MORPHOLOGY AND TAXONOMY OF THE KNOWN PUPAE OF COCCINELLIDAE (COLEOPTERA) OF NORTH AMERICA

Thesis for the Degree of Ph. D.
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DANG TRUNG PHUOC
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This is to certify that the

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OF COCCINELLIDAE (COLEOPTERA)
OF NORTH AMERICA

presented by

Dang Trung Phuoc

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of the requirements for

Ph.D. degree in Entomology

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Date 10 November 1972

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ABSTRACT

MORPHOLOGY AND TAXONOMY OF THE KNOWN PUPAE
OF COCCINELLIDAE (COLEOPTERA)
OF NORTH AMERICA

By

Dang Trung Phuoc

The structure of the pupae of 32 known genera and 49 species from 11 tribes of coccinellid pupae (mainly of North America) which are positively associated with adults either by collecting in the field or by rearing in the laboratory, were studied and described. Keys to known subfamilies, tribes, genera and species are presented. Based on the pupal characters, the tribal relationships within the family are discussed.

The COCCINELLINAE (Coccinellini and Psylloborini) are highly advanced with very little connection with the remainder of the family which is grouped in a separate stem where EPILACHNINAE split off very early and acquired highly modified structures to fit their exclusively phytophagous habit.

The COCCIDULINAE (Coccidulini and Scymnillini) and especially the STICHOLOTINAE (Stichlotini and Serangiini) are recognized as being most primitive groups and are closely related. Thus, they are grouped on the same stem of the phylogenetic tree. The Coccidulini (=Rhizobiini) are more closely related to the EPILACHNINAE than any other groups of COCCINELLIDAE.

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The CHILOCORINAE (Chilocorini) show some relationships with the STICHOLOTINAE and the SCYMNINAE, but independently evolved on a distinct stem.

The SCYMNINAE (Stethorini, Scymnini and Hyperaspini) have recently evolved. The Hyperaspini appear to be more primitive compared with Scymnini and Stethorini. The Stethorini are considered to be the most highly evolved within the SCYMNINAE, and have the closest affinity to the Chilocorini.

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I wish to thank the following individuals and institutions for the loan or donation of materials: Donald M. Anderson, Systematic Entomology Laboratory, USDA, U. S. National Museum, Washington D.C.; Kenneth S. Hagen, University of California, Albany California; Robert E. Waites, College of Agriculture, University of Florida, Gainesville Florida; Roland W. Portman, Department of Entomology, University of Idaho, Moscow Idaho; Raymond D. Eikenbary, Department of Entomology, Oklahoma State University, Stillwater Oklahoma and Donald C. Cress, Department of Entomology, Michigan State University, East Lansing Michigan.

I wish to express my sincere gratitude to Dr. Frederick W. Stehr for his invaluable advice during the course of my study and the preparation of this paper. I am deeply grateful to Dr. Roland L. Fischer for proofreading the final draft of this thesis and for his many valuable suggestions in making this project a success. I also wish to express my appreciation to Drs. Gordon E. Guyer, Robert F. Ruppel, and Thomas W. Porter for their valuable guidance. My appreciation also goes to Lyle Matteson and F. William Ravlin, Dr. Stehr's technician and student respectively for testing the keys in this paper.

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INTRODUCTION

The morphology of immature insects, especially of holometabolous groups, is an additional source of taxonomic information which unfortunately has not been used for many groups. According to Van Emden (1957) immature characters may be significant in the separation of sibling species, and may help to confirm or to reorganize the classification and phylogeny of groups of insects which have previously been classified only upon adult characters.

The classification of the family Coccinellidae has been based largely on the morphology of adults and larvae. The morphological study of the pupae has provided another source of data for more precisely understanding and interpreting the relationships and the natural classification within the family.

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LITERATURE REVIEW

The pupae of Coccinellidae have been little studied. There have been a few short notes or brief descriptions on the morphology, but often only for single species.

Coquillet (1889), Gorham (1892), Fonseca and Autuore (1931), Kanervo (1941), Kapur (1943), Kesten (1969), and Marthur and Srivastava (1966) have briefly described the pupae of Vedalia cardinalis (Mulsant), Orcus coeruleus (Mulsant), Calvia 15-punctata Fabricius, Solanophila clandestina (Mulsant), Thea bisoctonotata Mulsant, Anatis ocellata Linnaeus, Stethorus gilvifrons Mulsant, and Hyperaspis vinciguerrae Capra.

Palmer (1914) studied a group of common coccinellid species and provided brief descriptions of the pupae of Hippodamia convergens Guerin, Hippodamia sinuata Mulsant, Hippodamia parenthesis (Say), Coccinella 5-notata Kirby, Coccinella monticola Mulsant, Coccinella sanguinea Linnaeus, and Olla abdominalis (Say).

Binaghi (1941) has carefully studied the pupae of the Chilocorini. He offered a key to genera and the species Chilocorus bipustulatus Linnaeus, Exochomus 4-pustulatus Linnaeus, Exochomus auritus Scriba, Exochomus nigripennis Erichson, and Exochomus sjodstedti Weise.

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Recently, Savoiskaya (1962a) has redescribed the pupae of the tribe Chilocorini. Three genera were taxonomically separated (Chilocorus L., Brumus Muls., and Exochomus Redt.) and the following species were described: Brumus 8-signatus Gebl., Chilocorus bipustulatus Linnaeus, Exochomus flavipes Thunberg, Exochomus melanocephalus Zubk., and Exochomus semenovi Weise.

Savoiskaya (1962c) has also described and studied the larvae and pupae of the genus Coccinula Dobzhansky. He prepared a key separating the pupae of the genus Coccinula, including the following species: C. redimita Weise, C. 14-pustulata Linnaeus, C. sinuato-marginata Faldermann, and C. elegantula Weise.

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CLASSIFICATION OF COCCINELLINDAE

Modified from Sasaji (1971)

(*) indicates tribe with available pupae

STICHLOTINAE

- Sukunahikonini
- Serangiini (*)
- Sticholotini (*)
- Shirozuellini

COCCIDULINAE

- Lithophilini
- Coccidulini (*)
- Scymnillini (*)
- Exoplectrini
- Noviini (*)

EPILACHNINAE

- Epilachnini (*)

SCYMNINAE

- Hyperaspini (*)
- Scymnini (*)
- Stethorini (*)
- Cranophorini

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Psylloborini (*)

Coccinellini (*)

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METHODS OF STUDY AND SOURCES OF MATERIAL

The specimens examined were mainly from the U. S. National Museum and from the rearing program carried out throughout the study. Pupae obtained by rearing are preferred since identifications are positive. Pupae collected in association with adults in the field are not as positively identified as reared specimens; however, it is a good way to get a lot of material with minimal effort. The latter method can best be used if the pupae are allowed to emerge, and the pupal exuviae are associated with the newly emerged adult. Not only can the specimens be correctly identified this way, but the exuviae can be examined almost as well as the pupa itself.

In addition to the above materials, several important pupae have also been obtained from Kenneth S. Hagen, University of California, Albany, California; Robert E. Waites, University of Florida, Gainesville, Florida; Roland W. Portman, University of Idaho, Moscow, Idaho and Raymond D. Eikenbary, Oklahoma State University, Stillwater, Oklahoma.

The following pupae were available for this study:

STICHOLOTINAE

Delphastus pusillus (Leconte) (Serangiini)

Microweisea ovalis (Leconte) (Sticholotini)

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COCCIDULINAE

Rhizobius ventralis (Erichson) (Coccidulini)

Lindorus lophantae Blaisdell (Coccidulini)

Rodolia cardinalis Mulsant (Noviini)

Zagloba ornata (Horn) (Scymnillini)

EPILACHNINAE

Epilachna varivestis Mulsant (Epilachnini)

Epilachna borealis (Fabricius) (Epilachnini)

Epilachna sp. (Epilachnini)

SCYMNINAE

Scymnus creperus Mulsant (Scymnini)

Cryptolaemus montrouzieri Mulsant (Scymnini)

Hyperaspis binotata (Say) (Scymnini)

Thalassa montezumae Mulsant (Hyperaspini)

Stethorus atomus Casey (Stethorini)

Stethorus picipes Casey (Stethorini)

Stethorus punctum LeConte (Stethorini)

CHILOCORINAE

Chilocorus bivulnerus Mulsant (Chilocorini)

Orcus chalybeus (Boisd.) (Chilocorini)

Axion plagiatum (Olivier) (Chilocorini)

Axion tripustulatum (DeGeer) (Chilocorini)

Exochomus hoegei Gorham (Chilocorini)

Exochomus cubensis Dimmock (Chilocorini)

Brumoides suturalis (Fabricius) (Chilocorini)

COCCINELLINA

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COCCINELLINAE

Coccinella trifasciata Linnaeus (Coccinellini)

Coccinella transversoguttata Faldermann (Coccinellini)

Coccinella novemnotata Herbst (Coccinellini)

Coccinella septempunctata Linnaeus (Coccinellini)

Coccinella monticola Mulsant (Coccinellini)

Adalia bipunctata (Linnaeus) (Coccinellini)

Cycloneda munda (Say) (Coccinellini)

Cycloneda sanguinea (Linnaeus) (Coccinellini)

Mulsantina picta (Randall) (Coccinellini)

Mulsantina hudsonica (Casey) (Coccinellini)

Olla abdominalis Say (Coccinellini)

Neoharmonia venusta (Melsheimer)

Propylaea quatuordecimpunctata (Linnaeus) (Coccinellini)

Anatis ocellata Linnaeus (Coccinellini)

Anatis quindecimpunctata Olivier (Coccinellini)

Anisocalvia quatuordecimguttata Linnaeus (Coccinellini)

Synonycha grandis (Thunberg) (Coccinellini)

Hippodamia parenthesis (Say) (Coccinellini)

Hippodamia tredecimpunctata (Linnaeus) (Coccinellini)

Hippodamia convergens Guerin (Coccinellini)

Hippodamia glacialis (Fabricius) (Coccinellini)

Hippodamia quinquesignata (Kirby) (Coccinellini)

Coleomegilla maculata DeGeer (Coccinellini)

Naemia serriata (Melsheimer) (Coccinellini)

Eriopis connexa (Germar) (Coccinellini)

Psyllobora vigintimaculata Say (Psylloborini)

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The pupae were examined with a stereo-microscope with magnification from 6X to 200X. Pupae were submerged in a small dish containing alcohol with sandy subtrate on which the specimens can be oriented easily. The background may be adjusted from light to dark by using various colored sands which helps to reveal inconspicuous characters such as setae. Illumination was provided by an adjustable light source which could be varied from very dim to very bright. In addition, different colored light filters were helpful, a deep blue filter being most useful.

The dimensions of the pupae were measured by means of an ocular micrometer.

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COMPARATIVE MORPHOLOGY

General

Pupae of Coccinellidae are exarate with all appendages free. The last larval exuvium usually folds back and covers the anal end of the pupa (Figures 1, 234). However, in CHILOCORINI and NOVIINI the pupa is enclosed in an almost intact last larval exuvium, broken only by a dorsolongitudinal slit through which the pupa can be seen (Figure 239); and in HYPERASPINI (Hyperaspis binotata, and Thalassa montezumae) the last larval exuvium entirely covers the ventral surface of the body including the head.

The size may range from minute, 1mm in length, as in Microweisea ovalis, to moderately large, 12mm or more in length, as in Anatis guindecimpunctata, Anatis ocellata and Synonycha grandis. The body is usually slightly elongate oval. However, in Coccinella, Olla, and Axion the body is very rounded-oval and strongly convex dorsally; and in Hippodamia, Coleomegilla, Paranaemia, and Eriopis, the body is elongate-oval.

The maculation pattern also varies a great deal among coccinellid pupae. However, it is possible to distinguish two main groups. The first group consists of all members of COCCINELLINAE (Coccinellini and Psylloborini) in which the dorsal surface of the body including the elytra is usually distinctly marked with dark spots (brown, dark brown or black) or with pale spots (yellowish). The

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second group consists of the remaining species of the family in which the body is usually entirely pale, yellowish or brownish or brown, with spots rarely present.

Setae and external texture of the body wall

All members of subfamily COCCINELLINAE have setae that are very short and fine, with setal length never exceeding the thickness of the lateral margin of the pronotum. The remaining members of the family are usually very densely and coarsely setiferous, with the setal length greatly exceeding the thickness of the lateral margin of the pronotum.

Setae may be very coarse and bristle-like, called macrosetae (Figure 108) as in most SCYMININAE, CHILOCORINAE (Chilocorus) and EPILACHNINAE. Macrosetae may be born on a flat cuticular ring (Figures 108, 206, 241) as in Epilachna, Hyperaspis, Cryptolaemus and Thalassa, or on a tubercle (Figures 22, 110) as in Stethorus.

Microsetae which are distinguished from macrosetae by being either more slender or very short and fine are present on most of the species. In the COCCINELLINAE microsetae are usually borne on a slightly elevated cuticular ring with the tip either slightly enlarged and truncated (Figures 7, 8) as in Coccinella, Adalia, Hippodamia and Psyllobora, or pointed as in Cycloneda, Anatis, Mulsantina, Synonycha, or borne on a small tubercle or chalaza with the distal end strongly curved as in Propylaea and Anisocalvia (Figures 172, 177). Very long and fine hair-like setae are only present in Orcus chalybeus (Figure 29).

Ornamentation of the body surface (excluding "wrinkles") varies from being entirely smooth as in all members of the STICHOLOTINAE,

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EPILACHNINAE, and SCYMNINAE, and some members of the COCCINELLINI (Anatis and Synonycha), to being slightly rough with the surface clothed with very slightly rounded bumps (Figure 7) as in Cycloneda and Mulsantina. The body surface may also be covered with very fine sharp spines as on the elytral surface of Coccinella, Hippodamia and the hind wing apex of Coccinella and Adalia (Figures 8, 179-184). Spines may become more conspicuous and larger as on Axion and Exochomus (Figure 25).

Head

The head capsule of coccinellid pupae is of the opisthognathous type in which the mouth parts are deflected in a posteroventral position. Epicranial sutures are nearly obsolete or wanting but may be discerned as deep depressions in Coccinella and Hippodamia. The frontal sutures are distinctly visible in Stethorus and Rodolia (Figures 17-22, 50, 51). The cranial capsule is often well and homegenously sclerotized except in STETHORINI where the frontal area remains membranous and usually protuberant (Figures 20, 22).

The eyes do not vary much among coccinellid pupae. The inner lateral portion of the ocular suture is well defined, but the eye facets are not well defined.

The antennae, in contrast, vary a great deal from one group to another. In most cases, the antenna is long and may exceed the distance between the eye and the widest lateral margin of the pronotum as in Propylaea quatuordecimpunctata, or Psyllobora vigintimaculata (Figures 44, 46). In others, it only extends to the widest lateral

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margin of the pronotum (Figures 9, 10, 32) as in Coccinella, Hippodamia, Anatis, Cycloneda, Adalia, Microweisea and Epilachna. In a few cases the antenna is shorter, extending less than half the distance between the eye and the widest lateral margin of the pronotum (Figures 12, 15, 19) as in Synonycha grandis, Hyperaspis, Zagloba ornata and all members of the CHILOCORINI. The scape, flagellum and club of the antenna are distinct in most cases, but segmentation is poorly developed.

The scape may be enlarged and expanded caudally with the anterior surface flattened as in Coleomegilla maculata, Naemia serriata, or strongly convex as in Coccinella, Hippodamia and Olla. Only Cryptolaemus montrouzieri (SCYMNINI) and Epilachna sp. (EPILACHNINI) have a scape which is setiferous (Figures 10, 31, 59) on the anterior surface.

The flagellum is usually slender, slightly elbowed as in Coccinella, Hippodamia, and Anatis, or C-shaped as in Psyllobora, and Propylaea. The proximal end of the flagellum is greatly enlarged and somewhat "bisegmented" in Hyperaspis, Scymnus and Cryptolaemus, but is normal in all other species of the family. The distal end of the antenna is usually recognizable as a club which is often broadly enlarged and usually has four rings of well-developed papillae (Figures 52, 53). The club may be said to be "distinct" when the diameter is much greater than that of the flagellum (Figures 52, 53) or "indistinct" when the diameter of the club and the flagellum are subequal (Figures 55-57). In the latter case, the "club" can be recognized by the presence of papillae as in Anatis, Synonycha and Propylaea, but in Zagloba, Hyperaspis and the CHILOCORINI the flagellum is short and tapered distally, with no papillae present (Figures 61-63).

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The clypeus and labrum are usually united into a clypeolabrum in which the clypeolabral suture may be seen as a transverve arched depression. The clypeolabrum is usually large, subquadrate, subhexagonal or trapezoidal, and usually as long as wide (Figures 9, 14, 32) except in Rhizobius ventralis, Rodolia cardinalis and Psyllobora vigintimaculata where it is twice as wide as long (Figures 11, 46, 50). The apical margin may be truncated (Figure 46) as in Psyllobora vigintimaculata, slightly convex as in Anatis and Synonycha (Figure 32), slightly to deeply concave as in Coccinella, Cycloneda, Olla and Adalia, or deeply notched as in Eriopis connexa, and most Hippodamia (Figures 41, 49). The clypeus is greatly dilated laterally and conceals the antennal bases only in the CHILOCORINI (Figures 23-29).

The mandible is usually bifid and pointed at the tips as in COCCINELLINAE, STICHOLOTINAE and SCYMNINAE, (the posterior tip of the mandible of the latter is greatly reduced in size). In Epilachna the mandible is well developed for the phytophagous habit, with the chewing tips angulated, truncated or pointed as seen from the apex, and the mesal area broadly concave as in Figures 72-78. In members of the tribe CHILOCORINI, in contrast, the mandible is simple at the tip (Figures 64-67). Throughout the family the mola is usually rather well developed.

The maxilla is bulbous in appearance. The palpus is large, trapezoidal, or lanceolate, and is glabrous except in Zagloba ornata and Cryptolaemus montrouzieri where it is monosetose at the apex (Figures 84, 85), and in EPILACHNINAE where the palpus is densely setiferous (Figures 9, 10, 83).

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The galea is also bulbous, as viewed from the top, appearing subquadrate or subpentagonal with a small hook-shaped lobe at the inner anterior angle caused by the impression of the mandibular tip (Figures 79-82). The galea is small, but greatly enlarged in Psyllobora and Epilachna where the largest width of the galea is subequal to the base of the maxillary palpus (Figures 83, 92). The galeal surface is smooth, but may be armed with compact and sharp spinules in Coccinellini as in Anatis, Mulsantina, Cycloneda, and Adalia (Figures 79-82).

The lacinea is located beneath the galea, small and not as well defined.

The labium is bulbous with a distinct mentum. The labial palpi are large, stout, and short, with the tip rounded except in Chilocorus, Epilachna. In Delphastus the labial palpi appear more slender.

The hypopharynx is enlarged anteriorly as seen from the apex and is appressed laterally by the large and bulbous maxillary galeae (Figures 95, 100). The labrum is entirely glabrous, except in Epilachna where the labial palpi are monosetose at the tip, bisetose at the lateral margins of the base, monosetose at the base of the ligula (Figures 99, 100), and densely setiferous on the anterior face of the ligula in Hyperaspis (Figures 96, 97).

The thorax

The pronotum is large and immarginated as in Coccinella and STICHOLOTINAE, or strongly marginate apically as in most members of the COCCINELLINAE except Coccinella, Adalia, Hippodamia and Eriopis. In CHILOCORINI and Thalassa montezumae (HYPERASPINI) the pronotum is greatly expanded laterally (particularly along the posterior margin),

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pushing the lateral margin of the pronotum downward and forward, and in some cases (as in Axion) the lateral side may descend considerably beyond the lower margin of the eye (Figure 24) giving the pronotum as seen from the top, a crescent shape (Figures 106, 107). In the COCCINELLINAE, the pronotum is usually subquadrate with the anterior margin very slightly concave or almost straight. In contrast, the remaining species in all groups (including Epilachna) usually have the anterior margin of the pronotum deeply concave (Figure 108). The posterior margin of the pronotum is often rounded and convex (Figures 105, 112, 115) except in Stethorus where it is broadly tuberculated (Figure 110), and in Scymnus where it is expanded caudally into a rounded lobe (Figure 109). The lateral margins of the pronotum are straight or slightly concave in all cases, with the edge often rounded except in Hippodamia where it is greatly expanded into a sharp knife-like edge (Figure 133). A medio longitudinal pale line is usually seen in COCCINELLINAE (Figures 122-128).

The mesonotum is usually trapezoidal in shape, with the anterior side much longer than the posterior one, and often spotted in the COCCINELLINAE (Figure 1). The scutellar area may be recognized as an elevated area at mid-base.

The metanotum is more or less trapezoidal with the posterior margin usually straight except in HYPERASPINI where the margin is slightly sinuate (Figure 236). The metanotum is also often spotted in COCCINELLINAE.

The elytra are elongate oval or rectangular, bending ventrally to cover most of the hind legs and abdominal sterna. The elytral area of coccinellid pupae may be divided as in Figures 5 and 6, in which the

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apex possesses the most significant characters. In most cases the lateral angle is obtusely rounded and almost continuous with the lateral margin (Figure 5), but especially in Hippodamia (Figures 6, 164-170), the lateral angle sharply expands anteriorly into a well defined rounded lobe. The epipleuron is usually wide and slightly concave. In COCCINELLINAE, the lateral margin of the elytron is strongly marginate (Figure 161) but in the rest of the family it is immarginate (Figure 162). The elytral surface is smooth except in some members of the COCCINELLINI where the surface is covered with microscopic rounded bumps (micronodulated, Figure 7), and in the CHILOCORINAE (especially in Axion, Exochomus and Brumoides) where the elytral surface is obviously spinose (Figure 25).

The hind wing is usually semi-slerotized or membranous, bulbous and tapered apically. The surface is always smooth and glabrous except in Coccinella and Adalia where the apex is covered with very fine and sharp spines, (microspinulated, Figures 179-184), and in STICHOLOTINAE and COCCIDULINAE where the apex of hind wing is finely setiferous (Figures 232-234, 243).

The structure of the legs of coccinellid pupae is homogenous throughout the family. The articulations are poorly developed, with the femur and tibia apparently "fused" together along their margins. The tarsus is weakly segmented, but the terminal segment is rather clearly defined by being more slender and cylindrical. Claws are often undefined and obtuse except in Psyllobora vigintimaculata where the claws are more distinct and pointed. In Exochomus the terminal segment is more slender, with the diameter about one-fourth the dorsal length of the tarsus (Figure 104). Only in Stethorus and Scymnus with the

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metacoxae widely separated, where the distance between the procoxae one-half as wide as that between the metacoxae (Figure 238).

The abdomen

Abdominal terga: In general, coccinellid pupae may be placed in two groups, one group with broad intersegmental conjunctivae clearly visible between segments 4 and 5, 5 and 6, and 6 and 7 (Figures 1, 244, 245). These intersegmental conjunctivae appear to be as strongly sclerotized as the terga with the exception of a transverse line which allows the conjunctiva to fold upon itself. This morphological adaptation is exclusively in the COCCINELLINAE and allows the abdomen to move more freely. The conjunctivae are finely setiferous except in Hippodamia where they are glabrous.

The second group consists of the remaining species of the family in which all terga are closely opposed to one another without intervening conjunctivae (Figures 240-243), resulting in greatly reduced flexibility of the abdomen.

As mentioned above, the dorsum of the abdomen of COCCINELLINAE is distinctly maculate, while the remaining species of the family are usually immaculate and pale yellowish or brownish.

Urogomphi: Abdominal tergum 9 is usually modified into one pair of lateral cerci-like processes or urogomphi which serve as grasping appendages to permit the pupa to attach to the subtrate within the last larval exuvium. Tergum 9 also bears a dorsal median lobe or pygidium which is glabrous in COCCINELLINAE and STETHORINI, and finely setiferous in CHILOCORINI, SCYMNINI, HYPERASPINI, COCCIDULINI, SCYMNILLINI, SERANGIINI, STICHOLOTINI, and EPILACHNINI. The shape of

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the urogomphi is strikingly different from one group to other, except for the STICHOLOTINAE which have no urogomphi (Figures 195-198). The urogomphi may be long, slender and subcylindrical, with the tip simple and obtusely rounded as in Epilachna (Figures 199, 201) and Scymnus. In Stethorus, the urogomphal tip is slightly flared into a flat subcircular distal disk (Figures 210, 211). In Lindorus lophantae the tip is tapered to a point (Figure 202). In another case restricted to the COCCINELLINAE, the urogomphi appear less slender, with the distal end twisted and folded ventroanterad into a bilobed distal disk (Figures 218-229) as seen ventrally. The inner lateral side of the urogomphus is usually straight except in Anatis, Synonycha, Anisocalvia and Neoharmonia where a spine-like process (Figures 224, 225) is present. In HYPERASPINI the urogomphi are quite short, with the distal disk very well developed, sclerotized and double parenthesis-shaped as seen ventrally (Figures 207, 208). In Cryptolaemus montrouzieri, the urogomphi branch at the distal one-third into a large sausage-like process (Figures 205, 206), which is quite different from Scymnus where the urogomphi are unbranched. The urogomphi of CHILOCORINI are very characteristic, with either single or double branches and with the distal end greatly enlarged into rounded mushroom-shaped tips (Figures 215-217).

Abdominal pleura: The structure of the abdominal pleura is very homogenous in coccinellid pupae. They often are greatly expanded laterally into subquadrate or rhomboidal plates, with the lateral margin usually simple, straight, or slightly convex (Figures 171, 172, 174) except in Eriopis connexa, where the lateral margin of pleura 3, 4, and 5 is slightly angulate (Figure 175), and in Anisocalvia, Anatis and

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Synonycha where the posteriolateral angle projects laterocaudad into a conical or long, cylindrical spine-like process (Figures 176-178). In Neoharmonia venusta the posteriolateral angle of the pleura expands slightly caudally on segments 3, 4 and 5 (Figure 171). This is intermediate between the "Anatis type" and the undifferentiated type. Pleura 1 and 2 are always hidden under the elytra and pleuron 9 is often fused with the base of the urogomphus. In HYPERASPINI, unlike all other groups, the abdominal pleura strongly curve ventrally, and thus are invisible from above (Figure 236).

Abdominal sterna: The structure of the abdominal sterna is also very homogenous among coccinellid pupae. There are usually nine, however, the first two are greatly reduced in size and hidden beneath the hind coxae except in a few cases where they are visible medially as in Anatis and Synonycha. In the ♂, the ninth sternum is entirely flat and small whereas in the ♀ it is bipartite and mammillate with the tip of the mammilla usually more sclerotized than the base (Figures 215, 218). In SERANGIINI and STICHOLOTINI the tip is very large and elongate (Figures 195-198).

The spiracles

The prothoracic spiracles are elongate oval in most cases or rounded as in Adalia bipunctata and Eriopis connexa.

The abdominal spiracles are located on the anterolateral angle of the abdominal tergum and usually differ from group to group, except for members of tribe HYPERASPINI, in which the spiracles are wanting (Figure 236). The different types of spiracles can be distinguished as follows:

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-In EPILACHNINI all abdominal spiracles are slightly and subequally pedunculated, with the peduncles semisclerotized or membranous (Figure 235). This type of spiracle is also present in the COCCIDULINI, and Chilocorus; however, the peduncle progressively decreases in length as the spiracles approach the posterior end of the abdomen (Figures 234, 242).

-In CHILOCORINI and STETHORINI only the first abdominal spiracles are pedunculated, with the peduncle very long, conical and strongly sclerotized in CHILOCORINI (Figures 185-189, 240, 242), or very slender, usually cylindrical, and semisclerotized or membranous in STETHORINI (Figures 190-192). The remaining abdominal spiracles of these two tribes are without peduncles and are circular or nearly so (Figure 240).

-Also, in the CHILOCORINI, (Axion, Exochomus, Brumoides), in addition to the peduculated spiracles, one pair of pit-like gland openings is present between the anterior margin of the first abdominal tergum and the posterior margin of the metanotum (Figures 187, 239, 240). These are absent in Chilocorus and Orcus.

-Finally, the most common type of spiracle is observed in SCYMNINI, SCYMNILLINI, SERANGIINI, STICHOLOTINI, COCCINELLINI and PSYLLOBORINI where the spiracular peduncle is wanting, the opening is usually elongate oval or circular, and usually well sclerotized (Figures 1, 244, 245). The pair of spiracles on the first abdominal segment appears much larger than the rest, and is mostly hidden beneath the elytron (Figures 1, 244, 245).

KEY TO SUBFAMILIES AND TRIBES OF THE KNOWN PUPAE OF COCCINELLIDAE

1 Abdomen flexible with intersegmental conjunctivae of abdominal 3 to 6 exposed (Figures 244, 245); body finely setiferous, setae shorter than the thickness of the lateral margin of the pronotum; dorsal surface distinctly maculate (Figures 1, 244, 245), COCCINELLINAE.....2

1' Abdomen compact, without intersegmental conjunctivae exposed (Figures 240-243); body coarsely setiferous with various types of setae, the longest setae considerably longer than the thickness of the lateral margin of the pronotum (Figures 9-22); dorsal surface usually immaculate.....3

2(1) Clypeolabrum usually as long as wide (Figures 32-37); galea small, with the greatest width one-half as wide as the base of the maxillary palpus (Figures 90, 91); size medium to large, over 5mm in length.....COCCINELLINI

2' Clypeolabrum much wider than long (Figure 46); galea greatly enlarged, with the greatest width as wide as the base of the maxillary palpus (Figure 92); size small, less than 5mm in length.....PSYLLOBORINI

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3(1') Mandibles greatly enlarged with chewing tip broadly concave mesally (Figures 72-78); maxillary palpi densely setiferous (Figures 9, 10, 83); abdominal spiracles subequally pedunculate (Figure 235) EPILACHNINAE.....EPILACHNINI

3' Mandibles not enlarged, tip pointed, simple or bifid, maxillary palpi glabrous or monosetose (Figures 12, 31, 84, 85); abdominal spiracles variable but never subequally pedunculate.....4

4(3') Clypeus broadly expanded laterally, concealing antennal bases (Figures 23-29); mandible simple at tip (Figures 64-67); pupa usually enclosed in the last larval exuvium; and visible through a dorso-longitudinal slit (Figure 239), CHILOCORINAE.....CHILOCORINI

4' Clypeus normal, antennal bases visible (Figures 11-22); mandibles usually bifid at tip (Figures 68-71); pupa usually free from last larval exuvia (Figure 234).....5

5(4') Hind wing apex finely setiferous dorsally; setae fine and thin.....6

5' Hind wing apex glabrous; setae coarse or bristle-like, SCYMNINAE.....10

6(5) Urogomphi wanting (Figures 195-198); clypeolabrum as long as or longer than wide (Figures 13, 14) STICHOLOTINAE.....7

6' Urogomphi well developed (Figures 11, 12, 50); clypeolabrum wider than long, COCCIDULINAE.....8

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7(6) Pronotum with a dorsolongitudinal depression (Figure 13); abdominal pleura glabrous; posterior margin of pygidium deeply concave (Figures 195-196), Delphastus pusillus (Leconte).....SERANGIINI

7' Pronotum without such a dorsolongitudinal depression; abdominal pleura setiferous; posterior margin of pygidium subparallel with anterior margin (Figures 197-198), Microweisea ovalis (Leconte)..... .....STICHOLOTINI

8(6') Abdominal pleura 3 to 5 greatly expanded laterally with lateral margin strongly convex (Figure 234); dorsum of abdominal tergum non-tuberculate (Figure 234).....9

8' Abdominal pleura 3 to 5 not expanded laterally, subquadrate (Figure 243); dorsum of abdominal terga each with one transverse pair of tubercles (Figure 243), Rodolia cardinalis Mulsant.....NOVIINI

9(8) Antennae tapered distally (Figures 12, 61) and short, extending to a point about midway between the eye and the widest lateral margin of the pronotum (Figure 12); first four abdominal spiracles normal; maxillary palpus monosetose (Figures 12, 84), Zagloba ornata (Horn).....SCYMNILLINI

9' Antennae enlarged distally into a distinct club with well developed papillae (Figure 11), and extending to the widest lateral margin of the pronotum

10(5')

10'

11(10')

11'

(Figure 11); first four abdominal spiracles slightly pedunculated (Figure 234); maxillary palpus glabrous.....COCCIDULINI

10(5') Head with frontal area membranous and usually protuberant (Figures 20, 22); first abdominal spiracles pedunculated (Figures 190-192, 237); femora glabrous.....STETHORINI

10' Head with frontal area as sclerotized as the other areas; first abdominal spiracles not pedunculated or obsolete; femora setiferous.....11

11(10') Abdominal pleura visible from above, abdominal spiracles present; antennal club distinct (Figures 31, 58, 59).....SCYMNINI

11' Abdominal pleura not visible from above (Figure 236); abdominal spiracles absent; antennal club indistinct (Figures 15, 16).....HYPERASPINI

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SUBFAMILY STICHOLOTINAE

Diagnosis

This is the only known group of pupae of Coccinellidae which lack urogomphi. However, they appear to have a strong affinity to Coccidulinae by having the hind wing apex finely setiferous dorsally on the lateral angle (Figures 232-234). Moreover, the simple mandibular tip allies the Sticholotinae with members of Chilocorinae (Chilocorini) which have also retained this primitive type of mandible.

TRIBE SERANGIINI

Genus DELPHASTUS Casey

Specimens examined

The study was based on three pupae of Delphastus pusillus from the U. S. National Museum, collected in Havana, Cuba, 29 September 1928 by Brinner.

Diagnosis

Serangiini and Sticholotini are the only two tribes for which pupae were available in the subfamily Sticholotinae. They are usually minute in size (about 1mm to 1.50mm in length). Serangiini can be

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recognized by the dorsolongitudinal depressed line on the pronotum (Figures 13, 233), the abdominal pleurae and terga 3 to 5 are glabrous, and the posterior margin of the pygidium is deeply notched (Figures 195, 196). In the Sticholotini the dorsum of the pronotum is convex, all abdominal terga and pleura are homogeneously setiferous, and anterior and posterior margins of the pygidium are subparallel.

Delphastus pusillus (Leconte)

Description

Length: 1.5mm; width: 1mm. Body small, rounded oval, yellowish, immaculate, and densely setiferous dorsally. Head pale, setiferous. Antennae long with club greatly enlarged and slightly compressed dorsoventrally, with 3 rings of poorly developed papillae; antennal scape and the last 2 "segments" of flagellum somewhat papillated and enlarged (Figure 13). Clypeolabrum narrow, with lateral sides subparallel, greatly narrowed apically, and apical margin slightly concave (Figure 13). Mandibles simple at tip. Maxillary palpi long, slender, somewhat cylindrical (about 3 times or more longer than wide), and slightly curved inward at base (Figure 13).

Pronotum elongate oval as seen from above, with a wide dorsolongitudinal depression line (Figures 13, 233). Metanotum large and as long as the first two abdominal terga combined (Figure 242). Elytra pale yellowish, immaculate, and densely setiferous. Hind wings semimembranous with dorsal surface of lateral apical angle densely setiferous. Legs short and rather robust.

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Abdominal terga yellowish, immaculate, closed tightly together, with the first two terga and terga 6 to 9 setiferous, whereas terga 3 to 5 are very finely setiferous or apparently glabrous. Pygidium small with posterior margin deeply notched (Figures 195-196). Urogomphi wanting (Figures 195, 196). Abdominal pleura subquadrate, usually in a vertical position and glabrous. Abdominal sterum 9 of the ♀ characteristically modified with a pair of greatly elongate and conical "gonopods" (Figure 196). In the ♂, the sternum remains flat and small (Figure 195).

TRIBE STICHOLOTINI

Genus MICROWEISEA Cockerell

Specimens examined

The study was based on 2 pupae of Microweisea ovalis from the U. S. National Museum, collected in New Orleans, Louisiana, on 13 July 1923.

Diagnosis

See Delphastus pusillus for the separation of these two tribes.

Microweisea ovalis (Leconte)

Description

Length: 1.25mm; width: 0.75mm. Body pale brownish, immaculate and apparently setiferous. Very similar to Delphastus pusillus.

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Head longer than wide. Antennae long, extending to the widest lateral margin of the pronotum; club enlarged and with well developed papillae; flagellum cylindrical and slender. Clypeolabrum subtriangular, with apex very narrow and truncate (Figure 14). Mandibles simple at tip. Maxillary palpi slender, very long and cylindrical (Figure 14).

Pronotum nonmarginate and densely setiferous. Elytron brownish, and conspicuously and densely setiferous. Dorsal side of abdomen homogenously and densely setiferous. Pygidium small and subrectangular. Abdominal pleura subquadrate, with the 3rd and 4th pleura conspicuously and densely setiferous. Venter of abdomen entirely pale and sparsely setiferous. In the ♀, the "gonopods" (9th abdominal sternum) are conical and greatly elongate (Figure 198). Sternum 9 of the ♂ is short and inconspicuous (Figure 197).

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SUBFAMILY COCCIDULINAE

Diagnosis

Coccindulinae are separated from Sticholotinae by the presence of one pair of prominent urogomphi and by abdominal pleurae 3 to 6 being greatly expanded laterally, giving the lateral margin of the pleuron a strongly convex appearance (Figure 234). These two subfamilies in turn are distinguished from the remaining groups of Coccinellidae by the characteristically setiferous hind wing apex (Figures 232-234).

TRIBE COCCIDULINI

Diagnosis

The Coccidulini is the only group of pupae with at least the first four pairs of abdominal spiracles slightly pedunculate (Figure 234). This character is also observed in Epilachnini, but in the Epilachnini all abdominal spiracles except those on segment 9 are slightly and subequally peduculate. The above character separates Coccidulini from Scymnillini which have all abdominal spiracles circular or nearly so and normal (=not pedunculate). Furthermore, the long antennae with a distinct papillated club, and the slender urogomphi with the tip unevenly pointed, are very characteristic of this tribe. In the Scymnillini, the antennae appear short with an

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indistinct club, papillae are entirely absent, and the urogomphi have enlarged tips (Figures 12, 203, 204).

Key to Genera of the Known Pupae of Coccidulini

1 Body very densely setiferous, dorsum nearly clothed with short, thin, semierect setae whose tips strongly curve back to the body surface; macrosetae (long setae) sparsely distributed; pygidium shorter than abdominal tergum 7.....Rhizobius ventralis (Erichson)

1' Body less densely setiferous, setae erect with tip not curved back to body surface; pygidium as long as abdominal tergum 7.....Lindorus lophantae Blaisdell

Genus LINDORUS Casey

Lindorus lophantae (Blaisdell)

Specimens examined

The study was based on four pupae of Lindorus lophantae from the U. S. National Museum, reared by the Bermunda Department of Agriculture, 13 June 1952.

Diagnosis

This species, in general, is very easily separated from Delphastus pusillus and Microweisea ovalis by possessing very prominent and slender urogomphi (Figure 202), and by the clypeolabrum being much

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wider than long (Figure 11). In Delphastus and Microweisea the urogomphi are wanting, and the clypeolabrum is longer than wide (Figures 13, 14, 195-198).

Description

Length: 2mm; width: 1mm. Body elongate oval, densely setiferous, pale and immaculate. Head wide, clypeolabrum wider than long with apex slightly convex (Figure 13). Antennae long, extending to the widest lateral margin of the pronotum; club distinct and large, elongate cylindrical, with 4 rings of well developed papillae. Mandibles unequally bifid at tip.

Pronotum pale or brownish, densely setiferous both dorsally and ventrally, and immarginate with the anterior margin concave. Posterior margin of metanotum slightly sinuate (Figure 234). Elytron pale and setiferous (except brownish in one specimen); lateral margin immarginate. Hind wings membranous, gradually tapering toward apex where dorsal surface is setiferous (Figure 234). Legs short and robust with femora densely setiferous.

Abdominal terga subequal in length, each with 2 pairs of conspicuous groups of setae located at spiracular and dorsal areas. Spiracular group consisting of four conspicuous setae, whereas dorsal group consists of three (Figure 234). Pygidium large, trapezoidal, setiferous and as long as the 7th abdominal tergum. Urogomphi strongly sclerotized, extremely slender and cylindrical, tapering, and pointed apically (Figure 202). First 4 abdominal spiracles slightly pedunculate (Figure 234). Abdominal pleura 1 and 2 hidden under the elytron, pleura 3 to 6 greatly expanded laterally, with lateral margin strongly

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convex and conspicuously setiferous (Figure 234). Abdominal sterna pale, densely setiferous along posteriomarginal areas. Sternum 8 small, about one-half as long as sternum 7.

Genus RHIZOBIUS Stephens

Rhizobius ventralis (Erichson)

Specimens examined

The study was based on two pupae of Rhizobius ventralis from the U. S. National Museum collected in California on 15 June 1896.

Description and diagnosis

Very similar to Lindorus lophantae in many respects except for the following characters.

Length: 3.5-4mm; width: 1.5-1.8mm. Body more densely setiferous, with setae semi-erect and with the distal ends strongly curved back to the body surface. However, because of the poor condition of the specimens, it is very difficult to distinguish this species from Lindorus lophantae in terms of chaetotaxy. Pygidium much shorter than abdominal tergum 7.

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TRIBE SCYMNILLINI

Genus ZAGLOBA Casey

Specimens examined

The study was based on a single pupa of Zagloba ornata from the U. S. National Museum reared by the Bermuda Department of Agriculture from California stock, 13 June 1952.

Diagnosis

See diagnosis of Coccidulini for the separation of these two tribes.

Zagloba ornata (Horn)

Description

Length: 2.5mm; width: 1.5mm. Body pale brownish, very densely setiferous, similar to Lindorus lophantae except for the following characters:

Head pale yellowish, slightly longer than wide (Figure 12). Antennae short, extending to about one-fourth the distance between the eye and the widest lateral side of the pronotum; scape and the first two "segments" of flagellum greatly enlarged (much larger than distal portion which is somewhat cylindrical and rounded at tip) (Figure 12, 61). Clypeolabrum subquadrate and sparsely setiferous, apical margin slightly concave (Figure 12). Mandible unequally bifid at tip.

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Maxillary palpi long and cylindrical, with the apex rounded and monosetose (Figures 12, 84).

Pronotum and mesonotum slightly darker (brownish) than any other areas.

Abdomen appearing more densely setiferous than Lindorus. Abdominal spiracles subcircular and normal (without peduncle). Abdominal pleura 3, 4, and 5 greatly expanded laterally, rounded and densely setiferous (Figure 234). Urogomphi short (as long as pygidium), with distal end slightly enlarged and curved ventrally (Figures 203, 204).

TRIBE NOVIINI

Genus RODOLIA Mulsant

Specimens examined

The study was based on 8 pupae of Rodolia cardinalis collected in Gainesville, Florida, on 14 July 1972 by R. E. Waites. Two pupae are deposited in the Entomology Museum of Michigan State University, the remainder in the Department of Entomology and Nematology, University of Florida.

Diagnosis

Noviini can be separated from Coccidulini (=Rhizobiini) and Scymnillini by the subvertical position of the abdominal subquadrate pleura whose lateral margins are usually straight; and by the two-branched urogomphi. In Coccidulini and Scymnillini, the abdominal

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pleurae are usually greatly expanded laterally, are horizontal in position with strongly convex lateral margins. The urogomphal apices are pointed or slightly enlarged. The Noviini are placed in the subfamily Coccidulinae with the Coccidulini and Scymnillini because they possess the distinctive finely setiferous hind wing apex.

Rodolia cardinalis Mulsant

Description

Length: 4-4.5mm; width: 2.5-3mm. Body elongate oval. The abdomen is subcylindrical in cross section, retaining much of the larval aspect and is twice as long as the thorax. Dorsum yellowish to brownish, with undefined brown spots on mid-dorsal area of abdominal terga where a slight depression is located. In general, the body is densely setiferous with the setae on the pronotum and the dorsum of the abdomen appearing coarser than on the other areas of the body surface. The body is almost enclosed in the last larval exuvia.

Head broad, as wide as long. Antennae short, extending slightly beyond the outer lateral margin of the eye, without papillae. Club indistinct from the flagellum. Scape enlarged and rounded (Figure 50). Clypeolabrum large, much wider than long, with the apical margin slightly concave (Figure 50). Mandibles unequally bifid at the apex, with the posterior tip greatly reduced in size. Maxillary palpi with the apex enlarged.

Pronotum immarginate, mostly pale except for one pair of undefined brownish discal spots. Surface of the pronotum densely setiferous, and the setae adjacent to discal spots are strongly pigmented.

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Meso- and metanotum brown except scutellar area on mesonotum pale yellowish. Elytron elongate oval, pale whitish except for brownish basal and scutellar area. Lateral margin immarginate. Epipleura sparsely setiferous and slightly concave. Hind wing apex finely setiferous dorsally, especially along lateral margin. Legs short and robust with femora densely and finely setiferous.

Abdominal terga yellowish to brownish. Each tergum usually with a dorsally joined pair of depressions where the coloration is darker than other areas, and one pair of transverse-banded tubercles running the tergal width, on which setae are very dense. The tubercle much reduced in size or wanting on terga 6 to 9. Urogomphi bipartite, the outer branch with apex simple, the inner branch shorter but with apex modified into a parenthesis-shaped distal disk (Figures 230, 231). This character indicates some relationships with Hyperaspini (SCYMNINAE) and Chilocorini (CHILOCORINAE) whose urogomphi are usually bipartite. Abdominal spiracles small, inconspicuous and normal (nonpedunculate). Abdominal pleura subquadrate and in a subvertical position. Abdominal sterna entirely pale.

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SUBFAMILY EPILACHNINAE

TRIBE EPILACHNINI

Diagnosis

This is the only group of coccinellid pupae in which the chewing tip of the mandibles is distinctly and broadly concave mesally (Figures 72-78). The maxillary palpi are densely setiferous (Figures 9, 10, 83), and the abdominal spiracles are membranous and slightly pedunculate (Figure 245).

Genus EPILACHNA Chevrolat

Description

Length: 7.5mm-8.00mm; width: 4.5-5mm. Body moderately large, pale yellowish, usually immaculate and densely setiferous.

Head pale, as long as wide. Antennae (Figures 9, 56) long, extending to the widest lateral margins of the pronotums. Club monosetose distally, and indistinct, with three or four rings of papillae (Figures 56, 57). Flagellum long, subquadrate in cross section and slightly elbowed or C-shaped. Clypeolabrum narrow, subtrapezoidal with the apical margin concave (Figure 9). Mandible large, visible without removing the clypeolabrum; the chewing tip

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bifid as seen from the top and distinctly and broadly concave mesally (Figures 72-78). Maxillary palpi densely setiferous (Figure 83).

Pronotum nearly twice as wide as long, the basal margin arcuate and the anterior margin deeply concave. Macrosetae dense but confined along the margins of the pronotum (Figure 108). Elytron pale, immaculate, and three times as long as wide. Epipleura glabrous and wide. Hind wing pale and entirely glabrous.

Abdomen compact, usually immaculate and pale, with macrosetae somewhat sparsely distributed on dorsal surface. In contrast, the microsetae are more densely distributed over the rest of the body. Pygidium small and finely setiferous. Urogomphi slender, subcylindrical and straight at apex (Figure 199). All abdominal spiracles distinctly pedunculate (with the peduncle usually as long as the diameter of the spiracular opening.

Key to Species of the Known Pupae of Epilachna

1 Anterior surface of the antennal scape setiferous (Figure 10); both anterior and posterior mandibular tips pointed as seen from the apex (Figure 77).....
.....Epilachna sp.

1' Anterior surface of the antennal scape glabrous (Figures 9, 57); anterior mandibular tip truncate as seen from the apex (Figures 74, 78).....2

2(1') Posterior mandibular tip sharply pointed as seen from the apex (Figure 78); one pair of distinct eye-like

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Description

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brown spots present on abdominal terga 3 to 5.....
.....Epilachna borealis (Fabricius)

2' Posterior mandibular tip angulate or truncate as seen from the apex (Figure 74); abdominal terga 3 to 5 immaculate.....Epilachna varivestis Mulsant

Epilachna borealis (Fabricius)

Specimens examined

The study was based on a single pupa associated with adults, from the U. S. National Museum collected in Quincy, Florida 9 August 1944.

Diagnosis

Epilachna borealis has one pair of eye-like brownish spots per segment on abdominal terga 3 to 5 and only the posterior tip of the mandible is pointed as seen from the apex. In Epilachna sp. both the the posterior and anterior mandibular tips are pointed, and in Epilachna varivestis, the posterior mandibular tip is truncate or angulate as seen from the apex. The last two species are usually entirely pale dorsally.

Description

Length: 7mm; width: 5mm. Body pale yellowish, broadly oval with macrosetae sparsely distributed on dorsal surface.

Head entirely pale yellowish. Antennae long with flagellum C-shaped and scape distinct and glabrous. Mandible with the posterior

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Description

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tip pointed and the anterior tip truncate as seen from the apex (Figure 78). Dorsum of abdomen sparsely macrosetiferous. Abdominal terga pale and immaculate except terga 1 and 2 which have a brownish posterior margin, and terga 3 to 5 which have one pair of brown eye-like spots.

Epilachna varivestis Mulsant

Specimens examined

The study was based on 8 pupae from the U. S. National Museum, 1 pupa collected in Tippecanoe Co., Indiana, on 4 September 1970 by L. Matteson and 2 pupae collected in Michigan on August 1972 by D. C. Cress. The last two pupae are deposited in Entomology Museum at Michigan State University, East Lansing, Michigan.

Diagnosis

Epilachna varivestis is characterized by the truncate or angular posterior mandibular tip as seen from the apex (Figure 74). This differs from the other two available Epilachna pupae (Epilachna borealis and Epilachna sp.) whose posterior mandibular tip is sharply pointed (Figures 77, 78).

Description

Length: 6.5-7mm; width: 4.5mm. In general this species is very similar to E. borealis except that the body of E. varivestis is usually pale yellowish, and abdominal terga 3 to 5 are entirely immaculate. In addition, the number of spiracular macrosetae on

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abdominal segments 1-3 varied from 4 to 6, and the structure of the tip of the mandibles is strikingly different from E. borealis by having an angulate posterior mandibular tip as viewed from the apex (Figure 74).

Epilachna sp.*

Specimens examined

The study was based on a single pupa from the U. S. National Museum.

Diagnosis

This is the only known species among the available Epilachna pupae whose antennal scape is setiferous while in E. varivestis and E. borealis the antennal scape is entirely glabrous.

Description

Length: 7mm; width: 5mm.

Body largely densely macrosetiferous, immaculate and shiny brownish. Antennae long, with four rather well-developed papillae. Antennal scape bisetose or trisetose on anterior surface (Figure 10). Clypeolabrum trapezoidal with the apical margin truncate or slightly concave and densely setiferous. Mandible unequally bifid with anterior and posterior tips pointed as seen from the apex; the posterior tip twice as large as the anterior one (Figure 77). Maxillary palpi more

*A new species being described by Dr. Robert Gordon as E. austrina, Systematic Entomology Laboratory, USDA, c/o U. S. National Museum, Washington, D. C. 20560.

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SUBFAMILY SCYMNINAE

TRIBE HYPERASPINI

Diagnosis

The members of this tribe possess very short antennae with the distal end tapering, pointed and lack papillae (Figure 62). Moreover, the Hyperaspini may additionally be separated from the Scymnini by the lack of abdominal spiracles and the short urogomphi, with the distal disk strongly sclerotized and double parenthesis-shaped as seen ventrally (Figures 207-208).

Key to Genera of the Known Pupae of Hyperaspini

1 Body large, over 5mm in length; pronotum largely expanded laterally, pushing the posteriolateral margin downward beyond lower margins of the eyes (Figure 16); bristle-like setae only fringing marginal areas of the pronotum, elytra and abdomen (Figure 236). (Thalassa montezumae Mulsant).....THALASSA Mulsant

1' Body small, under 4mm in length; pronotum not expanded laterally with posteriolateral margin above the lower margins of the eyes (Figure 15); bristle-like setae densely and regularly distributed over the entire dorsal surface of the pupa.....
.....HYPERASPIS Chevrolat

Genus HYPERASPIS Chevrolat

Hyperaspis binotata (Say)

Specimens examined

The study was based on 30 pupae of Hyperaspis binotata collected in cottony maple scale, in association with adults in East Lansing, Michigan, 5 July 1971 by Dang T. Phuoc. The specimens are deposited in the Entomology Museum of Michigan State University and in the U. S. National Museum.

Diagnosis

This species may be separated from Thalassa montezumae Mulsant by the densely and regularly setiferous dorsal surface of the body, and its smaller size.

Description

Length: 3.5-4mm; width: 2.5-3mm. Body broadly rounded oval, dorsal surface yellowish to brownish and very densely setiferous with three types of setae. The first type is bristle-like, strongly

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sclerotized, brown and long, with the longest subequal to the clypeolabral length and densely distributed over the dorsal surface, including the elytra and pygidium. The second type of setae are as long as the first, but more slender and confined largely to the abdominal sterna, femora, and the apical and lateral margins of the elytra. The third type of setae are very short, with the diameter slightly greater and about 1/10 as long as the second type.

Head densely covered with bristle-like setae, including the labral apex (Figure 15). Antennae short, extending to about one-third the distance between the eye and the widest lateral margins of the pronotum (Figure 15), with distal half subcylindrical and tapering toward apex (Figure 62). Clypeolabrum gradually narrowed apically, with apical margin slightly concave.

Mandibles unequally bifid at tip, with the ventral tip considerably reduced in size (Figures 68, 69).

Pronotum yellowish, immarginate, with apical margin deeply concave. Posterior margin of metanotum slightly sinuate. Lateral margin of elyton immarginate; epipleura wide and glabrous. Legs robust and short, with anterior surface of femora densely setiferous (Figure 15). All abdominal terga densely setiferous and subequal in length, except for the pygidium (also setiferous) which is half as long. Urogomphi short, flattened at base, distal disk strongly sclerotized, consisting of a parenthesis-shaped outer lobe and a comma-shaped inner lobe as seen ventrally (Figure 207). Abdominal spiracles absent. Abdominal pleura subquadrate and in a vertical position (thus invisible from above). Abdominal sterna pale and finely setiferous (bristle-like setae absent).

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Genus THALASSA Mulsant

Thalassa montezumae Mulsant

Specimens examined

The study was based on one pupa and one exuvia of Thalassa montezumae from the U. S. National Museum, collected from Harlingen, Texas, 13 September 1932.

Diagnosis

The apparently glabrous dorsum of the body, except for the marginal areas which are densely and coarsely setiferous, distinctly separates this species from Hyperaspis binotata whose body is densely, coarsely and homogeneously setiferous.

Description

Length: 6mm; width: 4-4.5mm. Body large broadly rounded oval.

Head brown, with bristle-like setae confined on vertex and upper portion of frontal area; the rest of the head covered with fine and slender or short conical setae (Figure 16).

Pronotum with anterior margin deeply concave and greatly expanded laterally, with the posterior lateral side descended beyond the lower margin of the eye. Body surface brown and covered with fine, slender setae, except for the yellowish marginal areas which are fringed with long, bristle-like setae (Figures 16, 236). Meso- and metanotum apparently glabrous and brownish except for the yellowish scutellar

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area. Elytron brown, densely and finely setiferous, except for sutural and lateral margins which are fringed with long, bristle-like, stout setae. Legs robust with finely setiferous femora.

Abdominal terga brownish (except the first 2 yellowish), broadly tuberculated laterally, where dense, bristle-like setae are confined (Figure 236). Abdominal pleura subquadrate, invisible from above, and fringed with bristle-like setae on the lateral margins (Figure 236). Abdominal spiracles absent.

TRIBE SCYMNINI

Diagnosis

This tribe, in a general way, is very similar to the Hyperaspini, but the antennae (Figures 58, 59) have a distinct club and the abdominal spiracles are normally present. Moreover, the homogeneous sclerotization of the head capsule, with the frontal suture wanting, and with dense setae on the labrum, femora and pygidium separates this tribe from Stethorini which characteristically possess the membranous frontal area, the glabrous labrum, legs, and pygidium.

Key to Genera of the Known Pupae of Scymnini

1 Body homogeneously and densely setiferous; anterior surface of antenna scape glabrous (Figure 58); pronotum projected caudad at mediobasal area into a turbercle-like rounded lobe (Figure 109), and

apical margin continuous with the vertex of head (Figure 30); maxillary palpi glabrous.....SCYMNUS Kugelann

1' Body apparently densely and coarsely setiferous only along marginal areas (Figure 241); anterior surface of antennal scape setiferous (Figures 31, 59); pronotum with basal margin arcuate, mediobasal area normal and apical margin not continuous with the vertex of the head; maxillary palpi monosetose (Figures 31, 85).....CRYPTOLAEMUS Mulsant

Genus SCYMNUS Kugelann

Scymnus creperus Mulsant

Specimens examined

The study was based on a single pupa of Scymnus creperus from the U. S. National Museum, collected in Amherst, Massachusetts, on 18 July 1941 by M. E. Smith and identified by E. A. Chapin.

Diagnosis

Species of Scymnus are quite different from Stethorus for the head is slightly and homogenously sclerotized and all abdominal spiracles are normal, whereas in Stethorus the frontal area is membranous and usually protuberant and the first abdominal spiracles are prominently pedunculate.

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Description

Length: 3mm; width: 1.5 mm. Body generally pale or yellowish, slightly elongate oval, and very densely setiferous.

Head pale, homogenously sclerotized and setiferous, vertex largely visible from above. Antennae short, extending to about one-third of the distance between the eye and the widest lateral margin of the pronotum. Antennal scape projected caudally into a short spine-like process (Figure 58). The first 2 segments of the flagellum distinctly enlarged, and the club with papillae rather well developed. Clypeolabrum shorter than wide, with lateral sides rounded and apical margin truncate. Mandibles bifid. Maxillary palpi slightly enlarged apically.

Pronotum immarginate, with apical margin continuous with vertex of the head (Figure 30). Mediobasal area expanded caudally into a large tubercle-like rounded lobe (Figure 109). Elytron homogenously and densely setiferous, including the apical and sutural margins. Hind wings glabrous. Legs short and robust, with anterior surface of femora densely setiferous. Metacoxae widely separated, the distance twice as great as between the procoxae (Figure 238).

Dorsum of abdomen pale or yellowish and densely setiferous, with 2 types of setae. The macrosetae are twice the length of microsetae and consistent in location. They can be distinguished on each tergum as dorsal setae (usually a group of 3 somewhat transversely aligned setae), and subspiracular setae (usually a group of 2 setae). Pygidium small and very densely setiferous. Urogomphi cylindrical and very slender (as long as or slightly longer than the 8th abdominal tergum), with the distal end very slightly curved ventrally (Figure 201).

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Abdominal spiracles subcircular and normal. Abdominal pleura subquadrate or rhomboidal and very densely setiferous, especially along outer lateral half. Ventral side of abdomen pale and less densely setiferous than dorsal side.

Genus CRYPTOLAEMUS Mulsant

Cryptolaemus montrouzieri Mulsant

Specimens examined

The study was based on 4 pupae of Cryptolaemus montrouzieri from the U. S. National Museum, collected in Honolulu, Hawaii, 1 September 1894.

Diagnosis

This is the only known species of the Scymninae which has the antennal scape setiferous on the anterior surface (Figures 31, 59) and with the maxillary palpus monosetose at apex (Figures 31, 85). Cryptolaemus can also be separated from Scymnus by the appearance of dense and coarse setae confined along the marginal areas of the body as seen dorsally. Furthermore, the urogomphi of Scymnus are slender and straight, whereas in Cryptolaemus, the urogomphi prominently branch mesally into a large sausage-like process (Figures 205, 206).

Description

Length: 4-5mm; width: 2.5-3.5mm. Similar to Scymnus in many respects except the following.

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Body moderate large in size; in general, very densely and coarsely setiferous along marginal areas of the body.

Head pale, finely setiferous except the labrum and antennal scape which are long and slender setae. Antennae short, extending only half the distance between the eye and the widest lateral side of the pronotum; club with 4 rings of well developed papillae; flagellum short and subquadrate in cross section; scape somewhat rounded and setiferous on anterior surface (Figure 59). Clypeolabrum wider than long with apcal margin very narrow and slightly concave. Labral surface (including margins) densely setiferous. Maxillary palpi monosetose at apex (Figure 31).

Pronotum brownish, immarginate, densely and coarsely setiferous along lateral and basal margins. Meso- and metanotum brownish and apparently glabrous. Elytron brownish but pale at apex and epipleura; surface apparently glabrous except sutural; apical and lateral margin densely and coarsely setiferous (Figure 241). Hind wings glabrous. Legs coarsely setiferous on anterior side of distal ends of femora (Figure 31). Metacoxae narrowly separated.

Abdomen brownish and apparently glabrous dorsally, except that the lateral margins of each abdominal tergum are broadly turberculate and armed with dense and coarse setae. Pygidum finely setiferous dorsally. Urogomphi short and stout; as much sclerotized as the immediately previous tergum, and projected medially into a long sausage-like process (distal disk) (Figure 205). Abdominal pleura semi-sclerotized, tuberculate dorsally and laterally and armed with dense and coarse setae along lateral margins (Figure 241) except

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TRIBE STETHORINI

Genus STETHORUS Weise

Diagnosis

This is the only known tribe of Coccinellidae in which the frontal area of the pupae is membranous and usually protuberant (Figures 17-22). This character separates Stethorini from all other groups of the family where the pupal head capsule is homogenously sclerotized. Stethorus is also characterized by having one pair of prominent tubercles at the base of the pronotum (Figure 110). This character indicates some degree of affinity to Scymnus which has a single broad, rounded lobe directed caudally at the base of the pronotum (Figure 109).

Description

Length: 1.50mm-1.60mm; width: 0.9mm-1mm. Body shiny brownish, somewhat flattened dorsoventrally, elongate oval, tuberculated, and coarsely setiferous. Head pale, eyes very large and sub-rounded. Frontal suture sharply visible (Figures 17, 19, 21). Frontal area entirely membranous, often protuberant (Figures 20, 22). Antennae long, with very well-developed papillae arranged in 3 rings, but with the last two rings incomplete by lacking the dorsal and lateral

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papillae. Clypeolabrum glabrous and subrectangular, much shorter than wide, with apical margin deeply concave (Figures 17, 19, 21). Mandible unequally bifid at tips. Maxillary palpi large and cylindrical. Labial palpi slender and cylindrical.

Pronotum shiny brown, immarginate and broadly bituberculate mediobasally, with posteriolateral angle angulate (Figure 110). Elytron elongate oval, brownish and coarsely setiferous, with the epipleura wide. Hind wings brownish at apex and glabrous. Legs short, robust and glabrous; metacoxae widely separated, twice as wide as procoxae (Figure 238).

Abdomen compact, segments subequal in length and somewhat densely tuberculated dorsally. Pygidium small, whitish and glabrous. First pair of abdominal spiracles prominently pedunculated (Figures 190-192), the rest normal and circular (Figure 237). Urogomphi rather long, straight, and slightly flared at distal end into an oval flat disk, (Figures 210, 211). Abdominal pleura conspicuously setiferous, subrhomboidal and curved ventrally. Ventral side of abdomen entirely pale, each sternum with one pair of median prominent setae except sterna 1, 2, 8 and 9.

Key to Species of the Known Pupae of Stethorus

1 Body parsely setiferous, tubercles on mesonotum and subscutellar area of elytron prominent (Figure 237); first abdominal spiracle somewhat flattened laterally and short (Figure 192); 2nd abdominal pleuron glabrous.....*Stethorus atomus* Casey

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1' Body densely setiferous, tubercles on mesonotum and subscutellar area of elytron obsolete; first abdominal spiracle very slender and cylindrical (Figures 190, 191); 2nd abdominal pleuron setiferous.....2

2(1') Body dark and shiny brown, the membranous area on the frons large, broadly oval, seldom protuberant, with surface slightly concave; abdominal pleuron with more than 10 setae.....Stethorus punctum Leconte

2' Body pale brownish, the membranous area on the frons small, circular and usually protruded into a short cylindrical process (Figure 20); abdominal pleuron with less than 10 setae.....Stethorus picipes Casey

Stethorus atomus Casey

Specimens examined

The study was based on 7 pupae from U. S. National Museum collected in association with adults in Brownsville, Texas, 3 September 1957 by U. L. Stegman and determined by E. A. Chapin.

Diagnosis

This is the only known species of Stethorus which has the first abdominal spiracles with a short and somewhat flattened but conspicuous peduncle (Figure 192). All other known species have the first abdominal spiracles slender and cylindrical (Figures 190, 191).

Description

Length: 1.5mm; width: 0.9mm. Body bronze brownish; prominently tuberculated dorsally.

Head strongly sclerotized, especially on vertex except for the membranous and protuberant oval frontal area. Antennae short and well papillated. Scape and the first segment of flagellum largely expanded caudally along lower side (Figure 21). Clypeolabrum glabrous, wider than long, narrowed apically and deeply concave at apical margin, (Figure 21).

Mediobasal tubercles on the pronotum large, with 2 to 4 setae on each (Figures 22, 110). Mesonotum with one large and prominent dorsal tubercle at the scutellar area bearing 2 pairs of setae (actually a pair of tubercles entirely fused together) (Figure 237). Metanotum depressed dorsally, with tubercles greatly reduced in size and bearing 3 pairs of dorsal setae and one pair lateral setae (Figure 237). Elytron very elongate oval, setae on discal area more sparse than on lateral margin; sutural and apical margins glabrous, but subscutellar area prominently tuberculate (Figure 237). Hind wing somewhat strongly sclerotized at apical area and glabrous. Legs brownish at tibio-femoral joints.

Dorsum of the abdomen brownish except for the pale last segment. First abdominal spiracles flattened laterally, with base wider than one-half the length of 1st abdominal tergum (Figures 192, 237). Each abdominal tergum usually with one pair of dorsal tubercles bearing 3 setae on each, and one pair of subspiracular tubercles bearing 2 setae, except tergum 1 in which the subspiracular tubercles are wanting, and terga 8 and 9 which are entirely glabrous. Pygidium pale translucent

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Diagnosis

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(Figure 190)

Description

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white; urogomphi cylindrical, as long as the 8th sternum, slightly flared distally and ending in a flat subcircular disk more or less perpendicular to the urogomphal axis (Figures 210, 211). Abdominal pleura rhomboidal and curved ventrally; each pleuron with 4 setae occupying the outer half except for pleura 1, 2, 8 and 9 which are glabrous. Ventral abdomen pale; sterna 4, 5, 6, and 7 each with one pair of median setae; sternum 3 largest with 2 pairs of anteriomedial and posteriomedial setae.

Stethorus picipes Casey

Specimens examined

The study was based on 9 pupae from the U. S. National Museum, collected in Yakima, Washington, 4 September 1925.

Diagnosis

This species can be separated from Stethorus atomus by being more densely setiferous and paler, with the 1st abdominal spiracle very slender and cylindrical (as long as or longer than adjacent setae) (Figure 190), and the lack of large scutellar tubercle on the metanotum.

Description

Length: 1.6mm; width: 1mm. Similar to Stethorus atomus Casey except for the followings characters: In general, body paler and more densely setiferous, however, setae much more slender and slightly curved distally.

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Head pale with membranous area on the frons circular and sometimes protruding into a short cylindrical process (Figure 20). Antennal papillae not well developed and greatly reduced in number. Mediobasal tubercles on the pronotum more densely setiferous and each with more than four setae. Scutellar tubercles on the mesonotum much reduced in size or wanting. Discal area of elytron as densely setiferous as lateral margin.

First abdominal spiracles cylindrical, slender and as long as the neighboring setae (Figure 190), the diameter of spiracular opening equal to that of the spiracles on the second segment. Abdominal pleura densely setiferous (6-8 setae on each) except that pleura 1, 8 and 9 are glabrous and pleuron 2 bears two to three setae.

Stethorus punctum Leconte

Specimens examined

The study was based on 1 pupa and 3 exuviae from the U. S. National Museum, collected in a greenhouse in Amherst, Massachusetts, 22 July 1942, by M. E. Smith.

Description

Very similar to Stethorus picipes, except body darker and more shiny. The membranous area on the frons is large and broadly oval, with the surface slightly concave (Figures 17, 18). First abdominal spiracles with peduncle brownish, somewhat conical, and shorter than neighboring setae (Figure 191).

SUBFAMILY CHILOCORINAE

TRIBE CHILOCORINI

Diagnosis

Members of Chilocorini are very easily recognized by the greatly dilated epistoma which is expanded laterally conceal the antennal bases.

Similar to the Stethorini, one pair of well pedunculated spiracles is also present in all members of the Chilocorini, but here the peduncle is more strongly sclerotized and more prominent.

Furthermore, the pupae of Chilocorini are often easy to recognize by having the pupa enclosed in the last larval exvuvium except for a dorsolongitudinal slit which exposes the pupa.

Key to Genera of the Known Pupae of Chilocorini

1 First abdominal segment with one pair of pit-like gland openings located between anterior and posterior margins of the first abdominal tergum and metanotum respectively (Figures 239, 240).....2

1' First abdominal segment without such a pair of pit-like gland openings.....4

2(1') Pronotum crescent-shaped with anterior angle subacute (less than 90°) (Figures 106, 107); legs somewhat slender, with long tarsi, the width of terminal segment is one-fourth as long as dorsal length of the tarsus (Figure 104); size under 4mm in length.....3

2' Pronotum U-shaped with anterior angle near 90° (Figure 105); legs short and robust, tarsi not as long, with the width of terminal segment more than one-fourth as long as dorsal length of the tarsus (Figure 103); size large, over 5mm in length.....AXION Mulsant

3(2) Spiracular peduncle long, with the outer lateral side viewed from metanotum more than three times as long as the diameter of spiracular opening (Figure 187); dorsal surface inconspicuously spinose, with spines less than one-half of setal length, Brumoides suturalis.....BRUMOIDES Chapin

3' Spiracular peduncle short, with the outer lateral side viewed from metanotum less than three times as long as the diameter of spiracular opening (Figures 185, 186); dorsal surface conspicuously spinose, with spines one-half as long as setae..... .....EXOCHOMUS Redtenbacher

4(1') Size large, over 5mm in length, with large bristle-like setae on dorsal surface (Figures 23, 242); base of labrum much narrower than apex of clypeus (Figure 23).....CHILOCORUS Leach

4' Size small, under 5mm in length, with dense, and long hair-like setae giving the body a fuzzy appearance; never with bristle-like setae (Figure 29) on dorsal surface; base of labrum subequal to apex of clypeus (Figure 29), Orcus chalybeus.....ORCUS Mulsant

Genus CHILOCORUS Leach

Chilocorus bivulnerus Mulsant

Specimens examined

The study was based on 5 pupae of Chilocorus bivulnerus from the U. S. National Museum, collected in Florida.

Diagnosis

This species represents one group of species of Chilocorini including Orcus chalybeus that have no gland openings on the dorsum of first abdominal segment. The pupae of the remaining available genera (Axion, Brumoides and Exochomus) possess one pair of dorsal pit-like gland openings located between the anterior margin of the 1st abdominal tergum and the posterior margin of the metanotum (Figures 187, 239). Thus, Chilocorus and Orcus appear to have strong affinities. Chilocorus can be separated from Orcus by the much shorter and coarse setae, and the labral base much narrower than the clypeal apex (Figure 23). In Orcus the setae appear very long and slender, giving the body a fuzzy appearance, and the labral base is as wide as the clypeal apex (Figure 29).

Description

Length: 4.5-5mm; width: 2.5-2.8mm. Body elongate oval, entirely enclosed in the last larval exuvia, brownish, and slightly rugose and finely setiferous. Epistoma largely dilated laterally and concealing antennal bases (Figure 23). Antennae short and somewhat annulated, tapering apically and pointed at apex, (Figure 23). Labrum densely setiferous, small and much narrower than clypeal apex, with apical margin slightly concave (Figure 23). Mandible simple at tip (Figures 66, 67). Maxillary palpi glabrous, large and subcylindrical (Figure 88). Galea bulbous, glabrous and hook-shaped as seen from the top. Labial palpi cylindrical, slender, and rounded apically (Figure 93).

Pronotum large, immarginate, "U" shaped, brownish and densely setiferous, with bristle-like setae on discal area. Mediolongitudinal line yellowish and very distinct, with anterior angles pale and finely setiferous. Meso- and metanotum brownish with 2 groups of discal bristle-like setae. Elytron immarginate along lateral margin, brownish at base, then gradually lighter toward apex, and finely setiferous except for the subscutellar area which bears bristle-like setae (Figure 242). Lateroapical angle obtuse and rounded; epipleura wide. Hind wings semi-sclerotized and glabrous, tapering apically, with apex rounded. Legs short, yellowish to light brown; femora robust (Figure 23).

Abdominal terga brownish except the spiracular area of the 1st pale; posterior margin of terga 3, 4, 5, and 6 finely dentulate. Large bristle-like setae confined to one pair of dorsal tubercles on each tergum except terga 7, 8 and 9 where dorsal tubercles are nearly obsolete, and tergum 1, where large bristle-like setae are present on

the subspiracular area. Pygidium minute in relation to the 8th tergum and finely setiferous. Urogomphi long, subcylindrical, tapering toward apex, and ending in a kidney-shaped disk (Figures 212, 213). Abdominal spiracles circular and slightly pedunculate, with the peduncle of the first abdominal spiracle large and conspicuous (Figure 242). Abdominal pleura partially visible from above, semi-sclerotized and subquadrate. Abdominal sterna pale yellowish, the 7th sternum very large and twice as long as the 8th. In the ♀, sternum 9 is distinctly bimammillate (Figure 212).

Genus ORCUS Mulsant

Orcus chalybeus (Boisduval)

Specimens examined

The study was based on 30 pupae of Orcus chalybeus collected from Sydney, Australia, and deposited in the U. S. National Museum. However, because of poor condition of the specimens detailed studies of this species have been omitted.

Diagnosis

See Chilocorus diagnosis for the separation of these 2 species.

Description

Length: 3mm; width: 2mm. Body apparently setiferous, very fuzzy with long hair-like setae, and brownish on dorsal surface. Head

wide, hexagonal, with base of labrum subequal to clypeal apex (Figure 29), and apical margin of the labrum convex.

Pronotum brown with lateral margins greatly descended beyond the lower side of the eyes (Figure 29). Elytron brown at the base and the sutural area where long, hair-like setae are very dense; then gradually lighter toward apex and lateral margin. Abdominal terga brownish and very fuzzy, with long hair-like setae; the first abdominal segment with only one pair of short pedunculate lateral spiracles.

Genus AXION Mulsant

Diagnosis

This species is representative of one group of species of the Chilocorini with the dorsum of the first abdominal segment possessing one pair of gland openings located between the enterior and posterior margins of the first abdominal tergum and the metanotum respectively. Axion differs from Exochomus and Brumoides by its very large in size (over 5mm in length) and horseshoe-shaped pronotum (Figure 105). In Exochomus and Brumoides the size is much smaller (under 5mm in length) and the pronotum is crescent-shaped (Figures 106, 107).

Description

Length: 5-5mm; width: 4-4.5mm. Body broadly rounded oval, brownish to very dark brown with yellowish spots; dorsal surface densely spinose (Figure 25) and finely setiferous.

Head pentagonal (Figure 24), brownish, with frontal area spinose. Antennae short, mostly hidden under pronotum and epistoma,

the latter dilated laterally (Figure 24), flagellum subquadrate in cross section, with distal end truncated and club undistinct (Figure 63). Clypeolabrum as wide as distal end of epistoma and greatly narrowed apically (Figure 24). Mandibles simple at tip and mola well developed (Figure 64-65). Maxillary palpi trapezoidal, elongate oval in cross section, with sides subparallel (Figures 24, 89). Labial palpi short, subcylindrical, with apex rounded (Figure 94).

Pronotum large, "U"-shaped with apical margin deeply concave and surface densely spinose (Figure 105). Prothoracic spiracle oval. Elytron elongate oval, lateroapical angle obtuse and rounded, lateral side immarginated. Epipleura wide and slightly concave, and elytral surface finely nodulated and densely spinose. Hind wing semi-sclerotized with apex rounded. Legs short and robust, with femotibial joints brownish.

Abdominal terga without dorsal tubercles and densely spinose, each with 4 conspicuous groups of fine setae arranged in circles consisting of 2 dorsal and 2 lateral or spiracular setae. The area inside the ring of setae is often smooth. Urogomphi biramose, with distal ends mushroom-shaped and greatly enlarged (Figure 215). Pygidium minute in relation to the 8th tergum and glabrous. Abdominal segment 1 with 1 pair of lateral, prominently pedunculated spiracles, and 1 pair of characteristic pit-like gland openings located between the posterior and anterior margin of mentanotum and the first abdominal tergum at median three-fifths. Abdominal sterna smooth and pale, with sternum 7 twice as long as sternum 6.

Key to Species of the Known Pupae of Axion

1 Yellow spiracular spots on the first abdominal tergum present; the opening plane of the first abdominal spiracles perpendicular to peduncular axis (Figure 188); peduncle pale yellowish.....Axion plagiatum (Olivier)

1' Spiracular spots on the first abdominal tergum absent; the opening plane of the first abdominal spiracles oblique to the peduncular axis (Figure 189); peduncle dark brown to black.....Axion tripustulatum (DeGeer)

Axion plagiatum (Olivier)

Specimens examined

The study was based on 4 pupae associated with adults from the U. S. National Museum collected in Arizona, 19 June 1901, by Prescott, and from Los Angeles, California, by Coquillet.

Diagnosis

This species is separated from Axion tripustulatum by the presence of a large pair of subquadrate spiracular yellow spots on abdominal tergum 1, and the opening of lateral spiracle being perpendicular to the peduncular axis, with the peduncle pale yellowish. In A. tripuslatum, the spiracular opening of the first abdominal segment

is oblique to the peduncular axis, and the peduncle is dark brown or black.

Description

Length: 5.5mm; width: 3.5mm. Body rounded oval and moderately convex dorsally.

Head light brown with spines confined in the frontal areas (Figure 24). Pronotum dark brown, with two large discal yellow spots. Metanotum dark brown with mid-basal area yellow. Elytron dark brown at basosutural area, then gradually lighter toward apex and lateral margin. Abdominal terga dark brown except for medio-dorsal yellow areas, terga 6, 7, 8, 9 light brownish and the first abdominal tergum with 2 large subquadrate spiracular yellowish spots. Opening of the spiracles on abdominal tergum 1 perpendicular to the peduncular axis. Peduncle pale yellowish (Figure 188).

Axion tripustulatum (Degeer)

Specimens examined

The study was based on three pupal exuviae from the U. S. National Museum, collected in association with adults in College Park, Maryland, on 14 July 1873, and on 4 July 1940, by C. V. Riley and W. H. Anderson respectively. Adults were identified by E. A. Chapin.

Description and diagnosis

Very similar to A. plagiatum except the spiracular area on the first abdominal tergum is brownish, and the opening of the spiracles

on the first abdominal tergum is oblique to the peduncular axis, with the peduncle dark brown or black (Figure 189).

Genus EXOCHOMUS Redtenbacher

Description

Very similar to Axion except size much smaller (3-3.5mm in length). Dorsum light brown, with yellowish spots. Pronotum crescent-shaped with apical angles subacute (Figure 106). Legs somewhat slender, with long tarsi in which the diameter of terminal segment is about one-fourth as long as dorsal length of the tarsus (Figure 104). Spines one half as long as setae.

Key to Species of the Known Pupae of Exochomus

1 Elytron and frons never spinose; labral apex truncate or slightly concave (Figure 26); peduncular spiracles on the first abdominal segment cylindrical near the distal end (Figure 185).....Exochomus hoegei Gorham

1' Elytron and frons with scattered spines; labral apex subacute or convex (Figure 27); peduncular spiracles on the first abdominal segment conical, not quite cylindrical near the distal end (Figure 186).....Exochomus cubensis Dimmock

Exochomus hoegei Gorham

Specimens examined

The study was based on six specimens from the U. S. National Museum, collected in Douglas, Arizona, 2 October 1956, by J. H. Russel.

Diagnosis

This species can be easily separated from Exochomus cubensis by the concave clypeolabrum, and the spiracular peduncle is cylindrical near the distal end. In E. cubensis, the spiracular peduncle is conical and the clypeolabrum is convex.

Description

Length: 3.5mm; width: 2.5mm.

Head pentagonal (or hexagonal because of labral apex truncated or slightly concave). Antennae short, slightly elbowed, with the bases hidden under dilated epistoma (Figure 26). Pronotum U-shaped, with basal margin arcuate and largely extended anterad, pushing the lateral margins forward where the posteriolateral angles very obtuse (Figure 106). Dorsal surface of pronotum densely spinose dorsally, then gradually sparser laterally and with the margins never covered by spines. Mediodorsal surface of meso- and metanotum glabrous and smooth. Elytron finely setiferous and micronodulated but never spinose, brownish at base and along sutural area, and gradually lighter toward apex.

Mediodorsal areas of abdominal terga glabrous and smooth. First five abdominal terga brown except mediodorsal and spiracular

areas yellowish, the rest immaculate and pale yellowish; tergum 8 entirely smooth. Peduncular spiracles of the first abdominal segment somewhat slender and cylindrical near the distal end (Figure 185), and with the diameter of spiracular opening much less than that of the pit-like gland opening. Abdominal sterna pale, surface smooth.

Exochomus cubensis Dimmock

Specimens examined

The study was based on 2 pupae from the U. S. National Museum collected in Cuba by Dimmock.

Diagnosis and description

Similar to Exochomus hoegei in many respects except for the following.

Size from 3-3.5mm in length and 2-2.5mm in width. Frontal area and elytral surface spinose. Labral apex subacute or convex (Figure 27). Peduncular spiracles of the first abdominal segment conical (Figure 186) (in E. hoegei, the peduncular spiracles are cylindrical near distal end), the spiracular opening with the diameter as wide as or wider than that of the pit-like gland opening. Dorsally pale or very light brown, the first abdominal tergum pale yellowish with two large brownish subquadrate interspiracular spots located between gland opening and peduncular spiracle.

Genus BRUMOIDES Chapin

Brumoides suturalis (Fabricius)

Specimens examined

The study was based on 16 pupae of *Brumoides suturalis* reared by A. G. Selhime, from Florida, 1955, and deposited in the U. S. National Museum.

Diagnosis and description

Similar to *Exochomus* in many respects, except for the following.

Length: 3-3.5mm; width: 1.5-2mm. Body fusiform, finely setiferous and very inconspicuously spinose on dorsal surface where the spines are about one-third to one-fifth as long as the setae.

Head and dorsal surface pale yellowish. Pronotum crescent-shaped, with anterior angle subacute (Figure 107); usually pale yellowish or very light brown, especially on mediodorsal area. Peduncular spiracles on the first abdominal segment conical and long; peduncle height may exceed the distance along posterior margin of the metanotum between the pit-like laterodorsal gland opening and the elytral sutural impression line (Figure 187).

SUBFAMILY COCCINELLINAE

Diagnosis

This is the largest group of the family, consisting of the tribes Coccinellini, Psylloborini and Discotomiini. Pupae of the latter are not available. Pupae of Coccinellinae are characterized by the exposed intersegmental conjunctives between the abdominal terga 3 and 4, 4 and 5, 5 and 6, and 6 and 7, allowing for a strongly flexible abdomen and by having very fine setae which give the body an apparent glabrous aspect. In addition, the dorsum of the body of the Coccinellinae is distinctly maculate, while all other members of the family are usually immaculate and pale or brownish throughout.

TRIBE COCCINELLINI

Diagnosis

This tribe according to several authors is divided into several different tribes such as Coccinellini, Hippodamiini, Anisostictini, and Synonychini. Put as Sasaji (1968) has suggested, because there are many intermediate characters among these "tribes", the group should be regarded as a single tribe Coccinellini.

Pupae of the Coccinellini and Psylloborini are almost morphologically identical, except that the mouthparts are somewhat modified

to suit the fungiphagous habit in the Psylloborini. The clypeolabrum is much wider than long, with the apical margin truncate, the maxillary palpi have the apex broadly expanded (twice as wide as the base) and the galea is greatly enlarged, with the greatest width as wide as the base of the maxillary palpus.

In contrast, in the Coccinellini, the clypeolabrum is as long as, or slightly longer than wide, with the apical margin usually concave, the maxillary palpi have the width of the apex subequal to that of the base and the galea is usually small, with the greatest width one half as wide as the base of maxillary palpus.

Key to Genera of the Known Pupae of Coccinellini

1 Legs long, with front femora extended considerably beyond the widest lateral margins of the pronotum (Figures 41, 43, 49).....1

1' Legs short, with front femora not extended beyond the widest lateral margins of the pronotum (Figures 32-36).....2

2(1') Hind wing apex finely and densely spinulate (Figures 179-184).....3

2' Hind wing apex smooth or micronodulate.....4

3(2) Elytral surface densely spinulate (Figure 8); only ventromarginal areas of hind wing apex finely and densely spinulate (Figures 181-183); prothorcic spiracle elongate oval (Figure 194).....
.....COCCINELLA Linnaeus

3' Elytral surface smooth, both dorso- and ventromarginal areas of hind wing apex finely and densely spinulate (Figures 179-180); prothoracic spiracle rounded (Figure 193) Adalia bipunctata (Linnaeus).....ADALIA Mulsant

4(2') Urogomphi branched mesally into a spine-like process at the basal one-third (Figures 221-226).....5

4' Urogomphi not branched mesally (Figures 227, 228).....9

5(4) Abdominal pleura 3 to 5 with posterior lateral angle projected into a long spine-like process (Figures 176-178); antennal club indistinct, with the diameter subequal to that of the flagellum (Figures 54-55).....7

5' Abdominal pleura 3 to 5 subquadrate, with posterior lateral angle only slightly expanded laterocaudally (Figure 171); antennal club distinct and subpherical, with the diameter much larger than that of the flagellum (Figures 34, 52).....6

6(5') Antennal scape strongly convex anteriorly and distinctly separated from the flagellum (Figure 34); body rounded, apparently glabrous; posterior lateral angle of abdominal pleura 3 to 5 slightly rugose, Olla abdominalis (Say).....OLLA Casey

6' Antennal scape flattened anteriorly and hardly separated from the flagellum (Figure 40); body slightly elongate oval and finely setiferous; posterior lateral angle of abdominal pleura 3 to

5 deeply rugose and punctate (Figure 171), *Neoharmonia venusta* (Melsheimer).....NEOHARMONIA Casey

7(5) Abdominal pleura with the spine-like process projected laterocaudad and short, not exceeding the greatest width of the corresponding pleuron (Figures 177-178); antennae long, extending over two-thirds of the distance between the widest lateral margin of the pronotum and the eye (Figures 32, 45).....8

7' Abdominal pleura with the spine-like process projected lateroanterad and long, exceeding the greatest width of the corresponding pleuron (Figure 176); antennae short, extending to about half the distance between the widest lateral margin of the pronotum and the eye, *Synonycha grandis* (Thunberg).....
.....SYNONYCHA Mulsant

8(7) Apical margin of clypeolabrum slightly concave (Figure 45); spots large, almost covering the entire segment, but poorly defined; setae coarse, borne on a conspicuous tubercle with distal end strongly curved (Figure 177) *Anisocalvia quatuordecimguttata* Linnaeus.....ANISOCALVIA Crotch

8' Apical margin of clypeolabrum sinuate or slightly convex (Figure 32); spots smaller, with a well defined border; setae finer, borne on a flat cuticular ring or an inconspicuous tubercle.....
.....ANATIS Mulsant

9(4') Antennae very long, if straight, then extending beyond the widest lateral margins of the pronotum (Figures 44, 56); flagellum C-shaped; antenna with six rings of papillae; club not so distinct, with the diameter subequal to that of the flagellum (Figure 56); body rather coarsely setiferous, with chalaza-type setae, especially along lateral margin of abdominal pleura 3 to 5 (Figure 172), Propylaea quatuordecimpunctata (Linnaeus).....PROPYLAEA Mulsant

9' Antennae shorter, if straight, not extending beyond the widest lateral margins of the pronotum; flagellum slightly elbowed; antenna with less than six rings of papillae; club distinct, with the diameter greater than that of the flagellum (Figures 52, 53); body apparently glabrous or finely setiferous, with setae borne on a flat cuticular ring.....10

10(9') Antennal club subspherical (Figure 52); surface of the galea with less than five conspicuous fine teeth (Figures 81, 82).....11

10' Antennal club cylindrical-elongate or subrectangular block-shaped (Figure 53); surface of the galea with at least five conspicuous fine teeth (Figure 80).....MULSANTINA Weise

11(10) Antennae actually with three rings of papillae; scape greatly swollen (Figure 34); body apparently

glabrous and rounded, pale silky white dorsally, *Olla abdominalis* (Say).....OLLA Casey

11' Antennae actually with four rings of papillae (Figures 38, 39); scape flat and not so distinct from flagellum; body finely setiferous, yellowish, and slightly elongate-oval.....CYCLONEDA Crotch

12(1) Exposed conjunctivae on abdominal segments 4 to 7 glabrous; elytron with lateral angle broadly expanded anteriorly into a distinct rounded lobe (Figures 158, 159).....HIPPODAMIA Dejean

12' Exposed conjunctivae on abdominal segments 4 to 7 finely setiferous; elytron with lateral angle obtuse and rounded, almost continuous with the lateral margin; never expanded anteriorly into a distinct lobe (Figures 155, 156).....13

13(12') Apical margin of clypeolabrum deeply notched (Figure 49); anterior margin of pronotum non-marginate; lateral margin of abdominal pleura 3-4 slightly angulate (Figure 175), *Eriopis connexa* (Germar).....ERIOPIS Mulsant

13' Apical margin of clypeolabrum slightly concave (Figures 42, 43); anterior margin of pronotum strongly marginate (Figures 124-126); lateral margin of abdominal pleura 3-4 rounded convex (Figure 174).....14

14(13') Lower side of anterior edge of the pronotum descending to two-thirds of the eye length (Figure 42);

first abdominal spiracles entirely hidden under the elytra, Naemia seriata (Melsheimer).....NAEMIA Mulsant

14' Lower side of anterior edge of the pronotum never descending to two-thirds of the eye length (Figure 43); first abdominal spiracles mostly hidden under the elytra, Coleomegilla maculata DeGeer.....COLEOMEGILLA Timberlake

Genus COCCINELLA Linnaeus

Diagnosis

Coccinella represents one group in the subfamily Coccinellinae in which the body is usually rounded oval, moderately convex dorsally, and with short legs in which the front femora never extend beyond the widest lateral margins of the pronotum as viewed ventrally. By contrast, in the other group as represented by Hippodamia, Coleomegilla, Eriopis, Paranaemia and Naemia, the body is elongate oval, and has long legs in which the front femora extend considerably beyond the widest lateral margins of the pronotum. Coccinella is very similar to Adalia. The elytral surface is clothed with fine sharp spines in Coccinella, whereas in Adalia, the elytral surface is smooth. In addition, in Adalia, both dorsal and ventral surfaces of the hind wing apex are clothed with fine sharp spines (Figures 179, 180) whereas in Coccinella, only the ventral surface of hind wing apex is sharply spinulated (Figures 181-183). These two genera are quite different from the remainder of Coccinellini whose hind wing apex is usually smooth.

Description

Length: 5.5-8mm; width: 4-5mm. Body slightly elongate oval, strongly convex dorsally and finely setiferous.

Head somewhat hexagonal, slightly longer than wide, surface deeply rugose, brown to black, frontal area usually pale. Whitish or light yellow. Mediolongitudinal line well defined throughout the head length. Eye dark brown. Antennae long and slender, exceeding half the distance between the widest lateral margin of the pronotum and the eye (Figure 35). Antennal club subspherical and distinct from flagellum, and with four rings of papillae, the 3rd and the 4th incomplete (lacking some lateral papillae), with the ventral papillae of the 4th flattened but visible. Flagellum slender and subquadrate in cross section; antennal scape suboval and convex anteriorly. Clypeolabrum usually dark brown, with lateral edge slightly sinuate. Labrum almost black, surface with deep longitudinal and subparallel wrinkles. The apical margin of the laborum concave or sinuate-concave (Figure 35) and very narrow, about one half as wide as the base, with the lateral margin rounded convex. Mandibles bifid at tip, with mola well developed (Figures 70, 71). Maxillary palpus large, trapezoidal, usually dark brown or black and rugose, with lateral margin slightly convex (Figure 35). Galea smooth and brownish. Lacinea immediately beneath the galea with tip wedge-shaped. Labial palpus with deep longitudinal subparallel wrinkles.

Pronotum immarginate, usually yellowish with dark brown spots along marginal areas; mediolongitudinal line always present and the anterior margin deeply rugose. Mesonotum trapezoidal, usually yellowish or brownish with one pair of circular spots, and the scutellar area

elevated in the middle. Metanotum usually with two large oval spots at base where deep subparallel wrinkles are clearly visible. Prothoracic spiracle elongate oval (Figure 194).

Elytron large, somewhat rectangular, with wide and slightly concave epipleuron; the lateroapical angle slightly expanded anteriorly, forming a somewhat rounded lobe (Figures 141-152). Elytral surface densely covered with very fine sharp teeth. Coloration pattern may change from light yellow with dark spots or transverse bands to very dark brown or black with small yellowish areas. Hind wing apex slightly sclerotized, finely and densely spinulated along ventrolateral and ventrosutural margins (Figures 181-183).

Abdomen usually yellowish with dark brown spots on dorsal surface. Terga 4 to 6 slightly narrowed medially, and "detachable" from one another to show the intersegmental conjunctivae which are as strongly sclerotized as the terga and finely setiferous. Posterior margins of terga 3 to 6 finely and sharply dentulate. One pair of dorsal tubercles may be present on terga 2 to 8. Abdominal spiracles circular or nearly so, and gradually diminishing in size toward posterior of the abdomen; usually the first five spiracles well sclerotized. Abdominal pleura subquadrate with pleura one and two hidden and partly hidden under elytron respectively; pleura 8 and 9 somewhat fused together. Urogomphal disk bilobed, with inner lateral side of base straight (Figure 219). Abdominal sterna immaculate, yellowish and finely setiferous. Third sternum the largest, with anterior margin deeply sinuate, and with 2 sublateral elevated curved lines caused by metafemoral depressions. In the ♂, the 9th sternum is

flat and subrectangular, whereas, in the ♀, it is bibulbous, with the nipple-like tip well sclerotized (Figures 2, 219).

Key to Species of the Known Pupae of Coccinella

1 Hind wing apex finely spinulated along ventrolateral and ventrosutural margins (Figure 183); elytron with at least two transverse bands (Figures 141-142).....Coccinella trifasciata Linnaeus

1' Hind wing apex finely spinulated along ventrolateral margin only (Figures 181-182); elytron without transverse bands.....2

2(1') Elytral surface more than half dark brown or black, not spotted (Figure 148).....3

2' Elytral surface half or less than half dark brown or black, may have distinct spot(s).....5

3(2) Elytron with dark area(s) occupying over three-fourths of the total surface.....4

3' Elytron with dark area(s) never occupying three-fourths of the total surface.....7

4(3) Elytron with subhumeral and basal areas pale, and with a narrow pale stripe extending from outer apical angle to end of lateral margin (Figure 148); length of spinulated area on hind wing apex one-half as long as elytral apex (Figure 181); pronotum yellowish with dark brown marginal areas and no spots.....Coccinella transversoguttata Faldermann

4' Elytron with subhumeral and basal areas pale (Figure 152); length of spinulated area on hind wing apex shorter than one-half of elytral apex (Figure 182); pronotum brownish with darker margins and 2 pairs of circular and elongate oval pale spots.....Coccinella monticola Mulsant

5(3') Median spot at basal two-fifths twice as wide as long (Figure 145); subscutellar spot triangular and usually present (Figures 146, 147).....Coccinella transversoguttata Faldermann

5' Median spot at basal two-fifths never twice as wide as long (Figure 149); subscutellar spot oval if present.....6

6(5') Elytral spots unequal; median spot at basal two-fifths subquadrate, larger or as large as metanotal spot (Figure 149); disto-lateral spot absent.....Coccinella movemnotata Herbst

6' Elytral spots subequal; median spot at basal two-fifths rounded, oval and much smaller than metanotal spot (Figure 143); disto-lateral spot also rounded, oval, and located at distal end of lateral margin (Figure 143).....Coccinella septempunctata Linnaeus

7(3') Subscutellar and humeral dark areas somewhat truncate anterad, with a well-defined contour (Figure 144) a subscutellar spot may be distinct; mesonotal

spot half as large as metanotal spot.....

.....Coccinella septempunctata Linnaeus

7' Subscutellar and humeral dark areas somewhat pointed anterad, and with not so well-defined contour (Figures 150-151); subscutellar spot never present; mesonotal spot much less than half as large as metanotal spot.....Coccinella novemnotata Herbst

Coccinella trifasciata Linnaeus

Specimens examined

The study was based on 25 pupae which were reared in the laboratory from adults collected in Clinton Co., Michigan, on 30 May 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This is only known species of Coccinella with a very well defined maculation pattern on dorsal surface of the body, with at least 2 transverse dark brown bands on each elytron, and frequently a third and with the hind wing apex finely spinulated along both ventrolateral and ventrosutural margins. This is distinctly different from the remaining known species of Coccinella whose hind wing apex is only spinulated along the ventrolateral margin.

Description

Length: 6-6.5mm; width: 4-4.5mm. Body slightly elongate oval, finely setiforous and yellowish, with distinct dark brown spots and transverse bands on dorsum of the body.

Head with most of frontal area yellowish. Eyes and antennae dark brown. Antennal scape distinct, convex anteriorly. Club distinctly subspherical. Clypeus usually pale or light brown at base. Labrum with the apical margin concave and dark brown except for a mediolongitudinal whitish line. Mandibles unequally bifid at apex.

Pronotum with anterior margin dark brown except for the median area, one pair of large claw-shaped spots at posterior angles, and one pair of large subcircular spots at the base (Figure 112). In dark forms, one pair of median light brown spots may be present. Meso- and metanotum yellowish, each with one pair of small circular and one pair of large oval spots. Elytron (Figures 141, 142) always with sutural area and apex dark brown. Subscutellar spot triangular, separated or fused with a transverse band extending to humeral angle. The second and the third transverse bands extending from the median to lateral margin at basal two-fifths and three-fourths respectively. The third band may be reduced to a circular spot in light forms. Hind wing apex slightly sclerotized and very finely spinulated along ventrolateral and ventrosutural margins (Figure 183).

Abdominal terga 2 to 6 each with one pair of large spots, the rest immaculate or with very light spots. Tergum 2 with undefined spots consisting of one pair of spiracular and one pair of small dorsal spots. Tergum 3 similar to 2 but with large, subquadrate and subrectangular, more well-defined spots; and spiracular and dorsal

spots may fuse together. Terga 4, 5 and 6 each with only one pair of subquadrate dorsal spots. Posterior margins of terga 3 to 6 dark brown or black at portions corresponding to spots, and very finely and densely spinulated (including the lower surface). Abdominal pleura immaculate and yellowish, except that pleura 2 and 3 are almost covered by a large subquadrate dark brown spot. All abdominal sterna yellowish and immaculate; sternum 9 flat in the ♂ and bibulbous in the ♀ with the nipple-like tip well sclerotized.

Coccinella transversoguttata Faldermann

Specimens examined

The study was based on 25 pupae and 20 exuviae which were reared in the laboratory from adults collected in Saginaw Co., Michigan, on 5 August 1971 by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This species differs from Coccinella trifasciata by the hind wing apex being spinulated only along the ventrolateral margin (Figures 181, 182). It can be separated from Coccinella novemnotata by the presence of tergal spots on abdominal segment 1, and by the median spot on the elytron at the basal one-third always being twice as wide as long (in C. novemnotata it is subquadrate). In addition, in dark forms, the elytron is dark brown or black over three-fourths

of the surface, whereas in C. novemnotata, the dark area never reaches three-fourths of the elytral surface.

Description

Length: 6.5-8mm; width: 4.5-5mm. Body slightly elongate oval, yellowish, with well-defined, dark brown spots on dorsum and finely setiferous.

Head dark brown, with frontal area usually pale yellowish. In dark forms, the head is completely black except for one pair of circular yellowish spots on the frons. Mediolongitudinal pale whitish line always present. Eyes and antennae dark brown. Clypeolabrum dark brown except for mediolongitudinal pale line. Labral apex narrowed, with apicalmargin concave or sinuate concave. Surface of labrum deeply rugose, with deep longitudinal and subparallel wrinkles. Mandibles subequally bifid at apex.

Pronotum pale yellowish. In most cases with one pair of mediobasal subquadrate spots and two pairs of large claw-like spots, (one at anterior and one at posterior angles) (Figure 113). In dark forms all of these spots may fuse together except medially, thus framing the anterior and lateral areas of the pronotum in dark brown (Figure 114). In addition, one pair of mediobasal spots may be present, and one pair of very light brown, rectangular discal spots may also be present in some forms (Figure 114). Meso- and metanotum yellowish to brown, each with one pair of distinct large spots. Elytron varies from very light to very dark. In most cases, elytral suture, lateral margin, and apex light to dark brown. In light forms, a median subrectangular spot (twice as wide as long) at basal 1/3 is always present, a subcircular

median spot at basal 2/3 is present in most cases, and these two spots occasionally narrowly fuse (Figure 147). A subscutellar triangular spot is also very frequently present (Figures 146, 147). In dark forms, the elytron is excessively black or dark brown except for the yellowish subhumeral and basal areas and a narrow yellowish stripe extending from the suturo-apical angle to the posterior end of lateral margin. The apex of hind wing slightly sclerotized and finely spinulated along the ventrolateral side (the length of this spinulated area is one-half as long the lateroapical margin of the elytron). In light forms, at least one pair of dark brown or black spots are present on each abdominal tergum except that terga 7 to 9 are usually immaculate. The spots on terga 1 and 2 are small, subcircular, and oval respectively. The spots on terga 4 to 6 are large, subquadrate, or subrectangular. Tergum 3 usually has 2 pairs of large dorsal and spiracular spots, with the anterior margin deeply sinuate. Abdominal pleura usually immaculate and yellowish, except for the third which is almost entirely dark brown. In dark forms, all abdominal terga are brownish to dark brown with yellow spots, except that the 1st tergum is yellowish with two subcircular dorsal brown spots, and the 9th tergum is pale and immaculate. Terga 2 and 3 each with a median keyhole-like yellow spot. Terga 4 to 7 each with one pair of spiracular yellow spots diminishing in size from 4 to 7, and with a median vase-shaped yellowish spot. Tergum 8 brownish and immaculate.

The abdominal pleura are dark brown with a yellow spot on each, except that pleuron 1 is pale whitish, pleuron 2 brownish, pleuron 3 completely dark brown, pleuron 4 entirely yellowish and pleura 8 and 9 pale to very light brown.

Coccinella novemnotata Herbst

Specimens examined

The study was based on 18 pupae and two pupal exuviae which were reared from adults collected at the Gull Lake Biological Station, Kalamazoo Co., Michigan, on 20 May 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This species is very similar to Coccinella transversoguttata except that the tergal spots are absent on abdominal segment 1. On the elytron, the median spot at the basal one-third is subquadrate, whereas in C. transversoguttata it is subrectangular, twice as wide as long. In dark forms, the dark area of the elytron never reaches three-fourths of the surface, but does so in C. transversoguttata.

Description

Length: 6-7mm; width: 4-5mm. In general, very similar to Coccinella transversoguttata.

Head dark brown with two yellowish rounded spots which are medially fused on the frons. Labrum strongly convex dorsally, with longitudinal subparallel wrinkles usually shallower than those of clypeus. In a few cases, the surface of the labrum is smooth without such wrinkles. In most cases, anterior marginal spots of pronotum fused to each other except in the median area, and the posterior angular spot may joint the apical angular spot along the lateral

margin. Meso- and metanotum yellowish, with one pair of small circular and large oval spots on each. Elytron always dark brown along sutural area, lateral margin, and lateroapical angle. In light forms, at least two median spots are present on each elytron: a large sub-rectangular spot on the basal two-fifths; and a small and elongate longitudinal spot parallel to the sutural margin at the basal three-fifth. These two spots are often fused together (Figures 149-150). In dark forms, these median spots are completely fused with the dark sutural area, but this dark area never exceeds three-fourths of the elytral surface. Both the subscutellar and humeral dark area are tapered and pointed but without a well-defined border. The border is well-defined in C. septempunctata. First abdominal tergum immaculate. Urogomphi brownish or darker than abdominal sterna.

Coccinella monticola Mulsant

Specimens examined

The study was based on 11 dry pupae loaned from the U. S. National Museum, collected and identified by Dimmock.

Diagnosis

This species is very similar to Coccinella transversoguttata and C. novemnotata but the spinulated area on the hind wing apex appears shorter, near or less than one-half the length of the lateroapical side of the elytron. In C. transversoguttata and C. novemnotata it is as long as the length of the lateroapical side of the elytron.

Description

Length: 5.5-6mm; width: 3.5-4mm. Head completely dark brown without frontal yellow spots except the mediolongitudinal yellow line running the head length; surface deeply rugose.

Pronotum in most cases brownish, except apical and lateral margins are dark brown, with one circular sublateral and one elongate oval dorsal yellowish spot. These two spots may fuse medially in some forms (Figures 115, 116). The longitudinal median pale line clearly present. Meso- and metanotum brownish except for elevated and pale scutellar area. Elytron as in dark forms of Coccinella transversoguttata, but lacking the yellowish stripe extending from suturo-apical angle to distal end of lateral margin (Figure 152). The spinulated surface along ventrolateral margin of hind wing apex shorter than one half of elytral apex. All legs are brown or brownish at coxae, femotibial joints and tarsi.

Abdomen also as in dark forms of Coccinella transversoguttata except that median yellowish spots on abdominal terga 4 to 7 are large-mouthed-vase-shaped.

Coccinella septempunctata Linnaeus

Specimens examined

The study was based on 3 pupae from the U. S. National Museum collected in Denmark on 19 July 1893 by E. Rosenbero.

Diagnosis

This is only known species with subequal and well-defined oval spots on the elytron in light forms. In dark forms the elytral spot pattern is somewhat similar to the dark forms of Coccinella novemnotata; however, the humeral and scutellar ends of the dark area appeared rounded or truncated with a well-defined contour. In C. novemnotata the above areas are poorly defined and usually tapered and pointed.

Description

Length: 6mm; width: 4mm. Head as C. transversoguttata, but more rugose and usually entirely dark brown.

Pronotum usually pale along lateral margins. Circular spot on mesonotum large, about one-half as large as that on metanotum.

Elytron usually brown along sutural margin, lateroapical angle and part of the lateral margin. In light forms, three well-defined subequal oval spots (much smaller than metanotal spots) are present. The subscutellar spot and the mediosutural spot at the basal two-fifths may be more or less fused with the dark sutural area. The lateral spot at the distal end of the lateral margin is free. Sometimes a humeral spot may be present, but it is often fused with the lateral marginal dark area (Figure 143). In dark forms, the spots are not so distinct, but they are slightly darker than the surrounding areas. This dark form is very similar to the dark forms of Coccinella novemnotata, but the scutellar and humeral ends of the dark area are rounded or somewhat truncated with a well-defined contour (Figure 144) in C. septempunctata.

Genus ADALIA Mulsant

Adalia bipunctata (Linnaeus)

Specimens examined

The study was based on 12 pupae which were reared from adults collected in Kalamazoo Co., Michigan, 8 April 1972 by Dang T. Phuoc. The specimens studied are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This genus is very similar to Coccinella. As previously mentioned these are only 2 known genera of Coccinellidae which have the hind wing apex finely spinulated. Adalia is separated by the presence of spinules on the dorsal and ventral surface of the hind wing apex, whereas in Coccinella the hind wing apex is spinulated on the ventral surface only.

Description

Length: 4.5-5mm; width: 3.5-4mm. Body slightly elongate oval, convex dorsally, yellowish with large dark brown spots on dorsal surface and finely setiferous.

Head light to dark brown, nearly smooth but with a few wrinkles. Mediolongitudinal pale line always present. Eyes dark brown. Antennae long, extending over half the distance between the widest lateral margin of the pronotum and the eye; club subspherical with three rings of well developed papillae, the third ring incomplete by lacking some dorsal

papillae; flagellum subquadrate in cross section; scape flat, subtriangular and slightly expanded caudally. Clypeolabrum hexagonal (Figures 36, 37), slightly rugose with longitudinal wrinkles visible but shallow. Clypeus narrow at base. Labrum tapered apically and with apical margin deeply concave (Figure 37). Maxillary palpi large, trapezoidal, with outer lateral margin convex (Figure 36). Surface of galea armed with a few fine teeth at anterior inner angle (Figure 82). Labial palpus rugose and short.

Pronotum immarginate to slightly marginate along apical margin; surface rugose and irregularly brownish to dark brown. In most cases the apical and posterior angles, mediobasal area and mediolongitudinal line are pale yellowish. Prothoracic spiracles rounded (Figure 193). Mesonotum brownish to dark brown with two subtriangular pale spots at posterior angles. Scutellar area elevated in the middle with a triangular pale spot. Mediolongitudinal line pale and greatly enlarged anteriorly. Apical angles of mesonotum elevated. Metanotum slightly elevated along median line, with two large dorsal dark brown spots fused together in some cases and occupying most of the surface.

Elytron immaculate dark brown at median and sutural area, then gradually lighter toward apex and lateral margin. A median light brown, poorly defined spot may be present in some forms at about basal two-fifths. Lateral margin usually pale yellowish or light brown. Hind wing apex brownish, slightly sclerotized, finely and densely spinulated along ventrosutural and both ventro- and dorsolateral margins (Figures 179-180). Legs short, brownish except for pale yellowish femoral bases and tibiotarsal joints. Surface of the leg slightly rugose with a few transverse wrinkles.

Abdomen as in Coccinella, but slightly darker, each abdominal tergum with one pair of small subquadrate spiracular and one pair of large subrectangular dorsal dark brown spots. Spots on the first tergum greatly reduced in size; tergum eight brownish and immaculate. Abdominal pleura brownish with pale yellowish margins except for pleura 8 and 9 which are completely pale. Urogomphi as in Coccinella.

Genus CYCLONEDA Crotch

Diagnosis

This genus is representative of the remaining species of Coccinellini which possess a smooth hind wing apex. Cycloneda shows the closest affinity to Mulsantina Weise; however, Cycloneda can be separated by the subspherical antennal club (Figure 38), and the subacute apical angle of the clypeolabrum (Figure 38). In Mulsantina the antennal club appears cylindrical or subrectangular block-shaped (Figure 53), and the apical angle of the clypeolabrum is rounded (Figure 33).

Description

Length: 4.5-5mm; width: 3-3.5mm. Body slightly elongate oval and finely setiferous.

Head entirely brown with mediolongitudinal line or frontal area pale, surface smooth to very slightly rugose. Eyes brownish. Antennae (Figure 38) brown and long, extending over two-thirds of the distance between the widest lateral margin of the pronotum and the eye; club subspherical and distinct with four rings of well-developed

papillae; flagellum subquadrate in cross section; scape somewhat flat, subtriangular and with upper surface slightly rugose. Clypeolabrum subquadrate, slightly narrowed apically and with the apical margin concave. Apical angles of labrum subacute (Figure 38). Mandible bifid at tip. Maxillary palpus brown, large, trapezoidal or lanceollate. Galeal surface armed with several fine teeth, but less than five at the anterior inner angle. Labial palpus short and rounded, brown and slightly rugose at tip.

Pronotum pale yellowish, usually with dark brown spots along anterior and posterior margins. Lateral margin and especially the anterior margin strongly marginate (Figure 39). Prothoracic spiracle elongate oval. Meso- and metanotum pale, slightly rugose and sometimes maculated. Elytron immaculate, brown to dark brown along sutural margin from base to about the basal three-fourths, and gradually lighter toward lateral margin. Apical, subapical, basal and subbasal areas pale yellowish. Elytral surface finely setiferous and densely micronodulated (Figure 7). Epipleura wide and slightly concave. Hind wing slightly sclerotized at apex, surface smooth. Legs light brown except femoral bases and distal ends of tibia which are pale.

Abdominal terga whitish or yellowish, with dorsal dark brown spots. Posterior margin of terga 3 to 6 finely dentulated. Abdominal spiracles circular or nearly so. Abdominal pleura subquadrate and slightly rugose. Abdominal sterna pale immaculate. In the ♀ abdominal sternum 9 is bimammillate and well sclerotized at the tip.

Key to Species of *Cycloneda*

1 Setae with conspicuous cuticular ring; pronotum with 2 pairs of anterior and 2 pairs of basal subquadrate dark brown spots; mesonotum with one pair of large subcircular spots.....*Cycloneda munda* (Say)

1' Setae with inconspicuous cuticular ring; anterior and basal spots on pronotum greatly reduced or wanting; mesonotum usually immaculate...*Cycloneda sanguinea* (Linnaeus)

Cycloneda munda (Say)

Specimens examined

The study was based on 11 pupae which were reared from adults collected in Kalamazoo Co., Michigan, 24 May 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

Cycloneda munda may be easily separated from *C. sanguinea* by the conspicuous, well sclerotized cuticular ring surrounding the base of each seta, and the mesonotum usually having one pair of dark brown spots. In *C. sanguinea* the cuticular ring surrounding the base of the setae is obsolete and the mesonotum is usually immaculate.

Description

Length: 4.5-5mm; width: 3-3.5mm. Body slightly elongate oval and finely setiferous, but the setae with very conspicuous and well sclerotized cuticular rings.

Head light yellow except eyes, antennae and maxillary palpi brownish.

Pronotum pale light yellow with two pairs of apical and two pairs of basal subquadrate spots. Meso- and metanotum pale yellowish, each with one pair of large subcircular dark brown spots. Elytron dark brown along sutural area and gradually lighter toward lateral margin; basal, subbasal, apical and subapical areas light yellow.

Dorsal surface of abdomen light yellow, abdominal terga 1, 8, and 9 immaculate. The rest of the terga each have at least one pair of dorsal dark brown spots, except the second and third which have an additional pair of spiracular spots.

Abdominal pleura light yellow and immaculate, but the third one dark brown except for the margins.

Cycloneda sanguinea (Linnaeus)

Specimens examined

The study was based on 30 pupae from the U. S. National Museum collected in Florida on May 1875 and on 31 March 1971.

Description

Similar to Cycloneda munda except that the head is entirely brown except for the mediolongitudinal pale line, and the pronotum is

yellow, with the marginal spots greatly reduced or wanting. Mesonotum usually pale and immaculate or with very small spots. Setae with inconspicuous cuticular rings.

Genus MULSANTINA Weise

Mulsantina picta (Randall)

Specimens examined

The study was based on 12 pupae which were reared in the laboratory from adults collected in Clinton Co., Michigan, 30 May 1971, by Dang T. Phuoc. All specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

As mentioned before, this species is very closely related to Cycloneda (see Cycloneda diagnosis for separation of these 2 genera). Adalia, Coccinella, Cycloneda, Mulsantina and Propylaea represent a group of species of Coccinellini which has the mediolateral side of the urogomphi at about the basal one-third straight, and without lateral processes. Mulsantina in turn differs from Propylaea by having very fine and normal setae, whereas in Propylaea the setae appear more coarse and are borne on a small tubercle (chalaza) with the distal end strongly curved.

Description

Length: 6mm; width: 3.5mm. Body elongate oval, extremely pale yellowish and finely setiferous.

Head mostly pale and very smooth. Eyes brown, much darker than face. Antennae long, extending about two-thirds of the distance between the widest lateral margin of the pronotum and the eyes. Antennae dark brown on upper surface; club distinctly cylindrical elongate or subrectangular block-shaped with 4 rings of papillae; flagellum long and subquadrate in cross section; scape somewhat rectangular and slightly convex (Figure 53). Clypeolabrum smooth and pale, slightly wider than long, with lateral margins subparallel. Apical margin concave and apical angles rounded (Figure 33). Mandibles bifid at apex and with molar surface well sclerotized. Maxillary palpi trapezoidal, glabrous, slightly rugose and brownish, usually darker along lateral sides; surface of the galea armed with more than 5 very fine but conspicuous teeth (Figure 80).

Pronotum deeply marginate along apical margin, surface slightly rugose, mostly pale and finely setiferous. In dark forms, the pronotum usually with 2 pairs of apical spots (the inner larger and suboval), and 2 pairs of basal spots (the inner also much larger than the outer and comma-shaped) (Figure 122). Prothoracic spiracle elongate oval. In most cases, mesonotum entirely pale except for very light brown or brown margins. In dark forms, the mesonotum is light brown, with the anterior angles and lateral sides of scutellar area brown. Metanotum pale in all cases, usually with one pair of large boot-shaped spots (Figure 139). Elytron pale or light brown, surface micronodulate (Figure 7). Sutural margin dark, and epipleura pale, wide and slightly

concave. Hind wing membranous, inconspicuously micronodulate along midventrolateral margin but never on apex. Legs dark brown at femorotibial joints and tarsi; surface of femotibial joints micronodulate.

Abdominal terga pale and maculate, usually with two pairs of subquadrate spots on each (one pair spiracular and one pair dorsal) except the 1st, 8th and 9th which are completely pale and immaculate, and the 6th and 7th which lack subspiracular spots. In light forms, the spiracular spots greatly reduced in size, and the posterior margin of terga 3 to 5 is finely dentulate. Abdominal spiracles circular or nearly so, with the first 5 well sclerotized. Urogomphi with base simple and slightly darker than abdominal sterna. Abdominal pleura subquadrate, pale and immaculate except for the 3rd which has a light brown spot. Ventral surface of abdomen completely pale and immaculate.

Mulsantina hudsonica (Casey)

Specimens examined

The study was based on 4 pupae and an exuvia collected in Chippewa Co., Michigan, 19 June 1972, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Description and diagnosis

This species is very similar to dark forms of Mulsantina picta, except that the mesonotum is mostly brownish and the metanotal spots are large and subquadrate (Figure 140). Length: 5.5mm; width: 3-5mm. Hind wing apex micronodulated.

Genus OLLA Casey

Olla abdominalis (Say)

Specimens examined

The study was based on a single pupa from the U. S. National Museum collected in Folsom, California, July 1885, and 8 pupae collected in Gainsville, Florida, on 26 July 1972 by R. E. Waites. Two of the Florida specimens are deposited in the Entomology Museum at Michigan State University, the remainder have been returned to Dr. Waites, Department of Entomology and Nematology, University of Florida.

Diagnosis

This is only known species of Coccinellini with the body rounded and strongly convex dorsally, with the dorsum apparently glabrous and pale yellowish or silky white with well defined dark brown rounded spots. Other members of the tribe usually have a slightly elongate oval body and are finely setiferous. The strongly convex antennal scape, giving sharp separation between the scape and the flagellum, and the presence of a mesal process on the urogomphus (Figures 225, 226) separates this species from Cycloneda and Mulsantina whose antennal scape appears flat or very slightly convex anteriorly, and whose urogomphus is without such a mesal process. Furthermore, Olla can be separated from Neoharmonia by the mesal process appearing short and blunt, and the dorsum being more smooth. In Neoharmonia the mesal

process of urogomphi is slender and more pointed, and the dorsum is rugose and punctate.

Description

Length: 4mm; width: 3.5mm. Body rounded and convex dorsally, yellowish or silky white, with light brown to dark brown and well defined rounded spots on dorsal surface, and very finely and sparsely setiferous.

Head yellowish to light brown, surface smooth and somewhat shiny. Eyes brownish. Antenna yellowish to brown, and extending over two-thirds of the distance between the widest lateral margin of the pronotum and the eye. Antennal club subspherical and distinct, with three rings of papillae, the last ring incomplete by lacking some of the anterior papillae. Flagellum subquadrate in cross section. Scape strongly convex anteriorly and expanded caudally. Clypeolabrum gradually narrowed and slightly to deeply concave at apical margin (Figure 34). Mandibles bifid at apex. Maxillary palpi large, brownish and trapezoidal; surface slightly rugose, galea surface smooth and pale.

Pronotum basically yellowish, strongly marginate along lateral and especially along anterior margin (Figure 138). Marginal areas brownish, with one pair of small, rounded, dark brown anterodiscal spots and 2 pairs of rounded or subquadrate outer and inner basal spots which are three times as large as the anterodiscal spot (Figure 138). Prothoracic spiracle pale and elongate oval. Meso- and metanotum silky white, rugose with one pair of subcircular well-defined dark brown to black spots on each. Elytron yellowish at base and apex

with three large brown longitudinal sutural, median and lateral stripes extending from base to the apical one-third (Figure 245). The median stripe may be broken at the basal one-third to give a subbasal oval or rounded spot (Figure 245). The pupa from the U. S. National Museum has the elytron entirely pale yellowish (probably faded). Epipleura wide and concave, with lateral angle slightly expanded anteriorly, and elytral surface densely micronodulate.

Hind wings slightly sclerotized at apex, surface smooth. Legs short and pale except femorotibial joints and tarsi yellowish or light brown.

Abdominal terga silky white, each with one pair of dorsal and one pair of spiracular, well-defined, dark brown spots about one-third as big as the metanotal spots, except terga 1, 8 and 9 are immaculate, and the dorsal spots on tergum 2 are absent. Urogomphi slightly branched medially at about basal one-third into a short and dull spine-like process; urogomphal disk with inner lobe elongate oval and small, one-fourth as large as the outer one (Figure 226). Abdominal pleura subquadrate and yellowish, with posteriolateral angle slightly expanded caudally. Each pleuron with a rounded brown spot but getting gradually lighter and disappearing in pleura 6 to 9. First two pleura entirely pale and immaculate. Abdominal sterna immaculate and yellowish.

Genus PROPYLAEA Mulsant

Propylaea quatuordecimpunctata (Linnaeus)

Specimens examined

The study was based on 4 pupae of *Propylaea quatuordecimpunctata* which were reared in the laboratory from adults given by Dr. R. D. Eikenbary of Oklahoma State University. The specimens are deposited in the Entomology Museum of Michigan State University and the U. S. National Museum.

Diagnosis

This is only known species of Coccinellini with very long antennae with a C-shaped flagellum and with the tip partly hidden under the front femur. In addition only abdominal terga 5 to 7 are "detachable" from their margins, whereas all other members of the Coccinellini have terga 4 to 7 movable. Furthermore, *Propylaea* shows some degree of close affinity to *Anisocalvia* by the presence of chalaza-type setae on both forms. However, *Propylaea* can be separated from *Anisocalvia* by the lack of lateral process on abdominal pleura 3 to 5, and by the characteristic, long, C-shaped antennae.

Description

Length: 5mm; width: 4mm. Body oval, slightly elongate, light brown, with poorly defined dark brown spots on dorsal surface. Body somewhat coarsely and densely setiferous, and bearing chalaza-type setae whose tips strongly curve to the body surface.

Head entirely pale and smooth. Eyes light brown. Antennae (Figures 44, 56) light brown, very long, and if straight, extending considerably beyond the widest lateral margin of the pronotum. Antennae actually with six rings of papillae, the first two rings complete with well developed papillae, but the last four incomplete, with dorsal and anterior papillae wanting, or greatly reduced in size, especially in the sixth. Antennal club not so distinct, with the diameter subequal to that of the flagellum and hidden under the front femur. Flagellum long, "C"-shaped and subquadrate in cross section, with the proximal end somewhat flattened and slightly notched at lower side. Scape oval and distinct. Clypeolabrum smooth and subquadrate, with the apex abruptly narrowed apically and with the apical margin slightly concave (Figure 44). Mandibles bifid at tip. Maxillary palpi large, trapezoidal and light brown at the apex. Galea with upper inner surface armed with several very fine teeth. Labial palpi rounded, smooth and light brown at tip.

Pronotum deeply marginate apically, usually pale at apical angles, dark brown along the posterior margin, and gradually lighter toward apical margin. Mediolongitudinal line pale. Prothoracic spiracles elongate oval. Mesonotum light brown, scutellar area slightly elevated and pale. Metanotum pale with two large, poorly defined, dark brown spots. Elytron with lateroapical angle obtuse and rounded, and with a large, irregular, brown, transverse band extending from sutural area at the basal one-fifth to three-fifths to the lateral margin, and becoming gradually lighter toward the base and apex. Epipleura wide and slightly concave. Legs pale except light brown at coxae, femorotibial joints and tarsi.

Abdominal terga yellowish, immaculate except terga 3 and 4 each with one pair of large subquadrate spiracular spots which are considerably lighter or absent on the fifth or sixth terga. On the whole, the maculation is usually not well-defined.

Urogomphi straight along inner lateral margins and as dark as the previous tergum. Abdominal spiracles circular or nearly so and very slightly sclerotized. Abdominal pleura subquadrate, immaculate, light yellow to light brown, with pleura 3, 4, and 5 very coarsely and densely setiferous along the lateral margins (Figure 172). Abdominal sterna immaculate and pale. In the ♀, abdominal sternum 9 is bipartite and mammillate, and in the ♂ sternum 9 is rectangular, flat or very slightly convex.

Genus NEOHARMONIA Casey

Neoharmonia venusta (Melsheimer)

Specimens examined

The study was based on a single pupal exuvia of Neoharmonia venusta from U. S. National Museum, collected in Brownsville, Texas, 18 April 1944 by Callaghan.

Diagnosis

This species is representative of a group of known species of Coccinellini (including Anatis, Anisocalvia, and Synonycha) which possesses a mediolateral process at about the basal one-third of the urogomphus (Figure 222). However, the lack of a lateral process on

abdominal pleura 3 to 5 separates this species from the others in this group.

Description

Length: 6-7mm; width: 4-5mm. Body slightly elongate and finely setiferous.

Head light brown. Eyes brownish. Antennae long, extending about two-thirds the distance between the widest lateral margin of the pronotum and the eye. Antennal club subspherical, with three rings of distinct and well-developed papillae, the dorsal papillae of the third ring lacking. Flagellum subquadrate in cross section. Scape somewhat flat and slightly expanded caudad. Clypeolabrum smooth, gradually narrowed and slightly concave at apex, with rounded apical angles (Figure 40). Maxillary palpus large and trapezoidal, with outer lateral side slightly convex.

Pronotum rugose and deeply marginate along lateral and especially along the anterior margin, with two pairs of large oval brown spots at the base and one pair of large anterior spots (Figure 111). Mesonotum rugose and dark brown. Metanotum yellowish with two large subquadrate dark brown spots. Elytron finely setiferous and immaculate, brownish, with basal marginal area pale. Epipleura wide, slightly concave, and with the lateral angle of the elytron slightly expanded anteriorly.

Abdominal terga slightly rugose and punctate, yellowish to brownish, and with poorly defined dark brown spots. Each tergum usually with one pair of dorsal and one pair of spiracular spots, except that tergum 1 is pale and immaculate. Abdominal spiracles circular,

the first five well-sclerotized. Urogomphus branching medially into a long and slender spine-like process at basal one-fourth (Figure 222). Abdominal pleura yellowish or brownish, usually paler along marginal areas. Pleura 3 to 6 large, subquadrate, with the posterior lateral angles slightly expanded caudad and deeply rugose and punctate (Figure 171). Sternum 9 bipartite and mammillate in the ♀.

Genus ANATIS Mulsant

Diagnosis

This genus is representative of a group of three known pupae of Coccinellini (Anatis, Anisocalvia and Synonycha) which have a lateral process on abdominal pleura 3 to 5 (Figure 178). Anatis differs from Anisocalvia by the body being much larger with more well defined spots on the dorsum, and by having the apical margin of the labrum slightly sinuate (Figure 32). Anatis differs from Synonycha by the pleural process being much shorter (equal to or shorter than the corresponding pleuron).

Description

Length: 7-10mm, width: 5.5-6mm. Body light yellow with well-defined dark brown spots on dorsal side and finely setiferous.

Head dark brown, smooth except median line pale. Eyes brownish. Antennae long, extending to the lateral margin of the pronotum. Club not distinct, with the diameter of the club subequal to that of the flagellum. Flagellum long and subquadrate in cross section. Scape somewhat flat and slightly convex along lower margin. Antenna

actually with 6 rings of papillae, the apical 4 rings with well developed papillae and occupying the "club" of the antenna, the fifth and the sixth rings located on the flagellum, with the papillae greatly reduced in size or flattened (Figure 54). Clypeolabrum gradually narrowed apically, with the apical margin slightly sinuate, surface slightly rugose with a few shallow wrinkles (Figure 32). Mandibles bifid. Maxillary palpus smooth, large and trapezoidal, with lateral margins parallel (Figure 32). Surface of galea armed with several fine teeth, especially on the anterior inner angle (Figure 79). Labial palpi slightly rugose at tip, and one pair of fine teeth may be present on the ligula (Figure 98).

Pronotum pale and strongly marginate along lateral and anterior margins, with dark brown spots along antero- and basomarginal areas; lateromarginal areas always pale (Figures 120-121). Prothoracic spiracle elongate oval. Mesonotum with scutellar area elevated and usually with one pair of rounded spots anterior to the "scutellum". Metanotum slightly elevated along mediolongitudinal line with one large pair of subquadrate spots. Elytron pale yellowish, maculate and finely setiferous. Epipleura wide and concave; lateroapical angle obtuse and almost continuous with lateral margin. Legs light brown except femoral bases and tibiotarsal joints. Tibial papillae obtuse.

Posterior margins of abdominal terga 4 to 6 smooth. Urogomphi branched medially at basal one-third into a long spine-like process. Abdominal spiracles circular or nearly so and slightly sclerotized. Abdominal pleura 3 to 5 large and with a spine-like process on each which projects laterocaudad from posteriolateral angle (Figure 178). Abdominal sterna pale and immaculate, with the first 2 hidden under

the metacoxae, but visible and distinct medially. The third sternum the largest, with anterior margin deeply sinuate. In the ♀, abdominal sternum 9 bipartite and mammillate, and more homogenously and more strongly sclerotized than the previous sterna, whereas in the ♂ sternum 9 remains flat and subrectangular.

Key to Species of the Known Pupae of Anatis

1 Elytral apex pale (Figure 153); lateral margin of pronotum brown or light brown at posterior end (Figure 120); first abdominal tergum maculate.....Anatis ocellata (Linnaeus)

1' Elytral apex brown (Figure 154); lateral margin of pronotum entirely pale (Figure 121); first abdominal tergum immaculate.....Anatis quindecimpunctata Olivier

Anatis ocellata (Linnaeus)

Specimens examined

The study was based on 14 pupae which were reared in the laboratory from adults collected in Rose Lake Wildlife Experiment Station, Clinton Co., Michigan, 25 May 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and the U. S. National Museum.

Diagnosis

Two species of Anatis are known as pupae. They can be separated from one another by the elytral apex being brownish and the first abdominal tergum maculate in A. quindecimpunctata, whereas in A. ocellata the elytral apex appears pale and the first abdominal tergum is immaculate.

Description

Length: 7-10mm average 9mm; width: 5.5-6mm. Head brown except frontal area pale, surface smooth except clypeolabral area slightly rugose.

Pronotum (Figure 120) with two pairs of subquadrate spots along apical margin, one pair of extremely elongate oval spots at base and two large "L"-shaped spots at posterior angles. Mesonotum brown at anterior angles and along lateral margins, and with one pair of small circular spots located anterior to the scutellar area. Metanotum with one pair of large subquadrate spots. Elytron pale yellowish and maculate (Figures 153), with sutural marginal area dark brown except for the subapical portion. Epipleura pale with a large subquadrate subbasal spot and a lighter distal spot. Elytral surface with three large circular spots (consisting of a humeral and two sublateral at basal two-fifths and three-fifths respectively), and two mediosutural, elongate oval, large spots at basal one-third and two-thirds respectively. Basal area of elytron light brown.

Each abdominal tergum usually with one pair of large spiracular subquadrate spots and one pair of large subrectangular dorsal spots except tergum 1 where spiracular spots are absent. Terga 7, 8 and 9

immaculate. All abdominal pleura immaculate and yellowish, but pleuron 2 with a small light brown spot and pleuron 3 with a large subquadrate spot. Median spine-like process at basal one-third of urogomphus short and obtuse (Figure 224).

Anatis quindecimpunctata Olivier

Specimens examined

The study was based on 4 pupae which were reared in the laboratory from adults collected in Rose Lake Wildlife Experiment Station, Clinton Co., Michigan, on 24 May 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Description

Length: 7-10mm; width: 5-6mm. Similar to Anatis ocellata, but maculation slightly different. Lateral margin of the pronotum entirely pale, with the spot at posterior angle subtriangular (never "L"-shaped or claw-like). Lateral sides and anterior angles of mesonotum pale. Elytral apex and in some cases epipleura entirely light brown (Figure 154); basal area pale. First abdominal tergum entirely pale, spots greatly reduced in size, and spiracular spots on terga 5 and 6 also reduced in size or wanting. Median spine-like process at base of urogomphus long and slender with apex somewhat pointed (Figure 223).

Genus ANISOCALVIA Crotch

Anisocalvia quatuordecimguttata (Linnaeus)

Specimens examined

The study was based on one pupa and one exuvia saved from an emerged adult in Chippewa Co., near Tahquamenon State Park, Michigan, 18 June 1972 by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University.

Diagnosis

This genus is very closely related to Anatis, with lateral spine-like process at posteriolateral angle of abdominal pleura 3 to 5, and long antennae. However, the size is considerably smaller than Anatis, about 5mm in length, the apical margin of clypeolabrum is deeply concave, and the pleurolateral process is conical and densely setiferous with chalaza-type setae which are strongly curved distally (Figure 177).

Description

Very similar to Anatis in many respects except for the following:

Length: 5mm; width: 3.5mm. Head brownish along marginal areas, including eyes, antennae and maxillary palpi. Clypeolabrum subtrapezoidal, with apical margin deeply concave and apical angles subpointed (Figure 45).

Spot pattern on dorsal surface of the body very similar to Anatis ocellata, except that here the spots are very large, almost

filling the segment, and are usually subquadrate or subrectangular and not as well defined, especially those on the abdomen. Elytron light brownish, with 2 large longitudinal brown bands extending from base to about basal one-half, the sutural band appearing much darker than the sublateral band. Pleurolateral process on abdominal segments 3, to 5 conical and densely setiferous, with chalaza-type setae which are strongly curved distally (Figure 177). Posteriolateral angle of pleuron 6 angulate and densely setiferous.

Genus SYNONYCHA Mulsant

Synonycha grandis (Thunberg)

Specimens examined

The study was based on two broken pupal exuviae of Synonycha grandis from U. S. National Museum, collected in Buitenzog, Java, by Bryant and Palmer.

Diagnosis

This genus can be quite easily distinguished from Anatis and Anisocalvia by the short antenna which extends about half way between the widest lateral margin of the pronotum and the eye, by the presence of only 4 rings of papillae, and by the pleurolateral spinelike process of abdominal segments 4 to 6 being cylindrical and slightly curved cephalad, with the length exceeding the greatest width of the corresponding pleuron.

Description

Length: over 10mm (10-12mm); width: 6-8mm. Body larger than Anatis. Head entirely brown, smooth, except for clypeolabrum and genae which are slightly rugose. Antennae short, extending about half way between the lateral margin of the pronotum and the eye. Antennae with four rings of papillae. Flagellum short and subtriangular in cross section. Scape greatly expanded and somewhat flattened (Figure 55). Clypeolabrum large with apical margin convex. Mandibles bifid at apex. Maxillary palpi smooth, with outer lateral margin slightly sinuate and very obtuse at apex. Surface of galea covered with a few very fine teeth. Labial palpi smooth.

Pronotum deeply marginate, especially along apical and lateral margins. At least one pair of large subquadrate spots at apical margin, one pair of large subrectangular spots at posterior angles, one pair of subrectangular spots at posterior angles, and one pair of subquadrate spots at base. Prothoracic spiracle elongate oval. Meso- and metanotum pale, each with a pair of large brown spots. Elytron brown except for pale lateral margin, apex and sutural area. Epipleura light brown. Hind wing apex glabrous and smooth. Maculation on abdominal terga as in Anatis ocellata, except that the 1st tergum is immaculate. Urogomphi branched medially at about basal one-third into a long spine-like process.

Abdominal spiracles circular or nearly so and slightly sclerotized. Abdominal pleura immaculate and pale, except the third and the fourth which have a large subquadrate spot. Pleural spine-like process longer than the greatest width of the corresponding

pleuron, and projecting laterocephalad (Figure 176). Ventral abdomen immaculate and pale.

Genus HIPPODAMIA Dejean

Diagnosis

This genus is representative of a group of species of Coccinellini including Coleomegilla, Naemia, Paranaemia and Eriopis which possess long and slender legs, with the front femora considerably extended beyond the widest lateral margins of the pronotum. This character separates this group from the remaining species of the Coccinellini. Hippodamia in turn, is distinguished from other members of the group by the glabrous condition of the exposed intersegmental conjunctivae of abdominal segments 3 to 7 and by the lateral angle of the elytron which is greatly expanded anteriorly into a rounded distinct process (Figures 164-170).

Description

Length: 4mm-6mm; width: 2.5mm-3.5mm. Body elongate oval, finely setiferous, bright yellow and distinctly maculate. Surface of the body and elytra densely micronodulated.

Head deeply rugose, dark brown, always with mediolongitudinal pale yellowish line running the length of the head. Bright yellow frontal spots sometimes present. Eyes brown. Antennae dark brown and long, extending to the widest lateral margins of the pronotum, with 4 rings of well developed papillae. Club subspherical and distinct, with the diameter much larger than that of the flagellum which is subquadrate

in cross section. Scape strongly convex and expanded caudally (Figure 47). Clypeolabrum deeply rugose and dark brown, slightly longer than wide, with apical margin concave to deeply cleft. Mandibles bifid at tip. Maxillary palpi large, lanceolate, dark brown and rugose. Labial palpi dark brown and smooth.

Pronotum bright yellow with dark brown spots along marginal areas (Figures 128-137). Lateral margin strongly expanded into knife-like edge (Figure 133). Mesonotum with rugose anterior angles and elevated scutellar area. Metanotum smooth, with 2 large dark brown spots. Elytron yellow with lateral, sutural areas, lateral angle and apex brownish to dark brown. A humeral and a mediosutural spot sub-equal and small, well defined and distinct; a large medial spot, three to four times as large as the humeral or mediosutural spot, often fused with the sutural dark area. Lateral angle greatly expanded anteriorly into a prominent thumb-like rounded lobe (Figures 158-159); the lateral margin strongly marginate and the epipleura wide and slightly concave. Hind wing membranous, tapered apically and glabrous. Legs long, with front femora extending considerably beyond lateral margins of the pronotum (Figures 41, 47), and dark brown except for femoral bases and distal ends of tibiae which are pale. Tarsi light brown.

Abdominal terga bright yellow with large dark brown spots. Dorsal tubercles well developed (Figure 244). Posterior margins of terga 3 to 6 conspicuously spinulate. Exposed intersegmental conjunctivae of the abdominal segments glabrous. Abdominal spiracles circular or nearly so, except the first which is elongate oval and

partly hidden under the elytra. Abdominal pleura subquadrate. Abdominal sterna immaculate pale yellowish or brownish.

Key to Species of the Known Pupae of Hippodamia

1 Elytron with a subscutellar L-shaped spot.....
.....Hippodamia quinquesignata (Kirby)

1' Elytron without a subscutellar L-shaped spot.....2

2(1') Clypeolabrum subquadrate with apical margin slightly concave and never notched (Figures 47, 48); lateral angle of the elytron longer than wide (Figure 159).....Hippodamia parenthesis (Say)

2' Clypeolabrum not quite subquadrate, with apical margin deeply notched (Figure 41); lateral angle of the elytron as wide as long or slightly wider than long (Figure 158).....3

3(2') Scutellar area of mesonotum at least dark brown at base; lateral margin of the pronotum brownish to dark brown (Figures 136, 137).....4

3' Scutellar area of mesonotum always pale yellowish; lateral margin of the pronotum always pale yellowish (Figures 128-130).....
.....Hippodamia tredecimpunctata (Linnaeus)

4(3) Elytron with a subbasal transverse band extending from subsutural area to humeral angle (Figures.....
166-168).....Hippodamia quinquesignata (Kirby)

4' Elytron without such a subbasal transverse band (Figures 169-170).....5

5(4') Dorsal tubercles on abdominal segments very well developed, with the tip directed caudally as seen laterally (Figure 244).....Hippodamia convergens Guerin

5' Dorsal tubercles on abdominal segments not as well developed, slightly elevated above abdominal terga, the tip never directed caudally as seen laterally.....Hippodamia glacialis (Fabricius)

Hippodamia tredecimpunctata (Linnaeus)

Specimens examined

The study was based on 20 pupae reared in the laboratory from adults collected in East Lansing, Michigan, 21 August 1968, and eight pupae collected in East Lansing on 19 July 1972, by Dang T. Phuoc. The specimens are deposited in Entomology Museum at Michigan State University and the U. S. National Museum.

Diagnosis

This species, along with the other known species of Hippodamia, including H. convergens, H. glacialis and H. quinquesignata, can be separated from H. parenthesis by the apical margin of the clypeolabrum being deeply notched, by the apical angles being subpointed and strongly projected caudally, and by the lateral angle of the elytron being no longer than the base of the angle. In H. parenthesis, the clypeolabrum appears subquadrate with the apical margin slightly

concave or subtruncate, and never with the apical angles projected caudally. The lateral angle of the elytron appears longer than the basal width. H. tredecimpunctata in turn is separated from H. convergens, H. glacialis and H. quinquesignata by the always pale scutellar area of the mesonotum and the pale lateral margin of the pronotum where these areas of the last three species are brownish or dark brown.

Description

Length: 4.5mm-5mm; width: 2.5mm-3mm. Head rugose, dark brown except for mediolongitudinal pale yellowish line; frontal area may be pale. Antennae light to dark brown. Clypeolabrum slightly longer than wide, rugose with lateral margins subparallel but abruptly narrowed apically, the apical margin deeply notched with the apical angles projected caudally and pointed (Figure 41).

Pronotum yellowish, rugose along anterior marginal area. In light forms there are two pairs of subcircular spots at the anterior and posterior angles (Figure 128) while in dark forms the anterior and the posterior spots are connected anteroposteriorly by a large longitudinal band into one pair of elongate, hourglass-shaped spots (Figure 129). One pair of large subrectangular anterior spots, and one pair of small basal oval spots may be present. In some cases, all of these spots may be fused together; then the pronotum becomes black or dark brown with one pair of rounded, oval, lateral, yellow spots, and one large heart-shaped discodorsal yellow spot (Figure 130). Mesonotum yellow with brown anterior angles, scutellar area always pale yellowish even in very dark forms. Metanotum yellow with one pair of large oval or kidney-shaped lateral spots which are greatly enlarged in dark forms

filling the metanotal surface except for the pale yellow mediodorsal area. Elytron, in light forms, with a humeral, a mediosutural spot at the basal one-third, and a very large (as large as the other two spots combined) median spot at the basal one-half (Figure 160). In dark forms the elytron is completely dark brown or black.

Each abdominal tergum usually with one pair of spiracular and one pair of dorsal subquadrate spots, except that tergum 1 is immaculate or with one pair of small dorsal oval spots, terga 8 and 9 are immaculate and pale, and tergum 4 lacks spiracular spots. Terga 2 and 3 are in some cases almost entirely dark brown due to the spiracular and dorsal spots being greatly enlarged and fused except for the median pale area. Abdominal pleura yellow and immaculate except that the exposed portions of pleura 2 and 3 are dark brown.

In dark forms, dorsum of abdomen almost entirely dark brown or black except for a median pale yellow spot which is light bulb-shaped on segment 2, narrowly elongate subrectangular on segment 3, and large-mouthed-vase-shaped or subquadrate on segments 4 and 5. Terga 1, 7 and 8 yellow, each with one pair of subquadrate dorsal dark brown spots. Tergum 4 with an additional pair of large subquadrate spiracular yellow spots. Abdominal pleura half pale and half dark except for pleuron 3 which is entirely black.

Hippodamia parenthesis (Say)

Specimens examined

The study was based on six pupae and one pupal exuvia reared from adults collected in East Lansing, Ingham Co., Michigan, on

25 July 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This is only species among the known pupae of Hippodamia with the apical margin of the clypeolabrum slightly concave and never deeply notched, and with the lateral angle of the elytron longer than basal width, never shorter than basal width as in the remaining known pupae of Hippodamia.

Description

Length: 4mm-4.5mm; width: 2.5mm. Head dark brown with one pair of 8-shaped or rounded yellow spots. Clypeolabrum dark brown and subquadrate with apical margin more or less truncated or slightly concave (Figure 47).

Pronotum slightly marginate, bright yellow. In light forms, marginal spots are distinctly present, consisting of two pairs of large subquadrate anterior marginal spots and one pair of large, poorly defined spots at posterior angles, and one pair of basal oval spots (Figure 131). The outer anterior marginal spots and spots at posterior angles may fuse together along lateral margins. The inner anterior marginal spots may expand posteriorly toward the basal spots (Figures 132, 134). Mesonotum brown at anterior angle and base. Metanotum with one pair of very large bell-shaped spots. Elytron dark brown over one-half of the total surface, with an elongate 8-shaped yellow spot. In light forms, elytral suture and apex brown, two

subequal and small spots respectively at humeral and mediosutural area at the basal one-fourth, and a large median spot (as large as or larger than the two previous spots combined) at the basal one-half are distinctly present (Figure 163).

Abdominal terga bright yellow, each with two pairs of very large subrectangular dark brown spots except that tergum 1 is immaculate or with one pair of small rounded spots, and the pygidium is entirely immaculate. The tergal spots on the abdominal segments are very large, often almost filling the tergal surface except for the median area. Abdominal pleura brownish with marginal area yellowish; pleuron 3 in dark forms is entirely dark brown. Abdominal sterna yellowish to brownish and immaculate.

Hippodamia glacialis (Fabricius)

Specimens examined

The study was based on three pupal exuviae from the U. S. National Museum, collected in association with adults in Massachusetts by Dimmock.

Diagnosis

The maculation pattern of this species and Hippodamia convergens is very similar, especially on the elytron. However, it can be separated from H. convergens by the poorly developed dorsal tubercles on the abdomen, where in H. convergens the dorsal tubercles are greatly developed and directed caudally (Figure 244). This species also can be distinguished from H. quinquesignata by the lack of a transverse

band at the subbasal area of the elytron. (See Hippodamia tredecim-punctata diagnosis for the separation these two species and H. parenthesis).

Description

Length: 6mm; width: 3.5mm. Head rugose and dark brown with two yellowish rounded frontal spots. Clypeolabrum dark brown and rugose with apical margin deeply notched and apical angles subpointed and projected caudally. Antennal scape strongly convex anteriorly.

Pronotum yellowish, slightly marginate along lateral and anterior margins and with four pairs of spots: one pair of large subquadrate spots at medioanterior area which are often expanded posteriorly, one pair of elongate oval small spots at the anterior angles, one pair of oval spots at base and one pair of subquadrate spots at the posterior angles (Figure 135).

Meso- and metanotum basically yellowish, mesonotum with one pair of small, and metanotum with one pair of large, subcircular dark brown spots. Elytron yellowish (Figures 169, 170), with a subcircular humeral spot and a mediosutural spot about the same size as the previous spot at the basal one-fourth, and a median spot twice as large as the other two combined at the basal one-half. Lateral margin of the elytron dark brown; sutural area and lateral angle brown.

All abdominal terga yellowish, each tergum with one pair of large subquadrate dorsal spots and one pair of spiracular spots except for tergum 1 immaculate or with one pair of small dorsal spots. The pygidium immaculate. Abdominal pleura immaculate and yellowish except pleura 3 and the exposed portion of pleuron 2 dark brown.

Hippodamia convergens Guerin

Specimens examined

The study was based on five pupae and two pupal exuviae reared from adults collected in East Lansing, Ingham Co., Michigan, on 30 June 1971, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and the U. S. National Museum.

Diagnosis

See diagnosis of Hippodamia tredecimpunctata, H. parenthesis, H. glacialis for the separation of this species from the group.

Description

Pupae of this species are very similar to Hippodamia glacialis especially the maculation pattern on the elytron.

Length: 5mm-5.5mm; width: 3mm-3.30mm. Head entirely dark brown except for the pale yellowish mediolongitudinal line. The pronotum in dark forms has two pairs of subequal subquadrate dark brown spots, one pair at the medioanterior marginal area and the other pair at base, and two pairs of other spots at the anterior and posterior angles which are always fused together along the lateral marginal areas (Figures 136, 137). Discodorsal area of the pronotum varies from very light brown to brown. Meso- and metanotum pale yellowish. Mesonotum with one pair of small and metanotum with one pair of large subtriangular spots. In dark forms, mesonotum entirely dark brown

except for the pale mediolongitudinal line. Scutellar area of the mesonotum always brownish to dark brown.

The dorsal tubercles on the abdomen are characteristically well developed in this species where they are greatly elevated and directed caudally.

Hippodamia quinquesignata (Kirby)

Specimens examined

The pupae and adults were collected in Idaho in a cluster, mixed with several different species, on 31 July 1969 by R. W. Portman. Based on the maculation pattern on the elytron of the adults the pupae were carefully selected to have greatest possibility of correct identification. The variation of maculation pattern within the species is therefore very limited in this study.

The study was based on 16 selected pupae consisting of a single form. Four specimens are deposited in the Entomology Museum of Michigan State University, the rest will be returned to University of Idaho.

Diagnosis and description

Hippodamia quinquesignata is very similar to H. glacialis and H. convergens but differs in the maculation pattern on the elytron. The humeral spot and the mediosutural spot at the basal one-fourth are transversely fused into a transverse band extending from the subsutural area to the humeral angle (Figures 166-168). In lighter forms, the subbasal transverse band on the elytron becomes obsolete; in this

case, an L-shaped subscutellar spot is characteristic of this species (Figures 164, 165).

In addition, this species can also be separated from H. glacialis and H. convergens by the eighth abdominal tergum being glabrous; in H. glacialis and H. convergens the eighth abdominal tergum is finely setiferous.

Genus COLEOMEGILLA Timberlake

Coleomegilla maculata (DeGeer)

Specimens examined

The study was based on 18 pupae and eight pupal exuviae which were reared from adults collected in East Lansing, Ingham Co., Michigan, 30 June 1972, by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Diagnosis

This species, along with the closely related genera Naemia and Eriopis, form a group which is separated from Hippodamia by having the exposed intersegmental conjunctivae finely setiferous, and by having the lateral angle of the elytron obtuse, rounded, and almost continuous with the lateral margin (Figures 155-156). Coleomegilla in turn is separated from Naemia by the first abdominal spiracles being partly hidden under the elytra (in Naemia the 1st abdominal spiracles are entirely hidden under the elytra), and from Eriopis by the apical

margin of the clypeolabrum being slightly concave, whereas in Eriopis the apical margin of the clypeolabrum is deeply notched.

Description

Length: 4.5-5mm; width: 2.2-2.8mm. Body very elongate oval, yellowish and finely setiferous, with well defined dark brown spots on dorsal surface.

Head yellowish to light brown (supra ocular area sometimes brown) with the frons always pale; surface smooth or slightly rugose. Antennae long, extending over two-thirds of the distance between the eye and the widest lateral margin of the pronotum. Scape largely expanded caudally and flat. Flagellum elbowed and subquadrate in cross section. Club distinctly subspherical and with three rings of papillae, although the last ring is more or less obsolete. Clypeolabrum subquadrate, as long as or slightly shorter than wide, with apical margin slightly concave and apical angles rounded (Figure 43). Mandibles sharply bifid at tip. Maxillary palpi large, trapezoidal, yellowish to brown and smooth. Galea smooth without teeth.

Pronotum yellowish, large, subrectangular, deeply marginate along anterior and lateral margins, anterior margin strongly carinate and slightly projected anterally (Figure 126); a large pair of oval spots usually present at base (Figures 124-125). Meso- and metanotum each with one pair of large suboval dark brown spots in dark forms, whereas in light forms, the spots on the mesonotum are wanting or very light brown. Elytron smooth, finely setiferous, three times as long as wide. Epipleura wide and slightly concave; lateral angle of the elytron rounded obtuse and almost continuous with the lateral margin

(Figure 156). Elytra usually with well defined dark brown spots, consisting of a scutellar spot and a subsutural spot at basal two-thirds, (these two spots are usually fused with sutural dark area), a humeral rounded spot, two median spots, one at the basal two-fifths, and one at the apical one-fifth. The first medial spot large and subrectangular, extending from lateral margin almost to the sutural dark area; the second medial spot light brown and much smaller than the humeral spot; and finally, a distolateral poorly defined light brown spot. In some cases, the spots may become light or absent. Hind wing membranous, tapered apically and glabrous. Legs long, with femora slender and somewhat cylindrical, extending considerably beyond the widest lateral margins of the pronotum, finely setiferous and brown to dark brown except for the pale femoral bases and tibiotarsal joints. Hind femorotibial joints visible dorsally.

Abdominal terga yellowish, finely and densely setiferous, (including median area). Dorsal tubercles wanting. The exposed intersegmental conjunctivae finely setiferous. Most terga usually with one pair of lateral and one pair of dorsal spots which are often fused together except median area. Terga 7 to 9 are immaculate, and tergum 1 is either immaculate or with 2 small poorly-defined dorsal spots. Tergum 8, pygidium and urogomphi and glabrous. Abdominal spiracles circular or nearly so, except for the first which is large, elongate oval and mostly hidden beneath the elytra. Abdominal pleura subquadrate with lateral margin convex. Surface smooth, yellowish and finely setiferous except for the first 2 pleura which are pale and hidden beneath the elytra. Abdominal sterna immaculate, pale yellowish, and finely setiferous except for sterna 8 and 9 which are glabrous.

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Genus NAEMIA Mulsant

Naemia seriata (Melsheimer)

Specimens examined

The study was based on two pupae, including one reared exuvia of Naemia seriata collected in Mayo Beach, Maryland, 30 August 1944 by E. A. Chapin. The specimens were loaned from the U. S. National Museum.

Diagnosis

See diagnosis of Coleomegilla maculata for separation of these two species.

Description

The species is similar to Coleomegilla maculata in many respects except the following:

Length: 4-4.55mm; width: 2.5mm. Clypeolabrum tapering apically. Apical margin concave and narrow, about one-half as wide as the base (Figure 42).

Lower margin of anterior edge of the pronotum descending about two-thirds of the eye length (Figure 42). Elytral maculation pattern as in Coleomegilla maculata, but spots with an equal degree of brownness, and a common sutural and a common scutellar spot present. Legs short, not extended considerably beyond lateral margin of the pronotum (Figure 42). Abdominal tergum 1 with two large but poorly defined

dorsal spots. First abdominal spiracles entirely hidden under the elytra.

Genus ERIOPIS Mulsant

Eriopis connexa (Germar)

Specimens examined

The study was based on 10 pupae of Eriopis connexa reared in Albany, California, by R. L. Tassan. The specimens were loaned from Dr. K. S. Hagen's collection.

Diagnosis

This genus appears to have some close affinity to Hippodamia because the pronotum is very slightly marginate and rugose, the antennal scape is strongly convex, and the clypeolabrum is deeply notched at apical margin. In contrast, the wing form shows more affinity to Coleomegilla in which the lateral angle is obtuse and almost continuous with the lateral margin of the elytron. In general, this species is distinctly separated from Coleomegilla by the sharply notched apical margin of the clypeolabrum (Figure 49) and by the slightly angulate lateral margins of abdominal pleura 3 to 5 (Figure 175) (in Coleomegilla the apical margin of the clypeolabrum is slightly concave and the lateral margin of the abdominal pleura 3 to 5 is rounded convex). It is separated from Hippodamia by the exposed finely setiferous intersegmental conjunctivae on the dorsum of the abdomen, and by the obtuse and rounded lateral angle of the elytron (in Hippodamia the exposed

intersegmental conjunctivae on the dorsum of the abdomen are glabrous and the lateral angle of the elytron is greatly expanded anteriorly into a broad rounded lobe).

Description

Length: 5.5mm; width: 3mm. Body elongate, moderately convex dorsally and apparently glabrous.

Head dark brown along lateral area, including eyes and antennae; discal area yellow. Antennae long, extending to the widest lateral margins of the pronotum. Club with 4 rings of poorly developed papillae, with the diameter subequal to that of the flagellum. Scape convex and rugose. Clypeolabrum large, dark brown except medially, with apical margin angularly and deeply notched; surface slightly rugose. Maxillary palpi large with lateral margin sinuate (Figure 49).

Pronotum subquadrate, about 1/3 wider than long, shiny yellow, slightly and regularly rugose, very slightly marginate and with 2 large but not well defined basal brownish spots (Figure 127). Prothoracic spiracle rounded oval. Meso- and metanotum each with one pair of subtriangular spots. Elytron yellow, elongate (3 times longer than wide) with lateroapical angle obtuse, and almost continuous with lateral margin. Sutural and lateral margin dark brown. Hind wings glabrous. Legs long and slender, with front femora extending considerably beyond lateral margins of the pronotum. Abdomen yellow and slightly rugose dorsally. Each tergum with one pair of large but not well defined subrectangular spots (except terga 1, 7, 8, 9 which are immaculate). Exposed intersegmental conjunctivae on abdomen finely

setiferous. Abdominal pleura subquadrate, yellow and immaculate, with lateral margin slightly angulated (Figure 175).

TRIBE PSYLLOBORINI

Diagnosis

See diagnosis of Coccinellini for separation of these two tribes.

Genus PSYLLOBORA Chevrolat

Psyllobora vigintimaculata (Say)

Specimens examined

The study was based on over 30 pupae of Psyllobora vigintimaculata which were reared from adults collected in Clinton Co., Michigan, 10 June 1972 by Dang T. Phuoc. The specimens are deposited in the Entomology Museum at Michigan State University and in the U. S. National Museum.

Description

Length: 2.5-3mm; width: 1.5-1.8mm. Body slightly elongate oval, finely setiferous, pale whitish, with a few dark spots on dorsal surface. Head pale except for light brown eyes. Antennae very long with the tips hidden beneath the front femora, and more than twice as long as the distance between the antennal bases. Club not distinct

from the flagellum and with 2 entire rings of well developed papillae (Figure 46). Clypeolabrum subrectangular, about twice as wide as long, with apical margin truncated or very slightly concave (Figure 46). Mandible bifid. Maxillary palpi bell-shaped, with the apex greatly enlarged (Figure 46); galea greatly enlarged and rounded as seen from the top, with the greatest width as wide as the base of maxillary palpus (Figure 92).

Pronotum pale whitish, with anterior margin slightly concave and slightly marginate along anterior and lateral margins. Meso- and metanotum also pale whitish, each with one pair of subrounded dark brown spots. Elytron subrectangular, immaculate, whitish and finely setiferous. Lateral angle of the elytron obtuse and lateral margin marginate. Legs short and pale except terminal "segment" which is brownish with pointed "claws" (Figure 46).

Abdominal terga pale whitish and immaculate, except that the first 2 terga have one pair of poorly defined brownish spots on each, and the third tergum with 2 pairs of more distinct spiracular and dorsal subquadrate spots. Urogomphi well developed and similar to Coccinellini. Abdominal spiracles circular. Abdominal pleura pale, subquadrate, and with the lateral margin rounded and convex, except for pleura 2 and 3 which are brownish at the posterior and anterior marginal areas respectively. Abdominal sterna entirely immaculate and pale.

DISCUSSION AND CONCLUSIONS

Based on adults, the taxonomy of the Coccinelliae has been fairly well worked out. From this standpoint, several systems of classification within the family have long been proposed and used. The history of the classification of the family based on adult characters was presented by Watson (1956) and by Sasaji (1968, 1971). The system which has been most accepted by many authors is that proposed by Korschefsky (1931, 1932) in which the family Coccinellidae contains three subfamilies: the EPILACHNINAE, the LITHOPHILINAE with the monotypic genus Lithophilus Frölich, and the COCCINELLINAE which contains the majority of the members of the family. The system has not been greatly altered except some tribal rearrangements have been attempted. Watson (1956) proposed that the Coccinellini should be recognized as the three different tribes Coccinellini, Hippodamiini and Anisostictini after careful study of the morphology of the adults, despite the fact that Böving (1917), an early author who carefully studied the larval stages of COCCINELLIDAE, pointed out that the COCCINELLINI and HIPPODAMIINI can not be separated by using characters of the larvae.

A number of authors have worked on coccinellid larvae, including Böving (1917), Gage (1919), Strouhal (1926), Rees (1947, 1948), Van Emden (1949), Kapur (1950) and recently Savoiskaya (1960, 1962a, 1962b, 1962c, 1963, 1964a, 1964b), Kamiya (1965), and Sasaji (1968a).

Using larval characters Kamiya (1965) proposed new phylogenetic relationships among coccinellid tribes in which he considered EPILACHNINAE to have independently evolved from the COCCINELLINAE, the tribes COCCINELLINI and PSYLLOBORINI to be closely related and highly developed, the tribes HYPERASPINI, PLATYNASPINI, TELSIMINI, SCYMNINI, STETHORINI, NOVIINI, and CHILOCORINI to have branched from another stem in which the members of CHILOCORINI are most advanced, and the SUKUNAHIKONINI, SERANGIINI and PHARINI to be another stem. He also emphasized that members of HYPERASPINI and SUKUNAHIKONINI stand as the most primitive forms in the family.

After careful study of adult and larval characters Sasaji (1968) (newly adopted name of Kamiya) came up with a new system of classification in which the family is divided into six subfamilies, the STICHOLOTINAE, SCYMNINAE, CHILOCORINAE, COCCIDULINAE, COCCINELLINAE and EPILACHNINAE. He proposed a new tribal phylogeny and relationships which do not agree entirely with his previous work. He thought the EPILACHNINAE were very closely allied with the COCCINELLINAE, but had evolved divergently with the change of feeding habits from carnivorous to phytophagous. He also emphasized that these two subfamilies have evolved from a Sticholotine-like ancestor, with STICHOLOTINAE as the most primitive group in the family. On the other hand, he believed the CHILOCORINAE and SCYMNINAE are closely related and have evolved on a separate stem without any close connections to any other groups. Finally, he stated that although both groups were primitive, the COCCIDULINAE and STICHOLOTINAE did not have great affinity. Moreover, within the COCCIDULINAE, the NOVIINI appear to have a closer affinity

to SCYMNINI or ORTALIINI than to the COCCINDULINI. Therefore, the branching point of COCCIDULINAE is still very much in doubt.

Information on the pupae has never been used in the classification of the family Coccinellidae. However, from the material examined in this study, it is possible to arrive at some conclusions concerning the tribal relationships.

By the study of the comparative morphology of the pupae, the relative degree of advanced or primitiveness of the pupal characters has been determined by the application of Maslin's concepts (1952) on the use of morphological criteria for phyletic relationships (see Table 1).

For the following discussion refer to the phylogenetic diagram (Figure 246).

The COCCINELLINAE contains three tribes COCCINELLINI, PSYLLOBORINI and DISCOTOMINI (Sasaji, 1971), but pupae for the last tribe were not available. Based on pupal characters, the COCCINELLINAE is the most highly advanced subfamily and has evolved along a distinct line in which they, without exception among known pupae for the family, have distinct maculation on the dorsal body surfaces, have exposed conjunctivae between the abdominal segments which allow for expansion of the abdomen by means of a unique folding mechanism, and have fine and rather inconspicuous setae.

The PSYLLOBORINI are almost identical to the COCCINELLINI except for their smaller size and having greatly enlarged galea. As Sasaji (1968b) pointed out, the PSYLLOBORINI have recently diverged from the predaceous COCCINELLINI in adopting the fungiphagous habit. This opinion is substantiated by the morphology of the pupae.

TABLE 1.--Phyletic rating of selected pupal characters in the Coccinellidae

PUPAL CHARACTERS Primitive → Advanced (0) (5)	COCCINELLID TRIBES STUDIED STICHOLOTINI	SERANGIINI	NOVIINI	SCYMNILLINI	COCCIDULINI	EPILACHNINI	CHILOCORINI	HYPERASPINI	SCYMNINI	STETHORINI	PSYLLOBORINI	COCCINELLINI
ABDOMEN (Unflexible → flexible)	0	0	0	0	0	0	0	0	0	0	5	5
MACULATION PATTERN (Immaculate → maculate)	0	0	1	0	0	1	1	0	0	0	3	5
coarsely setiferous → finely setiferous → apparently glabrous → glabrous	0	0	0	0	0	0	0-3	0	0	0	5	5
ANTENNAE (Cubless → Clubbed)	4	4	0	0	4.5	3	0	0	2	2	4	4-5
MANDIBLES (Tip simple → Tip bifid)	0	0	4	2	4	5	0-0.5	3	3	3	4	4
FRONTAL AREA (Sclerotized → Menbranous)	0	0	0	0	0	0	0	0	0	5	0	0
CLYPEOLABRUM (Longer than wide → wider than long)	1	2	4	3	5	3	4.5	4	4.5	4	5	4
ELYTRON (Lateral margin) (nonmarginate → strongly marginate)	0	0	0	0	0	0	0	0	0	0	5	5

ELYTRON (Lateral margin) (nonmarginate → strongly marginate)	0	0	0	0	0	3	4.5	4	4.5	4	5	4
HIND WING APEX (Setiferous → glabrous)	0	0	0	0	0	5	5	5	5	5	5	5
ABDOMINAL SPIRACLES (Absent → nonpedunculate → pedunculate)	2	2	1	2	2.5	3-4	4	0	2	3	2	2
UROGOMPHI (absent → present → complex)	0	0	4	1	1	1	3-4	5	2-3	2	4	4

The remainder of the family is distinctly separated from the COCCINELLINAE by their usually pale and immaculate bodies, by the more or less compact abdomen in which the abdominal terga are firmly attached to one another without the intervening exposed conjunctivae, and usually by the presence of coarse, long and very conspicuous setae. Therefore, they are probably a monophyletic group which evolved from a common ancestor which is widely separated from the COCCINELLINAE.

The EPILACHNINAE split off early from this group, independently acquired the phytophagous habit and highly evolved mandibles whose tip is bifid and broadly concave mesally.

Following the EPILACHNINAE, the STICHOLOTINAE-COCCIDULINAE group diverged from the main stem of branch 1 evolving from a common ancestor which acquired setae at the apex of the hind wings.

The STICHOLOTINAE, according to Sasaji (1971), consists of four tribes: SHIROZUELLINI, STICHOLOTINI, SERANGIINI and SUKUNAHIKONINI. Unfortunately, pupae were available for only the STICHOLOTINI and SERANGIINI, but they appear to be the most primitive group within the family for they have retained many primitive characters (see Table 1).

According to Sasaji (1971) COCCIDULINAE contains the tribes NOVIINI, EXOPLECTRINI, LITHOPHILINI, and COCCIDULINI, but only pupae of the SCYMNILLINI, NOVIINI and COCCIDULINI were available. Because of the presence of setae on the pupal hind wing apex, the SCYMNILLINI are more closely related to the COCCIDULINI than to the SCYMNINI as Sasaji (1971) suggested. Therefore, the tribe SCYMNILLINI should be included in the COCCIDULINAE instead of the SCYMNINAE.

The COCCIDULINAE appear to be more advanced than the STICHOLOTINAE; however, they are far less advanced than the remaining groups of the

family. On one hand, the COCCIDULINI appear to be more closely related to EPILACHNINI than any other groups of COCCINELLIDAE outside of the COCCIDULINAE by retaining first four slightly pedunculated abdominal spiracles, and by having the urogomphi slender with a simple apex. The NOVIINI, on the other hand, appear to have a close relationship to the CHILOCORINI (CHILOCORINAE) and the HYPERASPINI (SCYMNINAE) than to the SCYMNILLINI and COCCIDULINI by having short, clubless non-pappillated antennae, bipartited urogomphi whose apexes are modified into a complex distal disk, and the subquadrate abdominal pleura in a subvertical position.

The CHILOCORINAE contains three tribes according to Sasaji (1971), the CHILOCORINI, PLATYNASPINI, and TELSIMIINI. Only pupae of the CHILOCORINI were available. The CHILOCORINI appear to have evolved along a separate branch by acquiring a broadly expanded clypeus. They show some degree of relationship with the STICHOLOTINAE-COCCIDULINAE group by retaining the primitive simple mandibles and the clubless non-papillated antennae which may be found in the STICHOLOTINAE (Microweisea ovalis, Delphastus pusillus) and in the SCYMNILLINI (Zagloba ornata).

Finally, according to Sasaji (1971) the SCYMNINAE consists of seven tribes, the ORTALIINI, ASPIDIMERINI, SCYMNINI, HYPERASPINI, CRANOPHORINI, STETHORINI, and SCYMNILLINI. However, the SCYMNILLINI have been shown above to belong to the COCCIDULINAE. Only pupae of the SCYMNINI, HYPERASPINI and STETHORINI were available. The SCYMNINAE have recently branched from branch 1. The STETHORINI appear to be the most highly evolved tribe with the frontal area entirely membranous, the well defined pedunculate first abdominal spiracles, and the glabrous

frons, clypeolabrum and pygidium. By having the well pedunculated first abdominal spiracles, STETHORINI appear to have close relationships with the CHILOCORINI. In contrast, the HYPERASPINI are the most primitive tribe in the SCYMNINAE, even though they have acquired some highly evolved characters such as the strongly sclerotized and complex distal disk of the urogomphi.

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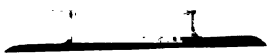
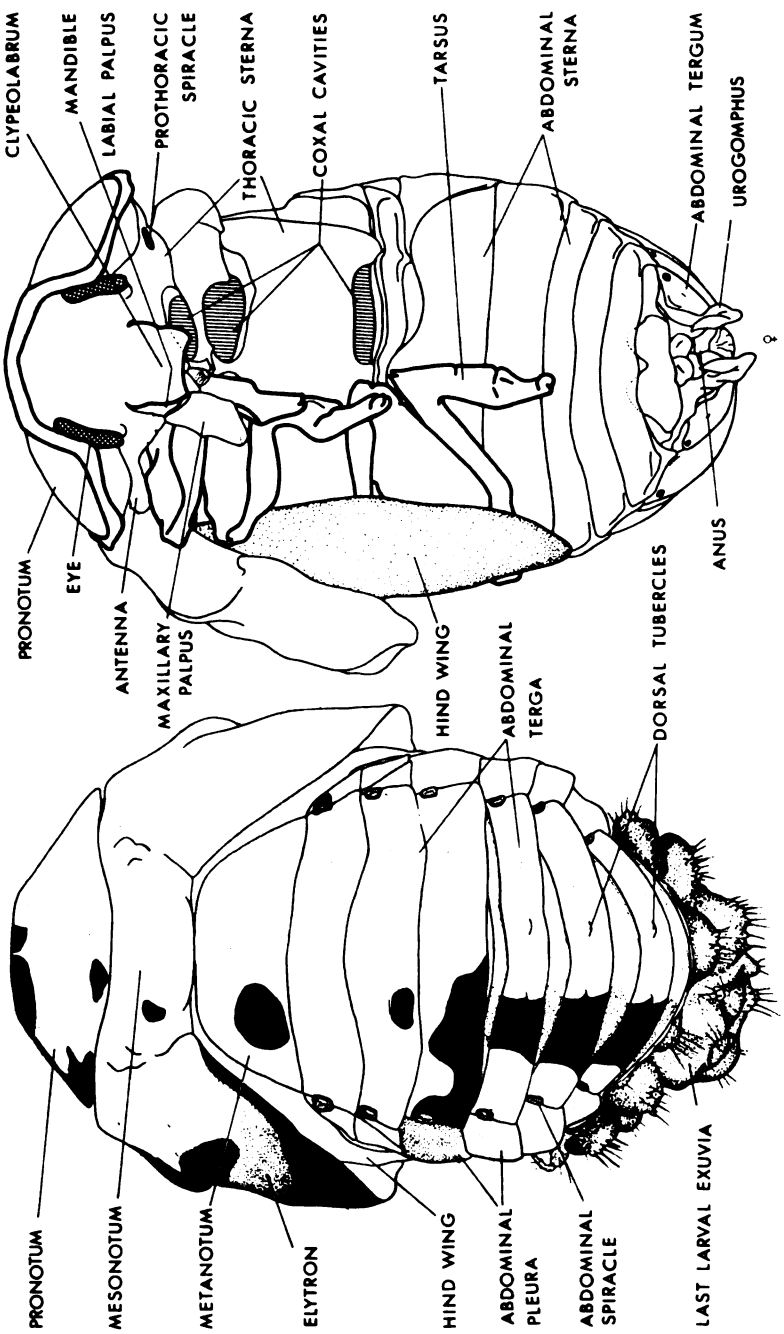
FIGURES



Figures 1-2: General morphological details of coccinellid pupae.

Figure 1. Coccinella novemnotata ♀, dorsal aspect.

Figure 2. Coccinella novemnotata ♀, ventral aspect.


CLYPEOLABRUM
MANDIBLE
LABIAL PALPUS
PROTHORACIC SPIRACLE
THORACIC STERNA
COXAL CAVITIES
TARSUS
ABDOMINAL STERNA
ABDOMINAL TERGUM
UROGOMPHUS
PRONOTUM
EYE
ANTENNA
MAXILLARY PALPUS
HIND WING
ABDOMINAL TERGA
DORSAL TUBERCLES
ANUS
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PRONOTUM
MESONOTUM
METANOTUM
ELYTRON
HIND WING
ABDOMINAL PLEURA
ABDOMINAL SPIRACLE
LAST LARVAL EXUVIA
♀
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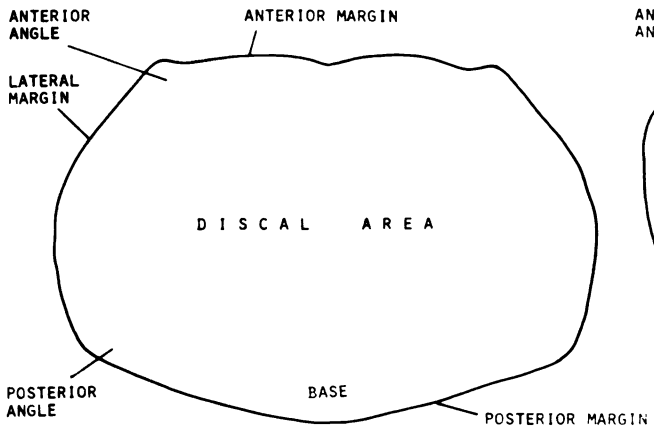
Figures 3-4. General areas on the pronotum of coccinellid pupae (dorsal aspect).

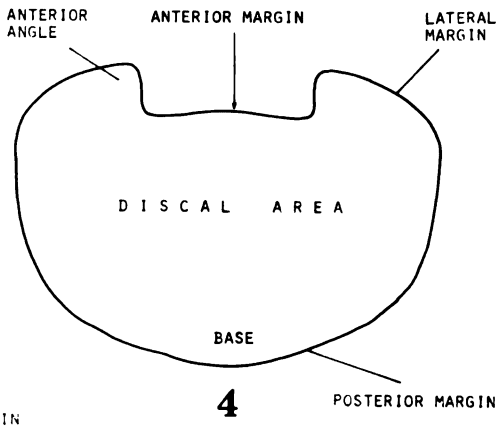
Figures 5-6. General areas on the elytra of coccinellid pupae.

Figure 7. Eriopis connexa, a close up portion of the surface of the apical margin of the elytron.

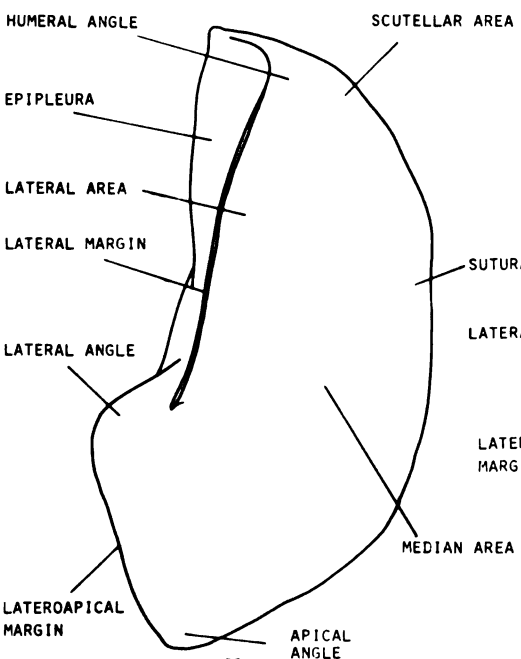
Figure 8. Coccinella novemnotata, a close up portion of the surface of apical margin of the elytron.


ANTERIOR ANGLE
ANTERIOR MARGIN
LATERAL MARGIN
DISCAL AREA
POSTERIOR ANGLE
BASE
POSTERIOR MARGIN

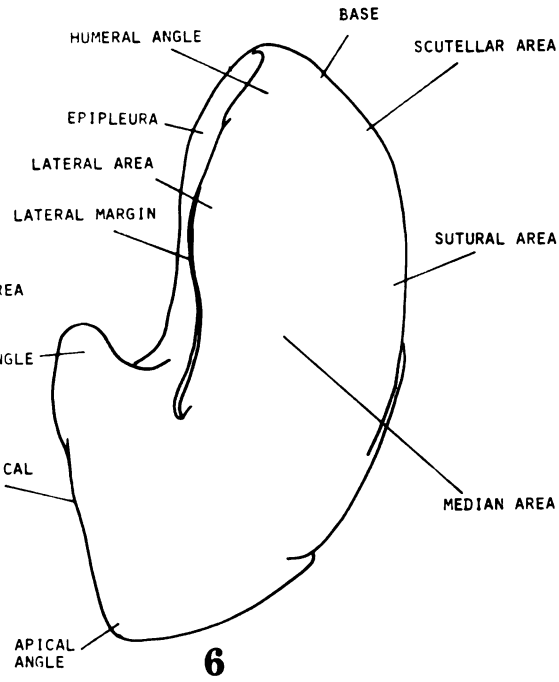
3


ANTERIOR ANGLE
ANTERIOR MARGIN
LATERAL MARGIN
DISCAL AREA
BASE
POSTERIOR MARGIN

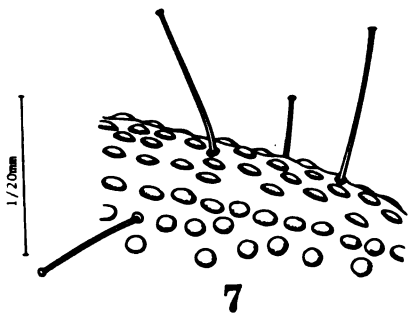
4


HUMERAL ANGLE
SCUTELLAR AREA
EPIPLEURA
LATERAL AREA
LATERAL MARGIN
SUTURAL AREA
LATERAL ANGLE
MEDIAN AREA
LATEROAPICAL MARGIN
APICAL ANGLE

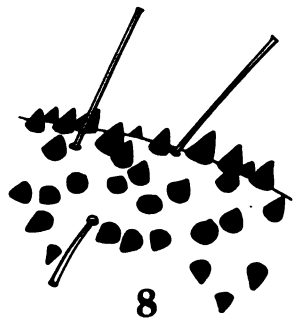
5


BASE
HUMERAL ANGLE
SCUTELLAR AREA
EPIPLEURA
LATERAL AREA
LATERAL MARGIN
SUTURAL AREA
LATERAL ANGLE
LATEROAPICAL MARGIN
MEDIAN AREA
APICAL ANGLE

6


1/20mm

7



8

Figures 9-16: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 9. *Epilachna borealis*

Figure 10. *Epilachna sp.*

Figure 11. *Lindorus lophantae*

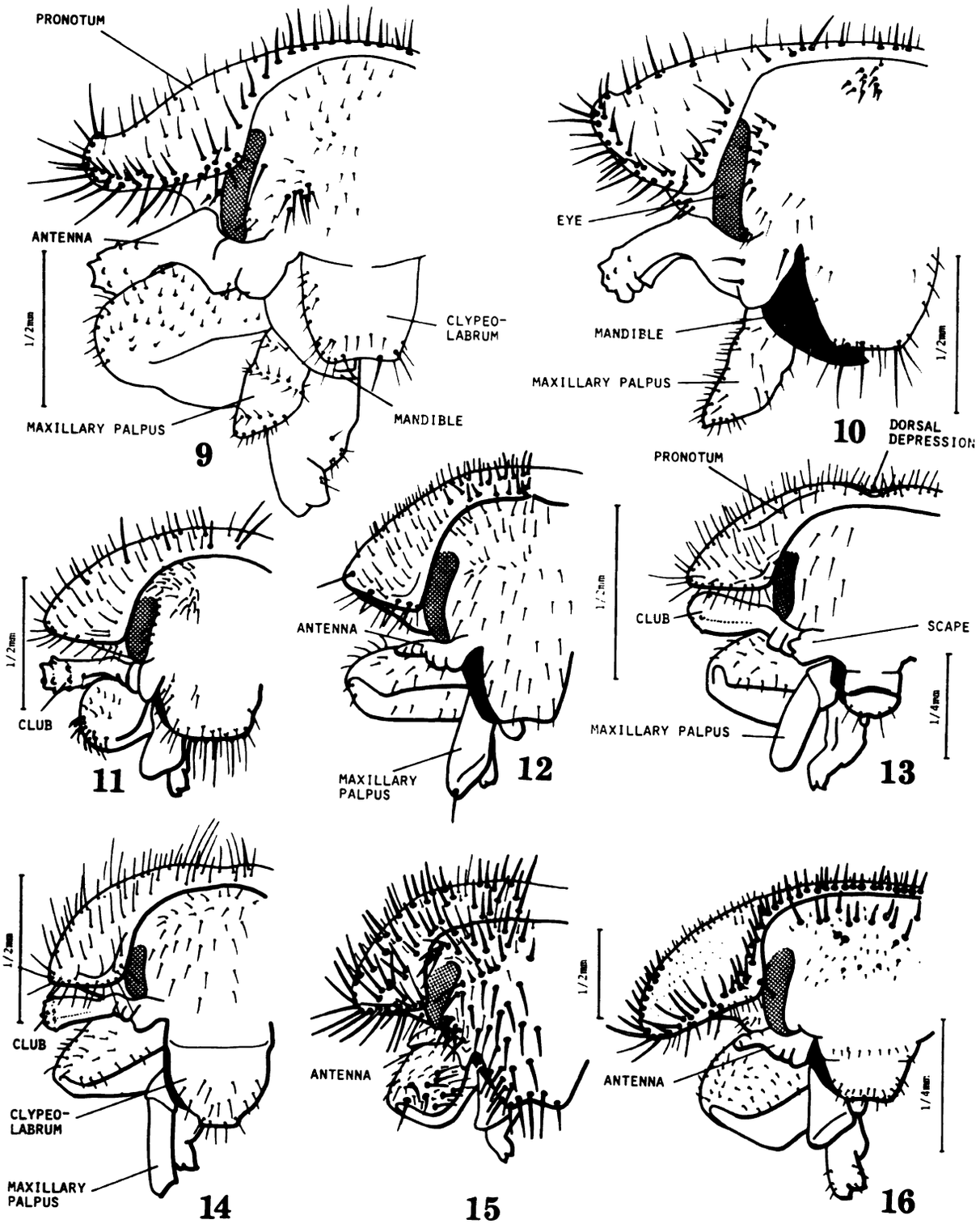
Figure 12. *Zagloba ornata*

Figure 13. *Elphastus pusillus*

Figure 14. *Microweisea ovalis*

Figure 15. *Hyperaspis binotata*

Figure 16. *Thalassa montrouzieri*


PRONOTUM
ANTENNA
1/2mm
CLYPEO-
LABRUM
MANDIBLE
MAXILLARY PALPUS
9
EYE
MANDIBLE
MAXILLARY PALPUS
1/2mm
10
DORSAL
DEPRESSION
1/2mm
CLUB
11
ANTENNA
MAXILLARY
PALPUS
12
PRONOTUM
1/2mm
CLUB
SCAPE
MAXILLARY PALPUS
1/4mm
13
1/2mm
CLUB
CLYPEO-
LABRUM
MAXILLARY
PALPUS
14
ANTENNA
15
1/2mm
ANTENNA
1/4mm
16

Figures 17-22: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 17. Stethorus punctum

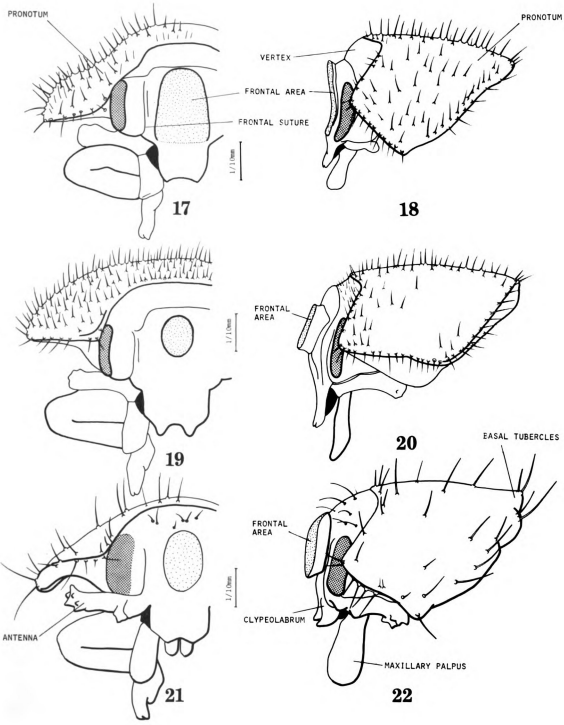
Figure 18. Stethorus punctum (lateral aspect)

Figure 19. Stethorus picipes

Figure 20. Stethorus picipes (lateral aspect)

Figure 21. Stethorus atomus

Figure 22. Stethorus atomus (lateral aspect)


PRONOTUM
VERTEX
FRONTAL AREA
FRONTAL SUTURE
1/10mm
17
18
19
20
EASAL TUBERCLES
ANTENNA
CLYPEOLABRUM
MAXILLARY PALPUS
21
22

Figures 23-31: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 23. Chilocorus bivulnerus

Figure 24. Axion plagiatum

Figure 25. Axion plagiatum, a close up portion of the surface of the pronotum.

Figure 26. Exochomus hoegei

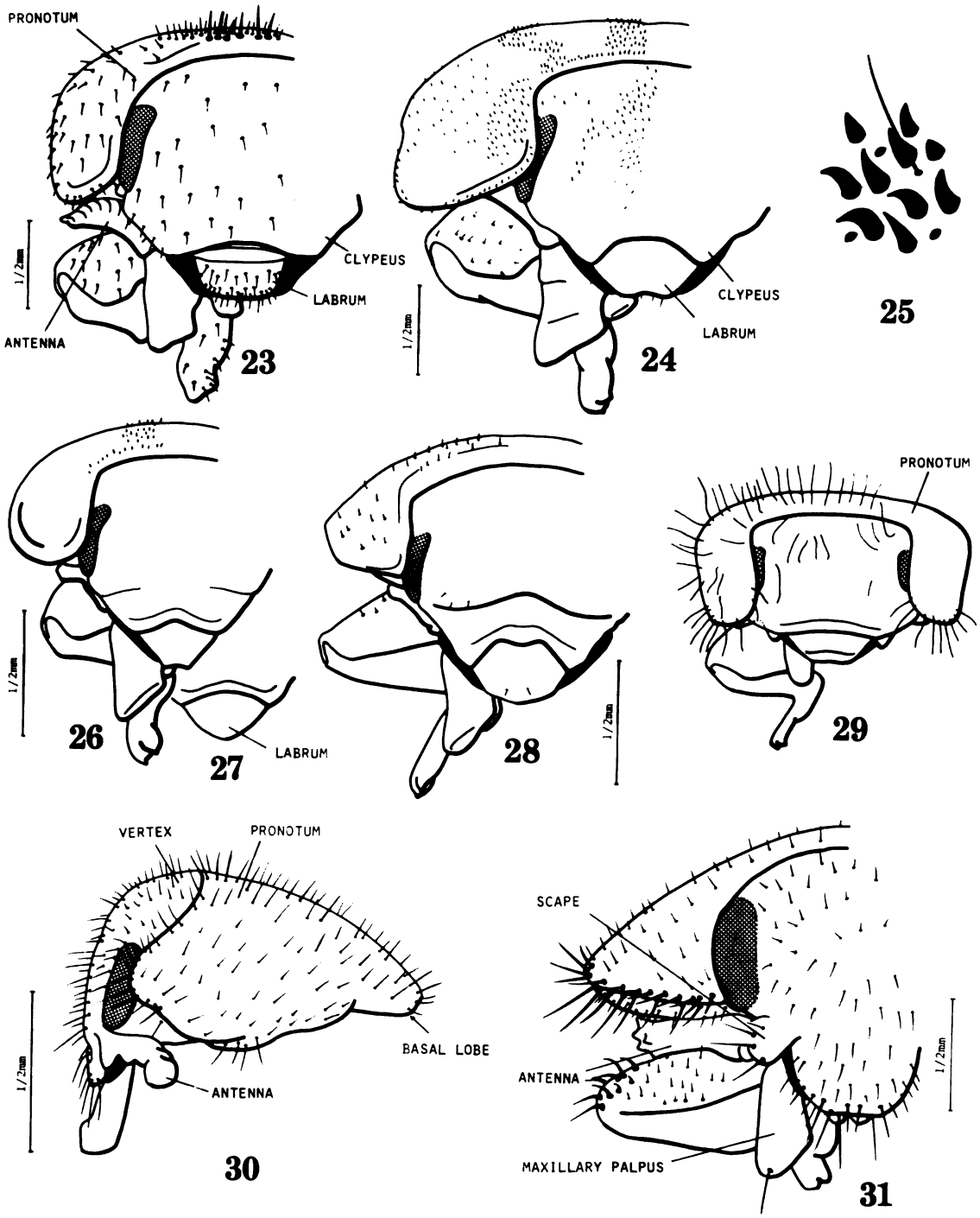
Figure 27. Exochomus cubensis, clypeolabral portion.

Figure 28. Brumoides suturalis

Figure 29. Orcus chalybeus

Figure 30. Scymnus creperus, lateral aspect.

Figure 31. Cryptolaemus montrouzieri


PRONOTUM
CLYPEUS
LABRUM
ANTENNA
1/2mm
23
CLYPEUS
LABRUM
1/2mm
24
25
1/2mm
26
LABRUM
27
28
1/2mm
PRONOTUM
29
VERTEX
PRONOTUM
BASAL LOBE
ANTENNA
1/2mm
30
SCAPE
ANTENNA
MAXILLARY PALPUS
1/2mm
31

Figures 32-37: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 32. Anatis ocellata

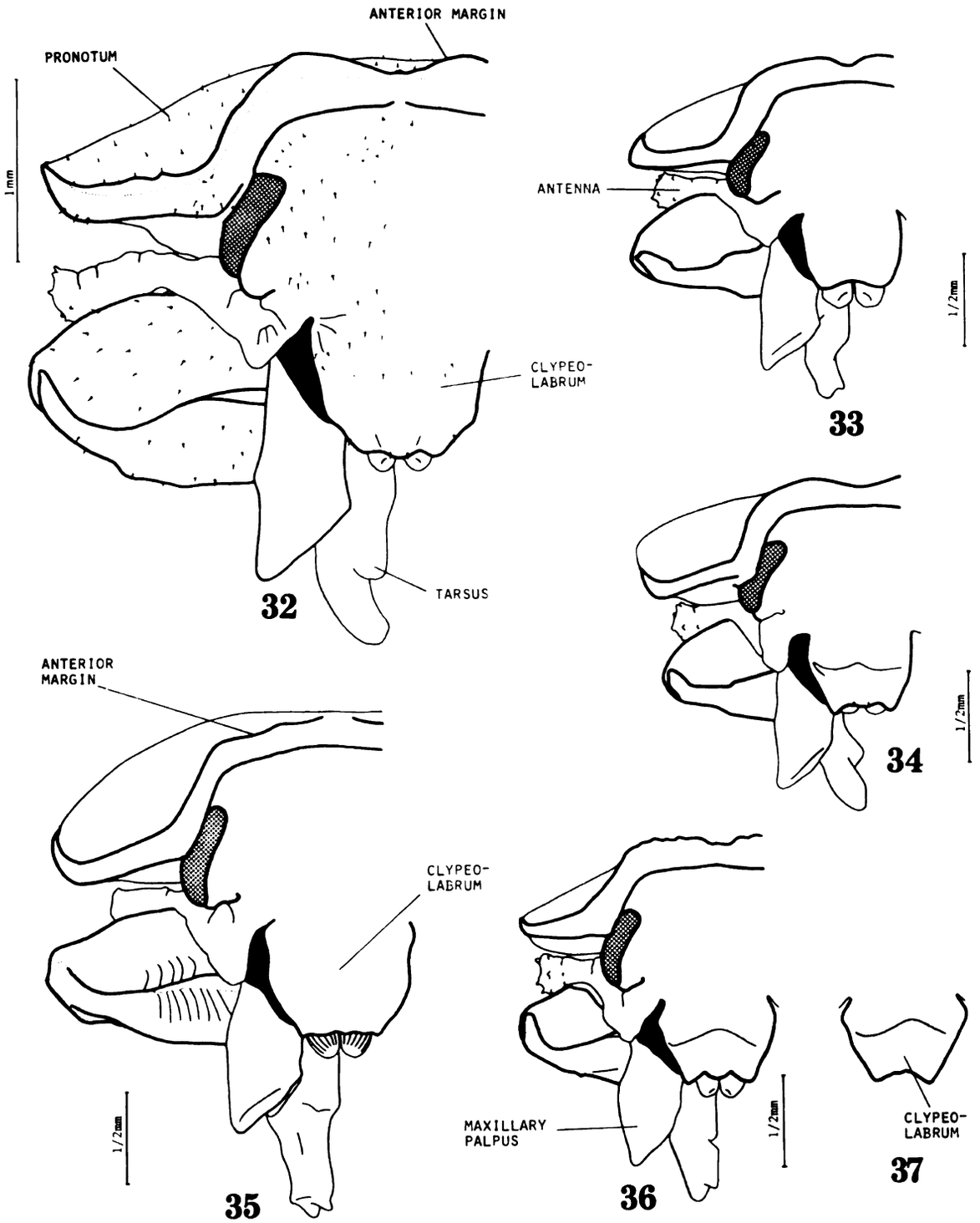
Figure 33. Mulsantina picta

Figure 34. Olla abdominalis

Figure 35. Coccinella novemnotata

Figure 36. Adalia bipunctata

Figure 37. Adalia bipunctata, clypeolabrum


ANTERIOR MARGIN
PRONOTUM
1mm
CLYPEO-
LABRUM
TARSUS
32
ANTENNA
1/2mm
33
1/2mm
34
ANTERIOR
MARGIN
CLYPEO-
LABRUM
1/2mm
35
MAXILLARY
PALPUS
1/2mm
36
CLYPEO-
LABRUM
37

Figures 38-43: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 38. Cycloneda munda

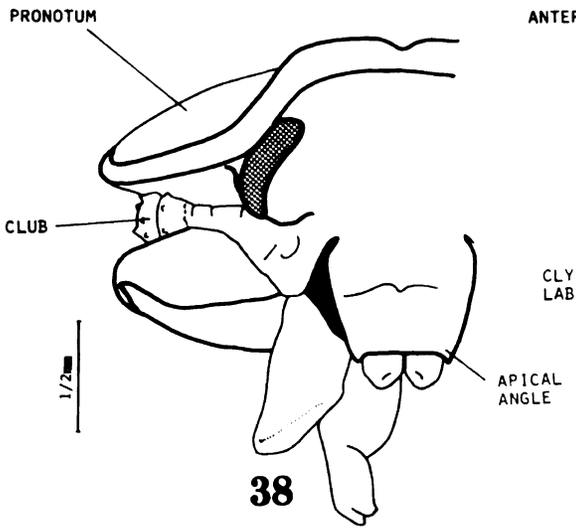
Figure 39. Cycloneda munda (lateral aspect)

Figure 40. Neoharmonia venusta

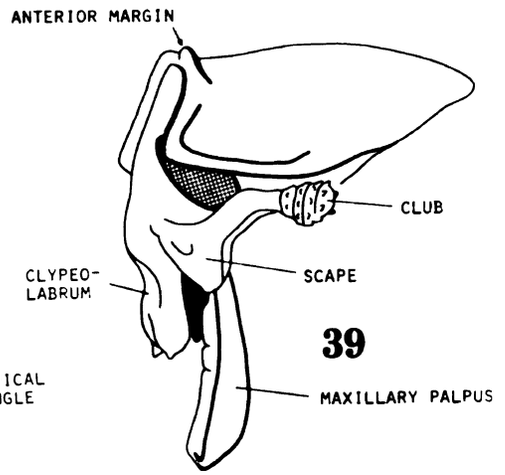
Figure 41. Hippodamia convergens

Figure 42. Naemia seriata

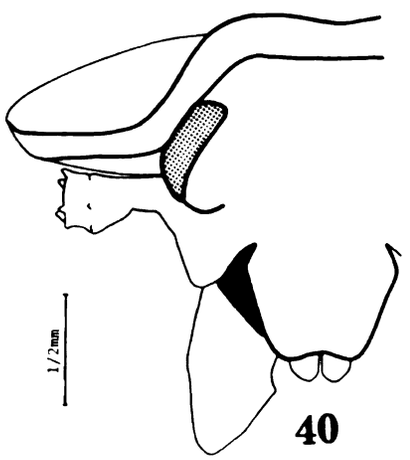
Figure 43. Coleomegilla maculata



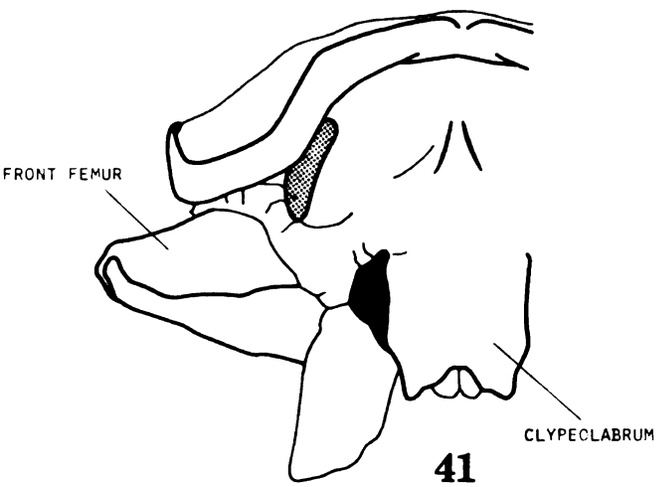
38



39



40



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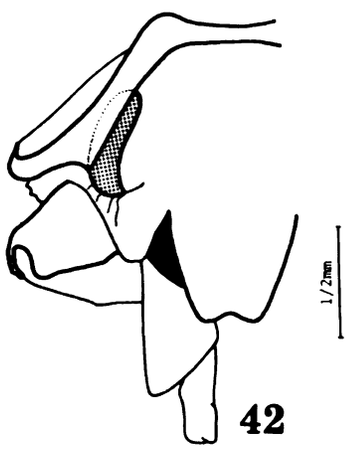

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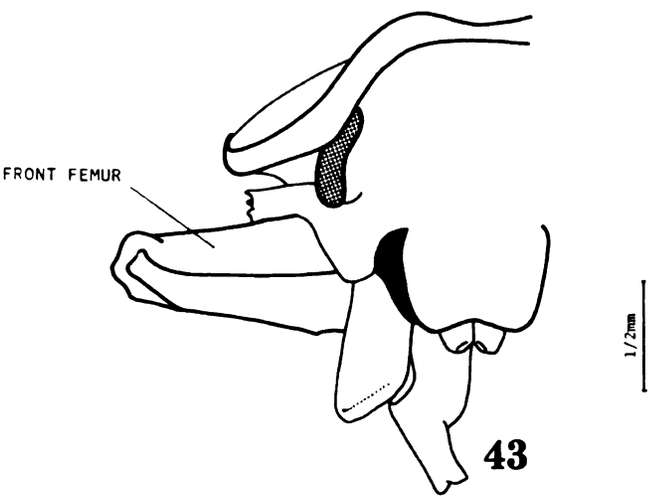


43

Figures 44-51: Frontal aspect of the prothoracic and cephalic portion of coccinellid pupae.

Figure 44. Propylaea quatuordecimpunctata

Figure 45. Anisocalvia quatuordecimguttata

Figure 46. Psyllobora vigintimaculata

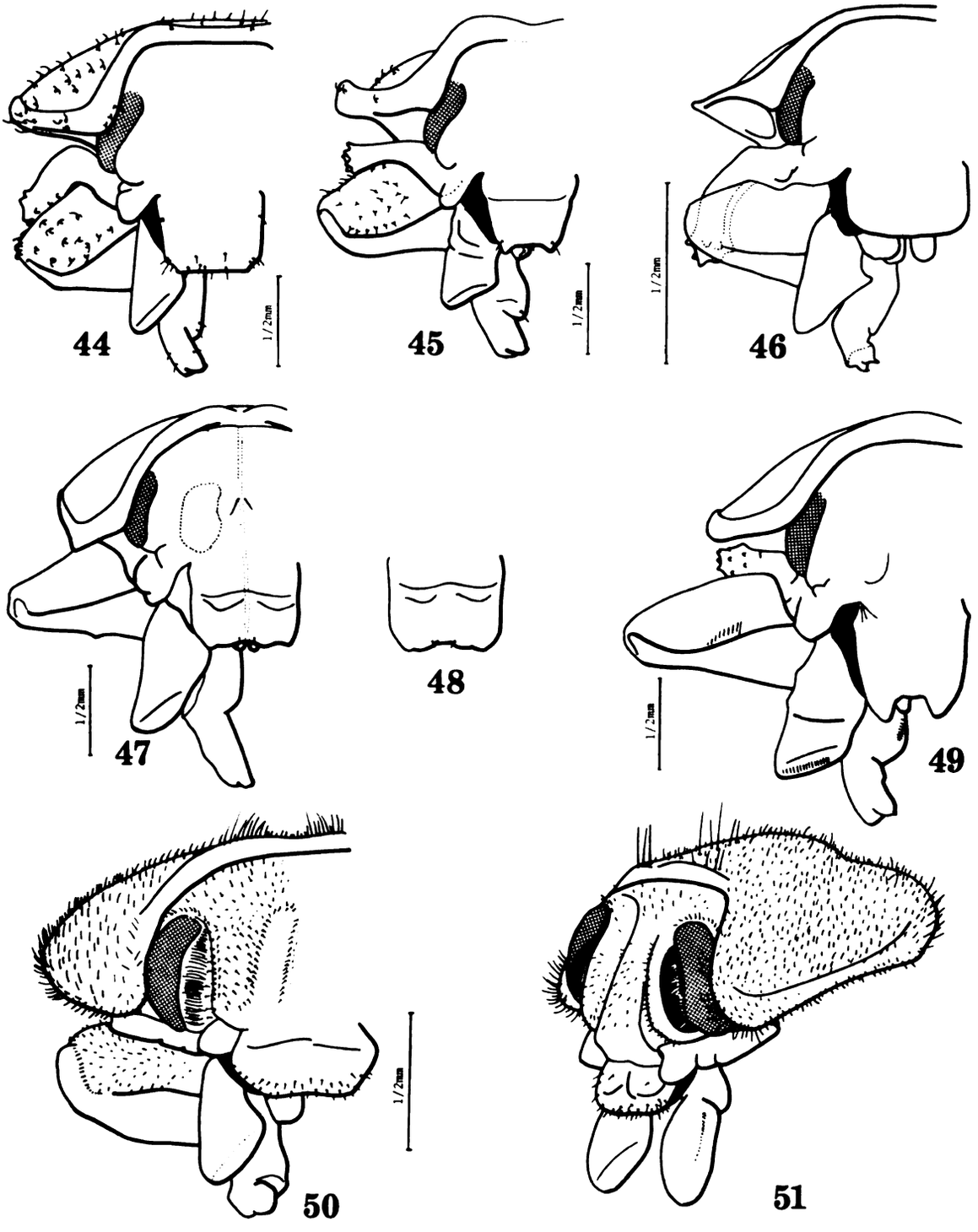
Figure 47. Hippodamia parenthesis

Figure 48. Hippodamia parenthesis, clypeolabrum

Figure 49. Eriopis connexa

Figure 50. Rodolia cardinalis

Figure 51. Rodolia cardinalis


1/2mm
44
1/2mm
45
1/2mm
46
1/2mm
47
48
1/2mm
49
1/2mm
50
51

Figures 52-63: Frontal aspect of left antenna of coccinellid pupae.

Figure 52. Coccinella novemnotata

Figure 53. Mulsantina picta

Figure 54. Anatis ocellata

Figure 55. Synonycha grandis

Figure 56. Propylaea guatuordecimpunctata

Figure 57. Epilachna borealis

Figure 58. Scymnus creperus

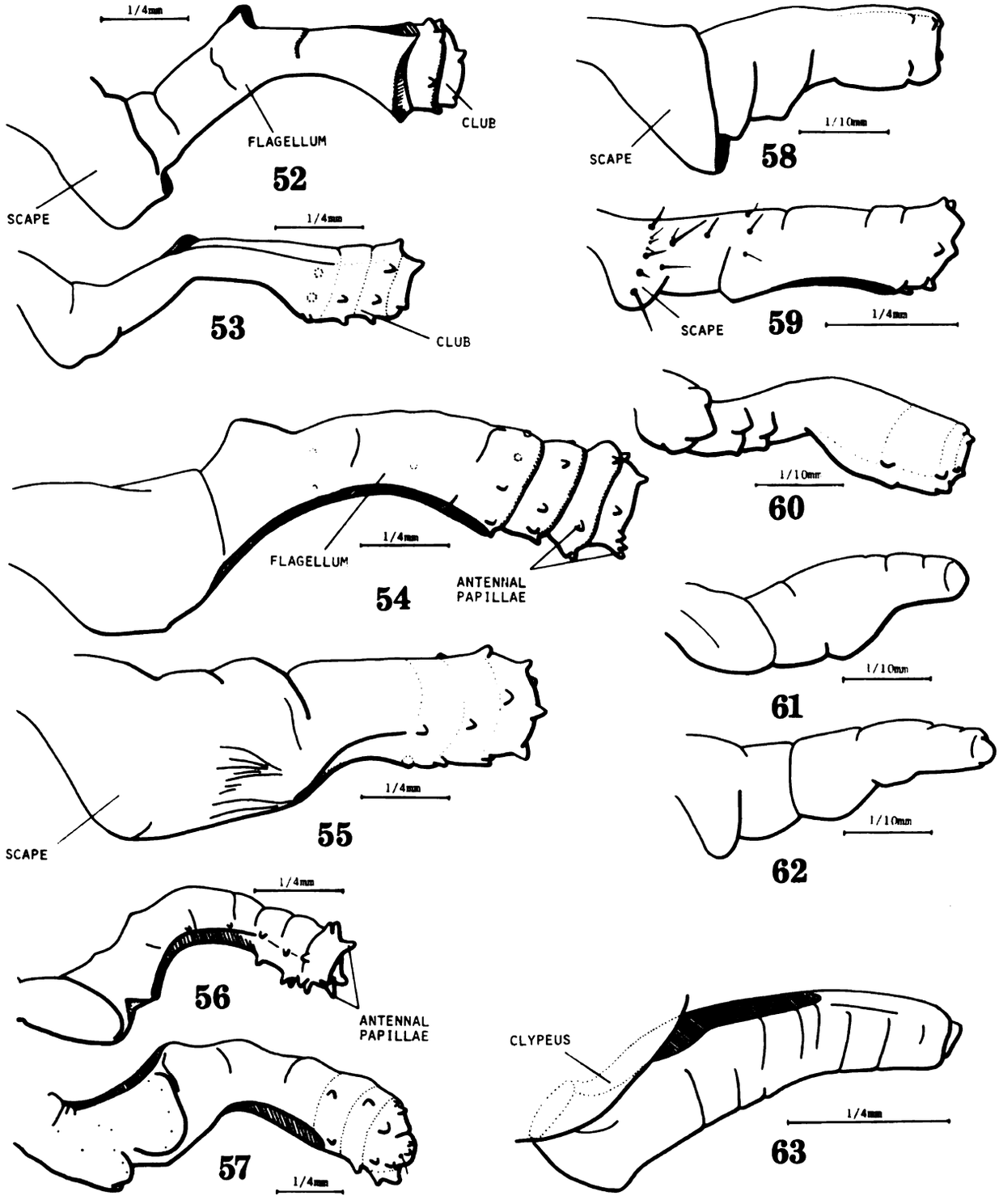
Figure 59. Cryptolaemus montrouzieri

Figure 60. Delphastus pusillus

Figure 61. Zagloba ornata

Figure 62. Hyperaspis binotata

Figure 63. Axion plagiatum


1/4mm
FLAGELLUM
CLUB
SCAPE
52
1/4mm
53
CLUB
SCAPE
58
1/10mm
SCAPE
59
1/4mm
60
1/10mm
FLAGELLUM
1/4mm
54
ANTENNAL PAPILLAE
61
1/10mm
55
1/4mm
SCAPE
62
1/10mm
1/4mm
56
ANTENNAL PAPILLAE
57
1/4mm
CLYPEUS
1/4mm
63

Figures 64-78: Left mandible of coccinellid pupae.

Figure 64. *Axion plagiatum*, dorsal aspect.

Figure 65. *Axion plagiatum*, mandibular apex as viewed from the top.

Figure 66. *Chilocorus bivulnerus*, mandibular aspect.

Figure 67. *Chilocorus bivulnerus*, mandibular apex as viewed from the top.

Figure 68. *Hyperaspic binotata*, dorsal aspect.

Figure 69. *Hyperaspis binotata*, mandibular apex as viewed from the top.

Figure 70. *Coccinella novemnotata*, dorsal aspect.

Figure 71. *Coccinella novemnotata* mandibular apex as viewed from the top.

Figure 72. *Epilachna varivestis*, dorsal aspect.

Figure 73. *Epilachna varivestis*, mesal aspect.

Figure 74. *Epilachna varivestis*, viewed from the top.

Figure 75. *Epilachna borealis*, dorsal aspect.

Figure 76. *Epilachna sp.*, dorsal aspect.

Figure 77. *Epilachna sp.*, viewed from the top.

Figure 78. *Epilachna borealis*, viewed from the top.

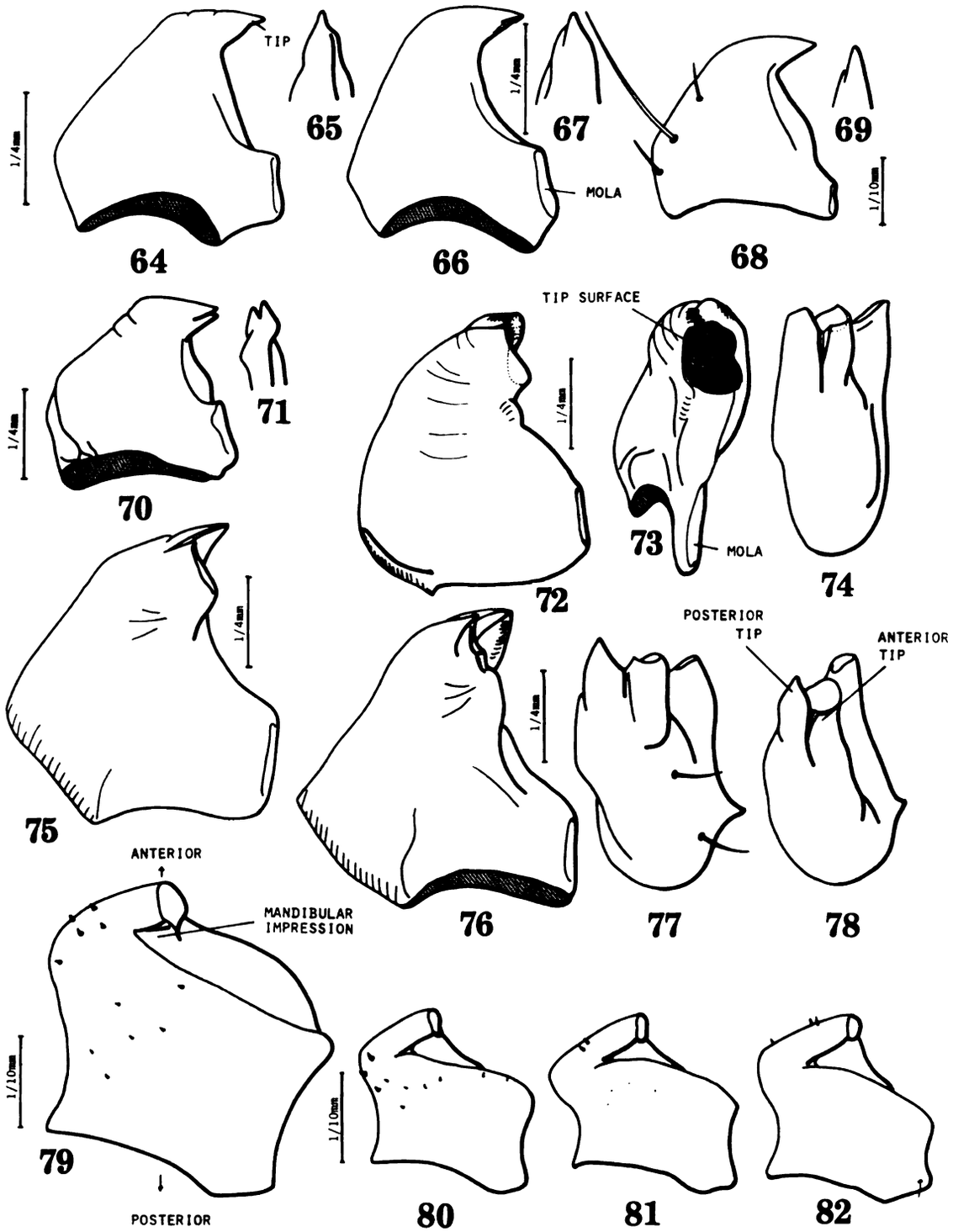
Figures 79-82: Left galea of coccinellid pupae as viewed from the top.

Figure 79. *Anatis ocellata*

Figure 80. *Mulsantina picta*

Figure 81. *Cycloneda munda*

Figure 82. *Adalia bipunctata*


TIP
1/4mm
65
64
1/4mm
67
MOLA
66
69
1/10mm
68
71
70
TIP SURFACE
1/4mm
72
73
MOLA
74
1/4mm
75
POSTERIOR TIP
ANTERIOR TIP
1/4mm
76
77
78
ANTERIOR
MANDIBULAR IMPRESSION
1/10mm
79
POSTERIOR
1/10mm
80
81
82

Figures 83-92: Dorsal aspect of the maxilla of coccinellid pupae.

Figure 83. Epilachna varivestis

Figure 84. Zagloba ornata

Figure 85. Cryptolaemus montrouzieri

Figure 86. Hyperaspis binotata

Figure 87. Delphastus pusillus

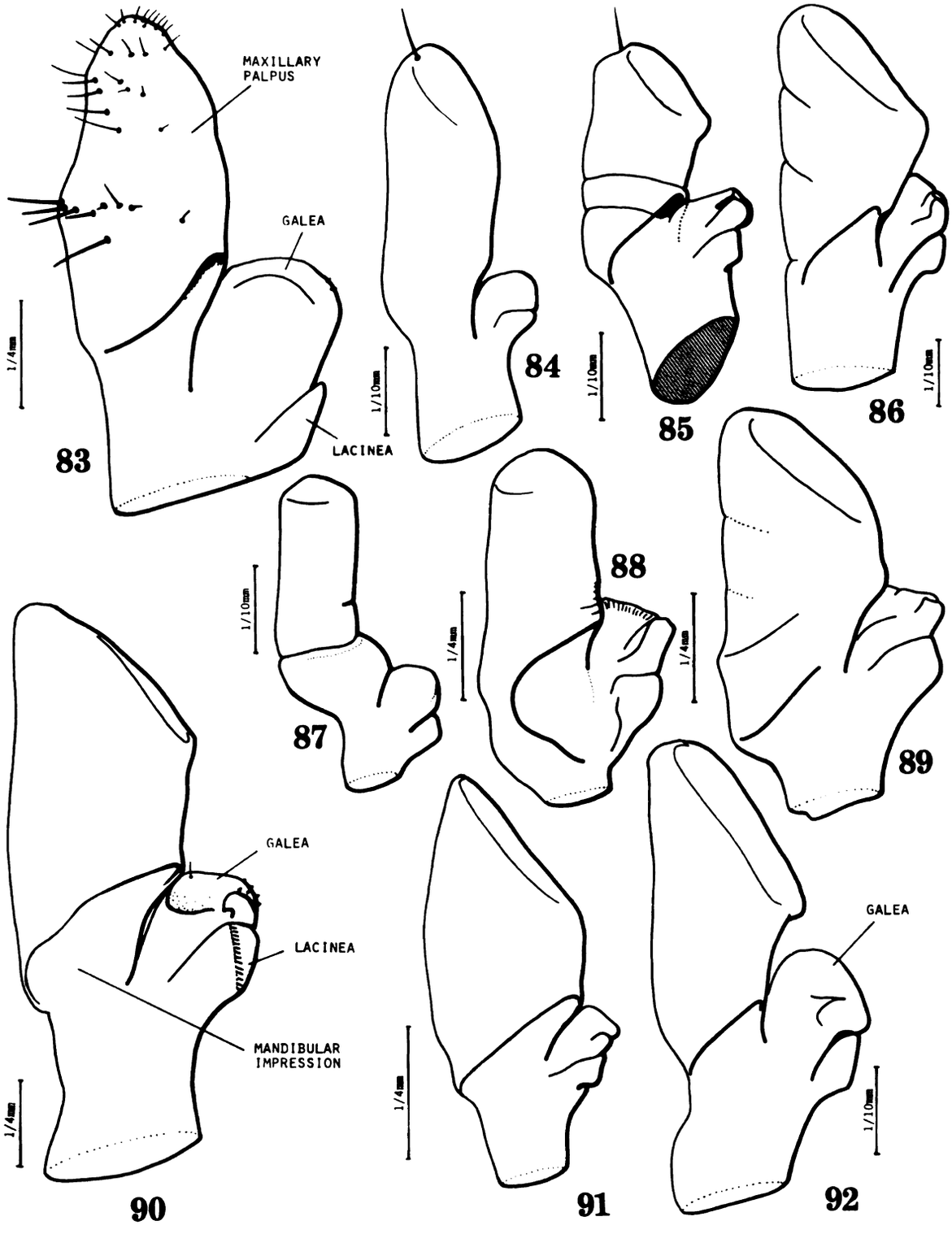
Figure 88. Chilocorus bivulnerus

Figure 89. Axion plagiatum

Figure 90. Anatis ocellata

Figure 91. Adalia bipunctata

Figure 92. Psyllobora vigintimaculata


MAXILLARY PALPUS
GALEA
LACINEA
1/4mm
1/10mm
83
84
85
86
87
88
89
90
91
92
MANDIBULAR IMPRESSION

Figures 93-102: Labium of coccinellid pupae.

Figure 93. Chilocorus bivulnerus, ventral aspect.

Figure 94. Axion plagiatum, ventral aspect.

Figure 95. Axion plagiatum, viewed from the apex.

Figure 96. Hyperaspis binotata, dorsal aspect.

Figure 97. Hyperaspis binotata, lateral aspect.

Figure 98. Anatis ocellata, ventral aspect.

Figure 99. Epilachna varivestis, ventral aspect.

Figure 100. Epilachna varivestis, viewed from the top.

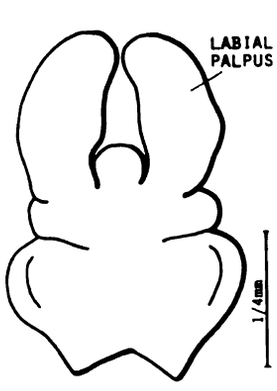
Figure 101. Delphastus pusillus, ventral aspect.

Figure 102. Zagloba ornata, ventral aspect.

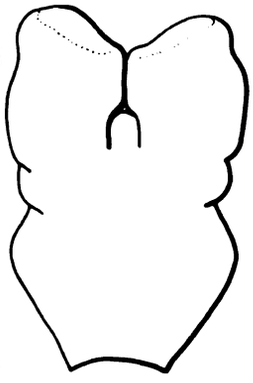
Figures 103-104: Hind legs.

Figure 103. Axion plagiatum

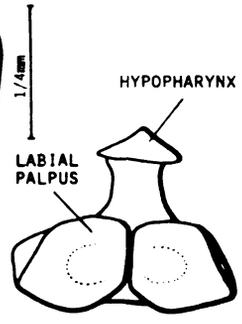
Figure 104. Brumoides suturalis



93



94



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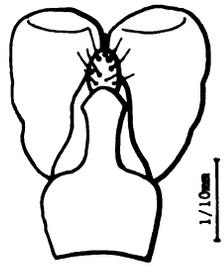

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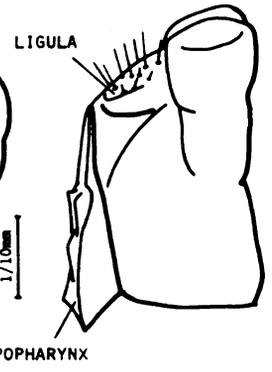

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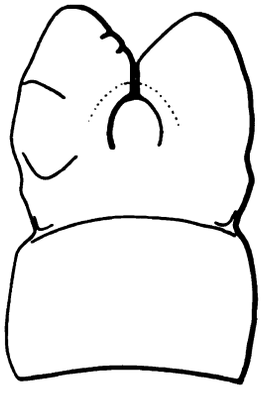
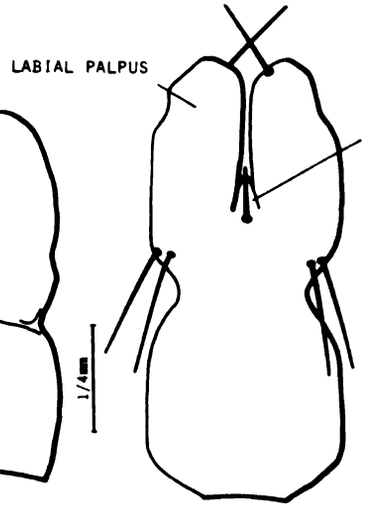


98



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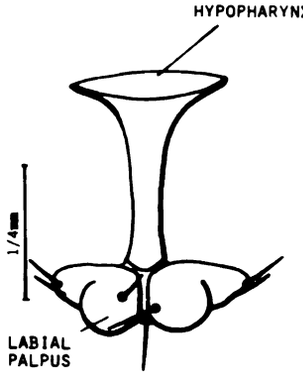
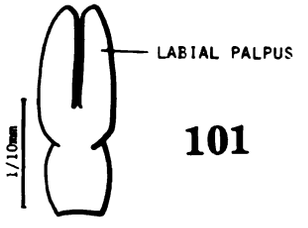


100



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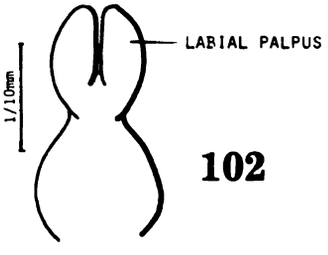

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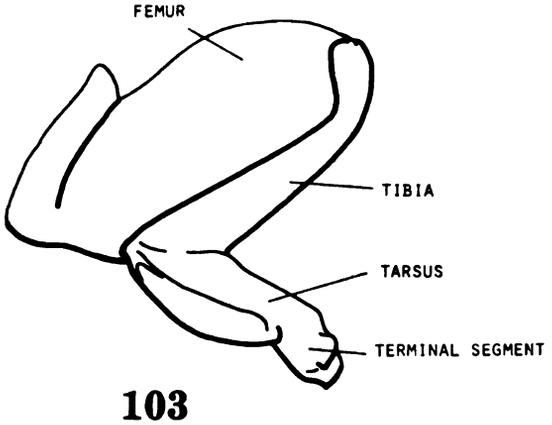

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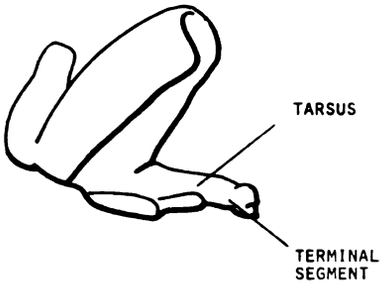

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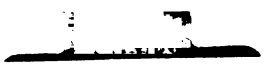


Figures 105-112: Dorsal aspect of the pronotum of coccinellid pupae.

Figure 105. Axion plagiatum

Figure 106. Exochomus hoegei

Figure 107. Brumoides suturalis

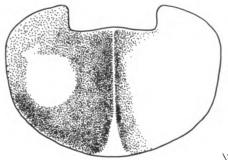
Figure 108. Epilachna corrupta

Figure 109. Scymnus creperus

Figure 110. Stethorus atomus

Figure 111. Neoharmonia venusta

Figure 112. Coccinella trifasciata



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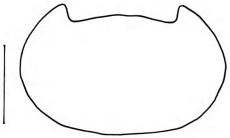
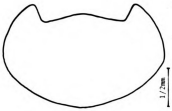
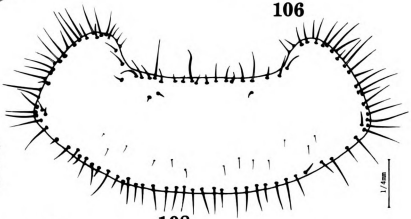


106



107



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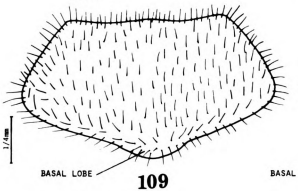
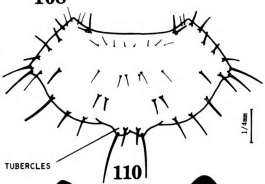


109



110

111

112

Figures 113-121: Dorsal aspect of the pronotum of coccinellid pupae.

Figure 113. Coccinella transversoguttata

Figure 114. Coccinella transversoguttata

Figure 115. Coccinella monticola

Figure 116. Coccinella monticola

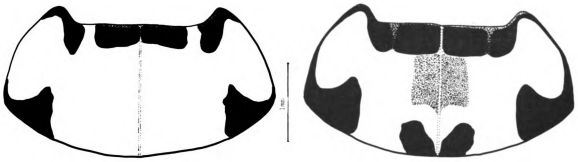
Figure 117. Adalia bipunctata

Figure 118. Adalia bipunctata

Figure 119. Adalia bipunctata

Figure 120. Anatis ocellata

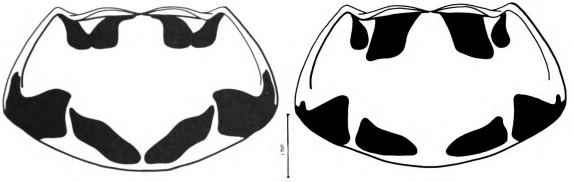
Figure 121. Anatis quindecimpunctata



113 114

115 116

117 118 119



120 121

Figures 122-130: Dorsal aspect of the pronotum of coccinellid pupae.

Figure 122. *Mulsantina picta*

Figure 123. *Mulsantina hudsonica*

Figure 124. *Coleomegilla maculata*

Figure 125. *Coleomegilla maculata*

Figure 126. *Coleomegilla maculata*, lateral aspect.

Figure 127. *Eriopis connexa*

Figure 128. *Hippodamia tredecimpunctata*, light forms.

Figure 129. *Hippodamia tredecimpunctata*, dark forms.

Figure 130. *Hippodamia tredecimpunctata*, dark forms.

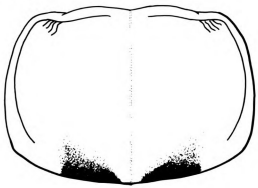
122

123

124

125

126



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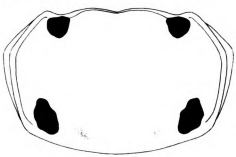


128

129

130

Figures 131-138: Dorsal aspect of the pronotum of coccinellid pupae.

Figure 131. Hippodamia parenthesis

Figure 132. Hippodamia parenthesis

Figure 133. Hippodamia parenthesis, cross section of lateral margin of the pronotum.

Figure 134. Hippodamia parenthesis

Figure 135. Hippodamia quinquesignatata

Figure 136. Hippodamia convergens

Figure 137. Hippodamia convergens

Figure 138. Olla abdominalis

Figures 139-140: Dorsal aspect of the metanotum of coccinellid pupae.

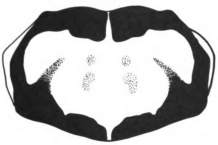
Figure 139. Mulsantina picta

Figure 140. Mulsantina hudsonica

131

132

133



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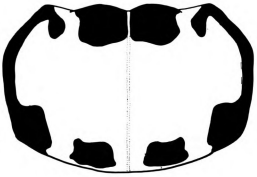
135



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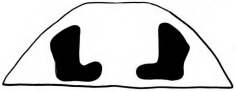


139

140

138

Figures 141-152: Dorsal aspect of left elytron of coccinellid pupae.

Figure 141. Coccinella trifasciata

Figure 142. Coccinella trifasciata

Figure 143. Coccinella septempunctata

Figure 144. Coccinella septempunctata, dark forms.

Figure 145. Coccinella transversoguttata

Figure 146. Coccinella transversoguttata

Figure 147. Coccinella transversoguttata

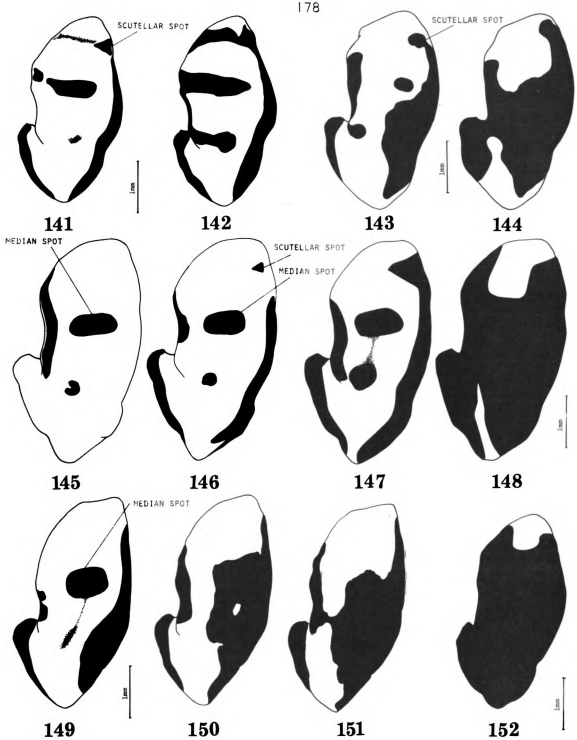
Figure 148. Coccinella transversoguttata, dark forms.

Figure 149. Coccinella novemnotata

Figure 150. Coccinella novemnotata

Figure 151. Coccinella novemnotata, dark forms.

Figure 152. Coccinella monticola



141 142 143 144

145 146 147 148

149 150 151 152

Figures 153-163: Dorsal aspect of left elytron of coccinellid pupae.

Figure 153. *Anatis ocellata*

Figure 154. *Anatis quindecimpunctata*

Figure 155. *Coleomegilla maculata*

Figure 156. *Coleomegilla maculata*

Figure 157. *Eriopis connexa*

Figure 158. *Hippodamia quinquesignata*, viewed from the apex.

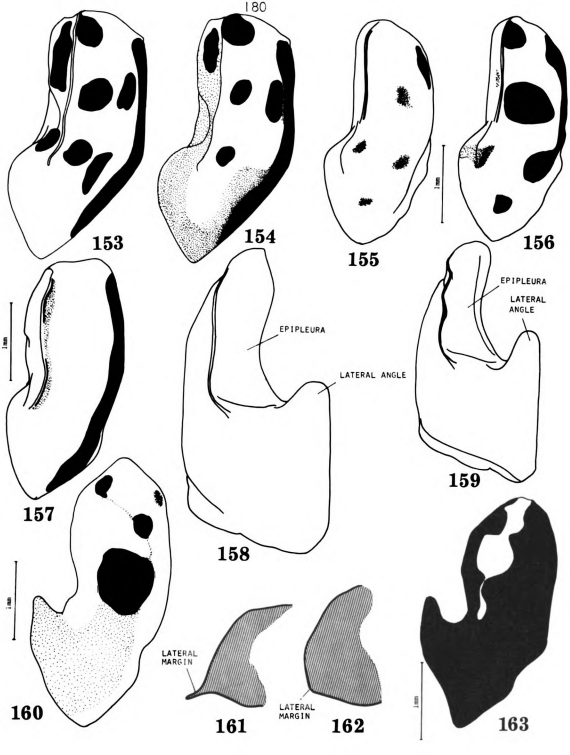
Figure 159. *Hippodamia parenthesis*, viewed from the apex.

Figure 160. *Hippodamia tredecimpunctata*, light forms.

Figure 161. *Hippodamia tredecimpunctata*, cross section of the elytron across the lateral margin.

Figure 162. *Scymnus creperus*, cross section of the elytron across the lateral margin.

Figure 163. *Hippodamia parenthesis*


153
154
155
156
157
158
EPIPLEURA
LATERAL ANGLE
159
EPIPLEURA
LATERAL ANGLE
160
LATERAL MARGIN
161
LATERAL MARGIN
162
163

Figures 164-170: Dorsal aspect of the elytron of coccinellid pupae.

Figure 164. Hippodamia quinquesignata

Figure 165. Hippodamia quinquesignata

Figure 166. Hippodamia quinquesignata

Figure 167. Hippodamia quinquesignata

Figure 168. Hippodamia quinquesignata

Figure 169. Hippodamia glacialis

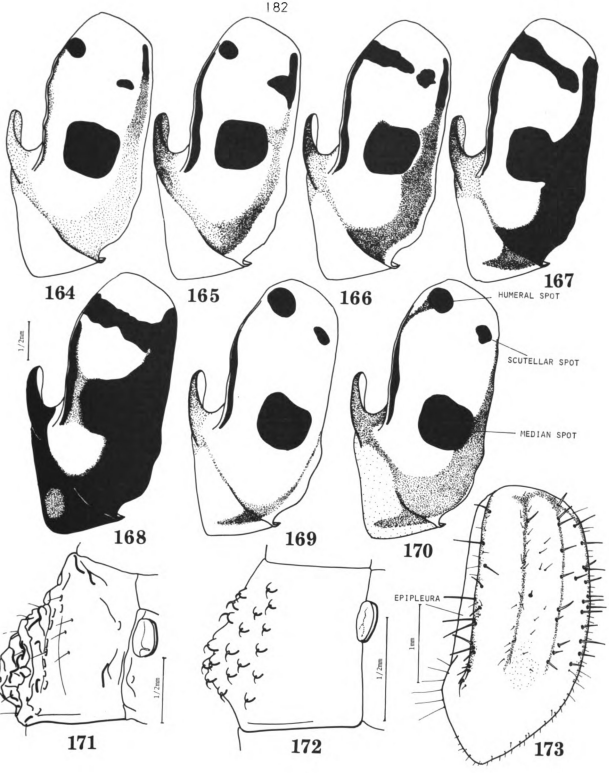
Figure 170. Hippodamia glacialis

Figures 171-172: Third left abdominal pleuron of coccinellid pupae.

Figure 171. Neoharmonia venusta

Figure 172. Propylaea quatuordecimpunctata

Figure 173. Epilachna varivestis, dorsal aspect of left elytron.


164
165
166
167
HUMERAL SPOT
SCUTELLAR SPOT
MEDIAN SPOT
1/2mm
168
169
170
EPIPLEURA
1mm
1/2mm
171
172
173

Figures 174-178: Third left abdominal pleuron of coccinellid pupae.

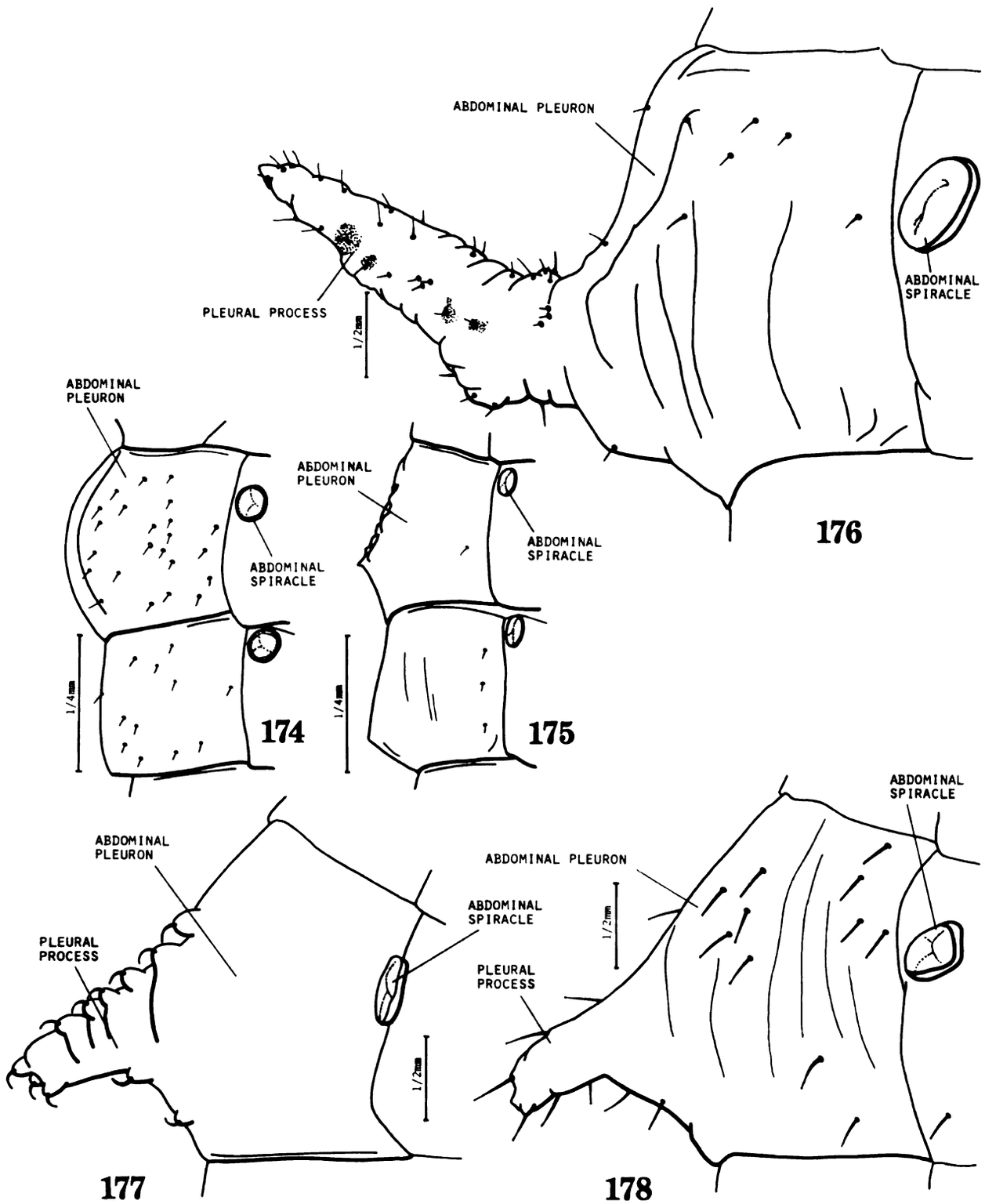
Figure 174. Coleomegilla maculata, third and fourth pleura.

Figure 175. Eriopis connexa, third and fourth pleura.

Figure 176. Synonycha grandis

Figure 177. Anisocalvia quatuordecimguttata

Figure 178. Anatis ocellata


ABDOMINAL PLEURON
PLEURAL PROCESS
1/2mm
ABDOMINAL SPIRACLE
176
ABDOMINAL PLEURON
ABDOMINAL SPIRACLE
1/4mm
174
ABDOMINAL PLEURON
ABDOMINAL SPIRACLE
1/4mm
175
ABDOMINAL PLEURON
PLEURAL PROCESS
ABDOMINAL SPIRACLE
1/2mm
177
ABDOMINAL SPIRACLE
ABDOMINAL PLEURON
1/2mm
PLEURAL PROCESS
178

Figures 179-183: Apex of left hind wing.

Figure 179. Adalia bipunctata, dorsal aspect.

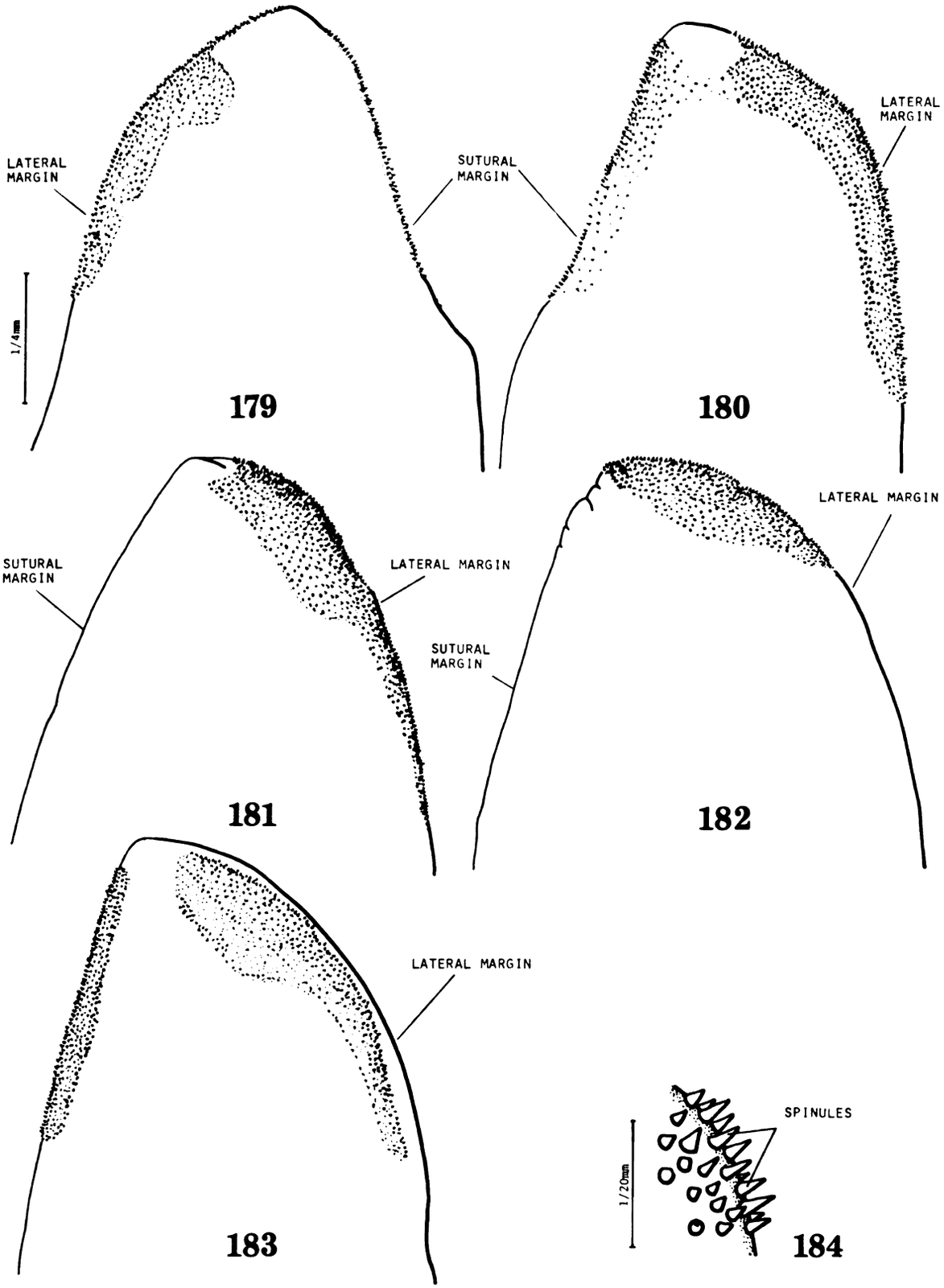
Figure 180. Adalia bipunctata, ventral aspect.

Figure 181. Coccinella transversoguttata, ventral aspect.

Figure 182. Coccinella monticola, ventral aspect.

Figure 183. Coccinella trifasciata, ventral aspect.

Figure 184. A close up portion of spinulate area on hind wing apex.


LATERAL MARGIN
SUTURAL MARGIN
1/4mm
179
LATERAL MARGIN
180
SUTURAL MARGIN
LATERAL MARGIN
181
LATERAL MARGIN
SUTURAL MARGIN
182
LATERAL MARGIN
183
SPINULES
1/20mm
184

Figures 185-192: First abdominal pedunculate spiracle, frontal aspect, as viewed from the pronotum.

Figure 185. Exochomus hoegei

Figure 186. Exochmus cubensis

Figure 187. Brumoides suturalis

Figure 188. Axion plagiatum

Figure 189. Axion tripustulatum

Figure 190. Stethorus punctum

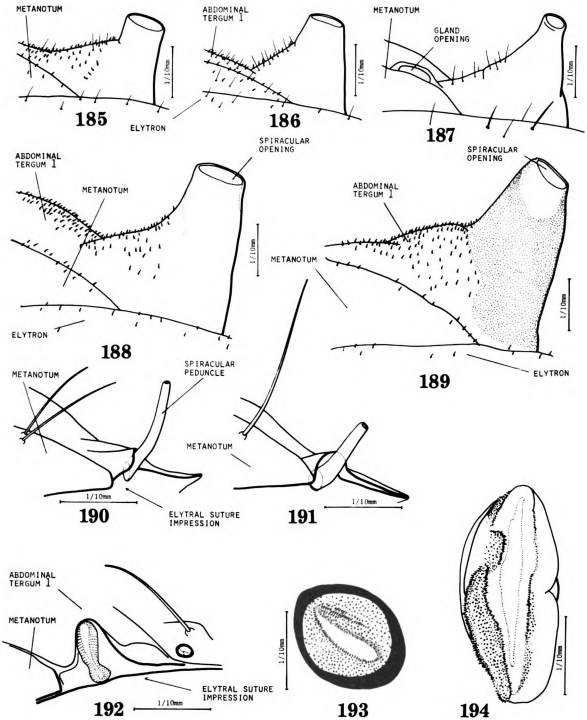
Figure 191. Stethorus punctum

Figure 192. Stethorus atomus, lateral aspect after removing the elytron.

Figures 193-194: Prothoracic spiracle

Figure 193. Adalia bipunctata

Figure 194. Coccinella transversoguttata


METANOTUM
ELYTRON
185
ABDOMINAL TERGUM 1
186
METANOTUM
GLAND OPENING
187
ABDOMINAL TERGUM 1
METANOTUM
SPIRACULAR OPENING
ELYTRON
188
ABDOMINAL TERGUM 1
SPIRACULAR OPENING
METANOTUM
ELYTRON
189
METANOTUM
SPIRACULAR PEDUNCLE
1/10mm
ELYTRAL SUTURE IMPRESSION
190
METANOTUM
1/10mm
191
ABDOMINAL TERGUM 1
METANOTUM
ELYTRAL SUTURE IMPRESSION
1/10mm
192
1/10mm
193
1/10mm
194

Figures 195-202: Ventral aspect of the anal end of the abdomen of coccinellid pupae.

Figure 195. Delphastus pusillus ♂

Figure 196. Delphastus pusillus ♀

Figure 197. Microweisea ovalis ♂

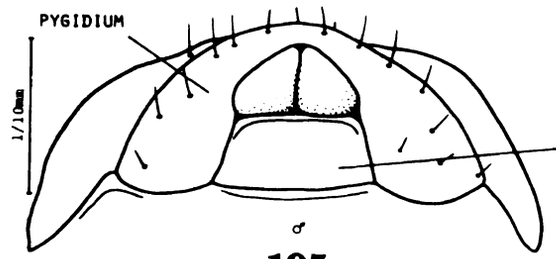
Figure 198. Microweisea ovalis ♀

Figure 199. Epilachna verivestis ♀

Figure 200. Epilachna verivestis ♀ (lateral aspect)

Figure 201. Scymnus creperus ♂

Figure 202. Lindorus lophantae ♂



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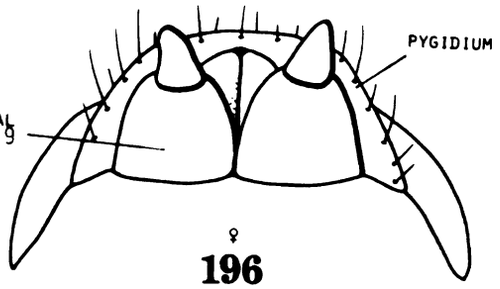

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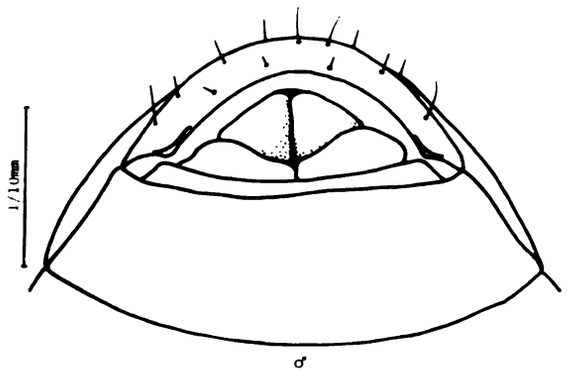

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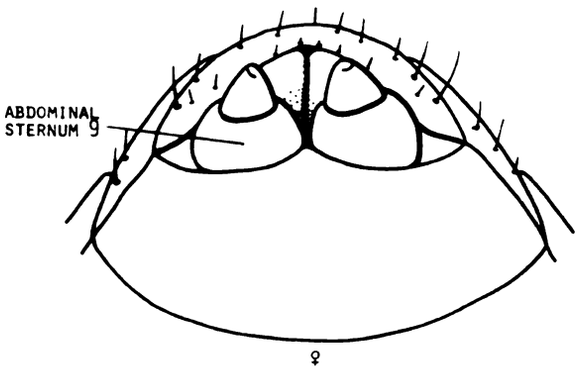

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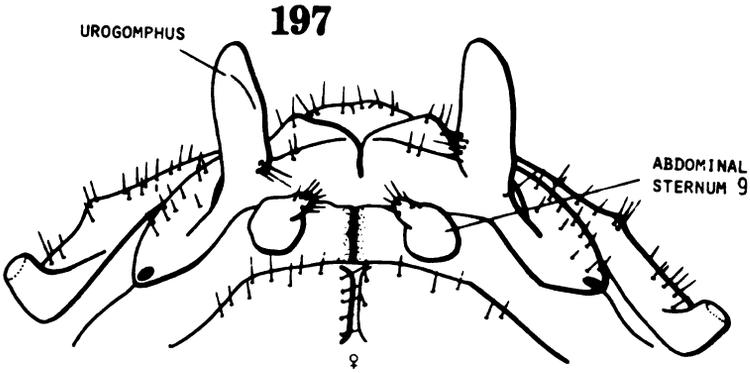
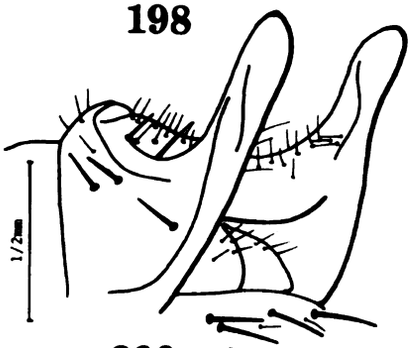


199



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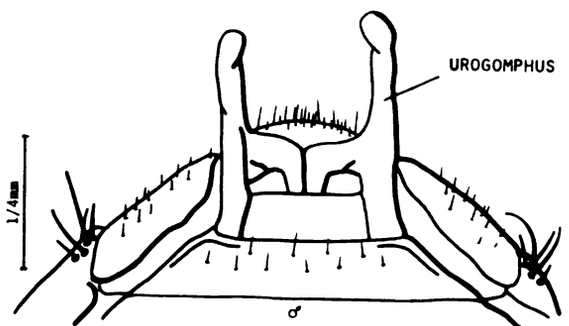

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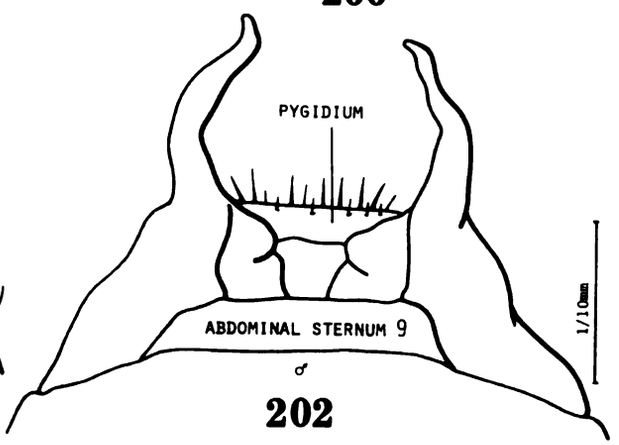


202

Figures 203-209: Ventral aspect of the anal end of the abdomen of coccinellid pupae.

Figure 203. Zagloba ornata ♀

Figure 204. Zagloba ornata ♀, lateral aspect.

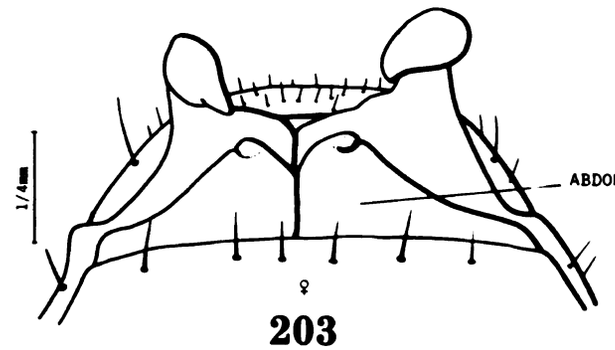
Figure 205. Cryptolaemus montrouzieri ♀

Figure 206. Cryptolaemus montruzieri ♀ (lateral aspect).

Figure 207. Hyperaspis binotata ♂

Figure 208. Thalassa montezumae ♂

Figure 209. Thalassa montezumae ♂ (lateral aspect).



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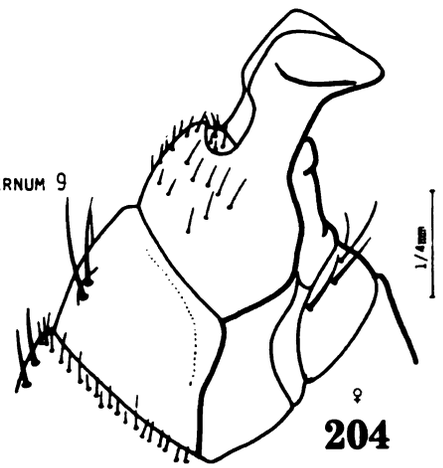

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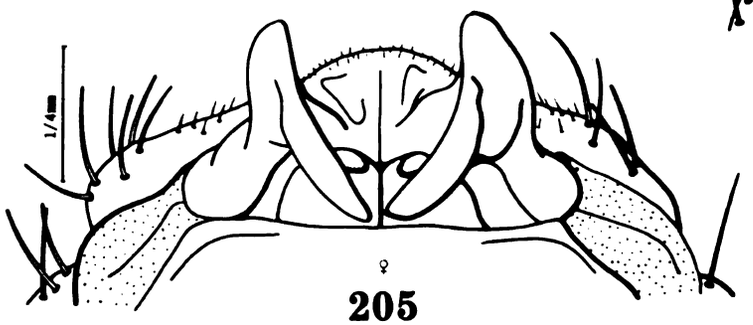

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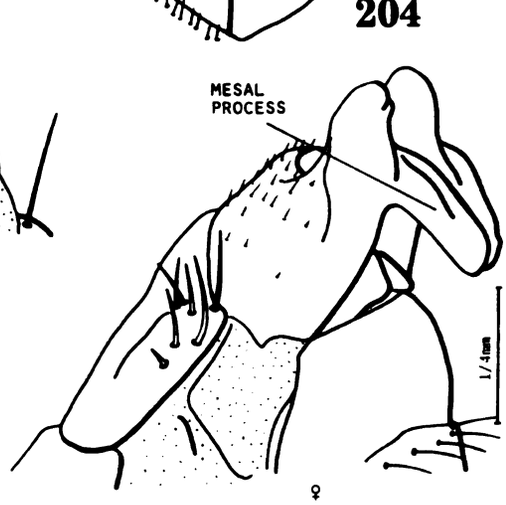

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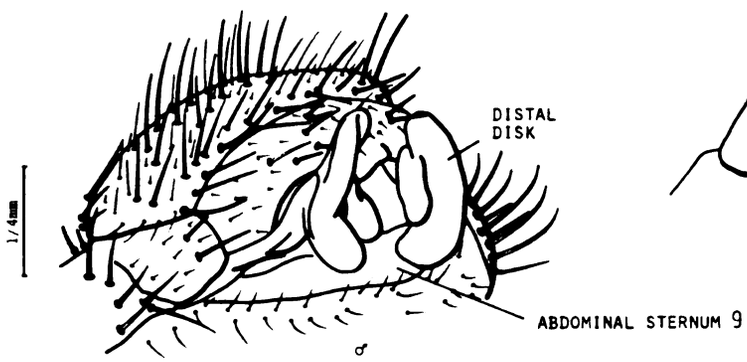

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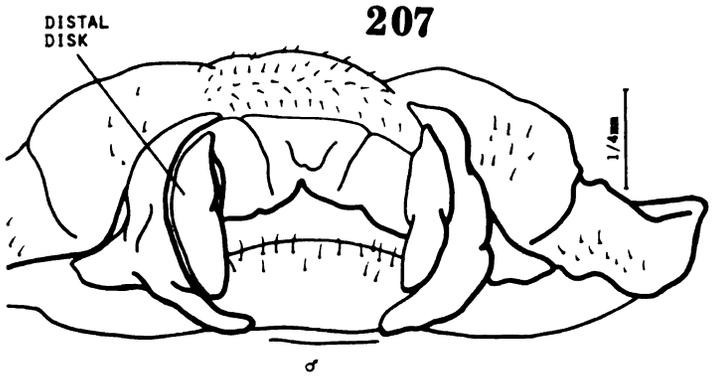

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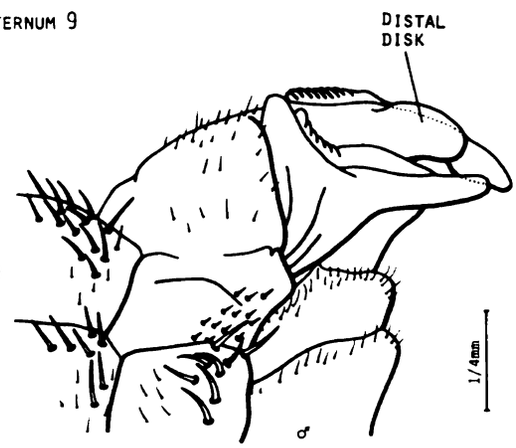


209

Figures 210-217: Ventral aspect of the anal end of the abdomen of coccinellid pupae.

Figure 210. Stethorus atomus ♂

Figure 211. Stethorus atomus ♂, lateral aspect.

Figure 212. Chilocorus bivulnerus ♀

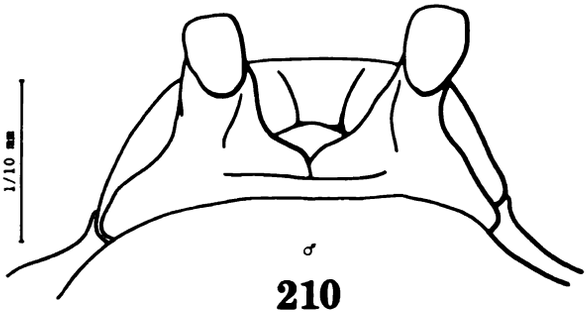
Figure 213. Chilocorus bivulnerus, lateral aspect of a right urogomphus.

Figure 214. Orcus chalybeus

Figure 215. Axion plagiatum ♀

Figure 216. Brumoides suturalis ♀

Figure 217. Brumoides suturalis, dorsal aspect of a right urogomphus.



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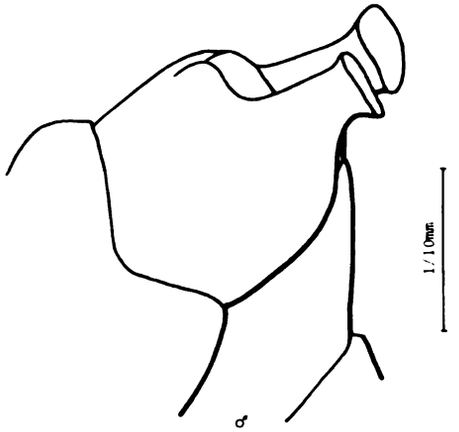

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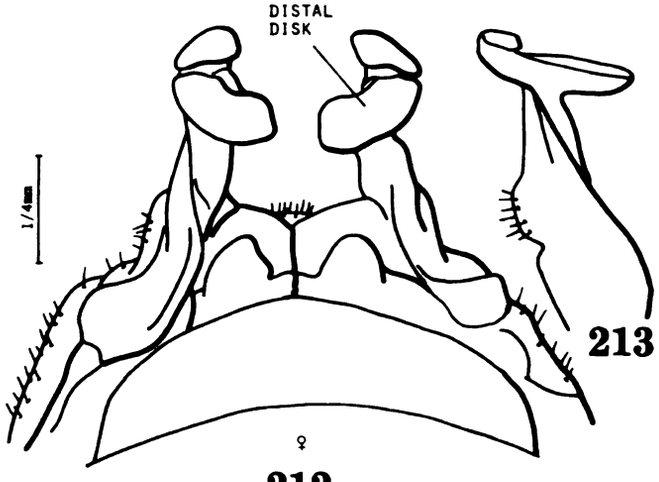

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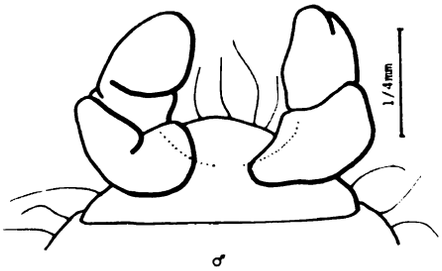
213



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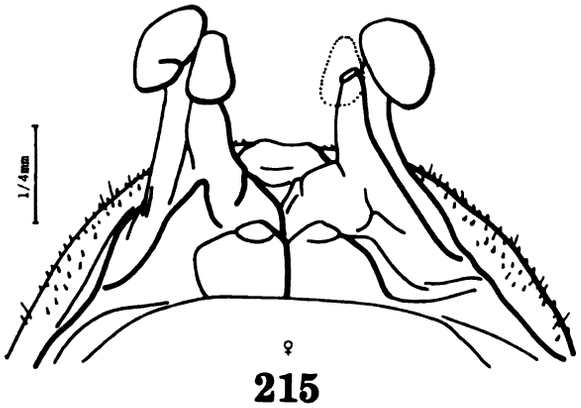

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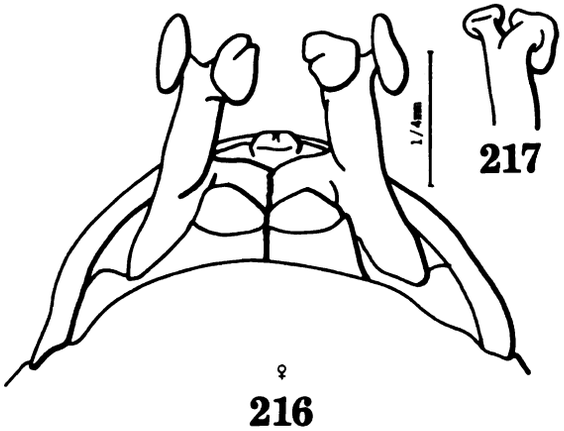


216

217

Figures 218-220: Ventral aspect of the anal end of the abdomen of coccinellid pupae.

Figure 218. Coccinella transversoguttata, lateral aspect of a left urogomphus.

Figure 219. Coccinella transversoguttata ♀

Figure 220. Coccinella transversoguttata ♂

Figures 221-231: Ventral aspect of a right urogomphus.

Figure 221. Anisocalvia quatuordecimguttata

Figure 222. Neoharmonia venusta

Figure 223. Anatis quindecimpunctata

Figure 224. Anatis ocellata

Figure 225. Olla abdominalis

Figure 226. Olla abdominalis, lateral aspect.

Figure 227. Hippodamia parenthesis

Figure 228. Hippodamia parenthesis, lateral aspect.

Figure 229. Psyllobora vigintimaculata

Figure 230. Rodolia cardinalis

Figure 231. Rodolia cardinalis, lateral aspect.

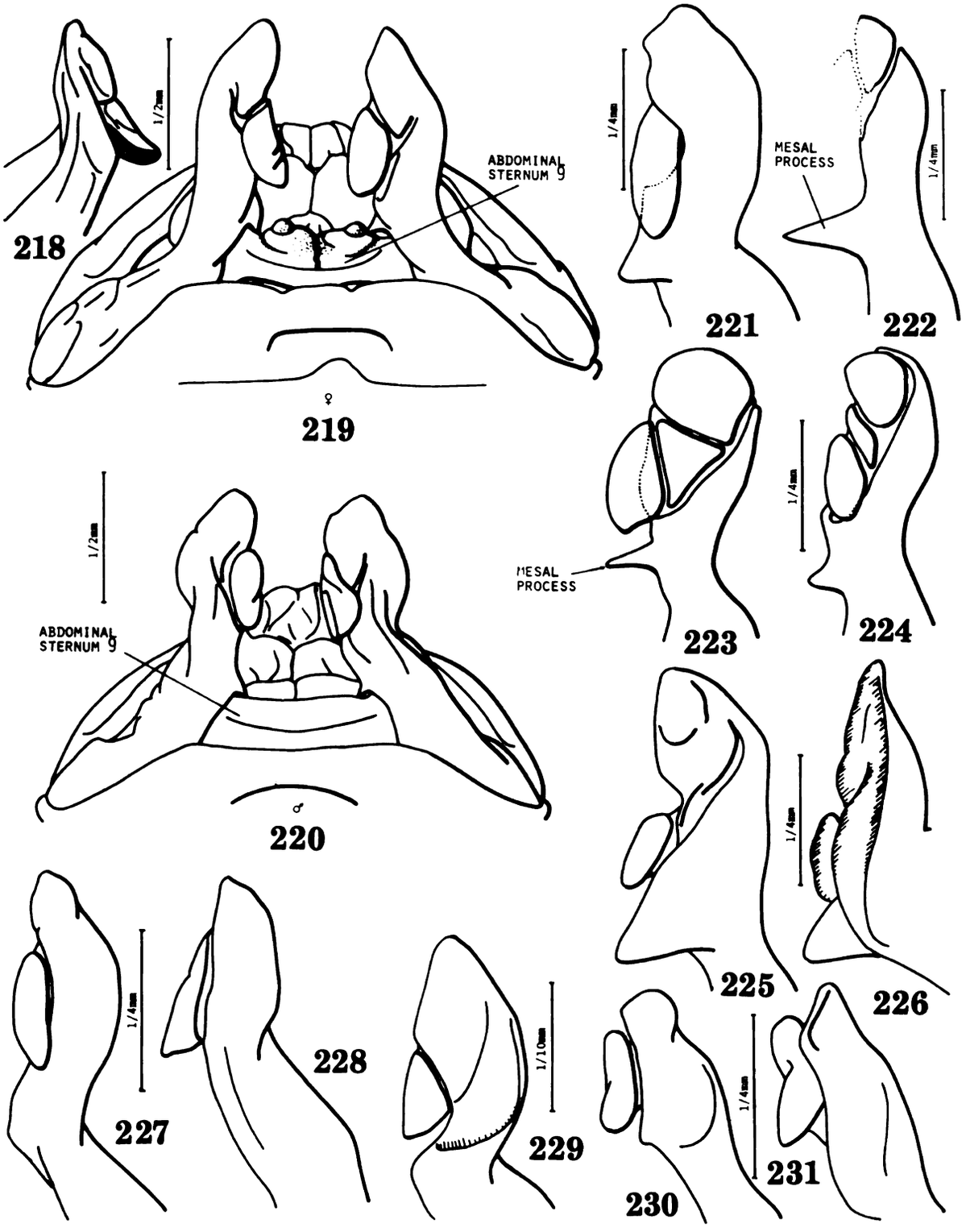

1/2mm
ABDOMINAL STERNUM 9
218
♀
219
1/4mm
221
MESAL PROCESS
1/4mm
222
1/2mm
ABDOMINAL STERNUM 9
♂
220
MESAL PROCESS
223
1/4mm
224
1/4mm
225
1/4mm
226
1/4mm
227
228
1/10mm
229
1/4mm
230
231

Figure 232. Microweisea ovalis, dorsal aspect.

Figure 233. Delphastus pusillus, dorsal aspect.

Figure 234. Lindorus lophantae, dorsal aspect.

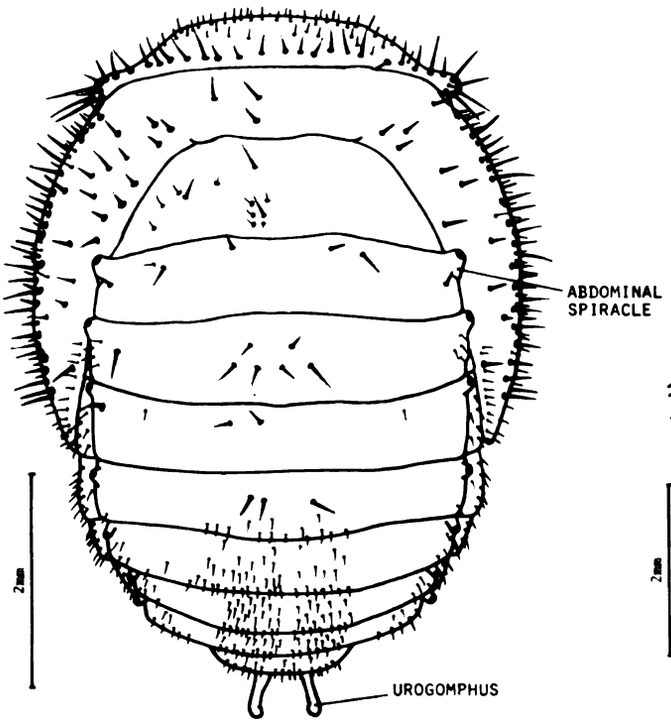
1/2mm
HIND WING APEX
232
1/2mm
ABDOMINAL PLEURON
HIND WING APEX
233
FIRST ABDOMINAL SPIRACLE
ABDOMINAL SPIRACLE
1/2mm
ABDOMINAL PLEURON
234

Figure 235. Epilachna varivestis, dorsal aspect.

Figure 236. Thalassa montezumae, dorsal aspect.

Figure 237. Stethorus atomus, dorsal aspect.

Figure 238. Stethorus atomus, dorsal aspect.



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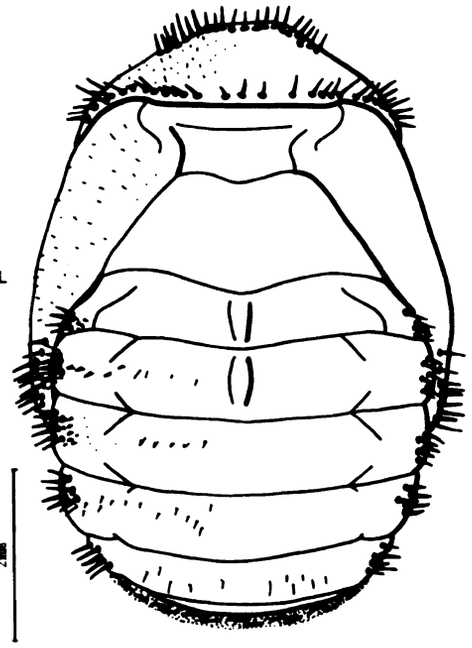
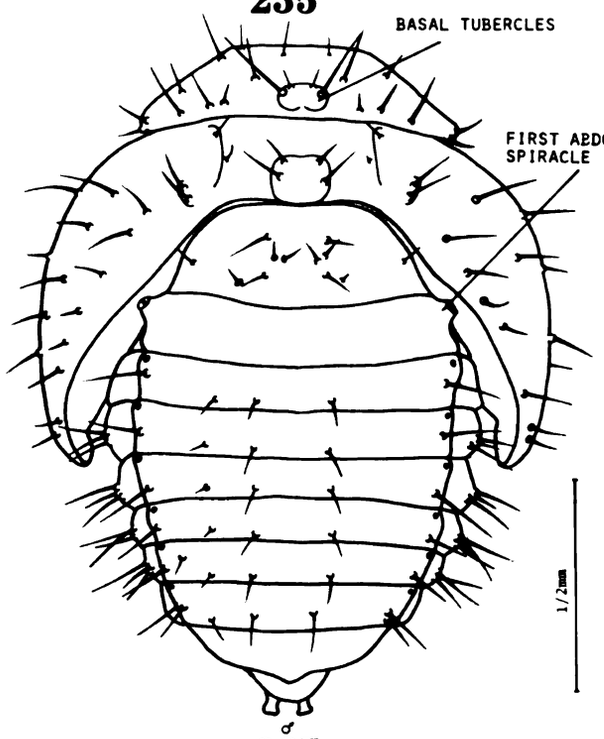
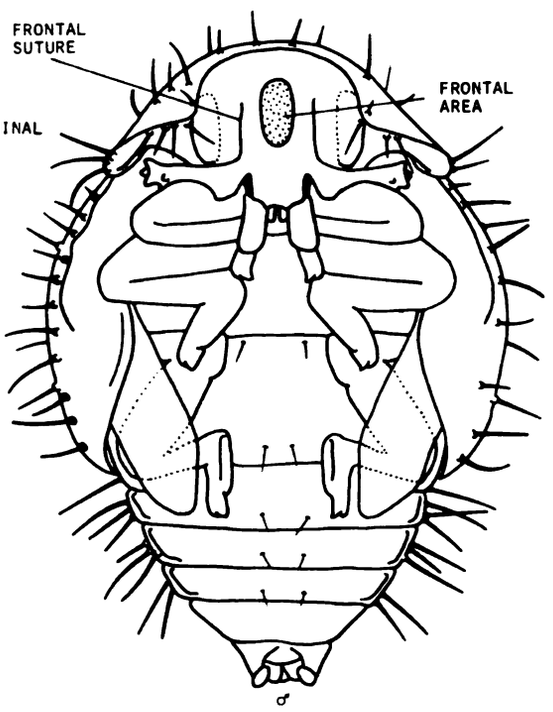


236



♂

237



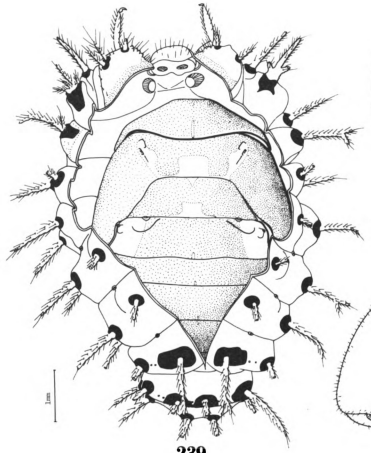
♂

238

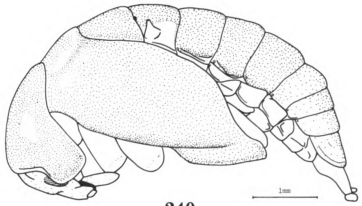
Figure 239. Axion plagiatum, dorsal aspect.

Figure 240. Axion plagiatum, lateral aspect.

Figure 241. Cryptolaemus montrouzieri, lateral aspect.



239



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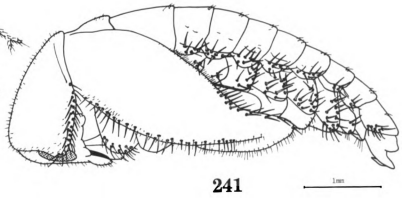

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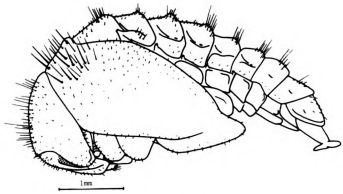
Figure 242. Chilocorus bivulnerus, lateral aspect.

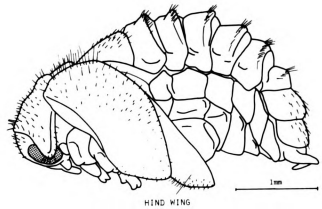
Figure 243. Rodolia cardinalis, lateral aspect.

Figure 244. Hippodamia convergens, lateral aspect.

Figure 245. Olla abdominalis, lateral aspect.



242



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244

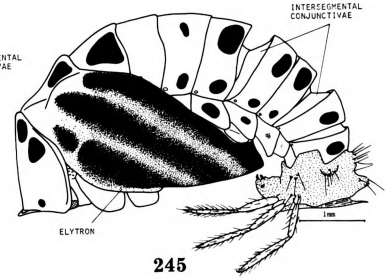

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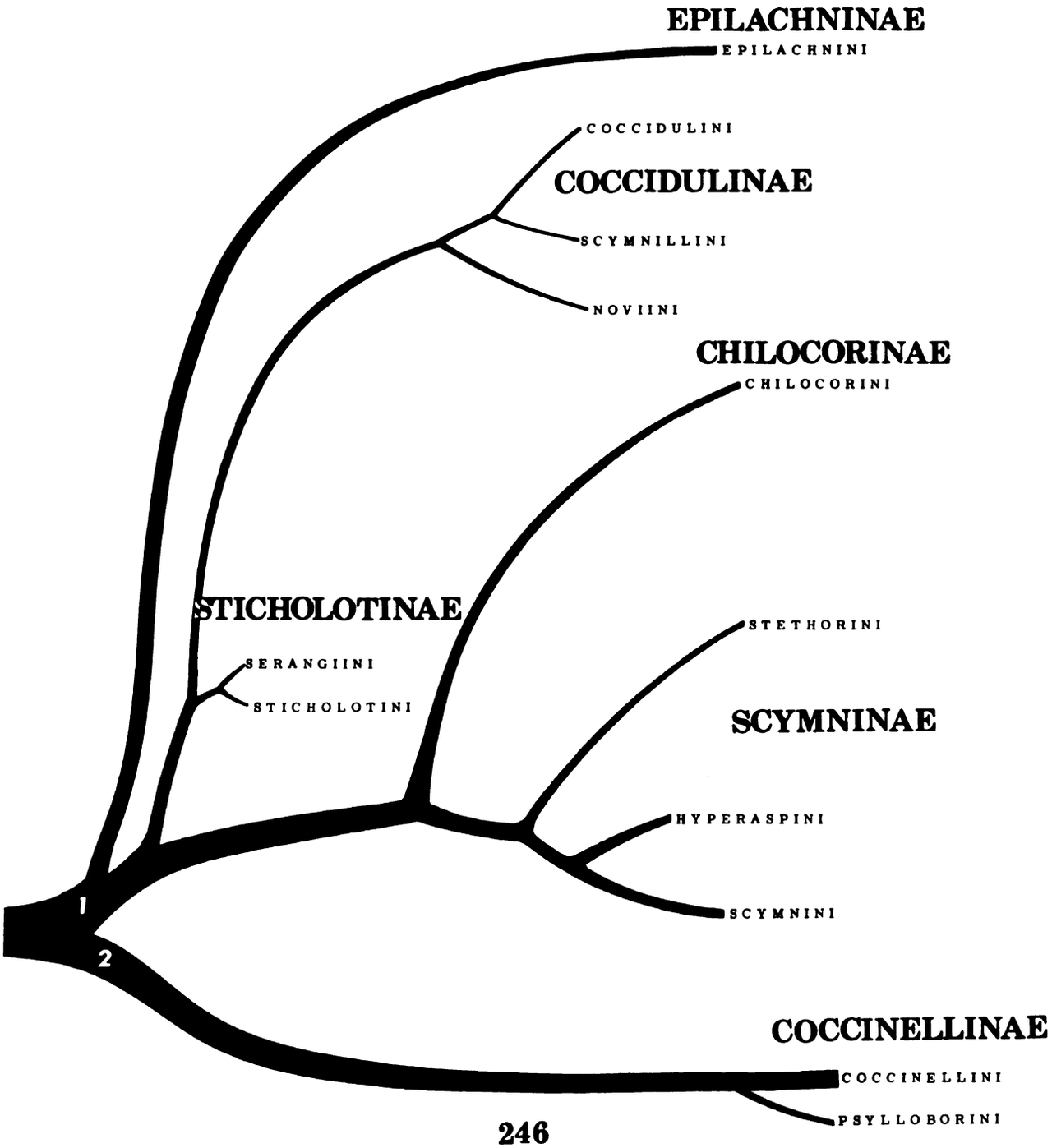
Figure 246. Suggested phylogenetic diagram of the Coccinellidae based on pupal characters.


EPILACHNINAE
EPILACHNINI
COCCIDULINI
COCCIDULINAE
SCYMNILLINI
NOVIINI
CHILOCORINAE
CHILOCORINI
STICHOLOTINAE
SERANGIINI
STICHOLOTINI
STETHORINI
SCYMNINAE
HYPERASPINI
SCYMNINI
1
2
COCCINELLINAE
COCCINELLINI
PSYLLOBORINI

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