal end of maxilla. Dorsal view.
N. " " : Thoracic spiracle.
O. " " : Larva; plb, pedal lobe. Lateral view.
P. " " : Right mandible. Dorsal view.
Q. " " : Antenna, ocellus, hypopharyngeal chitinization, labial palpus.

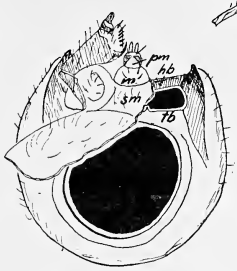


C. *Euparius*

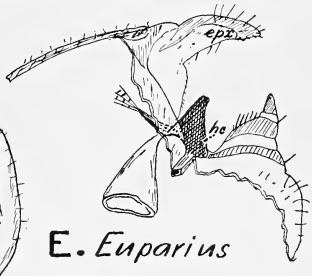


A. *Euparius*

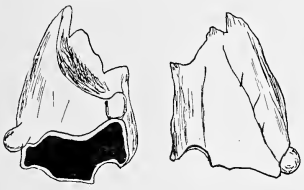
B. *Euparius*



D. *Euparius*

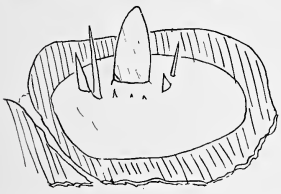


E. *Euparius*

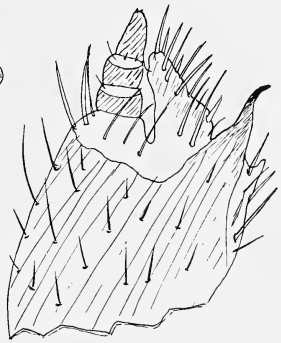


F. *Euparius* G. *Euparius*

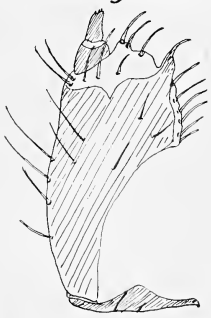
H. *Brachytarsus*



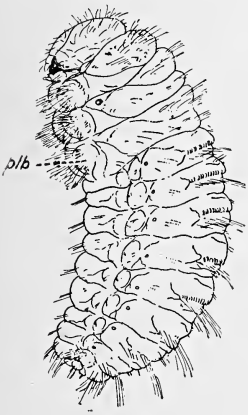
I. *Eurymycter*



J. *Eurymycter*



K. *Brachytarsus*



O. *Araecerus*

L. *Araecerus*

M. *Araecerus*

N. *Araecerus*

P. *Araecerus*

Q. *Araecerus*

Plate 118

Brenthidae,

Attelabidae-Rhynchitinae

A. Eupsalis minuta Drury (changed in Junk Col. Cat., 1927, by R. Kleine to Platysystrophus minutus Drury) : Diagrammatic section through median region of head. Sagittal cut.

B. Eupsalis minuta : Head. Ventral view.

C. " " : Thoracic segments. Ventral view.

D. " " : Larva. Lateral view.

E. " " : Spiracle.

F. " " : Right mandible. Ventral view.

G. " " : Right maxilla. Ventral view.

H. Rhynchites aeneus Boh. : Larva. Lateral view.

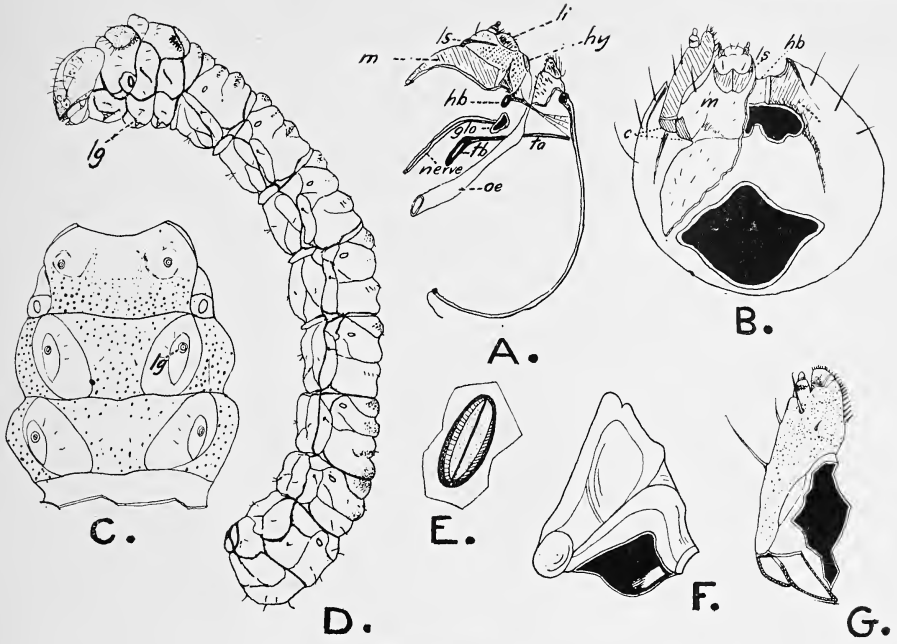
I. " " : Head. Dorsal view.

J. " " : Head. Ventral view.

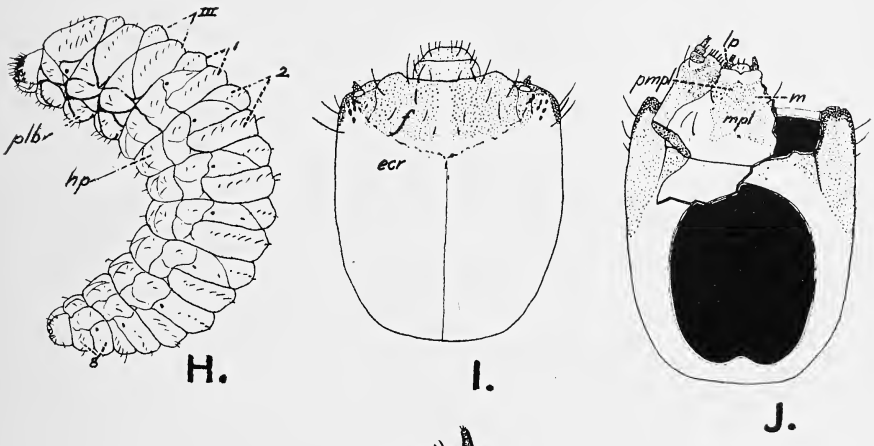
K. " " : Right mandible. Ventral view.

L. " " : Left maxilla. Ventral view.

M. " " : Spiracle (outline).



Enpsalis

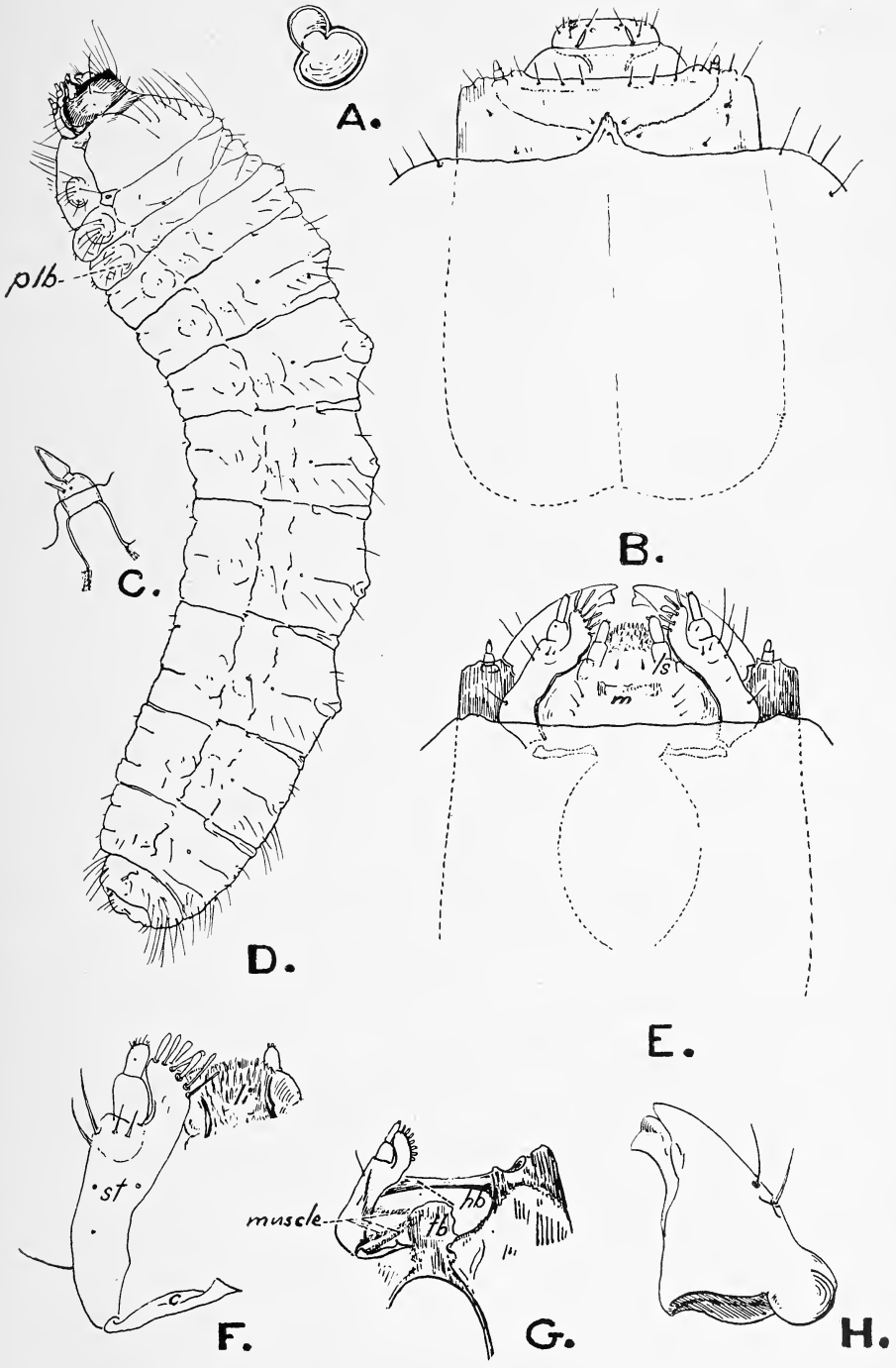


Rhynchites

Plate 119

Proterhinidae

A. Proterhinus anthracias Perkins (Kauai; Hawaii) : Mesothoracic spiracle.
B. " " : Head. Dorsal view.
C. " " : Antenna.
D. " " : Larva. Lateral view.
E. " " : Head. Ventral view.
F. " " : Right maxilla. Ventral view.
G. " " : Hypopharyngeal bracon, tentorium and right maxilla.
H. " " : Left mandible. Ventral view.



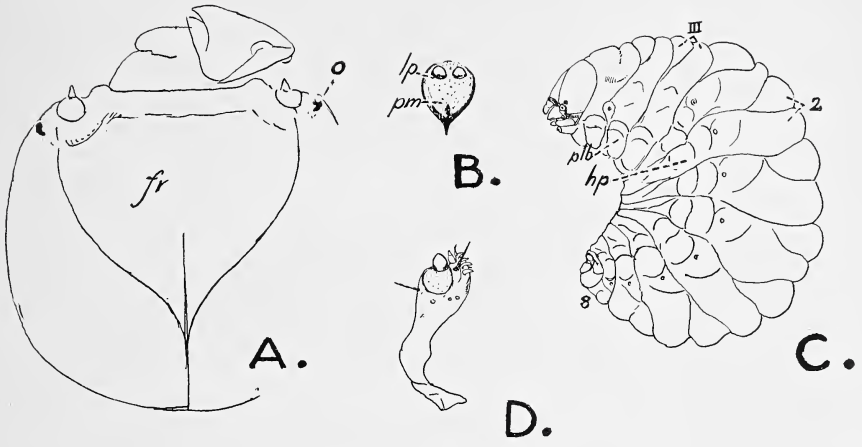
Proterhinus

PLATE 120

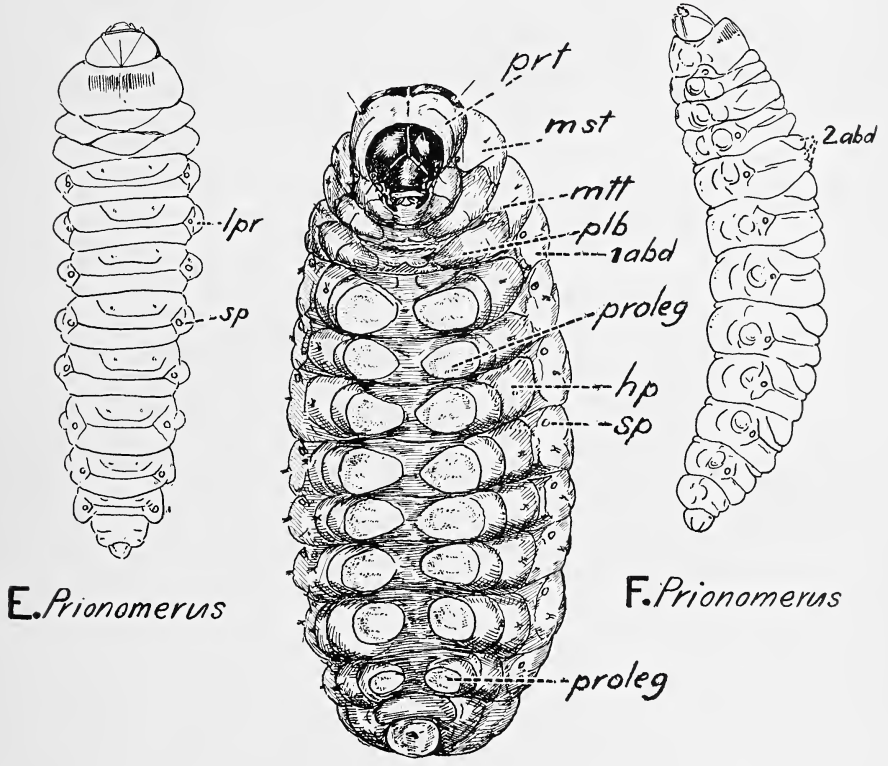
Apionidae (A–D),

Curculionidae-Curculioninae (E–G)

A. Podapion gallicola Riley : Head. Dorsal view.
B. " " : Prementum with labial palpi.
C. " " : Larva. Lateral view.
D. " " : Right maxilla. Ventral view.
E. Prionomerus calceatus Say : Larva; lpr, lateral process. Dorsal view.
F. " " : Larva. Lateral view.
G. Cionus scrophulariae L. (Denmark) : Larva. Ventral view.



Podapion



G. Cionus

Plate 121

Curculionidae

A. Lixus scrobicollis Boh. : Labrum and clypeus.
B. " " : Antenna.
C. " " : Abdominal spiracle.
D. " " : Left mandible. Ventral view.
E. " " : Antenna and two ocelli.
F. Balaninus sp. : Ventral mouthparts and tentorium. Ventral view.
G. Lixus scrobicollis : Larva. Lateral view.
H. " " : Ventral mouthparts. Ventral view.
I. " " : Ventral mouthparts. Dorsal view.
J. Geraeus penicellus Herbst. : Antenna.
K. " " : Epipharynx, hypopharynx, mandible from below, and oesophagus.
L. " " : Mandible. Buccal view.
M. " " : Ventral mouthparts. Ventral view.
N. " " : Ventral mouthparts and hypopharyngeal region.
O. Heilipus perseae Barber (Panama, C. Z.) : Anterior part of larva. Lateral view.
P. Cossonus sp. (Hopk. U. S. 10079j) : Larva. Lateral view.
Q. " " : Ventral mouthparts. Ventral view.
R. Naupactus sp. (Chili) : Right mandible. Exterior view.
S. " " : Larva. Lateral view.
T. " " : Head; co, skin connecting head and prothorax. Ventral view.
U. Phelypera distigma Boh. (Guatemala) : Larva. Lateral view.

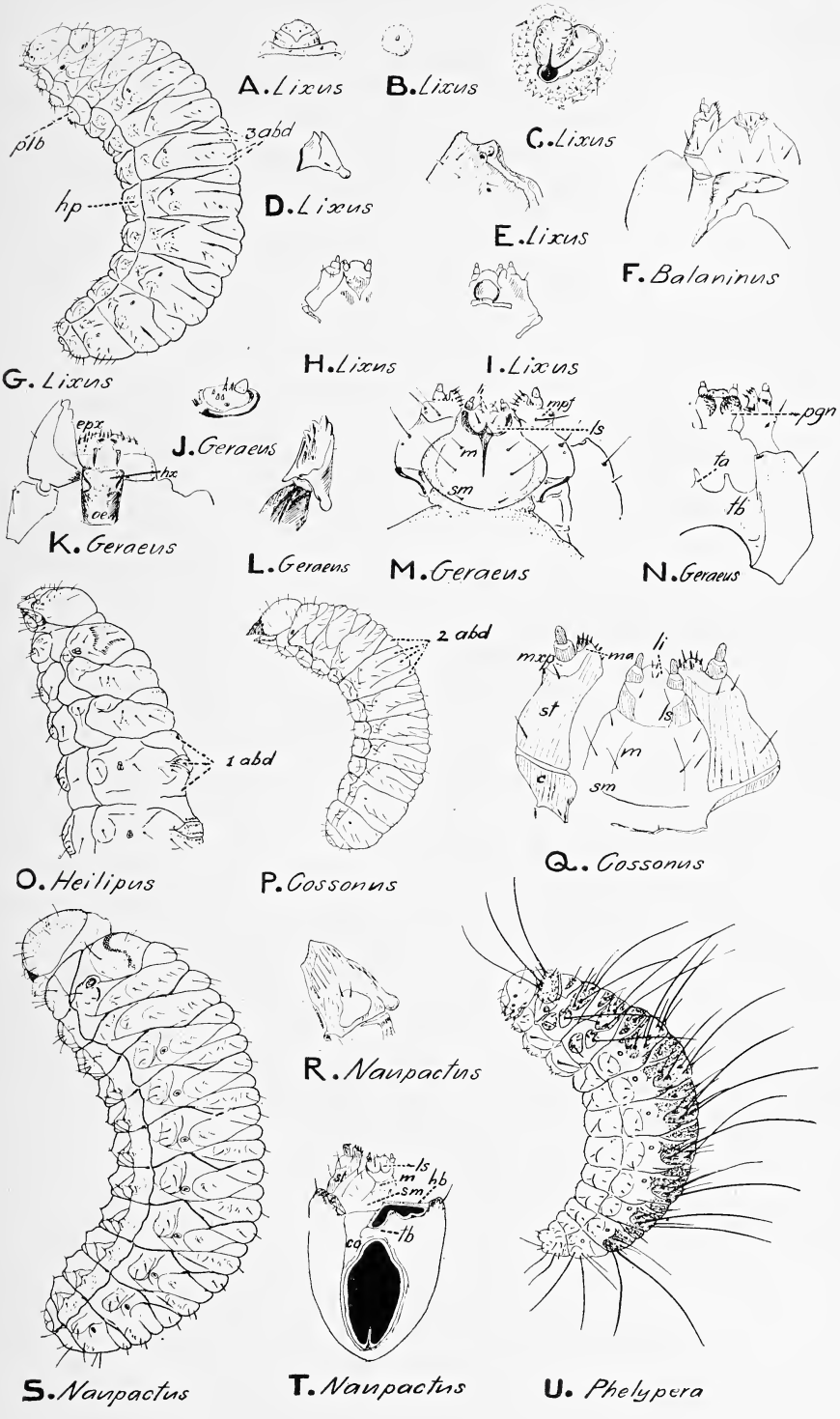
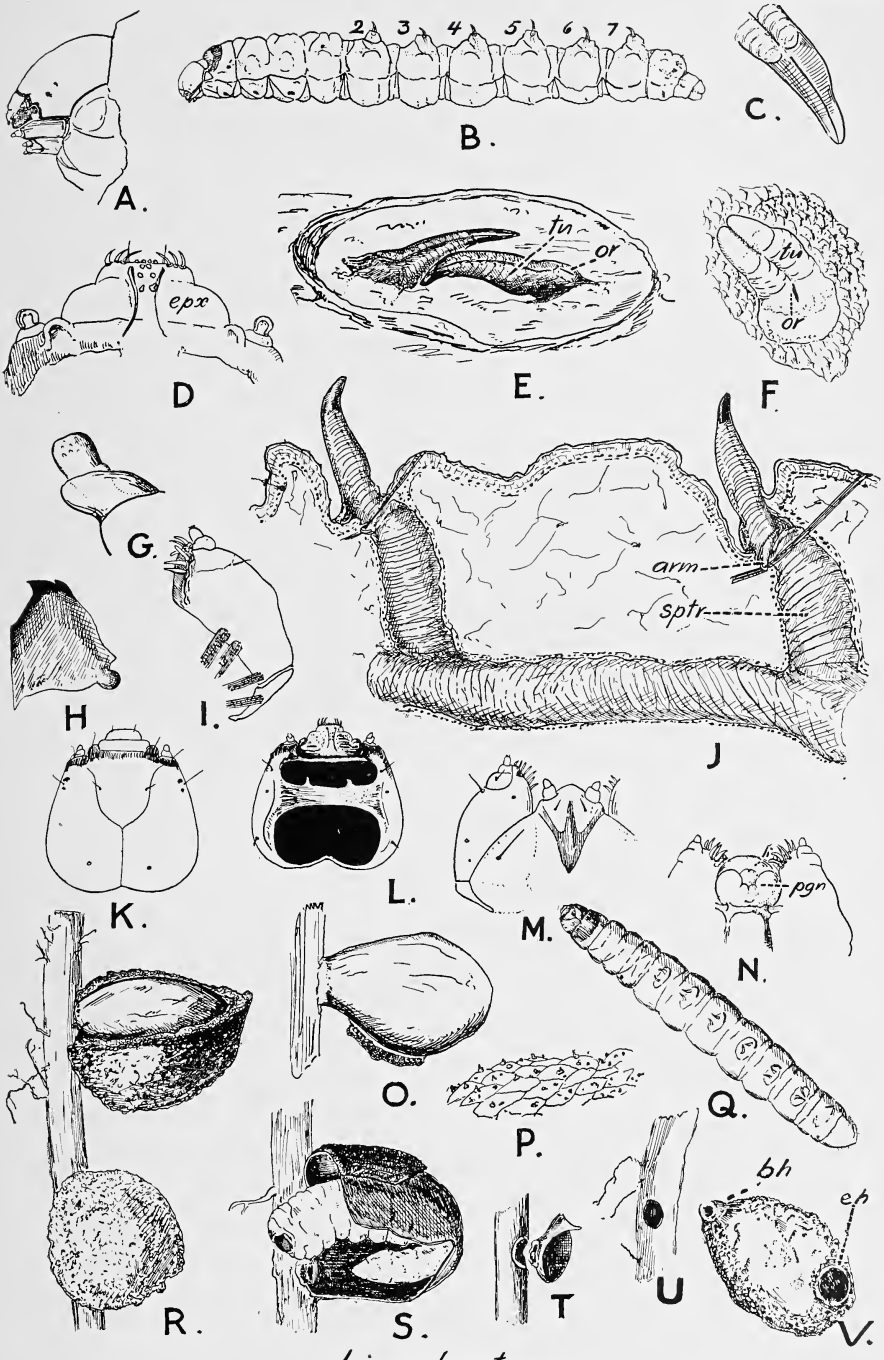

A. Lixus
B. Lixus
C. Lixus
D. Lixus
E. Lixus
F. Balaninus
G. Lixus
H. Lixus
I. Lixus
J. Geraeus
K. Geraeus
L. Geraeus
M. Geraeus
N. Geraeus
O. Heilipus
P. Cossonus
Q. Cossonus
R. Naupactus
S. Naupactus
T. Naupactus
U. Phelypera
plb
3 abd
hp
epx
hx
oe
mpt
ls
m
sm
pgn
ta
tb
2 abd
1 abd
mxp
ma
li
st
c
co

Plate 122

Curculionidae-Lissorhoptrinae

A. Lissorhoptrus simplex Say : Head. Lateral view.
B. " " : Larva, showing a pair of hook-shaped spiracles on the back of second to seventh abdominal segments. Lateral view.
C. " " : Apex of dorsal spiracular hook.
D. " " : Epipharynx.
E. " " : A pair of spiracular hooks. Dorsal view.
F. " " : Eighth abdominal spiracle; not freely projecting.
G. " " : Antenna.
H. " " : Left mandible. Ventral view.
I. " " : Right maxilla. Buccal view.
J. " " : Spiracular hooks; tracheal branch to spiracle (sptr); tracheal stem and closing apparatus.
K. " " : Head. Dorsal view.
L. " " : Head. Ventral view.
M. " " : Ventral mouthparts.
N. " " : Hypopharyngeal region.
O. " " : Cocoon with mud cover removed.
P. " " : Epidermis from which the cocoon is exudated.
Q. " " : Larva. Dorsal view.
R. " " : Two cocoons; one with mud cover removed from upper half.
S. " " : Cocoon opened to show the larva in position and completely clean after having exudated the cocoon; notice the breathing hole gnawn into the submerged rice stem.
T. " " : Hole in stem and cocoon.
U. " " : Hole on side of stem.
V. " " : Cocoon showing breathing (bh) and emergence (eh) holes.

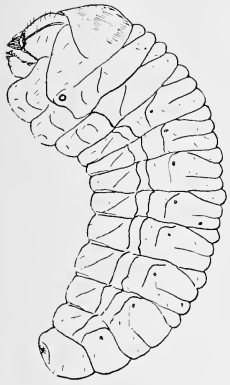


Lissorhoptrus

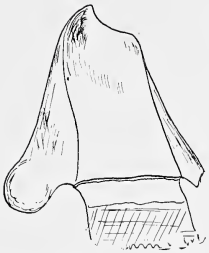
PLATE 123

Scolytidae (A–E),
Calendridae (F–H),
Platypodidae (I–P)

A. Scolytus muticus Say : Larva. Lateral view.
B. " " : Right mandible. Interior view.
C. " " : Mesothoracic spiracle.
D. " " : Head. Anterior view.
E. Dendroctonus valens Lec. : Larva. Lateral view.
F. Sitophilus granarius L. (= Calendra granaria L.) (Drawn by R. T. Cotton) : Hypopharyngeal region and ventral mouthparts. Buccal view.
G. Sitophilus granarius (Drawn by R. T. Cotton) : Spiracle.
H. Sitophilus granarius (Drawn by R. T. Cotton) : Larva. Lateral view.
I. Platypus compositus Say : Antenna.
J. " " : Left mandible. Ventral view.
K. " " : Larva. Lateral view.
L. " " : Head. Dorsal view.
M. " " : Mesothoracic spiracle.
N. " " : Ventral mouthparts. Ventral view.
O. " " : Head; mouthparts detached. Ventral view.
P. " " : Right maxilla. Dorsal view.

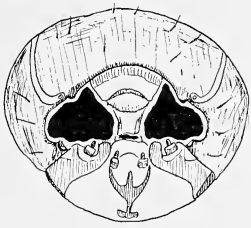


A. Scolytus

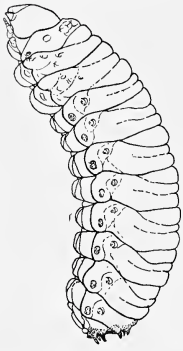


B. Scolytus

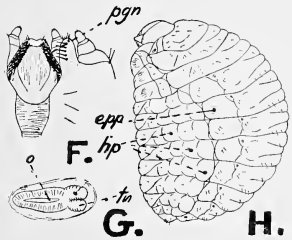
C. Scolytus



D. Scolytus

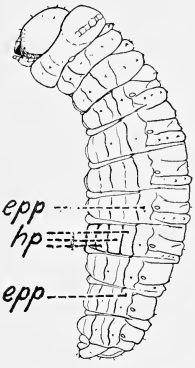


E. Dendroctonus



F. G. H.

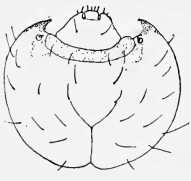
Sitophilus



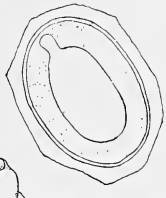
K. Platypus

I. Platypus

J. Platypus

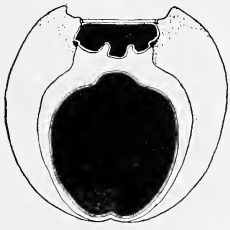


L. Platypus



M. Platypus

N. Platypus



O. Platypus

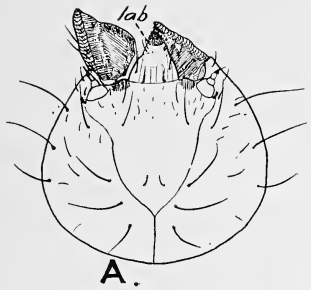
P. Platypus

Plate 124

Lymexylidae-Lymexylinae,

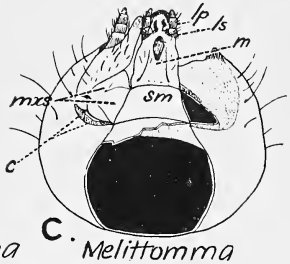
Lymexylidae-Hylecoetinae (H, L)

A. Melittomma sericeum Harris: Head. Dorsal view.
B. " " : Abdominal spiracle.
C. " " : Head. Ventral view.
D. " " : Left maxilla. Dorsal view.
E. " " : Hypopharyngeal region and ventral mouthparts. Dorsal view.
F. " " : Right mandible. Ventral view.
G. " " : Leg.
H. Hylecoetus lugubris Say : Left maxilla. Dorsal view.
I. Melittomma sericeum : Left maxilla. Lateral view.
J. " " : Tibia and tarsungulus.
K. " " : Prothorax and mesothorax. Ventral view.
L. Hylecoetus lugubris : Posterior end of abdomen; eppl, epipleural lobe.
M. Melittomma sericeum : Larva. Lateral view.



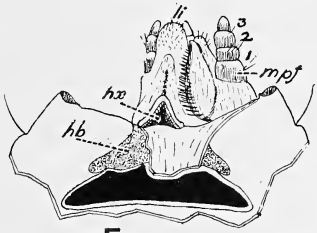
A. Melittomma

B. Melittomma

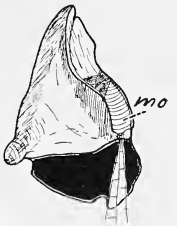


C. Melittomma

D. Melittomma

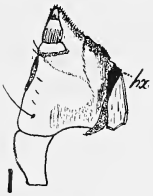


E. Melittomma

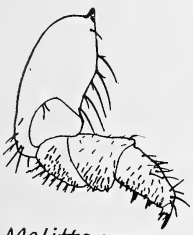


F. Melittomma

H. Hylecoetus

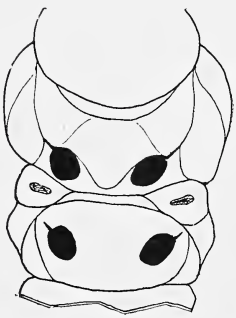


I. Melittomma

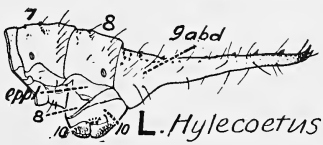


G. Melittomma

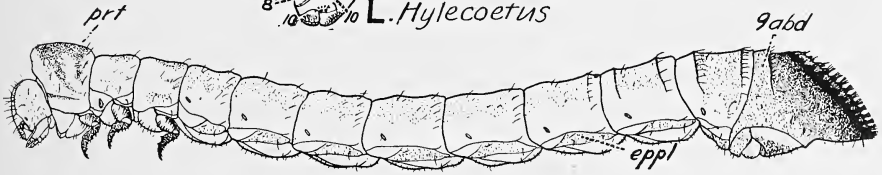
J. Melittomma



K. Melittomma



L. Hylecoetus



M. Melittomma

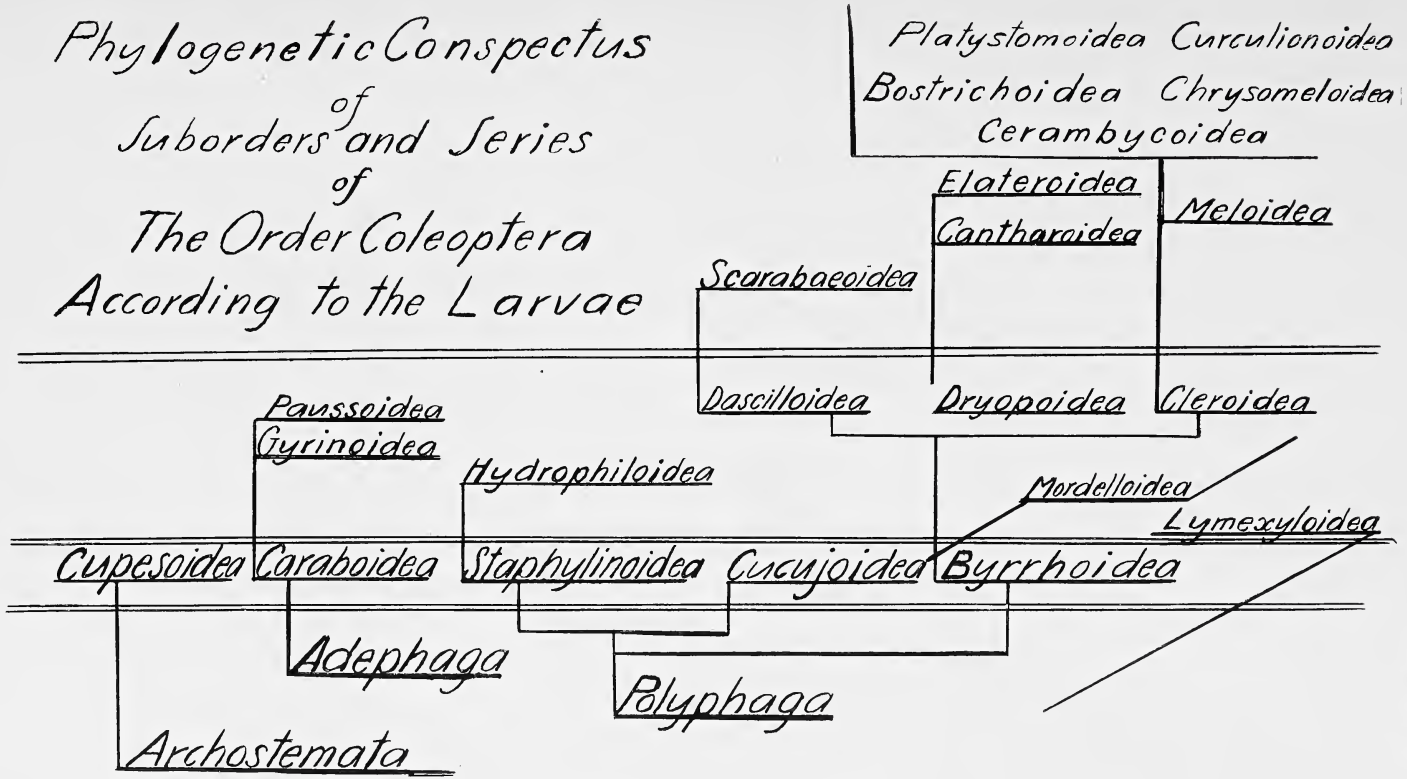

Phylogenetic Conspectus
of
Suborders and Series
of
The Order Coleoptera
According to the Larvae
Platystomoidea
Curculionoidea
Bostrichoidea
Chrysomeloidea
Cerambycoidea
Elateroidea
Meloidea
Cantharoidea
Scarabaeoidea
Dascilloidea
Dryopoidea
Cleroidea
Paussoidea
Gyrinoidea
Hydrophiloidea
Mordelloidea
Lymexyloidea
Cupesoidea
Caraboidea
Staphylinoidea
Cucujoidea
Byrrhoidea
Adephaga
Polyphaga
Archostemata

PLATE 125

INDEX

LIST OF ERRATA

(The changes should be made before using the book.)

Page 8, line 9. Insert before "the series Bostrichoidea": and from hypothetical cleroid ancestors or possibly directly from the Byrrhoidea may originate.

Page 8, line 27. For Melandryidae read: Synchroidae.

Page 9, line 7. For paragnathal read: maxillular.

Page 11, line 5. For individually read: usually.

Page 11, footnote 8. Insert before "some": Hydroscapha.

Page 12, footnote 14. For the entire footnote as it stands read: The larvae of the Catogenidae (pl. 33) are readily distinguished by their physogastric body, the larvae of the Epilachninae (pl. 38) by long, branched dorsal and lateral spines and by multicuspidate mandibular apices in the mature larvae, and the larvae of the Lamiinae (pl. 100) by their elongate, fleshy body with short or no legs and by the presence of a broad, transverse bridge closing the headcapsule behind protracted ventral mouthparts.

Page 18, line 42. For Driptinae read: Dryptinae.

Page 20, section 6. For Driptinae read: Dryptinae.

Page 20, section 9. Insert after "simple": or with a small accessory process at base.

Page 21, line 4. For Maronetes read: Maronetus.

Page 24, line 12. Read: urogomphi almost absent ..... *Cybisterinae.*

Page 29, line 5. For Megarthus read: Megarthrus.

Page 36, section 22, second part. Omit: ", or large, elongate trapezoidal, movable, and with posterior condyle."

Page 38, line 9. For Murmediidae read: Murmidiidae.

Page 38, footnote 49. For Murmediidae read: Murmidiidae.

Page 39, section 37. For Anaspidae read: Anaspididae.

Page 47, section 4. For Homolisidae read: Homalisidae.

Page 47, section 5. For Malthinae read: Malthininae.

Page 54, section 26. For Cetonini read: Cetoniini.

Page 59, footnote 72. For Horniiae read: Horiinae.

Page 60, line 13. Insert after "melandryid genera": as well as to the Ciidae.

Page 61, section 3. For "clypeus filling space" read: clypeus **never** filling space.

Page 70. For Driptinae read: Dryptinae.

Page 76. For Malthinae read: Malthininae.

Page 124. Discard figure H on plate 19 as it does not show the serrations with which the mandible is armed on the dorsal and ventral margins of the inneredge.

Page 130, figures B and C. Insert after "head": ; ang. f, angulus frontalis.

Page 138, figure B. Insert after "Head": ; a, articulating membrane of maxilla.

Page 180, line 2. For Anaspidae read: Anaspididae.

Page 200, figures K to N. For Gnathocerus cornutus F. read: **Uloma imberbis Lec.**

Page 227. Omit figures D and E. See figures by R. E. Blackwelder in Pan-Pacific Entomologist pp. 139–142, vol. 6, 1930.

Page 266, figure W. For Aspectus read: Apsectus.

ADDENDA

Page 15, footnote 20. For the entire footnote as it stands read: The systematic position of this series is uncertain. Its larval form approaches in important characters the larvae of the cucujoid family Oedemeridae but also appears to converge toward the larval form of the ancient suborder Archostemata. Giving serial rank to the group is in accord with the generally accepted views in regard to its phylogeny but from the larval form it could with equal rights be considered a mere family, Lymexylidae, of the series Cucujoidea. This latter classification can be expressed by altering and somewhat simplifying the parts of the keys relevant to the matter in the following way:

First alteration

Page 12. For section 10 as it stands read:

10. Distinct gula or gular structure present or absent; when absent, with mandibles possessing mola, or lacinia mandibulae, or retinaculum, or a long brush of hairs posteriorly on the inner margin, or extraordinary structures, except a pseudomola 11

Distinct gula or gular suture always absent, mandible either simple or possessing a pseudomola 20

Second alteration

Page 14. For section 18 as it stands read:

18. Ventral mouthparts as a rule retracted; when protracted[17] possessing a mandible with either molar part, or retinaculum, or other appendices 19

Ventral mouthparts always protracted; mandible always simple without molar part, retinaculum or other appendices. (Head-capsule closed posteriorly by a broad, transverse bridge separating the subfacial region of head from ventral region of prothorax) ..... *Cerambycoidea* (p. 60) (except cerambycoid subfamily *Disteninae*, p. 15, line 4 and p. 62.)

19. Maxillary mala simple or terminally slightly indentated
Cucujoidea (p. 33)
Maxillary mala divided into a lacinia and a lobe-shaped galea ..... *Platystomoidea* (p. 66)

Third alteration

Page 15. Section 23 to be completely eliminated.

Fourth alteration

Page 40. For section 44 as it stands read:

44. Paired urogomphi present 45
Paired urogomphi absent 44b
44b. Ninth abdominal segment heavily sclerotized, either cylindrical with obliquely truncate end (Lymexylinae), or elongate conical (Hylecoetinae)
Lymexylidae (pl. 124 A–M)
Ninth abdominal segment without sclerome .....
Oedemeridae-Oedemerinae (pl. 51 A–F)

Page 69. Insert:

1928: Emden, Fritz van. Die Larve von Phalacrus grossus Er. und Bemerkungen zum Larvensystem der Clavicornia. Ent. Blätter, vol. 24, 1928, pp. 9–20.

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1931-1932

PUBLISHED QUARTERLY BY THE
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1932

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Vol. XII (n. s.)

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ENTOMOLOGICA AMERICANA

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A MONOGRAPHIC REVISION OF THE TREEHOPPERS OF THE TRIBE TELAMONINI OF NORTH AMERICA

BY E. D. BALL

UNIVERSITY, TUCSON, ARIZONA

The treehoppers (*Membracidae*) of the north temperate region largely belong to a single sub-family, the *Smiliinae*. The members of this sub-family have simple tibiae and the pronotum extending over the entire body. They may be recognized easily by reference to a single character; *the terminal cell of the elytra is petiolate,* while in the other groups it is elongate with the base truncate. The *Smiliinae* may be divided into tribes as follows:

A. Elytra free, clavus uncovered ..... Tribe *Cerasini* Godg.
AA. Clavus and frequently part of corum covered by pronotum.
B. Underwing with the terminal cell sessile, its base truncate. Tribe *Telamonini* Godg.
BB. Underwing with the terminal cell petiolate. Tribes { *Smiliini* Godg. / *Polyglyptini* Godg.

TRIBE *Telamonini* GODING

The members of this tribe are almost all North American and limited to the more temperate regions. Certain species are found in the arid Southwest or in the high tablelands of Mexico and a very few still farther south in the higher mountains, but only in mountainous regions where the seasons are relatively short and the

temperatures moderate. This tribe and the *Smiliini* are strictly tree inhabiting and tree feeding forms while the other two tribes are found mainly on annual or perennial herbs. The single tribe *Telamonini*—includes all but three or four of the larger tree inhabiting forms occurring in the United States.

Generations

They are, as far as known, all single brooded throughout their range, pass the winter in the egg stage, usually in the twigs, and hatch out as soon as the leaves appear and the young growth starts. The nymphs are usually the color of the young bark and are found flattened down in the crotches where they are difficult to detect. In the normal temperature conditions of Iowa and Illinois they mature in early July and the majority of the adults are gone before the end of August.

Habitat

As suggested by Funkhouser, the members of this group are lovers of the open. An isolated tree or a scattered group on a low hill furnishes an ideal habitat. They are almost never found in the shade of a woods and only sparsely along the edges of dense growths. The adults depend upon their resemblance to the bark or foliage for concealment, but when approached too closely they snap away with a speed that the eyes cannot follow. This jump is not from one limb to another but out into the open where they unfold their wings and dart away. They prefer the outer limbs from six to ten feet above ground and only those in the open.

Collecting Methods

Successful collecting of these large treehoppers requires as much skill and furnishes as many thrills as trout fishing or quail hunting. One must know the favorable locations, the proper season and the right time of day. Even with these conditions met, a keen eye and a steady hand are necessary to success. The most satisfactory collecting bottle is made from a heavy walled glass tube one inch in diameter and six or more inches in length. Having located the treehopper resting as usual on a small limb in the outer part of the head of a tree, the glass tube must be moved straight towards it with a steady hand. If the hopper is resting on the underside the tube must move straight up until it touches the limb, then a slight sidewise movement until the glass taps the head and—snap—you either have a treehopper in the bottom of your bottle or else you

do not, depending upon how dextrous you were. By using a long light stick the outer limbs may be beaten over a net and both nymphs and adults collected.

Food Plants

The treehoppers of this group are with few exceptions confined to a single species of tree in their nymphal stages and in a few instances to restricted parts of the tree. For example, nymphs taken in the crevices of the bark of the trunk of the Bur Oak usually alongside a small sprout just under the head all hatched into one species while nymphs taken on the small branches of the outer part of the head all emerged later as another species. In the adult stage the males especially are often taken from other trees, but usually only a short distance from their host. Records of accidental captures therefore should not be used as guides to food habits.

Parasitism

Dr. Kornhauser has shown that the attacks of a Dryinid (*Aphelopus theliae*) larval parasite with polyembryony, produces profound modifications of the sexual organs and of the sexual color pattern in *Thelia bimaculata* and warns against being misled by parasitized individuals. The writer has found this or a similar parasitism affecting nearly all the species of this group and frequently producing greatly modified forms.

Diagnostic Characters

The characters most frequently used in other groups of Homoptera such as venation, genitalia and head shape are of no value in this group for either generic or specific separation. As most of the early descriptions were largely based on these characters and certain dark spots above the eyes which are almost equally variable, it has been very difficult to interpret descriptions and much confusion has resulted. The males are usually much smaller and darker than the female and have smaller and less angular crests so that they have often been separated or assigned to other species thus adding to the confusion and preventing correct food plant determinations.

The entire body being covered and protected by the pronotum in the adult stage there has been little reason for variation in the body structures with the result that the variation and adaptation has practically all taken place in the pronotum itself. When one considers that this covering arises from a small structure in the

last instar nymph and must be inflated, shaped and colored according to a definite pattern in a few hours of an early morning before the sun's rays harden the chitin, the wonder is not that it is variable but that it can assume such a variety of generic and specific patterns with such unfailing accuracy. The nymphs having no protective covering are subject to adaptive modifications in shape of head, pronotum and body, in color and in the development of spines and processes. Generic characters are expressed in various types of nymphal shapes and in the different patterns of modification of the pronotum such as horns, crests, arches, etc. Specific characters are almost entirely based on size, shape and color pattern, and differences in shape of horn, crests and humeral angles within the generic patterns.

Areas in which Collections have been Made

The writer began the study of the food plants and life histories of the treehoppers at Ames, Iowa, in 1894 and continued to collect in that rich area through 1897. Colorado and Utah were later intensively collected with relatively poor results. A number of trips to California and the Northwest were more productive. Two years in Wisconsin followed by two more in Iowa gave opportunity to work out many life histories and food plant relations. Several years in Washington and vicinity with trips to New England and several days on Fitch's farm at Salem, New York, were helpful. Three seasons in Florida were interesting and productive and the last two in Arizona have rounded out a survey of the large treehoppers of the United States.

Collections and Types Studied and Acknowledgments

In the course of the work the writer has visited and studied the following collections: American Museum of Natural History (Dr. Lutz); L. L. Woodruff; Chris E. Olsen; H. G. Barber; Boston Society of Natural History, including the Harris collection (Dr. Johnson); Royal Museum, Toronto, (McDunnough); Wm. T. Davis; State Museum of New York, Albany, including the Fitch collection (Dr. E. P. Felt); Cornell University collection including the Heideman collection; W. D. Funkhouser; Carnegie Museum, (Hugo Kahl); Academy of Natural Sciences, Philadelphia, (Dr. H. Skinner); U. S. Natural Museum including the Uhler, Baker and Goding collections (Aldrich, Rohwer and Morrison); Florida State Plant Board (G. Merrill); Ohio State University; H. Osborn; D. M. DeLong; J. G. Sanders; Illinois State Laboratory of Natural

History (T. H. Frison); Wisconsin University (Dr. Wm. Marshall); Prof. Wescott; University of Minnesota (C. H. Mickle); Iowa State College including the Van Duzee collection (Dr. Drake); Dr. H. H. Knight; University of Nebraska (Lawrence Bruner); University of Kansas (Dr. P. R. Lawson); Kansas Agricultural College (Prof. G. A. Dean); Colorado Agricultural College (C. P. Gillette); G. M. McElfresh and the California Academy of Sciences (E. P. Van Duzee).

To all of these institutions and individuals whose cooperation and assistance has been so generously given, grateful acknowledgment is made. Mr. W. E. China of the British Museum has kindly compared material and made many helpful drawings of types. Mrs. F. W. Streets has, as indicated, prepared and arranged the illustrations.

Synonymy and Bibliography

The Van Duzee Catalogue of 1914 and the Funkhouser Catalogue of 1926 give sufficient information so that no bibliography is appended and only primary synonymy is given except in cases where it is necessary to correct previous errors of reference in synoptic works. The genus *Telamonanthe* Baker has been omitted as it possesses the petiolate cell in the underwing and belongs in the tribe *Smilini* as described and not in *Telamonini* as placed in the Van Duzee and Funkhouser catalogues. On the other hand the genus *Tropidarnis* Fowler which was described as a Darnid is evidently a *Telamonini* and has been included. Every described species has been restudied. Of the 109 names considered, 13 have been transferred to other groups and the remaining 96 referred to 52 species and 3 varieties. Two species and 10 varieties have been added making a total of 54 species and 13 varieties, or 67 forms, discussed.

A critical consideration of the earlier descriptions and types has inevitably resulted in some startling changes in nomenclature but the writer is fairly confident that the oldest names have been correctly placed and that the present treatment will bring about specific stability.

Types of New Species and Varieties

The writer published in 1925 the new species discovered in the first draft of this work. The types of the two new species and ten varieties that it has been found necessary to characterize in order to complete the study are, unless otherwise stated, in the author's collection.

Key to the Genera of the Tribe *Telamonini*

A. Pronotum armed with a horn or crest.
  B. Pronotum with an anterior horn arising in front of or above the humeral angles.
    C. Horn extending anteriorly ..... 1. *Thelia* A. & S.
    CC. Horn erect, compressed ..... 2. *Glossonotus* Butler.
  BB. Pronotum with a crest, the major portion of which is behind the humeral angles.
    D. Crest not quadrangular, either overhanging, pyramidal, lobed or stepped.
      E. Crest overhanging, the dorsal and posterior margin blended into a uniform curve ..... 3. **Helonica** nov. gen.
      EE. Crest not overhanging, or if overhanging then the dorsal margin either lobed or stepped.
        F. Crest definitely stepped, the anterior lobe high and rounding, the posterior lower and quadrangular, humeral angles usually long and acute. 4. *Heliria* Stål.
        FF. Crest placed well forward and high, or pyramidal and farther back; dorsum sinuate or a slight step on the posterior slope, sometimes wanting.
          G. Crest arising from metapodium, high, foliaceous. 5. *Telonaca* Ball.
          GG. Crest placed well back of metapodium, pyramidal, very variable ..... 6. **Palonica** nov. gen.
    DD. Crest more or less quadrangular, variable, the dorsum variable, may be sloping but not definitely stepped nor ornamented with a pale spot ..... 7. *Telamona* Fitch.
AA. Pronotum without horn or angular crest. Either low and transversely convex or high and foliaceous throughout.
  H. Pronotum low and broadly rounding above as seen from the front. Species brown or dark ..... 8. *Carynota* Fitch.
  HH. Pronotum high and foliaceous or at least acutely angular as seen from front. Species green.
    I. Crest low and scarcely foliaceous, metapodium broadly rounding posteriorly without a raised carina. 9. *Tropidarnis* Fowler.
    II. Crest high and foliaceous. Metapodium upright or only slightly sloping with a raised carina ..... 10. *Archasia* Stål.

1. Genus *Thelia* A. & S.

Amyot and Serville, Hemip., p. 540, 1843.

Pronotum elongate, triangular, metapodium horizontal or slightly rounding superiorly before the base of the horn, an elongate slender tapering horn extending anteriorly almost

in line with the slope of the dorsum. Humeral angles moderately prominent, rectangular.

This genus was founded by Amyot and Serville in 1843 for *Membracis bimaculata* Fabr. As limited at present it contains only two North American species both widely distributed in the eastern United States.

The nymphs are flattened brown forms with a pair of projections on the front margin of the vertex, a double row of median spines on the abdominal segments, and in the later instars an increasing horn on the pronotum that projects forward. There is a single generation each year, the nymphs appearing in June and July and the adults in July and August.

Key to the Species of Thelia

A. Gray ♀ or bimaculate ♂, horn as seen from side usually broad at base and slightly curving upward ..... 1. *bimaculata* Fabr.

AA. Dark testaceous, uniform, horn as seen from side, usually straight, almost parallel-margined ..... 2. *uhleri* Stål.

1. *Thelia bimaculata* Fab. Plate 1, Fig. 1.

Membracis bimaculata Fabr., Ent. Syst. IV, p. 10, 1794.
Thelia unanimis Walk., List. Homop. B. M., p. 566, 1851.
Thelia bimaculata Funk., An. Ent. Soc. Am. VIII, p. 140, 1915 (life history).
Thelia bimaculata Kornh., Jl. Morph., 32, pp. 531–631, 1919 (effect of parasitism).

A strikingly large species with a dull gray female and a brown male with brilliant yellow markings. Length (without horn) ♀ 11 mm., ♂ 9 mm.

Pronotum almost equally triangular in both lateral and dorsal views; horn in female broad at base, variable, usually extending for about 4 mm. at an angle of 45°; male horn shorter and more slender; lateral angles prominent, almost right-angled and extending almost their width beyond the eyes.

Color. Female grizzled gray, often faint light lines running obliquely back from horn on either side and a narrow brown line on the dorsum. Male dark brown ,a broad yellow stripe on each side from the lateral angle slightly more than half way to apex.

Habitat. The writer has collected this species on black locust (*Robinia pseudacacia*) in southeastern Iowa, southern Wisconsin, Ohio, Ontario, District of Columbia, Maryland, and Virginia, and

has examined examples from Kansas, Illinois, Pennsylvania, New York, New Hampshire, Rhode Island, New Jersey, Delaware and North Carolina. Van Duzee reports it from Quebec and Harris from Massachusetts. Its distribution is limited by that of the black locust, the nymphs never occurring on any other host, the adults and larger nymphs usually resting on the branches near the base of a twig or leaf, often alongside the sharp spines which their projecting horns somewhat resemble. Funkhouser has given a full account of the life history and habits. Kornhauser has made an elaborate study of the parasite and the effect of parasitism in changing the structural characters and especially the sexual characters and coloration. Funkhouser found the eggs laid at the base of the trees and the young nymphs feeding there. The writer has found eggs and young nymphs on the smaller branches and Kornhauser in correspondence states that he has brought branches into the laboratory and allowed the eggs to hatch. Apparently eggs are laid in different places under different conditions. Kornhauser gives an interesting description of the collars built around the bases of the trees by ants in which third to fifth instar nymphs were found in abundance.

2. *Thelia uhleri* Stål. Plate 1, Fig. 2.

Thelia uhleri Stål. Öf. Vet. Akad. Forh., XXVI, p. 248, 1869.

Smaller than *bimaculata,* uniform rich brown, with a flat parallel-margined horn almost continuing the line of the dorsum. Length 8 mm. (without horn).

Pronotum long, triangular in both views, dorsum low and broadly evenly rounding; face and metapodium densely hairy, pronotum sparsely hairy, uniformly punctured with no definite lateral carinae; horn long, flattened and scarcely narrowed towards the apex. Lateral angle slightly obtuse and exceeding the eyes by little more than half their width.

Color. Mahogany-brown, usually a few pale dots and an obscure pale line running obliquely backward from each side of the horn; occasionally the median carina is light-margined back of the horn.

Habitat. The writer has collected this species on the wild plum (*Prunus* spp.) in South Dakota, Iowa, Minnesota, and Wisconsin, and has examined examples from northwestern Nebraska (Barber); Kansas (DeLong); Illinois (Ill.); Ohio (Osborn); Pennsylvania, New York and Maryland (U. S. N. M.) and Kingston, Ontario (Van Duzee–Ames).

In the writer's experience this species is found only on isolated clumps of old plum trees. The adults usually conceal themselves in the angle where a fresh watersprout a half inch or more in diameter comes out from the trunk or where two of these touch each other, their brown color together with the pale dots giving the exact appearance of the young plum growth with its "bloom" still present. The nymphs have a still more powdery appearance and are found on the smaller branches, usually in the angle of a twig. There is a single generation in a year, the nymphs appearing in June and early July, the adults in July and August.

2. Genus *Glossonotus* Butler.

Glossonotus Butler, Cistula Entomologica, II, p. 222, 1877.

> Pronotum short, triangular, the anterior part elevated into a tongue or horn often nearly as high as the pronotum is long. Metapodium almost horizontal, the upper margin rounding back before entering into the outline of the horn, horn often slightly overhanging the metapodium. Humeral angles prominent, usually acute.

Butler erected this genus for *Thelia acuminata* Fabr., apparently the only one of the group with which he was acquainted. Five species are now recognized, all apparently limited to the deciduous forest region of North America.[1]

Little is known of the nymphal stages of most species. The nymphs of *G. acuminata* resemble those of *Thelia* but the horn is more nearly erect. All of the species are apparently single-brooded, the adults appearing in late June and July and continuing into August. In this genus as in several others the females have larger and more characteristic horns and longer humeral angles than the males.

Key to the Species of *Glossonotus* (females)

A. Horn as seen from the side slightly constricted near base, definitely foliaceous and enlarged at apex. Pronotum without median stripes or if partially striped with definite lateral markings.

B. Large, pronotum obscurely marked, humeral angles large, acute ..... 1. *acuminatus* Fabr.

BB. Size medium, pronotum pattern definite, humeral angles rectangular ..... 2. *crataegi* Fitch.

[1] Funkhouser lists *gibbosa* Walk. from Brazil as a *Glossonotus* and credits Butler Cist. Ent. 2, p. 222, with the reference but this is an error—Butler referred this species to *Telamona*.

AA. Horn usually broadest at base. Pronotum without lateral pale markings, usually with a broad median stripe.
C. Horn high, tapering or constricted near tip, no lateral markings.
D. Light testaceous brown with a broad stripe. Horn slender, tapering ..... 3. *turriculatus* Emm.
DD. Unicolorous dark brown or with a narrow stripe. Horn variable, usually foliaceous at apex. Metapodium hairy. 4. *nimbatulus* Ball.
CC. Horn low, nearly as broad as its height. Metapodium not hairy ..... 5. *univittatus* Harr.

1. *Glossonotus acuminatus* Fabr. Plate 1, Fig. 3.

Membracis acuminatus Fabr. Syst. Ent., p. 675, 1775.

Gray-brown, mottled, with the dark crest extremely high, tongue-like and foliaceous at apex. Humeral angles prominent and acute. Length 10 mm., width 6 mm., height 8 mm.

Crest upright or slightly overhanging the metapodium, conical at base, constricted in the middle and foliaceous at at the rounding apex, humeral angles long, acute, almost half longer than the eye. Pronotum long, the acute apex usually exceeding the elytra. Color pattern dull and obscure but similar to that in *crataegi*.

Habitat. The writer has collected this species on black oak (*Q. velutina*) in Iowa, Minnesota and Wisconsin and has examined examples from Arkansas (McElfresh); Missouri; Kansas; Illinois (Osborn); Michigan (U. S. N. M.); Pennsylvania; New York (Ridgeway); Ontario (Van D. Coll., Ames); Rhode Island; Massachusetts (Woodruff); Connecticut (New York State); New Jersey (Barber) (Davis); Maryland; Virginia (Heid. Coll.); and North Carolina (Cornell).

The nymphs are found skillfully concealed in the crotches of the smaller branches in June and early July. The adults appear in late June and July and disappear soon after. They usually rest head down on the underside of the smaller branches coming out from the main trunk and well up out of reach. A long collecting bottle made out of one-inch glass tubing fastened by rubber bands to the end of a net handle, a good eye and a steady hand, made their capture easy.

2. *Glossonotus crataegi* Fitch. Plate 1, Fig. 4.

Thelia crataegi Fitch. Cat. Ins. N. Y., p. 52, 1851.

Rich brown and cream in a striking but variable pattern, crest broad, foliaceous, length 8 mm., width 4 mm., height 6 mm.

Crest resembling *acuminatus* but shorter, quite variable; humeral angles rectangular, no longer than eye, pronotum with apex slightly rounding, scarcely equalling the elytra; males much smaller and often with much shorter crests.

Color. Cream and chestnut-brown, face and most of metapodium creamy, humeral angles and crest chestnut irregularly margined with dark brown, a large irregular spot below crest creamy, a transverse creamy band a little nearer apex than crest, sometimes wanting, often a median creamy vitta behind the crest.

Habitat. The writer has collected this species on the hawthorn (*Crataegus* spp.) in Iowa and Ontario and has examined examples from Manitoba and Missouri (U. S. N. M.), Illinois (Titus), Michigan (Hungerford-Kansas), Ohio (Osborn), Pennsylvania (Davis), New York (Knight), Maine (Dickenson—A. M. N. H.), Massachusetts (Cate, U. S. N. M.), West Virginia (Davis) and Maryland (Uhler, U. S. N. M.).

This is a strikingly colored and easily recognized species but very difficult to capture on account of the spiny nature of its host plant. It was found quite commonly in July in company with two other species of treehoppers on long watersprouts growing inside the head of a tree at Ames, Iowa. Dr. Knight found it in abundance in July on quince at Batavia, New York, and on *Crataegus* in Iowa. It has been taken on apple and crab apple. Before the introduction of cultivated fruits it was undoubtedly confined to the wild species of *Crataegus*. The Fitch type in the New York State Museum, while faded, still shows the typical *crataegi* pattern and shape and leaves no question as to the identity of this species.

3. *Glossonotus turriculatus* Emm. Plate 1, Fig. 5.

Telamona turriculata Emm., Agr. of N. Y. V., p. 155, pl. 3, fig. 1, 1854.

Thelia turriculata Godg., Bull. Ill. St. Lab. Nat. Hist. III, p. 412, 1894.

Glossonotus univittatus Van D., Buff. Soc. Nat. Sci. IX, p. 58–59, 1908. (Not Harr.)

Glossonotus univittatus Funkh., Cornell Exp. Sta. Mem. II, p. 246, 1917. (Not Harr.)

Glossonotus univittatus Funkh., Insects. of Conn. Pt. IV, Hemip., p. 184, 1923.

Glossonotus univittatus Van D., Catalogue of the Hemiptera, p. 534, 1917. (Not *G. turriculatus* of the Van D. catalogue).

Grayish testaceous shading to dark brown against the broad dorsal vitta, crest extremely high, slender, erect or slightly overhanging the metapodium. Length 10 mm., width 5 mm., height 7 mm.

Horn slender, anterior, twice as high as its width, variable but usually slightly overhanging with the apex rounding back to form a slight angle behind. Humeral angles about equalling the eye, slightly acute. Face and metapodium pubescent, pronotum long, acute.

Color. Gray shading to brown on crest and along the margins of the broad creamy white dorsal vitta, an oblique dark cloud at apex of elytra.

Habitat. The writer has collected this species on *Crataegus* in Iowa and Wisconsin and examined examples from Iowa (from *Crataegus* Knight) Nebraska (Pierce), Kansas (DeLong), Missouri (Uhler, U. S. N. M.), Illinois (Ill.), Ohio (Osborn), Pennsylvania (DeLong), New York (many coll.), New Jersey (Davis), Massachusetts (Dickenson, A. M. N. H.), Long Island (Brooklyn Mus.), North Carolina (U. S. N. M.) and Georgia (Davis).

On July 6, 1919, the writer found an isolated tree of hawthorn at Ames, Iowa, that had several lusty watersprouts growing up through the older branches. The smaller upright branches of these watersprouts had an almost continuous row of treehoppers on the sunny sides, about evenly divided between this species and *T. crataegi.* Capturing them among the spiny branches was however another matter. They were all adults at this time and no larvae have been taken. Isolated examples have been taken on different oaks but they may have been accidental resting places. The other species of this genus are so restricted in food habits and it is doubtful if this species would have two food plants as different as thorn and oak.

There has been much confusion with reference to the application of names in this group as discussed under *univittatus.* There can, however, be no question but that this is the species Emmons described as having "a high narrow crest, rising somewhat in advance of the face; posteriorly the concavity is large, and continuous with the entire back." His figure shows an extremely tall over-hanging crest, a long acute pronotum with a broad white vitta bordered by dark margins, characters that at once separate it from Harris' species or *nimbatulus.*

4. *Glossonotus nimbatulus* Ball. Plate 1, Fig. 6.

Glossonotus turriculatus Van D., Buff. Soc. Nat. Sc. IX, p. 59, 1908.

Glossonotus turriculatus Van D., Cat. Hemip., p. 534, 1917 (not Emm.)

Glossonotus nimbatulus Ball, Proc. Wash. Acad. Sc. XV, p. 200, 1925.

Resembling *turriculatus* but smaller, darker, with a tall foliaceous variable crest resembling that of *acuminatus*. Length 7 mm., height 6 mm., width 4–.5 mm.

Horn anterior and nearly vertical, broad and high, constricted near middle, nearly evenly foliaceous at apex, as seen from front broadly inflated from just above the very short and weak lateral angles, tapering evenly just before the apex. Lateral angles obtuse, about one-half the width of the eye. Pronotum moderately acute in both planes.

Color. Uniform chestnut or darker varying to almost black, with pale points on the sides of the horn; in the lighter specimens a narrow light median stripe from the apex of horn to apex of pronotum, becoming narrower in the darker specimens and occasionally wanting.

Habitat. Examples have been examined from Karner, N. Y. (N. Y. State); Pennsylvania (Bak., U. S. N. M.); New Jersey (Davis, Barber); Long Island (Brooklyn); Framingham, Mass. (Frost, A. M. N. H.); White Mountains, N. H. (Ball).

The uniform dark color and the long inflated foliaceous horn will at once distinguish this distinct species which appears to be confined to scrub oak (*Quercus nana*) growing in sandy or rocky locations.

5. *Glossonotus univittatus* Harr. Plate 1, Fig. 7.

Membracis univittatus Harr., Rep. Ins. Mass., p. 180, 1841.

Thelia univittata Godg., Bull. Ill. St. Lab. Nat. Hist. III, p. 412, 1894. (Synonymy O. K.).

Thelia godingi Van Duzee, Ent. News VI, p. 203, 1895.

Glossonotus godingi Van Duzee, Bull. Buff. Soc. Nat. Sci. IX, p. 59, 1908.

Telamona dorsalis Buckton, Monograph of the Membracidae, p. 197, pl. 43, fig. 3, 1903.

Glossonotus godingi Van Duzee, Cat. Hemipt., p. 535, 1917.

Glossonotus godingi Funkh., Insects of Conn., p. 184, 1923.

Resembling *turriculatus* but shorter, stouter and darker with a much shorter, broader horn. Length 9 mm., height 5 mm., width 5.5 mm.

Testaceous shading to dark brown along the margin of the broad median, white vitta, crest upright very variable, often but little higher than wide, rarely twice as high, broad at

base, parallel margined or occasionally slightly knobbed. Humeral angles broadly rounding to right angled scarcely equaling the eye in width. Pronotum much broader and shorter than in *turriculatus*.

Habitat. The writer has collected this species in Colorado, Iowa and Wisconsin and has examined examples from New Mexico (Cockl., U. S. N. M.); Arkansas (McElf.); Manitoba (Wells, U. S. N. M.); Minnesota (Minn.); Michigan (Hill); Illinois (Godg., U. S. N. M.); Indiana (Bak., U. S. N. M.); Ohio (Osborn); Pennsylvania (Bak., U. S. N. M.); New York (Fitch, N. Y. St.); Canada (Bak., U. S. N. M.); New Hampshire (N. H.); Massachusetts (Harr., Bost. S. N. H.); New Jersey (Davis); Maryland (Uhl, U. S. N. M.); Georgia (Davis). It is one of the most common and widely distributed species of the group extending along the Rocky Mountains from New Mexico north to Montana and east through Manitoba, Ontario and Quebec on the north, to at least Georgia and Arkansas on the south. Harris and Fitch both give oak as the food plant. The writer has found both sexes on oak in numbers in Iowa and Wisconsin.

There has been much confusion with reference to the specific name of this species. Harris described it in 1841 as a *Membracis* from examples from Massachusetts, and later sent his collection to Dr. Fitch[2] who placed it in the genus *Thelia* and listed it in his catalogue of the Homoptera of New York in 1856. This species was referred to frequently and apparently correctly from this time on until 1894 so that the references in the Goding catalogue of that date are all correct.

In 1895 Van Duzee assigned the name *univittata* Harr. to the tall species described as *turriculata* by Emmons and described this species as *Thelia godingi*. The same error was repeated in his studies of North American Membracidae and again in his Catalogue and has been followed by Funkhouser in the Membracids of Cayuga Lake Basin and in the Membracidae of the Hemiptera of Connecticut.

The writer has twice visited the Boston Museum of Natural History and studied the types of this species, a pair labeled "200 N. H. on scrub oak," in the Harris collection. The female is a typical

[2] Dr. Fitch in the introduction to his Catalogue of the Insects of the State Cabinet of Natural History says, "An acknowledgment is due Dr. T. W. Harris of Harvard University who has been so kind as to place temporarily in my hands his entire collection of Homoptera including the several species named in his catalogue."

example of the species, the male has an unusually broad hump They fit the Harris description where he says, "It is about 4/10 of an inch in length, the thorax is brown, has a short obtuse horn, extending obliquely upwards from its fore part." The Museum collection has eleven specimens of this species from Massachusetts but no examples of the tall horned *turriculata*. The Fitch Collection in the State Cabinet of Natural History at Albany has a typical female of the Harris species and a male of true *turriculatus* along with it. The much shorter horns of the males in this group make this a natural mistake. The Fitch Collection in the National Museum contains a single typical female labelled *univittatus* Harr. Dr. Fitch evidently correctly recognized that the short broad species was Harris', and, as credited by Emmons, no doubt assisted that writer in determining that the species described as *turriculatus* was new. There can be no question as to the identity of these two species. Harris' "has a short obtuse horn" could only fit the species represented by his types and the female in the Fitch collection, while on the other hand Emmons' figure and description of *turriculatus* as noted above could only apply to that species. Van Duzee gives no type designation for his *T. godingi* but states that he had taken "a number of individuals about Buffalo," and that he sent one example to Dr. Goding. The writer has examined the examples in the Goding collection now in the National Museum, and examples in the Van Duzee collection at Ames labeled types and finds them typical of the Harris species.

Glossonotus univittatus var. **pumilus** n. var. Plate 1, Fig. 8.

Resembling *univittatus*, smaller, with an even lower and usually narrower horn. Pale gray, shading to brown along the white vitta in the female darker with a dark brown hump in the male. Length 7 mm, height 4.5 mm.

Holotype ♀ and allotype ♂ Palmer Lake, Colorado (Ball) paratypes, Rifle, Colorado (Ball), Veta Pass, Colo. (Drake), Colorado and New Mexico (U. S. N. M.), The writer has found this variety only on the low growing "scrub" oak (*Quercus gambelii*) in July while the two females from Dr. Drake were taken in August.

3. Genus **Helonica** nov. gen.

Resembling *Heliria* in the overhanging anterior lobe of the crest but entirely lacking the differentiation into a posterior lobe. Similar to *Telamona* in many characters but with larger humeral angles and an anterior projecting crest.

Pronotum relatively broad and short, scarcely reaching the apical cell of the elytra. Crest relatively broad at base,

placed well back on the metapodium, moderately high, the apex consisting of an overhanging lobe from which the dorsal and posterior faces are united in a broad curve, extending into the curve of the pronotum with only a faintly indicated posterior angle, the whole structure resembling a cornucopia. Humeral angles long, acute.

Type of the genus *Thelia excelsa* Fairm.

1. *Helonica excelsa* Fairm. Plate 1, Fig. 9.

Thelia excelsa Fairm., Ann. Ent. Soc. Fr. Ser. 2, IV, p. 310, 1846.

Telamona projecta Butler, Cist. Ent. II, p. 221, 1877.

Telamona magniloba Godg., Bull. Ill. St. Lab. N. H. III, p. 422, 1894.

Telamona albidorsata Fowler, Bio. Cent. Amer., Homoptera, p. 145, Table IX, fig. 8, 1896.

Telamona cucullata Van Duz., Bull. Buf. Soc. Nat. Sc. IX, p. 70, 1908.

Resembling an example of *Heliria scalaris* with the posterior lobe of the crest merged into the anterior and much paler in color. Length, female, 11 mm.. width 7 mm., height 5.5 mm. Length, male, 8 mm.

Pronotum and crest as in the genus, crest very variable in length and therefore in relative shape, sometimes narrow at base and much overhanging, again much broader and more upright. There is often a very slight angle on the posterior slope. Metapodium hairy; humeral angles long, acute; the posterior margin long, straight, sloping anteriorly; anterior margin curved, apex bluntly rounding, one-half longer than the eye.

Color. Pale brown with darker markings on the upper part of the metapodium just below the overhanging crest and margining the white lined posterior slope of crest, sometimes extending to the costa.

Habitat. The writer has examined examples from Galesburg, Ill., Stromberg (Ill. Coll.; Goding and Uhler Coll. U. S. N. M.); Ithaca, N. Y. (Cornell Coll.); Maryland (Uhl. Coll. U. S. N. M.); and the Fairmaire and Fowler types were from Mexico. Stromberg labeled his material from "wild grape." Dr. Knight sent a long and variable series taken on wild grapes at Ames, Iowa. Dr. Knight's examples were taken late in June, Stromberg's in July.

Fairmaire described this species from Mexico in 1846 as a *Thelia*. Fowler in the Biologia, Table 9, Fig. 4 and 4a, figures the type indicating a rather large, broad-crested female which he placed in *Telamona*. Butler described *projecta* in 1877 from an example in the British Museum without locality label. His figure has a nar-

rower crest than that of Fairmaire's type but is well within the normal variation and is undoubtedly the same species. Goding described *magniloba* in 1894 from a pair from Illinois (Stromberg). This description follows *T. excelsa* in his catalogue and he lists *excelsa* as occurring in Missouri and Illinois; but he gives no character by which they could be separated. The types are in the National Museum and are apparently from the same lot as those from Stromberg in the Illinois Collection which shows a wide variation in size and shape of crest including both *projecta* and *excelsa* forms. In 1896 Fowler in the Biologia described *Telamona albidorsata* from a single male from Vera Cruz. The writer from the figure and white lined dorsum thought that it was a *Glossonotus* and sent examples to W. E. China for examination and comparison. He reports that the humeral angles are more prominent and the posterior process much longer and more acute while the yellow mottling is not as distinct as shown. On further study in the light of these facts it was discovered that some narrow crested males of *excelsa* show this white line and agree with Fowler's "obtuse and hardly perceptible angle behind the middle." The unique female type of *excelsa* and the unique male type of *albidorsata* represent the two extremes in variation of crest width, and it is little wonder that their relationship was not suspected. The variation in size and in size of the humeral angles is typical of the sexes. In 1908 Van Duzee described *cucullata* from examples from Ithaca. Later in the same issue he notes that it is the same as *projecta* Butler, the illustration of which he previously overlooked. He placed this species in the genus *Telamona* but pointed out its relation to *Heliria* and *Thelia*.

Van Duzee remarks that it has the wing venation of an *Antianthe* which if correct would transfer this species to the trible *Smiliini*. This must have been from an observation of a variation on an individual wing. An occasional variation of this kind not infrequently occurs in all of the genera under consideration but an examination of a considerable series of this species indicates that this variation is rare and there can be no question as to this form belonging in the *Telamonini*.

4. Genus *Heliria* Stål.

Heliria Stål. Öf. Vet. Akad. Forh. XXIV, p. 556, 1867.

Large, robust, resembling *Telamona* but with crest more prominent and consisting of two lobes, the anterior highest, humeral angles prominent.

Pronotum long, low; the metapodium short, convex; crest very variable, usually broad, consisting of two definite lobes,

the anterior one high and usually rounding, the posterior one lower with a definite step or at least a sinuation and the junction marked by a light area; posterior process low, acute, but rarely reaching to the apex of the elytra.

Type of the genus *Thelia cristata* Fairm.

KEY TO THE SPECIES OF *Heliria* (FEMALES)

A. Humeral angles usually long and acute, longer than their basal width except in *molaris,* species large, not testaceous.
B. Crest large, anterior lobe long, foliaceous.
C. Anterior lobe of crest overhanging anteriorly.
D. Anterior lobe high, knob-like; posterior lobe long, low, highest at posterior angle. ..... 1. *cristata* Fairm.
DD. Anterior lobe little higher than posterior. 2. *gibberata* Ball.
CC. Anterior margin of crest upright or sloping posteriorly.
E. Crest definitely longer than its height.
F. Humeral angles longer than their basal width, narrow at base ..... 3. *mexicana* Stål
FF. Humeral angles broader at base than long, crest arising back of metapodium.
G. Crest with anterior lobe broad, pyramidal, the apex slightly rounding; posterior lobe sloping, the angle obtuse. ..... 4. *sinuata* Fowler.
GG. Crest with the anterior lobe lower, posterior lobe horizontal with a definite step and an acute angle.
H. Crest with anterior lobe arising abruptly, definitely higher than posterior. ..... 5. *fitchi* Ball.
HH. Crest with the anterior lobe arising in a long slope to the line of the posterior one. 6. *molaris* Butler.
EE. Crest with height and width about equal.
I. Crest much shorter than the posterior part of pronotum, oblique with a vertical inflation on either side ..... 7. *clitella* Ball.
II. Crest about equal to the length of the posterior pronotum, not inflated ..... 8. *gemma* Ball.
BB. Crest small, anterior lobe narrow, pyramidal, acute; humeral angles much longer than their basal width. 9. *strombergi* Goding.
AA. Humeral angles shorter, not exceeding their basal width or the breadth of the eye. Species smaller, brown or testaceous.
J. Crest broad, anterior lobe knob-like, overhanging ..... 10 *scalaris* Fairmaire.
JJ. Crest narrow, anterior margin upright or sloping posteriorly. ..... 11 *praealta* Fowler.

The representatives of this genus are the largest and most striking treehoppers occurring in the temperate regions of America. They are very rare in collections, however, no doubt largely on account of their remarkable agility. Only an occasional accidental capture has been made in the past, thus no one has determined host plants. Van Duzee in his "Studies of North American Membracidae" records only two species; Funkhouser in his Cornell List records only one, and in the Connecticut list only two, and these with the food plants unknown. Eleven species are discussed in this paper. Of these the writer has collected and determined food plants of nine. The nymphs have a pair of anterior projections between the eyes, a large pronotal hump and in the later instars a constantly enlarging projection from the anterior margin of this hump. The abdominal segments bear two adjacent rows of dorsal spines. There is a single annual generation, the nymphs appearing in late May and June and the adults in July and August in the Iowa-New York latitude.

1. *Heliria cristata* Fairm. Plate 1, Fig. 10.

Thelia cristata Fairmaire, Ann. Soc. Ent. Fr. Ser. 2, IV, p. 311, pl. 5, Fig. 14, 1846.
Telamona fagi Fitch, Homop, N. Y. St. Cab. p. 51, 1851.
Telamona acclivata Emmons, Nat. Hist. N. Y. Ins., p. 155, pl. 3, fig. 5, 1854.

Large, tawny or mottled, crest with a high overhanging anterior lobe and a low acutely angled posterior one. Female: length 11 mm., width 7 mm., height 6 mm.; male: length 10 mm.

Pronotum long, low, acute with weak striations; crest of medium length placed well back of the humeral angles rather low with the anterior half knob-like, overhanging in front, abruptly twice as high as the posterior half. Posterior half low, horizontal, the posterior angle definite, often slightly elevated and acute. Humeral angles inclined, their apices curving forward, much longer than the width of eye, broad, acutely angled, the apex rounding.

Color. Pale tawny, shading to gray-brown, slightly washed and mottled with fuscous, with a faint pattern emphasized around the base of the crest and running obliquely back to the costa. The humeral angles have a dark stripe both above and below with the anterior margin light.

Habitat. The writer has collected examples at Ames, Iowa, and Lake Geneva, Wisconsin, and has examined specimens from Kansas

(DeLong and Kans. Univ. Coll.); Illinois (Ill. Coll. and Wescott); Pennsylvania (Phil. Acad.); New York (Fitch Coll., Albany, and U. S. Nat. Mus.); New Jersey (Davis and Barber Colls.); Maryland (Uhl., U. S. N. M.); North Carolina (Cornell); one female, Louisiana (Uhl., U. S. N. M.); one male, Florida (Minn.), one male, Dallas, Texas, June 7, 1905 (Bishopp, U. S. N. M.), and Fairmaire described it from Mexico. It will probably be found throughout the deciduous forest belt of eastern North America. The writer has taken this species in late June (males) and early July on the burr oak except for what was no doubt an accidental capture on a black oak in a burr oak locality. Fitch credits *fagi* to beech but this was an unique example and no doubt an accidental capture.

This is a strikingly distinct species in the low crest with the large overhanging knob-like anterior lobe. Fowler in the Biologia figures Fairmaire's type, showing both the knob and the acute posterior angle. The writer has examined the Fitch type of *Telamona fagi* in the New York State Collection. It is a male (No. 687) and agrees in all respects with the males of this species. The anterior lobe, "double the height of the posterior half," would at once separate it from every other species except *scalaris*. Funkhouser placed it as a synonym of this species in his Cornell List but the long humeral angles at once bar it from consideration there. Emmons' figure of *Telamona acclivata* is typical of this species except from the green color which he does not mention in his description. The structural characters, however, leave no room for doubt that it belongs here. The Fitch Collection in the National Museum has a female of this species taken July 11, '82 which bears a green label "*acclivata*" and there is a female in the Uhler collection similarly labelled.

2. *Heliria gibberata* Ball. Plate 1, Fig. 11.

Heliria gibberata Ball. Jl. Wash. Acad. Sc. XV; p. 200; 1925.

Slightly smaller and darker than *cristata*, with the crest nearly uniform in height and only slightly overhanging. Female: length 10 mm., width 7 mm., height 5 mm.; male: length 8 mm.

Pronotum long, low, acute, weakly striated, crest prominent, situated as in *cristata* but with the posterior lobe long, almost as high as the anterior and nearly level, the anterior lobe rising in a gentle curve to the rounding and only slightly overhanging apex. Humeral angles very prominent in the

female; resembling *cristata*. The males are shorter with a lower and less differentiated crest and with the humeral angles much reduced.

Color. Pale creamy ground with irregular dark mottlings giving a grizzled appearance, these usually emphasized on anterior and posterior margins of crest, the latter often extending as an oblique stripe to costa.

Habitat. Collected in July by the writer and H. H. Knight in numbers on hackberry (*Celtis occidentalis*) at Ames, Iowa, a fine series from Galesburg, Ill., Stromberg (Ill. Coll.), (Goding Coll., U. S. N. M.); one female, Lincoln, Neb. (Osborn Coll.); and one from Louisiana (U. S. N. M.). In the American Museum is a specimen labelled "Post Oak Matausch," probably from New Jersey where he did most of his collecting. Both adults and nymphs were taken from hackberry. The nymphs were abundant in June and early July and were found feeding on the underside of small branches, usually resting against a leaf base or scar. The adults rest on larger branches where their resemblance to the rough warty bark affords almost perfect protection. The difference in the shape of both lobes of the crest renders this a strikingly distinct species. The hackberry occurs from Quebec and Manitoba south to North Carolina and Louisiana and doubtless where collectors learn to detect it this species will be found in favorable locations throughout the greater part of this range.

3. *Heliria mexicana* Stål. Plate 1, Fig. 12.

Telamona mexicana Stål. Öfv. Vet. Akad. Forh., p. 249, 1869.

Telamona mexicana Fowler. Biologia Homop., p. 144, pl. 9, fig. 5, 1896.

Heliria cornutula Ball. Jl. Wash. Acad. Sc., XV: p. 201, 1925.

Resembling *gibberata*, crest slightly longer, anteriorly upright or slightly retreating, superficially resembling *Telamona maculata*. Female: length 10–11 mm., height 6 mm., width 7 mm.; male: length 8.5 mm.

Pronotum low, the apex abruptly pointed, striations becoming definite posteriorly; crest larger, longer than in *gibberata* the anterior margin arising perpendicularly from the face of the metapodium, excluding the median convexity; anterior lobe large, anterior angle broadly rounding; posterior lobe but little lower than the anterior, upper margin horizontal, posterior angle almost right-angled. Humeral angles longer

than in *cristata,* rather narrow at base, then expanded and rounding to the long apices, as a whole, extraordinarily ear-like. Male crest smaller, the anterior margin sloping, the anterior lobe inclined to be broadly pyramidal.

Color. Pale gray, sometimes with a greenish tinge, mottled with darker, usually the dark color is emphasized across the metapodium; on the upper part of crest and in two bands behind the crest; two examples are closely and almost uniformly irrorate with dark.

Habitat. Two females were swept from sweet gum (*Liquidambar*) in July along the edge of a swamp at Sanford, Florida, by the writer. Examples have been examined from Long Island, N. Y. (Olsen and A. M. N. H.); Elizabeth, N. J., and Bronx, N. Y., October 3, 1905 (Matausch Coll. A. M. N. H.); two females, Pine Island, New York (Schaeffer, Brooklyn Mus.); a female, Hummelstown, Pa., Sept. 8, 1920 (Knull, De Long Coll.); a male, Maryland (Uhler Coll., U. S. N. M.); a female, Tennessee (Baker Coll. U. S. N. M.); a male from North Carolina (U. S. N. M.), and Stål's type from Mexico.

This species is intermediate in character between *gibberata* and *sinuata.* It can be readily distinguished however from both by its large upright crest and the constricted base of the humeral angles. The shape and coloring of the crest resemble that of the upright flakes of bark on the sweet gum.

Stål placed *mexicana* in *Telamona* although he emphasizes the extremely large humeral angles. His description and Fowler's figure in the Biologia indicate a much smaller insect (7 mm.) than here described. The face view shows the humeral angles with strongly upturned margins. The writer was misled by these differences and the fact that this species had only been found at that time from Long Island to Maryland. Later, collecting them in Florida and finding the food plant was the subtropical sweet gum led to a re-examination of the matter and the conclusion that Stål's type was either a male of this species or a small parasitized female and that the curved margins shown in Fig. 5b was a mistake in shading or an attempt to show dark markings as the colored figure does not indicate that they are curved. Matausch records a *Telamona* "near *Heliria*" from *Liquidambar* in New Jersey which he says was like one taken in the Bronx the previous year. This probably refers to this species but he apparently did not label his material.

4. *Heliria sinuata* Fowl. Plate I, Fig. 13.

Telamona sinuata Fowler. Bio. Cent. Amer., Vol. II, p. 144, table 9, fig. 7, 1896.

Telamona ehrhorni Ball. Proc. Biol. Soc. Wash., XVI, p. 180, pl. 1, fig. 4, 1903.

Resembling *mexicana* but with the crest shorter and placed well back of metapodium. Darker, shining. Female: length 10 mm., width 6 mm., height 5.5 mm.; male: length 9 mm.

Pronotum low with about four irregular but well marked striae arising below the crest and running to the apex. Another group of striae arise at the anterior base of the crest and spread out irregularly on its surface. Crest rather short, set well back of the metapodium, the anterior lobe an obtuse pyramid, the posterior lobe short but high, resembling a step on the posterior face of the pyramid. The crest is sharply and deeply compressed at the points, a line at the anterior base, and depressed oval near the apex of pyramid and a larger oval in front of the posterior base, behind which the posterior margin is much inflated. Humeral angles shorter and broader than in *mexicana,* broad at base, acutely angular with the margins straight.

Color. Mottled black and white, shining. Ground color, creamy-white with irregular black mottling, usually an irregular band across the metapodium, most of the crest, an oblique stripe to the costa and an apical band, dark. The more definitely marked specimens show a pair of large oval light spots on the upper face of the metapodium, a semicircular spot below the crest, a narrow line curving from the front of the crest around to the "step" and a transverse band back of crest and extending up its broad posterior face, white.

Habitat. The writer took four females from the "Blue" oak (*Quercus oblongifolia*) on the slopes of the Santa Rita Mts., Arizona, September 20, 1930. These oaks were isolated from any other trees and there can be little question about their food plant, especially as their color and markings blend perfectly with the color of the bark of the larger twigs. A single female from the Huachuca Mountains, Arizona, Aug. (H. Skinner, Phil. Acad.), two pairs from the same mountains (Brooklyn Mus.); one male from Arizona (Ehrhorn); and a male from Koehler, N. Mex., Aug. (Walton, U. S. N. M.). Fowler described it from Guerrero, Mexico. It is probbably confined to the mountains of the extreme southwest region.

This is a striking and distinct species in color and markings as well as in the heavy striae and compressed crest. *Telamona ehrhorni*

was described from a single male much smaller and more highly ornamented than the other examples. If further collecting should show that this was a constant form it would be worthy of varietal rank. See *H. clitella* for a discussion of Van Duzee's reference of an example in the Cornell collection to this species.

5. *Heliria fitchi* Ball. Plate I, Fig. 14.

Helira fitchi Ball. Jl. Wash. Acad. Sc., XV; p. 202, 1925.

Resembling *sinuata* but much lighter colored with a lower crest and a more definite "step." Length 11 mm., width 6 mm.

Pronotum very long, striae normal, crest moderate, placed well back of metapodium, intermediate in length between *sinuata* and *clitella,* anterior margin quite sloping, posterior margin vertical, anterior lobe almost uniformly rounding above, one-third higher than the posterior one, posterior lobe almost square. Humeral angles very short for this group, slightly acutely angled with the margin rounding.

Color. Pale creamy with quite definite dark mottlings, as follows: most of the crest including an oblique band to the costa, a spot on the costa before this and most of the apical region of pronotum. The oblique stripe and the apical markings are separated by a white band which is enlarged on the median line and contains a definite dark spot. One example is much darker than the others and the old examples are pale brown rather than creamy.

Habitat. Charter Oak, Pa., June 22 and July 9 (De Long Coll.); New York (Fitch Coll., U. S. N. M.); Maryland (Uhler Coll., U. S. N. M.).

This is a strikingly distinct species although closely related to *sinuata* and *clitella.* The examples from the Fitch collection in the National Museum are labeled *Telamona concava* Fitch and one parasitized example, probably a female, is labeled "type." This is not the species represented by the Fitch type in the Albany collection as will be discussed under *concava.* Apparently Fitch described *concava* from a single example which was later placed in the Albany collection. Later he collected this species which superficially resembles that species and placed it in his collection under the name *concava.* This may have been what misled Emmons into later describing the true *concava* as *ornata.*

6. *Heliria molaris* Butler. Plate I, Fig. 15.

Telamona molaris Butler. Cist. Ent., II, p. 222, pl. 3, fig. 13, 1877.

Telamona irrorata Godg. Bull. Ill. St. Lab. N. H., III, p. 418, 1894 (preoccupied).

Telamona dubiosa Van Duzee. Check List of Hemip., p. 59, 1916 (new name).

Telamona wescotti Funk. Biol. of the Memb. Cayuga Lake Basin, p. 253, pl. 26, fig. 17, 1917 (not Godg.).

A low heavy set dark species resembling *clitella* but with a lower longer crest sloping in front. Length 11 mm., width 6 mm.

Pronotum long low, equalling the elytra, striations prominent and reaching the apex. Crest set well back long and low, the anterior margin a long gradual slope from the metapodium. The dorsum nearly horizontal with only a slight sinuation between the two lobes; posterior margin slightly overhanging, the angle acute. Humeral angles very short almost right angled, not as prominent as in *fitchi.*

Color. Dark sooty brown; the darkest of the northern representatives of the genus with only slight mottlings of gray in the lighter examples.

Habitat. Nymphs and adults have been taken by the writer from the burr oak at Ames, Iowa; Lake Geneva, Madison and Lewis, Wisconsin. Examples have been examined from Ill. (Goding, Ill.), Lake Superior, Minn. (Lugger, Minn.), Grimsby, Ont. (Uhl., U. S. N. M.) and Butler's type was from "Saskatchewan" (Bourgeau).

Butler's species had never been recognized as his description is short and the figure small and very poor, the "bifid process" being much exaggerated. Examples of *Palonica pyramidata, P. tremulata* and *Heliria praealta,* the three species of large treehoppers that might possibly occur in Saskatchewan were sent Mr. W. E. China of the British Museum for comparison with the type. Mr. China reported that the type (♂) was closest to *H. praealta,* but was much larger, more coarsely punctate, had a strongly ribbed posterior process, wider and more swollen hump with the two lobes very distinct. He sent three sketches which with his description leave little room for doubt that *molaris* is the burr oak species that has been called *dubiosa.* This species has been found in Ontario, northern Wisconsin and on Lake Superior in Minnesota. The burr oak goes as far west as Manitoba and probably the "Saskatchewan" of Butler's day also included the territory west of Ontario. The nymphs are extremely long and slender with two angular projections from the vertex a relatively low pronotum and a double row of long abdominal spines laying flat and shingled over each other. The

nymphal characters are so distinctly those of *Heliria* that there can be no question but what this species belongs here rather than in *Telamona*.

7. *Heliria clitella* Ball. Plate II, Fig. 16.

Heliria clitella Ball. Jl. Wash. Acad. Sc., XV; p. 201, 1925.

Telamona sinuata Van Duzee. Bul. Buff. Soc. N. S., IX, p. 69, 1908 (not Fowler).

Resembling *sinuata* but with a short oblique crest and short humeral angles. Length 11 mm., width 6 mm.

Pronotum long, low, striae only normally developed and not prominent at apex. Crest shorter than in *sinuata,* anterior and posterior margins almost parallel, sloping, anterior lobe pyramidal or rounding, the posterior lobe short, the angle acute, produced. Crest with two compressed areas, one along front margin and the other parallel with it. Just before the posterior margin these two troughs are separated by a very pronounced ridge that extends to the apex of the pyramid. Humeral angles very short and broad, rounding to just before the slightly acute apices.

Color. Grizzled gray, heavily mottled with dark, without definite pattern, a broad creamy stripe arising from just below the posterior angle of the crest and extending two-thirds of the way to apex of pronotum.

Habitat. The writer has taken it from the "blue" oak (*Quercus oblongifolia*) along the foothills of the Santa Rita Mountains, Arizona, in late April and May. A pair from the Huachuca Mountains, Arizona (Schaeffer, Brooklyn Mus.); a male from Arizona (Cornell coll.); and another example from Arizona (Woodruff Coll.).

The grizzled combination of ashy and sooty lines is exactly like that presented by the ridges of bark on the limbs of its host plant. The much shorter crest and acute posterior angle will at once separate it from *sinuata* which is found on the same host. The Cornell example is the one Van Duzee listed with some doubt as *sinuata*.

8. *Heliria gemma* Ball. Plate II, Fig. 17.

Telamona sinuata Funk. Hemip. Conn., p. 191, 1923 (not Fowler).

Heliria gemma Ball. Jl: Wash. Acad. Sc., XV, p. 202, 1925.

Resembling *fitchi* but paler and with a less definitely sinuated crest; crest intermediate between that of *fitchi* and *concava*. Large, female light creamy with brown mottlings,

males brown; hairy, crest long, broadly pyramidal with a posterior sinuation or step. Length, female 11 mm., width 5.5 mm., height 5.5 mm.; male, length 8–9 mm.

Pronotum long, acute, crest arising just back of the metapodial slope, anterior margin sloping insensibly into the outline of the rather large broadly rounding anterior lobe, posterior lobe short, sometimes almost merged into the posterior slope of the anterior one, usually represented by a slight step or sinuation, the posterior angle obtuse and the margins rounding into the posterior process. Humeral angles very broad, about right-angled, equaling or exceeding the breadth of the eye.

Color. Female, pale creamy, irregularly irrorate and mottled with brown, the brown mottling emphasized on the crest, along the oblique stripe and at the apex of pronotum. The creamy shade emphasized in a semi-circle beneath the crest on either side and in a band behind the crest which is connected with a definite white stripe on the posterior face of crest. The semi-circles are irregular along the margin, have brown mottling along the lower border and have a tooth of light pushed up into the anterior base of the crest. The males are densely hairy, almost uniform brown, with traces of the creamy tooth and the posterior stripe.

Habitat. The writer has examined examples from Vermont? (Barrett); Lancaster, New York (Van Duzee Coll., Ames); Catskills, New York (Olson); Adirondacks, New York (Barber); Catskills, New York (Drake); Mt. Katahdin, Maine (Barber); New Hampshire and Massachusetts (U. S. N. M.), and Toronto, Ontario (Davis, Royal Mus.), all taken in August and September and all from the higher mountain regions except the Lancaster and Ontario specimens. No food plant has been recorded. The color and markings would harmonize well with the large toothed aspen (*Populus grandidentata*) which is found in this general region. An example in the Uhler collection with the locality label faded out is marked *concava* Fh. Although undoubtedly a *Heliria* and closely related to *fitchi* and *concava* this is a very puzzling species. The pyramidal crest suggests the species of *Palonica,* while in the extreme hairiness of the males and the difference in shape and color of the sexes it resembles the group of species in *Telamona* that includes *decorata.* It is undoubtedly a representation of a primitive type and probably indicates the line of development of these groups.

9. *Heliria strombergi* Godg. Plate II, Fig. 18.

Heliria strombergi Godg. Bull. Ill. St. Lab. N. H., III, p. 423, 1894.

Resembling *Palonica pyramidata* var. *declivata* but larger and with much longer humeral angles and a smaller crest. Long, slender, crest low, with the anterior lobe an acute pyramid and the humeral angles extremely long and slender. Length 10 mm., width 7 mm., height 4.5 mm. Male, length 8 mm.

Pronotum long, slender, acute, crest long, low, the anterior lobe an acute pyramid, one-half higher than the horizontal posterior lobe, the posterior margin sloping into the pronotum. Anterior and posterior lobes independently inflated. Humeral angles strongly oblique, almost twice longer than wide, their apices bluntly rounding.

Color. Pale almost uniformly gray in the females; definitely marked with brown on metapodium and crest in the males.

Habitat. The writer has collected this species at Ames and Davenport, Iowa, and Rock Island, Illinois, and examined the Goding types (U. S. N. M.) from Galesburg, Ill. (Aug. 1–7, 1892, Stromberg), a series from Stromberg (Ill. Coll.), a female from Jacksonville, O., Aug. 1, 1898 (Osborn Coll.), as well as a pair from Dr. Drake's collection from Tupelo, Miss., July 1, 1921, and Lexington, Miss., August 16, 1921. Dr. Goding records this species from black willow and the writer's specimens from Davenport and Rock Island were from black willow. The writer collected this species in abundance at Ames one very foggy day in late July, 1897, but the notebook containing the host plant record has been lost. This is a very distinct species, probably southern in its distribution and reaching its northern limits in Central Iowa, Illinois and Ohio. The remarkable "ears" and acute anterior crest will at once distinguish it from all other species.

10. *Heliria scalaris* Fairm. Plate II, Fig. 19.

Thelia scalaris Fairmaire. Ann. Soc. Ent. Fr., Ser. 2, Vol. IV, p. 311, pl. 5, fig. 14, 1846.

Telamona fagi Emmons. Nat. Hist. N. Y. Agr., p. 154, pl. 3, fig. 10, 1854. (Not Fitch.)

Rich brown, crest large, anterior lobe knob-like, overhanging anteriorly. Length, female 9 mm., height 5 mm.

Pronotum rather broad and high, crest well back of metapodium, posterior lobe rectangular, slightly higher than wide, anterior lobe consisting of an elevated overhanging knob as

in *cristata*. Humeral angles triangular, the margins straight, equaling or slightly exceeding the width of eye.

Color. Uniform rich brown, rarely slightly speckled with pale on face, metapodium, knob and in a transverse band behind the crest. A short white line on the margin below the posterior lobe of crest.

Habitat. The writer has collected this species in some numbers from *Crataegus* at Ames, Iowa, and examined specimens from Kansas City (K. U. Coll.); Missouri (Uhler Coll., U. S. N. M.); Illinois-Stromberg (Ill. Coll.); Uhler, God. Coll., U. S. N. M.) (Titus); Minnesota (Minn. Coll.); Pine Island, N. Y. (Brooklyn Mus.); Pennsylvania (Bak. Coll. U. S. N. M.); Maryland (Phil. Acad.). The Ames examples were found most abundantly resting in rows on watersprouts that grew up through the head of hawthorn trees. They were intermingled in these rows with *Glossonotus turriculatus* and *G. crataegi*. Occasional examples have been taken resting on small branchhes near the outer margin of the tree. The Illinois example from Titus was taken from a wasp's nest.

H. s. var. **clivulata** nov. var. Plate II, Fig. 20.

Resembling typical *scalaris* but with a narrower and much higher crest. The anterior lobe is still knob-like but almost upright while the posterior lobe is very tall and narrow, its upper margin slightly sloping and its posterior face rounding into the curve of pronotum. Length 9 mm., height 6 mm.

Holotype, ♀, Little Rock, Iowa, August 2, 1919 (Ball), paratypes, 1 ♀, taken with holotype, 1 ♀, Winnebago Co., Minnesota, in Minnesota collection. 1 ♀, Brookings, South Dakota, July 11, 1923, in Osborn collection. The writer took his examples from an isolated thicket of wild plum. This may prove to be a distinct species when more material is available for study.

11. *Heliria praealta* Fowler.

Telamona praealta Fowler. Tr. Ent. Soc. Lond., p. 420, 1894.

Telamona turritella Buckton. Monog. Memb., p. 198, pl. 43, fig. 7, 1903.

Heliria rubidella Ball. Proc. Bio. Soc. Wash., 31, p. 28, 1918.

Heliria rubidella Yothers, Webster and Spuler. Jl. Econ. Ent., 22–269, 1929.

Smaller and paler than *scalaris* with an upright or sloping crest. Crest shaped like *sinuata* or *fitchi* but much shorter.

Humeral angles short and broad, about equaling the eye, the margin slightly rounding to the angular apex. Length female 9 mm., width 5 mm., height 5 mm. Length male 7 mm.

Fowler in 1894 described *T. praealta* from "Saguenay, Brazil (V. Huart), Belgium Museum collection." Later it developed that the specimens were sent the Belgian Museum by Canon V. Huard, of Quebec, who formerly resided at Saguenay, a town on a river of that name, 100 miles or more northeast of Quebec. The Canon was not able to give any information as to the food plant and kept no material. Only three species are known from that far north so *Palonica pyramidata, P. tremulata,* and *Heliria rubidella* were sent Mr. China, who reported that it was undoubtedly the same as *rubidella.* Buckton in his characteristic careless way redescribed the species as *turritella* from the same material used by Fowler. Mr. W. E. China informs me that one of Buckton's types has the label *Thelia praealta* still on it.

Key to the Varieties of *Praealta* (Females)

A. Dark mottled brown. Crest usually higher than its width. 1. typical *praealta* Fowler.

AA. Testaceous or pale brown with light mottling. Crest usually broader than its height ..... 2. var. *rubidella* Ball.

Typical *praealta* Fowler. Plate II, Fig. 21.

Resembling *scalaris* but smaller and paler with a much narrower crest set well back of the metapodium, upright or slightly sloping, higher than its basal width, the anterior lobe upright, rounding above the posterior lobe, narrow, slightly sloping. The crest is narrower and higher than in var. *rubidella.*

Color. Dark dirty brown. In a few examples there are indications of a whitish "bloom" as in the var. *rubidella.* This species superficially resembles *Palonica pyramidata* var. *declivata* but is much smaller. The definite testaceous color and general structural character show an unmistakably close relationship to the *scalaris* group from which it was probably derived.

Prof. Cooley and the writer found this variety in abundance on the chokecherry (*Prunus melanocarpa*), in a canyon near Bozeman, Montana, July 27, 1923, and examples have been examined from Helena, Montana (Mann); Garland, Utah (U. S. N. M.), and Veta pass, Colorado, August 9, 1925 (Drake). M. A. Yothers sent a long series that were injuring apple trees at Wenatchee, Wash-

ington, June 30, 1930. The Quebec Province record indicates that it extends northward around the Great Lakes. The reference to *praealta* in the Van Duzee and Funkhouser Catalogs from "Pa." was based on an example of *Telamona concava* and that from "Fla." on an example of *Telonaca alta.*

Variety *rubidella* Ball. Plate II, Fig. 22.

Resembling *praealta* but much paler with a lower sloping crest with relatively little differentiation between the lobes; the dorsal margin sinuate and sloping rather than stepped, the posterior angle nearer a right angle than in *praealta.*

Color. Pale testaceous, a whitish "bloom" appears in mottlings on the metapodium, an oval extension below the crest and a transverse posterior band which connects with a light stripe on the posterior face of crest. Often the testaceous shades in to dark brown along the margin of the light areas, and the median carina may be dark brown and distinct in these areas. The males are much smaller and darker than the females and have very small and only slightly sinuate crests.

Habitat. The writer has taken this form in abundance from chokecherry in the mountains west of Fort Collins, Colorado, and a few from apple in his orchard at Logan, Utah, July 9, 1915, again in increasing numbers August 2, 1923, and in still greater numbers in August, 1928. Van Duzee records taking a variety of *scalaris* from chokecherry in the mountains of Colorado that was undoubtedly this species. The National Museum has an example from Bueno, Washington, and other examples from Colorado (Goding Coll.), LaVita, Colorado (Bak. Coll.), DeLong took it at Estes Park, Colorado.

5. Genus *Telonaca* Ball.

Telonaca Ball. Proc. Bio. Soc. Wash., 31, p. 27, 1918.

Resembling *Telamona* but with a slight sinuation or "step" on the posterior face of crest. Close to *Palonica* but in that genus the crest arises back of the metapodium. Crest broad, high, foliaceous at base, sometimes narrowing above; anterior margin, arising almost directly from the metapodium. Pronotum long, acute; humeral angles prominent, acute. The members of this group are intermediate in characters between *Heliria* on one hand and *Telamona* on the other. They might be placed in *Telamona* if it were not for the "step" character which at once sets them off as in reality quite distinct and more closely allied to *Heliria* and *Palonica.*

The nymphs are much like those of *Heliria* except that the projections on the head are smaller and there are only two pairs of very large spines on the abdomen.

Type of the genus *Telonaca ramona* Ball.

KEY TO THE SPECIES OF *Telonaca* (FEMALES)

A. Humeral angles long and acute, much longer than eye. Species gray or mottled ..... 1. *alta* Funk.
AA. Humeral angles but little more than a right angle, about equaling the eye; species green ..... 2. *ramona* Ball.

1. *Telonaca alta* Funk. Plate II, Fig. 23.

Telamona alta Funk. Ent. News, XXVI, p. 97, pl. 3, fig. 1 & 2, 1915.

Large, with an exceptionally high crest and acute humeral angles. Superficially resembling *Heliria mexicana* but with a much narrower and higher crest, resembling *Telamona collina* but with the crest much higher and possessed of a posterior "step." Length female 10.5 mm., width 7 mm., height 7 mm.

Pronotum broad, crest broad at base, very high equaling the width between the humeri, the anterior margin on a line with the metapodium. Apex broadly rounding, posterior margin slightly sloping with a distinct step and light area. Humeral angles long and acute, longer than their basal width, much longer than the eye.

Color. Pale yellowish, with fuscous mottling on the crest and slight indications of the usual oblique stripe and posterior band. The male differs from the female in the narrower crest, sometimes much narrower with a less definite step and less markings.

Habitat. W. E. Stone and the writer took nymphs and adults of this species from the turkey oak (*Quercus catesbaei* Mich.) growing on the high sandy ridges at Sanford and Clearmont, Florida. The nymphs appear in March and the adults in early April running on into May. Four other examples from Florida have been examined, a male, Tampa, May 22, 1908 (Van Duzee) and two females (Davis, Olson), 1 ♀ Gainesville (Weld). Funkhouser's type was a female from Spring Creek, Georgia, July 20, 1912. The nymphs resemble those of *Heliria gibberata* in general shape and anterior horn, but they have only the first two pairs of the abdominal spines developed.

2. *Telonaca ramona* Ball. Plate II, Fig. 24.

Telonaca ramona Ball. Proc. Bio. Soc. Wash. 31: p. 28, 1915.

Large, pale green, resembling *Telamona monticola* with a higher, variable but usually broadly pyramidal crest with a faint step. Length female, 10 mm., width 6 mm., height 6 mm.

Pronotum long and slender, crest pyramidal, very variable in width arising from the face of the metapodium with only a slight sinuation, sloping or occasionally upright in front. The whole crest may be narrowly pyramidal with a broad apex and a definite "step" on the posterior margin or much narrower, upright, with an acutely rounding apex and the "step" almost wanting. Humeral angles shorter than in *alta,* only slightly longer than the eye, the apices acutely angled, the anterior margins slightly rounding.

Color. Pale green fading to greenish-yellow in dried specimens, sometimes with a slight rufous cast, unmarked except for a single black spot above each eye.

Habitat. The writer has collected this species from oak at the mouth of a canyon, Pasadena, Cal., July 31. Prof. Hine took it in some numbers on oak in the foothills above Ontario, Cal., July 25. Examples have been examined from Los Angeles, Cal. (Coquillett, U. S. N. M.) and San Bernardino Co., California, in June (Van Dyke, Cal. A. S.) and females from the same place in September (Van Duzee, Cal. A. S.).

This species appears to be confined to a single species of oak growing in the lower parts of the canyons in southwestern California. The common form has the narrow crest with only a trace of a step while a rarer variety shows a much broader outline.

T. r. var. **pasadena** nov. var. Plate II, Fig. 25.

Resembling typical *ramona* in form and color but slightly smaller with a lower broadly pyramidal crest that is roundingly truncated above and rarely shows the step.

Holotype ♀ Pomona, Cal. (Fall); allotype ♂ Ontario, Cal. July 25, '07 (Hine). Paratype ♀ San Diego, Cal. 7–4–27 (Davis). Paratype ♂ San Diego, Cal., 6–5/13 (Van Duzee). Two males and a female paratype Forest Home, San Berd. Co., Cal., June 12 and 14, 1928 (Van Dyke). The Ontario example was taken from oak with typical *ramona*. Holotype, allotype and one paratype in the author's collection, paratypes in Calif. Academy of Science.

6. Genus **Palonica** nov. gen.

Related to *Telonaca* in the variable crest and the posterior "step" but the crest is placed well behind the metapodium instead of arising as a continuation. Resembling *Telamona* but with a very variable pyramidal crest which in typical cases shows a sinuation or "step" that is lacking in that genus.

Pronotum extremely long and acute, usually slightly exceeding the elytra; crest placed well back of the humeral angles; anterior margin arising back of the metapodium, varying from obtusely to acutely pyramidal, sometimes in the same species but in typical examples showing a definite "step" or sinuation; humeral angles variable but not long and acute as in typical *Heliria* nor as rounding as in many *Telamona*.

Type of the Genus *Telamona pyramidata* Uhl.

When describing the genus *Telonaca,* the writer called attention to the relationship between *T. ramona* and *Telamona pyramidata* and suggested that *pyramidata,* except for its wide variability within the species, was probably more typical of the group than *ramona.* The discovery of additional species and a careful study of the probable lines of development lead to the conclusion that there are two separate groups represented, both possessing the "step" but in other characters quite distinct.

Key to the Species of *Palonica* (Females)

A. Crest usually acutely pyramidal. Species creamy or gray-brown with dark brown markings.
B. Base of elytra not dark ..... 1. *pyramidata* Uhler
BB. Base of elytra dark (Mexican) ..... 2. *satyrus* Fowler
AA. Crest broadly obtusely pyramidal. Species green or very dark.
C. Crest sinuate and with a definite posterior angle, species dark ..... 3. *tremulata* Ball
CC. Crest very obtuse, almost symmetrical, species green. 4. *viridia* Ball

1. *Palonica pyramidata* Uhl.

Telamona pyramidata Uhler. Wheeler's Rept. Chief Eng. for 1877, p. 1333.

Long, slender, the apical process very long, slender, exceeding the elytra, with a variable but usually acute pyramidal crest well back of metapodium. Humeral angles rather prominent, equaling the eye. The males are much smaller than the females.

Color. Yellowish or grayish, with irregular dark mottlings usually in the form of two variable stripes arising on the metapodium, uniting on the crest, and again separated by an angular white area which they border to the costa.

Habitat. The writer has taken this species in abundance on the black willow wherever he has collected. It is undoubtedly one of the most widely distributed of the treehoppers, occurring from Massachusetts to Oregon and from Saskatchewan, south to Louisiana. It is widely variable in size and color and especially in the size and shape of the crest. The following forms, worthy of varietal rank, are separated as follows:

Key to the Varieties of *P. pyramidata* (Females)

A. Crest narrow, upright, acutely angulate.
  B. Large, grayish and obscurely mottled.
    C. Crest narrow, tongue-like or acuminate, sinuation or "step" sub-obsolete ..... 1. var. *pyramidata* Uhler
    CC. Crest slightly broader and shorter with a definite step or sinuation on the posterior face. 2. var. *declivata* Van Duzee
  BB. Small, creamy with definite brown markings. 3. var. **portola** nov. var.
AA. Crest much lower and broader.
    D. Crest nearly quadrangular, dorsum slightly oblique. 4. var. **ampliata** nov. var.
    DD. Crest very low with a long gentle slope from the metapodium and an abrupt upright posterior face. 5. var. **nasuta** nov. var.

1. Typical *pyramidata* Uhler. Plate II, Fig. 26.

Large, yellowish, obscurely mottled with dusky, the males frequently shading to brown. Crest narrow, upright, placed well back of the metapodium, narrowing to an obtusely rounding apex, usually higher than its basal width and lacking any definite "step" on the posterior face. Length, female, 9–11 mm.; male 8 mm.

Habitat. The writer has collected this variety on the black willow in California, Colorado, Iowa, Illinois and Wisconsin and has examined examples from California (Van Duzee), Star City, Saskatchewan (Skinner); Washington (Osborn); Oregon (Van Duzee); Yellowstone Park, Wyoming (Minn.); Montana (Drake); North Dakota and Minnesota (Minn.); Kansas (DeLong, Kan.); Illinois Goding, U. S. N. M.); Albany, New York (N. Y. State); Cranberry Lake, New York (Osborn and Drake); Boston, Massachusetts (Morrison, U. S. N. M.); Louisiana (Baker, U. S. N. M.).

The type of this species is a male in the Uhler Collection (U. S. N. M.) labeled "S. Colo.," which has the typical narrow pyramidal crest.

2. Var. *declivata* Van Duzee. Plate II, Fig. 27.

Telamona declivata Van D. Bull. Buf. Soc. Nat. Sc., IX, p. 64, 1898.

Resembling var. *pyramidata* in size and color, crest variable, not as tall and with a sinuation on the dorsum or a definite step on the posterior face.

Habitat. The writer has collected this variety on the black willow in Colorado, Utah, Iowa, Illinois, Wisconsin and District of Columbia and has examined examples from California (Osborn); Placerville County, California (Goding Coll., U. S. N. M.); Radison, Saskatchewan (Skinner); Idaho (Osborn, Piper); Beaver, Utah (Brooklyn Mus.); Yellowstone Park, Wyoming; Northwest Nebraska (Barber); Missouri (Uhler, U. S. N. M.); Illinois (Titus); Toronto, Ontario (R. M. Ontario); Ithaca, New York (Cornell); Maryland and Virginia (Uhler, U. S. N. M.).

This is the most abundant form of the species and has occurred along with the typical *pyramidata* form wherever the writer has collected. The separation is purely arbitrary as there are all gradations, sometimes occurring on the same tree but in general the two forms are quite distinct and may be kept separate for purposes of defining the variations. The variety was described from four females, of which the writer has examined one in the Cornell collection and one in the Davis collection. These differ somewhat but both show the step or sinuation and both have higher crests than the average. Van Duzee in describing this as a species limited *pyramidata* Uhl. to the mountains of Colorado and this species to the eastern United States. In his Catalogue, however, he recognizes *declivata* from California. The writer has collected the different varieties of *pyramidata* in California, Utah, Colorado, Iowa, Wisconsin and the District of Columbia, and feels certain that there is but one widely variable species throughout the entire region.

3. Var. **portola** nov. var. Plate II, fig. 28.

Resembling var. *pyramidata* in form and structure except for the narrow, upright crest, scarcely tapering to the abruptly rounding and slightly sinuated to almost stepped apex.

Color. Pale, creamy, an irregular mottling on the humeri, the crest except the margins, an oblique stripe to the costa

and most of the apical process rich brown with white flecks. There is a definite extension of the yellow into the base of the brown marking on the crest on either side that is quite characteristic.

Holotype ♀ Quincy, Cal., July 23, allotype ♂ and three paratypes, Doyle, Calif., July 21, collected on black willow by the writer. One male, Billings, Montana, and a pair, Lake City, Cal., July 27, 1922 (Fox), the latter pair in the California Academy of Science.

This variety has a strikingly distinct color pattern but in other characters it varies towards the previous variety. It appears to be limited to the western mountain regions. All of the examples examined have been much smaller than typical *pyramidata*.

4. Var. **ampliata** nov. var. Plate II, fig. 29.

Resembling var. *declivata* but with a broader and more nearly quadrangular crest and less of the fuscous mottling. Crest broader than its height. Slightly sloping posteriorly, the anterior margins sloping to the metapodium with only a slight sinuation, the dorsum sloping posteriorly and definitely sinuated. The posterior angle right-angled.

Color. Pale tawny with a white line on posterior face of crest.

Holotype ♀ and allotype ♂, Josephine Co., Oregon, May 11, 1910. Paratypes 1 male, Osceola, Wis. (Ball); one female, Mont., two Yakima, Washington (U. S. N. M.), one Kaslo, Br. Columbia (Caudell and Currie, U. S. N. M.), one, male Mt. Tamalpais, Cal. (Van Duzee). Two examples in the Royal Museum, Ontario, from Edmondson, Alberta. This indicates an extreme northern and mountain distribution.

5. Var. **nasuta** nov. var. Plate II, fig. 30.

Resembling var. *declivata* but with a much lower and more sloping crest, resembling *T. viridia* in shape but the anterior slope of crest is longer and the crest is lower. Crest low, gradually rising from the slope of the metapodium and running in a straight line back to the low right-angled posterior angle or sometimes with a slight indication of the anterior angle, in which case the top of the crest is narrow and the slope to the metapodium is long and uniform.

Holotype ♀ and three paratype ♀♀, Davenport, Ia., Aug. 16, 1919 (Ball). Allotype ♂ and one paratype ♀, Ames, Ia. (Ball), one ♂, Ft. Collins, Colorado (Ball) and one Onaga, Kansas (Crevecoeur), one example Ill. (U. S. N. M.). All those collected by the writer were on black willow.

2. *Palonica satyrus* Fowl.

Telamona satyrus Fowler Biolog. Cent. Am. Homoptera, p. 145, pl. 9, fig. 9, 1896.

The writer has considered this a large and well marked variety of *pyramidata* and sent examples to China for comparison with the type. He writes that it is quite distinct from the example sent. "It is a larger and more robust species with different color pattern, the humeral lobes much more prominent, the metapodium more vertical less convex and (together with the head) covered with short erect bristles; the coriaceous base of tegmen fuscous."

Habitat. Known only from Guatemala.

3. *Palonica tremulata* Ball. Plate II, fig. 31.

Telamona barbata Funk., Biol. Memb. and Hemip. Conn. (not Van. D.).

Telonaca tremulata Ball, Jl. Wash. Acad. Sc. 15 : 203, 1925.

Resembling *pyramidata* var. *declivata* and *ampliata*, slightly shorter, stouter, with a broader sloping sinuate crest and much darker pigmentation. Length female 9–10 mm., width 5.5 mm., height 5 mm. Length male 8 mm.

Pronotum stout, the apical process rarely as long as the elytra, with a long low pyramidal crest sloping from the metapodium to the anterior angle with a slight sinuation; anterior angle almost a right angle; top of crest long, sloping, concave, slightly sinuate, posterior angle obtuse, the posterior margin sloping slightly less than the anterior. Humeral angles prominent, similar to *pyramidata,* not as long as their basal width, scarcely equaling the eye in length, slightly acutely angular, the apex rounded.

Color. Variable, usually soiled yellow, so heavily irrorated and mottled with dark fuscous as to give a general dirty grizzled appearance with still darker areas on the crest and extending obliquely to the costa as well as at the apex. The males are usually darker, sometimes with a brownish shade. The Utah examples are pale creamy with definite dark markings in sharp contrast.

Habitat. The writer has collected this species in late July at Salem, New York; Osceola, Wisconsin; and Ephriam, Utah, all from quaking aspen (*Populus tremuloides*) and has taken nymphs that were undoubtedly this species in abundance from aspen at Little Beaver, Colorado. Other examples have been examined from Canada (Baker, U. S. N. M.); Kearney, N. J., on poplar; Bayfield, Wisconsin (Wickham, Barber) and Montana (Cooley).

Examination of specimens shows that this was the species reported by Osborn and Drake as *T. barbata* as occurring on aspen at Cranberry Lake, New York. The color of this species closely resembles that of the bark of an aspen at the base of the branches.

4. *Palonica viridia* Ball. Plate II, fig. 32.

Telamona viridia Ball, Proc. Bio. Soc. Wash., 16: p. 178, 1903.

Resembling *tremulata* in form but with a low pyramidal crest with a bluntly rounding apex. Females green. Length female 10–11 mm., width 5.5 mm., height 5 mm. Male length 9 mm.

Pronotum long, acute, crest wide, low, sloping about equally from both sides to the rounding apex which is much lower than the basal width, anterior margin sloping into metapodium as in *tremulata*. There is usually a slight sinuation on the posterior slope. Humeral angles shorter and blunter than in *pyramidata*, obtusely angled, the anterior margins rounding, the posterior margin inclined to be angled, especially in the male, giving an exceptionally "ear-like" appearance.

Color. Female pea-green, fading to yellowish in dried examples; male green or dirty yellowish with dark mottlings emphasized in a dark band running from the apex of crest obliquely to the costa.

Habitat. The writer has collected this species from the native cottonwood of the plains (*Populus deltoides*) in Denver and Greeley, Colorado, and Ames, Iowa, and has examined specimens from Las Vegas, New Mexico (Cockerell, U. S. N. M.); Arkansas (Bak., U. S. N. M.); Nebraska, Missouri and Illinois (Uhler, U. S. N. M.); Illinois (on cottonwood—Gerhart), South Dakota (Osborn); Ohio (on cottonwood—Osborn).

This species is apparently confined to this or closely related species of cottonwoods and is found on the smaller twigs low down in the head of the tree. They occur rather late in the season, the females sometimes as late as September, and at this time the terminal buds for the following year are about the same size and color as the females and the slightly angular outline of the outer scale often resembles the outline of the crest. Examples have been found at the base of trees during the winter, apparently hibernating, but as the writer has observed them laying eggs in the fall, these were probably late maturing individuals caught and chilled.

This is a strikingly distinct species in both form and color. Some of the darker males may superficially resemble the males of

tremulata except for the broad and obtuse humeral angles rather than the acute ones of that species.

7. Genus *Telamona* Fitch.

Telamona Fitch, Cat. Ins. of N. Y., p. 50, 1851.

Pronotum elongate, triangular, with a more or less quadrangular crest placed well back of the humeral angles, dorsum of crest usually horizontal or nearly so, sometimes sloping or sinuate but not definitely stepped and rarely showing a pale spot on the margin. Humeral angles variable, usually acute or rectangular.

Fitch erected this genus for the species with quadrangular crests but did not differentiate between this genus and *Heliria* of Stål.. As restricted in this paper, in agreement with its type *ampelopsidis*, it represents a fairly homogenous group of moderately large, tree-inhabiting forms that can be distinguished by their large rectangular crests usually set well back on the dorsum.

The species as far as known are all single-brooded, the nymphs usually appearing in the northern region in May and June and the adults in July and August. The nymphs are fairly common on the smaller branches of the trees but are difficult to detect because they usually resemble the bark in both color and pattern. They are broad and rather flat, rarely showing any crest or spines until in the last nymphal stage a slight anterior protuberance appears on the dorsum.

Key to the Species of *Telamona* (Females)

A. Crest very large, quadrangular, often slightly overhanging the metapodium, humeral angles usually prominent, acute.
B. Humeral angles often long and acute, longer than the eye.
C. Species plain or sparsely ornamented, crest not constricted.
D. Humeral angles longer than the basal width, nearly twice the length of the eye. Species plain or with a pair of spots.
E. A pair of black spots on costa.....1. *maculata* V. D.
EE. Without definite black markings.....2. *collina* Walk.
DD. Humeral angles not longer than their basal width, a wavy oblique line on crest or entirely dark.
3. *ampelopsidis* Harr.
CC. Species ornamented, crest constricted, then widening at apex.
F. Species small (8 mm. or less), crest almost over the metapodium, dorsum only slightly sinuate....4. *tristis* Fh.

FF. Species large (10 mm.), crest definitely back of metapodium, dorsum strongly sinuate ..... 5. *concava* Fh.

BB. Humeral angles shorter, right-angled or obtuse.

G. Crest upright in front, species brown..... 6. *extrema* Ball

GG. Crest sloping back from metapodium.

H. Female extremely large, green, anterior angle of crest distinct (♂ fasciate) ..... 7. *unicolor* Fh.

HH. Female smaller, brownish, anterior angle of crest rounding.

I. Crest very broad much broader than high (Fla.). 8. **dorana** n. sp.

II. Crest about equally broad and high (S. Calif.). 9. **coronata** n. sp.

AA. Crest smaller, often rounding, where quadrangular, placed well back on pronotum. Humeral angles rarely prominent.

J. Crest arising well back on pronotum, usually abruptly; as high or higher than its median breadth or quadrangular and about equal.

K. Species large (females 10 mm. or more). Crests narrowing from both margins, inclined posteriorly and obliquely truncate.

L. Female pale green with a coppery cast, and maculate with small creamy spots..... 10. *monticola* Fab.

LL. Female pale dirty yellow or greenish with dark markings.

M. A greenish cast, crest definitely higher in front, dark, the dorsal margins brown ..... 11. *tiliae* Ball

MM. Dirty yellow, crest level or slightly sloping, obscurely fuscous, dorsal margin lighter. 12. *spreta* Godg.

KK. Species smaller, crests upright.

N. Crest upright or slightly pyramidal.

O. Crest upright, dorsum oblique ..... 13. *gibbera* Ball

OO. Crest pyramidal, dorsum oval ..... 14. *tarda* Ball

NN. Crest low, quadrangular, species small and compact.

P. Crest as high as its median width, greenish-yellow with a dark apex ..... 15. *decorata* Ball

PP. Crest slightly broader than high, species reddish-brown.

Q. Cinnamon brown, scarcely marked, crest evenly inflated ..... 16. *woodruffi* Ball

QQ. Reddish brown with irregular creamy spots, crest with two inflated areas ..... 17. *compacta* Ball

JJ. Crest rounding or sloping from the metapodium without a definite angle broader than high, often much broader.

R. Crest very low, the posterior angle rounding or obsolete. 18. *wescotti* Godg.

RR. Crest with the posterior angle prominent, often acute.

S. Crest about twice as long as high, posterior angle acutely produced. (Atlantic and Gulf coasts). 19. *salvini* Dist.

SS. Crest higher, not twice as long as high, posterior angle not produced into a spine.

T. Crest low, longer than high, anterior base compressed, male crest obscure. (East of Rockies). 20. *reclivata* Fh.

TT. Crest higher and more oblique, anterior angle often obscure, anterior base inflated. Male similar to female. (Pacific Coast) ..... 21. *vestita* Ball

1. *Telamona maculata* V. D. Plate 3, fig. 33.

Telamona maculata V. D., Buff Soc. N. S., Vol. IX; p. 72, pl. 2, figs. 8, and 41, 1919.

Telamona lugubris Funk., Hemip. Conn., p. 188, 1923. (Not Ball).

Resembling *ampelopsidis* but with longer humeral angles and a broader crest. Length female, 10–11 mm.; width, 7 mm.; height, 6 mm.

Pronotum long, acute; crest broad, quadrangular, half longer than its height; anterior margin upright, arising just back of the line of the metapodium; anterior angle broadly rounded, dorsum slightly sloping posteriorly with the posterior angle slightly obtuse. Humeral angles extremely long, constricted at base, then slowly tapering to the blunt apices, nearly twice the length of the eye.

Color. Dirty straw-yellow with a trace of greenish, often a chestnut cloud on the anterior part of crest and rarely an interrupted band across the metapodium. There is usually a definite black mark on the costa just back of the crest extending down on to the nervures of the elytra.

Habitat. The writer has collected this species in Iowa, Minnesota and Wisconsin on the burr oak and has examined examples from Nebraska (Pierce), Missouri (Uhl, U. S. N. M.), Illinois, (Stromberg, Ill.), (Gerhart), Pennsylvania (DeLong), and Long Island (Davis).

2. *Telamona collina* Walk. Plate III, fig. 34.

Thelia collina Walk., List Homop. B. M., p. 565, 1851.

Telamona pruinosa Ball, Proc. Bio. Soc. Wash. Vol. 16, p. 177, pl. 1, fig. 7, 1903.

Telamona collina Funk., An. Ent. Soc. Am. 16, p. 109, pl. 4, fig. 6, 1923.

Resembling *ampelopsidis* and *maculata* but paler with a pruinose tinge and a sloping crest. Length female, 10–11 mm., width 6 mm., height 6 mm.

Pronotum as in *ampelopsidis*, crest higher in front and definitely sloping posteriorly to a weak posterior angle. The anterior margin of crest sloping back from metapodium or upright just before the apex, crest about the size of *maculata* but not as definitely quadrangular. Humeral angles longer and slenderer than in *ampelopsidis*, much shorter than in *maculata*, with a slight basal constriction.

Color. Pale cinnamon, with greenish and yellowish tinges, resembling the fresh bark of the sycamore with the bloom on. The metapodium is usually creamy with two cinnamon clouds above, while there may be traces of the rusty line of *ampelopsidis*.

Habitat. The writer has collected adults and nymphs of this Species on the sycamore in Iowa, Illinois and the District of Columbia and nymphs in Ohio and has examined examples from Kansas (K. U.), Missouri (Uhl, U. S. N. M.), Illinois (Gerhart), Ohio, Pennsylvania (Phila. Acad.), New York (Cornell and K. U.), Long Island (Davis), Maryland and Virginia (Uhl, U. S. N. M.). The type was from New York.

The nymphs are usually found on small limbs resting at the base of a leaf where they are almost indistinguishable from the branch in color and form. The color of the adults is almost identical with that of the fresh bark of the smaller limbs where they rest. They are usually found on the outer and lower limbs of old trees or in the tops of very small ones.

Funkhouser states that *pruinosa* Ball is a synonym of *collina* Walk. and gives two figures of the type drawn by Knight. One of these shows the humeral angles as extending beyond the eyes for more than twice the length of the eye which if correctly drawn would make it certain that *maculata* V. D. and not *pruinosa* Ball was the synonym as that is the only *Telamona* that has that character. The writer sent examples of both species to China for comparison with the type. He inclined to the belief that *pruinosa* was closer to the type but based his opinion largely on the shape of the crest and the absence of the black spot. Neither character is however definite, as Wm. T. Davis has an undoubted *maculata* from Long Island with a crest like China shows in his drawing of the type and the black spot varies in size and intensity and may have faded out on the type. He sent three drawings. The side view was quite different from that of Knight in showing a lower and

more evenly rounding crest and the face view showed humeral angles shorter than in Knight's figure but still longer than in *pruinosa*.

It will take a direct comparison by some one familiar with the variations in the two species to make a final determination so the writer has allowed this reference to stand.

3. *Telamona ampelopsidis* Harr. Plate III, fig. 35.

Membracis ampelopsidis Harris, Rept. Inst. Mass., p. 180, 1841.

Thelia cyrtops Fairm., Rev. Membr., p. 310, pl. 5, fig. 13, 1846.

Hemiptycha diffusa Walk., List Homp. B. M. Supp. p. 143, 1858.

Form of *pruinosa* nearly, crest slightly more rectangular, pale tawny, with an irregular, oblique brown line. Length 10 mm., width 6 mm., height 5.5 mm.

Pronotum with a large, almost quadrangular, crest arising just back of the line of the metapodium. Crest slightly longer than high, anterior and posterior margins varying from slightly sloping to upright or even slightly constricted at base, dorsum sloping as in *maculata*. Humeral angles long, acute, slightly longer than the eye, broader and shorter than in *maculata*.

Color. Grayish or pale creamy, with a tawny cast, an interrupted brown band across metapodium from the humeral angles, crest pale brown with an oblique stripe to costa. The lower margin emphasized into an irregular oblique line, broken upwards below the crest. The males are often much darker, occasionally almost black.

Habitat. The writer has collected this species, larva and adult, on the woodbine (*Ampelopsidis quinquefolia*) in Colorado, Iowa, Wisconsin, and Massachusetts, and has examined examples from Montana (Uhler), Nebraska (Pierce), Missouri (U. S. N. M.), South Dakota (Osborn), Illinois (Gerhardt), Indiana (U. S. N. M.), Ohio (Gossard), Kansas (K. U.), Pennsylvania (Warren), New York (all coll.), Ontario (Ont.), New Hampshire (U. S. N. M.), Maine (Bartlett, U. S. N. M.), Massachusetts (Boston Soc. N. H.), Rhode Island (U. S. N. M.), Connecticut (Conn.), New Jersey (Davis), Maryland (McAtee), Virginia and D. C. (Davis), North Carolina and Texas (U. S. N. M.).

Funkhouser reported the type of *diffusa* Walker as lost but recognized it as a distinct species of *Telamona* which he figured and lists in his catalogue. Mr. W. E. China found the type and

sent three drawings showing shape, venation and markings. From these it is evident that it is only the small dark marked form of *ampelopsidis* that occurs commonly in the North. Funkhouser's specimen was undoubtedly the same thing. Funkhouser calls attention to Van Duzee's error in placing this species as a synonym of *unicolor* but allows the same reference to stand on p. 259 of his catalogue.

Telamona ampelopsidis var. **tigrina** nov. var. Plate III, fig. 36.

Resembling *ampelopsidis* in size and general markings but with a lower and more rounding crest with the posterior angle almost obsolete. The crest is slightly more sloping in front than in the species, with a more rounding dorsum and the posterior slope extend from the crest far back on to the process without a definite posterior angle. Color pale straw without definite brown markings on crest except a number of fine but irregular and interrupted oblique lines. Length ♀, 11 mm.

Holotype ♀, April 26, 1907, Dallas, Texas. Two paratype females from the same place May 1, 1907.

4. *Telamona tristis* Fh. Plate III, fig. 37.

Telamona tristis Fitch. Cat. Ins. N. Y., p. 51, 1851.
Telamona coryli Fitch. Cat. Ins. N. Y., p. 51, 1851.
Telamona spreta of Van D. and Funk. (Not Godg.).

Small with a large quadrangular crest as in *concava*, resembling *ampelopsidis* but much smaller and more fragile. Length ♀, 8.5 mm., width 5 mm., height 5 mm.

Pronotum low and relatively short and blunt, shorter than the elytra, crest quadrangular, slightly longer than its height, definitely constricted at the base, the anterior margin not quite equalling the metapodium, dorsal margin slightly sinuate. Humeral angles right-angled or slightly acute, slightly exceeding the eye.

Key to the Varieties of *T. tristis*

A. Crest tawny or marbled with brown and white.
B. Crest tawny. ..... 1. *jucunda* nov. var.
BB. Crest marbled with brown and white. ..... 2. *tristis* Fh.
AA. Crest with a broad, median white band margined with dark brown. ..... 3. *coryli* Fh.

1. Variety **jucunda** nov. var.

Resembling typical *tristis* in size and structure.

Color. Pale tawny, sometimes with faint indications of white mottling in the female. Male tawny with a narrow

interrupted transverse band across the crest, broadly margined with tawny and narrow stripe on posterior margin of crest.

Holotype ♀, allotype ♀ and 3 pairs of paratypes, Osceola, Wisconsin (Ball) and three ♀♀ Onaga, Kansas (Crevecoeur). The writer collected his material from hazel brush (*Corylis americana*).

2. Var. *tristis* Fitch

Form and structure of the species.

Color. Dark brown or fuscous, mottled with paler spots, usually a definite white spot on anterior and posterior base of crest and a pair of spots on the dorsal margin. Sometimes the pattern of *coryli* is faintly outlined but obscured by the dark mottling.

Taken by the writer on hazel brush and ironwood in Iowa and Wisconsin and examples have been examined from Iowa (Knight on ironwood), Kansas (Crevecoeur), Missouri (K. U.), Illinois (Uhl., U. S. N. M.), Michigan (Hungerford, K. U.), Pennsylvania (DeLong), Ontario (U. S. N. M.), New York, (Fitch, Albany) (Davis), New Jersey (Davis), Connecticut (Conn.), Massachusetts and Vermont (B. S. N. H.), Maryland, West Virginia, and Florida (U. S. N. M.). Males of this variety are very rare; possibly all males are similar in color pattern.

3. Var. *coryli* Fitch

Form and structure of the species.

Color. Dark brown, mottled, with a broad white band occupying the entire crest except the anterior and posterior margins, and extending down the margin of pronotum; a small white spot on the anterior base of crest and a broad stripe on posterior face. The white band is often constricted at the base of the crest and there are usually brown mottlings along the edge of pronotum.

Taken by the writer on hazel brush and ironwood (*Ostrya*) with the preceding varieties in Iowa and Wisconsin and specimens have been examined by Iowa (Knight on ironwood), Kansas (Crevecoeur), Missouri (K. U.), Minnesota (U. S. N. M.), Illinois (Gerhart), Michigan (Hebard, Phil. Acad.), Pennsylvania (DeLong), Massachusetts (B. S. N. H.), New York (Fitch, Albany), Ontario (V. D., U. S. N. M.). Most of the males taken belong to this variety.

5. *Telamona concava* Fitch. Plate III, fig. 38.

Telamona concava Fitch. Homop, N. Y. St. Cab., p. 50, 1851.

Telamona ornata Emm. Nat. Hist. N. Y. Agr., p. 155, pl. 3, fig. 8, 1854.

Resembling *pruinosa* but with a high quadrangular crest. A small compact species with an almost square crest, sinuate above, a definite color pattern as in *Glossonotus crataegi*. Length 10 mm., width 6 mm., height 6 mm.

Pronotum relatively short and stout, crest well back of metapodium, tall, almost square, with the anterior angle broadly rounding, the posterior rectangular, slightly lower, dorsum concave. In some examples the crest is slightly inclined backwards with both faces parallel. Humeral angles almost equilaterally triangular or the margins a trifle rounding.

Color. Dark brown, irrorate, with the metapodium paler, a definite light crescent below the crest, a transverse band well back of crest extending forward on the median line to the crest, and a small semi-circular spot in the concavity of the crest, light. The dark areas are emphasized against the light markings, the lateral crescents extend in the form of oval spots into the base of the crest and often there is a connection between the crescent and the light area back of the crest.

Habitat. The writer has collected this species at Amery, Wis., and has examined examples from Michigan (Phil. Acad.); West Ohio and Bayfield, Wis. (Osborn Coll.); Illinois (Uhler Coll., U. S. N. M.); New York, (Fitch, Albany and U. S. N. M.; Woodruff); Chicopee, Mass. (Baker Coll., U. S. N. M.); Broad Top Mountain, Pa. (Phil. Acad.); Pennsylvania (Van Duzee). As far as present records go it appears to be northern in distribution. This species is very rare in collections and no host plant is known. The writer has examined the unique Fitch type (No. 686) in the State Cabinet at Albany and finds that it agrees with the description given by Fitch and also with the figure and description of *ornata* Emm. Emmons remarks that the color pattern of *ornata* resembles *G. crataegi*, which is the most distinctive character of this species. Fitch evidently had examples of both *concava* and *Heliria fitchi* in his collection but did not recognize them as distinct. When he came to select an example to describe and place in the State Cabinet he took the most definitely marked one, probably leaving in his own collection only examples of *fitchi* but labeled *concava*. This may explain why Emmons redescribed the species. The reference to *praealta* from Pennsylvania in the Van Duzee Catalogue was from an example of *concava* erroneously determined.

6. *Telamona extrema* Ball. Plate III, fig. 39.

Telamona extrema Ball, Proc. Bio. Soc. Wash. 16: p. 179, pl. 1, fig. 1, 1903.

Resembling *maculata* and *pruinosa* in size and form but with much shorter humeral angles and a larger, broader crest. Pale testaceous brown. Length ♀, 9 mm., width 5 mm., height 5.5 mm.

Pronotum relatively short and obtuse posteriorly, crest large, upright, longer than high, almost uniform in height, the anterior margin upright, arising on the line of the metapodium or nearly so. Dorsal margin convex, posterior margin very slightly sloping. Humeral angles roundingly right-angled, about equalling the eye.

Color. Uniform rich, testaceous brown, darkened a little on the dorsum of crest and narrowly margining a creamy white stripe on the posterior face of crest. The disc of the metapodium often has a greenish tinge.

Habitat. The writer has collected this species on the black oak in Iowa and Wisconsin, and has examined examples from Illinois (Godg., U. S. N. M.), Indiana (Gerhart), Pennsylvania (DeLong), New York (Woodruff, N. Y. S.), New Jersey (Davis), Long Island (Olson), Massachusetts (B. S. N. H.), West Virginia (Davis), Virginia (Phil. Acad.), Maryland (Uhl., U. S. N. M.), Alabama (Woodruff), Clayton, Ga. (Davis).

This is a strikingly distinct and easily recognized species by its large quadrangular crest and its uniform color. Examples of this species with the broadest crests approach the outline of an *Archasia* and suggests the line of development of this group.

7. *Telamona unicolor* Fitch. Plate III, fig. 40.

Telamona unicolor Fh. Cat. Ins. N. Y., p. 50, 1851. ♀
Telamona fasciata Fh. Cat. Ins. N. Y., p. 50, 1851. ♂

Resembling *ampelopsidis* in form but larger; female bright green, male straw color with dusky bands. Length female, 12 mm., width 6 mm., height 6 mm.

Pronotum strong, acute, crest broad and high, arising just back of the curve of the metapodium; anterior and posterior margins sloping, dorsal margin weakly convex and slightly inclined posteriorly; humeral angles broad, rounding, slightly obtusely angled, about equaling the eye.

Color. Female deep green in life fading to straw color in dried specimens. Base and apex of elytra fuscous. Male straw color, metapodium and anterior margin of crest mottled with brown, an oblique band near the posterior margin of crest, smoky brown.

Habitat. The writer has taken this species abundantly on hickory, black walnut and butternut in Iowa, Wisconsin, and Toronto, Can. Specimens have been examined from Arkansas (McElfresh), Kansas (DeLong), Missouri (K. U.), Michigan (Uhler, U. S. N. M.), Illinois (Gerhart), Ohio and Pennsylvania (DeLong) New York and Ontario (Albany), New Jersey (Phil. Acad.), Connecticut (Conn.), Massachusetts (B. S. N. H.), and Brownsville, Tex, (U. S. N. M.).

This is the largest species in the group and is strikingly distinct in the different color of the sexes. The nymphs have been taken abundantly on hickory and butternut. They are smooth bodied and resemble the bark of the smaller twigs in color and when resting in the shadow of some branch they are difficult to detect. The adults rest near the tips of the twigs where the green of the leaves protects them. Fitch described a variety of this species as *irrorata* which he said occurred on walnut but was very rare. From the description he evidently had a broad crested form of *monticola* in hand.

8. **Telamona dorana** n. sp. Plate III, fig. 41.

Resembling *monticola* in form and color but with a much longer crest and more acute humerals. Brown irrorate with white points. Length ♀ 11 mm., ♂ 10 mm., width 6.5 mm.

Crest extremely long fully one-half the length of the pronotum arising from the convex metapodium in front and slightly sloping to the rounding anterior angle. Top broad and broadly rounding or slightly sloping posteriorly to the definite but slightly obtuse posterior angle. Crest as long at base as in *extrema* but not as broad at apex the posterior margin with the same slope. Humeral angles slightly more acute than in *monticola,* about as in *extrema.* The crest is definitely more inflated than in *extrema* but not uniformly so as in *monticola.*

Color. Pale testaceous brown sprinkled with white points and with a white stripe on the posterior face of crest. Male darker brown with the white stripe broadened and emphasized.

Holotype ♀, allotype ♂ and 9 paratypes taken by W. E. Stone and the writer at Sanford, Florida, April 3, 1927; one female, Ocala, Florida, April 29, 1928; three males Mt. Dora, March 27, 1927, and one paratype female, Monticello, Florida, April 12, 1913 (Gill, U. S. N. M.). Nothing but males were taken March 27. On April 3 there were males, a few females and large nymphs which matured two days later. They were all taken on the turkey oak

(*Q. catesbaei*). The stout smooth nymphs were on limbs about the size of a lead pencil and resting in the angle of a branch.

Telamona extrema, dorana, coronata and *monticola* form a descending series in position and length of crest. They are however distinct species with definite characters, different food plants and distinct distribution.

9. **Telamona coronata** n. sp. Plate III, fig. 42.

Resembling *dorana* but smaller, paler, with a shorter and more angular crest, that is higher in front and sinuate dorsally. Length 9 mm., width 5 mm.

Crest arising in the line of the metapodium with only a slight slope, proportionally higher and more foliaceous than in *dorana*. The anterior portion highest, the angle narrowly rounding, dorsal line slightly sloping posteriorly and definitely sinuated, the posterior angle thereby emphasized and approaching a right angle. Humeral angles longer than in *dorana*, slightly acute.

Color. Pale greenish brown. The brown emphasized on the margins, no pale spots but the posterior margin of crest is light. Holotype ♂, June 5, 1913, San Diego Co., Calif. (Van Duzee), allotype ♀, October 20, 1913, San Diego Co., Calif., and one paratype female taken with the type. Holotype and paratype in collection of the Calif. Acad. Sciences. Allotype in collection of the writer.

This is a distinct litle species with a much longer and more upright crest than in *monticola*, much sharper humeral angles and it lacks the bulge in the metapodium of *dorana*. No food plant is recorded but it was taken the same day as an example of *Telonaca romona* which has the same color and they may well occur on the same oak.

10. *Telamona monticola* Fabr. Plate III, fig. 43.

Membracis monticola Fabr., Syst. Rhyn., 7, No. 4, 1803.
Telamona querci Fitch, Homop. N. Y. St. Cab., p. 51, 1851.
Telamona brunneipennis Buckton, Mong. Memb., p. 197, 1903.
Telamona unicolor var. *irrorata* Fh., 3d. Rep. p. 450, 1856.
Telamona celsa Godg. Am. Mus. Nov. No. 421, p. 21, 1930.

A large greenish-brown species, irrorate with small white spots. Crest set well back, about equal in height and width. Length female, 10 mm., width 6 mm., height 5 mm.

Pronotum short, broad and bluntly pointed at apex; crest almost quadrangular, inclined posteriorly; anterior margin sloping concavely into the curve of metapodium; dorsal margin convex, inclined posteriorly; posterior margin about

upright. Humeral angles broad, right-angled, about equaling eye. Lateral carinae obscure.

Color. Mottled brown and green, irrorate with light points and washed with a coppery reflection. The posterior face of the crest broadly white. The males are often smoky with only faint traces of the green.

Habitat. The writer has taken both nymphs and adults abundantly on the white oak with occasional captures on the bur and black oaks in Iowa, Wisconsin, District of Columbia, Virginia and Massachusetts and has examined examples from Manitoba (U. S. N. M.); Arkansas (McElfresh); Kansas (DeLong); Nebraska (Pierce), Missouri (K. U.); Illinois (Ill., Wescott); Michigan (Olsen); Indiana (Baker, U. S. N. M.), New York (Fitch, Albany); Ontario (Ont.); Pennsylvania (DeLong); Massachusetts (Titus); New Hampshire (Slosson); Vermont (B. S. N. H.); New Jersey (A. M. N. H.); Maryland (Barber); North Carolina (Sherman); Georgia (Davis); Alabama (Woodruff); Jacksonville, Fla., and Texas (U. S. N. M.).

This is one of the most abundant and easily recognized species of the group. In general outline it resembles *spreta* but is quite distinct in color. The writer has examined the Fitch type at Albany and there is no question about the species. Fairmaire's description of *monticola* was of course from an old specimen in which the green color had faded, but his mention of the broad, white stripe on the posterior face of crest would eliminate any other species that the outline would fit. It was probably described from a male in which the color is darker and the white stripe broader. Buckton's description and figure of *brunneipennis* are as usual very poor, but there can be but little question that he was also dealing with a male of this species. Fitch's description of *unicolor* var. *irrorata* was evidently based on females of this species which were accidental on walnut and therefore rare as he suggests.

Goding recently described *Telamona celsa* from Brazil. The type is in the American Museum collection and through the kindness of Dr. Lutz, Mr. C. E. Olesen has carefully compared it with examples of *querci* and reports that there is no character by which it could be separated. The eggs of this species pass the winter in oak twigs and it has no doubt been introduced into Brazil in nursery stock or arboretum material. A common European treehopper has been recently established in New Jersey in this same way.

Examples previously determined as *monticola* from central or southern Florida will probably prove to be *dorana* and, from California, *vestita* or *coronata*.

11. *Telamona tiliae* Ball. Plate III, fig. 44.

Telamona reclivata of Goding, Van Duzee and Funkhouser (not Fitch).

Telamona decorata Funkhouser, Bio. of the Memb., p. 264, plate 27, fig. 11, 1917 (not Ball).

Telamona tiliae Ball, Jl. Wash. Acad. Sc., XV, p. 203, 1925.

Intermediate between *spreta* and *reclivata* in outline, resembling *spreta* but with definite dark markings especially in the male. Length female, 10 mm., width 6 mm., height 5 mm.

Pronotum long, acute, crest broad, quadrangular, inclined posteriorly, the anterior margin sloping from middle of metapodium to middle of crest, crest obliquely truncate, the anterior angle roundingly rectangular, the posterior one obtuse, posterior margin upright, rounding into pronotum below. Humeral angles slightly obtusely angular, their margins curved, almost equalling the eye.

Color. Dirty grayish-green, fading to dirty yellowish, with most of the crest and an oblique strip to costa brown; in the females this brown area may only be emphasized on the margin but in the males it is broad and definite, a broad light stripe on anterior and posterior margins of crest.

Habitat. The writer has collected this species, both nymphs and adults, in abundance on basswood in Iowa, Wisconsin, and Ontario, and has examined examples from Minnesota (Baker, U. S. N. M.); Illinois (Wescott); Michigan (Bak., U. S. N. M.); Ohio (DeLong); Pennsylvania (Olson); New York (Albany), Ithaca, New York (K. U.); Pennsylvania (Olson); Ontario (K. U.); Massachusetts (B. S. N. H.); Connecticut (Uhl, U. S. N. M.); New Hampshire (Slosson).

This common basswood species has been almost universally determined as *reclivata* but the Fitch type at Albany shows the rounded anterior crest, as well as the other characters Fitch mentions in his description that make it certain that he was describing the much smaller oak species, as he stated. Funkhouser in his Biology of the *Membracidae* figures a strongly marked male of this species as *decorata* Ball and lists linden as a host. He probably did not have true *decorata* as he also records *barbata* from linden.

12. *Telamona spreta* Goding. Plate III, fig. 45.

Telamona spreta Godg., Cat. Membr. N. A., p. 417, 1894.

Telamona lugubris Ball, Bio. Soc. Wash., XVI, p. 179, 1903.

Superficially resembling *tiliae* but still larger and lacking the green and black contrast of that species. Length female, 11 mm., width 6 mm., height 5 mm.

Pronotum long, acute, lateral carinae obscure, crest as in *tiliae* or a little farther back with a longer anterior slope and a right-angled or often slightly acute posterior angle. Humeral angles as long as the eye, about right-angled, the margins rounding.

Color. Dirty brownish straw, with obscure markings on crest and an oblique band. These are sometimes almost wanting and again quite definite but not definitely black in color as in *tiliae.*

Habitat. The writer has taken this species, both nymphs and adults, commonly on the burr oak in Iowa, Minnesota and Wisconsin, and has examined examples from South Dakota (Knight), Illinois (Godg., U. S. N. M.), (Ill.), Michigan (U. S. N. M.) and Central Park, New York City (Davis). It no doubt occurs in the intermediate region but has not been recognized as a distinct species in collections.

Goding many years ago determined and distributed a number of different examples of *ampelopsidis* as his *spreta* with the result that *spreta* has been considered by every one as a synonym of that species. The writer, having Goding's erroneous determination in his collection, described this species as new. A study of the type, however, leaves no room for doubt that it was the burr oak species that Goding originally described. This species is much closer to *tiliae* in general appearance than to *ampelopsidis* and dried and faded specimens are sometimes separated with difficulty. The smaller size more definite green and black markings and shorter crest will ordinarily differentiate *tiliae.* The nymphs of this species have a double row of curved spines down the abdomen while most Telamona nymphs are smooth.

Telamona spreta var. **agrandata** nov. var. Plate III, fig. 46.

The writer has in his collection four female examples of what appears to be a variety of this species. They resemble typical *spreta* in color and ornamentation but are slightly larger, longer, with the humeral angles slightly longer and more acute and the crests placed well back and not sloping to the metapodium, while the dorsal margin is definitely sinuate, the anterior half rounding while the posterior half is slightly lower and straight or concave as in *concava.*

Holotype ♀, Madison, Wisconsin, June 16, 1918; paratypes one ♀ from Ames, Iowa, two ♀♀ Spirit Lake, Ia., August 1, 1919, all

collected by the writer. The Ames female had mated with a male *tiliae* but was not able to release the claspers and was captured by hand. This may prove to be a distinct species when more material is available for study. One example was taken on white oak and one on burr oak but both may have been accidental resting places.

13. *Telamona gibbera* Ball. Plate IV, fig. 47.

Telamona gibbera Ball, Jl. Wash. Acad. Sci., XV, p. 204, 1925.

Resembling *tiliae* but smaller and more definitely marked in the male. Slightly larger than *reclivata* with a taller, narrower and more definitely upright crest. Length female, 9 mm., width 5 mm., height 6 mm., length male 8 mm.

Pronotum low, rather broad with a narrow upright crest arising well back of the metapodium. Crest narrow, high with the anterior margin vertical and in line with the lateral angles; dorsum obliquely rounding, highest just back of the anterior margin and sloping down to the obtuse posterior angle, posterior margin slightly sloping and rounding into the broad apical portion; humeral angles broad, almost right angles, equaling the eyes, resembling *tiliae*. Male slightly smaller than the female with the crest lower, rounding, sloping equally from both front and back.

Color. Female dirty gray, irrorate, slightly darkened around the margin of crest and set off by a white stripe on the posterior slope. Male highly and strikingly ornamented as follows: Face and metapodium irregularly mottled with brown; crest heavily margined with dark brown with occasional light spots, a creamy area below the crest on either side which sends up a narrow yellow stripe into the dark of the crest, anterior carinae narrowly light and posterior slope broadly so.

Habitat. The writer has taken this species on *Quercus utahensis* in Long Valley, Arizona in August and has examined numerous examples from the higher elevations in Arizona where this species of oak grows, (Knight) (Wickham, Cal. Acad. Sc.—Ames) (Barber and Schwarz, U. S. N. M.) and Cloudcroft, N. M. (Wickham, Cal. Acad. Sc.).

14. *Telamona tarda* Ball. Plate IV, fig. 48.

Telamona tarda Ball, Jl. Wash. Acad. Sc., XV, p. 204, 1925.

Resembling *gibbera* but with a slightly more anterior and pyramidal crest. Length female, 8.5 mm., width 4.5 mm., height 5 mm. Length male, 7 mm.

Pronotum long and acute, about five lateral carinae strongly developed back of the crest as in *woodruffi;* crest arising only slightly back of the metapodium, anterior margin slightly sloping from the metapodium to just before the evenly rounded apex; apex about one-half the width at base, posterior margin more sloping than the anterior, its outline almost straight to where it rounds on to the pronotum. Humeral angles very short and rounding, one-half the length of the eye. Male very small, hairy, with a low rounding crest sloping equally from both margins.

Color. Pale dirty grayish-brown with slight darkening of the margins of the humeral angles and crest; median carina black interrupted before and behind the crest with light. Male darker with the crest mottled brown.

Habitat. The writer took one female in the District of Columbia and has examined examples from Roselle Park, N. J. (Matausch, A. M. N. H.). In the pyramidal crest with the slightly projecting blunt apex, the female of this species superficially resembles *Palonica pyramidata.* The smaller size, blunt humeral angles, darker color and lack of the "step" will, however, readily separate this species.

15. *Telamona decorata* Ball. Plate IV, fig. 49.

Telamona decorata Ball, Proc. Bio. Soc. Wash. XVI, p. 179, 1903.

Telamona barbata Van Duzee, Bul. Buff. Soc. N. S. IX; p. 65, 1908.

Resembling *tiliae* but much smaller, smaller and with narrower crest than *reclivata.* Greenish-straw with a black crest. Length female, 8 mm., width 4.5 mm., height 4 mm.

Pronotum moderately long, lateral carinae rather weak, irregular, crest low, quadrangular, placed well back on pronotum, very slightly sloping on both anterior and posterior face, the dorsum convex. Male smaller with a more rounding crest and with the entire pronotum densely hirsute.

Color. Greenish-straw with the crest pitchy, sparsely flecked with white, a narrow oblique band and the apex of pronotum brown, the posterior face of crest broadly white and a small white spot on anterior base. Male with the ground color distinctly brownish.

Habitat. The writer has taken this species, both nymphs and adults, on oak in Iowa and Wisconsin. Most of these were from the black oak (*Q. velutina*) but one nymph was taken from white oak and one from burr oak at Ames, Ia. Examples have been

examined from Ames, Ia. (Knight), Arkansas (McElfresh), Kansas (Crevecoeur), Missouri (Uhl., U. S. N. M.), Illinois (God., U. S. N. M.) (Gerhardt), Pennsylvania (DeLong), New York (Van Duzee, Cornell), (Schaeffer, Brooklyn Mus.) (Davis), Connecticut (Woodruff), New Jersey (Dickerson, A. M. N. H.), Maryland (Uhl., U. S. N. M.). Van Duzee's New Mexico male was *gibbera* and his California examples from willow were no doubt *P. pyramidata* var. *portola* which has the dark crest. True *decorata* has not been taken west of the plains.

This is a small compact and quite distinct species easily separated by its pitchy, almost quadrangular, crest and hirsute male. Funkhouser in his Cayuga List reported this species from basswood. On examination, however, most of his material proved to be highly colored males of *tiliae* (his *reclivata*) which frequently have the pitchy crest. He also reported *barbata* as a distinct species and credited it to oak and basswood, again confusing *tiliae* males. This species is undoubtedly confined to the oaks as food plants. In his Connecticut List Funkhouser quotes the writer as stating in correspondence that *barbata* was *not* an oak species. This statement was based on the common determination of *barbata* at that time and had reference to the species the writer has since described as *tremulata*.

16. *Telamona woodruffi* Ball. Plate IV, fig. 50.

Telamona woodruffi Ball, Jl. Wash. Acad. XV, p. 205, 1925.

Resembling *compacta* but with a slightly higher and more angular crest as in *reclivata* and less maculations. Length 8 mm., width 4 mm., height 5 mm.

Pronotum. Rather high, crest broader than high, slightly inclined posteriorly, dorsum long and straight, both angles rounding. Anterior margins sloping more than posterior and about in line with the humeral angles. Humeral angles roundingly right-angled, almost equaling the eye, much longer and more acute than in *compacta*. About five lateral carinae, quite definitely marked on the apical portion of the pronotum. Male with a smaller crest sloping into the metapodium anteriorly.

Color. Rich, red brown with occasional white flecks, much smaller and more obscure than in *compacta*. Carina interruptedly dark, posterior slope of crest light with dark margins. Male darker.

Habitat. The type material was taken at Elizabeth, N. J., by Matausch (A. M. N. H.).

17. *Telamona compacta* Ball. Plate IV, fig. 51.

Telamona compacta Ball, Proc. Bio. Soc. Wash., XVI, p. 180, 1903.

Smaller than *decorata* with a longer crest, red brown, maculate with white. Length female, 7.5 mm., width 4 mm., height 4 mm.

Pronotum low with a short blunt apex as seen from above, the lateral carinae irregular, obscure. Crest low, quadrangular, longer than high, set well back, sloping on both margins, slightly more anteriorly, inflated with a median depressed area. Humeral angles very short, obtusely rounding. Male with crest lower and sloping anteriorly.

Color. Testaceous, shiny, sparsely and irregularly mottled with white spots. White markings emphasized along the suture on metapodium, the anterior base of crest, the posterior face of crest, and in a transverse band posteriorly. The light markings at anterior and posterior base of crest may be definitely dark margined. Male darker.

Habitat. The writer has collected this species on the black oak in Iowa and Wisconsin and has examined examples from Arkansas (McElfresh), Minnesota (Minn.), Illinois (Uhl., U. S. N. M.).

The shiny red color of this species so exactly matches the color of the smaller twigs of the black oak where the adults normally rest that it is very difficult to detect them unless one can get a profile view.

18. *Telamona wescotti* Godg. Plate IV, fig. 52.

Telamona wescotti Godg., Cat. Memb. N. A., p. 415, 1894.
Telamona obsoleta Ball, Proc. Bio. Soc. Wash. 16: p. 178, fig. 2, 1903.
Telamona jugata Osb., Ia. Acad. Sci. I, Part 2. p. 128. pl. 28, 1891. (a Uhler mss. name).

A large, low, heavy set, black and white species with an extremely long low crest. Length female, 10 mm., width 5 mm., height 4 mm.

Pronotum extremely long and low, the metapodium almost wanting, about three well marked carinae on each side on the posterior half. Crest long, low, about three times longer than its height, anterior margin sloping into metapodium, posterior margin sloping or rounded, dorsal margin slightly concave. Humeral angles broad and obtuse, not equalling the eye. A pair of large black callosites on the upper margin of face.

Color. Creamy or white, more or less mottled with fuscous, a broad median dark stripe expanded in a diamond

shape on metapodium, sharply narrowed on reaching the anterior edge of crest, then obliquely widening to the margin of pronotum opposite the posterior end of crest. This stripe has a dark centered white spot in the diamond, another behind the crest, and often a smaller one between the two. Some examples are very light with distinct markings, while others are smoky with the markings obscure and the light spots wanting.

Habitat. The writer has taken this species, both nymphs and adults, on the burr oak in Iowa and Wisconsin and has examined examples from Kansas (DeLong), Missouri (U. S. N. M.), Minnesota (K. U.), Illinois (Godg., U. S. N. M.), Ohio (Osborn), New York (Cornell and N. Y. S.), Long Island (Davis), Massachusetts and New Hampshire (Uhl., U. S. N. M.), North Carolina (Osborn), Dallas, Tex. (Schwarz and Barber, U. S. N. M.).

This is a strikingly distinct species with no close affinities in this genus. Superficially it closely resembles *Heliria molaris* and at first the writer placed that species in *Telamona* next to *wescotti,* but the nymphs of *molaris* with their anterior projections and large abdominal spines are typical of *Heliria*, while the nymphs of this species are of the simplest *Telamona* pattern. The writer has studied the type in the Goding collection and also the one in Prof. Wescott's collection. Funkhouser in the Biol. Memb. discussed and figured this species as *obsoleta* Ball while his *wescotti* was *Heliria molaris.*

19. *Telamona salvini* Dist. Plate IV, fig. 53.

Telamona salvini Distant, Ent. Month. Mag. 16, p. 11, 1879.

Telamona subfalcata Van Duzee, Bull. Buff. Soc. N. S. X; p. 509, 1912.

Resembling *reclivata* Fh. in general form but much larger and with a long crest acutely produced posteriorly. Length of female, 10 mm., width 5 mm., height 5 mm.

Pronotum long, low, and with an extremely long acute apex. Crest twice as long as high, sloping uniformly from the middle of the metapodium to the obtuse anterior angle. Dorsum long, level, or slightly sinuate, posterior angle produced acute, the posterior margin upright. Humeral angles very broad, about right-angled, the anterior margin rounding. The anterior base and a round spot two-thirds of the way to the posterior base deeply compressed.

Color. Pale greenish yellow, fading to sulphur yellow, irregularly mottled or inscribed with dark lines which are

almost regularly spaced along the margin of the pronotum. A broad, black median line on each humeral angle.

Habitat. Examples have been examined from several places in Florida, Black Mountains, N. C., Beutenmuller (A. M. N. H.), St. Simeon's Island (Bradley, Cornell), a single male from Madison, N. J. (A. M. N. H.), and a large female from Chichavac, Guatemala, 8600 ft., August (Slevin, Calif. Acad. Sci.), through Van Duzee.

This is a strikingly distinct species easily recognized by the long, acutely angled crest. It is apparently confined to the eastern seaboard, from New Jersey south to Florida and Guatemala. The Florida examples are not as acutely angled and lack most of the dark mottling. Two of them were taken in a trap light in a hammock by Mr. W. E. Stone. No definite food plant record is available, but by elimination it is probably the sweet gum (*Liquidambar*) as that is the only tree that grows in the Florida hammocks and extends up the coast to New Jersey. Matausch records taking two species of nymphs from this tree in New Jersey and rearing two species of *Telamona*. One he recorded as "near *Heliria*", (See *H. mexicana*), the other was probably this species.

20. *Telamona reclivata* Fitch. Plate IV, fig. 54.

Telamona reclivata Fh., Homop. N. Y. St. Cab., p. 51, 1851.

Telamona modesta Godg., Cat. Memb. p. 420, 1894.

Telamonanthe modesta of Bak., V. D. Cat. and Funk. Cat. Not *Telamona reclivata* of authors (See *tiliae* Ball).

Smaller and less angular than *salvini*. Resembling *tiliae* and *decorata* but with the crest rounding to metapodium. Length ♀, 8 mm., width 4 mm., height 4 mm.

Pronotum long, low. Crest long, rather low, about half longer than high, the posterior margin upright, the anterior margin rounding to the metapodium, dorsum slightly rounding. Anterior base of crest compressed. Humeral angles broad, obtusely rounding, shorter than the eye. Male much smaller, densely hirsute, the crest very low and with an almost uniform oval outline.

Color. Dirty straw, with a greenish cast especially on the metapodium and more or less of smoky mottling. The crest pale brown, darkening along the dorsal line and with a definite oblique stripe expanding towards the margin. Male, less definitely marked.

Habitat. The writer has collected adults of this species commonly on burr oak and occasionally on black and white oaks in

Iowa and Wisconsin and has examined examples from Onaga and Manhattan, Kansas; Kansas City, Mo. (K. U.); Minnesota (Bak., U. S. N. M.); Illinois (Godg., U. S. N. M.); Michigan (U. S. N. M.); Indiana (Uhl., U. S. N. M.); New York (Fitch, Albany) (Woodruff); Long Island (Davis) (Olson); Pennsylvania (DeLong); New Jersey (A. M. N. H.); Maryland (Uhler, U. S. N. M.); North Carolina (Schaeffer, Brook, M.); Texas (Bishopp) (U. S. N. M.) (Calif. references refer to next species).

This is a small species superficially resembling *tiliae* and *decorata* but quite distinct in the sloping anterior margin of the crest in the female and the low oval crest of the male. This is not the species that has been listed as *reclivata* by all authors since Fitch, as explained under *tiliae*. A study of the Fitch type and description, however, leave no room for doubt that this was the species under consideration. Goding, accepting the erroneous determination of *reclivata*, described this species as *modesta*, a study of the type shows. Baker later erroneously referred this species to the genus *Telamonanthe*. Like all the species of *Telamonini* an occasional specimen will show a petiolate cell in the under wing but in all its characters it is a typical *Telamona*.

21. *Telamona vestita* Ball. Plate IV, fig. 55.

Telamona vestita Ball. Jl. Wash. Acad. Sci. XV: p. 205. 1925.

Resembling *monticola*, slightly smaller, darker, and with the crest rounding over from the metapodium almost to the posterior angle. Length female, 9 mm., width 5 mm., height 6 mm. Length made 8 mm.

Pronotum rather broad and short, crest very broad, occupying nearly one-half the pronotum, anterior margins arising as a continuation of the curve of the metapodium and rounding over to the elongate dorsum; posterior margin short, upright, the angle often slightly acute. Anterior base of crest inflated. Humeral angles more prominent than in *monticola* and roundingly right-angled,, equalling the eye.

Color. Pale, dirty yellowish, slightly flecked with brown, often definite brown margins to crest and an oblique band to costa, a light area on the posterior face of crest. The males are much smaller and darker and the Oregon female is dark.

Habitat. The writer has collected this species on an undetermined oak in a number of places in the mountains of California, from Tehachapi north to Quincy, and has examined other examples

from similar situation in California from San Bernardino north (Van Duzee, C. A. S. Coll.), Gold Hill, Oregon (U. S. N. M.), and Colostin, Oreg. (Van Duzee). This is a very distinct species, superficially resembling *monticola* but lacking the green color and the white irrorations. It is close to *reclivata* in structure but has a higher and more rounding crest. Three males sent by Van Duzee show the light band running up into the crest as in *gibbera*. It is apparently confined to the west coast region. Reference to *reclivata* from California refer to this species.

Telamona vestita var. carynotana nov. var. Plate IV, fig. 56.

Resembling *vestita* but with the female broader and much inflated; a uniform convexity from the metapodium to top of crest. Posterior angle rounding, posterior face slightly sloping, humeral angles slightly acute, male still broader and more inflated with a low crest almost as broad and as low as in *Carynota mera*.

Color. Female uniform brown with the face and triangular metapodium very pale, a broad white stripe on posterior face of crest.

Holotype ♀, Forest Home, San Bernardino Co., California, June 13, 1928. (Van Dyke); allotype ♂, Potwisha, Calif., June 13, 1929 (Van Dyke). Type in collection of California Academy of Science. Allotype in author's collection. This may prove to be a distinct species when sufficient material is available to determine its limits of variation. The male of this variety together with the males of *reclivata* form a transition from the crests of *Telamona* to the broadly convex type of pronotum found in *Carynota*.

8. Genus *Carynota* Fitch.

Carynota Fitch Hom. N. Y. State Cab. p. 48. 1851.

Medium sized compact dark or brown species with the dorsum rounding over without a compressed crest. Pronotum as seen from the front resembling a truncated cone with the top rounded over; as seen from the side the hump ends beyond the middle of the pronotum in a sudden declivity. Lateral angles broad and obtuse except in *maculata* where they approach a right angle.

Type of the genus *Membracis mera* Say.

The four species of this genus form a compact and easily recognizable group. The nymphs are broad and flat and resemble the color of the bark of the twigs. There is a single generation. The nymphs appear in June the adults in July and August in the latitude of New York and Iowa.

KEY TO THE SPECIES OF *Carynota* (FEMALES)

A. Dorsal crest relatively high, and joining the curve of the metapodium.
  B. Obscure greenish gray with an oblique black band just before the apex of hump. ..... 1. *mera* Say
  BB. Rich testaceous with creamy markings ... 2. *marmorata* Say
AA. Dorsal crest relatively long and low, placed well back with a definite sinuation behind the metapodium.
  C. Rich testaceous slightly mottled with cream (Northeastern) 3. *stupida* Walk.
  CC. Piceous or black with white dots or spots (extreme Southeastern) 4. *maculata* Funk.

1. *Carynota mera* Say. Plate IV, fig. 57.

Membracis mera Say, Jl. Acad. Nat. Sci. Phil. V. p. 310, 1831.
Darnis tripartita Walker, List Homop. B. M. p. 576. 1851.
Gargara majus Emmons, N. Y. Agr. Rep. 5, p. 156, p. 13, fig. 6, 1854
Carynota strombergi Godg., Cat. Memb. N. A. p. 443, 1894 (♂).

Large, greenish gray with an oblique black band. Length ♀, 9–10 mm., width 5 mm. Male smaller.

Pronotum with a long uniform rather high hump curving into the metapodium in front and dropping away rapidly posteriorly.

Color. Almost uniform greenish gray, with a narrow slightly oblique band from just before the apex of crest down onto the elytra. Just back of this is a pale band set off by the brown apex of pronotum and smoky apex of elytra. Males are much smaller, darker, with lower hump and are inclined to be hairy.

Habitat. The writer has taken this species both nymphs and adults on the hickory, black walnut and butternut in Iowa, Wisconsin and Ontario and has examined examples from Connecticut, Massachusets (A. M. N. H.), New Jersey (Barber), New York (Cornell), Pennsylvania (DeLong), Maryland (Minn), West Virginia and Georgia (Davis), North Carolina and Ohio (Ohio), Illinois (Ill.), Nebraska (Neb.), Kansas (DeLong).

2. *Carynota marmorata* Say. Plate IV, fig. 58.

Membracis marmorata Say, Journ. Acad. Nat. Sc. Phila VI. p. 301. 1831.
Thelia porphyrea Fairmaire, Rev. Memb. 306. 1846.
Carynota picta Prov., Pet. Fauna Can. III, p. 246. 1886.

Rich testaceous with creamy mottling. Short compact with a high uniform curve. Length ♀, 8 mm., width 4 mm. Males smaller. Shorter and more compact than *mera* with the hump high and uniform in curvature throughout. Apical portion of pronotum shorter.

Color. Rich testaceous irregularly mottled with creamy. Usually with numerous spots on the metapodium. A crescent on either side the hump, a white band back of the hump which often extends up the posterior face and may connect with a dorsal light line.

Habitat. The writer has collected this species on birch in July and August at Kilbourn, Wisconsin, and in the District of Columbia and has examined examples from New Hampshire, Vermont and Massachusetts (A. M. N. H.) New York (Albany), New Jersey (Barber), Pennsylvania (DeLong), Virginia and North Carolina (A. N. S.), Michigan (Gerhardt) and Minnesota (Minn.). The writer has not been able to find a single character by which *marmorata* Say and *porphyrea* Fairmaire can be separated. In fact it is apparent that there is but one variably colored species which Say described as "marbled" and Fairmaire without knowledge of a Say's species described as semi-circularly marked on either side.

3. *Carynota stupida* Walk. Plate IV, fig. 59.

Darnis stupida Walk., List Homop. B. M. 577. 1851.
Carynota muskokensis Goding, Cat. Memb. N. A. p. 444. 1894.
Carynota vera Goding, Can. Ent. p. 276, vol. 27. 1895
Carynota albopicta Buckton, Monog. Memb. p. 135, pl. 29, fig. 1. 1903.

Testaceous with few markings. Hump long, low, sloping to the long apex. Length ♀, 8–9 mm.

Longer and slenderer than *marmorata* almost as long as *mera* but with the hump low and placed well back from which it slopes uniformly to the long slender apex.

Color. Testaceous with irregular mottlings on the metapodium omitting the dark median carina, usually a triangular spot in the middle of the lower margin on either side and often scattered round dots on the posterior half sometimes coalescing into a median line on the posterior face of hump. Males are frequently nearly black.

Habitat. Osborn (1922) has given a good account of the life history of this species with figures of the stages. It was found only on yellow birch at Cranberry Lake, New York, the adults in July and August. Other examples have been examined from New

Hampshire (N. Hamp.), Massachusetts (A. M. N. H.), Connecticut, New York (Olson). *Vera* was described from Maine and *muskokensis* from Ontario.

4. *Carynota maculata* Funk. Plate IV, fig. 60.

Carynota maculata Funk., Ent. News 26: p. 98, pl. 3, fig. 3–4, 1915.

Smaller and more depressed than even *stupida*. Black shining with irregular white maculations. Length ♀, 7 mm., width 3 mm., height of crest 2 mm.

Metapodium almost wanting. The pronotum sloping back at a definite angle from the face and forming a slight convexity between the lateral angles, behind this there is a slight but definite sinus, before the low tumid and only slightly rounding hump that occupies less than one-half the pronotum. Apex of pronotum intermediate between *marmorata* and *stupida*. Face tumid, irregular.

Color. Black shining, irregularly maculate with white dots or spots.

Habitat. The writer beat a female from a large leafed oak at Ocala, Florida, April 29. Mr. W. E. Stone beat another from a willow oak at Orange City, Florida, while Funkhouser described it from specimens from Jacksonville and Gainesville, Florida, taken in April.

9. Genus *Tropidarnis* Fowler.

Tropidarnis Fowler, Biol. C. A., Homop. p. 60, 1895.

Resembling an *Atymna* but lacking the petiolate cell in the underwing. Elongate with a low but slightly angularly rounding crest covering the entire pronotum.

Pronotum long and slender as viewed from above, tapering uniformly from the lateral angles. Crest low not foliaceous, extending from the posteriorly rounding metapodium to the apex. Highest before the middle.

Type of the genus *T. tectigera* Fowler.

Fowler placed this genus in the Darninae but his artist showed the petiolate apical cell that would place it in the *Smiliinae* where it undoubtedly belongs. The nymphs resemble those of *Telamona* except that the dorsal hump is higher and more like *Archasia*.

1. *Tropidarnis tectigera* Fowl. Plate IV, fig. 61.

Tropidarnis tectigera Fowl., Biol. C. A., Homop. p. 60, pl. 5, fig. 7, 1895.
Tropidarnis acutior Fowl., Biol. C. A., Homop. p. 61, 1895.
Tropidarnis pellicolor Buckton, Mogr. Memb. p. 114, pl. 24, fig. 4, 1903.

Tropidarnis robustus Buckton, Monog. Memb. p. 114, pl. 24, fig. 5, 1903.

Characters of the genus; crest very variable in height and shape; green with a dark line on the margin of the lateral angles. Length ♀, 9 mm., ♂ 7 mm.; width 4.5 mm., crest 3 mm.

Habitat. Described from Amula in Guerrero, Mexico, 6000 feet. The writer has taken nymphs and adults from *Quercus emoryi* in the Santa Rita Mts., Arizona, in May and adults later in the season from oaks.

This is one of the most variable of the treehoppers in size and height of crest and somewhat so in color. Fowler gave no character by which his two species could be separated except the shape of crest and both fall within the normal range of variation as does Buckton's *robustus*. *T. pellicolor* of Buckton is given as 15 mm. long which is longer than any examples examined but, as it has no other distinguishing characters and no habitat, it is included in the synonomy.

10. Genus *Archasia* Stål.

Archasia Stal. Bid Hemip. Syst. p. 556, 1867.

Large compressed, leaf-like, green species, with highly arched crests. Quite distinct in this sub-family but resembling *Membracis* and *Smilia* in outline. Crests higher and more foliaceous than in *Tropidarnis*.

Pronotum narrow and extremely high and foliaceous throughout, metapodium obscure, the elevated carina of the crest reaching almost to the base. Lateral angles of moderate size rounding or only right angled.

Type of the genus *Membracis galeata* Fabr.

The three known species are all oak feeders and two at least live on a number of species of oak. There is a single generation in Iowa, and southern Wisconsin. The nymphs appear in May and June and the adults in June and July. The nymphs of *belfragei* are elongate smooth reddish brown forms with a semicircular protuberance extending upwards and forwards.

Key to the Species of *Archasia* (Females)

A. Dorsal crest overhanging in front, extremely high and foliaceous, without a dark line on margin. ..... 1. *galeata* Fab.

AA. Dorsal crest not overhanging in front, not so high, with a fine dark line throughout.

B. Crest vertical in front, where it is highest, broadly oval as seen from side. ..... 2. *belfragei* Stål.

BB. Crest somewhat pyramidal in side view. Slightly sloping in front and more so posteriorly. ..... 3. *pallida* Fairm.

1. *Archasia galeata* Fabr. Plate IV, fig. 62.

Membracis galeata Fabr., Syst. Rhyng. IV. 9, fig. 13, 1803.
Smilia auriculata Fitch, Cat. Hom. N. Y. p. 49, 1851.

Large, green, unmarked, the entire pronotum covered by a high almost uniformly rounding overhanging crest. Length ♀, 9 mm., height of crest 6 mm., width 5 mm. Male smaller.

Crest definitely overhanging the metapodium and extending to the apex of pronotum in a single curve in the female, slightly narrower in the male. Lateral angles broad, rounding.

Color. Bright green (in life) without marking except a faint smoky mottling in the carina and at the apex of elytra. Examples from the south may have a narrow line on the carina.

Habitat. The writer has collected this species in small numbers from oak in Iowa, Wisconsin, Massachusetts, District of Columbia and Florida and has examined examples from Colorado (Acad. N. S.), Arkansas (McElfresh), Kansas (DeLong), Nebraska (Crawford), Minnesota (Acad. N. S.), Ohio (Osb.), Pennsylvania (DeLong), New York (Olson), Connecticut (Ames). They are found most abundantly on cut over areas where the second growth is rank. The Florida males have a definite dark line on the carina and resemble females of *belfragei.*

2. *Archasia belfragei* Stål. Plate IV, fig. 63.

Archasia belfragei Stål, Bid. Memb. Kan. p. 250, 1869.
Archasia canadensis Prov., Pet. Faun. Can. III, p. 230, 1886.

Resembling *galeata* but crest smaller, darker with the front upright. Length ♀, 9 mm. Crest height 4.5 mm. Male smaller.

Crest vertical in front, not as high as in *galeata,* sloping posteriorly, with a sinuation before the acute apex of pronotum. Lateral angles right angled.

Color. Green with a slightly smoky cast, emphasized on a line on carina and a dusky spot at apex of elytra.

Habitat. The writer has taken this species in great abundance both larvae and adults on various oaks in Iowa and Wisconsin and has collected examples in Vermont and Ontario, examples have been examined from Arkansas (McElfresh), Kansas (DeLong), Ohio and Pennsylvania (DeLong), New York (Fitch).

3. *Archasia pallida* Fairm. Plate IV, fig. 64.

Thelia pallida Fairm., Rev. Memb. 308, 1846.
Thelia conica Walk., List Homop. B. M. 557, 1851.

Resembling *belfragei* but with a slightly lower crest that narrows from both front and rear. Length ♀, 9 mm., crest 4.5 mm., high. Male smaller. Crest sloping slightly back from metapodium, then broadly rounding above with the anterior portion highest, the posterior slope more acute than the anterior, then abruptly changing into the relatively long and acute apex of pronotum. Lateral angles rounding.

Color. Pale green with a heavy dark line along the carina.

Habitat. The writer with W. E. Stone collected male, female and large nymphs of this rare species from oaks at Sanford, Florida, April 9, 1927. Examples have been examined from Roselle Park, N. J., June 21 and July, 1911 (Matausch Coll. A. M. N. H.), a female, Wooster, Ohio, 8–7–20 (Osborn coll.), and another, St. Vincent, Pa. (Wirtner).

This species has apparently never been recognized since the original description in 1846. Walker (as usual) redescribed it as *conica* from Florida and his species has not been recognized. Funkhouser described and figured a species which he recognized as *conica* in discussing the Walker types but placed it in *Telamona*. What he had is not known, but it could not have been this species as it had dark markings not described by Walker and he would not have placed it in that genus. Funkhouser in his Cat. of Memb. p. 236 gives Arizona as a habitat for this species. No doubt a misidentification of *Atymna simplex*, a common species in Arizona which is similar in general outline, but belongs in a different subfamily.

Species Incorrectly Listed

THELIA LUTIPES Emmons = *Campylenchia latipes* Say

Thelia lutipes Emmons, Agr. N. Y., V. p. 156, pl. 13, fig. 18, 1854.
Thelia lutipes Funkhouser, Cat. Membr. p. 266, 1927.

This was merely a typographical error on page 156 of Emmons as he figures *latipes* and spells it correctly on the explanation of the plate. It was however Plate 13 and not 3, as cited, which is no doubt what misled Funkhouser and led him to insert this in his catalogue as a *Thelia*.

GLOSSONOTUS GIBBOSA Funk = a *Darninae*.

Funkhouser (Cat. p. 241) lists *Hemyptycha gibbosa* Walk. from Brazil as a *Glossonotus* and in error gives Butler as authority.

Butler referred *acuminatus* to *Glossonotus* and *gibbbosa* to *Telamona*? Walker was undoubtedly right in referring this species to the *Darninae*.

HELIRIA PULCHRA Godg. = *Telamonanthe rileyi* Godg.

Telamona mexicana Stål? or *pulchra* Goding, Ent. News 3, p. 109, 1892.

The type of this species was not found in the National Museum Collection. Goding very briefly described it and later states "I believe this to be the ♂ of *mexicana;* if it should prove to be undescribed it may be called *pulchra.*" It was described from a single male from Dr. Riley for which he gives the habitat "California"? Goding omits this reference and name in his catalogue although he includes *T. rileyi,* which preceded it but he does give the habitat "California (Goding)" under *mexicana.* Van Duzee gives *pulchra* in parenthesis under this reference to *mexicana* in his catalogue but omits it from his species list. Funkhouser omits it entirely from his catalogue but gives the "California"? habitat of *mexicana* crediting it to Van Duzee.

If *mexicana* is limited to the sweet gum it certainly does not occur in California and Goding's single structural item in the description "dorsal crest nearly thrice as long as high at base" would suggest that he had a specimen of *Telamonanthe rileyi* under consideration probably a parasitized female that he mistook for a male. This is also suggested by the description following that of *rileyi.*

HELIRIA ANOFLAVA Buckton = *Atypa gibba* La Porte (a *Darninae*).

Heliria anoflava Buckton, Mon. Memb., p. 198, pl. 43, fig. 4, 1903.

This is a characteristic example of Buckton's methods. He described this insect as a *Heliria* when his own figure of the venation (fig. 4a) shows conclusively that it cannot belong to that genus or even to the sub-family *Smilinae* but is according to Funkhouser a *Darninae* of a well known South American genus and not an inhabitant of North America at all. It was not a n. sp., not a *Heliria* not even that sub-family and not from North America; otherwise Buckton's treatment was fairly accurate.

TELAMONA RUFICARINATA Fowl., Trans. Ent. Soc. London, p. 421, 1894.

Telamona gibba Buckton, Mong. Memb., p. 197, pl. 43, fig. 2, 1903.

Funkhouser places Buckton's species as identical with Fowler's which from the description seems to be correct. Mr. W. E. China of the British Museum kindly examined the Buckton type and reports that there is no long spine-like structure on the pronotum as shown but that it was due to the elytron overlapping on the apical part. China's drawing of the venation of the elytra shows the apical cell with the base truncate which would exclude this species from the sub-family *Smiliinae*. From the outline of the pronotum it appears to be another of the double-humped *Darninae* from the Bogotá region.

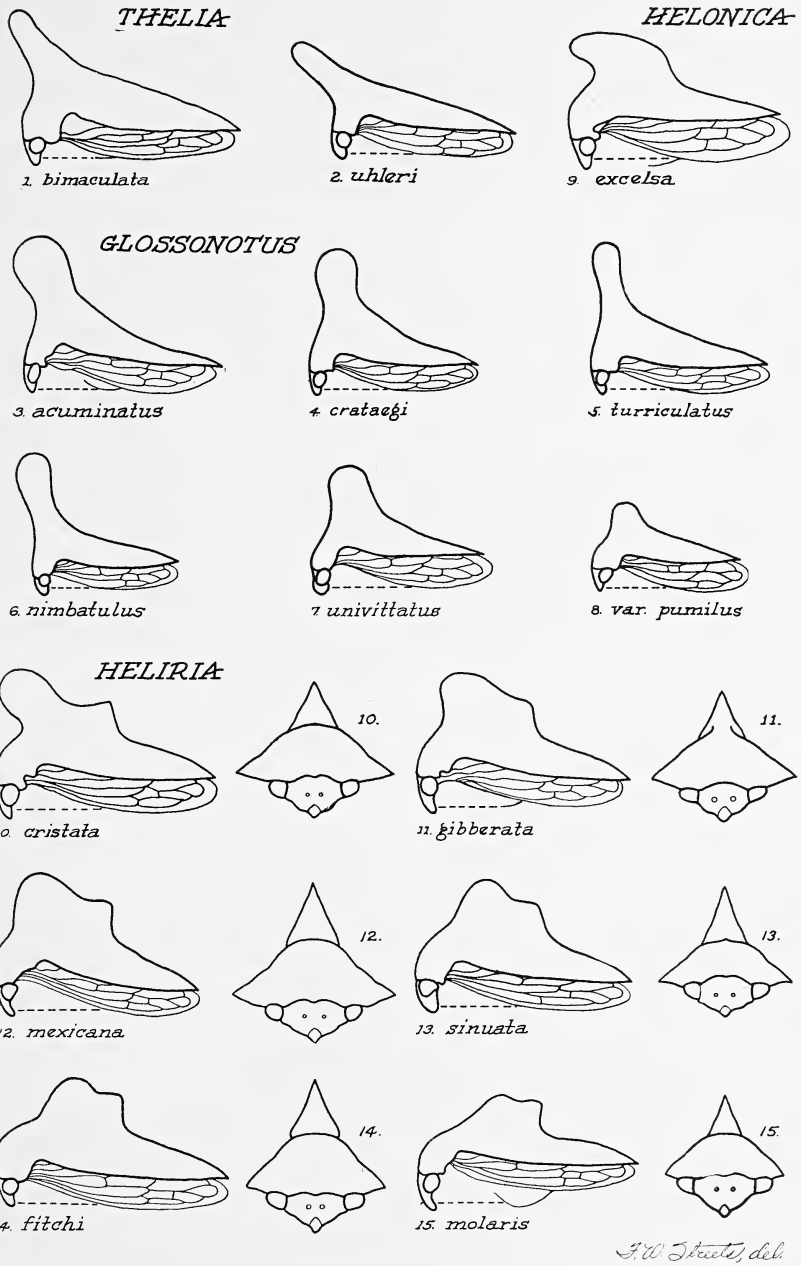
TELAMONA SPINIGER Haviland, Zoologica 6, p. 257, pl. 3, fig. 3, 1925.

This species from British Guiana cannot be a *Telamona* on account of the long spine, and if her description is correct cannot be a *Telamonini* as she says "Tegmina entirely free," which would place it in the tribe *Cerasini* if it belongs to the sub-family *Smiliinae*. China sent drawings of both elytra of the type as they differ somewhat in venation but neither one has any suggestion of a petiolate apical cell so it cannot belong to the *Smiliinae* and will probably be found to belong to the *Darninae* along with the other South American forms.

HELIRIA GOUNELLEI Fallou, Rev. Ent. 9, p. 353, 1891.

TELAMONA GOUNELLEI Fallou, Rev. Ent. 9, p. 354, 1891.

The writer has not seen the descriptions of these two species from Brazil but they probably belong with those above rather than in the *Telamonini*.


THELIA
HELONICA
1. bimaculata
2. uhleri
9. excelsa
GLOSSONOTUS
3. acuminatus
4. crataegi
5. turriculatus
6. nimbatulus
7 univittatus
8. var. pumilus
HELIRIA
10.
11.
10. cristata
11. gibberata
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12. mexicana
13. sinuata
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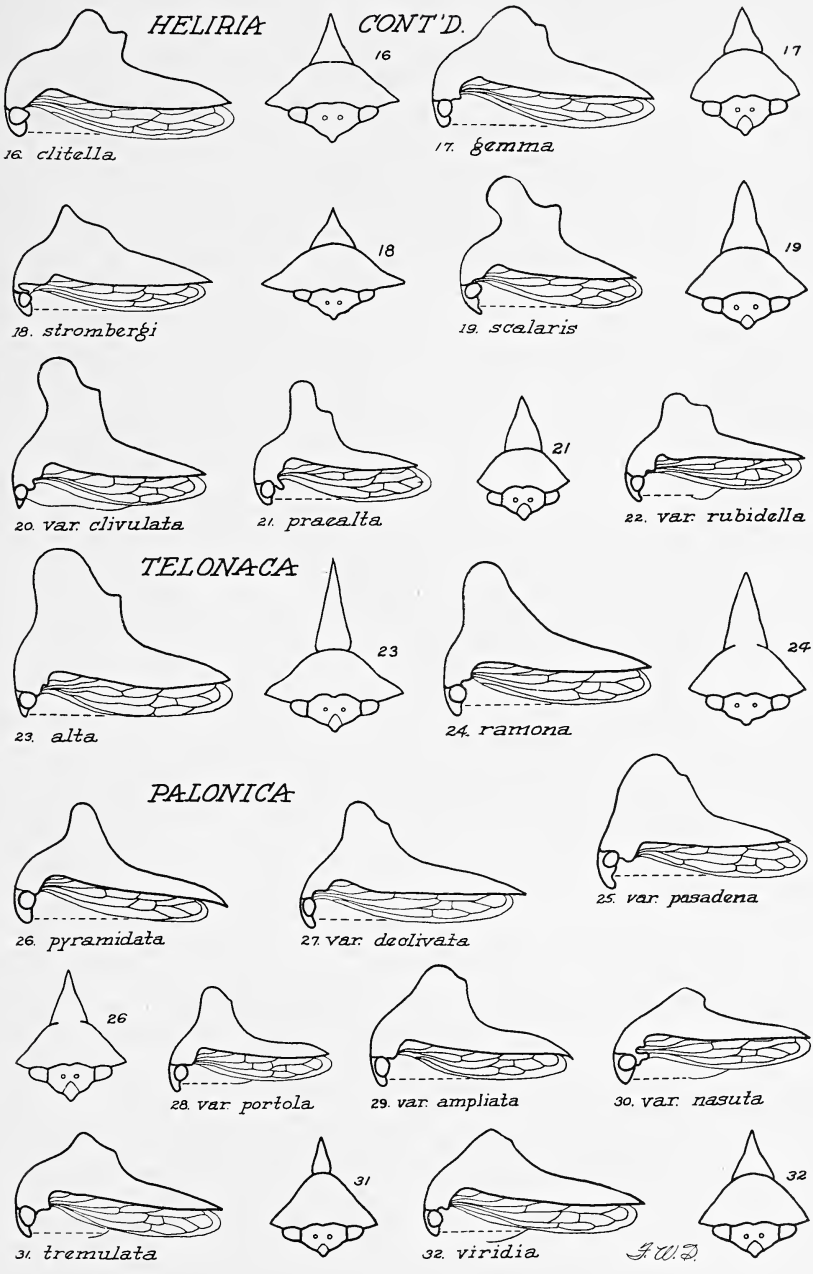
14. fitchi
15. molaris
F.W. Streets, del.


HELIRIA CONT'D.
16
17
16. clitella
17. gemma
18
19
18. stromberĝi
19. scalaris
20. var. clivulata
21. praealta
21
22. var. rubidella
TELONACA
23
24
23. alta
24. ramona
PALONICA
25. var. pasadena
26. pyramidata
27. var. deolivata
26
28. var. portola
29. var. ampliata
30. var. nasuta
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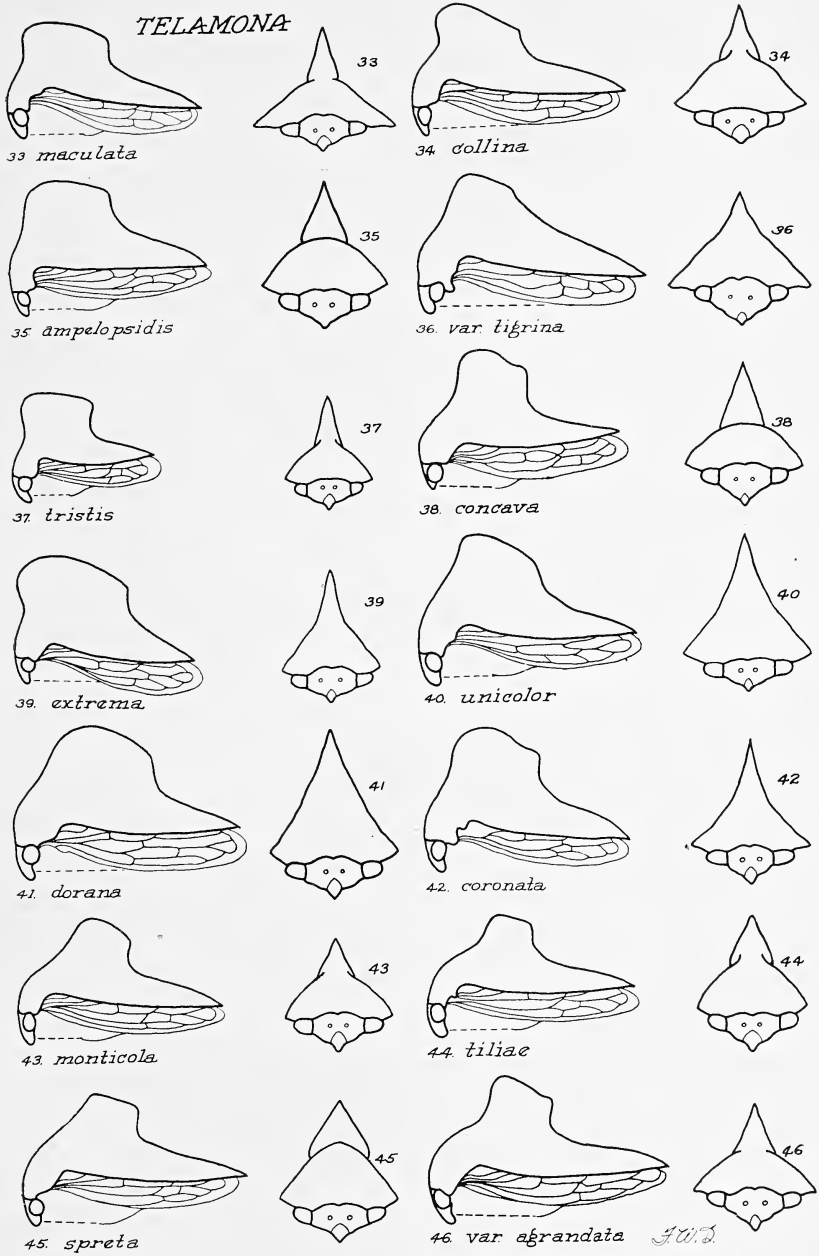
31. tremulata
32. viridia
F.W.P.


TELAMONA
33
34
33 maculata
34. collina
35
36
35 ampelopsidis
36. var. ligrina
37
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37. tristis
38. concava
39
40
39. extrema
40. unicolor
41
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41. dorana
42. coronata
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43. monticola
44. tiliae
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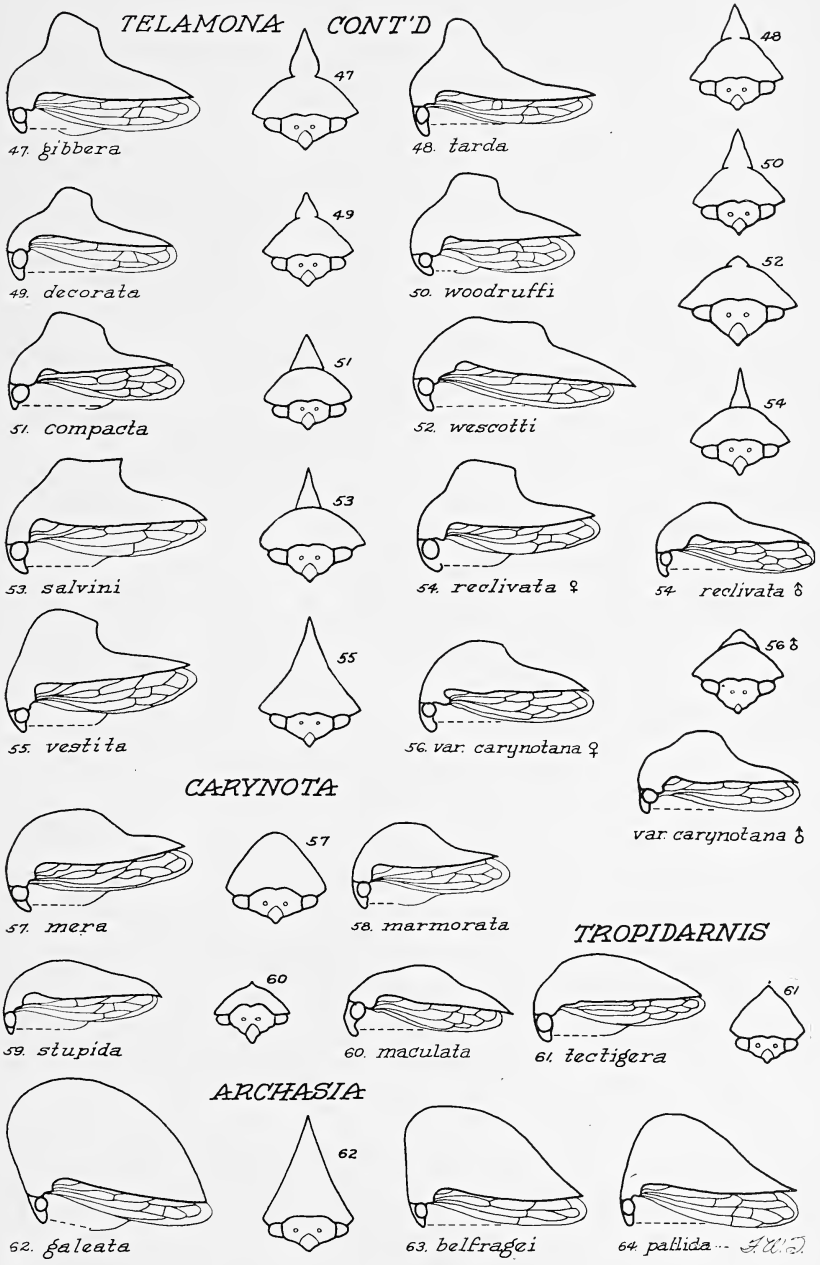
45. spreta
46. var. agrandata


TELAMONA CONT'D
47. gibbera
47
48. tarda
48
49. decorata
49
50. woodruffi
50
51. compacta
51
52. wescotti
52
53. salvini
53
54. reclivata ♀
54 reclivata ♂
54
55. vestita
55
56. var. carynotana ♀
56 ♂
var. carynotana ♂
CARYNOTA
57. mera
57
58. marmorata
TROPIDARNIS
59. stupida
60
60. maculata
61. tectigera
61
ARCHASIA
62. galeata
62
63. belfragei
64 pallida

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A TENTATIVE SYNOPSIS OF THE HORNETS AND YELLOW-JACKETS (VESPINAE; HYMENOPTERA) OF AMERICA

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Introduction

For several years past I have collected assiduously material for a monograph of the hornets and yellow-jackets of America and I have used every opportunity to study these insects in private and public collections. Although many thousands of specimens have passed through my hands, I do not feel that my present views concerning the relationships and variations of these wasps, are in any way final. Having been urged, however, by some of my correspondents to publish my results, I venture to present them in the form of a tentative synopsis.

The present paper should therefore not be regarded as a Monograph, but rather as an introduction to the study of the American Vespinae. It contains: (1) A key to the forms which may, in my opinion, be conveniently distinguished by names. (2) A condensed statement of the nomenclature and synonymy I have adopted, as a rule without entering into a discussion of the evidence on which my conclusions are based. (3) A summary of the distribution based upon the material I have studied. (4) A brief

account of the ethology, including unpublished observations, but without reviewing all published data.

My scheme of classification departs in many respects from that commonly used in this country. It is the outcome of an attempt to discover the relationships between the Old World and New World members of the subfamily, a line of investigation most likely to yield data of value to the zoögeographer. For, not only are the Vespinae the best defined of all the subfamilies of Diploptera; but they are also one of the few groups for which a northern common origin may most safely be assumed, since they are nowadays almost restricted to the Northern Hemisphere and are not indigenous to the Neotropical and Ethiopian Regions. In this connection it may be well to point out that, in my opinion, the Vespinae show no close relations to any of the other subfamilies of social wasps, least of all to the cosmopolitan subfamily Polistinae.

In tracing relationships I have used the same method as in my other papers dealing with Diploptera. Without entering into any formal discussion, I may state that I regard structural characters as of primordial value, and differences or similarities in color or pattern as of secondary importance. Only such forms are given specific rank as are separable by means of reliable structural peculiarities in at least one of the sexes. Groups of specimens differing from one another only in coloration, I consistently treat as forms of a single species, the first described being regarded as the "typical form," the others as "varieties." Although the term "variety" is non-committal, since it makes no implication as to the true genetic significance of the particular form in question, I believe, nevertheless, that "color varieties" are genetically subordinated to "structural species." I hold that, in the Diploptera at any rate, of the several slow or rapid changes which the organism undergoes in the process of evolution, those that affect color will occur most readily and will also be the least stable; hereditary modifications of structure, on the other hand, are more difficult to produce, but are more permanent once they have appeared. Frequently there is no apparent correlation between the evolutionary changes affecting the color and those influencing structure. Finally, color is more readily affected by environmental factors than structure.

In an earlier paper (1930, Bull. Brooklyn Ent. Soc., XXV, pp. 59–70) I have fully discussed the subfamily, generic and subgeneric characters of the Vespinae, as well as the general distribution of

the group. The discovery of additional characters has, however, necessitated a revised account of the subgeneric peculiarities of *Vespula*, proper, and *Dolichovespula*.

In the course of my studies I have perused with care all publications dealing with North American Vespinae, especially those of H. de Saussure (1853; 1857), J. McFarland (1888), H. W. Lewis (1897), R. du Buysson (1903–1905), and F. W. L. Sladen (1918). Lack of space precludes my entering into any historical discussion of previous work.

Male External Genitalia, or Terminalia, of the Vespinae.—Since the shape of the male terminalia affords, in my opinion, the most reliable specific characters in the subfamily Vespinae, it is necessary to consider these structures somewhat in detail. In order to study them no special technique is called for. The voluminous apparatus can readily be extracted with a pin, after relaxing the specimen in case of dry material. The several parts are then gently spread out so as to permit a full view of their shape.

There is as yet no agreement among the authors regarding the homology of the male external genitalia of the Vespinae and the names to be applied to the several parts. For the purpose of this paper I have borrowed most of my terminology from E. Zander's account (1900, Zeitschr. Wiss. Zool., LXVII, 3, pp. 461–489, Pl. XXVII).

We may regard the male genitalia as consisting of three groups of structures, which envelop the *ductus ejaculatorius* like a sheath or cloak.

1. At the base of the entire apparatus lies, ventrally, a small half-ring, the *cardo* (Fig. 1, *ca*), Dufour's "*pièce basilaire,*" which connects the genitalia with the abdomen. Superficially it appears to be divided, on the ventral side, by a median, longitudinal depression.

2. Dorsad and laterad of the cardo are placed two pairs of large appendages, the *valvae,* which can move on each other and in the cardo.

2*a*. The external pair of strong lateral pieces are the *valvae externae* (Fig. 1, *ve*), Dufour's "*branches du forceps*" (a term adopted by R. du Buysson) and Kluge's and Sladen's "*stipites.*" I here restrict the term *stipites* (singular, *stipes;* Fig. 1, *st*) to the external portion of the valvae externae, which is heavily sclerotized, broad and very convex, so that its inner concavity normally encloses most of the remaining parts of the genitalia. At the truncate apex

of each stipes one may as a rule distinguish an *outer edge* (Fig. 1, *oe*), an *upper* (or dorsal) *inner edge* (Fig. 1, *uie*), and a *lower* (or ventral) *inner edge* (Fig. 1, *lie*), the shape of which is often characteristic. Internally each stipes bears a scale-like or lobe-like appendage, which I call the *squama* (Fig. 1, *sq*), R. du Buysson's "*lobe de la branche du forceps,*" Zander's "*mediale Schuppe.*"

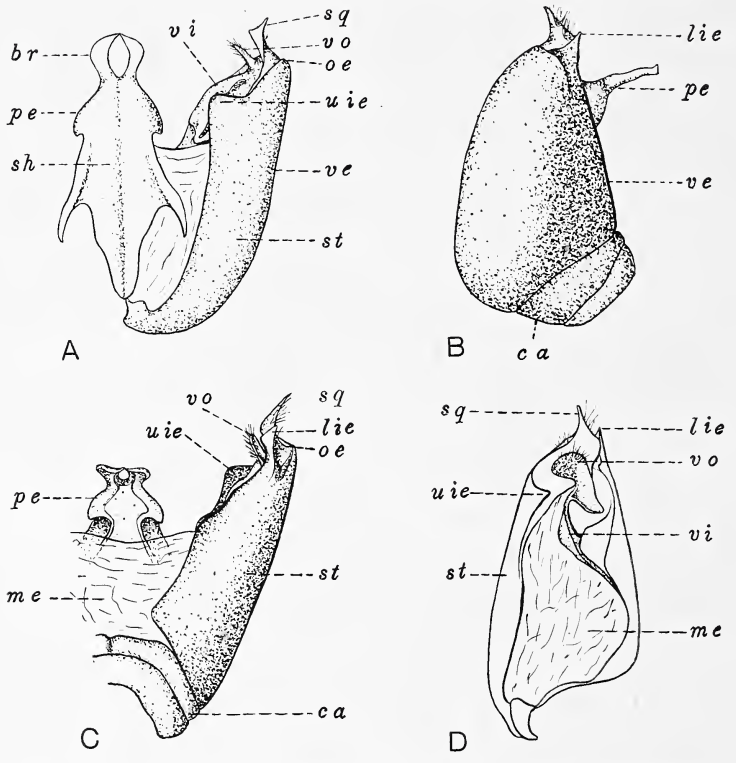

Fig. 1. Male external genitalia of *Vespula maculata* (Linnaeus): A, dorsal view; B, side view of left valva externa; C, ventral view; D, inner view of right valva externa, showing valva interna (dotted area).—*br*, branches of penis; *ca*, cardo; *lie*, lower inner edge of stipes; *me*, connecting membrane; *oe*, outer edge of stipes; *pe*, penis; *sh*, shaft of penis; *sq*, squama of valva externa; *st*, stipes of valva externa; *uie*, upper inner edge of stipes; *ve*, valva externa; *vi*, valva interna; *vo*, volsella of valva interna.

The squama is closely pressed against or ensheathed by the lower inner edge of the stipes, beyond the tip of which it generally protrudes.

2*b*. The internal pair of more slender and much smaller and softer pieces are the *valvae internae* (Fig. 1, *vi*), Dufour's and R. du Buysson's "*volselles*," Kluge's "*sagittae*." Their apical portion appears to be divided into three lobes, one of which generally forms a free, finger-shaped flap, often densely hairy or brush-like and protruding near the squama. I propose to restrict the term *volsella* (Fig. 1, *vo*) to this protruding lobe; Birula calls it the "*penicillum*." R. du Buysson's "*tenette*" seems to apply to the lobe at the base of the volsella, usually folded inward.

3. Dorsally and broadly attached to the valvae by means of a soft, extensible membrane (Fig. 1, *me*) is a median piece, the *penis* (Fig. 1, *pe*), Dufour's "*fourreau de la verge*," R. du Buysson's "*crochets*," Kluge's "*spatha*," Sladen's "*saggital piece*" or "*saggitae*." Originally it consisted of a pair of sclerotized rods, which in certain species of Vespinae are completely fused throughout, while in others they are partly free, forming two *apical branches* (Fig. 1, *br*). The basal portion, or *shaft* (Fig. 1, *sh*), may be slender, equally wide throughout, or triangular. The shape of the penis is distinctive in most species.

I have not attempted to give a complete description of the genitalia of every species, nor have I indicated all the peculiarities of these organs that might be found of specific value. In my key I have made use of those peculiarities that seemed to be most reliable as well as most readily appreciated. A comparison of the drawings will disclose other differences, some of which may be equally valid, while others are probably unreliable. I must particularly warn against relying too much on the aspect of the squama of the valva externa and the volsella of the valva interna. These parts are much less sclerotized than either the stipes or the penis, so that they may be curved or twisted in various ways, their appearance being often very deceptive.

Nomenclature.—The generic and subgeneric names used throughout this essay are those of my former paper (1930). Meanwhile, Dr. H. Bischoff, of Berlin, has published an important contribution to the knowledge of the Palearctic Vespinae,[1] in which he adopts a nomenclature differing in many respects from my own. The divergence of opinion in this case seems to show once more the utter futility of hoping for stability if one follows an intricate

[1] Bischoff, H. 1931. Zur Kenntnis der Gattung *Pseudovespa*. Sitzungsber. Ges. Naturf. Fr. Berlin, (1930), pp. 329–346. I am very much indebted to Dr. Bischoff for a copy of this paper.

system of rules, recommendations and opinions, which invariably leads to mere casuistry.

The following are the points in which Dr. Bischoff's system differs from that adhered to in this paper.

(1) In accordance with Opinion 79 of the International Commission of Nomenclature, Bischoff refuses to regard Lamarck's (1801) citation of *Vespa crabro* Linnaeus as an example of *Vespa* Linnaeus, as a valid designation of the genotype. Hence he accepts Latreille's (1802) selection of *Vespa vulgaris* Linnaeus as the type. *Vespula* Thomson (1869) thus becomes a synonym of *Vespa,* since it included *V. vulgaris.*[2]

(2) If the generic term *Vespa* is no longer available for the "Hornissen" or "hornets,"[3] these large wasps should go under the name *Macrovespa* Dalla Torre (Genotype: *Vespa crabro* Linnaeus).

(3) Bischoff refuses to admit Ashmead's (1902) designation of *Vespa austriaca* Panzer as the genotype of *Vespula* Thomson, because (a) *Vespa austriaca* was no longer available, having been eliminated from *Vespula* when Schmiedeknecht (1881) proposed the generic name *Pseudovespa* for that species;[4] and (b) Ashmead erroneously attributed a long oculo-malar space to the group in which he included *V. austriaca.*

(4) Bischoff admits *Pseudovespa* to full generic rank. He includes in it all inquiline wasps, which have lost the worker caste. He divides it, however, into two subgenera: *Pseudovespa* proper, with a short oculo-malar space, includes only the genotype, *P. austriaca;* while two inquiline forms with a long oculo-malar space,

[2] Stiles and Hassall (1928, U. S. Publ. Health Serv., Hyg. Lab. Bull. 150) apparently accept as binding Latreille's (1810) designation of *Vespa crabro* Linnaeus as the type of *Vespa,* in accordance with Opinion 11 of the International Commission on Nomenclature.

[3] In the British Isles the term "hornet" is correctly used for *V. crabro* only, and therefore corresponds to the German "Hornisse" and the French "frelon." But in America, where true hornets were originally unknown, the name is commonly applied to some of the larger indigenous wasps, such as *Vespula maculata.* Moreover, in some parts of the United States, where the Vespinae are relatively scarce, the term hornet is sometimes used even for species of *Polistes.*

[4] This is contrary to Opinion 62 of the International Commission on Nomenclature, which states that "type species of other genera are not excluded from consideration in the selection of the type of a genus."

P. adulterina (R. du Buysson) and *P. omissa* Bischoff, form the subgenus *Pseudovespula* Bischoff (Subgenotype: *Vespa norwegica* var. *adulterina* R. du Buysson, 1905).

Entomologists who feel inclined to accept Dr. Bischoff's nomenclature rather than my own will have to arrange the North American Vespinae as follows:

1. *Macrovespa* DallaTorre will include *M. crabro* (Linnaeus) only.

2. *Vespa* Linnaeus (Syn.: *Vespula* Thomson) will comprise two subgenera:

2*a*. *Vespa*, proper, with *V. vulgaris* Linnaeus, *V. maculifrons* R. du Buysson, *V. pensylvanica* H. de Saussure, *V. rufa* Linnaeus, *V. squamosa* Drury, and *V. sulphurea* H. de Saussure.

2*b*. *Dolichovespula* Rohwer, with *V. norwegica* Fabricius, *V. arenaria* Fabricius, and *V. maculata* Linnaeus.

3. *Pseudovespa* Schmiedeknecht will comprise two subgenera:

3*a*. *Pseudovespa*, proper, with *P. austriaca* (Panzer).

3*b*. *Pseudovespula* Bischoff, with *P. adulterina* (R. du Buysson).

Key to American Vespinae

1. Head very large, swollen behind the eyes, with wide outer orbits and long vertex; posterior ocelli only a little farther from the eyes than from each other, placed close to a line joining the middle of the upper lobes of the eyes and four to six times as far from the occipital margin as from each other. Inner orbits distinctly farther apart at the clypeus than on the vertex. Oculo-malar space short but distinct, about the length of the penultimate antennal segment in queen and worker. Clypeus of queen and worker slightly wider than long, uniformly covered with coarse punctures, its apical margin with a shallow, broad emargination. Sides of pronotum with a vertical carina over the entire upper portion. All tibiae with long, erect hairs on the upper face. Male with a pair of conspicuous longitudinal ridges (tyloides) on the under side of most of the segments of the flagellum; shaft of penis wide distally, the apical branches separated by a deep and broad, subcircular notch. Large species (20 to 30 mm. in total length), extensively reddish-brown, the head partly orange, the abdominal tergites with apical, dull yellow margins, very narrow on the first, much wider and more or less notched on the remainder; the last tergite mostly yellow (*Vespa*) ..... *Vespa crabro* Linnaeus.

Head not unusually large, not swollen behind the eyes, with narrow outer orbits and short vertex; posterior ocelli on a line close to, or tangent with, the supraorbital line and at most as far from the occipital margin as from the eyes. Smaller species, at most 20 mm. in total length (*Vespula*) .. 2.

2. Oculo-malar space short, at most half the length of the penultimate antennal segment in male, much shorter in queen and worker. Vertical carina of the sides of pronotum either obsolete or faintly marked in the lower portion only. Male: branches of penis completely fused throughout, the apical portion saddle-shaped or spoon-like. (Subgenus *Vespula* proper) ..... 3.

Oculo-malar space long, nearly as long as, or longer than, the penultimate antennal segment in male, queen and worker. Posterior orbit separated from the occiput in its upper half only, by a suture which is sometimes obsolete. Vertical carina of the sides of pronotum complete, well-developed in the upper portion. Upper face of tibiae with long, erect hairs over the whole length, especially noticeable on the hind legs. Male: branches of penis not completely fused, the apical portion deeply bifid; seventh tergite uniformly convex throughout. (Subgenus *Dolichovespula*) ..... 23.

3. Upper side of hind tibiae bearing long, erect hairs scattered over the whole length. Posterior orbit separated from the occiput by a ridge in its upper half only. Postscutellum impunctate. Black, abundantly marked with yellow; mesonotum without yellow stripes. Erect hair of first tergite black. Male: seventh tergite uniformly convex throughout, not notched at apex; penis broad, ending in a curved, saddle-shaped expansion, the apex truncate. Female: apical margin of clypeus with produced and somewhat raised, sharp lateral edges. No workers ..... *Vespula austriaca* (Panzer).

Upper side of hind tibiae without erect hairs, rarely with a few long hairs at the extreme base. Workers present ..... 4.

4. Mesonotum with two broad, longitudinal, curved, yellow stripes, not quite reaching the anterior and posterior margins. Posterior orbit separated from the occiput by a ridge in its upper half only. Male: seventh tergite evenly convex throughout, not notched at apex ..... 5.

Mesonotum entirely black or at most with two very short, lengthened, pale spots close to the scutellum ..... 6.

5. Second cubital cell of fore wing obliquely triangular, its lower side nearly twice as long along the cubitus as the third cubital cell; the distance between the tip of the second recurrent and the second intercubitus equal to or slightly over the length

of the third cubital cell along the cubitus. Queen, worker and male black with numerous bright yellow markings. Male: apex of penis with a horseshoe-shaped notch, seen from above ..... *Vespula sulphurea* (H. de Saussure).

Second cubital cell of fore wing more evenly triangular, its lower side not or slightly longer along the cubitus than the third cubital cell; the distance between the tip of the second recurrent and the second intercubitus much shorter than the length of the third cubital cell along the cubitus. Queen mostly orange, with black margins to the abdominal segments; worker and male black with numerous yellow markings. Male: apex of penis without horseshoe-shaped notch, slightly curved inward, seen from above.

Vespula squamosa (Drury).

6. Queens and workers ..... 7.
   Males ..... 15.
7. Posterior orbit separated from the occiput by a fine ridge or raised suture in its upper half or two-thirds only, its hind edge completely rounded off over some distance above the base of the mandible. First abdominal segment narrowed anteriorly, the horizontal area of the tergite slightly depressed behind the edge. Long, erect pilosity of first abdominal tergite black ..... 8.

   Posterior orbit divided from the occiput by a fine ridge over its entire length, down to the base of the mandible.[5] First abdominal segment equally broad throughout, the horizontal area of the tergite not at all depressed. Long, erect pilosity of first abdominal tergite mostly pale, grayish or yellowish ..... 13.
8. Pale markings white or ivory-white ..... 9.
   Pale markings yellow ..... 10.
9. First and second tergites and sternites of the abdomen marked more or less with rufous spots.

   Vespula rufa var. *intermedia* (R. du Buysson).

   Abdomen without rufous markings, only black and white. Apical white fascia of second tergite narrower than the following; that of the first tergite very narrow and widely interrupted, or absent.

   Vespula rufa var. *consobrina* (H. de Saussure).
10. First and second tergites and sternites of abdomen more or less marked with rufous. (Not in North America).

    Typical *Vespula rufa* (Linnaeus).

    Abdomen marked with black and yellow only ..... 11.

[5] When the pale color of the orbit extends over the under side of the head, the fine ridge is often difficult to see and may be readily overlooked.

11. Apical yellow fasciae of third, fourth and fifth tergites very wide, often more or less enclosing black lateral spots; that of the second tergite conspicuously narrower and gradually widened toward the sides; second tergite without free, yellow spots. Clypeus with three elongate, black spots placed more or less in a triangle below the middle, sometimes fused into a three-cornered or anchor-shaped spot.

Vespula rufa var. *vidua* (H. de Saussure).

Apical fasciae of third to fifth tergites not conspicuously wider than those of the second and first; the second tergite as a rule extensively yellow or with free yellow spots ..... 12.

12. Pronotum and abdomen very extensively yellow; most of the tergites yellow, with narrow black bases triangularly produced in the middle and with small black, lateral spots. Clypeus as a rule with three minute black dots, often barely indicated ..... *Vespula rufa* var. *atropilosa* (Sladen).

Yellow markings of pronotum and fasciae of abdomen moderately wide or narrow; second tergite usually with free, yellow, lateral spots. Clypeus sometimes with a broad, longitudinal black band, often anchor-shaped or expanded below.

Western *Vespula rufa* var. *sladeni* J. Bequaert and Eastern *Vespula rufa* var. *acadica* (Sladen).

13. Darker species, with the black color predominating. First tergite of abdomen as a rule black with an apical yellow fascia, sometimes narrowed in the middle. Yellow hind margin of pronotum usually even, parallel-sided. Propodeum without yellow spots. Clypeus with a broad, longitudinal black stripe, often anchor-shaped; outer orbits sometimes with a black spot. Black stripes connecting antennal sockets with vertex gradually broadened above. Antennal scape black. Tibiae sometimes spotted with black. Apical margin of mandible straight between the small basal notch and the first tooth, the latter forming a right angle. Eastern and Western, but of more northern distribution.

Vespula vulgaris (Linnaeus).

Lighter species, much more extensively marked with yellow, especially on the first tergite. Yellow hind margin of pronotum usually widened outwardly. Clypeus rarely with a short, median, black stripe, as a rule with one or three black spots; outer orbits yellow throughout. Black stripes above antennal sockets usually constricted above or completely separated from the black vertex and sometimes almost absent ..... 14.

14. Apical margin of mandible distinctly curved inward between the small basal notch and the first tooth, the latter forming

an acute angle. Antennal scape entirely yellow in front. Propodeum almost always with large yellow spots. Western ..... *Vespula pensylvanica* (H. de Saussure).

Apical margin of mandible straight between the small basal notch and the first tooth, the latter forming a right angle. Antennal scape black or at most with traces of yellow in front. Propodeum usually without yellow spots, more rarely spotted. Eastern ..... *Vespula maculifrons* (R. du Buysson).

15. Seventh abdominal tergite uniformly convex throughout; 7th tergite and sternite broadly rounded off and entire at apex. Genitalia: penis very broad throughout, the apical portion forming a subtruncate, saddle-shaped club ..... 16.

Disk of seventh abdominal tergite more or less depressed or saddle-shaped; both 7th tergite and 7th sternite truncate or slightly notched at apex. Genitalia: penis narrowed into a slender shaft, which ends in a spoon-shaped, subcircular or oval expansion ..... 21.

16. Pale markings yellow ..... 17.

Pale markings white or ivory-yellow ..... 20.

17. First and second tergites and sternites of abdomen more or less marked with rufous. Clypeus with an irregular, black, longitudinal fascia. (Not in North America).

typical *Vespula rufa* (Linnaeus).

Abdomen marked with black and yellow only ..... 18.

18. Apical yellow fasciae of third to sixth tergites very wide; that of the second conspicuously narrower and gradually widened toward the sides; second and succeeding tergites without free, yellow spots ..... *Vespula rufa* var. *vidua* (H. de Saussure).

Apical yellow fasciae of third to sixth tergites not conspicuously wider than those of the second and first ..... 19.

19. Abdomen very extensively yellow, much as in the queen. Apical yellow area of second tergite very wide, as a rule enclosing a pair of black spots; the basal black area without completely free yellow spots.

Vespula rufa var. *atropilosa* (Sladen).

Apical yellow area of second tergite narrow, rarely enclosing black spots; the basal black area often with two yellow spots, either entirely free or more or less united with the apical fascia.

Western *Vespula rufa* var. *sladeni* J. Bequaert and Eastern *Vespula rufa* var. *acadica* (Sladen).

20. First and second tergites of the abdomen more or less marked with rufous spots.

Vespula rufa var. *intermedia* (R. du Buysson).

Abdomen without rufous markings, only black and white. Apical fasciae of first and second tergites narrower than the others; that of the first more or less interrupted in the middle, or much reduced, or absent. Clypeus with an irregular, black, longitudinal band or cross in the apical two-thirds.

Vespula rufa var. *consobrina* (H. de Saussure).

21. Genitalia (Fig. 3*A*): shaft of penis without teeth or wing-like expansions at the base of the terminal spoon (ventrally); the spoon itself strongly concave and almost cup-shaped, heart-shaped in outline from above, the margin curved inward and with the proximal edges expanded close to the shaft (dorsally); upper inner edge of stipes, seen from above, short and wide, broadly truncate. Disk of seventh tergite very gradually sloping from the convex base to the flattened apical area, the apex as a rule not emarginate (at most with a slight inward curve). Western species.

Vespula pensylvanica (H. de Saussure).

Genitalia (Fig. 2*A*): shaft of penis with a sharp tooth on each side, close to the base of the terminal spoon (placed ventrally and directed basad); the spoon itself slightly concave, subcircular in outline seen from above, with the apex evenly rounded and the proximal edges not expanded dorsally near the shaft; upper inner edge of stipes, seen from above, very narrow, digitate and obtusely pointed ..... 22.

22. Disk of seventh tergite abruptly depressed at its basal third, the convex base forming in profile a sharp angle or notch with the flattened apical area; the apex itself not or hardly emarginate (Fig. 2*D* and *E*). Eastern species.

Vespula maculifrons (R. du Buysson).

Disk of seventh tergite gradually sloping from the convex base to the flattened apical area; the apex as a rule with a distinct, though shallow emargination (Fig. 2*B* and *C*). Eastern and Western, but of more northern distribution.

Vespula vulgaris (Linnaeus).

23. Queens and workers ..... 24.
Males ..... 29.
24. Pale markings yellow or dirty-yellow ..... 25.
Pale markings white or ivory-white ..... 27.
25. Lateral angles of anterior margin of clypeus very prominent, sharply set off and somewhat raised. Outer orbit rounded off behind, nowhere separated from the occiput by a distinct suture. Oculo-malar space about one-half the length of the scape. Flagellum of antennae entirely black. Yellowish hind margin of pronotum produced far downward along the anterior vertical carina; the apical fasciae of first and second

tergites wide and not or hardly interrupted in the middle (narrow and broadly interrupted in the var. *arctica*). No workers ..... *Vespula adulterina* (R. du Buysson).

Lateral angles of anterior margin of clypeus broadly rounded, not raised. Outer orbit with a suture or ridge in the upper third or half, separating it from the occiput. Oculo-malar space about two-thirds the length of the scape. Yellow color bright. Flagellum of antennae more or less dirty-yellowish on the under side. Workers present ..... 26.

26. Yellow margins of first and second tergites deeply notched or more or less interrupted on the middle line. Yellow hind margin of pronotum as a rule produced downward along the anterior, vertical carina. Outer orbits yellow throughout. Anterior truncate margin of clypeus rather deeply curved inward ..... *Vespula arenaria* (Fabricius).

Yellow margins of first and second tergites narrow, continuous, not notched in the middle. Yellow hind margin of pronotum not produced downward or with a slight extension. Outer orbits as a rule partly black, more rarely entirely yellow. Anterior truncate margin of clypeus shallowly curved inward ..... *Vespula norwegica* var. *norvegicoides* (Sladen).

27. Lower half of sides of pronotum (between humeral calli and coxae) finely, transversely striate; lower half of propodeum likewise with an irregular oblique striation, more distinct apically, where it delimits a depressed, semi-circular area. Flagellum of antennae pale ferruginous or dirty-yellow on the under side. Pale hind margin of pronotum extending downward along the anterior, vertical carina. First two tergites of abdomen entirely black; the third with a transverse, white, apical spot on each side (small in worker); the three following extensively white.

Vespula maculata (Linnaeus).

Lower half of sides of pronotum and propodeum punctate, not striate. Basal tergites of abdomen marked with white ..... 28.

28. Pale hind margin of pronotum narrowed anteriorly, not produced downward along the vertical, anterior carina. Flagellum of antennae often more or less yellowish on the under side. White margins of first and second tergites continuous and wide throughout. Workers present and generally with a pair of ferruginous or rufous spots on the second tergite (these spots never present in the queen); anterior, truncate margin of clypeus moderately projecting in the queen, with low, broadly rounded lateral angles. Outer orbit with a suture or ridge in the upper third, separating it from the occiput ..... *Vespula norwegica* var. *marginata* (Kirby).

Pale hind margin of pronotum widened anteriorly, showing at least a tendency to extend downward along the vertical, anterior carina. Flagellum of antennae entirely black. Pale margins of first and second tergites either very wide and hardly interrupted in the middle (typical *adulterina*) or narrow and broadly interrupted or even absent on the first (var. *arctica*). Anterior, truncate margin of clypeus much projecting, with prominent, raised lateral angles. Outer orbit rounded off behind, nowhere separated by a distinct suture from the occiput. No workers.

Vespula adulterina and its var. *arctica* Rohwer.

29. Most of the segments of the flagellum (beginning with the third) with conspicuous, longitudinal welts or ridges (tyloides) on the under side. Lower sides of pronotum and lower half of propodeum finely striate. Seventh sternite deeply, semi-circularly emarginate at apex, with sharp lateral edges. Penis very wide, expanded in its apical third, the terminal branches tong-shaped, flat and broad, curved inwardly, the sharp points touching each other. Upper inner edge of stipes bluntly rounded off, seen from above. Pale markings white, much as in the queen, but the apical margin of the first tergite often very narrowly white; flagellum pale ferruginous or dirty-white on the under side.

Vespula maculata (Linnaeus).

Flagellum either without tyloides, or with short ridges on the under side of the last five or six segments. Lower sides of pronotum and propodeum punctate. Seventh sternite not deeply emarginate. Penis of a different shape ..... 30.

30. Posterior orbit slightly wider than usual, either rounded off posteriorly or very faintly divided from the occiput by a suture in its upper part. Flagellum of antennæ entirely black, without tyloides (the terminal segment alone with a trace of a longitudinal welt near the base). Oculo-malar space distinctly shorter than the scape. Anterior margin of clypeus strongly projecting, rather angular at the sides. Penis: basal two-thirds triangularly narrowed toward apex, the shaft with a dorsal longitudinal crest, the terminal branches slender and almost straight. Upper inner edge of stipes forming a slight, blunt angle, seen from above ..... 31.

Posterior orbit of the usual width, separated from the occiput by a distinct ridge or raised suture in its upper third. Flagellum of antennæ with short ridges on the under side of the last five or six segments ..... 32.

31. Markings yellow or yellowish-white; apical fasciæ of the abdomen wide and deeply trisinuate; pale hind margin of

pronotum extending far down along the vertical, anterior carina; postscutellum and seventh tergite as a rule spotted with yellow; clypeus generally yellowish with a black, median, elongate spot, sometimes very small.

Vespula adulterina (R. du Buysson).

Markings white or ivory-white; apical fasciæ of the abdomen narrow, those of the first and second tergites often reduced or interrupted in the middle; pale hind margin of pronotum showing only a tendency to extend downward along the vertical, anterior carina; postscutellum and seventh tergite as a rule unspotted; clypeus generally with a black, longitudinal stripe, which is sometimes quite broad.

Vespula adulterina var. *arctica* Rohwer.

32. Last five segments of flagellum each with a short ridge (or tyloide) near the base. Markings white or dirty-white; second tergite usually with a pair of ferruginous spots; flagellum as a rule entirely black. Genitalia as in *norvegicoides* ..... *Vespula norwegica* var. *marginata* (Kirby).

Last six segments of flagellum each with two short ridges (or tyloides), one near the base, the other toward the apex. Markings yellow; second tergite without ferruginous spots; flagellum more or less extensively dirty-yellowish on the under side, rarely almost wholly black ..... 33.

33. Upper inner edge of stipes rectangularly produced, the blunt angle rounded off, seen from above. Penis broadly triangular, the shaft with a fine dorsal, longitudinal ridge, the apical branches flat and broad, with curved outer and straight inner margins, and with blunt points. Yellow markings much as in the queen; apical fascia of first tergite deeply notched or interrupted on the middle line; yellow hind margin of pronotum continued downward along the vertical carina; under side of flagellum extensively testaceous; posterior orbits with a continuous yellow band.

Vespula arenaria (Fabricius).

Upper inner edge of stipes slightly produced and broadly rounded off seen from above. Penis more narrowly triangular, the shaft with a dorsal, longitudinal crest, the apical branches tong-shaped, more slender, with curved outer and inner margins and sharp, long points. Yellow markings as in the queen; apical fascia of first tergite continuous in the middle; hind margin of pronotum not extended along the vertical carina; under side of flagellum slightly testaceous; posterior yellow orbits as a rule interrupted by a black median spot.

Vespula norwegica var. *norvegicoides* (Sladen).

Vespa Linnaeus

The genus *Vespa*, as here delimited, contains only the larger or true "hornets." Its characters and distribution have been discussed elsewhere (1930, Bull. Brooklyn Ent. Soc., XXV, p. 64). There are no indigenous species in America, although some of them have been introduced occasionally into the New World. Thus far only one species, *V. crabro* Linnaeus, has become naturalized in the eastern United States.

I have seen a queen of another species, *Vespa orientalis* Linnaeus, said to have been taken a few years ago by Mr. Geo. F. L. Moetz, at Williams Bridge Road, The Bronx, New York City. There is, however, as yet no evidence that this hornet has become established in North America. There are in the literature some scattered records of *Vespa orientalis, Vespa tropica* Linnaeus (= *V. cincta* Fabricius), and its var. *affinis* Fabricius, having been taken in the American tropics, evidently as accidental introductions. Moreover, some of these records may be based on erroneous labelling of specimens.

1. *Vespa crabro* Linnaeus.

Vespa crabro Linnaeus, 1758, Syst. Nat., 10th Ed., I, p. 572 (Europe).

The common hornet of Europe occurs over most of the Palearctic Region, south of Lat. 62°. It was introduced into North America by man between 1840 and 1860. According to H. de Saussure (1898, Ent. News, IX, p. 145), it was caught for the first time in the eastern United States in 1854; but J. Angus, in 1871, stated that in his vicinity (West Farms, New York) this hornet had been common for the past 25 years. At present it is thoroughly naturalized in Long Island, Staten Island, the southern part of New York State (as far north as Hudson, Nyack, West Point, and Poughkeepsie), northern New Jersey (as far south as Princeton and Riverton), and southwestern Connecticut (as far east as Milford and New Haven). Specimens have also been taken near Philadelphia, in Maryland and in Delaware. Published records from Illinois, Northern and Southern Carolina, and New Orleans are open to question.[6]

[6] The finding of a lilac branch, apparently gnawed by a wasp, in the Chicago area, as recorded by Bromley (1931, Jl. New York Ent. Soc., XXXIX, p. 124), is in my opinion insufficient proof of the occurrence of *V. crabro* in that region, since other animals may attack branches in a similar fashion. Moreover, *Vespula maculata* has been reported by Meehan (1878, Proc. Ac. Nat. Sci. Phila-

In the Palearctic Region, *V. crabro* is represented by a number of color forms (or races), as I have shown in a paper recently published in Konowia (1931, VIII, pp. 101–109). The form established in North America is the var. *germana* Christ [= *Vespa crabro germana* Christ, 1791, Naturgesch. Insekten Bienen, Wespen u. Ameisengeschl., p. 215, Pl. XVIII, fig. 3; *Vespa crabro vulgata* Birula, 1925, Arch. f. Naturgesch., XC, (1924), Abt. A, Heft 12, p. 100], of western and central continental Europe. In this form the thorax is abundantly marked with russet, the queen having at least two longitudinal russet stripes on the mesonotum.

V. crabro builds very large nests in some sheltered situation, preferably in hollow trees, under the roof of attics, porches or open sheds, in holes of rocks, in caves, or even in underground cavities. More freely exposed, aërial nests are completely enclosed by an envelope of very brittle paper. When the nest is placed inside a small cavity, as, for instance, in a hollow tree, the outer paper cover may be either completely lacking or only partly present. There are many accounts of the habits of this hornet, beginning with those of Réaumur (1742) and Degeer (1771). In North America they have been observed by J. Angus (1871), W. Beutenmüller (1898), J. A. Grossbeck (1908), E. P. Felt (1915), W. T. Davis (1924; 1925), and E. N. Cory (1931). A queen found hibernating at Picton, New Jersey, March 28, 1920, had the plaited wings tucked away between the hind legs and the lower sides of the abdomen, as is customary for the hibernating females of the Vespinæ.

Vespula C. G. Thomson

A more intensive study of the several species of *Vespula* has disclosed additional characters separating the two subgenera, *Vespula* proper, and *Dolichovespula*. That these two subgenera represent natural groups, and not artificial products of the taxonomic mind, I have not the slightest doubt.[7]

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delphia, p. 15) as stripping off the bark of young branches. Cory's record from Illinois (1931, Jl. Econ. Ent., XXIV, p. 50) also was not based upon specimens, but upon erroneous information. There are at present no Illinois specimens of *V. crabro* at the U. S. National Museum, at the State Natural History Survey of Illinois, and at the Field Museum of Natural History.

[7] Attention should be called to a very unfortunate error in the characterization of the subgenus *Vespula* proper, in my earlier paper (1930, Bull. Brooklyn Ent. Soc., XXV, p. 67). The statement "tibiæ as a rule with long hairs," should have read "tibiae as a rule *without* long hairs."

In each subgenus, the several species fall in a number of subgroups, which may be briefly mentioned.

1. Subgenus *Vespula proper.*

A. Subgroup of *Vespula vulgaris.*—Posterior orbit generally separated from the occiput over its entire length by a fine ridge, which as a rule reaches the base of the mandible (less distinct in the male). Male: disk of seventh tergite more or less depressed; shaft of penis slender, the two branches fused throughout and forming an apical, subcircular or heart-shaped spoon; stipes with a strong, inwardly projecting upper inner edge; volsella of valva interna very long, finger-shaped, densely hairy, extending to the tip of the squama of the valva externa. This subgroup contains *V. vulgaris* (Linnaeus), *V. germanica* (Fabricius), *V. maculifrons* (R. du Buysson), *V. pensylvanica* (H. de Saussure), *V. lewisii* (P. Cameron, 1903) (= *Vespa japonica* H. de Saussure, 1858; not of Radoszkowsky, 1857; *Vespa saussurei* W. A. Schulz, 1906), and *V. koreensis* (Radoszkowsky).

B. Subgroup of *Vespula rufa.*—Posterior orbit incompletely separated from the occiput, the ridge never reaching the base of the mandible. Male: disk of seventh tergite evenly convex; shaft of penis broad, the two branches fused throughout into a broad, elongate plate, hardly widened at the apex where it forms a subtruncate saddle-shaped piece; stipes with the upper inner edge not or very slightly projecting; volsella of valva interna short and slender, almost bare, not reaching the tip of the squama of the valva externa. This subgroup comprises *V. rufa* (Linnaeus), *V. austriaca* (Panzer), *V. structor* (F. Smith), *V. squamosa* (Drury), and *V. sulphurea* (H. de Saussure).

2. Subgenus *Dolichovespula.*

C. Subgroup of *Vespula norwegica.*—Lower sides of pronotum and propodeum punctate. Male: flagellum of antenna with at least traces of welts (tyloides) on the under side; seventh sternite not deeply emarginate; branches of penis incompletely fused, the basal shaft forming an elongate triangular piece, gradually tapering toward the two parallel, somewhat curved and flattened apical rods, which in profile are shaped like a hawk's bill with the hook turned upward; stipes with the upper inner edge slightly projecting, broadly rounded; volsella of valva interna long and broad, densely hairy, extending fully to the tip of the squama of the valva externa. This subgroup comprises *V. norwegica* (Fabricius), *V. arenaria* (Fabricius), and *V. adulterina* (R. du Buysson).

D. Subgroup of *Vespula sylvestris*.—Lower sides of pronotum and propodeum punctate. Male: flagellum of antennæ without tyloides; seventh sternite not deeply emarginate; branches of penis incompletely fused, the basal shaft narrowly triangular, passing very gradually into the two apical rods, which are parallel, closely appressed, thickened and very obtuse in profile; stipes with a strong upper inner edge, projecting apicad; volsella of valva interna short and moderately slender, nearly bare, much shorter than the squama of the valva externa. This subgroup contains only *V. sylvestris* (Scopoli) and its inquiline derivative *V. omissa* (Bischoff).[8]

E. Subgroup of *Vespula maculata*.—Lower sides of pronotum and lower half of propodeum finely striate. Male: flagellum of antennæ with strong welts (tyloides) on the under side; seventh sternite deeply, semicircularly emarginate, the notch with sharp lateral edges; branches of penis incompletely fused, the basal shaft very broad and expanded beyond the middle, the two apical branches flat and broad, tong-shaped; upper inner edge of stipes forming a broadly rounded angle; volsella of valva interna short and broad, densely hairy, not reaching the tip of the squama of the valva externa. This subgroup comprises *V. maculata* (Linnaeus) and *V. media* (Retzius), which are hardly more than color forms (or races) of one species.

The general distribution of these subgroups shows some points of interest. The subgroup of *V. sylvestris* is exclusively Palearctic. The other subgroups are Holarctic; but while certain species are restricted either to the Old World (*V. germanica, V. lewisii, V. media*) or to the New World (*V. maculifrons, V. pensylvanica, V. arenaria, V. maculata, V. squamosa,* and *V. sulphurea*), others are found in both the eastern and the western hemispheres (*V. vulgaris, V. rufa, V. austriaca, V. norwegica* and *V. adulterina*). Some of these Holarctic species show no appreciable variation, even in color, over their immense area (*V. vulgaris* and *V. austriaca*); more often though (*V. rufa, V. norwegica* and *V. adulterina*), they have produced a number of color forms, some of which may be restricted either to the Nearctic or to the Palearctic portion of their territory. It should, moreover, be noted that the characters separating some of

[8] To judge from the descriptions, *V. omissa* (Bischoff, 1931) is identical with *Vespula norvegica saxonica* morpho *ingrica* Birula (October, 1930), in which case the species will have to be called *Vespula ingrica* (Birula).

the strictly Nearctic and strictly Palearctic species of the same subgroup are very slight, so that these species in each case are clearly offshoots from some common ancestral stock.

V. koreensis and *V. structor* have been placed in their respective subgroups on the basis of queens and workers only. *Vespula orbata* (R. du Buysson) and *V. lama* (R. du Buysson) are as yet unknown to me.

Subgenus *Vespula,* proper

Oculo-malar space short, at most half the length of the penultimate antennal segment in the male; in female and worker almost absent, the eye practically touching the mandibular condyle. Tibiae as a rule without erect, long hairs on the upper face (except in *V. austriaca*), a few erect hairs being found near the base only. Vertical carina of the sides of the pronotum obsolete or faintly marked only in the lower portion. Third cubital cell about as long on the radius as on the cubitus (rarely a little longer). Male: flagellum of antennæ without distinct raised welts (tyloides) on the under side; branches of penis completely fused throughout into a single piece.

As a rule, the species of this group nest underground or in cavities inside fallen logs. Exceptionally the nest is placed close to the ground in bushes, in the shelter of a rock or among roots. It is never truly aërial.

1. *Vespula vulgaris* (Linnaeus).

Vespa vulgaris Linnaeus, 1758, Syst. Nat., 10th Ed., I, p. 572 (Europe; the holotype, a queen, is at the Linnean Society in London).

Vespa communis H. de Saussure, 1857, Stettin. Ent. Zeitg., XVIII, p. 117 (♀; North America).

Vespa alascensis Packard, 1870, Trans. Chicago Ac. Sci., II, p. 27, Pl. II, fig. 10 (♀; Lower Yukon, Alaska).

Vespa westwoodii Shipp, 1893, Psyche, VI, p. 450 (Boreal America).

Provisionally I regard *V. vulgaris* as specifically distinct from *V. maculifrons* (R. du Buysson), the two species differing structurally in the male only by the shape of the disk and apex of the seventh abdominal tergite, as indicated in the key. This view is based upon the following arguments: (1) all European males with the penis of *V. vulgaris* have the same type of seventh tergite, *viz.*, the *vulgaris* type; (2) in North America, where both the *vulgaris*

and *maculifrons* types of seventh tergite occur, no transitions have been observed between the two; (3) so far as studied, all males taken or bred from one nest show the same type of seventh tergite; (4) the two types are somewhat geographically segregated: only the *vulgaris* type is known from the Pacific Coast and the Rocky Mountains; in eastern North America, where both types occur, *vulgaris* is more northern and *maculifrons* more southern, although their areas partly overlap. I have been unable to find a consistent and wholly reliable difference in the male genitalia between *V. vulgaris* (Fig. 2*A*) and *V. maculifrons*.

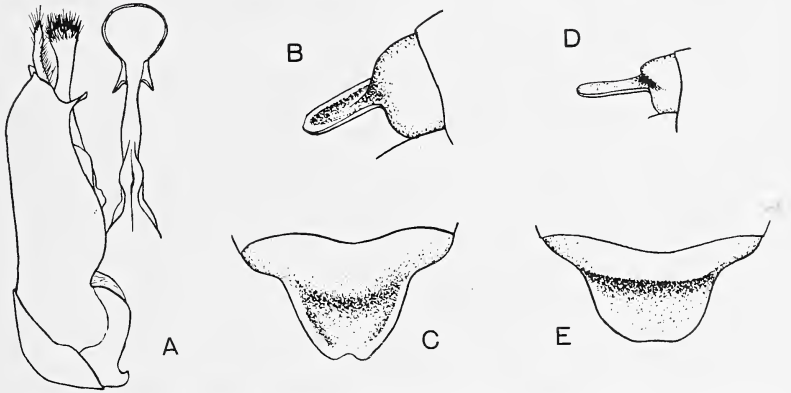

Fig. 2. A–C, *Vespula vulgaris* (Linnaeus): A, male external genitalia in dorsal view; B, seventh tergite of male in profile; C, the same in dorsal view. D–E, *Vespula maculifrons* (R. du Buysson): D, seventh tergite of male in profile; E, the same in dorsal view.

Queens and workers of *V. vulgaris* are, on the whole, more melanistic than those of *V. maculifrons*, but there are many transitions in coloration, due either to overlapping fluctuating variations or to hybridism. The occurrence of either *vulgaris* or *maculifrons*, or of both, in a given locality cannot be positively asserted without the examination of males.

V. vulgaris is widely distributed over the Palearctic Region. In North America it extends across the continent, approximately between 35° and 60° Lat. N. In the eastern half of the continent it is of more northern distribution and one of the more common yellow-jackets in the Canadian Zone (between 45° and 50° Lat. N.); but it enters also the Transition Zone, where it is sometimes found together with *V. maculifrons*. In the mid-Atlantic States it is restricted to the mountains. West of the Mississippi it is found

throughout the Rocky Mountain region from New Mexico to Alberta, and on the Pacific Coast it appears to be fairly common from southern Alaska and the Yukon Territory to central California. *V. vulgaris* has also been introduced into New Zealand (G. M. Thompson, 1923, p. 227).

I have seen males with the *vulgaris* type of seventh tergite from California, Alberta, North Dakota, New York, Connecticut, Massachusetts, Canada (Sherbrook), and the Hudson Bay Territory. Queens and workers, most probably belonging to *V. vulgaris,* I have examined from Alaska, Yukon Territory, British Columbia, Vancouver Island, Alberta, Washington State, Oregon, California, Idaho, Utah, Colorado, New Mexico, North Dakota, Iowa, Minnesota, Illinois, Michigan, Nova Scotia, Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Virginia, and North Carolina.

In Europe, *V. vulgaris* builds almost always underground, the nest consisting of several tiers of paper cells as a rule completely wrapped in a brittle envelope of paper. In the rare cases when a nest is found above ground, it is placed in a well-sheltered spot. Undoubtedly some of the accounts of supposed aërial nests of *V. vulgaris* were due to misidentifications. This is notably the case for that given by Degeer (1771, Mém. pour Servir à l'Hist. Insectes, II, 2, p. 772), which refers to *V. norwegica* var. *saxonica* (Fabricius). In North America, J. Wyman's (1861) observations on the nest of an undetermined *Vespa,* found in the slope of a bank at Cambridge, Mass., were possibly based upon *V. vulgaris.* I have found a nest of this species in the Adirondacks, N. Y., placed inside the decaying stump of a tree, nearly in the center. A very brittle cover of paper enveloped the whole nest, the entrance to the cavity being on the side of the stump. Mr. R. P. Dow, in 1929, dug up two underground nests, which, to judge from the specimens I examined, were built by *V. vulgaris.* One of these, found at Cold Spring Harbor, N. Y., on September 3, was resting on the sloping surface of a root, to which it was partly fastened; it consisted of three large combs and a smaller one, all inside an envelope of paper. Males were later bred from this nest. Some of the cells contained pupae of the ichneumonid, *Sphecophaga burra* (Cresson); before pupating, the larva of this parasite closes the cell, some distance below the top, with a brownish, silken partition, showing a slightly depressed, translucid circle in the center. Mr. Dow's other nest, from Huntington, Mass., August 18 and 19, showed no paper en-

velope around the four combs, which were attached among the roots of a black birch. It contained a queen and 183 workers. Mr. S. W. Bromley has recently (Sept., 1931) sent me queens, workers and males taken from an underground nest at Stamford, Connecticut.

2. *Vespula maculifrons* (R. du Buysson).

Vespa maculifrons "H." R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, 4, (1904), p. 608 (as a synonym of *Vespa communis* H. de Saussure, the name being found on the label of a specimen from Wilmington, Delaware, at the British Museum).

Vespula maculifrons Rohwer, 1926, Proc. Ent. Soc. Washington, XXVIII, p. 94.

Vespa communis var. *flavida* Sladen, 1918, Ottawa Naturalist, XXXII, p. 71 (♀; Eastern Canada, of "more southern range"; without more definite locality).

This is the wasp which in the eastern United States and Canada has often been called "*Vespa germanica.*" In my opinion the true *Vespula germanica* (Fabricius), of the Palearctic Region, has never yet been found in North America. All the so-called *V. germanica* from eastern North America, which I have seen in collections, differ from that species in the female and worker having the apical margin of the mandible shaped as in *V. vulgaris;* while in the male the shape of the seventh tergite and of the genitalia is very different. In true *V. germanica* the seventh tergite is evenly depressed beyond the gradually sloping convex base and usually has a distinct emargination at the apex, as in *V. vulgaris;* the genitalia have the shaft of the penis with narrow, wing-like expansions ventrally, close to the apical spoon, which is heart-shaped, with emarginate apex; the upper inner edge of the stipes of the valva externa forms a blunt lobe, which is much longer than wide (Fig. 3*B*). I have, however, not been able to find any reliable difference in color pattern between *V. germanica* and *V. maculifrons.*[9]

[9] Incidentally it may be noted that *V. vulgaris* and *V. germanica* are, in my opinion, two perfectly valid species, and not merely color variations of one specific type, as certain authors have claimed in Europe. In the males, each of these species is characterized by the peculiar shape of the genitalia (compare Fig. 2*A* and Fig. 3*B*), no transitions between these two types having ever been reported. In addition, the females and workers show a constant difference in the shape of the apical margin of the mandible, as recently pointed out by Bischoff (1931, Mitt. D. Ent. Ges., II, p. 7).

V. maculifrons is strictly North American and is commonly found in the eastern half of the continent throughout the Upper and Lower Austral and Transition Zones, between 28° and 48° Lat. N. I have seen males with the *maculifrons* type of seventh tergite from Maine, Massachusetts, Connecticut, New York, New Jersey, Maryland, Washington, D. C., Virginia, Texas, Nebraska (South Bend, Cass Co.), Kansas (Manhattan, all phases from two nests dug out by Mr. A. W. Lindquist), Michigan, and North Dakota; also queens and workers almost certainly of the same species from Quebec, Ontario, Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Maryland, Washington, D. C., Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida (Enterprise; Lakeland), Alabama, Arkansas, Texas, Missouri, Tennessee, Kansas (Douglas Co.), Nebraska (Omaha; La Platte; Fort Calhoun), North Dakota (Kelly; Grand Forks; Arvilla), Minnesota, Iowa, Illinois, Michigan, Indiana, and Ohio. There is no evidence of *maculifrons* having ever been taken west of the 100th Meridian.

Although the name "*maculifrons*" should be credited to R. du Buysson, since he was the first to validate it by citing it in connection with a description or published name, it was actually proposed nearly a century ago by Thomas Say. It was first used in print by Thaddeus Harris in 1833 (in Hitchcock, Report on the Geology, Mineralogy, Botany of Massachusetts, p. 589), but without a description or a reference to a described species. Here the name is followed by "S," an abbrevation for "Say, MS." Moreover, Harris' collection, now preserved at the Boston Society of Natural History, contains two workers, without locality, bearing Say's manuscript label, which agree with Rohwer's and my interpretation of *maculifrons*.

Most, if not all, the accounts of the habits credited by North American entomologists to *V. germanica* really refer to *V. maculifrons*. This is notably the case for those published by W. Couper (1870), C. L. Marlatt (1891), W. H. Ashmead (1894), P. and N. Rau (1918), and P. Rau (1930 and 1931). Moreover, the habits of *maculifrons* are essentially the same as those of *germanica* and *vulgaris*. The nest is usually placed underground, sometimes inside decayed stumps or hollow logs, or even in more unusual places. In mid-summer it comprises four to eight horizontal combs of cells, opening downward, and some 400 to 700 workers in addition to the old queen. P. Rau (1930) describes a nest consisting of only one

very large comb. Late in August the first males appear and these are followed a few weeks later by the virgin females. Mating takes place outside the nest and the impregnated females soon go into hiding for the winter. During hibernation they keep the plaited wings beneath the sides of the body, tucked away between the hind legs and the abdomen. The old colony dies out completely in the fall and the nests are usually deserted, although H. Skinner has recorded a nest collected near Philadelphia in the dead of winter and containing live wasps (1905, Ent. News, XVI, p. 25). In any case the young females never return to the old nests in spring, but each of them seeks out a location where she starts a new nest. These young queens appear rather late in the spring (about May or early June in Massachusetts).

According to Janet and other European observers, the nests of *V. vulgaris* and *V. germanica* may be readily recognized by the different appearance and texture of the enclosing cover. In *V. vulgaris* the envelope is described as very brittle, more or less dirty yellowish, and built of numerous, irregularly imbricated scales, so that it appears fluted or scalloped. *V. germanica* is said to build a more consistent cover of fibrous paper, grayish and forming a number of large, concentric sheets. It would be interesting to investigate whether somewhat similar differences might not characterize the nests of *V. vulgaris, V. maculifrons* and *V. pensylvanica* in North America.

3. *Vespula pensylvanica* (H. de Saussure).

Vespa pensylaniva H. de Saussure, 1857, Stettin. Ent. Zeitg., XVIII, p. 117 (♀; North America, Canada and the mountains of Mexico). R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, 4, (1904), p. 615 (♀ ☿ ♂).

Vespa occidentalis Cresson, 1874, Trans. Amer. Ent. Soc., V, p. 100 (♀ ☿, erroneously described as ♀ ♂; Nevada and New Mexico). Not *Vespa occidentalis* Olivier, 1791.

It appears that de Saussure originally based his *V. pensylvanica* upon a mixture of eastern (Canadian) specimens of what is now called *Vespula maculifrons* (R. du Buysson) and of western (Mexican) specimens of Cresson's *Vespa occidentalis*, although the statement "antennarum scapo antice flavo" is true of the western species only. R. du Buysson who examined one of de Saussure's cotypes from Mexico, at the Paris Museum, recognized that this

wasp was identical with *V. occidentalis* Cresson. Being the first reviser, he had the right to restrict the name *pensylvanica* to the western species, and there seems to be no way of avoiding the name, even though the species does not occur in Pennsylvania. Moreover, if *V. pensylvanica* were rejected as inappropriate or misleading, a new vocable would have to be introduced, since Cresson's name is invalidated by the earlier *Vespa occidentalis* Olivier (now placed in *Polybia*).

V. pensylvanica is peculiar to western North America, where it replaces *V. maculifrons*. Here it occurs between 18° and 52° Lat. N., mainly, it would seem, in the Transition Zone and as high up as 8,000 ft. In the southern part of its range it is rare and restricted to the mountains. Males with the genitalia and seventh tergite of

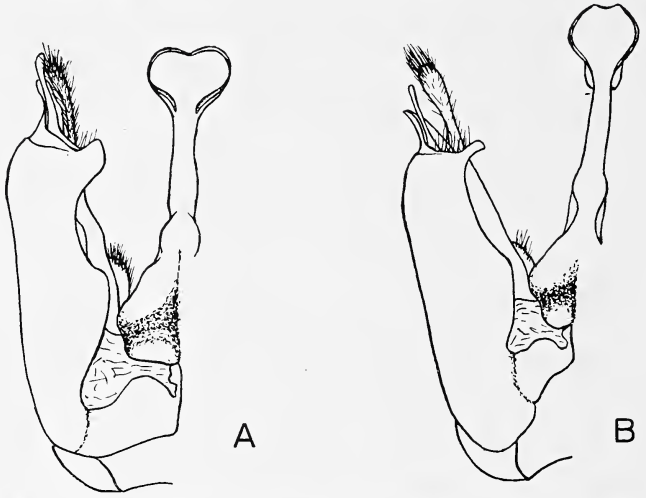

Fig. 3. A, male external genitalia of *Vespula pensylvanica* (H. de Saussure). B, the same of *Vespula germanica* (Fabricius). Both in dorsal view.

pensylvanica I have seen from Washington State, Oregon, California, Utah, Colorado, South Dakota, Arizona, and Mexico. I also refer to this species queens and workers from British Columbia (Terrace; Vernon; Nanaimo Biological Station; Selkirk Mountains; Kaslo), Vancouver Island, Washington State, Oregon, California, Idaho, Nevada, Utah, Wyoming, Colorado, South Dakota (Black Hills), Nebraska (Squaw Canyon, Sioux Co.), Arizona, New Mexico and Mexico City. There are reliable published records from Alberta and Montana. Probably the species occurs in the extreme western part of Kansas, but E. S. Tucker's record of *V. occidentalis*

from Lawrence, Kans. (1909, Trans. Kansas Ac. Sci., XXII, p. 285) I regard as based upon misidentified *V. maculifrons.* Males with the characters of *V. pensylvanica* have never yet been found east of the 100th Meridian. *V. pensylvanica* has been introduced by man into Kauai, Hawaiian Islands, where it was first recorded in 1919 and appears now to be common locally (O. H. Swezey, 1921, and F. X. Williams, 1931). Dr. Williams has sent me Hawaiian specimens, including males.

Very few observations have as yet been made regarding the habits of *V. pensylvanica.* According to G. W. Taylor's (1898) account, they are similar to those of *V. maculifrons,* the nest being placed underground. Taylor captured at the entrance of the nests, in British Columbia, 23 males and 4 females of an interesting parasitic wasp, *Trigonalys canadensis* Harrington.

4. *Vespula rufa* (Linnaeus).

Vespa rufa Linnaeus, 1758, Syst. Nat., 10th Ed., I, p. 572 (Europe; based on a worker).

This species occurs throughout the Palearctic and Nearctic Regions, in the following color forms:

(1) Typical *V. rufa,* with dull yellow markings and with rufous spots on the first or first and second abdominal tergites, at least in the worker; the rufous is rarely absent or diffuse in the male, but often lacking in the queen. Linnaeus' holotype, at the Linnean Society of London, is a worker in which, as Mr. Robert B. Benson writes me, "the first and second abdominal segments are marked with russet." This form occurs over most of Europe and western Asia, as far east as Long. 130°; northward it reaches 70° Lat. N., southward it extends into northern Spain, Italy, Crimea, Transcaucasia and Pamir. I have never seen it from North America and I regard all American published records of typical *V. rufa* as based upon misidentifications.

(2) *V. rufa* var. *schrenckii* (Radoszkowsky, 1861), of which *Vespa sibirica* Edm. André (1884) is a synonym, differs from the typical form in the pale markings being dirty-white or ivory-white, while (even in the worker) the russet spots are more often reduced or absent; they are never present in the queen. This form is found in northeastern Asia, between 110° Long. E. and the Pacific; it extends from the shores of the Arctic Ocean to northeastern Mongolia and I have also seen it from Japan.

(3) *V. rufa* var. *intermedia* (R. du Buysson). North America.

(4) *V. rufa* var. *atropilosa* (Sladen). Northwestern America.

(5) *V. rufa* var. *vidua* (H. de Saussure). Northeastern America.
(6) *V. rufa* var. *acadica* (Sladen). Northeastern America.
(7) *V. rufa* var. *sladeni* J. Bequaert. Northwestern America.
(8) *V. rufa* var. *consobrina* (H. de Saussure). North America.

My interpretation of the last-named six forms as North American representatives of *V. rufa* is based upon the failure to find structural characters to separate them from one another and from European specimens of typical *rufa*. In particular, the male genitalia of all these forms seem to me identical in every important detail.

4*a*. *Vespula rufa* var. *intermedia* (R. du Buysson).

Vespa rufa var. *intermedia* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, 4, (1904), p. 591 (♀ ♂; region of Lake Hanka in Manchuria and Hudson's Bay in North America).

This form is so close to the var. *schrenckii* of northeastern Asia, that I greatly doubt the advisability of keeping it separate. It differs from *schrenckii* only in the presence of more or less extensive russet markings on the first and second tergites of the queen, these markings being usually also found in the worker and male. From typical *rufa* it differs in the pale markings being ivory-white instead of yellow. L. Provancher (1882 and 1883) and T. W. Fyles (1903) based their descriptions of *V. rufa* upon specimens of the var. *intermedia*.

I regard the var. *intermedia* as peculiar to the Hudsonian Zone of boreal North America, where it seems to extend across the Continent. It is very rare in collections. I have seen it from Alaska (1 ♀ without more definite locality; 1 ♀ from the Lower Yukon; 1 ♀ from 850 miles up the Anvik River), North West Territory (1 ♂ from Oklavik on the Mackenzie River), Canada (2 ♀ without more definite locality), and Labrador (1 ♀ from Rama). There are reliable published records from eastern Canada (Chicoutimi and the Island of Orleans) and from Manitoba (Mile 137 of the Hudson's Bay Railway). I propose to select Hudson's Bay as the type locality, since I believe that du Buysson's specimen from Lake Hanka, in Manchuria, actually belonged to the var. *schrenckii*. Unfortunately R. du Buysson does not say whether the North American specimen (which is at the British Museum) was the queen or the male.

No account of the nesting habits is available.

4*b*. *Vespula rufa* var. *atropilosa* (Sladen).

Vespa atropilosa Sladen, 1918, Ottawa Naturalist, XXXII, p. 72 (♀ ☿; Lethbridge, Alberta; Vernon, Keremeos and Okanagan Landing, British Columbia).

This is an extreme xanthic form of *V. rufa*, widely distributed throughout western North America, where it covers much the same area as *V. pensylvanica*. Until Sladen's work, it was generally confused with that species, although structurally it is very different. There are, moreover, usually a number of color peculiarities by means of which *pensylvanica* and *atropilosa* may be told apart: (a) the yellow spots of the propodeum are usually present in *pensylvanica*, as a rule absent in *atropilosa;* (b) the black spots of the second tergite are regular rounded extensions of the black base in *pensylvanica*, whereas in *atropilosa* they are oblique and tend to fuse with the median triangular notch; (c) the black diamond of the first tergite is elongate and rather narrow in *pensylvanica*, wide and transverse in *atropilosa;* (d) the mesonotum often has yellow spots before the scutellum in *pensylvanica*, hardly ever in *atropilosa;* (e) the yellow ocular sinuses are usually connected with the outer orbits along the sides of the vertex in *pensylvanica*, as a rule broadly separated in *atropilosa*. All these differences in color, however, admit of exceptions.

I have seen the var. *atropilosa* from British Columbia (Kaslo; Fort McLeod; Vernon), Vancouver Island, Alberta (Medicine Lake), Washington State, Oregon, California, Idaho, Nevada, Montana, Wyoming, Utah, Colorado, Arizona, and Lower California (Tia Juana). Most likely it occurs also in New Mexico. The United States National Museum has one worker labelled "Texas, Belfrage," which may have been obtained in the western part of that state. There is, however, no reliable record of its occurrence east of the 100th Meridian.

Lewis' description of *Vespa infernalis* (1897) was almost certainly based upon specimens of the var. *atropilosa*, which is sometimes found in American collections as "*infernalis.*" H. de Saussure's original description of *V. infernalis* (1853), however, was drawn most likely from a female of *V. austriaca* (Panzer).

No observations have as yet been published regarding the nesting habits of this wasp. Mr. C. D. Duncan has sent me some specimens from a nest dug up in Utah, so that we may suppose that it builds underground or partly above the soil, like typical *V. rufa* and the var. *vidua*.

4c. *Vespula rufa* var. *vidua* (H. de Saussure).

Vespa vidua H. de Saussure, 1853, Et. Fam. Vesp., II, p. 136 (♀; Carolina).

The well-known *vidua* is readily recognized by the usually bright yellow markings, which are very extensive on the third and succeeding abdominal segments, while on the first and second they are reduced to a narrow apical margin; in addition, the edge of the first tergite bears two narrow transverse streaks (very rarely absent).

The var. *vidua* occurs throughout southeastern Canada and the eastern United States, where it is most common in the Upper

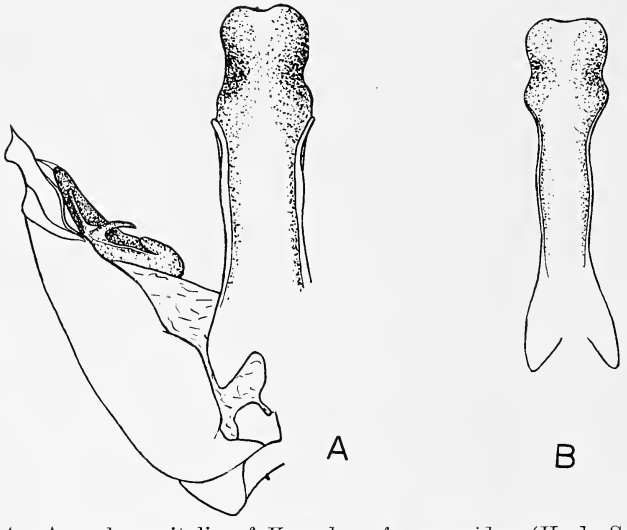

Fig. 4. A, male genitalia of *Vespula rufa* var. *vidua* (H. de Saussure); only the penis and the several parts of the valva interna dotted. B, penis of *Vespula austriaca* (Panzer). Both in dorsal view.

Austral Zone; occasionally it is found in the Transition Zone also. I have seen it from Ontario, Nova Scotia, Maine, Vermont, Massachusetts, Connecticut, Rhode Island, New York, New Jersey, Pennsylvania, Maryland, Delaware, Washington, D. C., Virginia, North Carolina, Georgia (Macon), Texas (one specimen without more definite locality, collected by Belfrage; this record needs confirmation), Indiana, Michigan, Wisconsin, Illinois, Minnesota, and North Dakota (Traill Co.).

Although this wasp is by no means rare, no account of its habits appears to have been written thus far. It nests underground.

S. W. Bromley (1923) lists it among the prey of the robber fly, *Proctacanthus rufus* Williston.

4*d*. *Vespula rufa* var. *acadica* (Sladen).

Vespa acadica Sladen, 1918, Ottawa Naturalist, XXXII, p. 72 (♀ ☿ ♂; in part: specimens from Nova Scotia; Painsec, New Brunswick; and Ottawa).

Vespa rufa var. *americana* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, 4, (1904), pp. 499, 500, and 592 (♂; Lewis near Quebec, Canada). Not *Vespa americana* Fabricius, 1775, nor *Vespa maculata americana* Christ, 1791.

Although only an examination of the types could positively settle the identity of du Buysson's var. *americana,* I believe that it was based upon a male color variant of Sladen's *V. acadica,* which I regard as a variety of *V. rufa.* A series of nine males, collected by Mr. G. B. Fairchild in Cape Breton Island, September 5, 1928, is extremely instructive in this respect. Six agree with du Buysson's description of var. *americana* in lacking free yellow spots on the second tergite, while they differ from males of var. *vidua* in having all the apical yellow fasciae of the tergites of about equal width; in one of them the free yellow streaks of the first tergite are barely indicated. One specimen has traces of free yellow dots on the second tergite, while in another these dots are quite distinct. In the ninth specimen there are two large spots on the disk of the second tergite, which, moreover, are connected both on the inner and outer angles with the apical fascia (thus enclosing a black spot); this specimen also has the yellow areas of the first tergite decidedly tinged with reddish. This series, taken the same day in the same locality, shows beautifully the relationship of *acadica* to typical *V. rufa* as well as to the var. *vidua.*

Sladen's *V. acadica* covered all specimens, of eastern as well as of western North America, intermediate in coloration between the var. *atropilosa* and the var. *vidua.* These specimens can, however, not possibly be accounted for by crossing of those two forms, which nowhere are known to occur together and whose ranges do not overlap. In my opinion, the eastern specimens of Sladen's *acadica* are extreme xanthic variants of the var. *vidua,* often with more or less extensive yellow spots in the black area of the second tergite. The western wasps which Sladen included in his "*acadica,*" on the other hand, are, I believe, a melanistic variation of the var. *atropilosa,* with much reduced yellow markings. In the present paper,

I describe this western form as var. *sladeni*. Through convergence, these eastern and western variants have come to look alike, so much so indeed that without referring to the locality labels, they often cannot be told apart. Nevertheless, if my interpretation be correct, they have a totally different ancestry, a fact which should, I believe, be duly recognized in the nomenclature. I shall therefore restrict the name *acadica* Sladen to the eastern form, Sladen's specimens from Nova Scotia, New Brunswick (Painsec), and Ottawa being the cotypes. His specimens from Kalso and Victoria, British Columbia, I refer to the new variety *sladeni*.

I have seen specimens of the var. *acadica* (as here restricted) from Canada (without definite locality), Nova Scotia (Portaupique; MacNabs Island; Halifax; Dublin Shore, Lunenburg Co.; Baddeck, Cape Breton Island), Quebec (Ironside), Hudson's Bay Territory, Maine (Ocean Point, 1 ♀; Wadloboro; N. E. Harbor, Mt. Desert), New Hampshire (Passaconaway; Mt. Washington), Minnesota (Two Harbors), and South Dakota (Custer). I suspect that the var. *acadica* will be found sporadically throughout the range of the var. *vidua* and in the nests of that form.

4*e*. *Vespula rufa* var. *sladeni*, new variety.

Queen (holotype).—Black, without traces of rufous, with bright yellow markings (nearest Ridgway's light cadmium) as follows: clypeus (except for the margins and an irregular, median, black streak, extending from the upper margin to below the middle, where it is connected with two small spots); a large lozenge-shaped spot between the antennae; a spot in the inner edge of the ocular sinus; a streak in the upper part of the outer orbit (close to the eye); most of the mandibles; under side of antennal scape; broad hind margins of pronotum; two large, transverse spots on scutellum; a triangular spot in the upper mesepisternum (beneath the base of the wings); most of the tegulae; moderately wide apical margins of the abdominal segments; two free spots on each of tergites 1 to 5; broad apices of femora; and most of the tibiae and tarsi. The yellow fascia is fairly uniform on tergite 1, which bears two transverse streaks on the edge; the fasciae are gradually wider on the sides of tergites 2 to 5; those of tergites 3 to 5 each have two semi-circular, anterior notches, corresponding to the pair of free, yellow spots; black area of tergite 2 also with two free, yellow spots; on the sternites each fascia has three very wide emarginations; tergite 6 with the side margins broadly yellow, the corresponding sternite black.

Length (h. + th. + t. 1 + 2) : 11 mm.; of wing : 12.5 mm.

Worker (allotype).—In most respects like the queen, except for the following: the black mark of the clypeus more or less broken up into three spots; lower part of outer orbit also with a yellow streak; two transverse yellow spots on postscutellum; free spots of second tergite much smaller; tergites 3 to 5 without free spots; femora more extensively yellow.

Length (h. + th. + t. 1 + 2) : 9 mm.; of wing : 8.5 mm.

Male (allotype).—Very similar to the worker allotype, but the yellow more extensive on the head (clypeus with only a minute central black dot; ocular sinuses completely filled with yellow; outer orbits yellow the whole length of the eyes); yellow spots of postscutellum very small; second or second and third tergites with small, free, yellow spots; seventh tergite with the sides broadly yellow, separated to the tip by a median black band. Genitalia as in typical *V. rufa*.

Length (h. + th. + t. 1 + 2) : 11 mm.; of wing : 12.5 mm.

In coloration these specimens can readily be matched with queens, workers and males of the eastern *V. rufa* var. *acadica* (Sladen). Some of the western specimens which I refer to var. *sladeni* show, however, a marked departure from the descriptions given above, in that, at least in the worker and male, the free spots of the second tergite may be either very small or entirely lacking. Specimens without free spots can, of course, not be distinguished from *V. rufa* var. *vidua* (H. de Saussure), except by their western origin, the true var. *vidua* having never been found west of the 100th Meridian. In one worker from Sitka, Alaska, the free spots of the first tergite have also disappeared. On the other hand, I have seen workers of *V. rufa* var. *atropilosa* (Sladen) in which the anterior spots of the first and second tergites were barely connected with the apical yellow areas. Such specimens connect the var. *atropilosa* with the form here described as var. *sladeni* and indicate the genetic relationships between the two.

My reasons for regarding var. *sladeni* as an extreme, melanistic variation of var. *atropilosa* are as follows: (1) one may, with sufficient material arrange a regular sequence of specimens showing all passages from the one to the other; (2) there is no evidence that the var. *vidua* occurs west of the 100th Meridian; at any rate, no true queens of *vidua* have ever been found in the western area; and (3) specimens of the form here described as *sladeni*, although rare, occur sporadically throughout the area occupied by *atropilosa*, particularly in the northern part of its range.

The description of the var. *sladeni* is based upon specimens from the following localities: Alaska: Sitka, one worker, paratype.—Vancouver Island: one worker, paratype (Am. Mus. Nat. Hist.)—British Columbia: Skagit Valley, one worker, paratype.—Washington State: one queen, holotype.—Oregon: Three Sisters, two workers, paratypes; Oregon Mt., Josephine Co., one worker, allotype; Mt. Hood, one worker, paratype (U. S. Nat. Mus.), and one queen, paratype (Oregon St. Agr. C.); Crater Lake Park, five workers, paratypes (Oregon St. Agr. C.); Newport, one worker, paratype (Oregon St. Agr. C.); Lake of the Woods, Klamath Co., one worker, paratype (Oregon St. Agr. C.); Mt. McLaughlin, Klamath Co., one worker, paratype (Oregon St. Agr. C.).—California: Santa Cruz Mountains, one queen, paratype; Laws, one male, allotype.—Wyoming: Stewart Ranger Station, one worker, paratype (Am. Mus. Nat. Hist.).—Utah: Ogden, one male, paratype; Utah Lake, East Side, one male, paratype; Uintah Mts., one worker, paratype.—Colorado: Boulder, one queen, paratype. The holotype and allotypes are at the Mus. of Comp. Zoöl., Cambridge, Mass. Before I made the distinction between the eastern var. *acadica* and the western var. *sladeni,* I had named in various collections specimens from Alaska, Oregon, California, and Idaho, calling them "*acadica.*" Although these specimens are not now available for study, I feel certain that they all belonged to the var. *sladeni.*

If my interpretation of the var. *sladeni* is correct, this form should be found in the nests of *V. rufa* var. *atropilosa.*

4*f*. *Vespula rufa* var. *consobrina* (H. de Saussure).

Vespa consobrina H. de Saussure, 1853, Et. Fam. Vesp., II, p. 141 (☿; Newfoundland).

Vespa arenaria H. de Saussure, 1853, Et. Fam. Vesp., II, p. 134 (☿; North America). Not *Vespa arenaria* Fabricius, 1775.

Vespa scelesta McFarland, 1888, Trans. Amer. Ent. Soc., XV, p. 298 (♀ ☿ ♂; Pennsylvania; Virginia; New Hampshire; Colorado; Montana; Maine; Washington State; Massachusetts). Cresson, 1928, Mem. Amer. Ent. Soc., No. 5, p. 57 (♀ from Montana at Ac. N. Sci. Phila., selected as type.)

Vespa sulcata L. O. Howard, 1901, The Insect Book, Pl. VI, fig. 18 (☿; without locality or description; probably misspelling of *scelesta*).

Structurally this well-known wasp is not separable from the several forms of *V. rufa.* For a long time I believed to have found

slight differences in the male genitalia, *viz.*, in the shape of the valva interna; but repeated observation has convinced me that these supposed differences are only apparent and not reliable.

The var. *consobrina* extends across the American Continent, being mainly an insect of the Canadian Zone. In the Transition Zone it is still fairly common, but it is much rarer in the Upper Austral. Northward it reaches about to 52° Lat. N., and southward into the mountains of North Carolina and the Rockies of Colorado. I have seen it from Hudson Bay Territory, Ontario, Quebec, Nova Scotia, Anticosti, Newfoundland, Maine, New Hampshire, Massachusetts, Vermont, Connecticut, New York, New Jersey, Pennsylvania, Virginia, North Carolina (Mt. Mitchell; Blowing Rock; Sunburst, Haywood Co.; Swannanoa; Black Mountains), Illinois, Michigan, Wisconsin, Minnesota, North Dakota (Grand Forks; Fargo), South Dakota (without more definite locality), Montana, Wyoming, Colorado, Utah, California (Redlands), Oregon, Washington State, British Columbia (Vernon; Terrace; Revelstoke and Beaver Mouth, Selkirk Mts.; Kaslo), Vancouver Island, Alberta (Atabasca Delta; Calgary; Bilby; Banff), and Saskatchewan. I have seen an old specimen labelled "New Orleans"; but this locality, as well as R. du Buysson's record from "Texas," appear very doubtful. The hibernating queen which Blatchley recorded from Indiana as *V. arenaria*, was probably the var. *consobrina* (1896, Psyche, VII, p. 458).

The nest of the var. *consobrina* is generally placed underground among roots or in the shelter of a rock; sometimes also on or close to the ground in brushwood. R. P. Dow (1930, Bull. Boston Soc. Nat. Hist., No. 56, p. 12) has published a photograph of a nest, dug up at Huntington, Mass., August 18 to 20. It was placed in humus soil, beneath the roots of mountain laurel, but not attached by a definite petiole. It consisted of three combs, inside a paper envelope of at least three layers. One nest which I found at Chittenden, Vermont, in August, 1916, was small and placed at a depth of about four or five inches in what appeared to be an old mouse nest.

5. *Vespula austriaca* (Panzer).

Vespa austriaca Panzer, 1799, Faun. Ins. German., VI, pt. 63, Pl. II (♂; Vienna, Austria).

Vespa borealis F. Smith, 1843, The Zoologist, I, p. 170, fig. (♀; Yorkshire, England; and north of Scotland). Not *Vespa borealis* W. Kirby, 1837, nor of Zetterstedt, 1840.

Vespa arborea F. Smith, 1849, The Zoologist, VII, Appendix, p. lx (substitute name for *Vespa borealis* F. Smith, 1843).

Vespa tripunctata Packard, 1870, Trans. Chicago Ac. Sci., II, p. 26, Pl. II, fig. 11 (holotype ♀ of Kutleet, Alaska, only). Not *Vespa tripunctata* Fabricius, 1787, nor of Schenck, 1861.

Vespa infernalis H. de Saussure, 1853, Et. Fam. Vesp., II, p. 139 (described as ☿, but probably a ♀; Philadelphia).

The main description and the figure of *V. tripunctata* were drawn from a female (now lost) of *V. austriaca;* but the additional specimens discussed by Packard in a footnote (p. 27), belong to other species. These specimens are now at the Museum of Comparative Zoölogy in Cambridge, where I have seen them. The female from Springfield, Oregon, is *V. pensylvanica* (H. de Saussure); the workers from Fort Bidwell, Siskiyou Co., California, are *V. rufa* var. *atropilosa* (Sladen).

H. de Saussure's *V. infernalis* has been a puzzle for years, owing to the fact that the author placed it among the species with a long oculo-malar space (subgenus *Dolichovespula*). No North American species of that group, however, has the color pattern described for *infernalis*. After studying several thousands of specimens of North American yellow-jackets, I have reached the conclusion that the species was inadvertently placed in the wrong group and that de Saussure described an American female of *V. austriaca*. The peculiar black-and-yellow pattern which he mentions for the second and third tergites is found in that wasp. *V. infernalis* was described from Spinola's collection and the actual specimen might yet be in existence.

In 1916, I have given a complete description of the female of *V. austriaca,* which differs conspicuously from the queen of all forms of *V. rufa* in the long pilosity on the outer side of the tibiae and in the pointed apical angles of the clypeus. In the male the apical edges of the clypeus are also more prominent than in that sex of *V. rufa*. The male genitalia are extremely similar to those of *V. rufa*. After a careful comparative study of several preparations of *austriaca* and of typical (Palearctic) *rufa* and most of its North American varieties, I find that the only dependable difference is in the shape of the penis (compare Fig. 4*A* and 4*B*). In *austriaca* the shaft is decidedly more slender, narrower than the apical saddle, with the slightly thickened margins not projecting apicad.

In the several forms of *rufa*, the shaft is wider, slightly broader than the apical saddle and with prominent thickened margins which end apicad in obtuse protuberances. Most of the other differences in the genitalia, pointed out by previous authors, notably by Birula (1930), do not seem to be wholly reliable, an opinion also expressed by H. Bischoff in his recent, excellent study of *V. austriaca* (1931, Sitzungsber. Ges. Naturf. Fr. Berlin, for 1930, p. 332).

V. austriaca ranges over the entire Holarctic Realm, but is everywhere one of the rarest wasps. In Europe it is known from the British Isles, Belgium, France, Switzerland, Tyrol, Germany, Scandinavia (northward to 70° Lat. N.), Finland, and the whole of Russia. In Asia it has been recorded throughout Siberia (south of 63° Lat. N.), Kamchatka, Central Asia (Tianschan Mts.), eastern Mongolia (Alaschan Mts.), and China (Shanghai). I have seen the following North American specimens: ALASKA: Savonoski, one female (J. S. Hine).—BRITISH COLUMBIA: Beaver Mouth, Selkirk Mts., two males (J. C. Bradley); Field, one female (D. Brown).—ALBERTA: Banff, one female (G. Salt).—QUEBEC: Montreal, one female (in Coll. T. H. Frison).—MAINE: Bar Harbor, Mt. Desert, one female (C. W. Johnson).—NEW YORK: Staten Island, one female (J. S. Hine); Keesevilla, one female (A. K. Fisher).—NEW JERSEY: Fort Lee, two females (J. Bequaert).—MICHIGAN: two females without more definite locality (M. C. Z.).—COLORADO: Estes Park, one female, 8,000 ft. (R. A. Leussler); one female without more definite locality (Ac. N. Sci. Phila.).—UTAH: Mt. Tukunikivatz, La Sal Mts., one female (I. Rasmussen).—OREGON: Crater Lake, one female (C. L. Fox); Mt. Hood, one female (G. P. Engelhardt); Three Sisters, one male (H. A. Scullen).—CALIFORNIA: Yosemite Valley (E. C. Van Dyke). The earliest positive record of the occurrence of this wasp in North America, by R. du Buysson in 1905, was based upon a specimen from the Yukon River, at the Paris Museum. Sladen also saw *V. austriaca* from Quebec (Ottawa; Chelsea), Winnipeg, and British Columbia (Kaslo).

V. austriaca has no worker phase. It is a so-called social parasite or inquiline wasp, which builds no nest of its own, but has its brood raised by the workers of other species of *Vespula*. In the Palearctic Region the host-species is *Vespula rufa* (Linnaeus), in the nests of which the females and males of *V. austriaca* have been found repeatedly. In North America, the host is as yet unknown; but since typical *V. rufa* does not exist here, I suspect that it must be one of the more common American forms of *V. rufa* (*vidua, atropilosa,* or *consobrina*). In 1916 (Bull. Brooklyn Ent.

Soc., XI, pp. 101–107), I have reviewed what was then known of the habits of this wasp. Birula (1930, Zool. Anzeiger, LXXXVII, p. 132) claims to have found workers of *V. austriaca;* but, as he overlooked the most reliable structural character of the species (*viz.,* the numerous long hairs of the tibiae), I cannot attach much importance to his statement.

6. *Vespula squamosa* (Drury).

Vespa squamosa Drury, 1773, Illustr. Nat. Hist., Index to Pt. I published with Pt. II) ; without name in 1770, *Op. cit.,* I, p. 98, Pl. XLIII, fig. 7 (♀; New York).

Vespa lineata Fabricius, 1775, Syst. Entom., p. 365 (America).

Vespa cuneata Fabricius, 1804, Syst. Piezat., p. 258 (Carolina).

Vespa cruciata Lepeletier, 1836, Hist. Nat. Ins. Hym., I, p. 513 (suggested emendation of *V. cuneata*).

Vespa carolina Lepeletier, 1836, Hist. Nat. Ins. Hym., I, p. 513 (♀; Philadelphia). H. de Saussure, 1853, Et. Fam. Vesp., II, p. 142 (♀). Not *Vespa carolina* Linnaeus, 1767.

Vespa bistriata McFarland, 1888, Trans. Amer. Ent. Soc., XV, p. 298 (♀; North America). Not *Vespa bistriata* Fabricius, 1804.

Vespa macfarlandi Lewis, 1897, Trans. Amer. Ent. Soc., XXIV, pp. 172 and 180 (♀; new name for *V. bistriata* McFarland).

This species has gone thus far under the name "*Vespa carolina* Linnaeus." Unfortunately Linnaeus' description was based upon an American species of *Polistes,* as de Saussure found by examining the type at the Linnean Society of London, where it is extant. Mr. Robert B. Benson, who has recently studied it at my request, writes as follows: "*V. carolina.* This specimen is in such appalling condition that I should not like to make any suggestion as to which species of *Polistes* it is. It is unicolorous fuscous with dust. Probably it is one of the dark-winged species and looks superficially like *annularis.*" Moreover, there are several points in Linnaeus' original description which do not fit the queen of the wasp which in America goes under the name "*carolina.*" Although de Saussure knew that Linnaeus' *V. carolina* was a *Polistes* (see 1853, Et. Fam. Vesp., II, p. 102, footnote), he nevertheless retained the name "*Vespa carolina,*" but credited it to Drury, who never used it. H. de Saussure's reference to Drury's "Illustr. of Ins. Tab. 44, fig. 4" also is erroneous, since that figure represents a *Chlorion.*

The earliest valid name for the wasp here under discussion is *Vespa squamosa* Drury, generally quoted as of 1770, the date of publication of the first volume of Drury's "Illustrations of Natural History," where the wasp is described and figured (Pl. XLIII, fig. 7). The first volume of Drury's work, however, used no binomials, these being introduced in the "Index," which purports

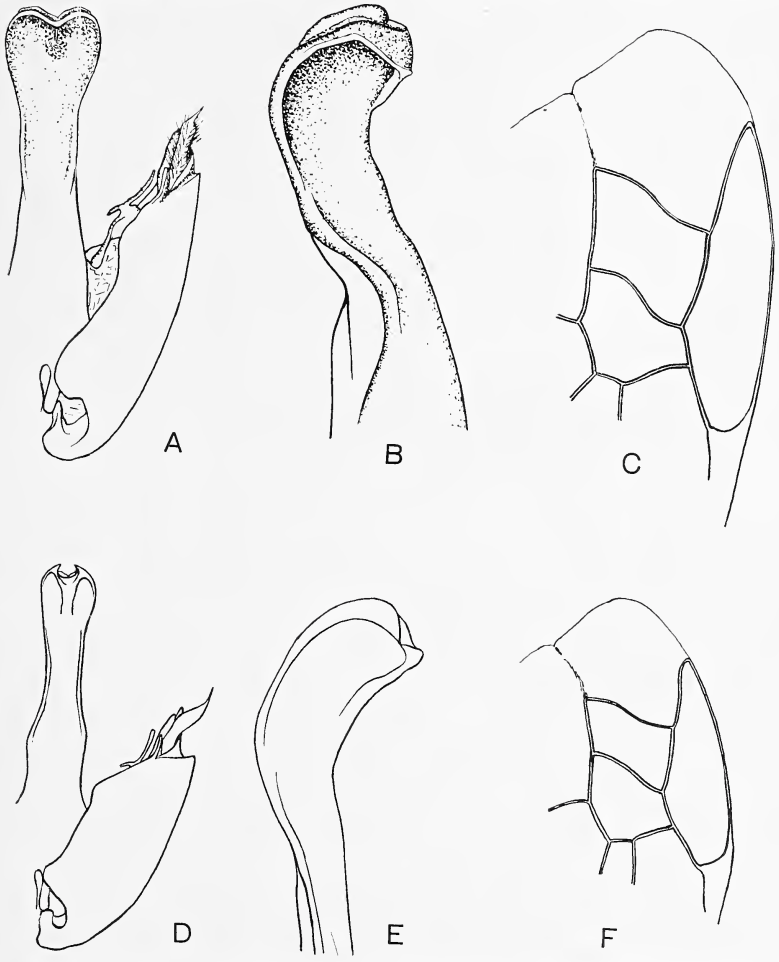

Fig. 5. A–C, *Vespula squamosa* (Drury): A, male external genitalia in dorsal view; B, tip of penis, much enlarged, in profile; C, apical portion of fore wing of queen. D–F, *Vespula sulphurea* (H. de Saussure): D, male external genitalia in dorsal view; E, tip of penis, much enlarged, in profile; F, apical portion of fore wing of queen.

to give the "names of the Insects, according to the System of Linnaeus." Some copies of the first volume lack this Index, others have it pasted in before the plates. The fact that, in this Index, Drury quotes names proposed by Linnaeus in the "Mantissa Plantarum," published in 1771, is intrinsic evidence that the Index was not published together with the first volume, but was issued three years later, with the second volume. Moreover, Westwood's revised edition of Drury's work (1837) invariably credits Drury's binomials of the first volume to "Drury, Append. vol. 2."[10]

H. de Saussure applied the name *Vespa lineata* Fabricius (1775) to a species of *Polistes* from Cuba, described by Lepeletier as *Polistes cubensis,* and subsequent writers have followed the same course. I cannot agree with this conclusion, for I feel certain that Fabricius' original description agrees better with the queen of *Vespa squamosa* Drury, than with any other American wasp known to me. Fabricius' description was based upon a wasp in Drury's collection, with which he became acquainted during a visit to London in 1773 (see Cockerell, 1930, Australian Zoologist, VI, 2, p. 141), and this insect was most probably Drury's specimen of *V. squamosa.*

That *Vespa cuneata* Fabricius was merely the worker of *V. squamosa* was first recorded by Ashmead (1894, Psyche, VII, p. 76). He stated that Mrs. McKewen had taken, from a single nest in Virginia, queens of "*V. carolina*" (= *V. squamosa* Drury) and workers and males of *V. cuneata.* Lepeletier, in 1836, noted that the worker and male of *V. cuneata* are colored much alike.

Vespula squamosa is characteristic of the southeastern United States, where it is especially common in the Lower Austral Zone. I have seen it from the following States: New Jersey (rarely seen north of Lakehurst), Pennsylvania (in the eastern part only), Maryland, Washington, D. C., Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Texas (as far west as Coleman and Kerrville), Oklahoma (Ardmore), Arkansas (Lawrence Co.; Hope; Imboden), Missouri (St. Louis), Indiana, and Illinois. The species must also occur in Tennessee, Kentucky, and Ohio. Sladen has one record from Point Pelée, which is on Lake Erie in the southernmost part of the Province of Ontario. Occasionally a queen is taken near New York City. I

[10] The lepidopterists seem to have generally known that the binomials to Drury's first volume date from 1773. Most other entomologists, however, quote them as of 1770. Dalla Torre, for instance, does so for the Hymenoptera.

have seen one from Pelham Parkway, another from Rockaway Beach (F. M. Schott), and a third taken years ago in Staten Island by Mr. W. T. Davis. Probably these were all stray specimens, accidentally imported by man, as there is no record of a nest having ever been found within the limits of New York State. H. de Saussure knew this wasp from Mexico (1853, Et. Fam. Vesp., II, p. 136; under *V. cuneata*); but the first definite locality from that country was given by R. du Buysson (Tahubaya; probably Tacubaya, a suburb of Mexico City). At the U. S. National Museum I have seen several workers from Mexico City, Tulychualco (State ?), and Puebla (State of Puebla). Prof. T. D. A. Cockerell has sent me a queen labelled: "in bark of dead tree, Puerto Barrios, Guatemala, March 18, 1913 (E. Bethel)"; another queen, with the same data, is at the U. S. National Museum. There is as yet no record of the occurrence of this wasp west of the 100th Meridian.

Vespula squamosa is unique, not only in the subfamily Vespinae, but among all social Diploptera, for the extraordinary dimorphism of the sexes. While worker and male are very similar, the queen is so different in size and color-pattern, that for a long time its true identity was not even suspected. Intermediate examples, which in most social Diploptera connect the fertile queens with the sterile workers, are not known for *V. squamosa.* The nest of this wasp is always placed under the ground, as results from the observations of C. L. Marlatt (1891), E. Daecke (1906), C. H. Turner (1908), A. H. Manee (1915), and W. W. Yothers (1925).

7. *Vespula sulphurea* (H. de Saussure).

Vespa sulphurea H. de Saussure, 1853, Et. Fam. Vesp., II, p. 137 (♀; California).

This wasp is restricted to the Pacific slope of the Rocky Mountains. I have seen many queens, workers and males from California, where the species seems to occur from the Mexican border to as far north as 40° Lat. N. Mr. T. H. Frison has sent me a queen taken by Oslar in the Huachuca Mts., Arizona. At the Ac. Nat. Sci. Philadelphia there is one worker labelled "Nev.," and since the species is common in California near Lake Tahoe, its occurrence in the extreme western part of Nevada is beyond question. It certainly will be found also in northern Mexico.

V. sulphurea is closely allied to *V. squamosa;* but, although worker and queen differ very considerably in size, they are alike in coloration. The male, which appears to be as yet undescribed,

is also similar to the other phases. There is no published account of the habits, but Mr. Carl D. Duncan has informed me that it nests in the ground.

Subgenus *Dolichovespula* Rohwer

Oculo-malar space long, nearly as long as the penultimate antennal segment or longer (in female and worker). Tibiae always with many long, erect hairs over the entire upper surface, especially noticeable on the hind legs. Vertical carina of the sides of the pronotum complete, well-developed in the upper portion also. Third cubital cell much longer on the radius than on the cubitus. Male: flagellum of antennae often with more or less distinct longitudinal welts (tyloides) on the under side of some of the segments (in a few species without tyloides); branches of penis incompletely fused, the apical portion of the penis consisting of two pointed or curved rods or tongs.

The species of this group build, as a rule, aërial nests, either freely suspended at some height or close to the ground in bushes. Exceptionally the nest is almost subterranean.

8. *Vespula maculata* (Linnaeus).

Vespa maculata Linnaeus, 1763, Cent. Insect. Rar., p. 30 (no sex; Pennsylvania). Not *Vespa maculata* Scopoli, 1763; nor of Drury, 1773.

Vespa maculata americana Christ, 1791, Naturgesch. Insekt. vom Bienen, Wespen und Ameisengeschl., p. 239 (no sex; North America).

V. maculata, the bald-faced wasp or black hornet, is the most widely spread of all North American Vespinae. It occurs across the Continent, between 53° and 28° Lat. N., being especially common in the wooded areas of the Lower Austral, Upper Austral and Transition Zones. East of the Mississippi it is fairly uniformly distributed; but west of the Great Plains, it is found almost exclusively in the Transition Zone of the mountains.

I have seen specimens from Ontario, Nova Scotia, Alberta, British Columbia, Maine, New Hampshire, Vermont, Massachusetts, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Washington, D. C., Virginia, North Carolina, Georgia, Florida (Gainesville), Louisiana, Texas, Tennessee, Ohio, Indiana, Michigan, Wisconsin, Illinois, Missouri, Nebraska (Omaha), Iowa, Minnesota, North Dakota (Grand Forks), Colorado (several localities), Arizona (Patagonia Mts.), New Mexico (Jemez Springs),

Utah, Idaho, Washington State, Oregon, and California. There are also reliable records from Vancouver Island, Quebec, and Kansas. It occurs almost certainly in West Virginia, South Carolina, Alabama, Mississippi, Kentucky, South Dakota, Montana, Wyoming, and Nevada; and it should be looked for in northern Mexico. R. du Buysson's record from the "Antilles" was certainly based either on an error in labelling or on a specimen accidentally carried from North America.

Vespula maculata is the North American representative of the Palearctic *Vespula media* (Retzius), which, although very different in coloration, is extremely similar morphologically. After a careful comparison, I find merely some slight differences in the male genitalia (shape of the two apical branches of the penis), in the male antennae, and possibly in the seventh sternite. But I am not yet convinced that these differences are constant and of specific value. The true *V. media* does not occur in North America, all published American records being based upon erroneous identifications.

Regarding the type of *V. maculata,* in Linnaeus' collection at the Linnean Society of London, Mr. Robert B. Benson writes me: "The label has been transferred to a new specimen by Smith. There are three old specimens, one female and two workers. I do not know which of these is to be regarded as the type."

Several accounts of the habits of *V. maculata* have been published, notably by I. Mauduit (1756), B. D. Walsh and C. V. Riley (1869), W. Couper (1870), G. W. Taylor (1884), H. C. McCook (1885), J. L. Zabriskie (1894), T. W. Fyles (1903), L. O. Howard (1915), P. and N. Rau (1918), C. Macnamara (1918), W. T. Davis (1919), J. B. Parker (1928), P. Rau (1929), and others. The nests are always aërial, most often hung up on the limbs of trees, high above the ground; occasionally they are found under the roof or eaves of buildings. They frequently are very large, reaching a foot or more in diameter. In a newly started nest, the envelope is usually extended downward, beyond the nest proper, into a hollow tube, about one-half inch in diameter and two and one-half inches long. This "neck" is removed as the colony grows. One of the earliest figures of such a young nest is that by H. C. McCook (1885, p. 445, fig. 140). The ichneumonid parasite, *Sphecophaga burra* (Cresson) (= *Sphecophagus praedator* Zabriskie), has been bred from the cells of this species. The adult wasps are occasionally caught by the robber flies, *Proctacanthus philadelphicus* Macquart, *P. nigriventris* Macquart, *P. rufus* Williston, and *Mallophora orcina*

Wiedemann (W. T. Davis, 1919; S. W. Bromley, 1931). As shown by J. B. Parker (1928) and P. Rau (1929), in the nests of *V. maculata* the cells are used over several times, as many as five larvae being sometimes reared in succession in the same cell.

9. *Vespula arenaria* (Fabricius).

Vespa arenaria Fabricius, 1775, Syst. Entom., p. 365 (no sex; America). Not of most American writers.

Vespa (*Dolichovespula*) *arenaria* J. Bequaert, 1928, Bull. Brooklyn Ent. Soc., XXIII, p. 54 (☿; holotype).

Vespa borealis W. Kirby, 1837, Fauna Boreali-Americana, IV, p. 264 (no sex; boreal North America in Lat. 65°). Not *Vespa borealis* Zetterstedt, 1840; F. Smith, 1843; Lewis, 1897.

Vespa diabolica H. de Saussure, 1853, Et. Fam. Vesp., II, p. 138 (♀ ☿; North America).

The identity of *V. arenaria* with *V. diabolica* has been settled through a study of Fabricius' type, which I have seen in the Banks' Collection at the British Museum. The type of *Vespa borealis* Kirby appears to be lost. R. du Buysson (1905) believed that Kirby's description was based upon North American specimens of *Vespula norwegica* (Fabricius) and I had accepted this conclusion in 1920. After a more careful study of Kirby's original account, I now believe that he most likely had before him *Vespula arenaria.* He describes the clypeus as being yellow with a black floriform discoidal spot, the external orbits as yellow, the abdomen with two black dots on the segments except the first, and the middle part of the black basal bands of the abdomen projecting into a triangular tooth. These statements apply only to *V. arenaria* among the wasps of boreal North America.

V. arenaria is possibly the most widely distributed of all Nearctic yellow-jackets. It extends across the Continent between 32° and 67° Lat. N.[11] It is perhaps most abundant in the Transition Zone. In the Rockies it has been taken as high up as 10,500 ft., though it probably does not nest above 9,000 ft. I have seen the typical form (without yellow spots on the propodeum) from Alaska (northernmost locality: Fort Yukon, on the Arctic Circle), North West Territory (Good Hope on the Mackenzie River), British

[11] J. M. Jones' record of *V. vulgaris* from the Bermudas (1876, The Visitor's Guide to Bermuda, p. 142) was based upon specimens of *V. arenaria.* In recent years, however, no yellow-jackets have been taken in those islands, where *V. arenaria* was evidently introduced by man at one time (See J. Bequaert, 1929).

Columbia, Vancouver Island, Alberta, Manitoba, Ontario, Quebec, Anticosti, Nova Scotia, Maine, New Hampshire, Vermont, Massachusetts (said to be the only Vespinae in Nantucket), Connecticut, New York, New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, North Carolina, Georgia, Michigan, Wisconsin, Minnesota, North Dakota (Fargo; Grand Forks; Langdon), South Dakota (Black Hills), Montana, Wyoming, Colorado, New Mexico (Cloudcroft; Las Vegas; Jemez Springs), California (Stanford University; Areata; San Francisco; S. Sonoma Co.; San Mateo Co.; Dixon), and Oregon. There are reliable records from Hudson's Bay, Newfoundland, Kansas (Douglas Co.), Arkansas (Fayetteville), and Arizona (Oak Creek, Coconino Co.). It most probably occurs also in the remainder of the United States, with the possible exception of Florida. Very likely it enters the Sierra Madre in Northern Mexico.

Structurally *V. arenaria* is exceedingly close to *V. norwegica* (Fabricius), and I am by no means certain that these two wasps are specifically distinct. In the queen and worker the anterior margin of the clypeus is much more deeply curved inward in *V. arenaria* than in *V. norwegica*, so that the lateral edges form more prominent, broadly rounded lobes. The difference is only of degree and difficult to describe, yet obvious when comparing the two species. The shape of the valva externa and penis of the male shows some slight differences as indicated in the key (compare Fig. 6*A* and 6*D*). *V. arenaria* is strictly Nearctic, while *V. norwegica* is Holarctic.

Most of the nests of *V. arenaria* I have seen, were placed close to the ground in high grass, low bushes, or shrubs, and were partly supported by twigs or brambles and grass-stalks. One nest, found in Vermont, was about 5 cm. above the ground, but another, dug up in the Adirondacks, on July 19, 1920, was attached to a root just below the surface, the outside cover being partly exposed. O. A. Stevens, in North Dakota, reports finding nests in trees and under the eaves of houses. W. M. Wheeler and L. H. Taylor (1921), in Connecticut and Massachusetts, found the nests mostly near the ground, occasionally in small trees or under roofs. They record an interesting observation of workers building a new nest, in the absence of the queen. They also found that *Vespula adulterina* var. *arctica* Rohwer is an inquiline in the nest of *V. arenaria*. Whether *V. arenaria* ever builds its nest actually underground or inside old stumps or logs, as Ashmead states, appears open to ques-

tion. H. B. Hungerford (1930) describes and figures a rather unusual nest of this species found in a log cabin in Michigan.

9*a*. *Vespula arenaria* var. *fernaldi* (Lewis).

Vespa fernaldi Lewis, 1897, Trans. Amer. Ent. Soc., XXIV, pp. 171 and 173 (♀☿; Colorado).

This is merely a xanthic variation of *V. arenaria*, especially notable for the presence of two yellow spots on the propodeum. As recently shown by C. D. Duncan (1924, Pan-Pacific Entomologist, I, pp. 40–42), one finds every conceivable intergradation between typical *arenaria* and *fernaldi*, and, in addition, the two

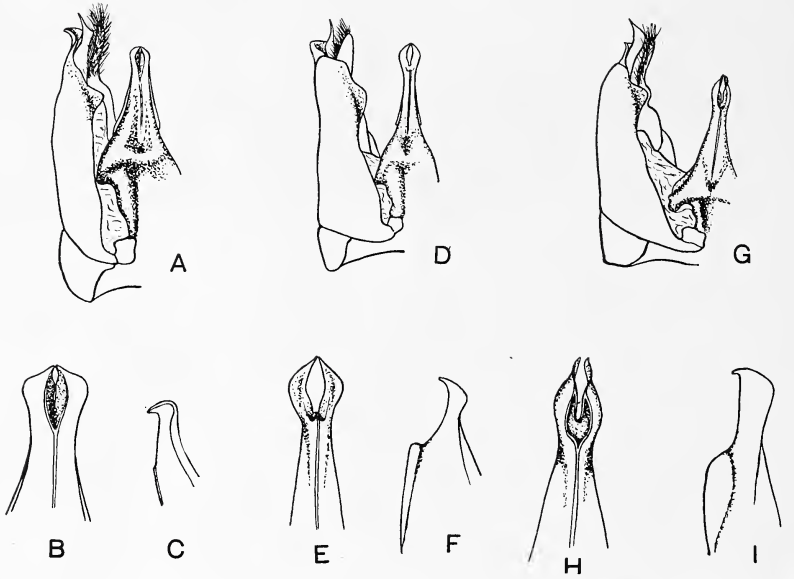

Fig. 6. A–C, *Vespula arenaria* (Fabricius): A, male external genitalia in dorsal view; B, apical branches of penis, much enlarged; C, the same in profile. D–F, *Vespula norwegica* var. *norvegicoides* (Sladen): D, male external genitalia in dorsal view; E, apical branches of penis, much enlarged; F, the same in profile. G–I, *Vespula adulterina* var. *arctica* Rohwer: G, male external genitalia in dorsal view; H, apical branches of penis, much enlarged; I, the same in profile.

forms occur promiscuously in the same nests. Duncan proposes to suppress *fernaldi* altogether. I believe, however, that there is some justification for retaining the name. Xanthic specimens are found throughout the range of *V. arenaria;* but, while they are rarely seen in the eastern United States, they are frequent in the Rocky

Mountains and on the Pacific Coast. In these western areas, the var. *fernaldi* shows a tendency to become the dominant form and might well eventually take the place of the typical *arenaria*.

I have seen eastern specimens of the var. *fernaldi* from Ontario (Gull Lake, 1 ♀; North Bay, 1 ♀), New York (Caroline-Harford, 1 ♀; Ithaca 1 ♀ and 1 ♂; Labrador Lake, Cortland Co., 1 ♀), North Carolina (Swannanoa, 1 ♀; Black Mountains, 1 ♀), Virginia (1 ♀), and Tennessee (1 ♀); also many western specimens from Alberta, British Columbia, Washington State, Oregon, California (much more common than typical *arenaria*), Idaho, Nevada, Arizona (Mt. Lemon, Sta. Catalina Mts.; Huachuca Mts.), Utah, Wyoming, Colorado, and New Mexico.

10. *Vespula norwegica* (Fabricius).

Vespa norwegica Fabricius, 1781, Species Insect., I, p. 460 (no sex; Norway).

Vespa britannica Leach, 1814, Zoological Miscellany, I, p. 111, Pl. L, figs. 1–3 (♀ ☿ ♂; England).

Vespa borealis Zetterstedt, 1840, Insecta Lapponica Descripta, p. 454 (♀; Lapland and Scandinavia). Not *Vespa borealis* W. Kirby, 1837.

Vespa saxonica var. *arctica* Friese, 1919, Mém. Ac. Sci. Russie, (8) XXVIII, No. 15, p. 1 (♀ ♂; several localities in northwestern Siberia). Not *Vespula arctica* Rohwer, 1916.

The above synonymy refers to the typical form only.

V. norwegica occurs throughout the Holarctic Realm in a number of color forms:

(1). Typical *V. norwegica* has, in the worker and male, rufous spots on the sides of the second or second and first abdominal tergites, in addition to the usual yellow markings. The queen, however, rarely shows these rufous spots, but, as a rule, is black and yellow only, even when found in a nest containing only workers and males marked with rufous. This form is strictly Palearctic and probably occurs over most of Europe and Siberia. It has so often been confused with the var. *saxonica* that it is difficult at present to trace its exact distribution. It extends northward beyond the Arctic Circle. I have seen it from England, Belgium, Germany, France, Switzerland, Finland, Sweden, and Lapland. I regard *Vespa borealis* Zetterstedt (1840, Insecta Lapponica Descripta, p. 454; ♀), *Vespa britannica* Leach (1814, Zoolog. Miscell., I, p. 111, Pl. L, figs. 1–3; ♀ ☿ ♂), and *Vespa saxonica* var. *arctica*

Friese (1919, Mém. Ac. Sc. Russie, (8) XXVIII, No. 15, p. 2; ♀ ♂) as not separable from typical *V. norwegica*.

(2). *V. norwegica* var. *monticola* Birula, a form richly marked with yellow, from the Caucasus Mountains, may be worth distinguishing by name.

(3). *V. norwegica* var. *saxonica* (Fabricius) differs from the typical form chiefly in lacking the rufous abdominal spots in the worker and male, as well as in the queen. I regard this form also as strictly Palearctic. Possibly it is found mainly in Western and Central Europe, and is perhaps of more southern distribution than typical *norwegica*. In many localities, however, the two forms occur together, nesting apparently under exactly the same ecological conditions. I have seen the var. *saxonica* from Germany and Sweden. *Vespa sexcincta* Panzer (1799, Faun. Insect. Germ. Init., VI, pt. 63, Pl. I), *Vespa bavarica* Schrank (1802, Fauna Boica, II, 2, p. 350; probably ♀), and *Vespa tridens* Schenck (1853, Jahrb. Ver. Naturk. Nassau, IX, 1, pp. 18, 19, and 38; ♀ ☿ ♂) are, in my opinion, synonyms of the var. *saxonica*.

(4). *V. norwegica* var. *pacifica* Birula (1930). This name has recently been proposed for the wasps of the Pacific Coast of Siberia and the neighboring islands, which R. du Buysson referred to the var. *marginata* (W. Kirby). According to Birula, they differ, however, from the American var. *marginata* in that the workers and males, as well as the queens, always lack the rufous spots of the second abdominal tergite. In this respect they agree with the var. *saxonica*, from which they may be told by the creamy-white or ivory-white, instead of bright yellow, pale markings of the body. I have seen, at the U. S. National Museum, a queen from Sakhalin and another from Kamchatka, received from Birula under the name *V. norwegica pacifica*.

(5). *V. norwegica* var. *norvegicoides* (Sladen). North America.

(6). *V. norwegica* var. *marginata* (W. Kirby). Boreal North America.

10*a*. *Vespula norwegica* var. *norvegicoides* (Sladen).

Vespula norvegicoides Sladen, 1918, Ottawa Naturalist, XXXII, p. 71 (♀ ♂; Nova Scotia to British Columbia).

This form has usually been called *Vespa norwegica* in American collections and writings. It differs from typical *norwegica* in lacking rufous abdominal spots in the worker and male, as well as in the queen. It is therefore very similar to the Palearctic var. *sax-*

onica, and it might even be questioned whether or not it is useful to retain these two varieties as distinct. All European *saxonica* I have seen appear to be more extensively marked with yellow than even the brightest North American *norvegicoides*, although the difference is more marked in the worker and male than in the queen. In *saxonica*, the yellow bands of the abdomen are, as a rule, very wide and the postscutellum is often spotted with yellow.

V. n. var. *norvegicoides* appears to be a wasp of the Canadian Zone of the North American Continent. In the Hudsonian Zone it seems to be replaced by *V. n.* var. *marginata*, while in the Transition Zone *V. arenaria* takes its place. I have seen it from southern Alaska (as far north as Anchorage, in about 61° Lat. N.), British Columbia, Vancouver Island, Alberta, Manitoba, Newfoundland, Nova Scotia, Maine, New Hampshire, Vermont, Massachusetts, Connecticut (Colebrook), New York (Adirondacks; Catskills), Virginia (Peaks of Otter), North Carolina (Mt. Mitchell; Black Mountains), Minnesota (Burntside Lake, St. Louis Co.; Beaver Dam, Cook Co.), Wyoming, Colorado, New Mexico (Pecos), Utah, Oregon, and Washington State. I have formerly recorded *V. norwegica* from Point Barrow, Alaska, north of 70° Lat. N., but I am no longer certain of the identification of this specimen, which I was not able to examine again. I suspect that it belonged to the var. *marginata*.

A nest of *norvegicoides* which I examined at Chittenden, Vermont, was placed in a dense thicket of brambles. It was attached to a twig, some 10 cm. above the ground, and was irregularly spherical. The entrance was on the under side of the nest, facing the ground. The colonies of this wasp are generally small. In the nest mentioned I found about 50 workers, in addition to the queen, on August 6. No males had yet hatched. In the Adirondacks, however, I have taken males as early as July 19.

10*b*. *Vespula norwegica* var. *marginata* (Kirby).

Vespa marginata W. Kirby, 1837, Fauna Boreali-Americana, IV, p. 265, Pl. VI, fig. 2 (described as ☿, but evidently ♀; boreal North America: "taken in the route from New York and again in Lat. 65°").

Vespa norwegica var. *marginata* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, 4, (1904), p. 599 (♀ ☿ ♂).

Vespa peruana H. de Saussure, 1868, Reise d. Novara, Zool., II, 1, Hym., p. 18 (☿; Quito, Peru; this locality was undoubtedly based upon an error in labelling.

R. du Buysson saw one of the types, apparently received from de Saussure, and recognized that it was *V. marginata* Kirby).

Vespa albida Sladen, 1918, Ottawa Naturalist, XXXII, p. 71 (☿ ♂; Alaska).

The var. *marginata* has the pale markings of the body ivory-white or creamy-white instead of bright yellow, and the second abdominal tergite often bears a rufous spot on each side; the legs are more or less reddish. The rufous spots are rarely absent in the worker and male; but I have never seen them in the queen. In color the var. *marginata* copies exactly *V. rufa* var. *intermedia* (R. du Buysson), which occupies the same habitat, but is much rarer. These two wasps offer an excellent example of "regional convergence," or the tendency, so common in the Diploptera, of different structural species to exhibit parallel color variation in the same region. By the protagonists of "mimicry" these cases would, I suppose, be regarded as "synaposematic" resemblances, that is of advantage as a protection against some mutual predacious enemy, who, after having been warned away by the sting of one or more of them, would learn to avoid them all as a group. I doubt, however, whether such is their true significance.

V. n. marginata is typical of the Hudsonian Zone of Boreal North America, although it has been found also at a few points well within the Arctic Zone. I have seen specimens from the following localities: Alaska: Iditarod, 2 ☿, July 22, 1918 (Alice Twitchell); Mt. Haystack, Eschscholtz Peninsula, 1 ♂ and 1 ☿, Sept. 5, 1922 (L. J. Palmer); Noorvik and Kiana, Kobuk River, 1 ♀, 1 ☿ and 3 ♂, July 1923 (L. J. Palmer); Kadiak, 1 ☿, July 1899 (T. Kincaid); Kukak Bay, 3 ♀, July 1899 (T. Kincaid); in Long. 141°, Lat. 69° 20′, 2 ♀ and 4 ☿, July 1912 (J. M. Jessup); Yukon River, 1 ♀ (Harrington); Healy, 3 ♀, June 23, 1924 (J. M. Aldrich); Rampart House, 1 ♀, June 1–6, 1912 (J. M. Jessup); Savonoski, Naknek Lake, 1 ☿, July 11, 1919 (A. J. Besinger), and 1 ♀, 5 ☿ and 3 ♂, Aug. 8, 1919 (J. S. Hine); Alfred Creek, 1 ☿, July 16, 1922 (R. L. Pope); Kutlik, 62° 30′ N., 163° W., 1 ☿ (Dall); Katmai, 4 ♀, June 10, 1919 (J. S. Hine); Bethel, Kuskokwim River, 2 ♀ (Ac. Nat. Sci. Phila.) and 1 ♀, July 24, 1922 (L. J. Palmer); Teller (F. Johansen).—Labrador: Nain and Rama, several ♀ and ☿ (H. Stecker and J. D. Sornborger); Caribou Island, Straits of Belle Isle, several ☿ (A. S. Packard).

There are also reliable records from the Yukon Territory, but I doubt the occurrence of the var. *marginata* in British Columbia.

Lewis' statement that it occurs in New York State is based upon a misunderstanding of Kirby's text, while the specimen which he describes from Orono, Maine, is clearly not *marginata*, but *norvegicoides*. I have never yet seen a specimen of the true var. *marginata* from within the borders of the United States.

R. du Buysson also referred to the var. *marginata* specimens from Sikkim, the Island of Sakhalin, Japan (near Tokio), and Western Siberia (Altai). Those from Sakhalin and Altai were undoubtedly *V. n.* var. *pacifica* Birula, as indicated above. The correct status of the specimens from Sikkim and Japan must, however, be left in abeyance.

V. n. var. *marginata* nests underground. The workers from Caribou Island, Labrador, listed above, were referred to *V. norwegica* by Packard (1870, Trans. Chicago Ac. Sci., II, p. 26, Pl. II, figs. 7, 8, 15 and 17). They are now at the Mus. Comp. Zoöl., Cambridge, Mass., where I have seen them. Referring to this wasp, Packard wrote: "It builds its nest underground, and the one observed was about five inches in diameter. The members of the colony, on being disturbed, seemed unusually sluggish and indisposed to sting, compared with our New England species." Sladen (1919, Report Canadian Arctic Expedition, III, Insects, Part G, p. 26 G) mentions one queen and 26 workers taken by F. Johansen at Teller, Alaska, July 26, 1913. "The nest contained larvæ and was in a hole under an old willow shrub at the brink of the lake. The nest was half hidden in the hole, half protruding from it and attached to the thick root of the willows, while heather twigs supported the outer layers of the nest."

11. *Vespula adulterina* (R. du Buysson).

In 1905, R. du Buysson described a var. *adulterina* of *Vespula norwegica*, which, he said, showed the same relationship to *V. norwegica* as *V. austriaca* does to *V. rufa*. He based his description upon a few females from Europe and one female from Corvallis, Oregon. For a long time this form was a puzzle to me. When I came to study a series supposedly of *V. arctica* Rohwer, from the Pacific Coast, I noticed that some of these specimens showed an evident tendency to be more abundantly marked with yellow, instead of with white. Some of the females from Oregon fit the description of *adulterina* to a nicety. As I have been unable to discover structural differences between these females (and their corresponding males) and specimens of *V. arctica* Rohwer, from the eastern United States, I believe that they all belong to one species

which should bear the earlier name, *Vespula adulterina* (R. du Buysson).

V. adulterina and its var. *arctica* are inquilines or social parasites, which lack the worker phase and have their brood reared by other social species of *Vespula*. They are, in the subgenus *Dolichovespula*, the exact counterpart of *V. austriaca* (Panzer) in the subgenus *Vespula*, proper. *V. adulterina* is evidently an offshoot of the *V. norwegica* stock, but the structural differences which separate it from that species are fully as pronounced as those found between *V. rufa* and *V. austriaca*. The following descriptions include the structural characters of both sexes, and apply to the typical form, as well as to the var. *arctica*.

Female.—Clypeus about as wide as long, with strongly projecting, median, truncate anterior margin, the edges of which form strong, triangular, blunt teeth, distinctly raised and directed outwardly; between the edges the clypeus slants strongly downward and the apical margin is deeply but evenly curved inward. Disk of the clypeus and interantennal area more convex than in either *V. arenaria* or *V. norwegica*. Oculo-malar space moderately long, about one and one-fourth times the length of the last, and one and one-half times that of the penultimate antennal segment, about two-thirds the width of the mandibular articulation, and about half the length of the antennal scape. Eyes nearly as far apart on the vertex as at the clypeus. Ocelli in a slightly flattened triangle; the posterior pair placed on the imaginary line traced over the vertex between the posterior orbits, and nearly twice as far from the eyes as from the occipital margin. Outer orbits about as wide as the eye in profile, without a distinct carina or suture dividing it from the occiput (very rarely with a trace of suture along the upper third). Third segment of labial palpi with a minute seta before the apex on the inner side. Anterior vertical carina of pronotum well marked, complete, gradually disappearing above the coxa; postero-lateral margin of pronotum not carinate, preceded by a fine suture. First abdominal tergite short and wide, very evenly rounded off between the anterior, vertical face and the posterior, horizontal area; the latter about three and one-half times as wide as long, scarcely narrower than, and about half the length of, the second tergite. All tibiæ with numerous, long, erect hairs on the outer side. Puncturation moderately abundant, as usual; no striation on sides of pronotum nor on propodeum; disk of clypeus with very few, much spaced, large punctures. Hairs of the body

long, erect, abundant, mostly gray, mixed with black on the vertex, dorsum and first tergite.

Male.—Clypeus markedly wider than long; the median, truncate, anterior margin moderately projecting (less so than in the female, but distinctly more than in the male of *V. arenaria*), with blunt, broadly rounded edges, which are very slightly raised, the anterior margin between them faintly curved inward. Oculo-malar space longer than in the female, about five-sixths of the length of the antennal scape, a little longer than the penultimate, but much shorter than the last antennal segment. Eyes a little farther apart on the vertex than at the clypeus. Posterior orbit at most with a trace of a suture near the occiput. Flagellum of antennæ without tyloides or longitudinal welts on the under side; the last segment only with a faint trace of a longitudinal welt near the base. Seventh abdominal tergite evenly convex throughout, its apical margin broadly rounded; seventh sternite broadly rounded, entire. Genitalia: branches of penis incompletely fused; shaft, seen from above, broadly triangular at the base, gradually tapering to the apex, which consists of two slender rods, somewhat widened basally, very narrow apically, and hardly curved toward each other; in profile, the median portion of the shaft bears a dorsal crest and the two end pieces are shaped like a hawk's bill, with the short point directed upward; stipes of valva externa broadly truncate and rounded at apex, the upper inner edge (seen from above) very blunt and slightly projecting, the squama broadly triangular and ending in a long, sharp point; volsella of valva interna short, elongate spoon-shaped at the tip, which is fringed with short hairs.

V. adulterina is readily distinguished from either *V. arenaria* or *V. norwegica* by the peculiar shape of the clypeus, the different relative length of the oculo-malar space, and the absence of a distinct ridge dividing the upper part of the outer orbit from the occiput. It is rather noteworthy that the prominent edges of the clypeus are likewise characteristic of *V. austriaca* in the subgenus *Vespula*, proper. Although it is difficult to correlate this structural peculiarity with the parasitic habits of these two species, yet the same factors must have been responsible for its appearance in both cases.

V. adulterina probably occurs sporadically throughout the Holarctic Realm, much in the same fashion as *V. austriaca*. Its apparent rarity in the Palearctic Region must be due to its being overlooked in collections and confused with *V. norwegica*. In the

Nearctic Region the species extends across the Continent, but apparently is restricted to the Canadian and Transition Zones.

In Europe and Asia, *V. adulterina* is known only in the typical form, which has very extensive pale markings, varying from dirty-yellowish or ivory-white to pure yellow (nearest Ridgway's picric yellow). In North America, this xanthic form occurs in the Pacific States only, where one finds occasionally specimens in which the yellow is very bright; in most cases, however, the markings fade to ivory-white or dirty-white, although even then they are usually much more extensive than in the eastern specimens. I do not therefore base the distinction between typical *adulterina* and its var. *arctica* upon the *tint* of the color markings, but rather upon their *extent*. East of the Mississippi, *V. adulterina* is always marked with white, and, as a rule, the markings are much reduced. These eastern specimens have thus far been known as *V. borealis* Lewis or *V. arctica* Rohwer; but they represent, in my opinion, the melanistic color form of *V. adulterina*. Transitions in extent of color occasionally occur between typical *adulterina* and its var. *arctica*, especially west of the Mississippi, where both forms are found. If for the present I keep them distinct, it is because names are available and because I have never seen eastern specimens with yellow or even yellowish markings. Moreover, the white var. *arctica* is not known from the Palearctic Region.

11*a*. *Vespula adulterina*, typical form.

Vespa norwegica var. *adulterina* R. du Buysson, 1905, Ann. Soc. Ent. France, LXXIII, (1904), pp. 600 and 628 (♀; Piedmont; Remiremont, Vosges, France; Rosegthal, Engadine, Switzerland; Corvallis, Oregon).

Vespa saxonica var. *adulterina* Bischoff, 1927, Biologie der Hymenopteren, p. 404 (suggests that it is a distinct species, parasitic upon *V. saxonica*).

Vespa adulterina Bischoff, 1931, Mitt. Deutsch. Ent. Ges., II, p. 6 (♀ ♂).

Pseudovespa adulterina Bischoff, 1931, Sitzungsber. Ges. Naturf. Fr. Berlin, (1930), pp. 330–334, figs. (in part) 1, 3, 4, and 5 (♀ ♂).

Vespula norvegica saxonica natio *colchica* Birula, 1930, Ann. Mus. Zool. Ac. Sci. U. R. S. S., XXXI, 2, p. 314 [♂; "Adscharien (Batum-Gebiet, Alpenwiesen, s. g. Jailag, bei Sarytschair auf der Höhe von etwa 2300 m. ü. d. M.)"].

My conclusion that *V. adulterina* is a distinct, inquiline species, was reached independently from Bischoff. It was based at first

upon the evident relationship of this wasp with *V. arctica* Rohwer and upon the parallelism in certain structural characters exhibited by *V. adulterina* and *V. austriaca*. That typical *V. adulterina*, in North America, has true parasitic habits was demonstrated by a recent find of Professor H. A. Scullen in Oregon. After killing with carbon disulphide a colony of *Vespula arenaria* var. *fernaldi*, at Crater Lake Park, he found among the contents two males of *V. adulterina*. In Europe, Bischoff reports that M. Müller caught a female of *V. adulterina* as it flew out of a nest of *V. norwegica*.

I have seen typical *adulterina* from the following localities: British Columbia: Downie Creek, Selkirk Mts., 1 ♂; Ground Hog Basin, Big Bend Country, Selkirk Mts., 1 ♂ (J. C. Bradley).—Alberta: Banff (Owen Bryant).—Vancouver Island: 1 ♀ (Am. Mus. Nat. Hist.).—Washington State: Paradise Valley, Mt. Rainier, 2 ♀ and 1 ♂ (E. C. Van Dyke); Mt. Olympic, 1 ♂ (Darlington).—Oregon: Clatskanie (H. A. Scullen); Cloud Cap Inn to Elk Cove, Mt. Hood, 6,000 ft. (H. A. Scullen); Eagle Ridge, Klamath Lake, 4 ♀ (C. L. Fox); Crater Lake Park, 6,500 to 7,000 ft., 16 ♂ (H. A. Scullen); Mary's Peak (H. A. Scullen); Mt. Hood, 1 ♀ and 1 ♂.—California: Alta Meadow, 8,000 ft., 2 ♂ (W. M. Wheeler); Nash Mine, Trinity Co., 1 ♀ (E. C. Van Dyke); Giant Forest, Sequoia National Park, 1 ♀ (R. C. Shannon); Gold Lake, Sierra Co., 1 ♀ (C. L. Fox).—Idaho: Beaver Canyon (L. Bruner); Moscow; Craigs Mt., 1 ♀; Priest Lake, 1 ♂.—Wyoming: Yellowstone National Park, 1 ♀ (R. C. Osburn).—Utah: 2 ♂ (Ac. Nat. Sci. Phila.); Bear Lake Valley, West Side, 1 ♀ (C. Lynn Hayward).—Colorado: Mill Gulch, 1 ♀; Chimney Gulch, Golden, 4 ♂ (Oslar); Copeland Park, Boulder Co., 1 ♂ (S. A. Rohwer); Longs Peak Inn, 9,900 ft., 1 ♀ (E. C. Van Dyke); Manitou, 1 ♀ (E. C. Van Dyke).

In addition to the localities listed with the original description, R. du Buysson also recorded specimens from Mongolia, the Island of Sakhalin, and the village of Lasevo near Viterbsk (western Russia). Possibly some of these specimens may have been one of the color forms of *V. norwegica*. On the other hand, Birula's description of the male for which he proposed the name *colchica*, agrees quite well with some of my specimens of typical *adulterina*. At the U. S. National Museum I have also seen a female of *V. adulterina*, from the Govt. Petropolis (Leningrad), sent by Birula under the name *V. norwegica* var. *ornata* Birula, a vocable which, so far as I can trace, has not yet been used in print in connection with a description.

11*b*. *Vespula adulterina* var. *arctica* Rohwer.

Vespula (*Dolichovespula*) *arctica* Rohwer, 1916, in Viereck, Guide to the Insects of Connecticut, III, Hymenoptera, p. 642 (new name for *Vespa borealis* Lewis).

Vespa borealis Lewis, 1897, Trans. Amer. Ent. Soc., XXIV, pp. 171 and 174 (♀ ♂; New York; Mt. Washington; British Columbia; Amherst, Mass.). Not *Vespa borealis* W. Kirby, 1837.

The var. *arctica* is found across the North American Continent, but is much more common in the eastern parts. It is, however, the only form known from Alaska. I have seen it from the following States and Territories: Alaska (Seward; Skagway), British Columbia, Quebec (Val Morin; Montreal), Maine, New Hampshire, Massachusetts, Vermont, Connecticut, New York, New Jersey, Pennsylvania, Virginia, North Carolina (Valley of the Black Mountains; Mt. Mitchell, 6,700 ft.; Andrews Bald Mt., Swain Co.), Michigan, Minnesota (International Falls; Beaver Dam, Cook Co.; Burntside Lake, St. Louis Co.; Cramer), Colorado (Peaceful Valley; Long Lake, Boulder Co.), Wyoming (Douglas), and Montana (Washington Creek, Madison Co.).

V. adulterina var. *arctica* is an inquiline in the nest of *V. arenaria* (Fabricius) (= *diabolica* H. de Saussure), as was first observed by J. Fletcher near Ottawa, Canada (see 1908, Ann. Ent. Soc. America, I, p. 80). More recently, W. M. Wheeler and L. H. Taylor have made detailed observations of the relations between *arctica* and its host-wasp in Connecticut (1921, Psyche, XXVIII, pp. 135–144, Pls. VI–VII). They found that *arctica* is a permanent social parasite of *V. arenaria*, her brood, consisting exclusively of males and fertile females, being reared by the *arenaria* workers.

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A GENERIC REVISION OF THE PIERIDAE (LEPIDOPTERA)

Together with a Study of the Male Genitalia

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INTRODUCTORY AND HISTORICAL

The present paper is an attempt on the part of the author to bring the generic classification of the family Pieridae up to date. The taxonomy is based on a thorough study of the male genitalia in addition to previously used characters. The nomenclature is based on the rules of the International Code of Zoological Nomenclature.

Aside from various works dealing with limited faunas, there has been no publication by a single author dealing with the Pieridae as a whole, since the adoption of the present Code. The synonomy is therefore in need of revision.

The work of the early naturalists and entomologists can hardly be called revisional because of the limited amount of material studied by them. The first work that can thus be termed revisional was that of Doubleday ('46). Butler ('70) next published a thorough revision and classification of the genera, making considerable use of the wing venation. Kirby ('71 & '76) paid little attention to the recently erected genera of Butler and others, preferring to hold to the few large genera of previous authors. Scudder ('75) in a list of the generic names proposed for butterflies made no attempt to coordinate his data, following an alphabetical arrangement for the group as a whole. His data regarding the genotypes is invaluable, though not entirely reliable.

Schatz ('92) published a fairly complete classification of the genera, but included little of nomenclature or other systematic details. Grote ('00) published a theory of the phylogeny of the family based on the venation, and included a few nomenclatorial changes. Dixey ('94) proposed a theory of the phylogeny of the family based on an exhaustive study of the pattern and geographical distribution. Finally, in a collective work on the Macrolepidoptera of the world various authors (Roeber '06 & '10, Aurivillius '10 and Fruehstorfer '10) treated the family very completely but almost entirely for the purpose of the identification of species, paying little attention to generic taxonomy.

THE TAXONOMIC VALUE OF THE MALE GENITALIA

Up to comparatively recent times little work has been done on the male genitalia of the *Pieridae,* workers being apparently either ignorant or distrustful of the taxonomic importance of these structures. Indeed many workers today adhere to one or the other of these opinions. What work has been done has been quite spasmodic, and in many cases has been based merely on examination of the external appearance.

Godman and Salvin ('89) thus made considerable use of the genitalia for generic separation, but only for the limited fauna included in their work. Fruehstorfer ('08) figured the genitalia of a number of species and subspecies, mainly in a somewhat abortive attempt to prove that these structures might be used for subspecific separation. His conclusions seem to be largely invalidated by an apparent lack of uniformity in the preparation of his material and by failure to allow for individual variation. Talbot ('28, '29a, b & c, '30a) has made considerable use of the genitalia in his monograph of the genus *Delias*, showing that they can be used for the separation of the species into groups, and, in the majority of cases at least, present characters for specific determination. Brown ('29) found excellent and stable characters for specific differentiation in the genitalia of the genus *Phoebis*. The present author ('28a, b, '29b, c, & '30) has figured the male genitalia of a number of genera and pointed out their taxonomic value in these cases.

In the majority of families of the Lepidoptera the taxonomic importance of the male genitalia is unquestioned. In many groups these structures are far more reliable than any other characters. The *Pieridae*, however, seem to have a bad reputation in this respect. Criticism of the use of the genitalia in this family appears to be of two kinds, based either on a belief that individual variation is so great as to prevent the systematic use of the structures, or on a fear that in structures so much used by and so vital to the insects, development may have been so rapid and at random as to invalidate their use in phylogeny.

Fears regarding the importance of individual variation may be set at rest by examination of a sufficient number of specimens, and by a realization that too much must not be expected of the genitalia as specific characters. Individual variation may occur in some genera to such an extent that all of the species cannot be safely differentiated by the genitalia. Far more often, however, the opposite is true; the genitalia show so little variation, even between very distinct species, that they cannot be used. Neither of these cases, however, need necessarily have anything to do with the use of the genitalia for generic separation.

As an example of this *Nathalis* will serve excellently. The author has been unable to find any stable characters for differentiating *iole* and *plauta* by the genitalia. On the other hand the genitalia of these two species are so utterly different from those of

any other *Pieridae* that failure to consider them as an important generic character would be absurd. In fact the author has found only one or two cases in which identification of a specimen to any of the genera and subgenera held as valid in this paper may not be accomplished by the genitalia alone, except in the case of a few subgenera (of doubtful value) whose only character is the presence or absence of sex scaling.

The subject of individual variation cannot be left without discussion of a factor that has in all probability caused a very large part of the misapprehension on this subject. In the preparation of the genitalia for study or in the preservation of such material, distortions may be very easily produced without the worker being conscious of the fact. Great care and uniformity of technique is therefore necessary in this matter. The abdomens of papered specimens are often considerably flattened, so that unless this effect is overcome the apparent size and shape of most of the important structures may be radically altered. Generally, however, thorough soaking in water or in a weak potash solution will more or less restore the organs to their normal shapes. Flattening of this sort must, however, always be allowed for.

Similarly pressure in mounting the genitalia for study on a microscope slide causes a great deal of distortion. To overcome this the author is in the habit of studying and drawing his material while it is immersed in a watch-glass or deep well-slide, thus doing away with danger of flattening due to the pressure of the cover-glass. Mounting on slides is only used as a handy means of preservation. The study of dried specimens is not to be recommended, in view of the unnatural effect of drying normally moist structures.

Beliefs regarding the untrustworthiness of the male genitalia of the *Pieridae* due to individual variation are then probably based on the following:

a. Study of too few specimens.

b. A tendency to expect at first too much of the genitalia.

c. Careless, faulty or uneven technique, or the use of badly preserved specimens, resulting in distortion of the genitalia.

The author believes also that the genitalia are to a great degree to be relied upon in a study of the phylogeny of the *Pieridae*. Opinions to the contrary appear to be based either on an opinion that the genitalia may have developed so rapidly and at random that their modifications may not safely be considered phylogenetic, or on a fear of the possibility of convergent modification of the genitalia in the case of really different stocks.

It seems reasonable to believe that in the course of the evolution of a species or of a larger group superficial characters would show a faster rate of modification than would more fundamental ones. Moreover it is impossible to discount the part played in such development by the process of adaptation to the environment, however it may be believed that this adaptation is brought about. If, then, we analyze the structures which are most likely to be affected by such adaptation we find that included in the list are all of those characters which the opponents of the use of the genitalia use in their own systems of classification. Color, pattern and size are all obviously very mutable. Locomotor organs such as the wings and legs, and sensory organs such as the antennae and palpi, are the very structures in which we may expect to see effected almost every response to a fluctuating environment. On the other hand in the genitalia are found a set of structures whose variations can hardly be affected by changes in environment, and must originate in changes within the protoplasm of the species, unaffected by external conditions. Moreover changes in the genitalia must of necessity be more slowly effected. In other characters the sexes may develop almost independently of each other; in the genitalia a change in the structures of one sex can only survive if there are corresponding changes in the structures of the other. Even a considerable change in the wing form of one sex need have no effect upon the ability of the individuals affected to survive and reproduce. Knowing as we do of the minute adaptations of the structures of the female genitalia to those of the male, or vice versa, we can hardly doubt the necessity of a very close correlation of the development of the genitalia of one sex with those of the other.

The development of practically all of the external features, motor organs and sensory organs must be regarded as modifications to some degree controlled by the physical environment of the species. The development of the genitalia must be regarded as modifications nearly or entirely independent of such environment. Neither of these types of modifications can be ignored in phylogenetic work. Conclusions based on data obtained from a study of only one of these, ignoring or slighting the other, must necessarily be false and unbalanced.

The possibility of accidental convergence must always be taken into account. Here again, however, the effect of environment must be considered, and most strongly with respect to those structures which are most likely to be affected by environment. To cite an

example familiar to all, attention must be called to the very close similarity existing between various mammals of widely differing relationships which, specialized for burrowing in the ground, have attained a form typified by the Mole. Thus we find a Marsupial Mole extraordinarily like the Insectivore Mole, and most fundamentally distinguished from it by the structure of the reproductive system. It is surely not too far-fetched to say that just as in these mammals the bones of the fore limb have become modified to a high degree of convergence so in Pierids the veins of the wings may become modified. There seems far more possibility of such an occurrence than of a convergence of such comparatively independently developing structures as the genitalia.

It must also be remembered that mathematically the chances of convergence in color, type of pattern, wing shape, venation and vestiture are far greater than in the genitalia. Pattern in the *Pieridae* is after all merely the effect of a very few different combinations of light and dark shades. Wing shape is limited to a comparatively few possibilities. With regard to the venation there are more combinations available, but the total number is really small. In the *Pieridae* only a few veins show any amount of modification; those that do so vary only in a definite direction. Moreover all of these structures are strictly limited in their variation to one plane. In the male genitalia, however, are a considerable number of structures which may develop to a considerable degree independently of each other in three dimensions as well as in mere size. In the venation we find that a greater degree of fusion among R_3, R_4 and R_5 must necessarily be accompanied by a moving toward the costa of M_1, which in turn usually brings about a corresponding movement of M_2. In the genitalia, however, we see that the uncus may develop quite independently of the juxta (cf. *Aporia crataegi* and *Synchloë callidice*) or vice versa, the saccus of the harpé (cf. *Colotis evippe* and *Neophasia menapia*), and so on; that while of course a certain functional balance must be kept there is little evidence of any great degree of correlation in the development of the various structures. It is obvious that there is here infinitely less possibility of convergence, and that a close similarity of structure is far more likely to indicate a close relationship.

The author has therefore taken the genitalia very seriously into account in reaching his phylogenetic conclusions. Because of the high degree of convergence evident in the wing venation this

character has been little used qualitatively, that is to say in determining actual relationship, although quantitatively, for determining the amount of development that has occurred, it is useful.

Discussions of the main lines of development in the various structures will be found in the following section with the descriptions of the terms employed for the structures, and in the phylogenetic discussions of each genus.

DESCRIPTION AND NOMENCLATURE OF MORPHOLOGICAL TERMS

Wing Venation

The Comstock-Needham system of nomenclature for the veins has in general been followed throughout. The primitive butterfly fore wing is possessed of five branches of Radius, (R_1, R_2, R_3, R_4 and R_5), and three branches of Media (M_1 M_2 and M_3) all of which arise from the cell separately from each other. The cross vein between the bases of R_5 and M_1 is the upper discocellular (*udc*), that between the bases of M_1 and M_2 is the middle discocellular (*mdc*), and that between the bases of M_2 and M_3 is the lower discocellular (*ldc*). In the hind wing R_1 has fused with Subcosta (*Sc*) forming the vein $Sc + R_1$, and the remaining branches of Radius have fused together to form the Radial Sector (R_s).

In the most primitive of the *Pieridae* we find that all five radials are present, with the branches of Media all arising from the cell (*Eroessa, Dismorphia*). The progress of development appears to have been along the lines of a fusion together of certain of the branches of Radius, or of a loss of one of these branches (R_2), or both. In any case the result is a reduction in the number of radials. This is accompanied by a moving toward the costa and apex of the branches of Media. The fusion of the radials is accomplished by a progressive coalescence of their bases from the discal cell toward the apex. R_4 and R_5 are the first to fuse (figs. 3 & 2), followed by the fusion of R_3 with R_{4+5} (figs. 6, 4, 5, 7). As stated R_2 may drop out (*Delias*), leaving only one radial arising from the cell, or it may show a tendency to coalesce with the other radials by progressive fusion toward the apex (fig. 7). R_1 never drops out, but may like R_2 tend to fuse with the other radials (fig. 2). Correlated with the reduction of the radials, M_1 moves toward the upper end of the cell and from there fuses progressively with the radials toward the apex (figs. 3, 6, 4, 5, 7). In the *Pierinae*

M_2 follows after M_1 with a corresponding shortening of the middle discocellular, but in the *Dismorphiinae* M_2 appears to remain in its more primitive position. In *Pseudopontia* R_3, R_4 and R_5 have all fused, and M_1 and M_2 have moved far toward the costa and apex and are well stalked on R_{3+4+5}. In the fore wing *Pseudopontia* is therefore definitely Pierine rather than Dismorphiine.

Comparatively few developments take place in the hind wing. The most noticeable is the occasional stalking of R_s and M_1, usually accompanied by a moving forward of the base of M_2.

We may therefore consider the possession of five radials as a primitive character, and the lessening in number of the radials as more highly developed. The separation of M_1 from the upper angle of the cell is primitive, and the progressive approach of the base of M_1 to the upper angle of the cell and its stalking on the Radial stem is highly developed. In the *Pierinae* and *Pseudopontiinae* the same holds true for M_2.

Leg and Foot (fig. 8)

The basal joint of the tarsus, longer than the others, is referred to as the *metatarsus*. In some cases the length of this joint compared with the length of the tibia appears to constitute a reliable taxonomic character.

The *paronychia* are slender membranous structures lying basad and to the outside of the tarsal claws. They are present in all of the genera of the family except *Nathalis, Colias, Baltia* and *Phulia.*

The *pulvillus* is a single median structure lying between the tarsal claws. It is present in all the genera of the Pierinae except *Gonepteryx, Colias, Nathalis, Baltia* and *Phulia.*

Male Genitalia

In previous papers the author has discussed the structures of the male genitalia more exhaustively than seems warranted here (see Klots '28a, '28b, '29b, '29c, '30). However it seems advisable to give here a short outline of the terms applied to the various structures, for the benefit of those who may not have these or other works available.

The male genitalia are composed of various structures lying within the distal portion of the abdomen and of others articulating to the distal margin of the eighth abdominal segment. The *vinculum* is a flattened ring, with which is connected the intersegmental membrane from the eighth abdominal segment. Ven-

trally the vinculum connects with the *saccus,* a tubular structure of varying size which extends cephalad inside the abdomen and must function as a brace. Dorsally the distal margin of the vinculum articulates with the *tegumen,* which is thin and more or less hemispherically bent. The *uncus* articulates to the distal margin of the tegumen. On the ventral (lateral) margins of the tegumen are found a pair of processes to which the dorsal-basal angles of the harpés articulate. These processes are here termed the *articulatory processes of the tegumen.* They may be homologous with the gnathos or in part with the transtilla of other lepidoptera.

The *rectum* runs caudad within the curve of the tegumen, ending with the *anus* which is connected to the ventral portion of the uncus. From below the anus a median fold of membrane runs ventrad and joins the *juxta.* Chitinization in the region of the anus, usually below it, is termed the *subscaphium.*

The paired *harpés* articulate dorsally with the articulatory processes of the tegumen, and ventrally along the median line with each other and basally with the vinculum. Each harpé is composed of an outer and an inner layer. The outer layer is usually evenly and well chitinized, with a thickened base for strengthening the articulations. From this base a thin membrane runs cephalad and joins the vinculum.

The inner layer of the harpé is thin and membranous in the central area, and more or less thickened, chitinized and setiferous at the margins. Pierce ('09) has termed the dorsal thickening of the harpé the *margin* and the ventral thickening the *sacculus.* The distal end of the harpé may bear a more or less elongated structure, the *distal process.* Various lobes or spines may arise from the margin or the sacculus. Only in *Nathalis* and *Kricogonia* are structures found attached to the outer face of the harpé.

In what the author considers the interrelated stock of genera from *Aporia* to *Delias* and *Leodonta* a spinulated membranous sac is found lying between the two layers of the harpé. Coincident with this structure, which is here termed the *inner sac* (figs. 65, 68) is a peculiar sort of a *fovea* in the central region of the harpé, often more or less covered by a chitinized flap. This fovea and flap appear to be present also in *Belenois* and *Prioneris.*

The *clasper* is a thin, usually heavily chitinized structure, present in only a few genera, which articulates basally to the basal portion of the inner face of the harpé, its free part lying parallel to the plane of the harpé. It is of very constant occurrence in more primitive Lepidoptera.

The sacculi are more or less fused together along the median line, and along this line of fusion usually articulate with the *juxta*. From cephalic or caudal aspect this latter structure is triangular or shield-shaped. It is thin, and usually rather heavily chitinized, although dorsally, where it connects with the median fold of membrane from the anus, it may be lightly chitinized. The juxta is sometimes flat, but is usually more or less hollowed out or "dished," the convex surface being toward the caudal end. In the Rhodocerini the juxta assumes the form of a long, thin bar; it lies caudad between the articulations of the sacculi, then bends abruptly cephalad and extends beyond the vinculum. At its extremity it is usually forked and supports a rounded, cephalad extension of the median fold of membrane, which in turn supports the penis. At the two points where the ends of the forked juxta meet with this membrane may be chitinized areas for their attachment, and the ends of the forks themselves may be somewhat expanded for attachment to these chitinized areas.

The term *penis* is here used for the heavily chitinized tube, inside of which is the more membranous tube of the *ejaculatory duct*, and outside of the basal part of which is a membranous tube which ends caudally in the median fold of membrane below the anus, or in the inner membranous folds running cephalad from the inner face of the harpé. The penis is sometimes armed with heavily chitinized spines or teeth, to which the term *cornuti* has been incorrectly applied by some authors. The true cornuti, in the sense as the term was first used by Pierce, are the chitinized spines on the eversible tip of the ejaculatory duct (figs. 1, 14, 16, 17, 18).

Attached ventrally to the basal part of the penis and usually running more or less caudad, is a sometimes heavily chitinized spur, which serves as a muscle attachment, and may contain a muscle for working the ejaculatory duct. This is here termed the *basal prong of the penis*. It is entirely absent in adult life in some genera. It appears to arise quite early in embryonic life. (Zander '03).

In the *Pseudopontiinae* and *Dismorphiinae* many changes have taken place from the types of structures described above for the *Pierinae* (figs. 11–18). In general so much fusion of various structures has occurred that the homologies of some of the parts are obscure. The tegumen appears to have become much reduced. The uncus has taken the form of a pair of lobes on either side of the anus. The harpés have become firmly fused together along

the ventral margins for the greater part. Their dorsal portions are strongly connected by a heavily chitinized transverse structure which may represent the juxta and is at least analogous to the transtilla. Immediately above this is a tubular sheath for the distal portion of the penis.

There is great need for some careful work on the pupal development of the Dismorphiine genitalia, similar to that of Zander ('03) and others, to determine the homologies of these organs, if such is possible. *Leptidia sinapis* L. should be an excellent subject.

As previously stated most of the developments of the various structures of the genitalia seem to have occurred quite independently of each other. This makes definite delineation of the lines of development rather difficult. The presence of a clasper may fairly safely be considered primitive. Those genera which show this character have been placed together in the *Euchloini,* although this may not be a truly natural grouping, as the structure may have been retained independently. *Teracolus subfasciatus* possesses a rudiment of a clasper only, and must therefore be considered as in this respect the most primitive of the *Colotis* group of subgenera and genera. *Mylothris* has a structure on the inner face of the harpé which resembles the clasper, but which the author does not consider truly homologous.

The most primitive forms appear to have had a comparatively simple harpé, with few structures. After the loss of the clasper various lobes, spines and processes may develop on the harpé. In the *Pierini* such developments occur quite spasmodically, and seem to have no great intergeneric phylogenetic significance. In the *Rhodocerini* the development of such structures is quite the rule, practically all of the genera showing something of the sort.

The tegumen remains comparatively constant throughout the *Pierini* and *Euchloini.* In the *Rhodocerini* it becomes reduced by shortening until in some of the genera it is little if any longer than the vinculum, and considerably shorter than the uncus. The articulatory process of the tegumen shows considerable variation in the *Pierini,* being very large in some genera (*i.e., Belenois*) and very small in others (*i.e., Catasticta*). These developments appear to be quite independent of the size of the tegumen itself. In the *Rhodocerini* the articulatory process of the tegumen varies less in size, but is nearly always of a characteristic slender, pointed shape.

Variation in the uncus is quite marked. Often the tip becomes bifurcate (*Terias* and *Hebomoia*). The free part of the uncus,

i.e. the part distad of the attachment of the anal membrane, may be extremely short (*Terias, Pyrisitia*) or many be very long and slender (*Itaballia*). The uncus may be long and slender (*Itaballia*) or very much thickened dorso-ventrally (*Aporia, Leptophobia*).

The juxta is normally a flat or slightly curved transverse plate, triangular or shield-shaped. Dorsally it is nearly always concave or notched where it serves as a support for the penis. In a number of the genera it becomes deeply ballooned out caudad (*Tatochila*). This process may affect the entire structure or may be confined to the central portion (*Pieris, Itaballia*) with the resulting formation of a long thin tube. In the *Rhodocerini* the juxta is in the form of a narrow bar extending cephalad and supporting a paired cephalad fold of the median membrane which in turn supports and surrounds the penis. This produces a structure very similar to some modifications of the *anellus* (Pierce '14 p. xxvi).

The penis shows a great deal of variation as regards length (cf. *Leptophobia* and *Moschoneura*), shape (cf. *Colias, Dercas* and *Dixeia*), presence or absence of the basal prong, and armament. The most striking example of the latter is found in *Catopsilia thauruma* (see Klots '29b, fig. 10b).

Comparatively few of the genera show any development of a subscaphium. Such as there is is slight, being limited to a small amount of chitinization in the anus. *Pereute* shows the greatest development in this respect.

There is thus no lack of characters for both taxonomic and phylogenetic use, although the genitalia of the family show far less differentiation than in practically any of the other families of the *Lepidoptera*. The male genitalia must be used as characters with great care, and only after the examination of sufficient series of specimens, but when so used they present facts which the careful worker cannot afford to slight or ignore.

SYNONYMIC CHECKLIST OF GENERA, WITH TYPE SPECIES

Family PIERIDAE

Subfamily Pseudopontiinae

1. Pseudopontia Ploetz, *paradoxa* Felder
   = *Globiceps* Felder, *paradoxa* Felder HOMONYM
   = *Gonophlebia* Felder, *paradoxa* Felder

Subfamily Dismorphiinae

2. Leptidia Dalman, *sinapis* L.
   = *Leucophasia* Stephens, *sinapis* L.
   = *Leptoria* Stephens, *sinapis* L.
   > *Azalais* Grote, *gigantea* Leach
3. Pseudopieris Godman & Salvin, *nehemia* Boisduval
4. Dismorphia Huebner, *laia* Huebner
   > *Leptalis* Dalman, *astynome* Dalman
   > *Hemerocharis* Boisduval, MS synonym of *Leptalis*
   Subg. ACMEPTERON Godman & Salvin, *nemesis* Latreille
   Subg. ENANTIA Huebner, *licinia* Huebner
   > *Licinia* Swainson, *melite* L. HOMONYM
   > *Enantia* Godman & Salvin, *melite* L.
   Subg. MOSCHONEURA Butler, *methymna* Godart
   Subg. nov. **PATIA**, *orise* Boisduval

Subfamily Pierinae

Tribe Euchloini

5. Eroessa Doubleday, *chilensis* Blanchard
6. Anthocharis Boisduval, *cardamines* L. (See discussion of synonymy)
   = *Mancipium* Stephens, *cardamines* L. HOMONYM
   > *Tetracharis* Grote, *cethura* Felder
   Subg. FALCAPICA Klots, *genutia* Fabricius
   = *Midea* Herrich-Schaeffer, *genutia* Fabr. HOMONYM
7. Zegris Rambur, *eupheme* Esper
   Subg. MICROZEGRIS Alphéraky, *pyrothoë* Eversmann
   = *Pyrothoia* Verity, *pyrothoë* Eversmann
8. Euchloë Huebner, *belia* Cramer
   Subg. ELPHINSTONIA Klots, *charlonia* Donzel
   > *Phyllocharis* Schatz, *tagis* Huebner, HOMONYM
9. Hesperocharis Felder, *erota* Lucas
   > *Heliochroma* Butler, *idiotica* Butler
   Subg. CUNIZZA Grote, *hirlanda* Stoll
   > *Cathaemia* auct. nec Huebner
   Subg. MATHANIA Oberthür, *esther* Oberthür
10. Pinacopteryx Wallengren, *eriphia* Godart
    = *Herpaenia* Butler, *eriphia* Godart
    = *Picanopteryx* Scudder, *eriphia* Godart
11. Hebomoia Huebner, *glaucippe* L.
    = *Iphias* Boisduval, *glaucippe* L.

Tribe Rhodocerini

12. Colias Fabricius, *hyale* L. (See discussion of synonymy)
    = *Eurymus* Swainson, *hyale* L. HOMONYM
    > *Eriocolias* Watson, *edusa* Fabricius
    > *Scalidoneura* Butler, *herminia* Butler
    Subg. ZERENE Huebner, *caesonia* Stoll
    = *Meganostoma* Reakirt, *caesonia* Stoll
    = *Megonostoma* auct.
13. Catopsilia Huebner, *crocale* L.
    > *Murtia* Huebner, *pyranthe* L.
14. Anteos Huebner, *maerula* Fabricius
    = *Amynthia* Swainson, *maerula* Fabricius
    Subg. RHODOCERA Boisduval & Leconte, *menippe* Huebner
15. Gonepteryx Leach, *rhamni* L. (See discussion of synonymy)
    = *Gonoptera* Dalman, *rhamni* L.
    = *Earina* Speyer, *rhamni* L.
    = *Goniapteryx* Westwood, *rhamni* L.
    = *Gonioptera* Wallengren, *rhamni* L.
16. Dercas Boisduval, *verhuelli* Hoeven
17. Phoebis Huebner, *argante* Fabricius
    = *Prestonia* Schaus, *clarki* Schaus (= ♀ *argante*)
    > *Callidryas* Boisduval & Leconte, *eubule* L.
    > *Metura* Butler, *cipris* Fabricius, HOMONYM
    > *Parura* Kirby, *cipris* Fabricius
    Subg. RHABDODRYAS Godman & Salvin, *trite* L.
    Subg. APHRISSA Butler, *statira* Cramer
18. Kricogonia Reakirt, *lyside* Godart
19. Leucidia Boisduval, *elvina* Godart
20. Gandaca Moore, *harina* Horsfield
21. Eurema Huebner, *daira* Godart
    > *Sphaenogona* Butler, *ectriva* Butler
    Subg. ABAEIS Huebner, *nicippe* Cramer
    = *Xanthidia* Boisduval & Leconte, *nicippe* Cramer
    Subg. PYRISITIA Butler, *proterpia* Fabr.
    Subg. TERIOCOLIAS Roeber, *atinas* Hewitson
    Subg. MAIVA Smith & Kirby, *brigitta* Cramer
    > ?*Kibreeta* Moore, *libythea* Fabricius
    Subg. NIRMULA Moore, *venata* Moore
    Subg. TERIAS Swainson, *hecabe* L.
    > *Heurema* Herrich-Schaeffer, *impura* Vollenhoven
22. Nathalis Boisduval, *iole* Boisduval

Tribe Pierini

23. Eronia Huebner, *cleodora* Huebner
    > *Dryas* Boisduval, *leda* Boisduval

24. Nepheronia Butler, *argia* Fabricius
    > *Leuceronia* Aurivillius, *buqueti* Boisduval
25. Pareronia Bingham, *valeria* Fabricius
    > *Paphia* Fabricius *in part*
26. Colotis Huebner, *amata* Fabr.
    > *Aphrodite* Huebner, *evippe* L.
    > *Idmais* Boisduval, *chrysonome* Klug
    > *Callosune* Doubleday, *danaë* Doubleday & Hewitson
    > *Anthopsyche* Wallengren, *achine* Cramer
    Subg. TERACOLUS Swainson, *subfasciatus* Swainson
    = *Ptychopteryx* Wallengren, *subfasciatus* Swainson
    = *Thespia* Wallengren, *subfasciatus* Swainson
    Subg. CALOPIERIS Aurivillius, *eulimene* Klug
    Subg. MADAIS Moore. *faustus* Olivet
27. **GIDEONA,** genus nov. *lucasi* Grandidier
28. Ixias Huebner, *pyrene* L.
    = *Thestias* Boisduval, *pyrene* L.
29. Eucheira Westwood, *socialis* Westwood
    = *Schatzia* Kirby, *socialis* Westwood
30. Neophasia Behr, *menapia* Felder
31. Catasticta Butler, *nimbice* Boisduval
32. Archonias Huebner, *tereas* Huebner
    = *Euterpe* Swainson, *tereas* Huebner
    > *Priamides* Huebner *in part*
    Subg. CHARONIAS Roeber, *eurytele* Hewitson
33. Aporia Huebner, *crataegi* L.
    = *Leuconea* Donzel, *crataegi* L.
    = *Futuronerva* Bryk, *crataegi* L. (a teratological aberration)
    Subg. MESAPIA Gray, *peloria* Hewitson
    Subg. METAPORIA Butler, *agathon* Gray
    = *Betaporia* Matsumura, *agathon moltrechti* Oberthür
34. Cepora Dalman, *nerissa* Fabricius
    > *Huphina* Moore, *coronis* Cramer
35. Delias Huebner, *egialea* Cramer
    > *Symmachlos* Huebner, *nigrina* Fabricius
    > *Thyca* Wallengren, *aganippe* Donovan
    Subg. CATHAEMIA Huebner, *caenaeus* L.
    > *Piccarda* Grote, *eucharis* Drury
36. Pieute Herrich-Schaeffer, *callinice* Felder
37. Teodonta Butler, *dysoni* Doubleday
38. Belenois Huebner, *calypso* Drury
    Subg. ANAPHAEIS Huebner, *creona* Cramer
39. Dixeia Talbot, *charina* Boisd.

40. Prioneris Wallace, *thestylis* Doubleday
41. Appias Huebner, *zelmira* Cramer
    Subg. CATOPHAGA Huebner, *melania* Fabricius
    > *Hiposcritia* Geyer, *pandione* Geyer
    > *Trigonia* Geyer, *nero* Fabricius
    > *Tachyris* Wallace, *nero* Fabricius
    > ?*Lade* de Niceville, *lalassis* Grose-Smith
    Subg. GLUTOPHRISSA Butler, *ilaire* Godart
    Subg. PHRISSURA Butler, *aegis* Felder
42. Udaiana Distant, *cynis* Hewitson
43. Saletara Distant, *panda distanti* Butler
44. Pieris Schrank, *brassicae* L.
    = *Ganoris* Dalman, *brassicae* L.
    Subg. nov. **GLENNIA**, *pylotis* Godart
    Subg. SYNCHLOE Huebner, *callidice* Esper
    = *Parapieris* de Niceville, *callidice* Esper
    Subg. PONTIA Fabricius, *daplidice* L.
    = *Leucochloë* Roeber, *daplidice* L.
45. Leptophobia Butler, *eleone* Hewitson
46. Leuciacria Rothschild & Jordan, *acuta* Rothschild & Jordan
47. Elodina Felder, *egnatia* Godart
    > ?*Parelodina* Fruehstorfer, *anticyra* Fruehstorfer, HOMONYM
    > ?*Elodinesthes* Fruehstorfer, *anticyra* Fruehstorfer
    > ?*Metelodina* Seitz, *anticyra* Fruehstorfer
48. Tatochila Butler, *autodice* Huebner.
    = *Tatocheila* Scudder, *autodice* Huebner
49. Baltia Moore, *shawi* Bates
50. Piercolias Grote, *huanaco* Staudinger
    = *Trifurcula* Staudinger, *huanaco* Staudinger, HOMONYM
    = *Andina* Roeber, *huanaco* Staudinger
51. Phulia Herrich-Schaeffer, *nymphula* Blanchard
52. Leptosia Hueber, *xiphia* Fabricius
    = *Nina* Horsfield, *xiphia* Fabricius
    > *Nychitona* Butler, *alcesta* Cramer
53. Itaballia Kaye, *pandosia* Hewitson
    Subg. nov. **PIERIBALLIA**, *mandela* Felder
54. Perrhybris Huebner, *pyrrha* Fabricius
55. Aoa de Niceville, *affinis* Vollenhoven
    = *Ava* auct.
56. Ascia Scopoli, *monuste* L.
    = *Mancipium* Huebner, *monuste* L.
    Subg. GANYRA Dalman, *amaryllis* Fabricius

57. Melete Swainson, *lycimnia* Cramer
    = *Daptonoura* Butler, *lycimnia* Cramer
58. Mylothris Huebner, *poppea* Cramer
    Subg. ? PSEUDOMYLOTHRIS Neustetter, *leonora* Kruger

KEYS TO SUBFAMILIES, TRIBES AND GENERA

The keys to subfamilies and tribes have been made "natural" as nearly as possible, in order to express the author's opinions regarding the phylogeny of the groups. The key to genera is more "artificial," making frequent use of superficial characters to facilitate its use. Phylogenetic discussions of the genera and keys to subgenera will be found in the succeeding section.

Key to Subfamilies

1. Tegumen very much reduced; uncus in the form of two lobes above or on either side of the anus; harpés fused together ventrad 2

   Tegumen not greatly reduced; uncus simple, at most furcate only at extreme tip, and always above anus; harpés never fused together for any great distance ..... Pierinae

2. All five radials present, stalked; M_2 of primary from cell with *mdc* long; $Sc + R_1$ of secondary separate from R_s; M_2 of secondary from cell with long *mdc;* antennal club distinct with prominent sense-pits; a heavily chitinized structure extending transversely between harpés just below penis. Dismorphiinae

   Only three radials present, R_1 and R_2 arising from cell; M_2 of primaries stalked on R_{3+4+5}; $Sc + R_1$ of secondary fused for a short distance at about $\frac{1}{3}$ with R_s; M_2 of secondary stalked with M_1; antennal club very slight; no heavily chitinized structure connecting harpés just below penis ..... Pseudopontiinae

DISMORPHIINAE

Key to Genera

1. Last abdominal segment deeply cleft 2
   Last abdominal segment not deeply cleft 3

2. Lobes of last abdominal segment rounded; M_1 of primary stalked on R-stem ..... *Pseudopieris*
   Lobes of last abdominal segment long and pointed; M_1 of primary from cell ..... *Dismorphia* (*Enantia*)

3. Tip of harpé with two heavily chitinized points; discal cell very short; *mdc* less than twice as long as *ldc;* Old World ..... *Leptidia*
   Tip of harpé with only one heavily chitinized point; discal cell long; *mdc* more than twice as long as *ldc;* New World ..... *Dismorphia* (other subgenera)

PIERINAE

Key to Tribes

1. Clasper present, well developed, with its distal end free. ..... Euchloini
   Clasper minute or absent or if present (*Mylothris?*) with its distal end not free 2
2. Third joint of palpus very short; antennal club gradual; raised line present; humeral vein usually greatly reduced or absent; color usually yellow or orange; tegumen short, usually considerably shorter than uncus; juxta usually bar-like and expanded at tip ..... Rhodocerini
   Third joint of palpus longer; antennal club usually more abrupt; raised line absent; humeral vein usually long; color usually white; tegumen longer than uncus; juxta a thin, transversely flattened plate ..... Pierini

EUCHLOINI

Key to Genera

1. Five radials present 2
   Four radials present 5

2. Base of uncus with paired, dorsal prominences; clasper with a strong dorsal point; tip of harpé with a patch of spines; M_1 of primary arising from cell; humeral bent slightly basad ..... *Eroessa*
   No paired, dorsal prominences at base of uncus; clasper rounded; tip of harpé unarmed; M_1 of primary stalked on R-stem; humeral straight 3

3. Dorsal margin of harpé with a triangular flap or tooth; R_2 from cell connate with or stalked on R-stem 4
   Dorsal margin of harpé unarmed; R_2 normally from cell somewhat below R-stem ..... *Anthocharis* (*Anthocharis*)
4. Apex of primary of male with an orange patch; saccus never twice as long as thick; penis lightly bent near base. ..... *Zegris* (*Zegris*)
   Apex of primary of male without an orange patch; saccus at least twice as long as thick; penis strongly bent near base ..... *Euchloë*

5. One radial from cell ..... *Hesperocharis*
   Two radials from cell 6
6. M_1 from cell; size very large ..... *Hebomoia*
   M_1 stalked on R-stem; size medium or small 7
7. R_2 arising from cell nearer to base of R_1 than to end of cell; wings above with heavy dark markings ..... *Pinacopteryx*
   R_2 arising from nearer end of cell than to base of R_1; wings above white with dark markings, if any, light and limited to apical part of primary 8
8. Dorsal margin of harpé unarmed; R_2 normally from cell somewhat before end ..... *Anthocharis* (*Falcapica*) some species
   Dorsal margin of harpé with a triangular flap or tooth; R_2 normally from cell connate with or stalked on R-stem. *Zegris* (*Microzegris*)

RHODOCERINI

Key to Genera

1. Primary with 3 radials; pupa without frontal prominence. *Nathalis*
   Primary with 4 radials; pupa with frontal prominence 2
2. Tarsus with both pulvillus and paronychia; primary with R_2 from cell 3
   Tarsus with pulvillus but without paronychia; primary with R_2 from cell ..... *Leucidia*
   Tarsus without pulvillus but with paronychia; primary with R_2 from cell; secondary with a sharp tail on Cu_1. *Gonepteryx*
   Tarsus without either pulvillus or paronychia; R_2 often stalked on $R_3 + R_{4+5}$ ..... *Colias*
3. Wing expanse not over 55 mm. 4
   Wing expanse over 60 mm. 6
4. *udc* of secondary longer than *mdc;* outer margin of secondary rounded 5
   udc of secondary shorter than *mdc*, or secondary angulate or with a sharp tail between M_3 and Cu_1 ..... *Eurema*
5. Apex of primary rather sharp; outer margin straight; *udc* of secondary more than twice the length of *mdc;* New World ..... *Kricogonia*
   Apex of primary rounded; outer margin convex; *udc* of secondary little longer than *mdc;* Old World ..... *Gandaca*
6. Secondary with a sharp tail on M_3, or M_1 of primary stalked more than half way from end of cell to fork of $R_3 + R_{4+5}$ 7
   Secondary without a sharp tail on M_3 8
7. Secondary of male with a sex-patch; New World ..... *Anteos*
   Secondary of male without sex-patch; Old World ..... *Dercas*

8. Pupa with greatly expanded wing-cases; R_2 arising from well distad of end of cell; New World ..... *Phoebis*
Pupa without greatly expanded wing-cases; R_2 arising from very near end of cell; Old World ..... *Catopsilia*

PIERINI

Key to Genera

1. Primary with 3 radials 2
Primary with 4 radials 12a
Primary with 5 radials 10
2. 2 radials arising from cell 3
1 radial arising from cell 7
3. M_1 stalked more than half way from cell to apex; tarsus without pulvillus and paronychia ..... *Phulia*
M_1 stalked less than half way from end of cell to apex; tarsus with both pulvillus and paronychia 4
4. M_2 connate with or short stalked on $R_3 + R_{4+5}$ ..... *Leptosia*
M_2 from cell separate from $R_3 + R_{4+5}$ 5
5. *mdc* of secondary more than half as long as *ldc; ldc* of secondary almost straight ..... *Mylothris*
mdc of secondary less than half as long as *ldc; ldc* of secondary angled 6
6. *udc* of secondary longer than *mdc:* humeral not bent sharply distad from very near its base ..... *Pieris* (*Pontia*)
udc of secondary about equal to *mdc;* humeral bent sharply distad from very near its base ..... *Perrhybris*
7. Two radials arising basad of the base of M_1 of primary; *mdc* of primary very short ..... *Elodina*
Only one radial arising basad of base of M_1; *mdc* of primary long 8
8. Tip of R_1 running along costal and apical margin, fusing with tip of R_3 ..... *Pereute*
Tip of R_1 ending well basad of tip of R_3 9
9. Secondaries with a short tail on Cu_1 and a shorter one on Cu_2; New World ..... *Leodonta*
Secondaries with outer margin rounded, without tails; Old World ..... *Delias*
10. *mdc* of primary less than half as long as *ldc;* harpé rounded, with no distal process; penis with basal prong ..... *Eronia*
mdc of primary half or more as long as *ldc;* harpé with a distal process; penis without basal prong 11
11. Apical and marginal areas of secondary above with large patch of scent-scales; wings with wide, dark outer borders and dark veins on a light ground; dorsal margin of harpé with a spined pad at about one-third ..... *Pareronia*

Apical and marginal area of secondary above without sex-patch; wings without wide, dark outer borders and heavily dark veins on a light ground; dorsal margin of harpé simple ..... *Nepheronia*

12a. M_1 arising from cell; or, if short-stalked on $R_3 + R_{4+5}$, with third joint of palpus very short, oval 12b

M_1 stalked on $R_3 + R_{4+5}$; third joint of palpus more than twice as long as broad 13

12b. M_1 from cell connate with $R_3 + R_{4+5}$; *mdc* of secondary less than half as long as *ldc* ..... *Colotis*

M_1 arising separate from $R_3 + R_{4+5}$; *mdc* of secondary nearly equal to *ldc* ..... *Eucheira*

13. One radial arising from cell of primary ..... *Archonias*

Two radials arising from cell of primary 14

14. R_3 and R_{4+5} very long-stalked, the veins themselves very short 15

R_3 and R_{4+5} shorter-stalked, the veins themselves long 23

15. M_2 of primary stalked ..... *Baltia*

M_2 of primary arising from cell 16

16. Apex of primary long and pointed; male with a long hair-pencil on 8th abdominal tergite, and another from intersegmental membrane between 8th abdominal sternite and saccus ..... *Saletara*

Apex of primary normal; male with no hair-pencil 17

17. M_2 from cell connate with $R_3 + R_{4+5} + M_1$ ..... *Piercolias*

M_2 from cell separate from $R_3 + R_{4+5} + M_1$ 18

18. *ldc* of primary straight or nearly straight 19

ldc of primary curved or angled to at least 160° 21

19. Fore metatarsus longer than fore tibia; apex of primary rounded; free part of uncus very long and slender; Neotropical ..... *Itaballia*

Fore metatarsus shorter than fore tibia; apex of primary more pointed; free part of uncus short; Holarctic & Ethiopian 20

20. R_2 running parallel with costa for its outer half, ending well beyond fork of R_3 and R_{4+5}; saccus extremely short. *Dixeia*

R_2 not running parallel to costa for any great distance, ending before fork of R_3 and R_{4+5}; saccus longer ..... *Pieris*

21. Humeral straight, bent only at tip 22

Humeral strongly bent distad from very near its base ..... *Ascia*

22. Humeral angle of secondary strongly expended; harpé with a distal process; uncus slender; Indo-Australian. *Leuciacria*

Humeral angle of secondary not strongly expanded; end of harpé simple; uncus thickened dorso-ventrally; Neotropical ..... *Leptophobia*

23. Humeral bent sharply distad from near its base 24
Humeral straight, bent near tip if at all 31

24. Male with a strong hair-pencil arising from the intersegmental membrane between 8th abdominal sternite and saccus. *Appias*
Male with no hair-pencil 25

25. Costa of primary heavily spinulated ..... *Prioneris*
Costa of primary not spinulated, or very lightly 26

26. *mdc* of primary straight, as long as or longer than *ldc* 27
mdc of primary curved, (sometimes straight) much shorter than *ldc* 28

27. Base of R_2 much nearer base of R_1 than end of cell; angle between *ldc* and *m–cu* cross-vein of primary less than 90°. *Belenois*
Base of R_2 about equidistant from base of R_1 and end of cell; angle between *ldc* and *m–cu* cross-vein of primary greater than 90° ..... *Melete*

28. M_1 stalked on R-stem of primary for a distance from the cell of about one-fifth the length of R_{4+5} ..... *Ixias*
M_1 stalked on R-stem for a distance from the cell greater than one-third the length of R_{4+5} 29

29. R_s of secondary from slightly beyond the middle of the cell; M_1 of primary stalked for a distance from the cell of about one-third the length of R_{4+5} ..... *Aoa*
R_s from two-thirds the length of the cell or more; M_1 of primary stalked for a distance from the cell of more than three-quarters the length of R_{4+5} 30

30. Base of R_2 nearer to end of cell than to base of R_1; R_{4+5} running to outer margin just below apex; harpés strongly hairy; uncus without a dorsal keel ..... *Udaiana* (*cynis*)
Base of R_2 about equidistant from base of R_1 and end of cell; R_{4+5} running to apex; harpés not strongly hairy; uncus with a strong dorsal keel ..... *Cepora* (*Huphina*)

31. *mdc* of primary about equal in length to *ldc;* humeral vein curved slightly basad; uncus very short, tegumen large ... 32
mdc of primary shorter than *ldc;* humeral vein straight; uncus not very small and tegumen very large and broad 33

32. *mdc* of secondary shorter than *ldc;* penis shorter than tegumen + uncus ..... *Neophasia*
mdc of secondary usually about equal to *ldc;* penis longer than tegumen + uncus ..... *Catasticta*

33. Apex of primary rounded; palpus short, with very long hairs; Old World ..... *Aporia*
Apex of primary more pointed; palpus longer, with shorter hairs; New World ..... *Tatochila*

SYSTEMATIC AND PHYLOGENETIC DISCUSSIONS OF GENERA AND SUBGENERA; SPECIES LISTS

In the following section the genera are arranged and numbered as in the checklist of genera. Under the heading of each genus the data are arranged as follows:

1. Generic and subgeneric names, and synonyms, with reference to the original publication of each name, its genotype, and reference to the designation of the genotype.
2. Lists of generic and subgeneric characters.
3. Key to subgenera, if given.
4. List of species examined in preparation of this paper. Those of which the genitalia were examined are marked with an asterisk (*).
5. Discussion of synonomy and phylogeny.

Except in the cases of *Delias, Phoebis* and *Eurema* the specific synonomy of Seitz, Macrolepidoptera of the World has been followed, unless some mistake in that work was very evident. In the three genera cited above the more recent revisions of Talbot, Brown and the present author have been followed.

Keys to subgenera have been omitted in small genera where the lists of subgeneric characters are sufficient.

In citing the designations of the genotypes the following abbreviations have been used:

"des." designated by (type by subsequent designation).
"des. in O. D." designated in original description of genus (type by original fixation).
"sole sp." or "sole sp. in O. D." the genus was proposed with a single original species (monotypical genus).

1. PSEUDOPONTIA Ploetz ('70) p. 348, *paradoxa* Felder, sole sp.
Globiceps Felder ('69) p. "30," *paradoxa* Felder, sole sp. (nec *Globiceps* Lep.-Serv. 1825).
Gonophlebia Felder ('70) p. 95, *paradoxa* Felder, sole sp.

Generic characters:

Antennae short with scarcely any distinct club; palpi short, apparently two-jointed, with basal patch about three-quarters

the length of the first joint; tarsi without paronychia; wings rounded, very thinly scaled; primary with apex and outer margin strongly rounded; R_1 and R_2 from the cell; R_3, R_4 and R_5 fused; M_1 and M_2 stalked on R_{3+4+5}; cell very short; secondary with $Sc + R_1$ and R_8 bent strongly to touch each other at about one-third; M_1 and M_2 stalked; cell very short; penis long, thin, straight; harpés fused together along entire ventral and distal margins; tegumen very much reduced; uncus reduced, bifurcate, a fork on either side of anus.

Species examined:

* *paradoxa* Felder.

Many authors have disagreed about the taxonomic position of *Pseudopontia,* some even claiming that it is not a butterfly at all. However the pupa (see Talbot, '28a), the absence of an epiphysis on the fore leg, the cleft tarsal claws and the structure of the male genitalia appear to the author to constitute a set of characters that definitely warrant the inclusion of this anomalous insect in the family *Pieridae.* The genitalia show characters very similar to those of the *Dismorphiinae* while the venation resembles that of the *Pierinae* as much as it resembles that of any other butterflies. A separate subfamily is undoubtedly justified, with the characters given above for the genus.

In the phylogenetic chart of the *Pieridae* (Fig. 99) an origin close to that of the *Dismorphiinae* has been shown. The author's reason for this is that he considers the similarity in fundamental structure of the genitalia to be of greater significance than the similarity of the venation to that of the *Pierinae.*

There is a peculiar tangle in the synonomy. The first generic name applied, *Globiceps* Felder, was a homonym. According to Scudder ('75, p. 259) *Pseudopontia* Ploetz was published in September, 1870 and *Gonophlebia* Felder in August, 1870, giving precedence to the latter name. According to Aurivillius ('98, p. 386) *Pseudopontia* was published in April, 1870, and *Gonophlebia* in June, 1870, giving precedence to the former. The present author has followed Aurivillius.

2. LEPTIDIA Dalman ('20) p. 76, *sinapis* L. sole sp.
Leucophasia Stephens ('28), I, p. 24, *sinapis* L. sole sp.
Leptoria Stephens ('34), IV, p. 404, *sinapis* L. sole sp.
Azalais Grote ('00) p. 13, *gigantea* Leach des. in O D.

Generic characters:

Wings white; palpi with third joint very short; paronychia narrow; antennal club distinct, abrupt; cell of both wings very short; primary with all five radials present and stalked, M_1, M_2 and M_3 all from the cell separately; secondary with humeral

well developed, "T"-shaped, R_s and M_1 long stalked, M_2 and M_3 from the cell separately; penis about twice as long as harpé, slightly curved, much thicker at base; saccus about as long as harpé; two lobes of uncus heavily chitinized and hooked dorsad at tip; penis sheath and transtilla well developed; harpés fused for almost entire ventral and distal margins, with two heavily chitinized distal processes, the lower the longer.

Species examined:

* *duponcheli* Staudinger.
* *sinapis* L. (various forms).
* *gigantea* Leech.

Both venation and genitalia show *Leptidia* to be undoubtedly closely allied to the New World genera here included in the *Dismorphiinae*. The synonomy is rather involved, with some points still in doubt. Various authors have claimed that Dalman's genera in Billberg's Enumeratio are invalid through not having been sufficiently characterized. Such claims fail to take into account the wording of Article 25 of the Code which definitely states ". . . That (prior to January 1, 1931) this name was published and accompanied by an indication, or a definition, or a description; . . .". The two uses of the word "or" seem to make it clear that in the erection of a new genus an "indication" alone is to be considered sufficient to validate the name. In the original description of *Leptidia*, Dalman definitely cited *sinapis* L. as composing his new genus. That is certainly sufficient indication of the limits and inclusiveness of the genus. Arguments as to whether Dalman actually meant *sinapis* L. or some other hypothetical species which was not *sinapis* L. have no status. Under the Code the genus *Leptidia* must stand, with *sinapis* L. as the genotype, as Dalman's paper probably antedates the signature of the Verzeichniss in which *Leptosia* was published.

The reference for the original description of *Leptoria* Stephens is cited from a paper by Walsingham and Durrant. The present author has not been able to examine the original.

Azalais, erected by Grote for *gigantea* Leach, does not seem worth retention. The venation characters cited by the author are slight and evanescent.

3. PSEUDOPIERIS Godman & Salvin ('89), p. 187, *nehemia* Boisduval, des. in O. D.

Generic characters:

Wings white; no prominent sex-patches on secondary of male; third joint of palpus short; antenna short; primary with

all five radials present, long-stalked, the base of the free part of R_1 being a third of the distance from the end of the cell to the apex, M_1 well stalked on $R_1 + R_2 + R_3 + R_4 + R_5$; secondary with humeral long, turned distad; R_s and M_1 long-stalked, *mdc* three to four times as long as *ldc;* penis at least three times as long as harpé, not swollen at base, curved; saccus less than half as long as penis; lobes of uncus heavily chitinized at extreme tip, not hooked dorsad; penis sheath and transtilla well developed; harpé with a single distal process, well developed, heavily chitinized at extreme tip, located as far dorsad as penis sheath.

Species examined:

* *nehemia* Boisduval.

* *penia* Hopffer.

Pseudopieris appears worthy of separation as a distinct genus. In venation it may be regarded as slightly less primitive than *Dismorphia* in that M_1 of the primary is consistently stalked. The species show no evidence of the riot of "mimicry" and development of immense sex-patches characteristic of the species of *Dismorphia.*

4. DISMORPHIA Huebner ('16) p. 10, *laia* Huebner, des. Butler ('70)

Leptalis Dalman ('23) p. 40, *astynome* Delman, des. in O. D.[1]

Hemerocharis Boisduval ('36) p. 412, as Ms. synonym of *Leptalis* Dalman

Subg. ACMEPTERON Godman & Salvin ('89) p. 179, *nemesis* Latreille, des. in O. D.

Subg. ENANTIA Huebner ('16) p. 96, *licinia* Huebner, des. Scudder ('75)

Licinia Swainson ('20) I, (1), p. 15, *melite* L. sole sp.

Enantia Godman & Salvin ('89) p. 174, 181, *melite* L. des. Godman & Salvin l. c.

Subg. MOSCHONEURA Butler ('70) p. 54, *methymna* Godart, des. in O. D.

Subg. nov. **Patia,** type *Leptalis orise* Boisduval, see below

Generic characters, Dismorphia:

Characters of the subfamily; antennae proportionately longer than in *Pseudopieris;* male with a large sex-patch on the under side of the primary and another on the upper side of the secondary; primary with M_1 usually from cell but sometimes stalked; secondary with R_s and M_1 usually stalked, *mdc* more than twice as long as *ldc;* cells of both wings long; transtilla

[1] *Fide* Scudder ('75).

and penis sheath well developed; harpé with only one definite distal process.

Subgeneric characters, Dismorphia:

Apex of primary rounded or, if long and pointed, falcate; primary with M_1 from cell; secondary with R_s and M_1 stalked; last abdominal segment entire; penis more than twice as long as harpé, gently curved, little swollen at base; tip of ejaculatory duct not swollen, with a considerable number of cornuti; harpé with short distal process; saccus longer than harpé.

Subgeneric characters, Acmepteron:

Apex of primary long and pointed, not falcate; primary with M_1 from cell; secondary with R_s and M_1 connate from cell; last abdominal segment entire; penis more than three times as long as harpé, slender, gently curved, slightly swollen at base; tip of ejaculatory duct not swollen, with a considerable number of cornuti; harpé with a short distal process; saccus longer than harpé.

Subgeneric characters, Enantia:

Apex of primary rounded; primary with M_1 from cell; secondary with R_s and M_1 stalked, *mdc* long, very straight; last abdominal segment deeply cleft, the lateral lobes slender and pointed; penis more than three times as long as harpé, slender, gently curved, little swollen at base; tip of ejaculatory duct slightly swollen, with 6 or more cornuti; penis sheath long, its ventral margin produced distad to form a long spur; distal process of harpé short; saccus longer than harpé.

Subgeneric characters, Moschoneura:

Apex of primary strongly rounded; primary with M_1 well stalked on R-stem; secondary with R_s and M_1 stalked; last abdominal segment entire; penis very long and slender, more than four times as long as harpé; tip of ejaculatory duct not swollen, with a considerable number of cornuti; penis sheath normal; distal process of harpé short; saccus long and slender, more than twice as long as harpé.

Subgeneric characters, **Patia,** *subgenus nov.:*

Apex of primary strongly rounded, outer margin somewhat concave; primary with M_1 from cell; secondary with R_s and M_1 stalked; last abdominal segment entire; penis about twice as long as harpé, strongly curved, considerably swollen at base; tip of ejaculatory duct swollen; with not more than three strong cornuti; distal process of harpé long and slender; saccus much shorter than harpé.

KEY TO SUBGENERA

1. Last abdominal segment deeply cleft ..... *Enantia*
   Last abdominal segment entire 2
2. R_s and M_1 of secondary stalked 3
   R_s and M_1 of secondary from cell ..... *Acmepteron*
3. M_1 of primary stalked beyond base of R_1; saccus and penis very long ..... *Moschoneura*
   M_1 of primary from cell; saccus and penis shorter 4
4. Distal process of harpé a long spine; saccus shorter than harpé ..... **Patia**
   Distal process of harpé short; saccus much longer than harpé. *Dismorphia*

Species examined:

D. (*Dismorphia*)

* *amphione* Cramer
* *arcadia* Felder
* *astynome* Dalman
avonia Hewitson
* *carthesis* Hewitson
cubana Herrich-Schaeffer
* *discrepans* Butler
foedora Lucas
* *fortunata* Lucas
* *lewyi* Lucas
* *lygdamis* Hewitson
* *lysis* Hewitson
* *medora* Doubleday
melia Godart
pallidula Butler
pimpla Hopffer
rhomboidea Butler
* *spio* Godart
* *teresa* Hewitson
* *thermesina* Hopffer
virgo Bates
* *zaela* Hewitson

D. (*Acmepteron*)

* *nemesis* Latreille

D. (*Enantia*)

* *cornelia* Felder
* *licinia* Huebner
* *limnorina* Felder
* *melite* L.
psamathe Fabricius
* *theugenis* Doubleday

D. (*Moschoneura*)

* *pinthaeus* L.

D. (**Patia**)

myris Godman & Salvin
* *orise* Boisduval
* *sororna* Butler

Licinia Cramer was designated as the genotype of *Enantia* Huebner by Scudder in 1875, so that the subsequent designations of *melite* L. by Godman and Salvin (*l. c.*) and Roeber ('10, p. 98) are invalid.

It is evident that in view of the great amount of mimicry that has occurred among the species of *Dismorphia* little reliance can be

placed on superficial characters for generic and subgeneric classification. The classification here adopted seems to be along natural lines. It is possibly a bit of a surprise that species like *thermesina* and *fortunata* should belong in *Dismorphia* rather than in *Enantia* and *Moschoneura* respectively, but the evidence from the venation and genitalia is too definite for any other interpretation.

Work on the early stages of *Dismorphia* is very badly needed. The author is not aware of a single life history in the genus having been published.

5. EROESSA Doubleday ('46) p. 56, *chilensis* Blanchard, sole sp.

Generic characters:

Palpi with third joint long; primary with all five radials present, R_1 and R_2 from cell, R_3, R_4 and R_5 long stalked, M_1 from cell with short *udc, mdc* and *ldc* straight, nearly equal; secondary with humeral long, slightly curved basad at tip, *mdc* about two-thirds as long as *udc* and half as long as *ldc,* 3d A short, little more than half as long as 2d A; penis about as long as harpé, lightly bent, with no basal prong; saccus shorter than tegumen; articulatory process of tegumen large; uncus about half as long as tegumen, with a pair of dorsad projecting knobs at its base; juxta well developed, rounded caudad; clasper large with a strong point projecting dorsad above margins of harpés; harpé with a distal process consisting of a patch of heavy setae.

Species examined:

* *chilensis* Blanchard.

Possessing as it does a well developed clasper, five radials and M_1 of the primary from distinctly below the R-stem, *Eroessa* represents an extremely primitive type. In none of the other *Pieridae* are all three of these primitive characters present. *Eroessa* may be regarded as ancestral, to a certain degree, to the other Euchloini. The long third joint of the palpus is probably also to be regarded as primitive. In the other genera of the Euchloini, with the exception of *Hesperocharis,* this joint is considerably shorter.

6. ANTHOCHARIS Boisduval ('32) pl. 5, fig. 6, 7, *cardamines* L. des. Scudder ('75)

Mancipium Stephens ('28), *cardamines* L. des. Westwood ('40) (nec *Mancipium* Huebner, 1819)

Tetracharis Grote ('98) p. 37, *cethura* Felder sole sp. and des. in O. D.

Subg. FALCAPICA Klots ('30) p. 83, *genutia* Fabr. des. in O. D.

Midea Herrich-Schaeffer ('67) ii, p. 16, *genutia* Fabr., sole sp. (nec. *Midea* Bruzelius 1854)

Generic characters, Anthocharis:

Males with apex of primary usually with an orange patch; antennae short with abrupt club; third joint of palpus short, oval; primary with five radials (usually), R_1 and R_2 from cell, R_3, R_4 and R_5 stalked, M_1 stalked on R-stem, *mdc* shorter than *ldc;* secondary with humeral vein long, straight, very slightly curved basad at extreme tip, R_s, M_1 and M_2 all from cell separately; penis about as long as harpé, curved near base, with no basal prong; saccus thick, about as long as tegumen; tegumen with small articulatory process; uncus simple, curved; juxta small, triangular, flat or slightly curved; harpé simple with dorsal margin evenly curved, bearing no structures; clasper simple, rounded.

Subgeneric characters, Anthocharis:

Apex of primary rounded, never falcate.

Subgeneric characters, Falcapica:

Apex of primary falcate, sometimes strongly so.

Species examined:

A. (*Anthocharis*)

* *cardamines* L.
* *gruneri* Herrich-Schaeffer
* *damone* Boisduval
* *eupheno* L.
* *euphenoides* Staudinger
* *sara* Boisduval
* *cethura* Felder
* *pima* Edwards

A. (*Falcapica*)

* *bieti* Oberthür
* *genutia* Fabricius
* *lanceolata* Boisduval
* *scolymus* Butler

With the formal invalidation of Huebner's Tentamen, *Mancipium* Huebner of the Tentamen ceases to have any status in nomenclature, so that the next subsequent usage of *Mancipium* is the official first publication of the name. This is, in all probability, that of Huebner in the Exotische Schmetterlinge, and the usage is, in the present author's estimation, perfectly valid. In this case *cardamines* was not included, so that Westwood's action in specifying this species as the type of *Mancipium* Huebner was incorrect. This being the case the type of *Mancipium* must be *monuste* L., as recently (Entomologist, 64: 272–273) designated by Hemming, whose wise action thus removes a bone of contention from this portion of the nomenclature. *Mancipium* Stephens, with type *cardamines* as designated by Westwood, must, of course, remain as a synonym of *Anthocharis.*

The genus has been more extensively treated by the present author in a previous paper (Klots, '30). As stated there, the author and others have found the venation to be in many respects

so variable as to render it not entirely trustworthy as a taxonomic character.

The trend of development in the Euchloini has also been treated in greater detail by the writer in the article referred to. The main line of development appears to have been along the line of simplification of the genitalia, correlated with a reduction in the number of the radials. *Anthocharis* shows the extreme of reduction of the genitalia, but is still in a more or less intermediate condition as regards the number of the radials, as is evidenced by the fact that some of the species possess five, others vary between four and five, and others regularly possess but four.

7. ZEGRIS Rambur ('36) p. 573, *eupheme* Esper sole sp.
Subg. MICROZEGRIS Alpheraky ('13), *pyrothoë* Eversmann, sole sp.
Pyrothoia Verity ('29) p. 348, *pyrothoë* Eversmann, sole sp.

Generic characters, Zegris:

Apex of primary of male with a usually narrow orange patch; antennae very short, with abrupt club; palpi very hairy; primary with 4 or 5 radials, M_1 stalked on R-stem, M_2 from cell well below $R_{3+4+5} + M_1$; secondary with R_s, M_1 and M_2 all separate, *ldc* much longer than either *udc* or *mdc;* penis short, lightly bent near base, with no basal prong; saccus very short and thick, shorter than uncus; articulatory process of tegumen small; juxta small, triangular, flat or slightly curved; dorsal margin of harpé produced dorsad at about middle to form a triangular flap or tooth, clasper simple, rounded, sometimes slightly produced dorsad.

Subgeneric characters, Zegris:

Primary with 5 radials; M_1 stalked on R-stem usually more than halfway from cell to base of R_3; R_2 usually stalked on $R_3 + R_4 + R_5 + M_1$; triangular flap on dorsal margin of harpé larger than in *Microzegris;* clasper somewhat narrowed at middle; saccus very short, little if any longer than thick.

Subgeneric characters, Microzegris:

Primary with 4 radials, R_4 and R_5 having united; M_1 stalked on $R_3 + R_{4+5}$ usually less than halfway from cell to base of R_3; R_2 usually arising from cell; dorsal margin of harpé at middle bearing a very small tooth; clasper very slightly narrowed at middle; saccus considerably longer than thick.

Species examined:

Z. (*Zegris*).
* *eupheme* Esper.
* *fausti* Christoph.

Z. (*Microzegris*).
* *pyrothoë* Eversmann.

As previously stated by the author ('30) there is some doubt that the peculiar characters cited by Rambur for the larva and pupa of *eupheme* are accurate. Some work on this subject is greatly to be desired. *Zegris* appears genitalically to represent more or less of a transitional form between *Euchloë* and *Anthocharis.* Venationally *pyrothoë* has developed to a point where the fusion of R_4 and R_5 is complete and constant.

8. EUCHLOË Huebner ('16) p. 94, *belia* Cramer, des. Butler ('70)
Subg. ELPHINSTONIA Klots ('30) p. 87, *charlonia* Donzel des. in O. D.
Phyllocharis Schatz ('92) p. 71, *tagis* Huebner des. in O. D. (nec *Phyllocharis* Dalman 1824).

Generic characters, Euchloë:

Apex of primary never with orange patch; primary normally with 5 radials; antennae short (longer than in *Zegris*) with abrupt club; third joint of palpus proportionately longer than in *Anthocharis* and *Zegris;* primary with M_1 normally stalked halfway from cell to base of free part of R_3, *mdc* very short; dorsal margin of harpé at about middle with a strong pointed flap or tooth; penis strongly curved near base; saccus always longer than thick.

Subgeneric characters, Euchloë:

Dark markings of secondary beneath not normally so heavy as to cover practically all of wing; pointed flap on dorsal margin of harpé long, heavily chitinized, projecting dorsad then bent mesad and ventrad with termination between harpés; penis not so strongly bent near base as in *Elphinstonia,* with no basal prong; larva apparently not so strongly tuberculate as larva of *Elphinstonia.*

Subgeneric characters, Elphinstonia:

Dark markings of secondary beneath heavy, often covering practically all of wing; pointed flap on dorsal margin of harpé shorter and less heavily chitinized than in *Euchloë,* extending above dorsal margin of harpé, not bent mesad and ventrad; penis very strongly bent basally, with a short blunt basal prong; larva apparently more heavily tuberculate than larva of *Euchloë.*

Species examined:

E. (*Euchloë*).
* *ausonides* Boisduval.
* *belemia* Esper.

* *belia* Cramer.
* *creusa* Doubleday & Hewitson.
* *daphalis* Moore.
* *falloui* Allard.
* *olympia* Edwards.
* *orientalis* Bremer.
E. (*Elphinstonia*).
* *charlonia* Donzel.
* *tagis* Huebner.

Euchloë, like *Anthocharis* and *Zegris,* shows considerable individual variation in venation. The genitalic characters appear more trustworthy.

9. HESPEROCHARIS Felder ('62) p. 493, *erota* Lucas, des. Butler ('70)
Heliochroma Butler ('69) p. 15, *idiotica* Butler des. in O. D.
Subg. CUNIZZA Grote ('00) p. 35, *hirlanda* Stoll, des. in O. D.
Cathaemia auct. nec Huebner
Subg. MATHANIA Oberthür ('90) p. xx, *esther* Oberthür, type not previously designated

Generic characters, Hesperocharis:

Antennae rather short with club more gradual; palpi with long slender third joint; primary with four radials, R_1 from cell, R_2 apparently missing, R_3, R_4 and R_5 stalked, M_1 from cell, *udc* shorter than *mdc, mdc* half or less the length of *ldc;* secondary with humeral long, bent slightly basad, R_8, M_1 and M_2 all from cell, well separated; penis about as long as harpé, slightly bent near base, with basal prong; saccus shorter than tegumen; articulatory process of tegumen well developed; uncus short, stout, with a pair of dorso-lateral protuberances at its base and a chitinized area (scaphium?) in anal membrane immediately below it and above anus; juxta well developed, hollowed-out; clasper well developed, somewhat produced dorsad; harpé simple, with a well chitinized area in inner membrane below articulation with tegumen.

Subgeneric characters, Hesperocharis:

Palpus less hairy than in *Mathania;* primary without a short spur into the cell from slightly above middle of *mdc,* and free part of R_5 never twice the length of the distance from the fork of R_3 and R_{4+5} to the fork of R_4 and R_5; cell of primary narrow; apex of primary more acute than in *Cunizza;* secondary usually more or less produced in the region of the tip of Cu_2,

but never with a sharp tail there; saccus shorter than in *Cunizza;* tip of uncus blunt.

Subgeneric characters, Cunizza:

Palpus less hairy than in *Mathania;* primary without a short spur into cell from *mdc,* and with free part of R_5 twice as long as the distance from the fork of R_3 and R_{4+5} to the fork of R_4 and R_5; cell of primary narrow; apex of primary rounded; secondary with rounded anal angle; saccus longer than in *Hesperocharis* and *Mathania;* tip of uncus blunt.

Subgeneric characters, Mathania:

Palpus much hairier than in *Hesperocharis* and *Cunizza:* primary with a short spur into cell from slightly above middle of *mdc;* free part of R_5 never twice as long as distance from fork of R_3 and R_{4+5} to fork of R_4 and R_5; cell of primary broader than in *Hesperocharis* and *Cunizza;* apex of primary acute; secondary with a sharp tail at anal angle; tip of uncus more slender than in *Hesperocharis* and *Cunizza.*

Key to Subgenera

1. Palpus very hairy; a short spur into cell from *mdc* of primary; anal angle of secondary acute ..... *Mathania*
   Palpus less hairy; no spur into cell fron *mdc* of primary; anal angle of secondary not acute 2
2. Free part of R_5 of primary twice or more the length of distance from fork of R_3 and R_{4+5} to fork of R_4 and R_5; apex of primary rounded ..... *Cunizza*
   Free part of R_5 of primary never twice the length of distance from fork of R_3 and R_{4+5} to fork of R_4 and R_5; apex of primary more acute ..... *Hesperocharis*

Species examined:

H. (*Hesperocharis*).
* *anguitia* Godart.
* *coloë* Fruehstorfer.
* *costaricensis* Bates.
* *erota* Lucas.
* *idiotica* Butler.
* *leucothea* Molina.
* *marchalii* Guerin.
* *nera* Hewitson.
* *nereina* Hopffer.

H. (*Cunizza*).
* *hirlanda* Stoll (various subspecies).

H. (*Mathania*).
* *agasicles* Oberthür.

The genus *Hesperocharis* as here held to be composed of the three genera *Hesperocharis, Cunizza* and *Mathania* may at first

glance seem too heterogeneous. When, however, the venation and structural characters are analyzed; it is apparent that the former separations of these genera have been based upon very superficial characters, and that in a broad classification their positions as even subgenera are none too secure. The differences in venation are relatively very slight; the hairier palpi of *Mathania* are hardly to be considered as very significant characters; and omitting the differences in wing shape, a rather mutable character, there remain only pattern characters which are hardly of the caliber required for generic or even subgeneric separation. However, to avoid too great changes in nomenclature, subgeneric rank has here been awarded.

Cathaemia Huebner has been used by many authors for the species here placed under the name *Cunizza*. The type of *Cathaemia* is *caenaeus* L. designated by Scudder ('75), so that this name must be placed under *Delias, q. v.*

There seems little reason for thinking that the grouping of *Hesperocharis* with *Eroessa, Euchloë*, etc., is not natural. Because of the loss of R_2 and the peculiar genitalic structures *Hesperocharis* has evidently developed to some extent on a line of its own. The genitalia of the three subgenera are very similar to each other, and very different from those of any other *Pieridae*, so much so that the author feels no reason to suspect that this similarity may be due to convergence.

10. PINACOPTERYX Wallengren ('57) p. 7, *eriphia* Godart des. Scudder ('75)

Herpaenia Butler ('70) p. 38, 52, *eriphia* Godart (as *tritogenia* Klug) des. in O. D.

Picanopteryx Scudder ('75), *eriphia* Godt. des. Scudder, *l. c.*

Generic characters:

Small to medium sized butterflies, primary not over 35 mm. in length; antennae less than half as long as primary, with abrupt club; palpus with third joint short, oval; light ground color of wings largely obscured by a heavy and peculiar pattern of dark markings; primary with four radials, R_1 and R_2 arising from the cell, R_3 and R_{4+5} stalked, M_1 stalked on $R_3 + R_{4+5}$, M_2 from cell with *mdc* less than one-quarter the length of *ldc;* secondary with humeral short, slightly curved distad, R_s, M_1 and M_2 from cell separately, *mdc* very short, cell less than half the length of the wing; penis considerably longer than harpé, with short blunt basal prong, gently curved; saccus

shorter than tegumen; articulatory process of tegumen very small; a saddle-like protuberence on dorsum of end of tegumen; uncus more than half as long as tegumen, slightly curved, blunt; no subscaphium; juxta very small, flat; harpé simple, with rounded end; clasper large, thin, with a dorsal point.

Species examined:

* *eriphia* Godart.

* *lacteipennis* Butler.

Scudder's designation of *eriphia* as the genotype of *Pinacopteryx* must hold unless some earlier designation be found. *Herpaenia* Butler is therefore placed as a synonym. *Pinacopteryx* has here been placed in the *Euchloini* because of the possession of a clasper. The author feels that this classification is not natural, but does not consider that any other characters warrant the placing of this genus anywhere else. The peculiar pattern may have some mimetic significance. The short third joint of the palpus may have been accidentally developed or may be considered another bit of evidence of Euchloine relationship.

11. HEBOMOIA Huebner ('16) p. 96, *glaucippe* L., des. Butler ('70)

Iphias Boisduval ('36) I, p. 595, *glaucippe* L.

Generic characters:

Size large, primary more than 40 mm. long; antennae less than half as long as primary, with gradual club; palpus with short oval third joint, with not very long bristly hairs; primary with R_1 and R_2 from cell close together, running almost parallel and close together for most of their length, R_3 and R_{4+5} long-stalked, M_1 from cell with short *udc*, *mdc* about half as long as *ldc* which is angled; secondary with humeral long, bent sharply distad from one-third to one-quarter, R_s, M_1 and M_2 from cell separately; penis about as long as harpé, slightly recurved, without basal prong; saccus about as long as tegumen, slender; articulatory process of tegumen large; uncus short, curved, bifurcate; a well chitinized area immediately beneath base of uncus (scaphium?) and above anus; juxta well developed, hollowed out; harpé with a dorsal process and a distal process; clasper medium sized, located toward base of harpé, with a dorsal point.

Species examined:

* *glaucippe* L. (various subspecies).

Hebomoia shares with *Hesperocharis* alone of the *Pieridae* the possession of a structure above the anus very similar to some form

of the scaphium. With others of the *Euchloini* it shares the short third joint of the palpus, and with all the other *Euchloini* it possesses a well developed clasper. As previously stated, the author does not regard the Euchloini as here delineated as being an entirely natural group, but in view of the known facts such a grouping seems to do about as well as any.

12. [2] COLIAS Fabricius ('07) 6: 284, *hyale* L. (see below)
Eurymus Swainson ('29) p. 129, 134, *hyale* L. sole sp. (nec *Eurymus* Rafinesque, 1815)
Eriocolias Watson ('95) 28: 166, *edusa* Fabr., des. in O. D.
Scalidoneura Butler ('71) p. 250, *herminia* Butler sole sp. in O. D.
Subg. ZERENE Huebner ('16) p. 97, *caesonia* Stoll., des. Scudder ('72)
Megonostoma Reakirt ('63) p. 356, *caesonia* Stoll., des. Butler ('70)

Generic characters:

Medium sized (primary not over 35 mm.) butterflies, the ground color of the wings white, yellow or orange; antenna short, with gradual club; palpus with short, oval third joint; tarsus with neither pulvillus nor paronychia; primary with four radials, R_1 from cell, R_3 and R_{4+5} long stalked, M_1 stalked more than one-third from cell to apex, *mdc* half or less the length of *ldc;* secondary with humeral nearly or entirely absent, R_8, M_1 and M_2 from cell separately; penis long, strongly curved, with long basal prong; saccus thick; tegumen with a mid-dorsal lobe and small articulatory process, shorter than uncus; uncus short, slightly curved, free part half or more its length; juxta filiform, recurved cephalad, supporting "anellus," expanded at tip; harpé higher than long.

Subgeneric characters, Colias:

Apex of primary more or less rounded, never acute, outer margin of primary somewhat convex; R_2 normally stalked on $R_3 + R_{4+5} + M_1$; tip of penis flattened dorso-ventrally, with a number of fine teeth; saccus shorter than tegumen + uncus; mid-dorsal lobe of tegumen long; harpé very much higher than long, without a rounded finely-toothed distal process.

[2] Just as this goes to press Heming (Entomologist, Vol. 64, No. 823, p. 272–273) has ignored both *Scalidoneura* and *Eriocolias,* as well as the possibility of *Colias* and *Zerene* being congeneric, and proposed the generic name *Coliastes* for this group. His name is, of course, a synonym of *Colias, Zerene,* or *Scalidoneura,* whichever is eventually decided upon.

Subgeneric characters, Zerene:

Apex of primary acute, outer margin straight or slightly concave; R_2 arising from cell; tip of penis not strongly flattened dorso-ventrally, without teeth; saccus longer than tegumen + uncus; harpé nearly as long as high, with a rounded finely-toothed distal process, its dorsal margin not swollen.

Species examined:

C. (*Colias*).

alpherakii Staudinger.
aurora Esper.
aurorina Herrich-Schaeffer.
* *alexandra* Edwards.
* *behrii* Edwards.
caucasica Staudinger.
christina Edwards.
christophi Grum-Grshmaïlo.
chrysotheme Esper.
cocandica Erschscholtz.
* *dimera* Doubleday & Hewitson.
* *edusa* Fabricius.
electo L.
eogene Felder.
* *erate* Esper.
* *eurytheme* Boisduval.
euxanthe Felder.
fieldii Menetries.
harfordi Henry Edwards.
hecla Lefebre.
* *hyale* L.
* *interior* Scudder.
* *meadii* Edwards.
melinos Eversmann.
montium Oberthür.
myrmidone Esper.
nastes Boisduval.
occidentalis Scudder.
palaeno L.
pelidne Boisduval.
phicomene Esper.
* *philodice* Godart.
romanovi Grum-Grshmaïlo.
sagartia Lederer.
* *scudderi* Reakirt.
siphanica Grum-Grshmaïlo.
thisoa Menetries.
vautieri Guerin.

C. (*Zerene*).
* *caesonia* Stoll.
cynops Butler.
* *eurydice* Boisduval.

Here again as in the case of *Anthocharis* the author has retained a name which according to the Code should not be used. Regardless of various arguments to the contrary the genotype of *Colias* was fixed by Latreille ('10, p. 440) as *rhamni* L. The next subsequent designation of a type for *Colias* was Leach's restriction of the name to *hyale* ('15, p. 716). If the Code is strictly followed in this case it will mean that *Colias* will replace *Gonepteryx* Leach (*q.v.*) and that since *Eurymus* Swainson, a name now used by some authors for this group, is a homonym, *Scalidoneura* Butler will have to be used as the next oldest name. The confusion attendant upon such a proceeding would be too great. *Zerene* Huebner would apply as the generic name for those who accept the present writer's placing of *caesonia* and *hyale* in the same genus, and this would add to the confusion. To be forced to use *Zerene* (*Zerene*) for the *caesonia* species, *Zerene* (*Scalidoneura*) for the *hyale* species and *Colias* for the *rhamni* species would be unbearable.

Latreille's designation of *rhamni* as the type of *Colias* has been questioned. The matter has been covered by Opinion 11 of the International Commission of Zoological Nomenclature.

Colias (as here used), *Catopsilia* and *Anteos* constitute a group of three genera distinguished from all the other Rhodocerini by the presence of a large basal prong on the penis, a short saccus, a mid-dorsal lobe on the tegumen, the absence of swollen wing-cases on the pupa, and other minor characters. Whether this grouping is entirely natural is a matter for discussion. The present author thinks that it is. The matter has been covered by him at greater length (Klots '29b & c).

13. CATOPSILIA Huebner ('16) p. 98, *crocale* L. des. Scudder ('72) p. 37
Murtia Huebner ('16) p. 98, *pyranthe* L. (as *minna* Cramer) sole sp.

Generic characters:

Males with "mealy border" of wings wide, an oval sex-patch on upper side of secondary near base of costal margin and a strong hair-pencil on under side of primary near base of inner margin; antenna short with gradual club; palpus with short oval third joint; tarsus with both pulvillus and paro-

nychia; primary with R_1 from well basad on cell, R_2 from near end of cell, R_3 and R_{4+5} long stalked, M_1 stalked on $R_3 + R_{4+5}$ about a third of the distance from end of cell to apex, M_2 from cell with *mdc* half or more as long as *ldc;* secondary with humeral vein short, curved slightly basad, R_s, M_1 and M_2 from cell separately; penis long, curved, bearing chitinized teeth (not to be confused with *cornuti*), with long basal prong; saccus thick, shorter than tegumen + uncus; tegumen short, with (usually) a mid-dorsal lobe, articulatory process small; uncus slender, free part long; juxta slender, recurved cephalad, expanded at tip; harpé higher than long, with a rounded dorsal process and an angulate or somewhat rounded distal process.

Species examined:

* *crocale* Cramer.
* *etesia* Hewitson.
* *florella* Fabricius.
* *pyranthe* L.
* *scylla* L.
* *thauruma* Reakirt.

The author has figured the genitalia of *Catopsilia* in a previous article ('29c), pointing out at length the reasons for its separation from the New World species placed in *Phoebis.* There seem no valid reasons for holding any subgenera. The relationships of the genus are discussed above under *Colias* and at somewhat greater length in the article cited above.

14. ANTEOS Huebner ('16) p. 99, *maerula* Fabricius, des. Godman & Salvin ('89) p. 148
Amynthia Swainson ('32) p. 65, *maerula* Fabricius des. in O. D. (*fide* Scudder '75)
Subg. RHODOCERA Boisduval & Leconte ('29) p. 70, *menippe* Huebner, des. Butler ('70) p. 35

Generic characters:

Size large, primary more than 40 mm. long; antenna short with gradual club; palpus with short oval third joint; male with a sex patch on upper side of secondary below base of $Sc + R_1$; without hair-pencil on primary; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked usually slightly more than half way from end of cell to apex, M_1 stalked on R-stem less than a third way from cell to apex; secondary with humeral vein short, slightly curved basad, R_s, M_1 and M_2 from cell separately; penis little if any longer than ventral margin of harpé, heavy, curved, with two or more chitinized teeth and a strong basal prong; saccus little if any longer than tegu-

men + uncus, thick, swollen distally; tegumen short with mid-dorsal lobe, articulatory process small; uncus slender, curved, with free part long; harpé as high as long, with a simple distal process, a trough-shaped lobe arising at about middle from inner face below dorsal margin, and a rounded setiferous lobe on sacculus.

Subgeneric characters, Anteos:

Apex of primary falcate; secondary with a short pointed tail on M_3, primary with R_2 arising from end of cell or very near end; sex-patch of secondary not reaching costad to $Sc + R_1$; distal process of harpé short; a dorsal setiferous rounded lobe on inner face of harpé basad of middle; a number of small teeth on penis; basal prong of penis longer than trough-shaped dorsal lobe of harpé.

Subgeneric characters, Rhodocera:

Apex of primary not falcate; outer margin of secondary rounded, without tails; primary with R_2 arising from well basad of end of cell; sex-patch of secondary reaching to $Sc + R_1$; distal process of harpé long and pointed; no dorsal setiferous lobe on harpé; two large teeth on penis; basal prong of penis shorter than trough-shaped lobe of harpé.

Species examined:

A. (*Anteos*)
* *clorinde* Godart
* *maerula* Fabricius

A. (*Rhodocera*)
* *menippe* Huebner

The genitalia and other structures of this genus have been figured and more extensively discussed by the author in a previous article ('29b). In that article, however, it was stated that *menippe* was not worthy of subgeneric distinction from the other species. Since then a more intensive study of the Rhodocerini has caused the author to revise this opinion.

As stated by the author in this previous article there is no valid reason whatsoever for including the New World species of *Anteos* in the essentially Old World genus *Gonepteryx*. The resemblance between the species is purely fortuitous and in this way means nothing whatsoever.

15. GONEPTERYX Leach ('15) p. 716, *rhamni* L. sole sp. in O. D.
Gonoptera Dalman ('20) p. 76, *rhamni* L. type not previously specified
Earina Speyer ('39) p. 98, *rhamni* L. type not previously specified

Goniapteryx Westwood ('40) p. 87, *rhamni* L. des. in O. D. (*fide* Scudder, '75)

Gonioptera Wallengren ('53) p. 145, *rhamni* L. type not previously designated

General characters:

Antenna very short with gradual club; palpus with short oval third joint; tarsus with paronychia but without pulvillus; primary with costa strongly bowed before apex, apex acute, falcate; secondary with a sharp short tail on tip of Cu_1; wings without sex-patches or mealy border; primary with R_1 and R_2 from cell, R_2 from well basad of tip, R_3 and R_{4+5} long-stalked, M_1 stalked on $R_3 + R_{4+5}$, M_2 from cell with *mdc* short, about a third as long as *ldc;* secondary with humeral vein very greatly reduced or absent, *mdc* very short, about a fifth as long as *ldc;* penis long, slender, more than three times as long as tegumen + uncus,[8] without basal prong; saccus slender, longer than tegumen + uncus; tegumen very short, without mid-dorsal lobe, articulatory process small; uncus short, slender, sometimes bifurcate; harpé longer than high, with simple distal process, one dorsal spine on inner face near tip and a small triangular spine on ventral edge near tip.

Species examined:

* *alvinda* Blanchard
* *amintha* Blanchard
* *aspasia* Menetries
* *cleobule* Huebner
* *farinosa* Z.
* *rhamni* L.
* *zaneka* Moore

The species of *Gonepteryx* constitute a very homogeneous group, characteristic of and limited to the Palearctic region. As previously stated they bear no relationship to the New World *Anteos.* Any further division of the genus would be unwarranted.

Genitalically *Gonepteryx* appears related to the genera which follow.

The author has already discussed under *Colias* his reasons for retaining the name *Gonepteryx* for the present group, although under the Code this proceeding is incorrect.

16. DERCAS Boisduval ('47b) p. 70, *verhuelli* Hoeven, sole sp.

Generic characters:

Apex of primary acute, falcate; secondary sometimes with a sharp tail on Cu_1; antenna very short, with gradual club; palpus with short, oval third joint; cell of both primary and

secondary short, considerably less than half the length of wing; primary with four radials, R_1 and R_2 from cell, R_2 from end of cell, R_3 and R_{4+5} stalked halfway from cell to apex, M_1 stalked more than halfway from end of cell to fork of R_3 and and R_{4+5}, *mdc* about half as long as *ldc;* secondary with humeral vein very short, *udc* about equal to *mdc*, less than half as long as *ldc;* penis very long and slender, about four times as long as tegumen + uncus, with two chitinized teeth near tip; saccus very long and slender, swollen at tip, more than twice as long as tegumen + uncus; uncus long, slender, with free part long; harpé simple, rounded, with no distal process, with one spine from inner face below dorsal margin near tip.

Species examined:

* *gobrias* Hewitson

* *lycorias* Doubleday

As pointed out by Dixey ('94) and others *Dercas* is rather closely related to *Gonepteryx* and represents an offshoot from this group that has invaded the Indo-Australian region. The extraordinarily long penis is very characteristic, being exceeded in proportionate length in the Pieridae only by *Dismorphia* (*Moschoneura*) *pinthaeus.*

17. PHOEBIS Huebner ('16) p. 98, *argante* Fabricius, des. Butler ('73) I, 155

Prestonia Schaus ('20) p. 109, *argante* Fabricius, sole sp. in O. D. (as *clarki* Schaus)

Callidryas Boisduval & Leconte ('29) p. 73, *eubule* L., sole sp. in O. D.

Metura Butler ('73) p. 154, *cipris* Fabricius, des. in O. D. Homonym

Parura Kirby ('96) p. 229, *cipris* Fabricius, des. in O. D.; n. name for above

Subg. RHABDODRYAS Godman & Salvin ('89) p. 146, *trite* L., des. in O. D.

Subg. APHRISSA Butler ('73) p. 155, *statira* Cramer, des. in O. D.

Generic characters:

Medium sized to large butterflies; antenna short with gradual club; palpus with third joint short, oval; wings usually with mealy border and sex-patches in males; primary with R_1 and R_2 from cell, R_2 from before end of cell, R_3 and R_{4+5} stalked, R_{4+5} considerably longer than the distance from the end of the cell to its base, *mdc* usually slightly more than half as long as *ldc;* secondary with humeral vein very short, R_s,

M_1 and M_2 from cell separately with *mdc* the shortest of the three discocellulars, *ldc* distinctly angled; penis slender, as long as or longer than tegumen + uncus, usually gently recurved, without basal prong; saccus as long as or longer than tegumen + uncus, slender, gently curved; tegumen short with long slender articulatory process; uncus long; harpé longer than high, with a distal process, usually with an internal, rounded setiferous lobe, or if without this with a dorsal heavily chitinized spine or toothed process.

Subgeneric characters, Phoebis:

Mealy border and sex-patches of males either present or absent; dorsal margin of harpé with a dorsad projecting spine or process and inner face of harpé below this with a mesad and ventrad projecting, rounded setiferous process; setiferous "transtilla" not present.

Subgeneric characters, Rhabdodryas:

Dorsal margin of harpé without spine or process; setiferous process arising from inner face of harpé projecting dorsad above dorsal margin of harpé; setiferous "transtilla" present; mealy border present in males; secondary of male with a sex-patch near base below $Sc + R_1$, primary with no sex-patch.

Subgeneric characters, Aphrissa:

Dorsal margin of harpé with a heavily chitinized spine or a toothed process; inner margin of harpé without setiferous process; "transtilla" absent; mealy border present in males; males with a sex-patch on upper side of secondary near base below $Sc + R_1$ and one on under side of primary near base below Cu.

Species examined:

P. (*Phoebis*)
- * *agarithe* Boisduval
- * *argante* Fabricius
- * *avellanada* Herrich-Schaeffer
- * *cypris* Fabricius
- * *eubule* L.
- * *philea* L.
- * *rurina* Felder

P. (*Rhabdodryas*)
- * *trite* L.

P. (*Aphrissa*)
- * *boisduvalii* Felder
- * *godartiana* Swainson
- *jada* Butler
- * *orbis* Poey
- * *statira* Cramer

The genus has been studied in detail and the genitalia figured by both Brown ('29) and the present author ('29c). In *Phoebis* the male genitalia present excellent and stable characters for specific differentiation, more so than in any other of the *Pieridae*. Brown has, in fact, demonstrated that two species, *rurina* Felder and *intermedia* Butler can only be satisfactorily separated by the genitalia.

The specific differences shown by the genitalia are greater than those between many other genera of the Pieridae. Differences in wing shape, mealy border and sex-patches are correspondingly large. From this it is evident that *Phoebis* is a genus within which specific differentiation has proceeded very quickly, in structural characters as well as in more superficial ones. Because of this the present author is not inclined to agree with Brown in splitting off the *statira* species as a separate genus. In a group such as this where all specific differences are so great the characters for *Aphrissa* do not seem so important as they would in a group where the specific differences shown by the genitalia are almost nil.

The species here placed in *P.* (*Phoebis*) show great differences from each other, especially in the matter of the mealy border and the sex-patches. These differences are not, however, nearly as fundamental as those used for the subgeneric characters, and so it has seemed best to "lump" these species together into one rather heterogeneous subgenus.

18. KRICOGONIA Reakirt ('63) p. 355, *lyside* Godart, sole sp.

Generic characters:

Antenna short with somewhat abrupt club; palpus with third joint short, oval; male with mealy border very wide, covering practically all of wings; primary with apex sub-acute, slightly falcate; primary with R_1 and R_2 from cell, R_3 from slightly before end of cell, R_4 and R_{4+5} stalked, M_1 stalked about a third of the distance from end of cell to apex, *mdc* over half as long as *ldc;* secondary with humeral vein practically absent, R_s, M_1 and M_2 from cell separately, *mdc* shorter than *udc* and *ldc;* penis slender, strongly curved, without basal prong, less than twice as long as tegumen + uncus; saccus shorter than tegumen + uncus, thick; tegumen with long articulatory process; uncus long, thick at base, abruptly narrowing to a long, thin, gently curved free part; juxta less expanded at tip; harpé with a very complicated armature, as follows: from inner face at dorso-basal angle a long flat process with a patch of heavy setae at the end; from *outer* face a small triangular process bearing two heavy setae at end; a flat toothed process

from dorsum near tip; a simple elongate distal process; a short rounded lobe from sacculus, bearing a patch of heavy setae at its tip; a pair of very heavy setae from base of harpé on inner face about one-third way dorsad from ventral margin.

Species examined:

* *lyside* Godart (various subspecies)

Kricogonia lyside is a very peculiar insect, whose exact relationships are only to be guessed at. From the presence of a very wide mealy border and from the general structure the author considers it to be an offshoot from somewhere well back on the *Phoebis* stock. The peculiar structures on the harpé are like nothing else in the *Pieridae.* Especially noteworthy is the small dorso-basal process from the outer face of the harpé. Only here and in *Nathalis* does any structure arise from such a position.

19. LEUCIDIA Boisduval ('47) p. 77, *elvina* Godart, des. Scudder ('75) (nec *leucoma* Bates = *brephos* Huebner des. Butler ('70))

Generic characters:

Very small butterflies, primary not over 15 mm. in length; wings very thinly scaled; apex and outer margin of primary strongly rounded; antenna short, with gradual club; palpus with short oval third joint; tarsus with pulvillus but without paronychia; primary with R_1 from cell, R_2 stalked on $R_3 + R_{4+5} + M_1$, R_3 and R_{4+5} very short, M_1 stalked on $R_3 + R_{4+5}$ nearly or quite halfway from end of cell to apex, M_2 from cell with *mdc* at least half as long as *ldc;* secondary with humeral vein sometimes extending halfway to margin, R_s and M_1 stalked, M_2 from cell with *mdc* at least two-thirds as long as *ldc;* costa of secondary of male sinuate; male with a sex-patch near base of inner margin of primary beneath and another near base of costa of secondary above; penis thick, somewhat swollen at base, curved, more than twice as long as tegumen + uncus, without basal prong; saccus slender, swollen at tip, about twice as long as tegumen + uncus; tegumen short, articulatory process long; uncus slender, curved; harpé higher than long, with an obtusely pointed tip and a single long spine from inner face just above ventral margin near tip.

Species examined:

* *brephos* Huebner

* *pygmaea* Prittwitz

As in the case of *Kricogonia* the relationships of *Leucidia* are rather hard to trace. It may be an offshoot from the ancestral stem of *Eurema,* to some of the species of which the genitalia are very

similar. None of the species of *Eurema,* however, show a sex-patch development approaching that of *Leucidia.* This may, however, very well be a secondary development. In venation *Leucidia* is slightly more advanced than *Eurema,* in which genus only *amelia* Poey and the *Teriocolias* species have R_2 stalked.

20. GANDACA Moore ('06) 7: 33–35, *harina* Horsfield sole sp.

Generic characters:

Small, length of primary not over 28 mm.; wings broad, apex of primary somewhat rounded; sex-patches not present; antenna short with gradual club; palpus short with short oval third joint; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked, R_{4+5} as long as the distance from the end of the cell to the fork of R_3 and R_{4+5}, M_1 stalked about a quarter of the distance from end of cell to apex, *mdc* at least half as long as *ldc;* secondary with humeral very thin, directed basad, extending about one-third way to the margin, *udc* and *mdc* about equal, approximately one-third as long as *ldc;* penis slender, straight, three times as long as uncus + tegumen, with no basal prong; saccus slender, more than two-and-a-half times as long as uncus + tegumen; tegumen very short, articulatory process well developed; uncus slender at base, considerably thickened dorso-ventrally to tip, projecting dorsad; harpé higher than long, with a long slender distal process, juxta very much reduced.

Species examined:

* *harina* Horsfield (various subspecies)

Moore's erection of *Gandaca,* based on relatively slight differences in wing-shape and venation from *Terias,* has been vindicated by the structures of the genitalia, which show excellent generic characters. Judging by these it seems as if *Gandaca* may have arisen from some relatively simple ancestral stock common to itself and *Eurema.*

21. EUREMA Huebner ('16) p. 96, *daira* Godart (*delia* Cramer) des. Butler ('70)

Sphaenogona Butler ('70) pp. 35, 44, *arbela* Huebner (*ectriva* Butler) des. in O. D.

Subg. TERIOCOLIAS Roeber ('10) p. 89, *atinas* Hewitson sole sp. in O. D.

Subg. ABAEIS Huebner ('16) p. 97, *nicippe* Cramer, des. Butler ('70)

Xanthidia Boisduval & Leconte ('29) p. 48, *nicippe* Cramer, des. Scudder ('75)

Subg. PYRISITIA Butler ('70) pp. 35, 44, *proterpia* Fabricius, des. and sole sp. in O. D.

Subg. MAIVA Smith & Kirby ('93) p. 96, *brigitta* f. *zoë* Hopffer (*sulphurea* Smith) des. in O. D.

Kibreeta Moore ('06) p. 36, *libythea* Fabricius, des. in O. D.

Subg. NIRMULA Moore ('06) *venata* Moore, des. in O. D.

Subg. TERIAS Swainson ('20) p. 22, *hecabe* L., des. in O. D. (*fide* Scudder '75)

Heurema Herrich-Schaeffer ('67b) p. 105, *impura* Vollenhoven, sole sp. in O. D.

General characters:

Size small, not over 28 mm. length of primary; antenna short, with gradual club; palpus with short third joint, with scaly vestiture; male sometimes with sex-patch on under side of primary, above base of inner margin; primary with 4 radials, R_1 from cell, R_2 usually from cell, R_3 and R_{4+5} stalked, M_1 stalked on $R_3 + R_{4+5}$ usually less than one-third of the distance from end of cell to apex, *mdc* variable in length; secondary with humeral vein very much reduced or absent, *udc* usually absent (R_s and M_1 stalked) or shorter than *mdc,* which is nearly always less than half as long as *ldc;* penis always longer than uncus + tegumen, usually more than twice as long, swollen at base, gently curved, without basal prong; saccus slender, somewhat swollen at tip, usually longer than uncus + tegumen, sometimes twice as long or more; tegumen short, with long articulatory process; uncus never strongly thickened at tip; juxta well-developed, although never very heavily chitinized; harpé always longer than high, always with a distal process and one or more lobes or spines in addition, sometimes with a considerable armature.

Subgeneric characters, Eurema:

Palpus not very hairy; antenna not heavily clothed basally with scales; male with no sex-patches; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked, the free part of R_{4+5} never greatly less than the distance from the end of cell to its base, M_1 stalked about halfway from end of cell to base of free part of R_{4+5}, *mdc* long; secondary with R_s and M_1 from cell separately or stalked, *mdc* always less than half as long as *ldc;* penis slender, somewhat swollen at base, more than twice as long as tegumen + uncus; saccus slender, one-and-a-half or more times as long as tegumen + uncus; tegumen short with small articulatory process; uncus long, slender, with long free part; harpé with a distal process and two or more lobes or spines.

Subgeneric characters, Teriocolias:

Palpus strongly hairy; antenna thickly clothed with scales; primary with R_1 from cell, R_2 well stalked on $R_3 + R_{4+5} + M_1$, R_3 and R_{4+5} long stalked with free part of R_{4+5} less than two-thirds the length of the distance from end of cell to its base, M_1 stalked on $R_3 + R_{4+5}$ for a distance nearly or quite equal to length of free part of R_{4+5}, *mdc* less than half as long as *ldc;* secondary with R_s and M_1 connate from cell, *mdc* less than half as long as *ldc;* penis about one and one-half times as long as tegumen + uncus, slender, lightly curved; saccus about equal in length to tegumen + uncus; base of uncus thick, free part long, curved down, slender.

Subgeneric characters, Abaeis:

Palpus not strongly hairy; antenna not thickly clothed with scales basally; primary of male with a sex-patch beneath below base of Cu; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked with free part of R_{4+5} as long as or very little shorter than distance from end of cell to its base, M_1 stalked for a distanc equal to about one-third of the length of R_{4+5}, *mdc* half or more than half as long as *ldc;* secondary with R_s from cell with very short *udc, mdc* less than half as long as *ldc;* penis two and one-half times as long as tegumen + uncus; saccus about twice as long as tegumen + uncus; articulatory process of tegumen large; free part of uncus little longer than basal part, slender, tapering, downcurved; harpé with simple distal process.

Subgeneric characters, Pyrisitia:

Palpus not strongly hairy; antenna not thickly clothed basally with scales; male without sex-patches; primary with R_1 and R_2 from cell, free part of R_{4+5} equal to or longer than distance from end of cell to its base, M_1 usually stalked more than halfway from end of cell to fork of R_3 and R_{4+5}, *mdc* half or more the length of *ldc;* secondary with R_s, M_1 and M_2 separately from cell; penis at least longer than uncus + tegumen; tegumen very short, articulatory process located very near its base; uncus long, often very lightly chitinized, with very short free part, sometimes turned dorsad, simple at tip; harpé with at least two dorsal and one ventral lobes, usually with a toothed distal process.

Subgeneric characters, Maiva:

Palpus not very hairy; antenna not very heavily clothed with scales; male without sex-patches; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked with free part of R_{4+5} longer than the distance from end of cell to its base, M_1 short stalked, *mdc* more than half as long as *ldc:* secondary with R_s, M_1 and M_2 from cell separately, *udc* half the length of *mdc, mdc* about

half the length of *ldc;* penis more than three times the length of uncus + tegumen, slender, considerably swollen at base; saccus more than twice the length of the uncus + tegumen, slender; tegumen very short; uncus very short, with free part very short, tip turned dorsad and deeply bifurcate, not expanded laterad; harpé with two dorsal spines, a simple distal process and two ventral spines.

Subgeneric characters, Nirmula:

Palpus not very hairy; antenna not very heavily scaled; male with a sex-patch on under side of secondary below base of Cu; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked with free part of R_{4+5} twice as long as distance from end of cell to its base, M_1 short-stalked, *mdc* more than half as long as *ldc;* secondary with R_s and M_1 from cell very close together or connate, *mdc* less than half as long as *ldc;* penis slender, more than three times as long as uncus + tegumen, swollen at base; saccus slender, more than twice as long as uncus + tegumen; tegumen very short, with large articulatory process; uncus short, with very short free part, tip simple and not turned dorsad; harpé with two dorsal spines, its distal process with a ventral flap, and one ventral spine.

Subgeneric characters, Terias:

Palpus not very hairy; antenna not heavily clothed with scales; male with a narrow elongate sex-patch above and below basal portion of Cu on primary under side; primary with R_1 and R_2 from cell, free part of R_{4+5} about one-and-a-half times as long as distance from end of cell to its base, M_1 stalked more than halfway from end of cell to base of free part of R_{4+5}, *mdc* more than half as long as *ldc;* secondary with *udc* very short, *mdc* less than half as long as *ldc;* penis slender, more than twice as long as uncus + tegumen, somewhat swollen at base; saccus little longer than uncus + tegumen; tegumen fairly long, with small articulatory process; uncus long, with very short free part, tip expanded laterad and more or less bifurcate, harpé with never less than two dorsal and two ventral spines in addition to distal process.

Key to Subgenera

1. Free part of uncus much shorter than basal part 2
   Free part of uncus longer than basal part 4
2. Sex-patch on under side of primary of male narrow, located both above and below basal portion of Cu ..... *Terias*
   Sex-patch an oval patch below Cu ..... *Nirmula*
   Male without sex-patch 3

3. Tip of uncus bifurcate; Ethiopian and Indo-Australian ..... *Maiva*
   Tip of uncus simple; Neotropical ..... *Pyrisitia*
4. Male with a sex-patch on under side of primary near base of inner margin ..... *Abaeis*
   Male with no sex-patch 5
5. R_2 of primary stalked on R-stem ..... *Teriocolias*
   R_2 of primary from cell ..... *Eurema*

Species examined:

E. (*Eurema*)

daira group

* *daira* Godart
* *agave* Cramer
* *elathea* Cramer
* *jucunda* Boisduval & Leconte
* *nigrocincta* Dognin
* *palmyra* Poey
* *phiale* Cramer

boisduvaliana group

* *boisduvaliana* Felder
* *ecuadora* Hewitson
* *graduata* Butler
* *gratiosa* Doubleday & Hewitson
* *xanthochlora* Kollar

mexicana group

* mexicana Boisduval
* *salome* Felder

single species

* *adamsi* Lathy
* *albula* Cramer
* *amelia* Poey
* *deva* Doubleday
* *lucina* Poey
* *priddyi* Lathy
* *pseudomorpha* Klots
* *reticulata* Butler

E. (*Teriocolias*)

* *andina* Forbes
* *atinas* Hewitson

E. (*Pyrisitia*)

proterpia group

* *gundlachia* Poey
* *proterpia* Fabricius

nise group

* *dina* Poey
* *lisa* Boisduval & Leconte
* *nise* Cramer
* *venusta* Boisduval

messalina group

* *messalina* Fabricius
* *portoricensis* DeWitz
* *pyro* Godart

E. (*Abaeis*)

* *nicippe* Cramer

E. (*Maiva*)
* *brigitta* Cramer (& f. *zoë* Hopffer)
* *pulchella* Boisduval

E. (*Nirmula*)
* *venata* Moore

E. (*Terias*)
* *blanda* Boisduval
* *brenda* Doubleday & Hewitson
* *candida* Cramer
* *desjardinsi* Boisduval
* *floricola* Boisduval
* *hecabe* L.
* *mandarina* Orza
* *norbana* Fruehstorfer
* *sari* Horsfield
* *senegalensis* Boisduval
* *tilaha* Horsfield
* *tominia* Vollenhoeven

As in the case of *Phoebis* so in *Eurema* it is very hard to make hard and fast statements. The genus is evidently one of the most actively developing of the Pieridae. There are far greater structural differences betwen closely related species than there are between many other genera. It is obvious that for this reason the same standards cannot be applied, or else *Eurema* would be resolved into a perfect host of very small genera.

Teriocolias Roeber has therefore been brought back into *Eurema,* as well as most of the various genera erected by Moore and others. There is no reason beside a chance and superficial resemblance for thinking that *Teriocolias* is related to *Colias.* The stalking of R_2 of the primary has evidently occurred too many times for it to be regarded as a phylogenetic character of any importance. Only one of Moore's genera, *Gandaca,* appears to be worthy of full generic status.

For phylogenetic purposes a free use of subgenera and species groups seems to be sufficient. The classification here used is based largely on the male genitalia and the sex-patches. In the case of the species placed in *Pyrisitia* the author is not entirely satisfied that the grouping is a natural one.

The author has not been able to examine enough of the Old World species to feel competent to divide these into species groups. A great deal of specific differentiation has taken place here, especially in *Terias.*

The genus as it stands here is quite homogeneous. None of the subgenera possess characters essentially different from those of the others, being characterized almost entirely merely by different combinations of a limited set of characters. Further research may very possibly show that some of these subgenera are not worthy of even that rank.

Further details regarding the New World species may be found in the author's papers on the subject (Klots, '28a, '28b and '29a).

The author has not had the opportunity of examining the genitalia of *libythea* Fabricius, the genotype of *Kibreeta* Moore, so that the present placing of that genus as a synonym of *Maiva* is based largely on supposition.

22. NATHALIS Boisduval ('36) p. 589, *iole* Boisduval, sole sp.

Generic characters:

Size small, length of primary not over 19 mm.; antenna short with abrupt club; palpus with third joint long and slender; tarsus with neither pulvillus, or paronychia; primary with 3 radials, R_1 and R_2 from cell, R_3, R_4 and R_5 fused, M_1 stalked on R_{3+4+5} about a quarter to a third of the distance from end of cell to apex, *mdc* a half to two-thirds the length of *ldc;* secondary with humeral vein rudimentary or absent, R_s, M_1 and M_2 from cell separately, *udc* and *mdc* about equal in length, about a third of the length of *ldc;* male with a small oval sex-patch on upper side of secondary above base of R_s; penis long and slender, slightly swollen basally, about one-and-a-half times as long as tegumen + uncus, without basal prong; saccus about equal in length to tegumen + uncus, thick proximally; tegumen long, about two-thirds as long as uncus, with large articulatory process; uncus long, slender, tapering, with long free part; juxta very small and inconspicuous; harpé with a large forked spine, bearing many small spines, arising from outer face, a number of chitinized teeth on inner face and dorsal margin near tip, and a spinulated distal process.

Species examined:

* *iole* Boisduval

* *plauta* Doubleday & Hewitson

Nathalis is a most peculiar little genus, the relationships of which are practically impossible of definite determination. The reduction of the juxta is unique in the *Rhodocerini,* as is the considerable length of the tegumen as compared with the uncus. The shape of the penis and the excessive ornamentation of the harpé suggest *Eurema.* The type of sex-patch in the male is found in a number of other genera, of which *Colias* is one. The absence of paronychia and pulvilli on the tarsi is also suggestive of *Colias.* The general appearance of *iole* suggests *Colotis* or *Eurema,* that of *plauta* in a vague way *Colias.* The pupa is hardly *Pierine.* The author has only one example of this stage, which possesses no trace of the frontal prominence characteristic of the family.

23. ERONIA Huebner ('22) ii, *cleodora* Huebner sole sp.
Dryas Boisduval ('47b) 2: 588, *leda* Boisduval

Generic characters:

Antenna fairly long with gradual club; palpus with short oval third joint; male with no sex-patches; tarsus with pulvillus and paronychia, the latter very broad; primary with 5 radials, R_1 and R_2 from cell, R_3 R_4 and R_5 stalked, M_1 from cell connate with R-stem, *mdc* less than half as long as *ldc;* secondary with humeral long, turned distad from near its base, *mdc* shorter than *udc* and about one-third of *ldc;* penis very stout, nearly twice the length of tegumen + uncus, lightly curved, with heavy basal prong; saccus slender, enlarging distad, about as long as uncus + tegumen; tegumen long with fairly large articulatory process; uncus long, slender, tapering, free part about one-third of its ventral length; juxta very small and lightly chitinized; harpé simple, rounded, with no armature.

Species examined:

* *cleodora* Huebner
* *leda* Boisduval

24. NEPHERONIA Butler ('70) 1: 38, 53, *argia* Fabricius des. in O. D. (as *idotaea* Butler)
Leuceronia Aurivillius ('95) 16: 256, *buqueti* Boisduval, des. in O. D. (?) and Aurivillius ('98)

Generic characters:

Antenna fairly long with gradual club; palpus with short oval third joint; male with no sex-patches; tarsus with pulvillus and paronychia; primary with 5 radials, R_1 and R_2 from cell, R_3, R_4 and R_5 stalked, *mdc* more than half as long as *ldc;* secondary with humeral long, usually turned distad from near its base, *mdc* from half as long as *ldc* to nearly as long; penis very thick, little longer than tegumen + uncus, gently recurved, with no basal prong; saccus thick, about as long as tegumen; uncus tapering, free part about one-third of ventral margin; juxta small; harpé with a simple distal process but without other armature.

Species examined:

* *argia* Fabricius
* *avatar* Moore
* *pharis* Boisduval
* *thalassina* Boisduval

25. PARERONIA Bingham ('07) 2: 276, *valeria* Cramer des. in O. D.
Paphia Fabricius in part (*P. baebera* Esch. Kotzb. Reise, 3: 211, t. 6, f. 10, = *Pareronia valeria* Cr.)

Generic characters:

Antenna long with gradual club; palpus with short oval third joint; male with large sex-patch on apical and marginal area of secondary above; tarsus with both pulvillus and paronychia; primary with 5 radials, R_1 and R_2 from cell, R_3, R_4 and R_5 stalked, M_1 from cell connate with R-stem, *mdc* more than half as long as *ldc;* secondary with humeral long, turned distad very much less than in *Eronia* and *Nepheronia* and from nearer tip; R_s, M_1 and M_2 from cell separately, *mdc* nearly or as long as *ldc;* penis thick, little longer than tegumen + uncus, gently recurved, without basal prong; tegumen long with long articulatory process; uncus long, tapering, with free part about one-half of ventral margin; harpé with a simple distal process and a setiferous pad on dorsal margin; juxta well developed, strongly "dished."

Species examined:

* *pingasa* Moore
* *tritaea* Felder
* *valeria* Cramer

The three genera just taken up, *Eronia*, *Nepheronia* and *Pareronia*, are evidently quite closely related. They show, however, excellent and constant characters for differentiation in the male genitalia, which alone would warrant their separation. Venational differences are comparatively slight. So much variation in pattern and color occurs in *Eronia* and *Nepheronia* that these can not be taken very seriously. The pattern of *Pareronia* is, however, a good character. The species of this genus are evidently mimetic. *Pareronia* has evidently been derived from *Nepheronia; avatar* is somewhat of a transitional form between the two groups. Inasmuch as the pattern and genitalia of this species correspond very closely with *Nepheronia* it has been placed in that genus, although its venation and geographical distribution correspond more with *Pareronia.*

In the possession of five radials these three genera are evidently primitive. The very short third joint of the palpus has led the author to believe that they may conceivably represent forms closely allied to the ancestral stock from which the Rhodocerini were derived. The enlarged wing cases of the Eroniine pupa may also be adduced as evidence in favor of this contention. The Eroniine genera as they are, however, undoubtedly belong in the *Pierini.*

26. COLOTIS Huebner ('16) p. 97, *amata* Fabricius des. Scudder ('75)

Aphrodite Huebner ('16) p. 95, *evippe* L. type not previously designated? (nec *Aphrodite* Leske, N. Physiol. An. p. xv, 1775)

Idmais Boisduval ('36) p. 584, *chrysonome* Klug des. Scudder ('75)

Callosune Doubleday ('46) p. 57, *danaë* Doubleday & Hewitson des. Scudder ('75)

Anthopsyche Wallengren ('57) p. 10, *achine* Cramer des. Scudder ('75)

Subg. TERACOLUS Swainson ('32) 2: 115, *subfasciatus* Swainson sole sp.

Ptychopteryx Wallengren ('57) p. 17, *subfasciatus* Swainson (as *bohemanni* Wall.) sole sp. *nomen praeocc*

Thespia Wallengren ('58) p. 77, *subfasciatus* Swainson (as *bohemanni* Wall.) n. name for above

Subg. CALOPIERIS Aurivillius ('98) p. 415, *eulimene* Klug des. in O. D.

Subg. MADAIS Moore ('06) 7: 28, *faustus* Olivet, des. in O. D.

Generic characters:

Antenna fairly long with abrupt club; palpus with short third joint; male usually without sex-patches; tarsus with pulvillus (sometimes very small) and paronychia; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked more than halfway from end of cell to apex, M_1 from cell connate with R-stem, or short-stalked on R-stem, *mdc* usually at least half as long as *ldc;* secondary with humeral long, bent distad, R_s from cell well basad from end, M_1 and M_2 either from cell separately or connate, or stalked, *ldc* practically always more than twice as long as *mdc;* penis very thick, strongly curved from base, always longer than tegumen + uncus, with short, heavy basal prong; saccus slender or thick, shorter than tegumen + uncus; tegumen large; uncus stout basally, tapering, with free part about one-half of ventral margin; harpé sometimes with a distal process and a rudimentary clasper, never with any other lobes or spines; juxta small, lightly chitinized.

Subgeneric characters, Colotis:

Male without sex-patches; apex of primary more rounded than in *Teracolus;* M_1 of primary sometimes stalked; *mdc* of secondary sometimes absent by stalking of M_1 and M_2; penis one and a half times as long as tegumen + uncus, or longer; harpé simple, with no distal process and no rudimentary clasper.

Subgeneric characters, Teracolus:

Male without sex-patches; apex of primary more acute than in other subgenera; M_1 of primary always connate from cell with R-stem; *mdc* of secondary never much shorter than *udc;* penis not one and a half times as long as tegumen + uncus; harpé sometimes with a rudimentary clasper, always with a sharp finely toothed distal process.

Subgeneric characters, Calopieris:

The author has not had the opportunity of examining a specimen of *Calopieris eulimene.* According to the description of the author of the genus, (Aurivillius, '98, p. 415) the most striking character is the extreme shortness of the palpus.

Subgeneric characters, Madais:

Male with an oval sex-patch on under side of primary above basal portion of 2d A; primary with M_1 connate from cell, *mdc* less than half as long as *ldc;* secondary with *mdc* about half as long as *udc;* male genitalia with no essential differences from those of *C.* (*Colotis*).

Key to Subgenera

1. Male without sex-patches 2
   Male with sex-patch on under side of primary ..... *Madais*
2. Harpé simple, without distal process 3
   Harpé with a distal process ..... *Teracolus*
3. Palpus very small and short, hardly reaching beyond front. *Calopieris*
   Palpus longer ..... *Colotis*

Species examined:

C. (*Colotis*).
- * *amatus* Fabricius.
- * *bacchus* Butler.
- *elgonensis* E. Sharpe.
- *eucharis* Fabricius.
- * *evarne* Klug.
- * *evippe* L.
- *gueni* Mabille.
- *incretus* Butler.
- * *ione* Godart.
- * *mananhari* Ward.
- * *omphale* Godart.
- * *venustus* Butler.
- *wallengreni* Butler.
- * *zoë* Grandidier.

C. (*Teracolus*).
- * *eris* Klug.
- * *subfasciatus* Swainson.

C. (*Madais*).
- * *faustus* Olivet.

Colotis presents a strange complex of species showing great variation in color, pattern and venation, without there being many tangible characters for their separation. Within the subgenus *Colotis* as here held are found some species with M_1 of the primary stalked, while others have this vein from the cell. Some species have M_1 and M_2 of the secondary stalked, while others have these veins well separated from the cell. In view of the evident close relationship of some of the species which differ from each other widely in these characters too much reliance cannot be placed upon them. The male genitalia of practically all of the species of *Colotis* which the author has examined show no tangible specific characters whatsoever. It has therefore seemed best to the author to recognize as subgenera such groups as have some reasonable excuse for existence, and to leave further splitting, if any may be required, to some future time.

In view of the great degree of homogeneity in the male genitalia of most of the species the difference of these structures in *subfasciatus* and *eris* assumes larger proportions. They may be regarded as somewhat more primitive in this respect than the other species. *Subfasciatus* even shows a trace of the vanishing clasper of the ancestral stock.

Lucasi Grandidier not only differs considerably from the *Colotis* species in size, general appearance and wing-shape but in the male genitalia, so that the author considers it worthy of being placed in a separate genus.

27. **GIDEONA** genus nov., type *Callidryas lucasi* Grandidier

Generic characters:

Size large, length of primary over 32 mm.; antenna long, with abrupt club; palpus reaching beyond front, with third joint very short, oval; male without sex-patches; apex of primary slightly falcate; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked, the free part of R_{4+5} about two-thirds as long as the distance from the end of cell to its base, M_1 from cell practically connate with R-stem, *mdc* more than half as long as *ldc;* secondary with humeral extending about halfway from $Sc+R_1$ to margin, curved distad from about one-third way out, *mdc* about four-fifths as long as *udc* and about half as long as *ldc;* penis very slender, bent near middle to nearly 90°, about one and three-quarters as long as tegumen + uncus, with small basal prong; saccus slender, about two-thirds as long as tegumen; tegumen long with large articulatory process; uncus short, less than half as long as tegumen, tapering, with free

part less than half of length of ventral margin; harpé much longer than high, with a long slender pointed distal process; juxta very large and heavily chitinized, deeply dished out.

Species examined:

* *lucasi* Grandidier.

In venation *lucasi* agrees well with various species of *Colotis*. The presence of a distal process on the harpé may be merely primitive. The very short third joint of the palpus shows relationship to *Colotis* or *Eronia*. The other genitalic characters and the large size and falcate apex of the primary may be regarded as individual developments. Its exact relationships are therefore uncertain. Madagascar has a well-deserved reputation for producing queer species, and *lucasi* is one of these.

28. IXIAS Huebner ('16) p. 95, *pyrene* L. des. Butler ('70)
Thestias Boisduval ('36) p. 590, *pyrene* L. type not previously designated.

Generic characters:

Antenna fairly long, with rather gradual club; palpus with third joint short and oval; male without sex-patches; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked with R_{4+5} more than two-thirds as long as distance from end of cell to its base, M_1 short-stalked on R_3+R_{4+5}, *mdc* not half as long as *ldc;* secondary with humeral fairly long, at about one-third bent sharply distad with a short spur projecting basad from the angle, *mdc* about equal in length to *udc* and about half as long as *ldc;* penis rather thick, about one-and-a-quarter times as long as tegumen + uncus, bent strongly from base, with a short thick basal prong; saccus slender, shorter than uncus; tegumen large with very small articulatory process; uncus shorter than tegumen, tapering, blunt, with free part about one-third of length of ventral margin; juxta small and lightly chitinized; harpé simple, rounded, with no spines or distal process;

Species examined:

* *flavipennis* Grose-Smith.
* *kuehni* Roeber.
* *pyrene* L. (various subspecies).
* *undatus* Butler.

Ixias is evidently very closely related to *Colotis,* and has probably been almost directly derived from that genus, being slightly higher in venation in having M_1 of the primary always definitely stalked. The similarity in pattern between *C. zoë* and *I. kuehni* is noteworthy.

29. EUCHEIRA Westwood ('34) p. 38–44, *socialis* Westwood, sole sp. in O. D. Not a homonym of *Eucheirus* Dejean 1833

Schatzia Kirby ('96) p. 162, new name for above (unjustified).

Generic characters:

Antenna fairly long, with abrupt club; palpus with third joint slender, nearly as long as second; both primary and secondary with discal cell long; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked nearly halfway to apex, M_1, M_2 and M_3 from cell separately, *udc* about half as long as *mdc,* which is slightly shorter than *ldc;* secondary with humeral long, turned slightly basad, *udc* longer than *mdc* and *ldc* which are nearly equal; penis fairly thick, little longer than tegumen + uncus, strongly curved from base, with a short basal prong; saccus very short and thick, about half as long as tegumen; tegumen very large and broad, with a lightly chitinized area in center, articulatory process very small; uncus very short, pointed, with free part about one-half of ventral length; juxta small; harpé simple, rounded, with no armature, dorsal margin swollen dorsad for distal half; larvae living gregariously in a thick silken web, pupating in the web.

Species examined:

* *socialis* Westwood.

With *Eucheira* begins a series of genera, *Neophasis, Catasticta* and *Archonias* being the others, which are characterized most strikingly by an extreme development in size of the tegumen, with a correlated decrease in size of the articulatory process and an extreme shortening of the uncus, as well as other characters. The author feels that these genera are all rather closely related to each other, not merely because of the genitalic similarities, but because of corresponding likeness in venation, pattern, and to a certain degree in habits. In venation *Eucheira* is the most primitive, having all the branches of Media arising from the cell. In *Catasticta* and *Neophasia* M_1 has become stalked, and in *Archonias* R_2 has also moved distad and become stalked. It is noteworthy that the larvae of *Neophasia* show an approach to the extreme gregarious habit of those of *Eucheira.* In all of these genera the humeral vein is fairly long and slightly turned basad, and the saccus is likewise very short and thick in all.

30. NEOPHASIA Behr ('69) p. 303, *menapia* Felder sole sp. in O. D.

Generic characters:

Antenna fairly long, with flattened, abrupt club, palpus

with third joint slender, more than half as long as second; both primary and secondary with discal cell long; primary with R_1 and R_2 from cell, R_3 and R_{4+5} stalked, the free part of R_{4+5} being less than half as long as distance from end of cell to its base, M_1 stalked on R_3+R_{4+5} from a third to nearly half of the distance from end of cell to fork of R_3 and R_{4+5}, M_2 from cell with *mdc* nearly as long as *ldc;* secondary with humeral long, slightly turned basad, R_s, M_1 and M_2 from cell separately; penis very short, slender, shorter than tegumen + uncus, with large basal prong, strongly curved from base; saccus very short and thick, shorter than uncus; tegumen large with very small articulatory process; uncus short, pointed, with free part less than a third of the ventral length; juxta small, lightly chitinized; harpé simple, rounded, with no armature, its dorsal margin not noticeably swollen.

Species examined:

* *menapia* Felder.
terlootii Behr.

31. CATASTICTA Butler ('70) p. 34, 43, *nimbice* Boisduval, des. in O. D.

Generic characters:

Antenna fairly long, with flattened, abrupt club; palpus with third joint slender, more than half as long as second; both primary and secondary with discal cell long; primary with R_1 and R_2 from cell, the latter from the end, R_3 and R_{4+5} long-stalked with free part of R_{4+5} less than half as long as distance from end of cell to its base, M_1 stalked about a quarter to a third way from end of cell to fork of R_3 and R_{4+5}, *mdc* and *ldc* about equal in length, long, straight; secondary with humeral long, slightly turned basad, often forked at tip; penis considerably longer than tegumen + uncus, fairly slender, with basal prong, strongly bent from base; saccus very short and thick; tegumen large and wide, with very small articulatory process; uncus short, pointed, free part about one-third of its ventral length; a slight chitinization beneath the anus (subscaphium); juxta small; harpé rounded, with no armature, its dorsal margin considerably swollen dorsad.

Species examined:

* *corcyra* Felder.
eurygania Hewitson.
flisa Herrich-Schaeffer.
pinava Doubleday.
* *pitana* Felder.
suasa Staudinger.
* *nimbice* Boisduval.
philoscia Felder.
* *pieris* Hopffer.
teutila Doubleday.
* *uricoecheae* Felder.

32. ARCHONIAS Huebner ('25) fig. 461–462, *tereas* Huebner sole sp.

Euterpe Swainson ('32) p. 24, *tereas* Huebner sole sp.

Priamides Huebner ('16) p. 87, (*P. iulus* Huebner in Zutr. Exot. Schmett. f. 383, 384, 1923, = *Archonias tereas* Huebner).

Subg. CHARONIAS Roeber ('10) p. 68, *eurytele* Hewitson, not previously designated as genotype.

Generic characters:

Antenna long, with flattened abrupt club; palpus with third joint slender, two-thirds as long as second; primary with R_1 from cell, R_2 stalked, R_3 and R_{4+5} long-stalked, M_1 stalked beyond base of R_2, *mdc* and *ldc* nearly equal, very straight; secondary with humeral fairly long, curved basad, R_s, M_1 and M_2 from cell; penis considerably longer than tegumen + uncus, slender, considerably swollen at base, strongly curved from base, with short basal prong; saccus very short and thick; tegumen very wide, with very small articulatory process; uncus very short, pointed, with short free part; juxta small; harpé considerably swollen dorsad.

Subgeneric characters, Archonias:

Pattern simple, mimicking the *Aristolochia* group of *Papilio;* wings shorter than in *Charonias;* middle and lower discocellulars of primary usually more or less equal in length; *mdc* of secondary usually considerably shorter than *udc;* no constant genitalic differences from *Charonias.*

Subgeneric characters, Charonias:

Pattern more complex, with (usually) a row of marginal or submarginal spots, and darker streaking along veins; wings longer and narrower than in *Archonias; mdc* of primary shorter than *ldc,* sometimes only half as long; *mdc* of secondary as long as or longer than *udc.*

Species examined:

A. (*Archonias*).

* *bellona* Cramer.

* *pharnakia* Fruehstorfer.

* *tereas* Huebner (various subspecies).

A. (*Charonias*).

* *eurytele* Hewitson (various subspecies).

* *theano* Boisduval.

The characters for *Charonias* are slight, and hardly sufficient to validate its subgeneric rank, much less a generic status. The *A.* (*Archonias*) species must be regarded as a group which has diverged along the lines of mimicry of the *Aristolochia* group of

Papilio, while the *A.* (*Charonias*) species have retained more of the ancestral pattern of the group. The venational characters cited by Röber were partially incorrect, the remainder being rather inconstant.

33. APORIA Huebner ('16) p. 90, *crataegi* L. sole sp. in O. D.
Leuconea Donzel ('37) p. 80, *crataegi* L. sole sp.
Futuronerva Bryk ('28) p. 50, *absurda* Bryk sole sp.
Subg. MESAPIA Gray ('56) p. 92, *peloria* Hewitson, sole sp.
Subg. METAPORIA Butler ('70) p. 38, 51, *agathon* Gray, des. in O. D.
Betaporia Matsumura ('19), *moltrechti* Oberthür, des. in O. D. (= *agathon moltrechti*).

Generic characters:

Antenna fairly long with rather abrupt club; palpus with third joint slender, nearly or as long as second; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked, M_1 stalked nearly or quite half as much, M_2 from cell with *mdc* varying from half as long as *ldc* to as long as *ldc;* secondary with humeral angle considerably expanded, humeral vein reaching from about halfway to margin to nearly reaching margin, straight, with tip usually either bent distad or forked; R_s, M_1 and M_2 from cell separately; penis fairly slender, bent strongly from base, as long as or longer than uncus + tegumen, with basal prong; saccus varying from very short and thick to slender and as long as uncus + tegumen; tegumen large, with small articulatory process; uncus short or long, considerably thickened dorsoventrally, sometimes bifurcate, with free part about half its ventral length; juxta small and lightly chitinized; harpé simple, rounded, sometimes with a rudimentary rounded distal process, with inner sac and central fovea.

Subgeneric characters, Aporia:

Size in general medium, length of primary seldom over 34 mm.; palpus hairier than in *Metaporia;* wings shorter and broader than in *Metaporia* and *Mesapia;* R_2 arising closer to end of cell than in *Metaporia mdc* and *ldc* or primary more nearly equal than in *Metaporia* and *Mesapia;* saccus very short and thick, little if any longer than uncus; uncus not greatly swollen distad of anus, never bifurcate; end of harpé more or less with a rounded point.

Subgeneric characters, Mesapia:

Small, length of primary not over 27 mm.; wings very thinly scaled; palpus very hairy; primary with R_2 arising very close to end of cell, *mdc* about half as long as *ldc;* secondary with *udc* about five times as long as *mdc* and twice as long as

ldc; genitalia not essentially differing from those of *Aporia* except that free part of uncus is considerably swollen as in *Metaporia.*

Subgeneric characters, Metaporia:

Large, length of primary usually considerably over 36 mm.; wings longer and thinner than in *Aporia;* palpus not so hairy as in *Aporia;* primary with R_2 arising further back on the cell and *mdc* considerably shorter than in *Aporia;* saccus much more slender than in *Aporia,* longer than uncus, somewhat swollen at tip; uncus considerably swollen distad of anus, then abruptly pointed, bifurcate; harpé in general with end more rounded than in *Aporia.*

Species examined:

A. (*Aporia*)
* *crataegi* L.
* *hippia* Bremer
* *leechii* Moore
* *leucodice* Eversmann

A. (*Mesapia*).
* *peloria* Hewitson.

A. (*Metaporia*).
* *acraea* Oberthür.
* *agathon* Gray.
* *delawayi* Oberthür.
* *largeteaui* Oberthür.

At it stands *Aporia* is a very homogeneous genus. The characters for the subgenera are relatively slight, although constant.

With *Aporia* begins a series of genera, the others being *Cepora, Delias, Pereute* and *Leodonta,* which show a marked relationship to each other. In most of these the uncus is thick and often bi- or trifurcate. In all of them the harpé is very thick and contains between the two normal layers a peculiar spinulated sac. In addition there is a sort of a fovea located in the center of the harpé, usually more or less covered on the inner face by a chitinized flap. Previous authors (Dixey '94, Talbot '29a, and others) have pointed out the evident relationship of *Aporia* and *Metaporia* with *Delias* and *Cepora,* and discussed the probability of the first named genera representing ancestral forms for the latter. Such a theory is strengthened by the structures of the genitalia.

In the New World, *Pereute* and *Leodonta* show the same type of structure as possessed by *Delias.* The venation is also of very much the same type, with the exception of the humeral vein. A striking character showing the relationship of *Pereute* to *Delias* is the form of the pupa, which is practically indistinguishable from that of *Delias* (Fig. 10). It is only reasonable to suppose that

Pereute and *Leodonta* represent New World offshoots from this same *Aporiine* stock, which have become isolated in the tropics.

34. CEPORA Dalman ('20) p. 76, *nerissa* Fabricius, des. Scudder ('75)

Huphina Moore ('81) p. 136, *coronis* Cramer des. in O. D.

Generic characters:

Antenna fairly long with fairly abrupt club; palpus with third joint slender, as long as second joint and sometimes third, with long bristly hair; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked, M_1 stalked on R-stem from less than a third to nearly halfway from end of cell to fork of R_3 and R_{4+5}, *mdc* from a third to over half as long as *ldc;* secondary with humeral vein fairly long, bent distad from near its base; penis as long as or longer than tegumen + uncus, bent to nearly 90° from about one-third, without basal prong; saccus shorter than tegumen, slender; tegumen long, not very wide, with small articulatory process; uncus long, slender, pointed, with a well-developed, bladelike dorsal keel, free part about one-half of ventral length; juxta medium-sized, somewhat hollowed-out ventrally; harpé with strong inner sac and central fovea, dorsal margin sometimes lightly notched, without distal process or lobes.

Species examined:

* *abnormis* Wallengren.
* *amalia* Vollenhoven.
* *aspasia* Stoll.
* *coronis* Cramer.
* *judith* Fabricius.
* *laeta* Hewitson.
* *nadina* Lucas.
* *nerissa* Fabricius.
* *perimale* Donovan.
* *phryne* Fabricius.
* *timnatha* Hewitson.

The supposed phylogenetic position of *Cepora* has already been discussed under *Aporia.* The coloring and pattern of many of the species is exceedingly similar to the types displayed by some species of *Delias,* and there seems no reason for not accepting a relationship between these genera.

Reasons for accepting Dalman's generic names and for not considering them uncharacterized have already been set forth under *Leptidia.* In the case of *Cepora vs. Huphina* it does not seem worth while to retain *Huphina.* The name has only been in use for a comparatively short time, and its loss will not cause as much confusion as would result from the loss of *Anthocharis* and *Gonepteryx.*

Aoa affinis Vollenhoven has usually been placed in *Cepora,* later authors being disinclined to accept Moore's genus for it. The

present author not only considers it a good genus but thinks that it is not at all closely related to *Cepora* for reasons which will be set forth under *Aoa*.

35. DELIAS Huebner ('16) p. 91, *egialea* Cramer, des. Butler ('70)
Symmachlos Huebner ('22) ii, *nigrina* Fabricius, sole sp.
Thyca Wallengren ('58) p. 76, *aganippe* Donovan, des. Scudder ('75)
Subg. CATHAEMIA Huebner ('16) p. 92, *caenaeus* L. des. Scudder ('75)
Piccarda Grote ('00) p. 32, *eucharis* Drury des. in O. D.

Generic characters:

Antenna long with somewhat abrupt club; palpus with third joint slender, as long as or longer than second joint; tarsus with both pulvillus and paronychia; primary with R_1 from cell, free at tip, R_2 missing, R_3 and R_{4+5} long-stalked, M_1 stalked on R_3+R_{4+5} for a quarter to a third the distance from cell to apex, *mdc* and *ldc* subequal; secondary with humeral long, bent distad from base, R_s, M_1 and M_2 from cell separately; penis never much longer than tegumen + uncus, curved from base, with short thick basal prong; saccus shorter than tegumen, often slender at base and enlarged distally; tegumen with large articulatory process; uncus long, free part swollen, often bi- or trifurcate; a slight chitinization in subscaphium; juxta small or medium-sized, hollowed-out; harpé large, thick, with large inner sac and prominent central fovea, dorsal margin often swollen dorsad, often with a distal process which may bear a patch of setae distally.

Species examined:

* *aglaia egialea* Cramer.
belisama Cramer.
* *belladonna* Fabricius.
descombesi Boisduval.
dorimene Cramer.
eucharis Drury.
* *harpalyce* Donovan.
* *hyparete* L.
* *inferna* Butler.
* *mysis* Fabricius.
* *nigrina* Fabricius.
* *pandemia* Wallengren.
* *thysbe* Cramer.

Because of lack of sufficient material for study the author feels that he is not qualified to make any further definite statements regarding *Delias*. There is no particular need of such, as the genus has been very completely monographed by Talbot ('28, '29a, '29b, '29c, '30). The classification above is that of Talbot, with minor exceptions.

(*Continued in March, 1932*)

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(*Continued from page 204.*)

36. PEREUTE Herrich-Schaeffer ('67b) p. 105, *callinice* Felder des. Butler ('70)

Generic characters:

Antenna long, with somewhat abrupt club; palpus with third joint slender, nearly as long as second; tarsus with both pulvillus and paronychia; primary with R_1 from cell, its tip running along coastal and apical margin to fuse with tip of R_3, R_2 missing, R_3 and R_{4+5} long-stalked, M_1 stalked on R-stem for about a third of distance from end of cell to fork of R_3 and R_{4+5}, *mdc* and *ldc* sometimes nearly equal, or *mdc* longer than *ldc* with latter angled; secondary with humeral long, bent slightly basad, R_s, M_1 and M_2 from cell separately; penis longer than tegumen + uncus, slender, strongly recurved, with basal prong; saccus thick, shorter than tegumen; articulatory process of tegumen medium-sized; uncus thick, swollen dorso-ventrally after anus, trifurcate; considerable chitinization in subscaphium; juxta small; harpé simple, rounded, its dorsal margin somewhat swollen dorsad, with large inner sac and central fovea; pupa with forked frontal prominence, slender and bent dorsad at middle.

Species examined:

* *antodyca* Boisduval.
* *callinice* Felder.
* *charops* Boisduval.
* *cheops* Staudinger.
* *telthusa* Hewitson.

37. LEODONTA Butler ('70) pp. 34, 55, *dysoni* Doubleday, des. in O. D.

Generic characters:

Antenna long with flattened abrupt club; palpus with third joint slender, nearly as long as second; tarsus with both pul-

villus and paronychia; primary with R_1 from cell, its tip free, R_2 missing, R_3 and R_{4+5} long-stalked, M_1 stalked about a third way from end of cell to fork of R_3 and R_{4+5}, *mdc* and *ldc* about equal; secondary with humeral vein extending about two-thirds way to margin, slightly curved basad, *udc* and *mdc* subequal, about half as long as *ldc* which is strongly recurved; penis very slender, longer than tegumen + uncus, strongly recurved, with basal prong; saccus thick, shorter than tegumen + uncus; articulatory process of tegumen small; uncus thick, free part swollen dorso-ventrally, faintly trifurcate; a chitinization in subscaphium; juxta very small; harpé simple, rounded, with large inner sac and central fovea.

Species examined:

* *dysoni* Doubleday (various subspecies).

38. BELENOIS Huebner ('16) p. 92, *calypso* Drury, sole sp. in O. D.

Subg. ANAPHAEIS Huebner ('16) p. 92, *creona* Cramer, des. Scudder ('75)

Generic characters:

Antenna long with abrupt club; palpus with third joint slender, usually slightly longer than second; tarsus with pulvillus and paronychia present; primary with R_1 and R_2 from well basad of end of cell, R_3 and R_{4+5} long-stalked, M_1 stalked a third or more of the distance from end of cell to fork of R_3 and R_{4+5}, *mdc* sometimes slightly longer than *ldc,* curved or straight; secondary with humeral fairly long, curved distad from base, R_s, M_1 and M_2 from cell separately; penis about as long as tegumen + uncus, slender, straight, with very small basal prong; saccus slender, shorter than tegumen, flattened, with longitudinal mid-lateral keels; tegumen long, not very wide, with very large articulatory process; uncus about half as long as tegumen, blunt, free part about one-half of the ventral length; juxta fairly large, sometimes deeply dished or curved; harpé long with a pointed distal process, with no inner sac but with a structure much resembling the central fovea.

Species examined:

* *antsianaka* Ward
* *calypso* Drury
* *creona* Cramer
* *gidica* Godart
* *helcida* Boisduval
* *johnstoni* Crowley
* *mesentina* Cramer
* *severina* Cramer
* *solilucis* Butler
* *theuzi* Dewitz
* *thysa* Hopffer
* *zochalia* Boisduval

There are no constant characters of even subgeneric worth for the retention of *Anaphaeis.* The fact that *calypso,* the type of

Belenois, happens to be very slightly different from the other species does not make the slight venational and pattern differences shown by some of the *Anaphaeis* species any more important than they really are; and these differences are slight and not at all clean-cut.

There are, however, in the male genitalia as well as in venation and pattern, excellent differential characters for *Belenois*, and so the genus seems well worth splitting off from *Pieris*, in which many authors have placed it.

39. DIXEIA Talbot ('32) 65: 1–2, *charina* Boisd., des. in O. D. *Pinacopteryx* auct.

Generic characters:

Size small, length of primary not over 30 mm.; antenna long, with abrupt club; palpus with third joint slender, as long as second; tarsus with both pulvillus and paronychia present; primary with R_1 and R_2 from cell, R_3 and R_{4+5} very long-stalked, *mdc* slightly shorter than *ldc;* secondary with humeral vein fairly long, curved distad from its base, *udc* and *mdc* usually about equal, shorter than *ldc;* penis shorter than tegumen + uncus, slender, bent to nearly 90° at middle, with very long, very narrow basal prong; saccus exceedingly short, thick, curved dorsad; tegumen long and narrow, with fair-sized articulatory process; uncus long, blunt; juxta large, shallowly dished or hollowed out; a slight chitinization in subcaphium; harpé long and narrow with a simple or bifurcate distal process.

Species examined:

* *doxo* Godart
* *pigea* Boisduval

Whereas the species of *Belenois* show a striking uniformity of structure in the genitalia, those of *Dixeia* appear to show more specific variation. The uniformity shown by the *Belenois* species also makes the generic differences shown by the *Dixeia* species more striking, and assures the validity of their generic rank.

40. PRIONERIS Wallace ('67) p. 383, *thestylis* Doubleday, des. Butler ('70)

Generic characters:

Size large; antenna long, with somewhat gradual club; palpus with third joint slender, nearly as long as second; costa of primary heavily spined; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked, M_1 stalked, in some cases about one-fifth, in others one-third of the distance from end of cell to fork of R_3 and R_{4+5}, *mdc* slightly to considerably longer than *ldc;* secondary with humeral vein long, curved distad, R_s, M_1 and M_2 from cell separately; penis about as long as tegumen +

uncus, straight, with very small basal prong, with two mid-lateral rows of spines on distal third; saccus fairly thick, about as long as tegumen; tegumen long, narrow, with very large articulatory process; uncus about a quarter to half as long as tegumen, slender, blunt; juxta small, hollowed, bent caudad at middle; harpé long, with a mid-dorsal spine and a blunt distal process, with no inner sac but with a central fovea.

Species examined:

* *autothysbe* Huebner
* *clemanthe* Doubleday
* *thestylis* Doubleday

In the genitalia *Prioneris* strongly resembles *Belenois,* and may very well be closely related to this group. The harpé has a well developed central fovea, but no trace of a spinulated inner sac that the author has been able to see.

41. APPIAS Huebner ('16) p. 91, *zelmira* Cramer, des. Butler ('70)
    Subg. CATOPHAGA Huebner ('16) p. 93, *melania* Fabricius, des. Scudder ('75) as *paulina* Cr.
    Hiposcritia Geyer ('32) p. 16, *pandione* Geyer sole sp. in O. D.
    Trigonia Geyer ('37) p. 21, *nero* Fabricius, des. Scudder ('75), nomen praeocc.
    Tachyris Wallace ('67) p. 361, *nero* Fabricius, des. Scudder ('75)
    Lade de Niceville ('98) p. 153, *lalassis* Grose-Smith, des. in O. D.
    Subg. GLUTOPHRISSA Butler ('87) p. 248, *ilaire* Godart, des. in O. D. (as *poeyi* Butler)
    Subg. PHRISSURA Butler ('70) p. 37, 49, *aegis* Felder, des. in O. D. as *cynis* Hewitson and corrected to *aegis* later (71b, p. 171)

Generic characters:

Antenna long with abrupt club; palpus with third joint very slender and pointed, as long as or longer than second; tarsus with both paronychia and pulvillus; male and sometimes female with a long hair-pencil arising from intersegmental membrane caudad of eighth abdominal segment; primary with R_1 and R_2 from well back from end of cell, R_3 and R_{4+5} long-stalked, M_1 stalked from one-quarter to one-third of the distance from end of cell to fork of R_3 and R_{4+5}, *mdc* usually about half as long as *ldc;* secondary with humeral vein long, curved distad from its base, R_s, M_1 and M_2 from cell separately, *ldc* longer than *udc* or *mdc;* penis slender, longer than tegumen +

uncus, often strongly curved at base, with basal prong; saccus short, swollen, attached to a long cephalad extension of vinculum; tegumen long, narrow, with good-sized articulatory process; uncus slender, free part one-half to one-third of its ventral length; juxta medium-sized, hollowed out; harpé with a distal process, an inner subdorsal lobe, or unarmed.

Subgeneric characters, Appias:

Apex of primary long, but not extremely long and pointed; *mdc* of primary little shorter than *ldc;* penis slender, not strongly recurved at base, with a small distal process; tip of saccus somewhat upturned; uncus short, about half as long as tegumen; articulatory process of tegumen very large; harpé long, with a long, curved, sharply pointed distal process.

Subgeneric characters, Catophaga:

Apex of primary variable, sometimes very long and pointed; *mdc* of primary considerably shorter than *ldc;* penis slender, strongly recurved at base, with a long distal process; uncus well over half as long as tegumen; articulatory process of tegumen smaller; harpé long, rounded, with a subdorsal, curved, blunt inner spine at about middle; no distal process.

Subgeneric characters, Glutophrissa:

Apex of primary never very long and pointed; *mdc* of primary much shorter than *ldc;* penis long, slender, strongly recurved at base, with long basal prong; uncus more than three quarters as long as tegumen; harpé simple, rounded, with no distal process or inner lobe.

Subgeneric characters, Phrissura:

Primary with apex not at all drawn out and pointed; R_2 of primary from end of cell; secondary with *mdc* about two-thirds as long as *udc* and half as long as *ldc;* penis much as in *A.* (*Appias*); uncus considerably thickened dorso-ventrally, narrowing to an abrupt point; harpé simple as in *A.* (*Glutophrissa*).

Species examined:

A. (*Appias*)

* *zelmira* Cramer

A. (*Catophaga*)

* *cardena* Hewitson
* *celestina* Boisduval
* *lalage* Doubleday
* *leptis* Felder
* *melania* Fabricius
* *nero* Fabricius
* *pandione* Huebner
* *placidia* Stoll
* *zarinda* Boisduval

A. (*Glutophrissa*)

* *agathasia* Fruehstorfer
* *epaphia* Cramer
* *ilaire* Godart
* *lyncida* Cramer

* *hombroni* Lucas
* *phaola* Doubleday
* *rhodope* Fabricius
* *nephele* Hewitson
* *sabina* Felder

A. (*Phrissura*)
* *aegis* Felder

Many authors have attempted to split *Appias* into a number of smaller genera. Such efforts have, however, been based on minor venational differences and differences of wing shape, relatively unimportant and variable characters. The genitalia give distinct groupings, which have been followed here. However it may be decided, if it ever is, how much importance to attach to such genitalic characters, it must at least be admitted that they are more tangible and less liable to intergradation than others. The grouping together of such seemingly unrelated species as *ilaire*, *hombroni* and *rhodope* may appear unnatural, but if it is borne in mind that the appearance of most or all of the African species may have been modified in mimicry of or with *Mylothris* such a grouping seems less farfetched. At any rate the author is firmly convinced that whatever else may be done the genus *Appias* as it stands here should not be further split into other genera.

The author has not been able to examine a specimen of *lalassis* Grose-Smith, and so his placing of *Lade* under *Catophaga* is merely speculative.

In the original description of *Phrissura*, Butler designated *cynis* Hewitson as the genotype. His identification of the specimen before him was, however, incorrect, and the description was actually based on *aegis* Felder. Butler discovered this in a short time and ('71b, p. 171) published a note to this effect, changing the name of the genotype of *Phrissura* to *aegis* Felder.

Whether this proceeding is valid under the Code is a matter for some doubt. In Opinion 65 of the Commission the difficulty of laying down a general rule to cover such cases is mentioned, and it is recommended that such cases be referred to the Commission for individual decision.

In the present case there is fortunately no doubt that Butler had before him a specimen of *aegis*. His description states "abdomen of type with a tuft of hair below anal valves," a character possessed by *aegis* and not by *cynis*. Since, therefore, there can be no ambiguity of this sort, the present author has followed Butler's emendation, using *aegis* as the type of *Phrissura*. Distant later proposed the genus *Udaiana* for *cynis;* this proposal, too, has been followed.

42. UDAIANA Distant ('85) pp. 286, 300, *cynis* Hewitson, des. in O. D.

Generic characters:

Length of primary not over 30 mm.; antenna long with gradual club; palpus with third joint slender, as long as second; male without abdominal hair-pencil; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked but shorter stalked than in *Appias,* M_1 stalked about one-third way from end of cell to fork of R_3 and R_{4+5}, *mdc* about half as long as *ldc, ldc* very lightly and evenly curved, never angled; secondary with humeral vein long, sharply bent distad from near its base, *mdc* slightly shorter than *udc* and about half as long as *ldc;* penis rather thick, not strongly recurved at base, with large basal prong; saccus slender; tegumen long and fairly broad; uncus long, slender, pointed, tapering; juxta large and hollowed out; harpé simple, rounded, very hairy, with no armature.

Species examined:

* *cynis* Hewitson (various subspecies)

Udaiana seems worth retention as a genus, although rather close to *Appias.* The lack of the abdominal hair-pencil is its most salient character, although the shorter stalking of R_3 and R_{4+5} and the shape of the discocellulars are important.

43. SALETARA Distant ('85) pp. 287, 316, *panda distanti* Butler

General characters:

Apex of primary very long and acuminate; male with a hair-pencil from 8th abdominal tergite and another from intersegmental membrane distad of 8th abdominal segment; antenna long with gradual club; palpus with third joint slender, pointed, longer than second; primary with R_1 and R_2 arising from cell, well basad of end, R_3 and R_{4+5} very long stalked, almost completely fused, M_1 stalked about one-sixth of distance from end of cell to apex, *mdc* about two-thirds as long as *ldc,* angled, with a short spur projecting into cell from angle, *ldc* straight; secondary with humeral vein fairly long, tapering, sharply curved distad from near base, discocellulars subequal, *mdc* very oblique; penis nearly twice as long as tegumen + uncus, slender, strongly curved from near base, with long basal prong; saccus slender, shorter than tegumen; tegumen fairly long with large articulatory process; uncus slender, strongly recurved dorsad and then caudad, with a pair of strong lateral barbs just before the tip; juxta rather small; harpé extremely long, with a slender, curved, sharp distal process.

Species examined:

* *liberia* Cramer

* *panda* Godart (various subspecies)

Saletara is an extremely distinct genus. Its affinities are evidently with *Appias* and there seems no reason for not believing that it may very well have been derived from that stock. The shape of the harpé and the distal process are similar to *A. zelmira,* which may represent more or less of an ancestral form.

44. PIERIS Schrank ('01) pp. 152, 164, *brassicae* L., des. Latreille ('10)

Ganoris Dalman ('16) pp. 61, 86, *brassicae* L., des in O. D. (*fide* Scudder ('75))

Subg. nov. **Glennia,** type *Pieris pylotis* Godart

Subg. SYNCHLOË Huebner ('18) I, p. 26, *callidice* Esper, des. Butler ('70)

Parapieris de Niceville ('97) p. 563, *callidice* Esper, des. in O. D. (as *chumbiensis* de Niceville)

Subg. PONTIA Fabricius ('07) p. 283, *daplidice* L., des. Curtis ('24) pl. 48 (*fide* Scudder ('75))

Leucochloë Roeber ('06) p. 49, *daplidice* L., type not previously designated

Pontieuchloia Verity ('29) p. 347, *chloridice* Huebner, sole sp. in O. D.

Generic characters:

Antenna long, with abrupt club; palpus with third joint slender, from nearly as long as to slightly longer than second; tarsus with both paronychia and pulvillus; R_1 and R_2 from cell, R_3 and R_{4+5} either very long-stalked with free parts of the veins nearly fused, or else completely fused, M_1 stalked on R-stem from less than a quarter to nearly a third of the distance from end of cell to apex, *mdc* oblique, from a third to more than half as long as *ldc;* secondary with humeral fairly long, its outer half or two-thirds curved strongly distad, R_s, M_1 and M_2 from cell separately, *mdc* shorter than *udc* and *ldc*, *ldc* more or less angled; penis stout, more or less curved, with basal prong; saccus thick, usually shorter than tegumen; tegumen large, with large articulatory process; uncus usually shorter than tegumen, usually considerably thickened dorso-ventrally; juxta large, its upper part nearly flat or slightly curved, its lower part deeply hollowed out caudad so as to form a conical structure, the closed apex of the cone caudad, the cone never more than twice as long as wide at its base; harpé simple, rounded, usually somewhat swollen dorsad, without armature (other than distal process of *P. brassicae*).

Subgeneric characters, Pieris:

Primary with R_3 and R_{4+5} long-stalked, not completely fused; wings longer with apex of primary more pointed than in *Glennia;* penis abruptly swollen before middle, then constricted, then slightly swollen again, tapering to a blunt point; saccus very short, not very thick; uncus rather slender, free part about one-third its ventral length; lower half of juxta forming cone; harpé with a pointed distal process.

Subgeneric characters, **Glennia,** subgenus nov.:

Wings shorter and broader than those of other members of genus; with apex of primary more rounded; R_3 and R_{4+5} long-stalked, not completely fused; penis slender, very straight; saccus slender, as long as tegumen; uncus very long, as long as tegumen, free part nearly half its ventral length; lower conical part of juxta not very deep, caudal tip of cone strongly rounded; harpé simple, dorsal margin little expanded dorsad.

Subgeneric characters, Synchloë:

Wings longer, with apex of primary more pointed than in *Glennia;* primary with R_3 and R_{4+5} long-stalked, not completely fused; penis somewhat curved, even in thickness, with large basal prong; saccus thick, shorter than tegumen; uncus with free part much less than one-third of ventral length; juxta with lower conical portion small, never very deep; harpé simple, rounded, somewhat swollen dorsad.

Subgeneric characters, Pontia:

Wings longer, with apex of primary more pointed than in *Glennia;* primary with R_3 and R_{4+5} completely fused; penis strongly curved from base, extreme basal portion strongly expanded laterally, basal prong small; saccus very short and thick; tegumen long with large articulatory process; uncus thick, free part about a third or less of ventral length; lower conical portion of juxta not very deep; harpé simple, rounded, somewhat swollen dorsad.

Species examined:

P. (*Pieris*)
- * *brassicae* L. (various subspecies)

P. (*Glennia*)
- * *pylotis* Godart

P. (*Synchloë*)
- * *beckeri* Edwards
- * *callidice* Esper (various subspecies)
- * *canidia* Sparrman
- * *manni* Mayer
- * *melete* Menetries
- * *napi* L. (various subspecies)

* *occidentalis* Reakirt
* *protodice* Boisduval
* *rapae* L. (various subspecies)
* *sisymbri* Boisduval
* *virginiensis* Edwards

P. (*Pontia*)
* *chloridice* Huebner
* *daplidice* L. (various subspecies)

Pieris is here limited to the rather closely related species listed above, instead of being used in the far more inclusive sense of many previous authors. As such it is a homogeneous group, not a conglomeration of loose ends. There seems no sense in placing *daplidice* in a separate genus because of the complete fusion of R_3 and R_{4+5}. These veins are so near to complete fusion in most of the other *pieris* species that the difference of *daplidice* is relatively slight.

Most of the species are so much alike in the male genitalia that contrasted with this mass of homogeneity the slight differences shown by *brassicae* and *pylotis* assume larger proportions than they would in a group where each species showed definite characters.

With the removal of many of the New World species to *Leptophobia, Tatochila, Itaballia, Ascia* and *Ganyra,* the range of *Pieris* is extended into South America only by *pylotis;* as might be expected in such a case *pylotis* shows somewhat aberrant characters.

Of the remaining genera many show close relationship to *Pieris,* both in venation and pattern and in the genitalia. The peculiar conical development of the lower part of the juxta is especially characteristic of *Pieris* and its related forms. This is shown very strongly by *Leptophobia, Itaballia* and *Perrhybris,* and less distinctly by *Tatochila, Phulia* and *Ascia.* It is also shown by *Nina,* but here the juxta has become very much reduced in size. The plain, rounded harpé of *Pieris* is also to a certain degree characteristic, but too much reliance must not be placed on this character. The trend of development in this group of the *Pieridae* is often toward a reduction of the primitive structures of the harpé, so that a simple harpé may have been developed independently many times.

45. LEPTOPHOBIA Butler ('70b) pp. 35, 45, *eleone* Hewitson, des. in O. D.

Generic characters:

Antenna very long, with somewhat gradual club; palpus with third joint slender, as long as or longer than second;

primary with R_1 and R_2 from cell, R_{4+5} long-stalked, M_1 stalked from about a quarter to nearly half of the distance from end of cell to apex, *mdc* usually much shorter than *ldc,* sometimes nearly as long; secondary with humeral slightly curved basad, usually with tip more or less forked, *udc* and *ldc* about equal, with *mdc* either very much shorter or about equal; penis short, bent strongly at extreme base, with long basal prong; saccus short and thick; tegumen with fairly large articulatory process; uncus long, considerably thickened dorso-ventrally, abruptly narrowing to a sharp point; juxta fair-sized, with lower part hollowed out to form a shallow cone; harpé simple, rounded, with no armature.

Species examined:

* *aripa* Boisduval
* *caesia* Lucas
* *cinerea* Hewitson
* *eleone* Hewitson
* *eleusis* Lucas
* *olympia* Felder
* *penthica* Kollar
* *philoma* Hewitson
* *pinara* Felder
* *stamnata* Lucas
* *tovaria* Felder

The species fall into two groups, those with lustrous underside of the secondary and with short *mdc* of both primary and secondary, and those with non-lustrous underside of the secondary and long *mdc.* Of the latter the author has examined only *caesia* (*tenuicornis*) and *cinerea. Olympia* appears to be somewhat transitional to these in the length of the discocellular. The author has been unable to distinguish any constant genitalic characters between these groups, and so does not consider them of subgeneric rank. *Caesia* and *cinerea* may in this way represent transitionals from the Pierine stock to the other species.

46. LEUCIACRIA Rothschild & Jordan ('05) p. 463, *acuta* Rothschild & Jordan, sole sp. in O. D.

Generic characters:

Small, length of primary not over 22 mm.; antenna long, with abrupt club; palpus with third joint very slender, about as long as second; secondary beneath with a pearly luster; primary with R_1 and R_2 from cell, R_3 and R_{4+5} very long-stalked, M_1 stalked about two-fifths of the distance from end of cell to apex, *mdc* about half as long as *ldc;* secondary with humeral angle strongly expanded, humeral vein straight, reaching about halfway to margin, slightly forked at tip, *mdc* about half as long as *udc,* which is slightly shorter than *ldc;* penis shorter than tegumen + uncus, its basal portion very strongly curved, with long basal prong; saccus very small, about one-half

as long as uncus; tegumen long, narrow, with large articulatory process; uncus long and slender, free part about half its ventral length; juxta very small; harpé very large, dorsal margin expanded from near base, with a short sharp distal process.

Species examined:

* *acuta* Rothschild & Jordan

Various authors have pointed out resemblances of *Leuciacria* to both *Leptophobia* and *Elodina*. It is possible that there is such a relationship, but this possibility is not borne out by any characters other than superficial ones. Neither the venation nor the genitalia of *Leuciacria* point out definite relationships of any sort, and it must for the present at least be regarded as a somewhat isolated genus.

47. ELODINA Felder ('65) p. 215, *egnatia* Godart, des. Butler ('70)

Parelodina Fruehstorfer ('10) p. 123, *anticyra* Fruehstorfer, type not previously designated. Nomen praeocc.

Elodinesthes Fruehstorfer ('14) p. 33, *anticyra* Fruehstorfer, type not previously designated; new name for *Parelodina*.

Metelodina Seitz ('27) p. 1108, *anticyra* Fruehstorfer, type not previously designated; new name for *Parelodina*.

Generic characters:

Size small, length of primary not over 24 mm.; antenna long with fairly abrupt club; palpus with third joint slender, little over half as long as second; secondary beneath with a pearly luster; primary with R_1 from cell, R_2 stalked on $R_{3+4+5} + M_1$ or from upper angle of cell, M_1 stalked on R_{3+4+5} about one-third of the distance from end of cell to apex, M_2 from cell connate with R-stem + M_1 or with very short *mdc*, *ldc* very long and recurved; secondary with humeral vein long, nearly reaching margin, straight, sometimes slightly forked at tip, *udc* very short, *mdc* short, about one-third the length of *ldc* which is strongly curved; penis slender, swollen basally, nearly twice as long as tegumen + uncus, without basal prong; saccus slender, longer than tegumen; tegumen with fair-sized articulatory process; uncus short, thick, with a pair of dorsad-extending processes at base; juxta very small; harpé simple, rounded, with no armature.

Species examined:

* *angulipennis* Lucas
* *egnatia* Godart
* *hypatia* Felder
* *walkeri* Butler

Like *Leuciacria, Elodina* has been thought to be related to *Leptophobia,* and a very close relationship to *Leuciacria* has been postulated, largely because of the pearly luster of the secondaries beneath. In every way *Elodina* is a distinct genus with no near relatives. Its relationships are very doubtful because of the great amount of development that has taken place. In venation it is very highly developed, with R_2 and M_1 both stalked, R_3 and R_{4+5} completely fused, and M_2 from the upper angle of the cell. Genitalically considerable reduction has taken place. The author prefers not to even guess at *Elodina's* ancestry and immediate relationships.

Elodinesthes Fruehstorfer is based on a very minor venational character, the fact that in some of the species R_2 arises from the upper angle of the cell instead of being stalked. The author has not been able to examine any of the species that show this character, and so his placing of *Elodinesthes* as a synonym is merely tentative.

48. TATOCHILA Butler ('70) pp. 38, 51, *autodice* Huebner, des. in O. D.
Tatocheila Scudder ('75) p. 276, *autodice* Huebner, des. in O. D.

Generic characters:

Body very hairy; primary with rather acuminate apex; antenna long, with flattened abrupt club; palpus with slender pointed third joint, about as long as second; primary with R_1 and R_2 from cell, R_3 and R_{4+5} long-stalked, the free part of R_{4+5} about one-quarter of the distance from end of cell to apex, sometimes nearly a third, M_1 short-stalked, *mdc* from one-half to one-third as long as *ldc,* secondary with humeral vein reaching about halfway to margin, straight, tapering, *mdc* about half as long as *udc* and a quarter as long as *ldc;* penis short, thick, bent basally, with basal prong, its distal portion flattened and expanded dorso-ventrally; saccus short and stout, shorter than tegumen; tegumen long and narrow, with large articulatory process; uncus fairly long and thick, free part about one-third of its ventral length; juxta very large and heavily chitinized, its upper two-thirds deeply hollowed out, its lower third smaller and more or less conical as in *Pieris;* harpé with a rounded or pointed distal process, otherwise unarmed.

Species examined:

* *autodice* Huebner
* *menacte* Boisduval
* *theodice* Boisduval
volxemi Capronnier
* *xanthodice* Lucas

Tatochila is most probably derived from *Pieris* or from stock closely related to *Pieris,* and may be regarded as the South American representative of the *Synchloë* (*callidice*) group of species. *Menacte* has heretofore been placed in *Pieris.* In every way, however, it belongs to *Tatochila.*

49. BALTIA Moore ('78) p. 288, *shawii* Bates, des. in O. D.

Generic characters:

Small, length of primary not over 22 mm.; antenna fairly long with abrupt club; palpus with third joint slender, shorter than second; palpus, body and wings very hairy; tarsus without pulvillus and paronychia; primary with R_1 and R_2 from cell, R_3 and R_{4+5} very long-stalked, M_1 stalked nearly halfway to apex, M_2 short-stalkd, *ldc* evenly curved; secondary with humeral angle considerably expanded, humeral vein long, bent distad near tip, *mdc* about one-third the length of *udc, ldc* slightly shorter than *udc;* penis short, rather straight, with small basal prong; saccus short, fairly thick, about two-thirds the length of tegumen; tegumen large with large articulatory process; uncus short, thick, free part about two-fifths of its ventral length; juxta very small; harpé simple, unarmed, broadly rounded, higher than long.

Species examined:

* *butleri* Moore
* *shawii* Bates

Baltia probably represents a group, originally derived from *Synchloë* or some closely related stock, that has become considerably modified, both in venation and genitalia. Many of its modifications can be traced to the effect of living at high altitudes. Similar developments are found in *Phulia, Piercolias, Teriocolias,* etc.

50. PIERCOLIAS Grote ('03) p. 139, *huanaco* Staudinger, des. in O. D. and sole sp.
Trifurcula Staudinger ('94) p. 56, taf. 1, figs. 7, 16, 18, *huanaco* Staudinger, sole sp. in O. D. *nomen praeocc.* (nec *Trifurcula* Zeller 1848)
Andina Roeber ('10) p. 97, *huanaco* Staudinger sole sp. in O. D.

Generic characters:

Very hairy; antenna long, with abrupt club; apex of primary sharp, outer margin convex; primary with R_1 from well basad on cell, R_2 from upper angle of cell, R_3 and R_{4+5} very long-stalked, M_1 stalked about halfway to apex, M_2 from upper angle of cell, *ldc* long, evenly curved; secondary with humeral angle very strongly produced, humeral vein long, bent basad, *mdc* shorter than *udc* or *ldc*.

The author has not had the opportunity of examining the genitalia of *P. huanaco*. It is evidently closely related to *Phulia*, but in venation somewhat more primitive. If it be postulated that *Piercolias* and *Phulia* represent a group of species descended from the *Synchloë callidice* stock of *Pieris* then *Phulia* with its greatly reduced venation must be at the top of this line of development, with *Piercolias* representing an intermediate stage.

The author has not had the opportunity of determining whether *Piercolias* lacks both pulvillus and paronychia on the tarsus as does *Phulia*. In this respect it is worth noticing that *Baltia*, the Old World Alpine derivative from the *Synchloë* stock, also lacks these structures. Whether there is a real relationship between *Baltia* and *Phulia* or whether the resemblances are merely to be regarded as similar developments, in the same type of environment is a matter of doubt. It is noteworthy in this connection that *Colias*, an Arctic-Alpine genus of the Rhodocerini, also lacks pulvillus and paronychia. The other Rhodocerine genus that lacks these is, however, *Nathalis*, which is not Alpine by any means.

Tatochila, which must be regarded as a still more primitive South American derivative from the *Synchloë* stock, and which may be on the direct ancestral line of *Piercolias* and *Phulia*, possesses both the pulvillus and the paronychia, although somewhat reduced in size. *Tatochila* is by no means, however, an Alpine genus.

51. PHULIA Herrich-Schaeffer ('67) p. 17, *nymphula* Blanchard, sole sp. in O. D.

Generic characters:

Small, length of primary not over 21 mm.; antenna long with very abrupt club; palpus with slender short third joint; body, wings and palpi very hairy; tarsus without pulvillus and paronychia; primary with R_1 and R_2 from well basad of end of cell, R_3 and R_{4+5} completely fused, M_1 stalked nearly or quite two-thirds way to apex, M_2 short stalked, *ldc* long, angled at middle; secondary with humeral angle strongly expanded, humeral vein long, curved slightly basad, *mdc* about two-fifths

as long as *udc* and *ldc* which are subequal; penis shorter than tegumen + uncus, curved basally, with long basal prong; saccus very thick, shorter than tegumen; tegumen long, with large articulatory process; uncus long, thick, free part less than half its ventral length; juxta large, hollowed out; harpé with a short, pointed distal process, otherwise unarmed.

Species examined:

* *nymphula* Blanchard

52. LEPTOSIA Huebner ('18) I, p. 13, type *xiphia* Fabr., des. Scudder ('75) (as *chlorographa* Huebner)

Nina Horsfield ('29) p. 140, *xiphia* Fabricius, sole sp. in O. D.

Nychitona Butler ('70) pp. 34, 41, *alcesta* Cramer des. in O. D.

Generic characters:

Primary with apex and outer margin very strongly rounded; antenna fairly long, with long, gradual club; palpus short, with second and third joints short, the third considerably shorter than the second; primary with R_1 and R_2 from cell, R_3 and R_{4+5} completely fused, M_1 stalked from a third to about two-fifths way to apex, M_2 from cell with very short *mdc,* or connate with R-stem + M_1, or very shortly stalked, *ldc* long, curved; secondary with humeral vein short, strongly curved distad, M_1 and M_2 connate from cell, or *mdc* very short; penis long, slender, nearly straight, with short basal prong located well distad from base; saccus shorter than tegumen, thin proximally, swollen distally; tegumen long, with very large articulatory process; uncus short, thick, free part about half its ventral length; a slight chitinization in subscaphium; juxta very small; harpé long, rounded, with no armature, a very heavy chitinization in membrane proximad and ventrad of its dorso-basal angle.

Species examined:

* *alcesta* Cramer (various subspecies)
* *immaculata* Aurivillius
* *medusa* Cramer
* *nupta* Butler
* *xiphia* Fabricius (various subspecies)

Leptosia has probably been derived from some far-back *Pierine* stock. In none of its characters does it show any close relationship to any other modern *Pieridae,* but stands alone. Genitalically it has reached a high point of reduction. In venation, likewise, it shows a high degree of specialization, only three branches of Radius

being present, and M_1 and M_2 having moved far costad and distad of their primitive positions.

53. ITABALLIA Kaye ('04) p. 204, *pandosia* Hewitson, des. in O. D.

Subgenus nov. **Pieriballia,** type *Pieris mandela* Felder

Generic characters:

Apex of primary rounded; antenna very long, with very slightly thickened, gradual club; palpus with third joint slender and pointed, much longer than second; fore metatarsus longer than fore tibia; tarsus with both pulvillus and paronychia; primary with R_1 and R_2 from cell, R_1 running very close to Sc, R_3 and R_{4+5} very long-stalked, M_1 stalked from a quarter to nearly a third of the distance from end of cell to apex, *mdc* half or more than half as long as *ldc;* secondary with humeral vein long, bent sharply distad from its base, *mdc* shorter than either *udc* or *ldc, udc* shorter than *ldc;* penis shorter than tegumen + uncus, quite straight, somewhat enlarged at base; saccus never much longer than tegumen; tegumen with good-sized articulatory process; uncus very long and very slender, pointed, free part at least three-quarters of its length; juxta with upper part little hollowed out, lower part forming a deep, narrow cone; harpé simple, rounded, with no distal process or lobes.

Subgeneric characters, Itaballia:

Outer margin of primary more convex than in *Pieriballia;* third joint of palpus more slender than in *Pieriballia;* dark marginal border of primary of male sending a spur into disc of wing below tip of M_3, which may meet with dark markings along costa to form a band across wing; penis with rudimentary basal prong, if any; saccus slender, as long as tegumen; lower, conical or tubular part of juxta twice as long as wide; inner face of ventral portion of harpé without chitinized corrugations.

Subgeneric characters, **Pieriballia:**

Outer margin of primary straighter than in *Itaballia;* third joint of palpus thicker than in *Itaballia;* dark marginal border of primary of male not sending a deep spur into disc of wing; penis with large basal prong; saccus shorter than tegumen, thick; lower, conical or tubular part of juxta shallow, little if any longer than wide; inner face of ventral portion of harpé with many chitinized corrugations.

Species examined:

I. (*Itaballia*)

* *demophile* L. (various subspecies)

* *pandosia* Hewitson

* *pisonis* Hewitson

I. (*Pieriballia*)

* *mandela* Felder (various subspecies)

* *viardi* Boisduval

In every way, pattern of both males and females, wing shape, venation, palpus, antenna, front leg and male genitalia, the species here placed in *Pieriballia* show a much closer relationship to *Itaballia* than to *Pieris*. They differ from *Itaballia,* however, in many important details, so that the author has considered it best to erect a new subgenus for them.

The genus *Itaballia* is evidently a Neotropical derivative of the *Pieris* stock. The exceedingly long, thin uncus is its most characteristic feature. This form of uncus is not possessed by *Perrhybris,* which is evidently closely related to *Itaballia,* although having a more highly specialized venation. *Itaballia* cannot therefore be placed as directly ancestral to *Perrhybris,* but must be considered as an offshoot from the line leading to the latter genus.

54. PERRHYBRIS Huebner ('16) p. 91, *pyrrha* Fabricius, des. Scudder ('75)

Generic characters:

Apex of primary rounded; antenna very long, with very slightly thickened, gradual club; palpus with third joint slender, much longer than second; foreleg with metatarsus shorter than tibia; primary with R_1 and R_2 from cell, R_3 and R_{4+5} completely fused, M_1 stalked from a quarter to a third of the distance from end of cell to apex, *mdc* about half as long as *ldc;* secondary with humeral vein long, tapering, bent sharply distad from its base, *udc* and *mdc* usually about equal, half or slightly more as long as *ldc;* penis short, stout, straight with large basal prong; saccus never longer than tegumen, thick; tegumen with fair-sized articulatory process; uncus thick at base, tapering, free part about one-half its ventral length; juxta good-sized, upper part flattened, conical lower part large, not deep; harpé ending in a rounded point, with a small setiferous pad in region of sacculus.

Species examined:

* *lorena* Hewitson

* *lypera* Kollar

* *pyrrha* Fabricius (various subspecies)

As stated under *Itaballia, Perrhybris* represents a relatively high development from an original *Pieris* stock. The females show the same highly-colored and heavy pattern as those of *Itaballia.* Possibly this is mimetic.

55. AOA de Niceville ('98) p. 153, *affinis* Vollenhoven, des. in O. D.

Generic characters:

Antenna long, with slightly thickened, gradual club; palpus with third joint slender, as long as second, bearing no long hairs; primary with R_1 and R_2 from well basad of end of cell, R_3 and R_{4+5} stalked about two-thirds of the distance from end of cell to apex, M_1 stalked about one-third of the distance from end of cell to fork of R_3 and R_{4+5}, *mdc* curved, about half as long as *ldc* which is slightly angled; secondary with humeral vein long, curved distad from about one-third its length, *udc* and *ldc* about equal and longer than *mdc;* penis considerably longer than tegumen + uncus, very thin, with long basal prong; saccus shorter than tegumen, thin proximad, swollen distad; tegumen large and broad, with large articulatory process; uncus thick at base, tapering regularly to a sharp point, with no dorsal keel, its free part about one-third its ventral length; juxta very small; harpé simple, rounded, with no armature, inner sac or central fovea.

Species examined:

* *affinis* Vollenhoven

As stated under *Cepora, Aoa* appears to the writer to have little or no connection with that genus, in which it has previously been classified. Its exact relationships are, however, very obscure. Perhaps a thorough knowledge of the life-history will help.

56. ASCIA Scopoli ('77) p. 434, *monuste* L., des. Scudder ('72)
Mancipium Huebner ('18) L., pl. [135–147], *monuste* L., des. Hemming, Entomologist, 64: 272, 1931
Subg. GANYRA Dalman ('20) p. 76, *amaryllis* Fabricius, des. Scudder ('75)

Generic characters:

Size medium to large, length of primary normally over 26 mm.; wings with or without sex-scaling; antenna long, with usually somewhat abrupt club; palpus with third joint slender and pointed, longer than second; primary with R_1 and R_2 from cell, well basad of end, R_3 and R_{4+5} very long-stalked, the free parts of these veins very short, M_1 stalked about a quarter of the distance from end of cell to apex, *mdc* straight, half or less as long as *ldc;* secondary with humeral fairly long, bent sharply

distad from its base, *udc* and *mdc* shorter than *ldc;* penis about as long as or slightly longer than tegumen + uncus, slender, somewhat swollen at base, with long slender basal prong; saccus shorter than uncus; tegumen long and quite narrow, with large articulatory process; uncus stout, its free part about one-half its ventral length; juxta large, hollowed out, its lower part not forming a conspicuous cone; harpé long, with a distal process.

Subgeneric characters, Ascia:

Club of antenna quite abrupt; wings of male without sex-scaling; *mdc* of secondary not much shorter than *udc;* juxta larger, more deeply hollowed out than in *Ganyra;* harpé with a short dorsal tooth near tip, and a distal process composed of a group of strong setae.

Subgeneric characters, Ganyra:

Club of antenna more gradual than in *A.* (*Ascia*); male with sex-scaling on wings above along veins; *mdc* of secondary much shorter than *udc;* harpé with no dorsal tooth; distal process simple, short, pointed.

Species examined:

A. (*Ascia*)

* *monuste* L. (various subspecies)

A. (*Ganyra*)

* *amaryllis* Fabricius

* *buniae* Huebner (various subspecies)

* *sevata* Felder

As pointed out by various authors *Ascia* is well worth generic differentiation from *Pieris.* This is, however, no reason for using the term "*Asciidae*" instead of "*Pieridae.*" There is no strict rule of priority in family names, and such a proceeding would only cause great confusion without serving any worth-while end.

The species here included in *Ganyra* are evidently more closely related to *Ascia* than to anything else. They also show many points of similarity to the African *Belenois.* The author's reasons for accepting Dalman's names have already been set forth under *Leptidia.*

57. MELETE Swainson ('32) p. 79, *lycimnia* Cramer, sole sp. in O. D.

Daptonoura Butler ('70) pp. 37, 50, *lycimnia* Cramer, des. in O. D. (as *flippantha* Fabricius)

Generic characters:

Outer margin of primary slightly concave; antenna long, with gradual club; palpus with third joint slender, much

longer than second; primary with R_1 and R_2 from cell, the latter well basad of end, R_3 and R_{4+5} stalked, the free part of R_{4+5} being about one-third as long as distance from end of cell to its base, M_1 stalked for a distance from cell about equal to length of R_{4+5}, *mdc* about equal to or longer than *ldc;* secondary with humeral vein reaching about halfway to margin, straight, discocellulars subequal; penis longer than uncus + tegumen, rather straight, thin, somewhat swollen at base, with short basal prong; saccus thin and very short, shorter than uncus; tegumen with fair-sized articulatory process; uncus about half as long as tegumen, with a pair of basal, dorsad-projecting, spiny processes, its free part about one-half its ventral length; juxta very small and lightly chitinized; harpé with a large toothed process on dorsum and a long curved distal process.

Species examined:

* *isandra* Boisduval
* *leucanthe* Felder
* *lycimnia* Felder (various subspecies)
* *peruviana* Lucas

Melete is a very distinct genus. The peculiar form of the harpé is characteristic of all the species which the author has examined, and cannot be confused with any similar structure in other groups. The genitalia appear to show specific differences.

Idiotica Butler, for which Butler erected the genus *Heliochroma*, has been placed in *Melete* by some authors, mainly on account of a superficial resemblance. It does not belong in *Melete* or anywhere near it, but is a *Hesperocharis,* without a doubt.

The exact relationships of *Melete* are vague. Because of the form of the male genitalia the author considers it to be descended from some stock related to *Ascia,* but the matter is open to question.

58. MYLOTHRIS Huebner ('16) p. 90, *poppea* Cramer, des. Butler ('70) p. 42
? Subg. PSEUDOMYLOTHRIS Neustetter ('29) p. 191, *leonora* Kruger, sole sp. in O. D.

Generic characters:

Apex of primary sometimes rather rounded; antenna fairly long, with abrupt club; palpus with third joint very slender, longer than second; primary with R_1 and R_2 from cell, R_3 and R_{4+5} entirely fused, M_1 stalked about one-third or more of the distance from end of cell to apex, *mdc* half to two-thirds as long

as *ldc;* secondary with humeral vein fairly long, curved distad from its base, *udc* and *mdc* subequal, shorter than *ldc;* penis longer than tegumen + uncus, stout, sharply bent at about its middle, with a very small basal prong; saccus thick, shorter than tegumen; tegumen very long and very narrow, with a very large articulatory process; uncus very short, pointed, its free part about two-thirds of its ventral length; juxta fairly large, well chitinized, rather flat; harpé rounded, somewhat expanded dorsally, with a short distal process, inner face with a rounded, lobed structure which seems to originate dorsally and is attached for most of its distal edge to inner face of harpé.

Species examined:

* *agathina* Cramer
* *chloris* Fabricius
* *dimidiata* Aurivillius
* *phileris* Boisduval
* *rubricosta* Mabille
* *smithi* Mabille

Mylothris is placed here at the end of the *Pieridae* largely because of the high degree of development shown in the venation, and because of the similarly high developments of the genitalia. These are not as great as in some of the *Rhodocerini,* but taken all in all are probably greater than in any other *Pierini.* The author is not inclined to consider the inner structure on the harpé as homologous to the clasper. If such were the case *Mylothris* would be very primitive in the retention of this structure.

The author has not had the opportunity of examining a specimen of *leonora* Kruger, the type of Neustetter's genus *Pseudomylothris.* The characters cited by Neustetter do not seem great enough to place this as a full genus, and so it has been placed tentatively as a queried subgenus.

SUMMARY AND ACKNOWLEDGMENTS

The present paper can be by no means regarded as a finished product. There is still a very great deal to be discovered about the Pieridae before our knowledge of the family can be considered as in any way complete. For this reason the writer has not stressed speculations about the phylogeny of the genera, preferring to leave such to a time when more is known about the early stages and such structures of probable taxonomic value as the scent-scales and body sclerites.

From the data on hand certain relationships may, however, be postulated. These have been shown in two "family trees," (Figs. 99 and 100), in which are the conclusions reached by the author regarding the probable relationships of many of the genera.

The relationships of the three subfamilies are somewhat in doubt. In the structure of the genitalia, as already stated under *Pseudopontia,* the Dismorphiinae are very similar to *Pseudopontia,* as regards the fusion of the harpés and the reduction and bifurcation of the tegumen and uncus. *Pseudopontia* has a unique type of venation, but one which does not show any Dismorphiine characteristics. Therefore it has seemed best to place the probable point of origin of *Pseudopontia* very low on the Dismorphiine stem. If it should be considered, however, that the resemblance in the genitalia of *Pseudopontia* and the Dismorphiinae is accidental, this point of origin would have to be from the lower part of the Pierine stem, remote from that of the Dismorphiinae.

The Dismorphiinae form a compact group, with all the genera closely related to one another. There can be no doubt that *Leptidia* belongs here, as the sole Old World representative of the subfamily. In the New World too little is known about the forms to allow of speculation about the phylogeny. Most of the species of *Dismorphia* are probably mimetic, so that it might be considered that the non-mimetic species are therefore closer to the ancestral type. Nothing is known about the life-histories of the New World species.

In the Pierinae the divisions into tribes are obvious. The Euchloini have here been separated because of the possession of a clasper, a structure which may safely be regarded as primitive. This has been lost in the other genera. The Rhodocerini are characterized by a considerable number of rather intangible characters, such as those cited in the key to tribes of the Pierinae. The change of food-plant of the Rhodocerinae genera to Leguminosae is also noteworthy.

Whether the author's limitation of the Euchloini is justified is largely a matter of opinion. Both *Hebomoia* and *Pinacopteryx* have little in common with the other genera other than the possession of a clasper. *Eroessa* is evidently closely related to the true "orange tips," and probably represents an ancestral form. In venation it is exceedingly primitive. *Hesperocharis* is also rather evidently related to the "orange tips," having a more specialized venation. *Colotis* and *Ixias* have been placed as direct derivatives of the Euchloini. Some of the more primitive species of *Colotis*

still possess a rudiment of the clasper. The relationship between *Colotis* and *Ixias* is evident. The only real difference between the two genera is the relatively slightly more specialized venation of *Ixias*. The extraordinary similarity of *Colotis zoë* and *Ixias kuehni* is noteworthy.

Gideona is probably to be regarded as an offshoot from *Colotis*. It is possible, however, that it may belong with the Eroniine genera. The structure of the pupa would be of great help in determining its relationship.

The three Eroniine genera must be placed in the Pierini, where they occupy a very primitive position. They probably represent something like ancestral forms of the Rhodocerini, as stated in the text, because of the very short third joint of the palpus, the swollen wing-cases of the pupa, and other characters.

The phylogeny of the Rhodocerini is extremely involved by the great amount of specialization that has taken place in some of the genera. As stated under *Colias* (*q.v.*) this genus, *Anteos* and *Catopsilia* appear to represent one line of development in the genitalia, while the other genera are on another line. It is possible that this is not a natural grouping. The relationships of the other genera are very obscure. *Kricogonia* is possibly related to *Phoebis*. *Gonepteryx* and *Dercas* show considerable similarity, and it is probable that the latter is a tropical derivative of the former, which is practically limited to the Palearctic region. *Nathalis* is very peculiar, and almost certainly represents an independent line of variation, as *Leucidia* possibly does also. Within *Eurema* a great deal of specialization has taken place. As previously stated under that genus the author does not, however, consider any of the subgenera included in *Eurema* as worthy of generic rank.

As already stated the Eroniae must be regarded as primitive Pierini. *Colotis* and *Ixias* are also included in this tribe, in spite of their evident Euchloine derivation.

Eucheira, Neophasia, Catasticta and *Archonias* all show great similarity of structure in the genitalia, and probably represent a distinct line of development. *Eucheira* is the most primitive member of the group, and may represent more or less of an ancestral form to the others. The social habit of the *Eucheira* larvae is also possessed, though to a lesser degree, by *Neophasia*. *Archonias* has probably developed along the line of mimicry of the *Aristolochia* Papilios, while *Charonias* has retained the ancestral streaked pattern or mimics *Ithomiidae*.

Aporia, Cepora, Delias, Pereute and *Leodonta* probably represent another distinct line of development. The three latter genera are highly specialized in venation, possessing only three radials. It is possible that the resemblance of *Pereute* and *Leodonta* to *Delias* is merely accidental. The fact of their isolation in the New World tropics, with no geographical connecting links to *Delias* or *Aporia* is an argument in favor of a theory of their independent origin. The author considers, however, that their similarity to *Delias* is too great, and in too many structures, to be purely fortuitous.

Belenois and *Prioneris* are evidently related to each other, and are very possibly related to the *Aporia-Delias* line, as evidenced by their possession of a fovea in the harpé. In pattern, however, there is considerable evidence that *Belenois* is closely related to the *Synchloë* group of *Pieris,* and such may be the case. The *Belenois* pupa is more like that of *Pieris* than that of *Delias.*

The species of *Dixeia* show evidences of having been derived from either *Belenois* or *Pieris,* more probably the former. The structures of the genitalia are of a type that can easily have been formed from those of *Belenois.*

There is no valid reason for splitting the species here included in *Appias* into a greater number of genera as has been done in the past. *Saletara* is very distinct and well worthy of generic rank, having been evidently derived from *Appias.* The exact origin of *Appias* is uncertain. At present all that can safely be said is that it has probably been derived from the generalized Pierine stock fairly well back, as shown in Fig. 100.

Pieris is here limited to a definitely related group of subgenera instead of being used, as has been done in the past, as a term for any Pierid with 4 radials that did not evidently belong in one of a short list of other, early-recognized genera. The genitalia are very simple, a condition evidently arrived at by reduction. No highly specialized and striking structures are present. The venation is in general at the point where R_4 and R_5 are about to fuse completely, and this has happened in *P.* (*Pontia*), producing a three-radialed condition. *Pieris* may therefore be said to be on the direct line of simplification from the ancestral form of the family, showing no distinct sidewise specializations with the possible exception of the form of the juxta.

Leptophobia is evidently closely related to *Pieris,* and probably represents a derivative of some form of that genus in the Neo-

tropical region. Whether there is any real relationship between *Leptophobia, Leuciacria* and *Elodina* is a matter for much doubt. It is probable that the resemblances between these genera are merely fortuitous, and that the two latter represent independent lines of development.

Baltia in the Old World and *Tatochila, Phulia* and *Piercolias* in the New World probably are derivatives from *P.* (*Synchloë*) or some closely related ancestral stock of that group, more or less specialized for an Alpine existence. The close similarity of *Baltia* to the other three genera cited may indicate a real relationship, or may result merely from more or less parallel development from a common ancestor. The latter case is the more likely.

Leptosia appears to have no close relatives. It probably represents a derivative of a stock that split off far back on the Pierine line of development.

Itaballia represents another independent line of development from the general Pierine stock. In many ways the group shows closest relationships to *Pieris,* with *I.* (*Pieriballia*) representing somewhat of a transitional form from this genus to the species of *I.* (*Itaballia*). *Perrhybris* is much more highly specialized in venation than *Itaballia,* having only 3 radials, and would appear in pattern and wing-shape to be an *Itaballia* derivative. The genitalia of *Perrhybris* show, however, none of the peculiar characteristics of those of *Itaballia,* so that it must be supposed that the connection of *Itaballia* and *Perrhybris* was at a point subsequent to the derivation of the pattern and wing-shape and previous to the development of the *Itaballia* genitalia.

Aoa has long been classified with *Cepora* (*Huphina*). The author has already stated his reasons for considering it not only unrelated to this latter genus but on an independent line of development.

Ascia, as has been a number of times demonstrated, is undoubtedly generically distinct from *Pieris.* It is probably, however, a derivative of this genus, or of one of its immediate ancestral forms. The Neotropical species best characterized by the presence of sex-scaling along the veins of the males are here considered worthy of subgeneric rank. Their relationship is evidently with *Ascia.* The genitalia are in many ways rather similar to those structures in *Belenois,* and it is conceivable that some slight connection exists between these two groups.

Melete is a genus of rather uncertain relationships. The resemblance of one or two of the species to *Appias* can only be considered

as accidental; it is probable that it is a derivative from some ancestral form of *Ascia*.

Mylothris undoubtedly represents an independent line of development. In venation it is highly specialized, possessing but three radials. If the structure in the middle of the harpé is a true clasper, then in this respect *Mylothris* must be regarded as primitive; if, on the other hand this is an independently derived structure it shows a high degree of specialization and one without parallel in the Pierini. This structure is fused with the harpé along its distal margin and is more or less sac-like and lobed, characteristics very unlike any form of clasper known to the author.

In any work such as the present, errors are bound to creep in. The author has not been able to examine nearly as many species in many genera as he would like to have, and for this reason some of the taxonomic characters cited may prove unreliable. Likewise he has not been able to examine the original publication of many of the generic descriptions, and has therefore been forced to rely to some extent on the bibliographies and citations of other authors, some of which may contain errors. For any omissions and lapses of his own which may occur no excuses can be offered.

Perhaps the author has attached too much importance to the characters afforded by the genitalia. That will be for future workers, with more complete knowledge and better facilities, to decide. However this may be, he hopes that he has sufficiently demonstrated that these structures do offer important characters, which competent workers cannot afford to ignore as has been done in the past.

Application of the present International Code of Zoological Nomenclature has, of course, necessitated a number of changes in names. In the case of the majority of these the author has followed the Code. In three cases he has not done so (*Anthocharis, Colias* and *Gonepteryx*). At least one other case cannot be determined by the Code at present (*Phrissura*) but will require special ruling.

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INDEX TO GENERIC NAMES

The number given after each name refers to the number of the genus in which the name will be found, both in the checklist of genera and the discussions.

EXPLANATION OF FIGURES

(Plates V–XIII)

All figures of the male genitalia are of the left lateral aspect, unless specifically stated to be otherwise. In the *Pierinae* the genitalia have been drawn with the right harpé removed. In the *Dismorphiinae* and *Pseudopontiinae* this has not been done.

The figures of the genitalia are intended to represent these organs in their natural shape, without distortion or flattening. In most cases the harpé has been shown as normally articulated to the vinculum and tegumen. In a few cases it has been drawn detached from these structures. Spines on the harpé have been drawn as if flattened in the plane of the harpé, in order to show their size and shape, although their normal position may be at an angle with the plane of the harpé.

In most cases the penis has been drawn below the other structures. In a few *Dismorphiinae* it is shown *in situ.*

No attempt has been made to show the membranous areas, excepting where a chitinization in the subcaphium has necessitated showing part of the median fold. The point where the anal membranes attach to the ventral part of the uncus has been shown by a short line.

The juxta has been shown attached to the sacculus except where its relation to the median fold or vinculum has seemed important.

Inasmuch as mere size is not regarded as a genitalic character the structures have all been drawn approximately the same size, with no fixed scale of enlargement.

Plate V

Figure

1. Diagrammatic representation of generalized Pierid male genitalia. The basal portion of the penis and its surrounding structures have been shown in optical section. The membrane extending from the basal edge of the outer layer of the harpé to the vinculum has not been shown.
2. Venation of *Pseudopieris nehemia* Boisd.
3. " " *Nepheronia argia* Fabr.
4. " " *Leucidia brephos* Hueb.
5. " " *Pieris brassicae* L.
6. " " fore wing, *Phoebis argante* Hueb.
7. " " *Leptosia alcesta* Cr.
8. Various structures of *Pieris brassicae* L.
   a. Lateral aspect of fore leg
   b. Lateral aspect of end of tarsus

c. Dorsal aspect of end of tarsus
d. Lateral aspect of palpus

9. Lateral aspect of palpus, *Anteos maerula* Fabr.
10. Lateral aspect of pupa, *Pereute nigricans* J. & T.
11. Left lateral aspect, ♂ genitalia, *Pseudopontia paradoxa* Feld.

Plate VI

Figure

12. Left lateral aspect, ♂ genitalia, *Leptidia sinapis* L.
13. " " " " " *Pseudopieris nehemia* Boisd.
14. " " " " " *Dismorphia astynome* Dalm.
15. " " " " " *Acmepteron nemesis* Latr.
16. " " " " " *Enantia licinia* Hueb.
17. " " " " " *Moschoneura pinthaeus* L.
18. " " " " " *Patia orise* Boisd.
19. " " " " " *Eroessa chilensis* Blanch.
20. " " " " " *Anthocharis cardamines* L.
21. " " " " " *Zegris eupheme* Esp.
    a. Enlarged drawing of dorsal spine of harpé
22. Left lateral aspect, ♂ genitalia, *Euchloë belia* Cr.
23. " " " " " *Hesperocharis erota* Luc.

Plate VII

Figure

24. Left lateral aspect, ♂ genitalia, *Cunizza hirlanda apicalis* Fruehst.
25. " " " " " *Mathania agasicles* Hew.
26. " " " " " *Pinacopteryx eriphia* Godt.
27. " " " " " *Hebomoia glaucippe* L.
    a. Dorsal aspect of tip of uncus
28. Left lateral aspect, ♂ genitalia, *Colias hyale* L.
    a. Lateral aspect of tip of penis, enlarged
29. Left lateral aspect, ♂ genitalia, *Zerene caesonia* Stoll.
30. " " " " " *Catopsilia crocale* L.
31. " " " " " *Anteos (Rhodocera) menippe* Hueb.
32. " " " " " *Gonepteryx rhamni* L.
33. " " " " " *Dercas gobrias* Hew.
34. " " " " " *Phoebis argante* Fabr.
35. " " " " " *Rhabdodryas trite* L.

Plate VIII

Figure

36. Left lateral aspect, ♂ genitalia, *Aphrissa statira* Cr.
    a. Lateral aspect, tip of penis, greatly enlarged
    b. Lateral aspect of juxta

37. Left lateral aspect, ♂ genitalia, *Kricogonia lyside* Godt.
38. " " " " " *Leucidia brephos* Hueb.
39. " " " " " *Gandaca harina* Horsf.
40. " " " " " *Eurema daira* Godt.
41. " " " " " *Abaeis nicippe* Cr.
42. " " " " " *Pyrisitia proterpia* Fabr.
43. " " " " " *Pyrisitia messalina* Fabr.
44. " " " " " *Teriocolias atinas* Hew.
45. " " " " " *Maiva brigitta* Cr.
    a. Dorsal aspect of tip of uncus
46. Left lateral aspect, ♂ genitalia, *Nirmula venata* Moore
47. " " " " " *Terias hecabe* L.
    a. Dorsal aspect of tip of uncus

Plate IX

Figure

48 & 49. Left lateral aspects of inner faces of harpés of various species of *Eurema* (*Terias*)
50. Left lateral aspect, ♂ genitalia, *Nathalis iole* Boisd.
51. " " " " " *Eronia cleodora* Hueb.
52. " " " " " *Nepheronia argia* Fabr.
53. " " " " " *Pareronia valeria* Fabr.
54. " " " " " *Colotis evippe* L.
    The distal portion of the saccus is shown detached and above the proximal portion
55. Left lateral aspect, ♂ genitalia, *Teracolus subfasciatus* Swains.
56. " " " " " *Gideona lucasi* Grand.
57. " " " " " *Ixias pyrene* L.
58. " " " " " *Neophasia menapia* Feld.
59. " " " " " *Eucheira socialis* Westw.

Plate X

Figure

60. Left lateral aspect, ♂ genitalia, *Catasticta nimbice* Boisd.
61. " " " " " *Archonias tereas* Hueb.
62. " " " " " *Charonias eurytele* Hew.
63. " " " " " *Aporia crataegi* L.
64. " " " " " *Metaporia agathon* Gray
    a. Dorsal aspect of tip of uncus
65. Left lateral aspect, ♂ genitalia, *Cepora coronis* Cr.
    a. Outline of harpé, showing "inner sac"
66. Left lateral aspect, ♂ genitalia, *Delias egialea* Cr.
67. " " " " " *Delias nigrina* Fabr.
68. " " " " " *Pereute callinice* Feld.
    a. Outline of harpé, showing "inner sac"

69. Left lateral aspect. ♂ genitalia, *Leodonta dysoni* Dbldy.
70. " " " " " *Belenois calypso* Drury
71. " " " " " *Belenois creona* Cr.

Plate XI

Figure
72. Left lateral aspect, ♂ genitalia, *Dixeia pigea* Boisd.
73. " " " " " *Prioneris thestylis* Doubleday
74. " " " " " *Appias zelmira* Cr.
75. " " " " " *Catophaga nero* Fabr.
76. " " " " " *Glutophrissa ilaire* Godt.
77. " " " " " *Udaiana cynis* Hew.
78. " " " " " *Saletara panda distanti* Butl.

a. Dorsal aspect of tip of uncus

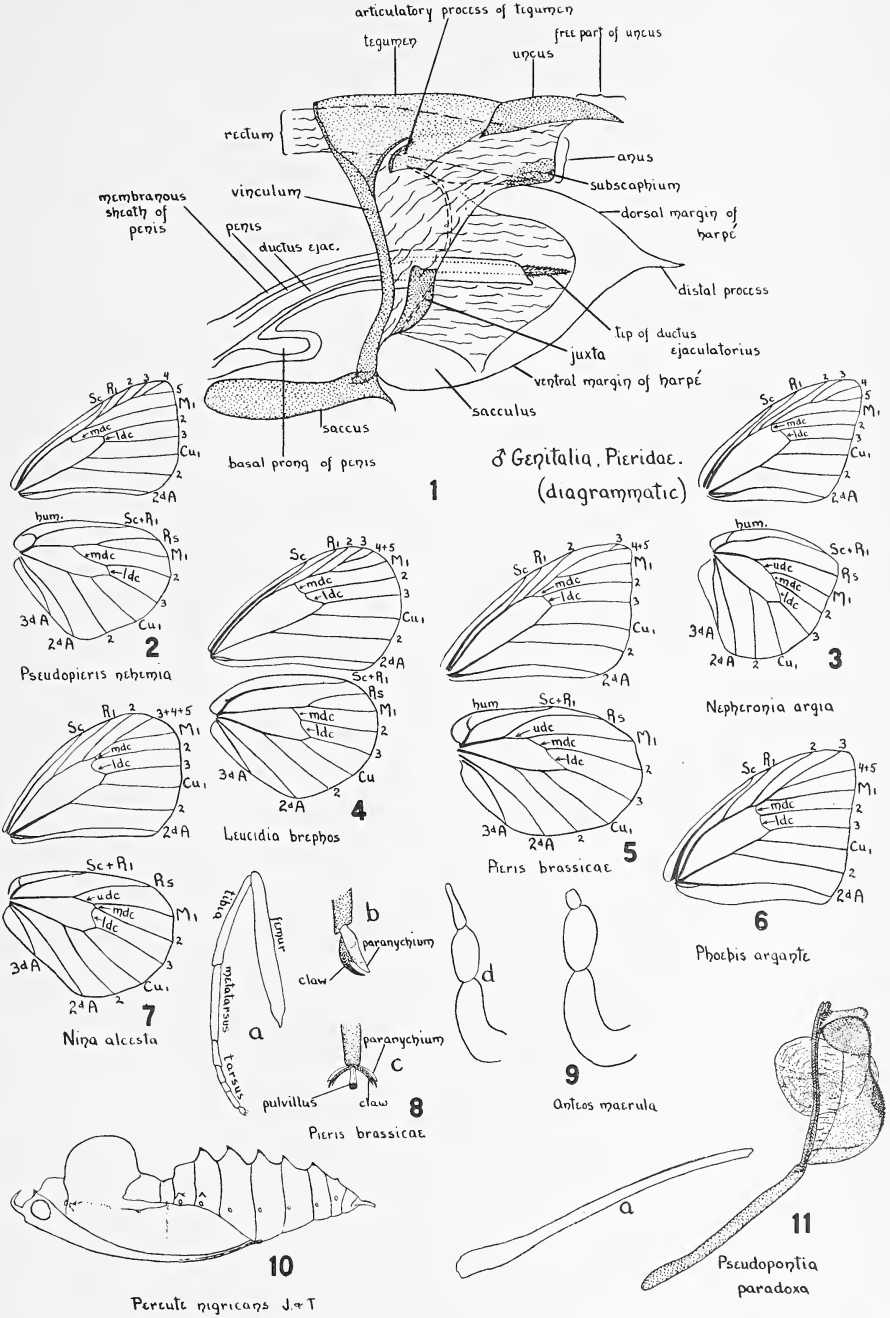
79. Left lateral aspect, ♂ genitalia, *Pieris brassicae* L.
80. " " " " " *Glennia pylotis* Godt.
81. " " " " " *Synchloë rapae* L.
82. " " " " " *Synchloë callidice* Esp.
83. " " " " " *Pontia daplidice* L.

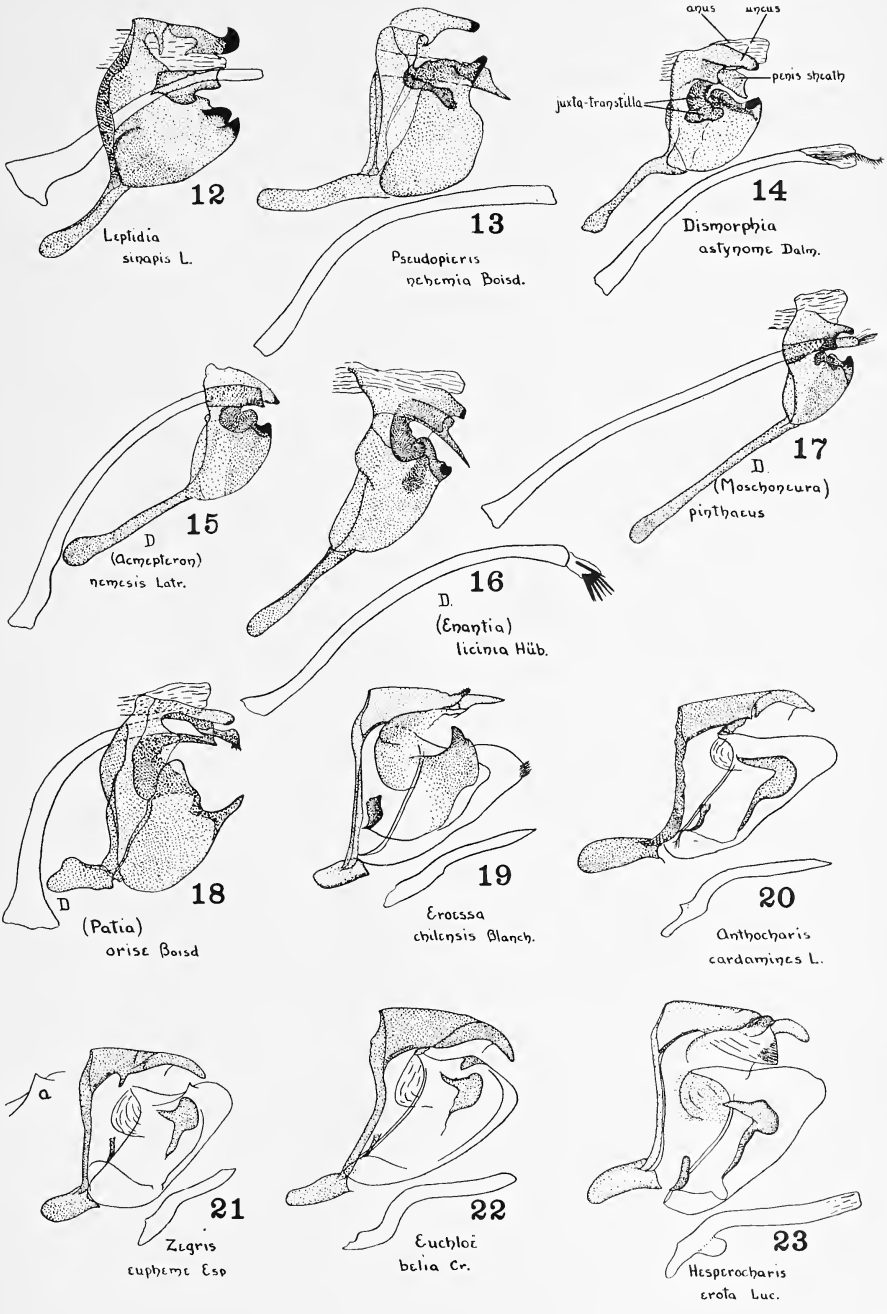
Plate XII

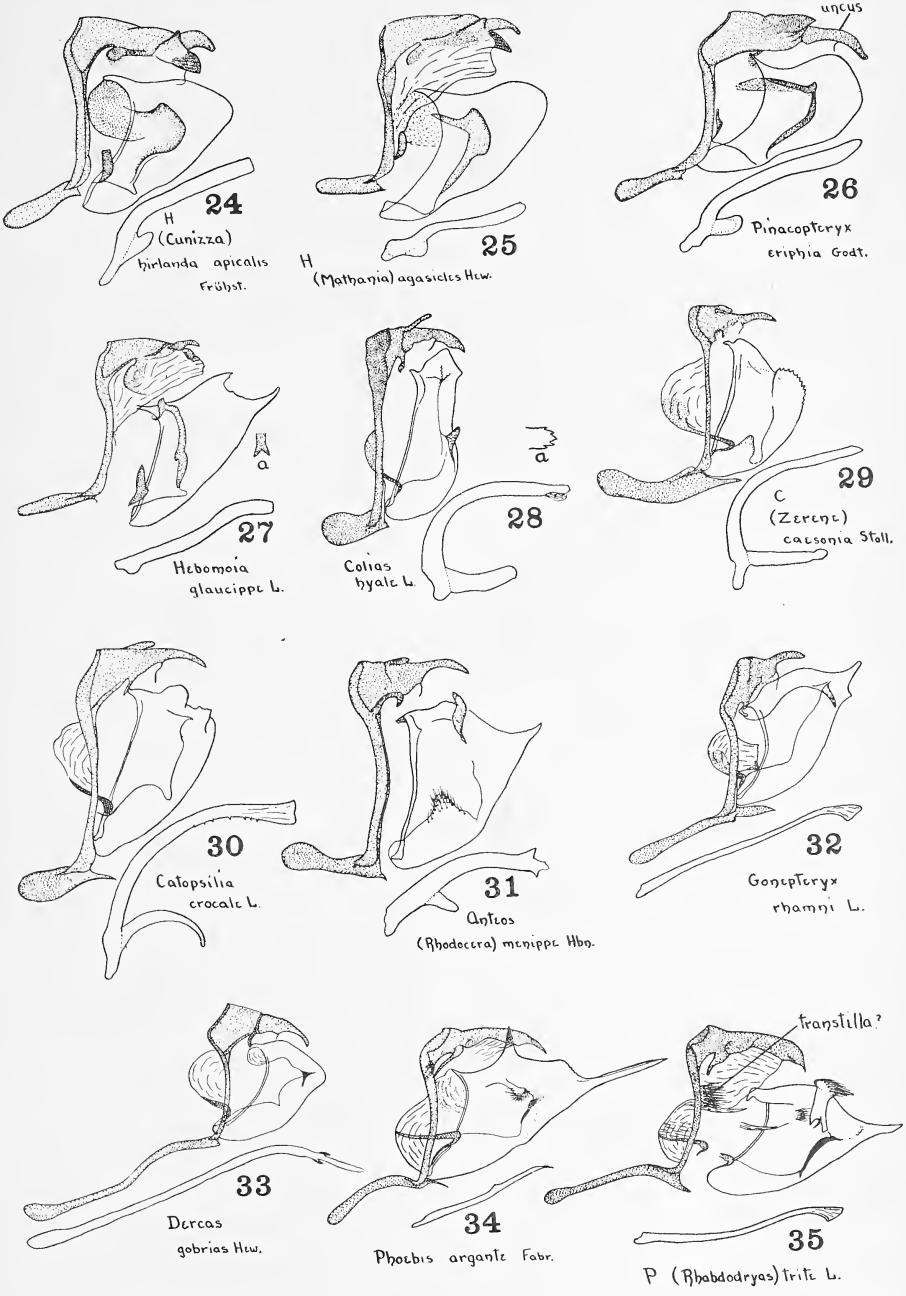
Figure
84. Left lateral aspect, ♂ genitalia, *Leptophobia eleone* Hew.
85. " " " " " *Leuciacria acuta* R. & J.
86. " " " " " *Elodina egnatia* Godt.
87. " " " " " *Tatochila autodice* Hueb.
88. " " " " " *Baltia shawii* Bates
89. " " " " " *Phulia nymphula* Gay
90. " " " " " *Leptosia xiphia* Cr.
91. " " " " " *Itaballia pisonis* Hew.
92. " " " " " *Pieriballia mandela* Feld.
93. " " " " " *Perrhybris pyrrha* Fabr.
94. " " " " " *Aoa affinis* Vollenh.
95. " " " " " *Ascia monuste* L.

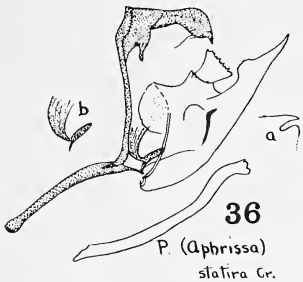
Plate XIII

Figure
96. Left lateral aspect, ♂ genitalia, *Ganyra buniae* Hueb.
97. " " " " " *Melete lycimnia* Cr.
98. " " " " " *Mylothris poppea* Cr.
99. Hypothetical phylogenetic chart of the subfamilies of *Pieridae*
100. Hypothetical phylogenetic chart of the main stock of the subfamily *Pierinae*. See text pp. 223–231.


articulatory process of tegumen
tegumen
free part of uncus
uncus
rectum
anus
subscaphium
membranous sheath of penis
vinculum
penis
ductus ejac.
dorsal margin of harpe
distal process
tip of ductus ejaculatorius
juxta
ventral margin of harpe
sacculus
saccus
basal prong of penis
♂ Genitalia, Pieridae. (diagrammatic)
1
Pseudopieris nehemia
2
Leucidia brephos
4
Pieris brassicae
5
Nepheronia argia
3
Phoebis argante
6
Nina alcesta
7
Pieris brassicae
8
Antos matrula
9
Pereute nigricans ♂ & ♀
10
Pseudopontia paradoxa
11


anus
uncus
penis sheath
juxta-transtilla
12
Leptidia
sinapis L.
13
Pseudopieris
nehemia Boisd.
14
Dismorphia
astynome Dalm.
15
D
(Acmepteron)
nemesis Latr.
16
D.
(Enantia)
licinia Hüb.
17
D
(Moschoneura)
pinthaeus
18
D
(Patia)
orise Boisd
19
Erocssa
chilensis Blanch.
20
Anthocharis
cardamines L.
a
21
Zegris
eupheme Esp
22
Euchloë
belia Cr.
23
Hesperocharis
erota Luc.


uncus
H
24
(Cunizza)
hirlanda apicalis
Früh.
H
25
(Mathania) agasicles Hew.
26
Pinacopteryx
eriphia Godt.
a
27
Hebomoia
glaucippe L.
a
28
Colias
hyale L.
29
C
(Zerene)
cæsonia Stoll.
30
Catopsilia
crocale L.
31
Anteos
(Rhodocera) menippe Hbn.
32
Gonepteryx
rhamni L.
33
Dercas
gobrias Hew.
34
Phoebis argante Fabr.
transtilla?
35
P (Rhabdodryas) trite L.



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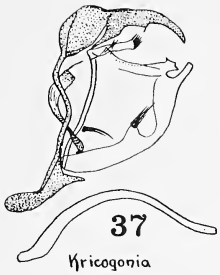
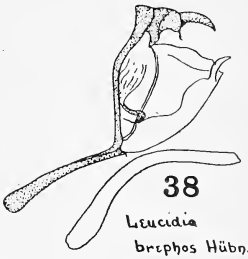
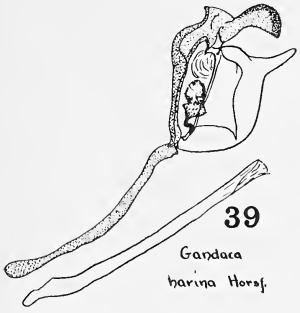
P. (Aphrissa)
statira Cr.



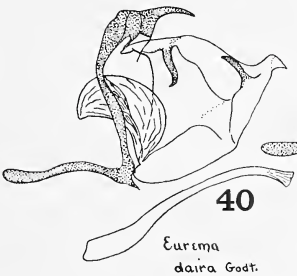
37
Kricogonia
lyside Godt.



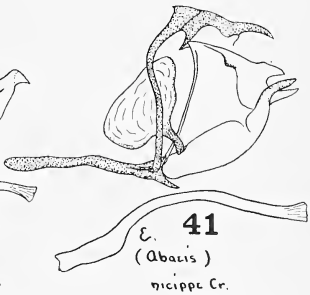
38
Leucidia
brephos Hübn.



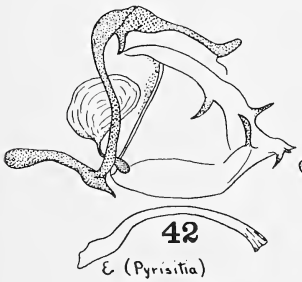
39
Gandaca
harina Horsf.



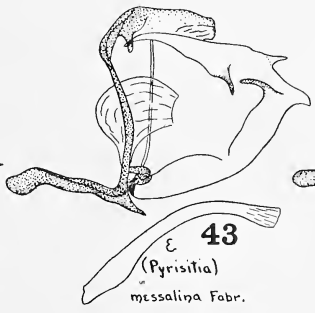
40
Eurema
daira Godt.



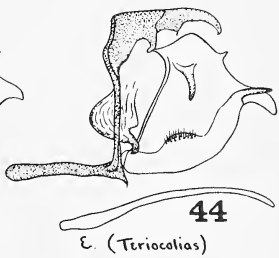
♂ 41
(Abaeis)
nicippe Cr.



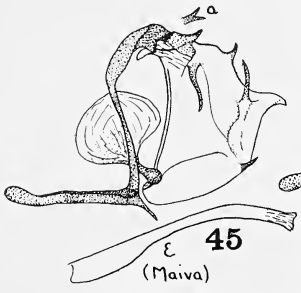
42
♂ (Pyrisitia)
proterpia Fabr.



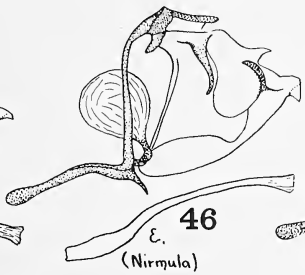
♂ 43
(Pyrisitia)
messalina Fabr.



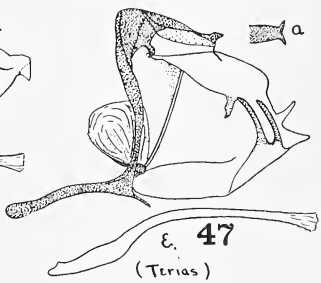
44
♂ (Teriocolias)
atinas Hew.



♂ 45
(Maiva)
brigitta Cr.



♂ 46
(Nirmula)
venata Moore



♂ 47
(Terias)
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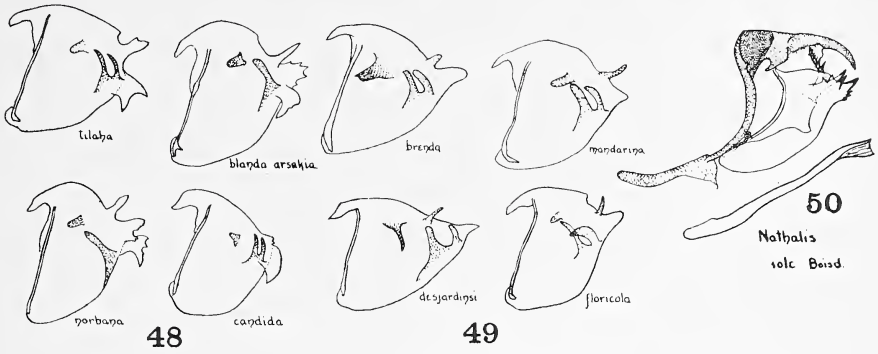

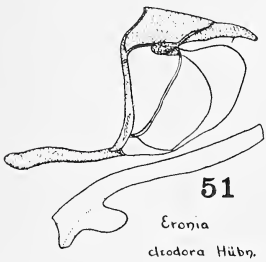
51
Eronia
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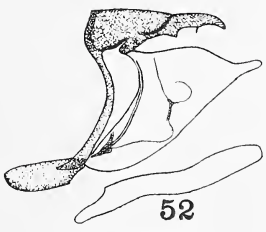
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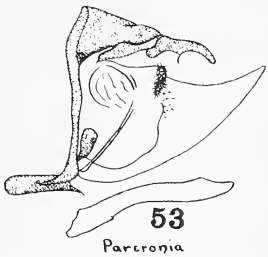
argia Fabr.


53
Pareronia
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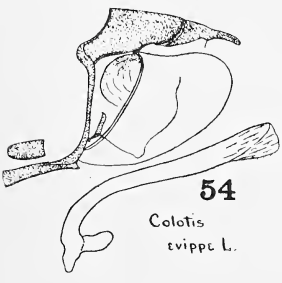
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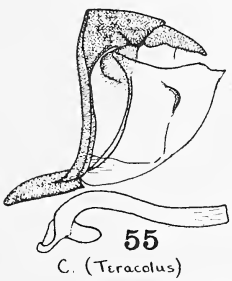
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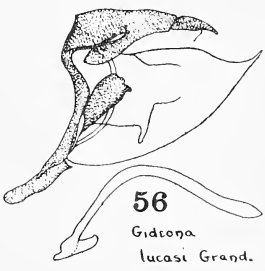
56
Gideona
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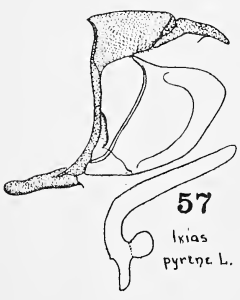
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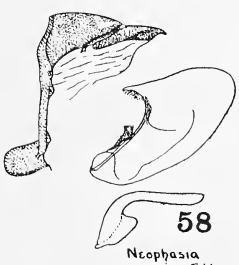
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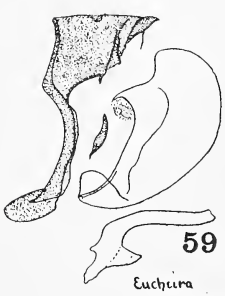
menapia Feld.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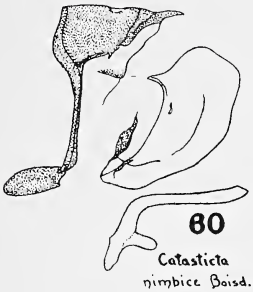

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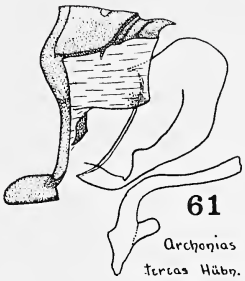

61
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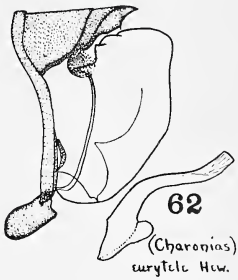
tereas Hübn.



62
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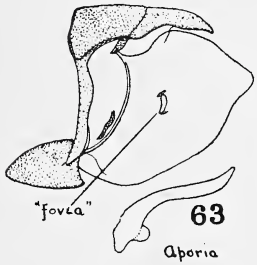
eurytele Hew.



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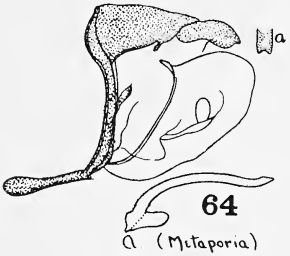
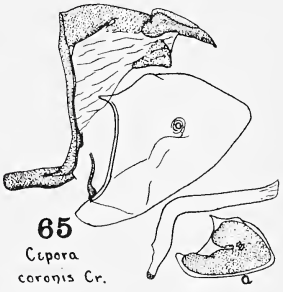
63
Aporia
crataegi L.



64a
64
a (Metaporia)
agathon Gray



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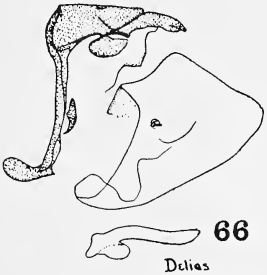

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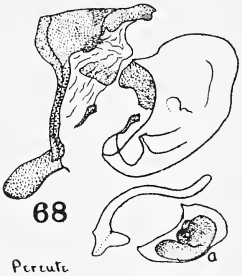
Delias
nigrina Fabr.



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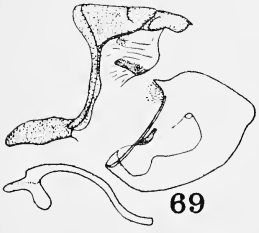

69
Leodonta
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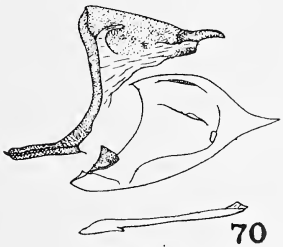

70
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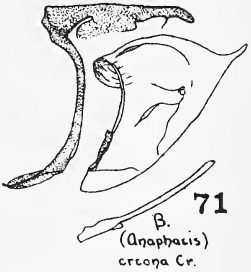
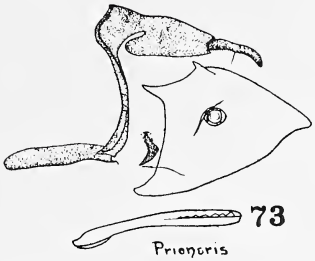
calypso Drury.



71
β.
(Anaphaeis)
orcona Cr.

72
Dixeia
pigea Boisd.



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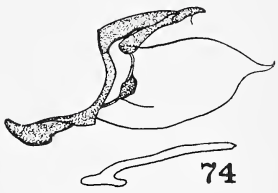

74
Appias
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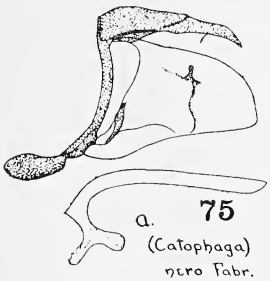
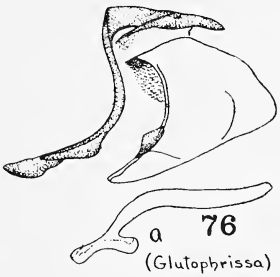


75
(Catophaga)
nero Fabr.



76
(Glutophrissa)
ilaire Godt.

77
a. (Udaiana)
cynis Hew.

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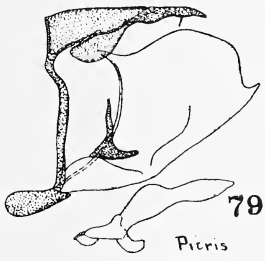
panda distanti Butl.



79
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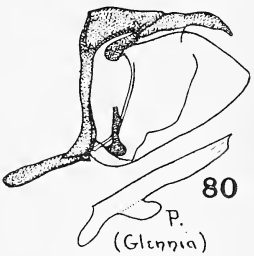
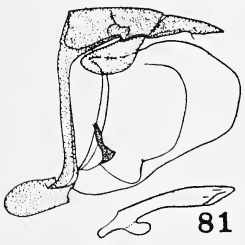
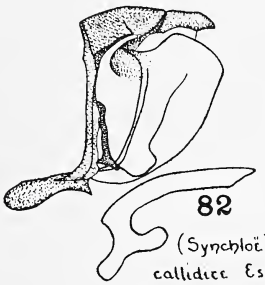


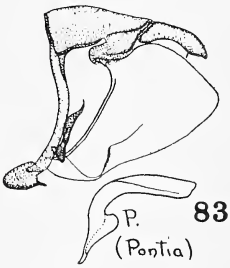
80
P.
(Glennia)
pylotis Godt.



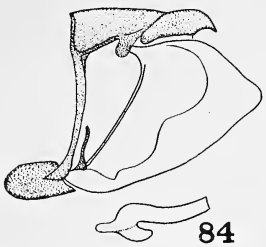
81
P. (Synchloë)
rapae L.



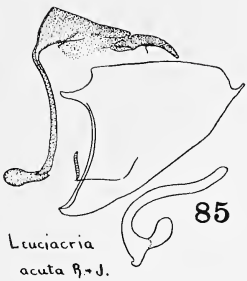
82
(Synchloë)
callidice Esp.



83
P.
(Pontia)
daplidice L.



84
Leptophobia elcone Hew.



85
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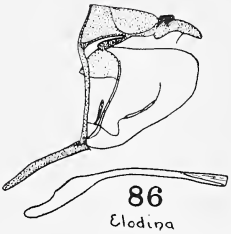
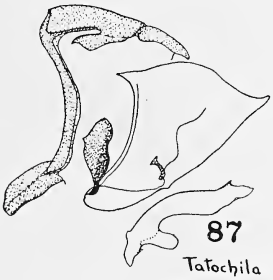


86
Elodina egnatia Godt.



87
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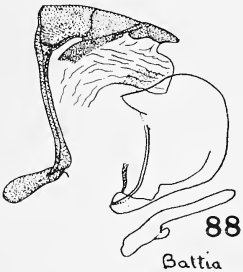
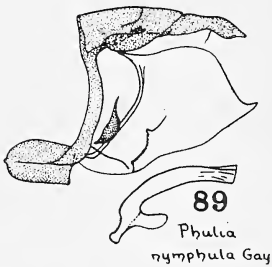


88
Battia shawi Bates



89
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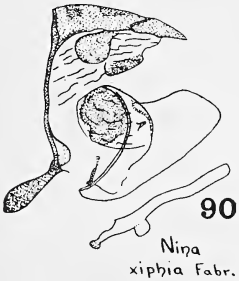

90
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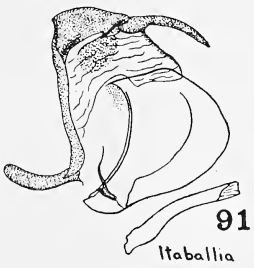
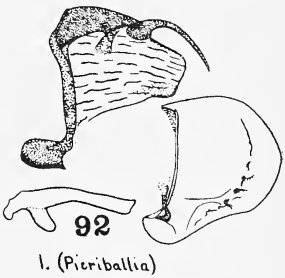
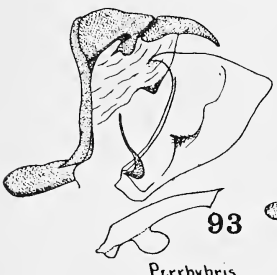


91
Itaballia pisonis Hew.



92
I. (Pieriballia) mandela Feld.



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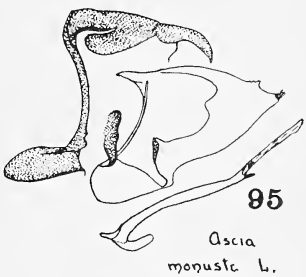

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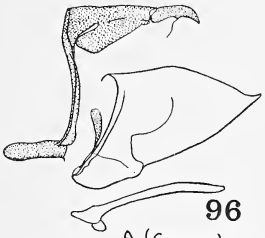

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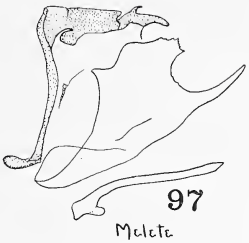
A (Ganyra) bunias Hueb.



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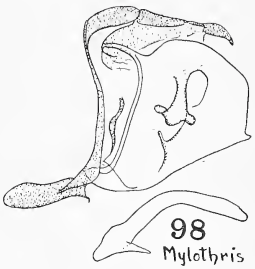

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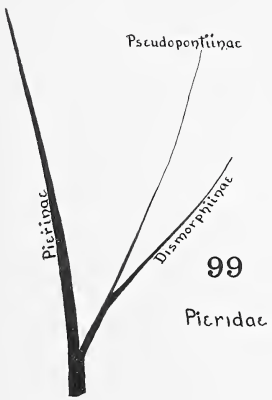

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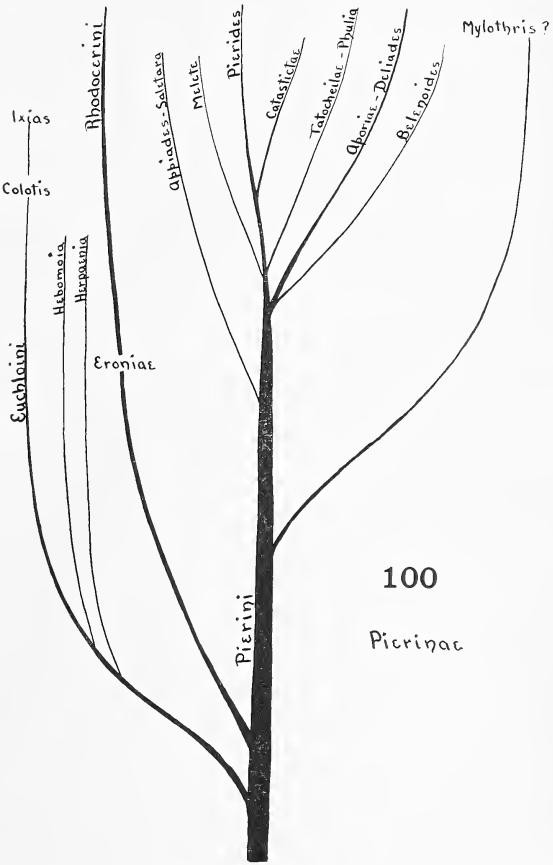

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Pierinae

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