SYSTEMATICS OF THE COPIDOSOMATINI: POLYEMBRYONIC PARASITES (HYMENOPTERA: ENCYRTIDAE)

A Dissertation

by

GREGORY ZOLNEROWICH

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 1995

Major Subject: Entomology

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ABSTRACT

Systematics of the Copidosomatini: Polyembryonic Parasites
(Hymenoptera: Encyrtidae). (May 1995)
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Copidosomatini, a tribe within Encyrtidae, is comprised of 12 genera in the subtribes Coelopencyrtina, Parablastothrichina, Ageniaspidina, and Copidosomatina. Species in this tribe are polyembryonic and utilize non-butterfly Lepidoptera and aculeate Hymenoptera as hosts.

Phylogenetic analysis using parsimony methods and successive approximations was used to analyze a data matrix of 47 characters and 67 taxa. A number of new characters and characters used in identification were evaluated for their phylogenetic utility. Many were found to be homoplastic but several proved to be very informative. Characters were analyzed using the full dataset, a reduced number of taxa, a reduced number of characters and a reduced number of characters and taxa. Reducing the number of taxa had the least effect and reducing the number of taxa and characters simultaneously had the strongest effect compared to results using the full dataset. *Apsilophrys* De Santis, *Paralitomastix* Mercet, and *Raffaellia* Girault were found to be phylogenetically indistinguishable from species of *Copidosoma* and are synonymized with it. Three subtribes are monophyletic and the fourth, Coelopencyrtina, although appearing to be paraphyletic is retained as an entity in the tribe.

The subtribes show distinct differences in biologies. Species of Coelopencyrtina parasitize aculeate Hymenoptera but have not been conclusively demonstrated to be polyembryonic. Members of the other subtribes attack Lepidoptera, but polyembryony has been demonstrated only in Ageniaspidina and Copidosomatina. Congruence between the phylogenies of Parablastothrichina, Ageniaspidina, and Copidosomatina and that of Lepidoptera suggests that ancestral copidosomatines utilized leaf-mining monotrysian Lepidoptera as hosts. While species of Parablastothrichina and two genera within Ageniaspidina continue to parasitize plesiomorphic Lepidoptera, members of *Ageniaspis* and Copidosomatina have expanded their host ranges to more derived families of Lepidoptera. Reports of polyembryony in two other species from two genera unrelated to Copidosomatini would indicate the multiple evolution of this trait in Encyrtidae.

A key to the 57 Nearctic species of *Copidosoma* is provided, along with descriptions of 35 new species and redescriptions of 13 species. Host and distribution information are given, and new combinations and new synonymies for genera and species are proposed.

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INTRODUCTION

Polyembryony is a form of asexual reproduction in which a single egg gives rise to multiple embryos, a phenomenon rare in the animal kingdom. Polyembryony as a normal means of reproduction has been recorded in earthworms, marine bryozoans, armadillos, and insects (Patterson 1919, Silvestri 1937). In the insects, one species of Strepsiptera is polyembryonic, otherwise, polyembryony is restricted to four families of parasitic Hymenoptera: one genus of Braconidae, one genus of Platygasteridae, one species of Dryinidae, and many genera of Encyrtidae (Ivanova-Kasas 1972). Polyembryonic development in animals reaches its zenith in the encyrtid tribe Copidosomatini. Depending on the species, offspring from a single copidosomatine egg may number from several to hundreds (Silvestri 1906, Cruz 1986a) to well over 1000 (Silvestri 1906, Stoner and Weeks 1976).

Encyrtidae is one of the largest and most diverse families in the Chalcidoidea, containing over 3,000 species in about 450 genera (Gauld and Bolton 1988). There is an extensive tribal classification for the encyrtids based largely on the work of Trjapitzin (1973a, b), who recognized 36 tribes in the Encyrtinae and 12 tribes in the Tetracneminae. Though his work remains the most comprehensive systematic treatment of Encyrtidae, it is not phylogenetic in the Hennigian sense. Consequently, many of the groups are artificial and many genera cannot be assigned to a tribe with any confidence. Nevertheless, many of the tribes and subtribes appear to be natural groups and their use facilitates the understanding of genera in a larger context. One such group is the Copidosomatini.

This tribe, composed of the subtribes Copidosomatina, Ageniaspidina, Parablastotrichina, and Coelopencyrtina, has been recognized by the possession of mandibles with three teeth, a sharp occipital margin, and antennae inserted near the mouth margin. However, the subtribes are more unambiguously defined than the tribe as a whole. Historically, Copidosomatini have been united by the putative synapomorphies of polyembryonyic development and utilization of Lepidoptera and aculeate Hymenoptera as hosts, which are unusual for encyrtids.

A brief history of each subtribe is presented below and summarized in Table 1. Especially interesting is the similarity between the work of Hoffer (1955) and Erdös and Novicky (1955). Current status and information on the tribe concerning distribution,

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number of species per genus, and hosts are presented in Table 2. More complete biological information is presented in the Biology chapter.

Copidosomatini Hoffer, 1955

Copidosomini Erdös and Novicky, 1955. Synonymized by Trjapitzin (1973b).

Hoffer (1955) established the tribe Copidosomini to include *Copidosoma* Ratzeburg, *Verdunia* Mercet (=*Copidosoma*), *Litomastix* Thomson (=*Copidosoma*), *Paralitomastix* Mercet (=*Copidosoma*), *Sectiliclava* Hoffer, and *Cerchysius* Westwood.

In a close parallel to Hoffer's work, Erdös and Novicky (1955) independently erected the tribe Copidosomini. In addition to *Copidosoma*, *Litomastix*, and *Paralitomastix*, they included *Ageniaspis*, *Holcothorax*, *Geniaspidius*, *Parageniaspis*, and *Athesmus* Erdös and Novicky as members of the tribe.

Trjapitzin (1973b), as first reviser, used Hoffer's tribal name but corrected it to the proper latinized family-group name Copidosomatini.

Copidosomatina Hoffer, 1955

Copidosomina Erdös and Novicky, 1955. Synonymized by Trjapitzin (1973b).

Copidosomatina are characterized by the stigmal vein sensilla being arranged in a square (Fig. 6), lack of an uncus, and enlarged anterior mandibular setae (Fig. 406). Member genera are *Copidosoma* Ratzeburg, *Copidosomopsis* Girault, and *Neapsilophrys* Noyes. All species for which biologies are known are polyembryonic parasites of Lepidoptera.

Hoffer (1955) established the tribe Copidosomini; which made the subtribal name available. Erdös and Novicky (1955) independently erected the subtribe Copidosomina, but included only *Copidosoma*, *Litomastix*, and *Paralitomastix* as members. Trjapitzin (1973b), as first reviser, used Hoffer's subtribal name but corrected to the proper latinized family-group name Copidosomatina, and synonymized Erdös and Novicky's name.

Trjapitzin (1973b) expanded the subtribe to include *Pentalitomastix* Eady (=*Copidosomopsis* Girault), *Apsilophrys* De Santis (=*Copidosoma*), and *Copidencyrtus* De Santis(=*Copidosoma*) and further refined the tribe by removing *Sectiliclava* and *Cerchysius*.

Noyes (1980) described *Neapsilophrys* with one species and placed it in Ageniaspidina. However, *Neapsilophrys* lacks the antennal structure, sculpture, and genitalia that unite

most ageniaspidines. As discussed in the Phylogenetic Analysis chapter, there is strong evidence for including *Neapsilophrys* within Copidosomatina.

Ageniaspidina Hoffer, 1955

Ageniaspidina Erdös and Novicky, 1955. Synonymized by Trjapitzin (1973b).

Ageniaspidina are distinguished by an elongate postmarginal vein, the stigmal vein sensilla not arranged in a square (Fig. 15), and the scutellum usually with striate sculpture (Figs. 423-424). Included genera are *Ageniaspis* Dahlbom, *Holcothorax* Mayr, *Paraleurocerus* Girault, *Ethoris* Noyes and Hayat, and *Zelencyrtus* Noyes. Species for which biologies are known are polyembryonic parasites of Lepidoptera.

Hoffer (1955) established the tribe Ageniaspidini to include *Ageniaspis*, *Holcothorax*, *Eustrius* Hoffer, *Geniaspidius* Masi, and *Parageniaspis* Masi. Erdös and Novicky (1955) erected the subtribe Ageniaspidina within their tribe Copidosomini, incorporating *Ageniaspis*, *Holcothorax*, *Geniaspidius*, *Parageniaspis*, and *Athesmus* Erdös and Novicky. Trjapitzin (1973b) reduced Hoffer's tribe to a subtribe and placed it into Copidosomatini to include only *Ageniaspis*, *Holcothorax*, and *Paraleurocerus*. He also synonymized Erdös and Novicky's subtribe with Hoffer's.

Noyes and Hayat (1984) described *Coagerus* and *Ethoris* and suggested that these monotypic genera belong in Ageniaspidina. Individuals of the species of *Coagerus* were later reared from *Aphis spiraecola* Patch (Homoptera: Aphididae), and on the basis of this very different host *Coagerus* is removed from Copidosomatini and placed as *incertae sedis*. Males and hosts are unknown for *Ethoris*, and inclusion in the tribe needs to be reassessed when further information becomes available.

Noyes (1988b) described *Zelencyrtus* with one species from New Zealand, and placed it in Copidosomatina. As discussed in the Phylogenetic Analysis chapter, the elongate postmarginal vein, shape of the stigmal vein sensilla, and male genitalia are much more similar to those of Ageniaspidina and the genus is transferred here from Copidosomatina .

Parablastotrichina Erdös and Novicky, 1955.

Parablastothrichina Trjapitzin and Gordh, 1978b. **New synonymy.**

Parablastotrichina are distinguished by greatly enlarged eyes that nearly reach the base of the mandibles (Fig. 401), peglike anterior mandibular setae (Fig. 407), and males with

pectinate antennae. This subtribe includes only *Parablastothrix* Mercet. Species have been reared from Lepidoptera but polyembryony has not been established.

Hoffer (1955) established the subtribe Pentacnemii within his Microteryni to accomodate *Parablastothrix*, *Calometopia* Mercet, and *Pentacnemus* Howard. Erdös and Novicky (1955) erected the subtribe Parablastotrichina in their Microteryni to include only *Parablastothrix* and *Calometopia*. Trjapitzin (1973b) retained Hoffer's subtribe, which he transferred to Copidosomatini, but curiously made no mention of Erdös and Novicky's work.

Trjapitzin and Gordh (1978a) synonymized *Pentacnemus* with *Litomastix*, and later established Parablastothrichina (Trjapitzin and Gordh 1978b) to accomodate *Parablastothrix* and *Calometopia*, apparently unaware that Erdös and Novicky (1955) had already established the subtribe.

Trjapitzin (1989) synonymized *Calometopia* with *Parablastothrix*, leaving it as the sole genus in the subtribe. Noyes and Hayat (1984) suggested that *Parablastothrix* is morphologically closer to Aphycini, but gave no details and did not list this genus in their table of tribes and genera.

Coelopencyrtina Trjapitzin, 1973b.

Members of Coelopencyrtina are distinguished by a very broad oral fossa, large mandibles, stigmal vein with an uncus and stigmal vein sensilla not arranged in a square (Fig. 18), and characteristic male genitalia that includes thin, elongate parameres and digiti with two claws (Fig. 19). Included are *Coelopencyrtus* Timberlake, *Xylencyrtus* Annecke, and *Nathismusia* Noyes and Hayat. This is the only group of encyrtids that parasitize aculeate Hymenoptera, but polyembryony has not been demonstrated.

Trjapitzin (1973b) established this subtribe to include *Coelopencyrtus*, *Giraultella* Gahan and Fagan (=*Coelopencyrtus*) and *Xylencyrtus*. Noyes and Hayat (1984) described *Nathismusia* from a single female in India and placed it, with reservation, in Coelopencyrtina. Males and hosts are unknown for *Nathismusia*, and inclusion in the tribe needs to be reassessed when further information becomes available.

Noyes and Hayat (1984) suggested that the tribe Rhinoencyrtini, containing only *Paratetracnemoidea* Girault, the senior synonym of *Rhinoencyrtus* Mercet, was related to Copidosomatini based on ovipositor structure and wing venation, but did not include it in Copidosomatini. Gordh (1985), however, later placed this genus in Copidosomatini. Like species of Copidosomatina, the marginal vein is very short and the stigmal vein sensilla are

arranged in a square. However, the venation in *Paratetracnemoidea* is extremely reduced and similarities to Copidosomatina most likely represent convergences. The ovipositor and hypopygium of *Paratetracnemoidea* (Figs. 10-11) are unlike those of copidosomatines but virtually identical to those of *Aschitus* Mercet and *Trichomasthus* Thomson (Jensen 1989, Jensen and Sharkov 1989). Species in these genera are parasites of Coccidae, Diaspididae, Eriococcidae, and Pseudococcidae (Homoptera). The biology and host of *Paratetracnemoidea* are unknown, but mealybugs (Pseudococcidae) have been suggested as hosts (Gordh 1985). Based on the strong similarities of the ovipositor and hypopygium between *Paratetracnemoidea* and *Aschitus* and *Trichomasthus*, *Paratetracnemoidea* is transferred from Copidosomatini and placed in Discodini (=Microteryini).

After *Pentacnemus* was synonymized under *Copidosoma* by Noyes and Hayat (1984), Shafee et al. (1989) proposed that the family group name Pentacnemii Hoffer, 1955 should be the tribal name instead of Copidosomatini Hoffer, 1955 based on page precedence. Their proposal is rejected because the International Code of Zoological Nomenclature (1985) does not recognize page precedence as a valid criterion for nomenclatural precedence. In addition, their proposal could be rejected on the grounds of the Principle of the First Reviser, Article 24 of the International Code of Zoological Nomenclature. Trjapitizin (1973b) acted as a first reviser by designating Copidosomini Hoffer as the name for the tribe and transferring Penctacnemii as a subtribe from Microteryini to a subtribe in Copidosomatini. He also placed two subtribes in synonymy and erected a new subtribe, Coelopencyrtina. Thus, Trjapitzin clearly acted as a first reviser for the tribe and chose not to use Pentacnemii as the name for the tribe.

While recent years have seen a number of workers use phylogenetic methods to make significant progress in understanding relationships within Chalcidoidea (Heraty and Darling 1984, Schauff 1984, Gibson 1986, 1989, Woolley 1988, Heraty 1990), such an effort has been lacking in Encyrtidae. Several workers have discussed groundplan states or character polarity for encyrtids (Trjapitizin 1968, 1977, Jensen 1989, Jensen and Sharkov 1989, Noyes and Hayat 1994), but none has provided explicit data or methodology or presented cladograms to indicate inferred relationships.

The first objective of this study is a phylogenetic analysis using cladistic methodology to determine the relationships within the tribe. This work is necessary because improved classifications and questions such as host shifts or radiations are best addressed through a robust phylogenetic analysis.

The second objective is to complete a revision of the Nearctic species of *Copidosoma*. While the European fauna is well known and keys to species there have been available for over 100 years, the Nearctic fauna has been poorly studied.

This dissertation specifically treats three aspects of the Copidosomatini. A phylogenetic hypothesis is presented for the four subtribes based on an analysis of 47 characters and 67 species, representing 14 genera. The biologies of members of the tribe are reviewed and congruence between the phylogenetic position of three subtribes and their lepidopteran hosts is discussed. The revision of the Nearctic species of *Copidosoma* treats 57 species, with 35 species being described as new and redescriptions provided for 13 additional species. The revision includes keys to species and distribution and host information for each species. New combinations and new synonymies for several genera and species are proposed.

This dissertation is not considered a valid publication as defined by the International Code of Zoological Nomenclature. New names or nomenclatural changes presented here are not to be considered as available or part of the permanent, public scientific record.

MATERIALS AND METHODS

Over 10,000 specimens from 43 museums and individuals from North and South America and Europe were examined. The following acronyms represent institutions or individuals who loaned material for study or are repositories of types mentioned in the text.

AEI	American Entomological Institute, Gainesville, Florida, USA
AMNH	American Museum of Natural History, New York, New York, USA
ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania, USA
ASU	Arizona State University, Tempe, Arizona, USA.
BMNH	The Natural History Museum, London, United Kingdom
CAS	California Academy of Sciences, San Francisco, California, USA
CDFA	California Dept. of Food and Agriculture, Sacramento, California, USA
CNC	Canadian National Collection, Ottawa, Ontario, Canada
CSU	Colorado State University, Fort Collins, Colorado, USA
CU	Cornell University, Ithaca, New York, USA
CUE	Clemson University, Clemson, South Carolina, USA
DCD	D. Christopher Darling, personal collection
FSCA	Florida State Collection of Arthropods, Gainesville, Florida, USA
HBMNH	Hungarian Natural History Museum, Budapest, Hungary
IARI	Indian Agricultural Research Institute, New Delhi, India
IEE	Instituto Español de Entomología, Madrid, Spain
INHS	Illinois Natural History Survey, Champaign, Illinois, USA
ISU	Iowa State University, Ames, Iowa, USA
LACM	Los Angeles County Museum of Natural History, Los Angeles, California, USA
LDC	Lonny D. Coote, personal collection
LSU	Louisiana State University, Baton Rouge, Louisiana, USA
MBA	Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina
MCZ	Museum of Comparative Zoology, Cambridge, Massachusetts, USA
MEM	Mississippi Entomological Museum, Mississippi State, Mississippi, USA
MNM	Museo Nacional de Ciencias Naturales, Madrid, Spain
MSU	Montana State University, Bozeman, Montana, USA
MSUE	Michigan State University, East Lansing, Michigan, USA

NCSU	North Carolina State University, Raleigh, North Carolina, USA
NFC	Northern Forestry Research Centre, Edmonton, Alberta, Canada
BMNHV	Naturhistorisches Museum, Vienna, Austria
NIAS	National Institute of Agro-Environmental Sciences, Tsukuba, Japan
NMVM	National Museum of Victoria, Melbourne, Australia
QMB	Queensland Museum, Brisbane, Australia
ROM	Royal Ontario Museum, Toronto, Ontario, Canada
SAMA	South Australian Museum, Adelaide, Australia
SMNH	Swedish Museum of Natural History, Stockholm, Sweden
SDNH	San Diego Natural History Museum, San Diego, California, USA
SUNY	State University of New York, Syracuse, New York, USA
TAMU	Texas A&M University, College Station, Texas, USA
UA	University of Arizona, Tucson, Arizona, USA
UC	University of Connecticut, Storrs, Connecticut, USA
UCB	University of California, Berkeley, California, USA
UCD	University of California, Davis, California, USA
UCR	University of California, Riverside, California, USA
UGA	University of Georgia, Athens, Georgia, USA
UMSP	University of Minnesota, St. Paul, Minnesota, USA
UNLP	Universidad Nacional de La Plata, La Plata, Argentina
USNM	U.S. National Museum, Washington, D.C., USA
UW	University of Wyoming, Laramie, Wyoming, USA
UZIL	Universitets Zoologiska Institut, Lund, Sweden
VPI	Virginia Polytechnic Institute, Blacksburg, Virginia, USA

Specimen Preparation and Examination

Most specimens examined in this study were air-dried and mounted on points or cards. Air-dried specimens usually have the head and mesosoma in good condition, but frequently the antennae and metasoma are somewhat collapsed, making dimensions of the flagellum, position of the hypopygium, and exact placement of the cerci difficult to determine. In addition, the epiproct or divided syntergum is almost impossible to see in air-dried material.

Specimens stored in alcohol were critical-point dried with a Tousimis Samdri-790A semiautomatic drier using 100% ethyl alcohol as an intermediate fluid and liquid CO_2 as the transitional fluid (Gordh and Hall 1979) prior to mounting. While critical-point drying often expands the metasoma, usually enough undistorted specimens are produced to

correctly determine hypopygium length and cerci placement. As an unexpected benefit, the expanded metasoma produced by critical-point drying made it relatively easy to determine the presence or absence of an epiproct or divided syntergum.

Slide mounts using Canada balsam and loosely following the techniques of Noyes (1982) were made for each species if enough specimens were available. Wings were removed, cleaned in clove oil, and mounted in Canada balsam. The body was cleared in 10% NaOH for 24 hours, followed by rinses of distilled H20, 15% acetic acid, and distilled H20. The specimen was then dehydrated in successive concentrations of ethyl alcohol and placed a terpineol–alcohol solution under a warm lamp. Dissection with minutin pins was made after the alcohol had evaporated from the terpineol solution. The head, antennae, mesosoma, metasomal tergites, metasomal sternites, and genitalia were usually separated for mounting. Coverslips were added after a few days.

Card- and point-mounted specimens were examined with a Zeiss DR dissecting microscope equipped with 16x and 25x eyepieces and 4x and 6.3x objective lenses. Light was provided by a Dolan-Jenner 180 fiber optic light with strips of mylar drawing film placed over the ends of the optical fibers. This provided a diffuse light which clearly illuminated fine detail such as sculpture. Slides were viewed with a Zeiss compound microscope equipped with Nomarski contrast enhancement. Specimens examined by scanning electron microscopy were mounted on double-sided tape on aluminum stubs or affixed on the end of a minutin pin and inserted through copper tape into silicon-filled holes drilled in the stubs, which elevated the specimen several millimeters above the upper surface of the stub and was coated with colloidal carbon after specimen coating. This provided a black background for photography and allowed the specimen to be viewed from a variety of angles. Specimens were coated with gold-palladium using a Technics Hummer 1 sputter coater. A JEOL JSM 25S and JEOL JSM T330A scanning electron microscope were used for SEM examination.

Hand-drawn illustrations were produced with a drawing tube attached to the Zeiss compound microscope, or with a camera lucida attached to a Wild M5A dissecting microscope if the specimen was unique and not slide-mounted. Measurements of body length and some structures used in ratios were made with an eyepiece reticle on the Zeiss dissecting microscope or Zeiss compound microscope.

Descriptive Format

Species are treated in alphabetical order. Fourteen of the 22 described species of Nearctic *Copidosoma* were described before 1941, with most of these being described

between 1885 and 1907. The older descriptions frequently are inadequate and often are based on a single series, or do not take into account individual or geographic variation. Redescriptions are provided for all previously described species, except for nine species that were adequately described. These follow the same format as descriptions of new species.

For new and described species, label data for primary types is presented exactly as recorded on the specimen labels, with the label data enclosed by quotation marks and each line of the label separated by a slash. Label data for non-type material is standardized and multiple records from the same locality are combined. Square brackets denote author comments and indicate items such as misspelled words and whether the label information is printed or handwritten. Label colors, except white, are noted in author comments. Much of the primary type material of previously described species is damaged and the condition of this material is noted.

Accompanying each description are sections on host, distribution, and material examined. Host genera and species are given where known, along with host family and subfamily. Host records are taken from the labels of specimens examined and records from the literature. Host data presented without a literature reference are taken from label data. Host determinations could not be confirmed in most cases. Distribution is summarized from label data listed under Material Examined or taken from the literature. Material Examined contains a list of the collection localities, collection date, collector, and host, followed in parentheses by the number and sex of specimens examined and the institution or individual who owns them. The Material Examined section is truncated for four species (*Copidosoma bakeri*, *celaenae*, *floridanum*, and *innocuellae*) that were represented by hundreds of specimens and numerous collections.

Morphology and Measurements

Morphological terms and measurements, except where noted, generally follow those of Noyes and Hayat (1984) and Noyes (1988b). Terms for genitalia follow those of Snodgrass (1935, 1941), except for part of the ovipositor, where outer plate is used instead of ninth tergite. Those that may need clarification are presented below, and additional explanation of character states for some morphological terms are found in the phylogenetic analysis.

Head

Anterior mandibular seta – seta located on anterior surface of first mandibular tooth, frequently enlarged (Fig. 406).

Club – distal part of the antenna, with 1–3 segments, nearly always differentiated from the funicle and usually with a well defined micropilose sensory area (Fig. 4).

Dorsal arms of tentorium – paired extensions of the tentorium that extend anteriorly from the posterior tentorial pits to the inner surface of the face (Fig. 404).

Eye height – measured as the maximum vertical height of the eye in lateral view (Fig. 2).

Flagellum – the antenna distal to the pedicel, composed of the funicular segments and club (Fig. 4).

Frontovertex width – distance between the eyes as measured across the median ocellus (Fig. 1).

Funicle – antennal segments between the pedicel and club that possess setae (Fig. 4), excluding the anellus, which is minute and does not bear setae.

Head width – measured as the maximum width of the head in frontal view (Fig. 1).

Malar space – measured as the minimum distance between the ventral eye margin and mouth margin (Fig. 2).

Malar sulcus – sulcus joining the ventral eye margin to the mouth margin (Fig. 1).

OOL – measured as the minimum distance between the eye margin and the posterior ocellus (Fig. 3)

OPL – measured as the minimum distance between a posterior ocellus and the occipital margin (Fig. 3).

POL – measured as the minimum distance between the inner margins of the posterior ocelli (Fig. 3).

Posterior mandibular seta – seta located on posterior surface of mandible, frequently enlarged (Fig. 406).

Sensory area of club – micropilose field at the apex or extending along the ventral margin of the club (Fig. 4).

Wings

Filum spinosum – distinct, short, peglike setae along outer margin of linea calva (Fig. 6).

Forewing length – measured from the distal end of the humeral plate to the apex of the wing (Fig. 5).

Forewing width – measured as the maximum width perpendicular to the anterior wing margin, usually slightly distad of the postmarginal vein (Fig. 5).

Hyaline break of submarginal vein – distal interruption of the submarginal vein just proximal to the marginal vein (as in Figs. 12, 14).

Linea calva – oblique bare field extending from the marginal and stigmal veins to the posterior wing margin (Fig. 5) that may have 1 or more lines of setae interrupting it (as in Figs. 38, 97).

Marginal vein – measured from the point the where the submarginal vein reaches the anterior wing margin to the origin of the postmarginal and stigmal veins (Fig. 6).

Postmarginal vein – measured from the distal junction of the marginal and stigmal veins to its most distal point, which is usually indicated by a single enlarged seta (Fig. 6).

Stigmal vein – measured from the junction of the marginal and postmarginal veins to its most distal point (Fig. 6).

Stigmal vein sensilla – group of 3–5 placoid sensilla near the apex of the stigmal vein (Fig. 6).

Legs

Hyaline ring of mid femur – hyaline or light colored ring, usually with well-defined margins, present near the base of the mid femur.

Metasoma

Epiproct – small sclerotized plate or thin paired sclerotized strips between the syntergum and ovipositor, best seen in critical-point dried material (Figs. 434-435).

Fifth and sixth sternites – two sternites anterior to the hypopygium.

Hypopygium – apical sternite, referred to by some workers as the seventh sternite (Fig. 7). The hypopygium may have anterior or posterior lobes (Fig. 207), and is described as *simple* if lacking lobes (Fig. 92).

Ovipositor length – measured from the most anterior portion of the first valvulae to the apex of the combined first and second valvulae (Fig. 8). Length of the exserted portion is measured from the apex of the syntergum to the apex of the third valvulae (Fig. 7).

Phallobase flange – paired medial edges of the phallobase that are deflected ventrally (Fig. 437).

Phallobase length – measured from the anterior edge to the apex of the paramere (Fig. 9).

Midrib of phallobase – dark, longitudinal thickened area of ventral phallobase that originates at the base of the digiti and extends anteriorly (Fig. 70)

Spicules – toothlike or peglike projections on the anterior portion of the second valvifer (Figs. 430-433).

Syntergum – apical metasomal tergite (Fig. 7).

Color

While use of color in the discrimination of taxa can be subjective and color can change according to specimen age or method of preservation, color can be an extremely useful tool in distinguishing between species. Overall body color, such as dark brown, is given in the description of each species. Additional descriptions of green, blue, or purple highlights overlaid on the base color are provided for specific regions such as the frontovertex or scutellum. These highlights or reflections depend on the particular structure being viewed and the different plays of light available. Color of a structure, such as the pronotum or tegulae, can be taken to be the same as the body color if not stated otherwise. Even if color has changed with age or been lost due to storage in alcohol, the base color or original patterns of light and dark frequently remain. The colors of the head, mesoscutum, scutellum, and legs are particularly important. Light portions of the legs can be quite variable, even within a series. Air-dried specimens often have the light areas of the legs darker than corresponding areas on critical-point dried specimens. These light areas are frequently transparent cuticle through which muscles are visible, and critical-point drying preserves the muscles in a lighter state than air-drying.

Sculpture

Sculpture, like color, can be somewhat subjective but is useful in the discrimination of taxa. The species descriptions present the type of sculpture found on the head, mesoscutum, and scutellum, and the different types of sculpture are used in the species keys and as character states in the phylogenetic analysis. The terms used to describe sculpture include: **reticulate** – netlike pattern of polygonal or circular cells defined by ridges (Figs. 413-414, mesosoma); **elongate reticulate** – similar to reticulate but with the cells distinctly longer than wide (Figs. 417-418); **striate** – composed of longitudinal lines that lack, or have very few, septa joining them (Figs. 423-424); **imbricate** – composed of cells that overlap like shingles or fish scales (Figs. 425-426); **polished** – devoid of sculpture or without definite septa. Sculpture of the frontovertex is usually described as reticulate, though in some cases the term alveolate might have been applied.

The depth of the cells, or the thickness and elevation of septa above the surface of the cuticle, varies with the overall size of the specimen. Thus, a small frontovertex might have reticulate sculpture, but a larger specimen with larger, thicker septa might be described as having alveolate sculpture.

Sexual Dimorphism

Males are usually easily distinguished from conspecific females. They have similar coloration and sculpture but tend to be smaller. The most visible distinguishing features are elements of the antenna and protruding genitalia. Male toruli are usually further from the mouth margin than in females and the setae on the funicular segments are longer and more erect. The male antennal club is usually unsegmented and lacks the conspicuous micropilose sensory area found on the female club. Exceptions include several species such as *Copidosoma floridanum*, where both sexes are very similar and have unsegmented, strongly obliquely truncate clubs and unexserted genitalia.

PHYLOGENETIC ANALYSIS

The conceptual approach used in this phylogenetic analysis is that of Hennig (1966), where relationships are inferred by the possession of putative homologous derived character states, or synapomorphies, that are shared through common ancestry. A number of workers have recently made significant progress in understanding the higher relationships in many chalcidoid families based on explicit phylogenetic methods (Heraty and Darling 1984, Schauff 1984, Gibson 1986, 1989, Woolley 1988, Heraty 1990). Prior work in Encyrtidae includes that of Trjapitzin, who outlined a hypothetical generalized encyrtid (1968) and discussed a number of primitive and advanced characters in Encyrtidae (1977). Jensen (1989) and Jensen and Sharkov (1989) established groundplan states and polarized characters for the encyrtine tribe Discodini. Noyes and Hayat (1994) established groundplan states and polarized 65 morphological characters for the tetracnemine tribe Anagyrini based on comparison with members of the Tanaostigmatidae, Encyrtinae, and Tetracneminae. However, none of these works provide explicit data or methodology or present cladograms to indicate relationships. Polarizing characters enables groundplan states to be constructed and might be used to formulate hypotheses of relationship, but remains a heuristic exercise unless a phylogenetic analysis is undertaken to investigate the interaction between characters and taxa and potential character conflicts.

The goals of this phylogenetic analysis are twofold. First is an evaluation of characters, and the distribution of character states, for their utility in a phylogenetic analysis. The tribe Copidosomatini offers a number of characters that have not been employed in previous phylogenetic analyses. It is hoped that this analysis will provide other workers with characters that may be of use in their respective groups, or stimulate further exploration of new and unanalyzed characters in chalcidoids. The second goal is the analysis of relationships of genera within the tribe. Establishing a single "true" phylogeny might be akin to seeking the Holy Grail, given that data are missing for a number of characters in three genera, many characters are being investigated for the first time, and the large amount of homoplasy that seems to be typical of phylogenetic analyses in large and diverse taxa such as Chalcidoidea. However, the data matrix is relatively complete and contains a large number of taxa, so I believe the phylogenetic analysis is robust enough to serve as foundation for further investigations.

Operationally, workers often presuppose a relationship between the outgroup and the ingroup. Given the lack of knowledge and uncertainty regarding relationships within Encyrtidae, this would be difficult to do with any confidence. Maddison et al. (1984) state

if outgroup relationships are not well known prior to a phylogenetic analysis, complications in assigning polarity to character states can arise. Nixon and Carpenter (1993) argue that an initial analysis of the outgroup or detailed knowledge of relationship between the outgroup and ingroup are unnecessary. Care must be taken, however, that taxa selected as the outgroup are not members of the ingroup.

Trjapitzin (1973b, 1989) and Noyes and Hayat (1984) placed Microteryini as one of the more basal tribes of the subfamily Encyrtinae. Two species of *Syrphophagus*, members of the Microteryini, were used to represent the outgroup. Species of *Syrphophagus* are parasites of larvae of Syrphidae (Diptera) or hyperparasites of aphids and psyllids (Homoptera), do not undergo polyembryonic development, and are not related to the ingroup under investigation. Copidosomatini, the ingroup, has been recognized on the basis of the following characters: mandible three-toothed; occipital margin sharp; antennae inserted near mouth margin; polyembryonic development; and by use of Lepidoptera and aculeate Hymenoptera as hosts, which is unusual for encyrtids. Polyembryony traditionally has been regarded as the strongest evidence for monophyly of the tribe, though polyembryony has not been conclusively demonstrated in two subtribes.

Taxa selected for the ingroup include 14 of the 17 genera placed within the Copidosomatini as it was defined prior to this study. *Xylencyrtus*, which contains two species from South Africa and is similar to *Copelopencyrtus*, was not available for detailed study. *Coagerus* and *Paratetracnemoidea*, which were previously included in the tribe, are removed based on reasons given in the Introduction. Because even small amounts of missing data can lead to a less than robust analysis (Platnick et al. 1991), only species for which data were available for both sexes were used in the analysis. Unfortunately, males and hosts are unknown for the monotypic genera *Ethoris*, *Nathismusia*, and *Neapsilophrys*, so these genera are missing data for a number of characters. In addition, *Nathismusia* is known from a single female and internal characters could not be evaluated.

The data matrix is composed of 47 characters and 67 taxa, and appears in Table 4. Characters were coded as binary variables (0, 1), multistate characters (0, 1, 2, 3), or meristic counts (5, 6, etc.). The outgroup method was used to establish polarity for all characters. Each analysis treated characters as unordered with initial weights of 1. Multistate characters were treated as unordered because specifying a transformation series for each character would have invoked an unacceptable number of assumptions concerning the evolutionary path of character states. Treating such characters as unordered, however, also makes the implicit assumption that each character state is free to transform to any other

state. This assumption was felt to be more acceptable than specifying a particular order for each character.

Character state descriptions and their distribution among taxa are shown in Tables 3 and 4. A number of species used in the analysis were polymorphic for certain characters, such as the number of male club segments and characters of the male genitalia. Polymorphisms present in the data matrix therefore represent multiple character states observed in taxa, not uncertainties in the data. Twelve of the 47 characters used had multiple character states for at least one species, and six characters were polymorphic in four or more species.

Characters

1. *Number of female funicular segments*. The common number of funicular segments in encyrtids is six, with five segments less common but occurring in a number of genera. Trjapitzin (1977) hypothesized eight funicular segments as the groundplan for encyrtids, as Gibson (1986) did for Chalcidoidea. Reduction in the number of funicular segments from 6 to 5 is regarded as apomorphic. Coded as a meristic count of 5 or 6.

2. *Number of female club segments*. This character has been important in encyrtid systematics and frequently appears in keys to genera. Trjapitzin (1971) hypothesized a 3-segmented club as the groundplan for Encyrtidae, and Gibson (1986) hypothesized the same for Chalcidoidea. Two taxa in the analysis are polymorphic, with a club that can be unsegmented or incompletely 3-segmented. Two species of *Copidosoma* not included in the analysis have a 2-segmented club. Coded as a meristic count of 1 or 3.

3. *Female club apex*. Trjapitzin (1971, 1977) believed the plesiomorphic club in encyrtids to be poorly differentiated from the funicle. Clubs that are obliquely truncate at the apex are usually very distinct from the funicle, and a rounded or truncate club apex may be plesiomorphic. Coded as a multistate character: 0, club apex rounded (Fig. 66); 1, truncate; 2, obliquely truncate, with the truncate area less than 0.25x club length (Fig. 253); 3, strongly obliquely truncate, with the truncate area greater than 0.25x club length (Fig. 36).

4. *Male funicular segments joined centrally*. Many males have filiform or short funicular segments that are joined at the center. Others have the funicular segments joined much more ventrally, which is often associated with a dorsal expansion of the segments. This is hypothesized as the apomorphic state. Species with pectinate antennae, such as *Parablastothrix* and some species of *Coelopencyrtus*, were coded as missing for this character because it could not be accurately assessed. Coded as: 0, funicular segments joined at center (Fig. 73); 1, joined ventrally (Fig. 45).

5. *Number of male club segments*. Most male encyrtids have an unsegmented club, but several species in the analysis are polymorphic with one or two segments. Coded as a meristic count of 1 or 2.

6. *Male club apex*. Coded as character 3.

7. *Male funicle pectinate*. Males with pectinate antennae are found in several encyrtid tribes. All *Parablastothrix* males possess elongate branches, as does one species of *Copidosoma*. Several species of *Coelopencyrtus* have short branches, and several species of *Copidosoma* and *Coelopencyrtus* have short outgrowths that are incipient branches. Presence of pectinate antennae is considered apomorphic. Coded as a multistate character: 0, funicle without branches (Fig. 30); 1, with incipient branches (Fig. 392); 2, with elongate branches (Fig. 58).

8. *Position of toruli*. Position of the toruli very near the mouth margin has been cited as one of the characteristics of the tribe (Trjapitzin 1973b), though this is mostly true for the subtribe Copidosomatina. Coelopencyrtina, Parablastotrichina, and some members of the Ageniaspidina have the toruli rather distant from the mouth margin. Most males in the tribe have the toruli further from the mouth margin than females. Coded as a multistate character: 0, female toruli at mouth margin; 1, toruli within their own length of mouth margin; 2, toruli greater than their own length from mouth margin.

9. *Mandibular teeth*. Mandibular teeth traditionally play an important role in encyrtid systematics. The number of teeth is one of the characters used to separate the two subfamilies and their shape or form is frequently used at the generic level. Trjapitzin (1971, 1977) hypothesized a mandible with three equal teeth as the groundplan for encyrtids. Most copidosomatines have 3 subequal teeth, though the clade that parasitizes Noctuidae shows a transformation to having the anterior and middle teeth greatly reduced. Coded as a multistate character: 0, three subequal teeth (Fig. 406); 1, middle tooth largest; 2, anterior tooth reduced and posterior tooth largest (Fig. 405); 3, posterior tooth largest and remaining teeth smaller and subequal.

10. *Anterior mandibular seta*. All mandibles examined have a single seta on the anterior surface that is variable in size or shape. Another seta present on the medial surface of the mandible was used as a standard of comparison for deciding if the anterior seta was normal or enlarged. The enlarged state is marked by its greater thickness and length, and the distal portion is frequently curved or deflected. All *Parablastothrix* examined have the anterior seta short and peglike. Coded as a multistate character: 0, anterior mandibular seta normal (Fig. 405); 1, enlarged (Fig. 406); 2, peglike (Fig. 407).

11. *Posterior mandibular seta.* All mandibles examined have a single setae on the posterior surface that is variable in size or shape. The same seta on the medial surface of the mandible used to judge the state of the anterior mandibular seta was used to judge the posterior seta. The enlarged state has this seta thickened proximally, but the distal portion is never curved or deflected as is the anterior mandibular seta. The extreme case has the posterior seta flattened and bladelike. In this state it is just visible with a dissecting microscope and is probably the "indicio de cuarto diente en el ángulo interno apical" Mercet (1921) observed in *Paralitomastix*. A similar bladelike posterior setae is found in some genera of Habrolepidini, such as *Comperiella* and *Habrolepis*. Coded as a multistate character: 0, posterior mandibular seta normal (Fig. 408); 1, enlarged (Fig. 409); 2, bladelike (Fig. 406).

12. *Dorsal arms of tentorium.* Most encyrtids examined have thin dorsal arms of the tentorium extending anteriorly from near the posterior tentorial pits to the inner surface of the face. The dorsal arms are present in a number of chalcidoid families, though sometimes reduced, and are therefore considered plesiomorphic. Coded as: 0, dorsal arms of tentorium present (Fig. 404); 1, absent.

13. *Malar sulcus.* Many encyrtids and other chalcidoid families possess a malar sulcus. Most copidosomatine genera lack the malar sulcus. Coded as: 0, malar sulcus present (Fig. 1); 1, absent.

14. *Eye size. Parablastothrix* has the compound eyes abnormally enlarged and the genae extremely reduced or absent. Coded as: 0, eyes normal (Fig. 402); 1, eyes enlarged (Fig. 401).

15. *Mesoscutum sculpture.* Each subtribe tends to have characteristic sculpture on the mesoscutum. Ageniaspidines possess striate sculpture, coelopencyrtines have imbricate sculpture, and copidosomatines have polygonal or elongate reticulate sculpture. Coded as a multistate character: 0, mesoscutum with polygonal reticulate sculpture (Figs. 413-414); 1, with elongate reticulate sculpture (Figs. 417-418); 2, with striate sculpture (Figs. 423-424); 3, with imbricate sculpture (Figs. 425-426).

16. *Tegula color.* Several species of *Copidosoma* and *Parablastothrix* have tegulae that are partially or completely white or yellow. *Copidosoma innocuellae* females have tegulae that are either completely dark or have yellow in the proximal portion, so this species was coded as polymorphic. Coded as: 0, tegulae completely dark; 1, with some light color.

17. *Axillae meeting.* Gibson (1989) hypothesized contiguous axillae as the groundplan for Encyrtidae, and this is the state most common in the family. A single species,

Copidosoma mutabilis, has axillae that do not meet. Coded as: 0, axillae separate; 1, meeting.

18. *Axillae height*. Gibson (1989) hypothesized that axillae in the same relative horizontal plane as the dorsal surface of the scutellum represent the groundplan for encyrtids. Most copidosomatines have the axillae slightly elevated above the level of the scutellum. *Apsilophrys* and several species of *Copidosoma* have prominent axillae greatly elevated above the scutellum. Coded as a multistate character: 0, axillae flat (Fig. 419); 1, slightly elevated above scutellum (Figs. 418, 424); 2, greatly elevated above scutellum (Figs. 420, 422).

19. *Scutellum sculpture*. Coded as character 15.

20. *Propodeal spiracle*. Most encyrtids examined have circular propodeal spiracles, but New World species of *Copidosomopsis* have elongate spiracles. Coded as: 0, spiracle round (Fig. 427); 1, elongate (Fig. 428).

21-23. *Fore-, mid, and hind coxae color*. Several taxa have varying combinations of light color on the coxae, with light defined as white, yellow, or orange. Most species in the tribe have all coxae dark in color. Coded as a binary character for each pair of coxae: 0, coxae without light color; 1, with light color.

24. *Forewing color*. Trjapitzin (1971) considered a hyaline forewing to be the groundplan for Encyrtidae, and many copidosomatines have forewings with varying degrees of infuscation. The most common states are a hyaline wing or a wing that is entirely, but slightly, infuscate, with the darkest color around the marginal and stigmal veins. Coded as a multistate character: 0, forewing hyaline; 1, infuscate around marginal and stigmal veins; 2, more extensively infuscate.

25. *Hyaline break of submarginal vein*. Many encyrtids have a complete or partial distal break in the submarginal vein just before it meets the marginal vein. Coded as: 0, submarginal vein without hyaline break (Fig. 61); 1, with hyaline break (Fig. 14).

26. *Marginal vein length*. Trjapitzin (1971, 1977) considered an elongate marginal vein plesiomorphic for Encyrtidae and a short marginal vein is cited as characteristic of Copidosomatini (Hoffer 1955, Trjapitzin 1973b). Most genera in the tribe have the marginal vein 1.5-3x longer than broad. Coded as a multistate character: 0, marginal vein as broad as long (Fig. 61); 1, length 1-3x longer than wide (Fig. 54); 2, length greater than 3x width (Fig. 14).

27. *Postmarginal vein length*. Trjapitzin (1971, 1977) considered an elongate postmarginal vein plesiomorphic for Encyrtidae and cited an elongate postmarginal vein as characteristic of Ageniaspidina (Trjapitzin 1973b). Most genera in the tribe have the

postmarginal vein shorter than the stigmal. Coded as a multistate character: 0, postmarginal vein absent or rudimentary (Fig. 12); 1, shorter than stigmal vein (Fig. 39); 2, as long as stigmal vein (Fig. 54); 3, longer than stigmal vein (Fig. 14).

28. *Linea calva*. The linea calva may be entire or interrupted by a one or more rows of dorsal setae. Several species of *Coelopencyrtus* are polymorphic for this character. *Nathismusia* lacks a linea calva and filum spinosum and was coded as missing for this character. Coded as: 0, linea calva not interrupted (Fig. 68); 1, interrupted (Fig. 38).

29. *Number of stigmal vein sensilla*. The number of sensilla at the apex of the stigmal vein was coded as a meristic count of 3 or 4 (Fig. 6).

30. *Shape of stigmal vein sensilla*. Copidosomatina and many Parablastotrichina have the apex of the stigmal vein rounded or square and the sensilla arranged in a square pattern, while other genera have an uncus and the sensilla arranged in a more linear pattern. A convergent arrangement of the sensilla on the stigmal vein is found in *Bothriothorax* and *Paratetracnemoidea*, which resemble some genera of Copidosomatina in having extremely short marginal and postmarginal veins. Coded as: 0, stigmal vein sensilla arranged in a square (Fig. 12); 1, arranged otherwise (Figs. 15, 18).

31. *Hypopygium position*. Position of the hypopygium relative to the apex of the metasoma is frequently used in identification. Coded as a multistate character: 0, hypopygium in middle 1/3 of metasoma; 1, in apical 1/3 of metasoma; 2, at apex of metasoma; 3, extending beyond apex of metasoma.

32. *Cerci position*. Trjapitzin (1971) believed position of the cerci near the posterior of the metasoma to be plesiomorphic for Encyrtidae. Most species in the analysis have cerci in the middle 1/3 of the metasoma, and some were coded as polymorphic. Coded as a multistate character: 0, cerci in anterior 1/3 of metasoma; 1, in middle 1/3 of metasoma; 2, in posterior 1/3 of metasoma.

33. *Sternites 5-6*. The two sternites anterior to the hypopygium may have various forms. The most common state, and presumed plesiomorphic condition, are unmodified sternites that are simply transverse or U-shaped, as found in *Coelopencyrtus* and many *Copidosoma*. The divided state, found in *Copidosomopsis*, *Ageniaspis*, *Holcothorax*, *Paraleurocerus*, and *Copidosoma deceptor* is marked by an unsclerotized median band. A number of *Copidosoma* species have a prominent anterior median lobe on these sternites, and *Copidosoma whartoni* has the anterior margin of the sternites incised or notched. Coded as a multistate character: 0, sternites simple (as in Fig. 92); 1, divided medially (Fig. 13); 2, lobed (Fig. 48); 3, incised (Figs. 227, 396).

34. *Syntergum*. Species such as *Copidosoma gelechiae* and *C. geniculatum* have the syntergum completely or partially divided along the midline. This character is difficult to see in air-dried specimens that have the metasoma partially collapsed, but easy to see in critical-point dried material. Several species not included in the analysis but similar to *Copidosoma gelechiae* also have the syntergum divided. Presence of a divided syntergum is apomorphic. Coded as: 0, syntergum not divided medially; 1, completely or partially divided medially (Fig. 160).

35. *First valvifer articulation*. The first valvifer articulates with the first valvula, the second valvifer, and the outer plate. Two patterns of articulation were found. The first pattern (state 0) has the articulation between the first valvifer and the outer plate located on the posterior dorsal corner of the first valvifer. This articulation results in a first valvifer shaped like a broad to narrow triangle (Figs. 40, 432). This type of first valvifer tends to be near the anterior end of the second valvifer and in species with short ovipositors. In the second pattern (state 1), the articulation between the first valvifer and the outer plate is located medially along the posterior edge of the first valvifer, resulting in an oval or elongate first valvifer (Figs. 8, 429). This state is common in species of *Copidosoma* with exserted ovipositors but also present in *Coelopencyrtus* and *Parablastothrix*, which have short ovipositors. Assessing the polarity of this character will entail a further survey of encyrtids and other chalcidoids. Coded as: 0, first valvifer with dorsal articulation to outer plate (Figs. 40, 432); 1, with medial articulation (Figs. 8, 429).

36. *Second valvifer spicules*. Most specimens examined have a series of minute toothlike structures on the anterior end of the second valvifer. I was unable to find any reference to these structures in texts such as Snodgrass (1935) or more recent morphological studies of ovipositors (Smith 1970, Copland and King 1972, Fergusson 1988). Torre-Bueno (1985) defines a spicule as "a minute pointed spine or process", which seems an apt term for these structures. The simplest type (state 1) consists of several rows of longitudinal or oblique spicules, with each spicule delineated from adjacent ones (Figs. 430-431). This state is common in derived species of *Copidosoma*. The second type (state 2) consists of transverse rows with clusters of spicules sharing a common base (Fig. 432) and is found in *Paralitomastix*, *Raffaellia*, and species of *Copidosoma* that parasitize Noctuidae. The third type of pattern (state 3) is the most complex and what I have termed compound spicules. These consist of minute spicules set in tabs or plates in transverse overlapping rows, frequently on a bulbous or projecting portion of the second valvifer (Fig. 433), as in *Coelopencyrtus* and *Parablastothrix*. This state is also found in species of *Adelencyrtoides*, *Bothriothorax*, *Odiaglyptus*, *Ooencyrtus*, *Paratetracnemoidea*,

and *Syrphophagus* and may be plesiomorphic for Encyrtidae. Spicules are absent in ageniaspidines, *Copidosomopsis*, and two species of *Copidosoma* (state 0). The function of these spicules is unknown, and accurate assessment of the polarity of this character will entail a further survey of encyrtids and other chalcidoids. Coded as a multistate character: 0, second valvifer spicules absent; 1, individual spicules in longitudinal or oblique rows (Figs. 430-431); 2, transverse spicules with a common base (Fig. 432); 3, compound spicules (Fig. 433).

37. *Second valvifer fused to third valvula.* The plesiomorphic state is interpreted as a complete separation of the second valvifer and third valvula. Coded as: 0, second valvifer not fused to third valvula; 1, second valvifer fused to third valvula.

38. *Third valvulae exserted.* Copidosomatines are highly variable with respect to the length of the third valvulae, with most species having the valvulae at least slightly exserted and visible in dorsal view. Coded as a multistate character: 0, third valvulae not exserted; 1, exserted less than 0.25x length of metasoma; 2, exserted 0.25-0.5x length of metasoma; 3, exserted 0.5-1.0x length of metasoma; 4, exserted more than length of metasoma.

39. *Phallobase setae.* Trjapitzin (1973b) cites extensive setation of the phallobase as characteristic of the Copidosomatina. While many species of *Copidosoma* have 10 or more pairs of elongate setae on the phallobase, most other genera have relatively few. Coded as a multistate character: 0, phallobase with 1-5 pairs of setae (Fig. 70); 1, with 6-10 pairs of setae (Fig. 55); 2, with 11 or more pairs of setae (Fig. 62).

40. *Phallobase flange.* Several related species of *Copidosoma* that parasitize Noctuidae have the inner edge of each paramere deflected ventrally to form a flange, which is shown in Snodgrass' (1941) illustration of *Copidosoma bakeri* but not explicitly referred to. Presence of the flange is considered apomorphic. Coded as: 0, phallobase flange absent (Fig. 55); 1, present (Figs. 43, 437).

41. *Phallobase midrib. Apsilophrys* and some species of *Copidosoma* have a narrow, sclerotized, longitudinal thickened area in the ventral surface of the phallobase that originates between the base of the digiti and extends anteriorly. This midrib is visible as a dark line even in uncleared specimens of *Apsilophrys*. Coded as; 0, phallobase midrib absent (Fig. 55); 1, present (Fig. 70).

42. *Number of digital claws.* Males of *Coelopencyrtus*, *Parablastothrix*, most Ageniaspidina, and *Apsilophrys* have two claws on each digitus, but the number is variable within Copidosomatina. Most *Copidosoma* have three claws (Fig. 63), but that number can vary within a species or even an individual, as some specimens have three claws on one digitus and four on the other. Such species were recorded as polymorphic. Since the digiti

swing aside during mating and the claws do not appear to make any contact with the female, any function remains unknown. Coded as a meristic count of 1-5.

43. *Position of digital claws*. Arrangement of the claws on the digiti varies in the tribe and can be diagnostic for certain taxa. Most common are claws in a transverse row at the apex of the digiti (state 0). Several species have 2-4 claws at the apex of the digitus, with 1 claw proximal to those (state 1). Least common are the typical apical claws and a claw well-separated from the others, at about half the length the digitus (state 2). *Copidosoma celaenae* and *C. cuproviridis*, whose males are difficult to separate, are polymorphic for all three states recorded. Coded as a multistate character: 0, digital claws transverse at apex of digiti (Fig. 34); 1, claws offset at apex of digiti (Fig. 382); 2, with proximal and apical claws (Fig. 116).

44. *Pores of digiti*. A number of taxa have one or two pores on each digitus, frequently near the claws at the apex of the digiti. *Copidosoma celaenae*, *C. cervius*, and *C. cuproviridis*, which are polymorphic for the position of the claws on the digiti, are also polymorphic for the number and location of pores on the digiti. Function of the pores is unknown. Coded as a multistate character: 0, digital pores absent (Fig. 34); 1, with 1 apical pore (Fig. 116); 2, with 1 proximal pore (Fig. 221); 3, with 2 apical pores (Fig. 70), 4, with proximal and apical pores (Fig. 85).

45. *Aedeagal hooks*. Several species of *Copidosoma* that parasitize Noctuidae have a pair of hooks projecting ventrally from the aedeagus. The function of these hooks is unknown, and I cannot find a structure on the ovipositor that corresponds to them. The hooks do not make contact with any sclerotized structure such as the spicules in a slide mounted mating pair of *Copidosoma celaenae* in which the aedeagus is fully inserted. *Copidosoma deceptor*, which does not parasitize Noctuidae, has unique lateral and medial hooks that may not be homologous to those found in the clade possessing the paired hooks. Coded as a multistate character: 0, aedeagal hooks absent (Fig. 35); 1, one pair of hooks present (Figs. 44, 438); 2, lateral and medial hooks present (Figs. 134, 439).

46. *Aedeagal sensilla*. A number of genera have one or more pairs of sensilla on the dorsolateral surface of the aedeagus. Most species of *Copidosoma* examined lack the sensilla or have only one pair, but other genera may have four or more pairs. Coded as a multistate character: 0, aedeagal sensilla absent; 1, with 1 pair (Fig. 437); 2, with more than 1 pair.

47. *Host*. The hosts of Copidosomatini, Lepidoptera and aculeate Hymenoptera, are unusual for encyrtids. Species of only 18 genera of Encyrtidae are known to utilize Lepidoptera as a host, and of those, only Ageniaspidina and Copidosomatina are egg-larval

parasites (Tachikawa 1981). Species of *Parablastothrix* are known to parasitize Lepidoptera but little else is known of their biology. Species of *Coelopencyrtus* are distinct in being the only encyrtids known to parasitize Vespidae and different families of bees. Coded as a multistate character: 0, host Aphididae; 1, aculeate Hymenoptera; 2, Lepidoptera.

Parsimony Analysis

The data were analyzed with the Phylogenetic Analysis Using Parsimony computer program (PAUP version 3.1.1 by D. Swofford) on Macintosh computers. The outgroup method was used to establish polarity for all characters. Each analysis treated characters as unordered with initial weights of 1. All available addition sequences were evaluated to determine which resulted in the most parsimonious cladograms. Using the RANDOM or CLOSEST addition sequence with the TREE BISECTION-RECONNECTION branch swapping algorithm produced the most parsimonious cladograms. Additional discussion of the use of the RANDOM addition sequence is presented later.

Three common indices of the information content of characters are available. The consistency index, or CI, measures the homoplasy, or inconsistency, of the character state changes on a cladogram and is calculated as CI = m / s, where m represents the minimum number of state changes a character can undergo and s represents the minimum number of character state changes a character underoes on a cladogram. Thus, if a character has 3 states the minimum number of possible state changes (m) is 2. If the character state changes appear 5 times on a cladogram (s), homoplasy exists in that character and the CI is 3 / 5 = 0.4. The retention index, RI, takes into account the CI of a character and the number of taxa that have undergone a character state change and is calculated as RI = $g - s$ / $g - m$, where g is the maximum number of steps a character may undergo on a cladogram and m and s are as above. For example, if the value of g for a character is 13, and m and s are as above, RI = 13 – 5 / 13 – 2 = 0.727. The rescaled consistency index, RC, is calculated as CI × RI and using the above values would be 0.4 × 0.727 = 0.29. The RC represents a refinement over the CI for assessing the fit of a character to a cladogram, for the value of RC can become zero when a character fits a cladogram as poorly as possible, while the CI can approach but never reach zero (Farris 1989).

The values of these character indices may vary between equally parsimonious cladograms and the maximum, minimum, or mean value of each index can be computed from all the cladograms in a group. Thus, given 100 equally parsimonious cladograms, the maximum value of RC for a character would be the highest value found among the 100

cladograms, the minimum value would be the lowest RC score found in the group, and the mean value would be the average based on the scores from all the cladograms. Different analyses utilized the mean or maximum values of RC to weight characters, as discussed below.

Because each analysis generated a large number of equally parsimonious cladograms, the successive approximations weighting method of Farris (1969) was employed. This explicit *a posteriori* character weighting technique used the value of RC to weight each character. For an initial parsimony search all characters are assigned a weight of 1. After an initial group of cladograms is found, the RC values for each character are used to reweight the characters and another search for the most parsimonious cladogram(s) is performed. New RCs calculated from the resulting cladograms then are used to reweight the data again, and another search performed. This process is repeated until the weights or resulting cladograms do not change. Reweighted characters were given a base weight of 100. Thus, a perfect character with an RC of 1.00 received a weight of 100, while a character with an RC of 0.250 received a weight of 25.

As discussed above, using the RANDOM or CLOSEST addition sequences produced the most parsimonious cladograms. The CLOSEST addition sequence proceeds by evaluating the lengths of all possible three-taxon cladograms. The shortest three-taxon cladogram is used as the initial cladogram, and the remaining unplaced taxa are connected to the growing cladogram at the point that requires the smallest increase in cladogram length. Thus, there is a single starting cladogram whose branches are rearranged in an attempt to find more parsimonious solutions. If a shorter cladogram is found, the collection of longer cladograms is discarded, which may limit the possibility of finding even more parsimonious cladograms because of the existence of islands of similar cladograms. An island is defined as a collection of cladograms of equal length, each differing from the next by a single rearrangement of branches, and each connected to every other cladogram through a series of cladograms, but not directly connected to cladograms composing other islands (Maddison 1991). Thus, the branch rearrangements performed on a single starting cladogram might arrive at an island of cladograms and be forced to remain there because the path to an island of equal or shorter length cladograms may entail utilizing less parsimonious cladograms.

Use of the RANDOM addition sequence is one way to test whether a group of cladograms represents all of the most parsimonious solutions or only an island that the search algorithm is marooned on. The RANDOM addition sequence uses random permutations of the order taxa are added to the initial cladogram, which provides a number

of different starting cladograms that are subjected to branch rearrangements. For the analyses discussed below, an initial set of cladograms was determined using the CLOSEST addition sequence. The RANDOM addition sequence was then employed to determine if a shorter collection of cladograms existed. In most instances, the RANDOM addition sequence did find shorter cladograms. Shorter cladograms found using the RANDOM addition sequence were themselves tested by conducting additional random sequence searches. A minimum of 300 random addition sequence replications were performed after each iteration to insure that the iteration actually produced the most parsimonious set of cladograms available.

Because much of this effort was exploratory in nature, six different analyses were undertaken. These analyses examined the effects of different weighting methods or using a reduced number of characters and taxa. The conditions for each analysis are listed below.

Analysis 1. Utilized full dataset of 47 characters and 67 taxa and employed successive approximations with characters weighted by the mean value of the RC.

Analysis 2. Utilized full dataset and employed successive approximations with characters weighted by the maximum value of the RC.

Analysis 3. Excluded character 47, host information, and employed successive approximations with characters weighted by the mean and maximum values of the RC.

Analysis 4. Utilized only 49 taxa and employed successive approximations with characters weighted by the maximum value of the RC.

Analysis 5. Utilized the 25 best characters as determined by Analysis 1 and employed successive approximations with characters weighted by the maximum value of the RC.

Analysis 6. Utilized the same 49 taxa as Analysis 4 and the same 25 characters as Analysis 5. This analysis employed successive approximations with characters weighted by the maximum value of the RC.

Results

Analysis 1. This analysis utilized the full data matrix of 67 taxa and 47 characters. The initial search produced 1,032 equally parsimonious cladograms of 345 steps, each with the CI = 0.371 and RI = 0.697. Each individual cladogram was well resolved, but placement of Ageniaspidina, several genera within Copidosomatina, and several species of *Copidosoma* varied between trees. Despite the large number of cladograms, the strict consensus tree (Fig. 440) shows distinct lineages representing genera and species groups that remained intact through the successive approximations process. Employing successive approximations immediately reduced the number of equally parsimonious cladograms and

required seven iterations before the weights stabilized and the cladograms did not change. The number of equally parsimonious cladograms and their lengths for each iteration appear below.

Iteration	# of cladograms	Length
1	1032	345
2	14	8380
3	14	8350
4	7	8351
5	14	8390
6	7	8398
7	7	8422

For the final set of cladograms, the CI excluding uninformative characters = 0.461 and the RI = 0.822. Characters 14, 20, 36, 40, 45, and 47 were perfectly consistent and informative, with the CI and RI = 1.0. The CI, RI, and final weight for each character appear in Table 3. When the characters from the final iteration are reweighted to a value of 1, the cladograms are 353 steps with the CI = 0.363 and RI = 0.685.

The final seven cladograms differ from each other only in the species relationships within *Coelopencyrtus*. One cladogram (cladogram 4) was chosen from the final seven to illustrate support for each node. Cladogram 4 is identical to the other six cladograms except the species relationships in *Coelopencyrtus* are the least resolved. Character support for each node appears in Figs. 441 and 442. Each character and its state plotted on the cladogram are identical on all seven final cladograms. All characters shown have a single model of state change on all seven cladograms, except character 47, host. This character, shown in italics, has two identical models of state change on all seven cladograms. Character 47 is shown using the DELTRAN assumption of state change, which delays the transformation of character states. If plotted using the ACCTRAN assumption, which postulates the earliest possible change of character state, the two occurrences of character 47 each move one node basally on the cladogram. Characters with the CI < 0.4 are marked with an asterisk, characters undergoing a reversal are boldfaced, and those which show parallelisms on the cladogram are marked with a "+". If the cladogram is rooted with a monophyletic outgroup, character 42 has more than one model of state change between the outgroup and the ingroup.

Analysis 2. This analysis utilized the maximum value of the RC to weight the characters instead of the mean value as in Analysis 1. In this analysis, only four iterations were required to reach a stable set of weights and cladograms. The number of equally parsimonious cladograms and their lengths for each iteration appear below.

Iteration	# of cladograms	Length
1	1032	345
2	42	9114
3	21	8414
4	21	8394

For the final set of 21 cladograms, the CI excluding uninformative characters = 0.461 and the RI = 0.821. When the characters from the final iteration are reweighted to a value of 1, the cladograms are 353 steps with the CI = 0.321 and RI = 0.685. Cladograms resulting from this analysis are nearly identical to those of Analysis 1, differing only in the species relationships within *Coelopencyrtus* and *Parablastothrix*. Final weights for six characters changed slightly, as shown below. All other final weights did not differ between the two analyses.

Character	Final weight Analysis 1	Final weight Analysis 2
13. Malar sulcus	14	24
16. Tegula color	17	25
24. Forewing color	5	4
30. Shape of stigmal vein sensilla	45	34
43. Position of digital claws	27	21
44. Pores of digiti	22	24

Analysis 3. This analysis used all the characters except character 47, host information. Coddington (1988) argued that to avoid circularity, characters such as biological information that are part of an evolutionary hypothesis should not be used to construct a cladogram, but should be mapped onto a cladogram derived from independent characters. Pagel and Harvey (1988) echoed Coddington in stating the effects of adaptation and phylogeny should be partitioned. On the other hand, Kluge and Wolf (1993) presented convincing arguments that as part of the phylogenetic history of an organism, such characters should be used in the phylogenetic reconstruction of a group.

In any case, excluding character 47 had no effect on the resulting cladograms. Employing successive approximations with the characters reweighted by the mean or maximum values of the RC produced iterations and cladograms identical to those in Analyses 1 and 2, but with the first iteration 2 steps shorter and the following iterations 200 steps shorter.

Analysis 4. This analysis used only 49 taxa to test the effect of a reduced number of taxa. Three species of *Coelopencyrtus* and 15 species of *Copidosoma* that represented terminal taxa or clades in Analysis 1 were excluded from the analysis. Excluded taxa include *Coelopencyrtus odynerus*, *C. swezeyi*, *C. watmoughi*, and *Copidosoma bakeri*, *C. beckeri*, *C. brandysae*, *C. cervius*, *C. charisoma*, *C. confusa*, *C. cuproviridis*, *C. desantisi*, *C. geniculatum*, *C. howardi*, *C. hypenapurpura*, *C. lymani*, *C. melanocerum*, *C. timberlakei*, and *C. whartoni*. This analysis employed successive approximations with characters weighted by the maximum value of the rescaled consistency index and required four iterations to reach a stable solution, as shown below.

Iteration	# of cladograms	Length
1	2492	270
2	4	7223
3	12	6612
4	12	6609

For the final set of 12 cladograms, the CI excluding uninformative characters = 0.479 and the RI = 0.796. When the characters from the final iteration are reweighted to a value of 1, the cladograms are 274 steps with the CI = 0.342 and RI = 0.657. The 12 equally parsimonious cladograms differ from each other in species relationships within *Coelopencyrtus* and in the placement of *Copidosoma bucculatricis*, *C. innocuellae*, and *C. longiclava*. The strict consensus cladogram, with character support for each clade overlaid on the cladogram, appears in Figs. 443 and 444. All characters plotted on the consensus cladogram were identical on all 12 final cladograms, and each had a single model of state change on each of the 12 trees. Character notation in Figs. 443 and 444 is the same as in Fig. 441.

Using a reduced number of taxa resulted in cladograms very different from those of Analysis 1 (Figs. 441 and 442), which used the full data. *Nathismusia* moved from being basal to Parablastotrichina+Ageniaspidina+Copidosomatina to become the sister group of Ageniaspidina, and *Neapsilophrys* moved from Copidosomatina into Ageniaspidina.

Ethoris was removed as the sister group to *Zelencytus*, and *Nathismusia*+Ageniaspidina became basal to Parablastotrichina+Copidosomatina (Fig. 443). However, it must be pointed out that *Ethoris*, *Nathismusia*, and *Neapsilophrys* are expected to be the most unstable taxa since they are missing the most characters.

In the Copidosomatina, *Copidosoma chalconotum* and *Copidosomopsis* remained basal to the remaining taxa. *Raffaellia* was removed from close relationship with *Paralitomastix*, and a number of individual species of *Copidosoma* assumed different relationships (Fig. 444).

Analysis 5. This analysis tested the effect of using a reduced number of characters by utilizing only characters 6, 7, 9, 10, 12, 14, 15, 20, 27, 28, 30, 31, 33-36, and 39-47. These were the 25 most informative characters from the full set of 47 as determined by Analysis 1, each having either a CI ≥ 0.50 or an RC ≥ 0.20 for all 7 cladograms in that analysis. The number of equally parsimonious cladograms and their lengths for each iteration appear below.

Iteration	# of cladograms	Length
1	16,600+	155
2	1270	6539
3	140	5761
4	1269	5761

The first iteration accumulated 16,600 equally parsimonious cladograms before exhausting the computer's memory. For the final set of 1,269 cladograms, the CI = 0.585 and the RI = 0.866. When the characters from the final iteration are reweighted to a value of 1, the cladograms are 155 steps with the CI = 0.497 and RI = 0.811.

Major differences from Analysis 1 (Figs. 441 and 442) include the paraphyly of *Coelopencyrtus* and placement of *Copidosomopsis* as the sister group to Ageniaspidina (Fig. 445). Most unexpected is the placement of *Nathismusia+Zelencyrtus* as the sister group to *Apsilophrys*. Though some clades within *Copidosoma* remained intact, relationships between those clades differed from Analysis 1 (Fig. 446).

Analysis 6. This analysis used the most reduced dataset and included the same 49 taxa as Analysis 4 and the same 25 characters as Analysis 5. This analysis employed successive approximations with characters weighted by the maximum value of the rescaled consistency index and required four iterations to reach a stable solution, as shown below.

Iteration	# of cladograms	Length
1	48	115
2	4	4878
3	8	4731
4	8	4733

For the final set of eight cladograms, the CI excluding uninformative characters = 0.581 and the RI = 0.856. When the characters from the final iteration are reweighted to a value of 1, the cladograms are 116 steps with the CI = 0.457 and RI = 0.798. One cladogram (cladogram 6) was chosen from the final eight to illustrate support for each node. Cladogram 6 was selected because the species relationships in *Copidosoma* were the least resolved. Character support for each clade appears in Figs. 447 and 448. Each character and its state plotted on the cladogram have a single model of state change and are identical on all eight final cladograms. Character notation in Figs. 447 and 448 is the same as in Fig. 441.

This analysis also produced results very different from Analysis 1 (Figs. 441-442). Though *Coelopencyrtus* and *Parablastothrix* retained their basal positions, *Nathismusia* moved to become basal to *Ethoris+Zelencyrtus*, and these three genera formed the sister group to *Apsilophrys*. *Copidosomopsis* appeared as the sister group to Ageniaspidina as in Analysis 5 (Fig. 447). In Copidosomatina, the largest differences were the shifting of a number of individual species of *Copidosoma* and removal of *Paralitomastix+Raffaellia* as the sister group to the clade of *Copidosoma* species that parasitize Noctuidae (Fig. 448).

Because many of the characters employed have not been previously evaluated for their phylogenetic usefulness, it is useful to compare the relative consistency of the characters in different analyses. A comparison of the CI and RI values for each character from Analyses 1, 4, 5, and 6 appears in Table 5. Characters which had consistently high CI and RI values through most analyses include the male club apex, mandibular teeth, anterior mandibular seta, mesoscutum sculpture, postmarginal vein length, sternites 5-6, first valvifer articulations, and second valvifer spicules.

A number of characters important for identification of taxa or expected to be conservative and phylogenetically informative proved to be of little value in all analyses. Among those are the number of funicle segments, number of club segments, male funicle pectinate, malar sulcus, coxae color, and scutellum sculpture. Internal characters that were expected to be very informative but performed poorly include dorsal arms of the tentorium, second valvifer fused to third valvulae, and aedeagal sensilla.

The CI of many characters, and consequently the weight assigned to them, was found to vary between analyses. For example, character 39, phallobase setation, was highly variable in its CI values but fairly consistent in the RI values. This character received a weight of 21 in Analysis 1 (full data, CI = 0.250, RI = 0.829), a weight of 45 in Analysis 4 (reduced taxa, CI = 0.500, RI = 0.900), and a weight of 100 in Analysis 6 (reduced taxa and characters, CI = 1.000, RI = 1.000). Thus, in three different analyses the weight contributed by this character varied by a factor of 4.7. The difference in CI values can be attributed to the number of steps required for this character on the cladograms from the different analyses. Character 39 underwent eight steps in Analysis 1, four steps in Analysis 4, and only two steps in Analysis 6. Thus, the CI value varied but the RI remained high since this character affected a large number of taxa.

Tracking the information content of each character through a variety of analyses reveals those which are consistently informative, consistently uninformative, or variable according to the dataset used. The results of these analyses also demonstrate that the successive approximations weighting method can produce different results depending on the combination of characters and taxa used. Because the CI for each character may vary between analyses, the corresponding weight assigned to characters may vary, and the iterative sequence of successive approximations will emphasize those differences. This points out the care that must used in drawing conclusions about the information content of characters or the cladograms they produce using a reduced set of characters or taxa.

Discussion of Phylogeny

The phylogeny shown in Figures 441 and 442 represents one of the seven most parsimonious explanations of character states found by using all available data, employing two species of *Syrphophagus* as an outgroup, and without ordering character states. The discussion of phylogeny and conclusions drawn from the analysis will focus on this cladogram because it contains the most information and represents the best working hypothesis of relationships at present. It is possible that using another outgroup or imposing certain ordering of character states would change these results. In addition, as further biological or morphological information concerning *Ethoris*, *Nathismusia*, and *Neapsilophrys* becomes available, their relationships will need to be reassessed. Four subtribes within Copidosomatini are recognized from the phylogenetic analysis, as shown in Fig. 441. The tribe and each subtribe are discussed separately below.

Copidosomatini

Monophyly of Copidosomatini remains best supported by their biology as parasites of non-butterfly Lepidoptera and aculeate Hymenoptera. Despite the number of characters used in the various analyses, no single morphological character emerged that could be used as an autapomorphy to indicate monophyly of the tribe. Morphological support for the tribe rests on the number of digital claws (character 42), with a change from one to two claws between the outgroup and the ingroup. The basal three subtribes, Coelopencyrtina, Parablastotrichina, and Ageniaspidina (except *Zelencyrtus*), all have two claws on each digitus, and the remaining taxa generally have two, three, or four claws.

Use of Lepidoptera or Hymenoptera as a host thus remains the best evidence for monophyly of the tribe. If character 47, host, is plotted on the cladogram shown in Fig. 441 using the ACCTRAN option, the node supporting the ingroup would show aculeate Hymenoptera as host, with a host shift to Lepidoptera in the interval below Nathismusia+ Parablastotrichina+Ageniaspidina+Copidosomatina. However, host information is shown in Fig. 441 using the DELTRAN option, which is believed to be a more realistic assumption because it does not require a host switch from aculeate Hymenoptera to Lepidoptera, but treats these as independent events. Plotting host information using this assumption provides strong support for Parablastotrichina+Ageniaspidina+Copidosomatina and does not assume a lepidopteran host for *Nathismusia*, whose host remains unknown. A correlation between the phylogeny of these three subtribes and the phylogenetic position of their lepidopteran hosts is discussed in the Biology section.

Coelopencyrtina

Trjapitzin (1973b) erected the subtribe Coelopencyrtina to include *Coelopencyrtus* and *Xylencyrtus* and placed the subtribe within Copidosomatini in the belief that these groups are polyembryonic. *Xylencyrtus* was not used in the analysis, but its morphology and biology are very similar to *Coelopencyrtus*. Noyes and Hayat (1984) also stated that species of *Coelopencyrtus* undergo polyembryonic development. However, no cytological or embryological studies have been conducted on members of this subtribe and polyembryony has not been conclusively demonstrated.

Noyes and Hayat (1984) placed *Nathismusia* in Coelopencyrtina with reservation, for the genus was described from a single female. *Coelopencyrtus* and *Nathismusia* did not form a monophyletic lineage in the analysis and membership of *Nathismusia* remains provisional. As further biological or morphological information concerning *Nathismusia* becomes available, its relationships should be reassessed.

Coelopencyrtina is retained for the present as a paraphyletic subtribe composed of *Coelopencyrtus*, *Nathismusia*, and *Xylencyrtus*. No single morphological apomorphy to define this subtribe was found, although *Coelopencyrtus* was consistently supported by the number and arrangement of pores on the digiti (character 44). Monophyly is best supported by biology, as species of *Coelopencyrtus* and *Xylencyrtus* are the only encyrtids known to parasitize aculeate Hymenoptera.

Parablastotrichina+Ageniaspidina+Copidosomatina

This group of subtribes is weakly supported by position of the hypopygium (character 31). The strongest evidence of monophyly is use of Lepidoptera as a host (character 47), which has a single alternate model of state change, as discussed above.

Parablastotrichina

Parablastotrichina is a monophyletic lineage composed of the genus *Parablastothrix*. Monophyly of this group is well supported by the enlarged eyes (character 14), peglike anterior mandibular setae (character 10), and the pectinate male funicle (character 7), as shown in Fig. 441. Placement of *Parablastothrix* as a basal lineage is supported by the presence of the plesiomorphic type of second valvifer spicules (character 36). The wing venation is similar to that of Copidosomatina, especially the square shape formed by the stigmal vein sensilla (character 30). However, some species of *Parablastothrix* are polymorphic for this character. Arrangement of the stigmal vein sensilla in a square may be a consequence of reduced venation and lack of an uncus, for a convergent state is found in *Bothriothorax* and *Paratetracnemoidea*, two genera with extremely reduced venation.

Ageniaspidina+Copidosomatina

Both morphological and biological evidence provide evidence for the monophyly of these two subtribes. A single unambigous character, lack of second valvifer spicules (character 36), supports the monophyly of this clade (Fig. 441). Biologically, these two groups are the only confirmed polyembryonic, egg-larval parasites of Lepidoptera, as discussed below in the Biology section.

Ageniaspidina

Ageniaspidina is a monophyletic subtribe composed two distinct clades: *Ageniaspis*, *Holcothorax*, and *Paraleurocerus*, and a sister clade composed of *Ethoris* and *Zelencyrtus*. Monophyly of the subtribe is based on the elongate postmarginal vein (character 27).

Paraleurocerus+Holcothorax+Ageniaspis is supported by loss of the dorsal tentorial arms (character 12), an interrupted linea calva (character 28), and divided sternites (character 33). The divided sternites are also found in *Copidosomopsis*, a member of Copidosomatina.

Monophyly of *Ethoris+Zelencyrtus* is based on the longer middle tooth of the mandible (character 9). However, nothing is known about the biology of these genera, and males are unknown for *Ethoris*. Noyes and Hayat (1984) placed *Ethoris* in Ageniaspidina with some reservation, and its membership in the tribe remains provisional. Noyes (1988b) placed *Zelencyrtus* in Copidosomatina, however, the elongate postmarginal vein and shape of the stigmal vein sensilla (Fig. 16) are much more similar to those of Ageniaspidina (Fig. 15). Though length and shape of the parameres and digiti were not used in the analysis, the male genitalia of *Zelencyrtus* (Fig. 17) is very similar to that of other ageniaspidines (Fig. 9).

Copidosomatina

Copidosomatina is a monophyletic subtribe comprised of *Copidosoma*, *Copidosomopsis*, and *Neapsilophrys*. *Apsilophrys*, *Paralitomastix*, and *Raffaellia* were found to be indistinguishable from, or merely derived forms, of *Copidosoma* and are discussed below.

Monophyly of the largest subtribe is supported by enlargement of the anterior mandibular setae (character 10) and arrangement of the stigmal vein sensilla in a square pattern (character 30) (Fig. 441). The enlarged anterior mandibular setae revert to the plesiomorphic state in two species of *Copidosomopsis* and a clade of seven species of *Copidosoma* that parasitize Noctuidae. The square pattern of stigmal vein sensilla is reversed in *Neapsilophrys* and also is present as a polymorphism in *Parablastothrix*.

Copidosomopsis is well supported by the extreme reduction of the postmarginal vein (character 27) and divided sternites (character 33), though similar sternites are found in ageniaspidines.

Copidosoma emerged as paraphyletic with a number of well-defined clades. *Copidosoma chalconotum* and *C. cervius*, two similar species, usually occupied a basal position in Copidosomatina well-separated from other species in the genus (Fig. 441).

The clade containing *Copidosoma pseudoinnocuellae* as its basal member (Fig. 442) is supported by bladelike posterior mandibular setae (character 11) and the presence of one pair of aedeagal sensilla (character 46), two character states which are homoplastic. The relationship of *C. pseudoinnocuellae* to other taxa shifted frequently between the analyses, and its position must be viewed as tenuous. In contrast, the remainder of that clade, which

is composed of seven *Copidosoma* species that parasitize Noctuidae (*C. noyesi* through *C. confusa*) and its sister group, *Paralitomastix+Raffaellia*, are strongly supported by the unique arrangement of the second valvifer spicules (character 36) (Fig. 442). Though support for this group of *Copidosoma* species rests on the reversal of an interrupted linea calva (character 28), relationships within that clade are extremely well supported by the strongly oblique male club apex (character 6), strong reduction in the anterior and middle mandibular teeth (character 9), the presence of one pore near the apex of each digitus (character 44), and presence of a phallobase flange (character 40) and aedeagal hooks (character 45).

Morphological support for *Paralitomastix+Raffaellia* is weak and based upon position of the digital claws (character 43). *Paralitomastix* has been distinguished from *Copidosoma* on the basis of the white color of the proximal funicle segments, and to a lesser extent, on the elongate sculpture of the scutellum. However, other species of *Copidosoma* have similar sculpture on the scutellum, and except for the white color of the funicle segments, *Paralitomastix* is indistinguishable from *Copidosoma*. Support for *Raffaellia* rests mainly on the very short marginal vein (character 26), a feature not unique to the genus. The habitus of *Raffaellia* is that of a very small *Copidosoma* with five funicular segments, and no unique character supports this taxon. The minor differences between *Copidosoma* and *Paralitomastix* and *Raffaellia* do not warrant separation of the latter two genera as distinct. *Paralitomastix* and *Raffaellia* will be treated as junior synonyms of *Copidosoma* and treated as species groups without nomenclatural standing in the chapter concerning *Copidosoma*.

The remaining taxa are united by the first valvifer with a medial articulation to the outer plate (character 35) and very setose phallobase (character 39), although the articulation of the first valvifer represents a reversal (Fig. 442). The first species in this group, *Copidosoma deceptor*, was similar to *C. pseudoinnocuellae* in that it was unstable through the analyses. *Copidosoma deceptor* shares two strong plesiomorphies, divided sternites (character 33) and lack of second valvifer spicules (character 36), with *Copidosomopsis* and most Ageniaspidina.

The remaining large clade of 26 species, from *Copidosoma mutabilis* to *C. beckeri* (Fig. 442), is strongly supported by the arrangement of the second valvifer spicules in longitudinal rows (character 36). The most derived clade is supported by a median lobe on sternites 5-6 (character 33). Although some lineages appear very stable in this group, their support is often based on reversals or homoplastic characters.

Apsilophrys consistently emerged in the group of derived *Copidosoma* species with elevated axillae (character 18) (Fig. 442). *Apsilophrys* has been distinguished from

Copidosoma on the basis of white or silvery setae on the mesoscutum, elevated axillae, the sculpture of the scutellum forming a whorled pattern, and a longer marginal vein. The white setae are most prominent on specimens from the Neotropics that have the entire mesoscutum shiny green. Nearctic forms with the anterior portion of the mesoscutum dark brown and the posterior portion shiny green have dark setae anteriorly and light setae posteriorly, so the setae color may be an artifact of cuticular color. A number of species of *Copidosoma* have been found to have elevated axillae. Examination of the whorled sculpture shows it is elongate reticulate sculpture that curves around the posterior end of the scutellum, instead of running only longitudinally as in *Copidosoma*.

A male representing an intermediate form from the southern Mexican state of Guerrero has the elongate reticulate sculpture on the scutellum that is common in *Copidosoma*, but with genitalia that is typical of *Apsilophrys*. Other specimens examined from the southwestern U.S. have the wing venation typical of *Apsilophrys*, but unlike the latter the hypopygium does not reach the apex of the metasoma and the ovipositor is barely exserted. Although *Apsilophrys*, described from the Neotropics, has a longer marginal vein than Neotropical species of *Copidosoma*, that difference disappears when compared to species of *Copidosoma* from other regions. *Apsilophrys* may represent a distinct lineage within *Copidosoma*, but there are no differences that justify separation of these genera. *Apsilophrys* will be treated as a junior synonym of *Copidosoma* and as a species group without nomenclatural standing.

Neapsilophrys was placed in Ageniaspidina by Noyes (1980) who noted that it appeared intermediate between Ageniaspidina and Copidosomatina in its characters. This genus is an excellent example of the conflicting evidence that can be provided by strong characters. Though it resembles Ageniaspidina in having an elongate postmarginal vein (character 27) and the stigmal vein sensilla in a non-square pattern (character 30), *Neapsilophrys* differs from most ageniaspidines in having dorsal tentorial arms (character 12), enlarged anterior mandibular setae (character 10), and the first valvifer articulations (character 35) and second valvifer spicules (character 36) of derived copidosomatines. Because both males and biological information are unknown for *Neapsilophrys*, it is premature to synonymize the genus with *Copidosoma*, although retaining this group renders *Copidosoma* paraphyletic. The relationship of *Neapsilophrys* should be reassessed as further information becomes available.

Conclusions

A number of morphological characters were investigated for members of the tribe Copidosomatini, and many were found to be homoplastic or marginally informative. Several conservative and phylogenetically useful characters were revealed through different analyses, and these support the monophyly of a number of clades. Various combinations of taxa or characters subjected to successive approximations produced different results. Reducing the number of taxa had the least effect compared to using the full dataset, and reducing the number of both characters and taxa had the strongest effect. Based on the analysis of the full dataset, four subtribes are recognized, although one of thses, Coelopencyrtina, is paraphyletic. Ageniaspidina is expanded to include *Zelencyrtus* and Copidosomatina now includes *Neapsilophrys*. A number of distinct lineages in *Copidosoma* are recognized. Three genera, *Apsilophrys*, *Paralitomastix*, and *Raffaellia*, are synonymized with *Copidosoma*.

BIOLOGY

Host or life history information is available for 8 of the 12 genera included in the tribe Copidosomatini. Members of the Parablastotrichina, Ageniaspidina, and Copidosomatina parasitize Lepidoptera, but only Ageniaspidina and Copidosomatina have been demonstrated to be polyembryonic.

Little is known of the biology of Parablastotrichina other than host information. Available rearing records indicate that a single individual of a species of *Parablastothrix* emerges from the cocoon of its host (Miller 1965, Khan 1983, R. Zuparko, pers. comm.). However, this does not completely eliminate the possibility that *Parablastothrix* is polyembryonic. Polyembryonic development can occur with the emergence of a single adult parasite, as in *Macrocentrus ancylivorus* Rohwer (Hymenoptera: Braconidae), a species which is parasitic in many of the same lepidopteran genera as copidosomatines (Daniel 1932, Marsh 1979). The question of polyembryony in Parablastotrichina remains open until an embryological study is done.

The polyembryonic development is similar for the species of Ageniaspidina and Copidosomatina which have been studied. All species are egg-larval parasites, with one or two parasite eggs oviposited into each host egg and the adult parasites emerging from the terminal larval instar of the host. If one egg is deposited, single-sex broods of male or female result. In a two-egg oviposition, the first egg is a diploid female and the second is a haploid male, resulting in a mixed brood that is highly female-biased (Strand 1989a). Oviposition into the egg stage is an important step in eluding host defenses, for eggs lack cellular defense mechanisms (Strand 1986).

Eggs are the typical encyrtiform type, but are very small and lack yolk material (Ivanova-Kasas 1972). After the host egg hatches, normal host larval development occurs up to the final instar. As the host develops, the parasite egg undergoes cleavage to produce an aggregate of blastomeres and membranes referred to as a polygerm. Host tracheae readily permeate the polygerm, and a layer of host tissue envelopes it. The development of membranes around the polygerm and adherance of a layer of host tissue to it prevents encapsulation and melanization, a common defense in larvae (Salt 1968). In *Copidosoma floridanum*, the polygerm of female broods is suspended in the host's thorax, but the male polygerm is located in the host's abdomen (Grbic et al. 1992). The polygerm divides repeatedly to form clusters of grape-like morulae. After the host larva molts to its final instar, the parasite larvae disassociate from the morulae and feed within the host, completely consuming all internal tissues. Larvae of *Ageniaspis fusicollis* and *Copidosoma*

floridanum have two instars (Nénon 1978, Strand 1989b), but those of *Copidosomopsis tanytmemus* may have four (Cruz 1986a). Parasitized caterpillars feed longer than normal in the terminal instar and are frequently larger than unparasitized caterpillars (Fitzgerald and Simeone 1971, Strand 1989b, Byers et al. 1993). Some host species are able to spin a cocoon in preparation of pupation but die soon thereafter (Doutt 1947).

The parasites pupate within the host integument inside individual chambers and adult wasps emerge en masse or within hours of each other. Depending on the species, offspring from a single copidosomatine egg may number from several to hundreds (Silvestri 1906, Doutt 1947, Fitzgerald and Simeone 1971, Cruz 1986a, Wang and Laing 1989) to well over 1000 (Silvestri 1906, Patterson 1921, Leiby 1922, Stoner and Weeks 1976, Byers et al. 1993). Adult females are proovigenic and immediately mate or begin searching for hosts (Leiby 1922, Cruz 1986a, Strand 1989a, b). Strand (1989c) detailed the oviposition behavior of *C. floridanum*. *Copidosoma floridanum* females (reported as *C. truncatellum*) contain 40-50 eggs each and oviposit most of their eggs within 24 hours of emergence (Stoner and Weeks 1976). Adult longevity is variable and dependent on factors such as temperature and food supply. Adults of *Copidosomopsis tanytmemus* live 10 days and can survive to 25 days when fed honey and water (Cruz 1986a). *Copidosoma bakeri* lives 12-20 days but can extend its life span to 2 months if supplied with honey and water (Cheng 1977, Byers et al. 1993).

Certain morulae give rise to larvae variously termed asexual, teratoid, or precocious. Such larvae are found only in polyembryonic encyrtids and are reported from species of *Copidosoma* (Silvestri 1906, Leiby 1922, Doutt 1947), *Copidosomopsis* (Cruz 1986a), and *Paraleurocerus* (Fitzgerald and Simeone 1971). Precocious larvae have not been reported in species of *Ageniaspis* (Nénon 1978) or *Holcothorax* (Wang and Laing 1989). These larvae lack respiratory, circulatory, and excretory systems but they are mobile and possess well-developed mandibles, and digestive, muscular, and nervous systems (Silvestri 1937). They enter the host hemolymph before the normal larvae, but begin to die as their normal siblings exit the morulae. Cruz (1981, 1986b) hypothesized that precocious larvae function as defender morphs against interspecific parasites by physically attacking them, but Strand et al. (1990b) found no direct evidence of this. Grbic et al. (1992) reported that precocious larvae were usually absent in male broods of *Copidosoma floridanum*, and that precocious larvae derived from the female polygerm preferentially attack and kill male larvae in mixed broods. This destruction of male siblings provides an explanation for the reduced number of males found in mixed broods. It is possible that the

precocious larvae function to remove all competitors to the developing female larvae, whether the competitor is a male sibling or another species of parasite.

Coelopencyrtina are the only Encyrtidae known to use aculeate Hymenoptera as hosts. No biological information other than host records and number of offspring per host is available for species of *Coelopencyrtus* and *Xylencyrtus*. Species of *Coelopencyrtus* have been reared from mature larvae and prepupae of *Odynerus* (Vespidae: Eumeninae), *Hylaeus* (Colletidae: Hylaeinae), and *Xylocopa* (Anthophoridae: Xylocopinae) (Tachikawa 1981). Species of *Xylencyrtus* have been reared from *Allodape* and *Allodapula* (Anthophoridae: Xylocopinae) (Annecke 1968). Species of these host genera nest in the ground, in wood galleries, or cavities in wood and other plant material.

Trjapitzin (1973b) placed *Coelopencyrtus* and *Xylencyrtus* in Copidosomatini in the belief they are polyembryonic, and Noyes and Hayat (1984) also stated that *Coelopencytus* develops polyembryonically. Reports of polyembryony in these genera are based on the oviposition of a single female parasite producing multiple offspring from each host individual, with the lowest recorded number of progeny being 4 and the highest 167 (Timberlake 1919, Krombein 1967, Annecke 1968). It is unknown which stage of the host is attacked, but Krombein (1967) believed a female *Coelopencyrtus* oviposited into the mature host larva. Adult parasites emerge from the last larval instar or prepupa.

Examination of 25 rearing records from a number of sources in the literature shows that 20 broods contained both female and male offspring, with a variable number of offspring and an often, but not always, female-biased sex ratio. Examples of small broods and the female:male sex ratio per brood are 10:1, 11:9, and 14:8. Other broods may produce females and males in numbers and ratios such as 38:3, 47:46, 68:3, 76:7, and 125:2. Strongly female-biased sex ratios are similar to those found in Ageniaspidina and Copidosomatina, in which polyembryony has been demonstrated. Unlike these two subtribes, however, many mixed broods within Coelopencyrtina do show roughly equal numbers of males and female, and oviposition appears to be in the host larva, not the egg. The possibility exists that these genera contain gregarious parasites, and because no embryological studies have been conducted, the question of polyembryony in Coelopencyrtina remains unanswered. If shown to be polyembryonic, oviposition into a different host stage and the unusual sex ratios in mixed broods may indicate the evolution of polyembryony in this group independent of the Lepidoptera-parasitizing members of the tribe.

In Hymenoptera, polyembryony has been demonstrated in four parasitic families: one genus of Braconidae, one genus of Platygasteridae, one species of Dryinidae, and the

species of Encyrtidae within Ageniaspidina and Copidosomatina (Strand et al. 1991). Two species of Encyrtidae outside Copidosomatini have been reported, but not conclusively demonstrated, to be polyembryonic. A species of *Epiencyrtus* Ashmead has been reared in Costa Rica from a species of *Enicospilus* Stephens (Ichneumonidae) parasitizing a saturniid caterpillar. More than 1,000 individual parasites were reared from the prepupa of the ichneumonid (D. Janzen, pers. comm.). However, host remains were not retained and this evidence remains anecdotal.

Voynovich and Sugonyayev (1994) reported the occurrence of polyembryony in another encyrtid, *Pseudorhopus testaceus* Ratzeburg, a parasite of *Physokermes hemicryphus* Dalman (Homoptera: Coccidae). They found *P. testaceous* oviposited 1-3 eggs into each host, with a mean of 27 adult parasites emerging from each host. Because *Epiencyrtus* and *Pseudorhopus* are not related to Copidosomatini, if shown conclusively to be polyembryonic this would indicate that polyembryony must have evolved independently at least three times in Encyrtidae.

Lepidoptera Host Relationships

Members of Parablastotrichina, Ageniaspidina, and Copidosomatina all parasitize non-butterfly Lepidoptera. While host specificity in these subtribes is variable, there is a distinct correlation between the phylogeny of the subtribes and the phylogenetic position of their lepidopteran hosts (Table 6). The classification of Lepidoptera follows that of Hodges et al. (1983). There is disagreement among Lepidoptera workers whether the Monotrysia, a group of plesiomorphic families frequently listed as a suborder, represent a monophyletic taxon (Davis 1986, Nielsen and Common 1991).

Parablastothrix, the most basal member of Copidosomatini that attacks Lepidoptera, parasitizes leaf miners in the families Nepticulidae, Heliozelidae, Lyonetiidae, and Gracillariidae (Green 1979, Tachikawa 1981, Khan 1983). The first two families belong to separate superfamilies in the primitive suborder Monotrysia, and Lyonetiidae and Gracillariidae are members of the Tineoidea, the most basal superfamily of the more advanced suborder Ditrysia.

Within Ageniaspidina, two genera have restricted host ranges. *Holcothorax* is similar to *Parablastothrix* in that its species parasitize the plesiomorphic families Nepticulidae and Gracillariidae, while species of *Paraleurocerus* utilize only Gracillariidae. In contrast, *Ageniaspis* has expanded its host range to encompass seven families found across four disparate superfamilies: Tineidae, Lyonetiidae, and Gracillariidae (Tineoidea);

Yponomeutidae and Argyresthiidae (Yponomeutoidea); Tortricidae (Tortricoidea); and Pterophoridae (Pterophoroidea).

Species of Copidosomatina have the widest aggregate host range. For example, species of *Copidosoma* species utilize 13 families distributed over 7 superfamilies (Table 6), although hosts for a number of species remain unknown. In contrast to Parablastotrichina and Ageniaspidina, none of the species in Copidosomatina is known to parasitize families within Monotrysia or Tineoidea. Although this most derived subtribe of Copidosomatini does not use the most plesiomorphic host taxa, it is difficult to generalize further about host taxa because species of *Copidosoma* are so variable. Many Nearctic species of *Copidosoma* use Gelechiidae, Tortricidae, or both families as hosts. Trjapitzin (1989) provides host information for more than 30 Palearctic species of *Copidosoma* and lists the most common host families as Coleophoridae, Gelechiidae, and Tortricidae. The large clade that includes *C. floridanum* and *C. truncatellum* is the only group of species that attacks Noctuidae.

Some species of *Copidosoma* may be family-specific, other species may utilize a few host species ffom a few families, and the most polyphagous species each attack a number of host species in a number of families. For example, *Copidosoma desantisi* and *C. koehleri* are seemingly monophagous, as they have been reared from a single host, the gelechiid *Phthorimaea operculella* (Zell.). *Copidosoma celaenae* is restricted to Noctuidae but parasitizes 15 species of 10 noctuid genera. One of the most polyphagous species, *C. deceptor*, parasitizes 23 species found in four families, with each of those families representing a different superfamily.

Use of Lepidoptera as hosts and the development and success of polyembryony in Copidosomatini can be used to support a hypothesis of coevolution if examined in the light of the general correspondence in phylogenetic relationship between subtribes and their hosts. The complex of hormonal interactions between the host and the parasite that permits an intimate developmental synchronicity and host regulation (Strand 1989b, Strand et al. 1990a) point to a long association.

The earliest hymenopterans appeared in the fossil record during the Middle Triassic (Gauld and Bolton 1988) and chalcidoid families were well-established and differentiated by the Cretaceous (Darling and Sharkey 1990). The oldest lepidopteran fossil is known from the Lower Jurassic (Shields 1988), and Lepidoptera had differentiated enough that nepticulid leaf mines are known from the Upper Cretaceous (Nieukerken 1986).

Given the age and phylogenetic position of the taxa involved, it is hypothesized that an ancestral copidosomatine underwent a host shift to begin successfully parasitizing a leaf-

mining monotrysian Lepidoptera. If *Parablastothrix* proves to develop by monoembryony instead of polyembryony, use of Lepidoptera as hosts may have been a prerequisite to the development of polyembryony in these parasites. Polyembryony may have arisen after the ancestral copidosomatine was already established on a lepidoperan host.

Species of the basal subtribe, Parablastotrichina, continue to utilize plesiomorphic families of Lepidoptera, as do those of two genera of Ageniaspidina. Copidosomatina, the most derived subtribe, have expanded their host range into a number of families, but do not parasitize the more plesiomorphic ones. Species of *Copidosoma* have undergone a dramatic radiation and lineages within the genus have shifted to more derived families such as Geometridae and Noctuidae, but little overall congruence with a phylogenetic pattern of higher Lepidoptera is apparent. It appears that the evolution of polyembryony and associated adaptations have allowed *Copidosoma* to undergo this radiation and exploit a wide range of Lepidoptera families as hosts.

It is interesting that some prominent superfamilies of Lepidoptera, such as Papilionoidea, Bombycoidea, and Sphingoidea, are not parasitized by copidosomatines. Relatively few genera of Encyrtidae attack these families of Lepidoptera. It is unknown whether this can be attributed to ecological or physiological reasons. The most obvious difference between the host families used by the tribe and the butterflies and larger moths lies in their feeding habits. Host families such as Nepticulidae, Gracillariidae, Gelechiidae, Tortricidae, Pyralidae, and others are leaf miners, leaf rollers, leaf tiers, gall makers, or otherwise feed in a concealed or protected environment. There are a few exceptions to this rule, as some species of *Copidosoma* utilize exposed feeders such as inchworms (Geometridae) and loopers (Noctuidae: Plusiinae). In contrast, butterflies and larger moths such as saturniids, lasiocampids, sphingids, and arctiids tend to feed in more exposed situations. While feeding in exposed situations may be correlated with sophisticated chemical defenses, it is unknown whether the chemical defenses themselves or the exposed feeding habit has prevented utilization of these families as hosts by copidosomatines.

It should be noted that species of the few genera of encyrtids that do attack these families, such as *Aphycoideus*, *Echrodryinus*, *Epiencyrtus*, *Hesperencyrtus*, *Leurocerus*, and *Ooencyrtus*, are egg parasites, pupal parasites, or hyperparasites (Noyes 1980, Tachikawa 1981, Noyes and Hayat 1984).

Conclusions

The four subtribes that constitute Copidosomatini show distinct differences in biologies. While the biologies of species of Coelopencyrtina and Parablastotrichina remain

largely unknown, those of Ageniaspidina and Copidosomatina have been detailed by a number of workers. A congruence between the phylogeny of Parablastotrichina, Ageniaspidina, and Copidosomatina and of Lepidoptera (Table 6) suggests that ancestral copidosomatines utilized leaf-mining monotrysian Lepidoptera. Species of Parablastotrichina and two genera of Ageniaspidina continue to utilize more plesiomorphic hosts. Species of *Ageniaspis* and Copidosomatini have expanded their host ranges to more derived families of Lepidoptera. There is some evidence of polyembryony in two genera of Encyrtidae outside of Copidosomatini. Demonstration of polyembryony in these genera would indicate the multiple evolution of this trait in Encyrtidae.

REVISION OF NEARCTIC *COPIDOSOMA* RATZEBURG

Although the European species of *Copidosoma* are well known and keys to species have been available for over 100 years, the Nearctic fauna has been poorly studied and keys to species have not been available. The following revision includes keys to the 57 species of *Copidosoma* found in the Nearctic, descriptions of 35 new species, and redescriptions of 13 additional species.

All available type specimens were examined. However, several type specimens representing genera that are now considered to be junior synonyms of *Copidosoma* were not available for study. Type specimens from Ratzeburg and Ishii have been destroyed and other specimens, particularly Girault's Australian material, were not available for loan. J. Heraty kindly illustrated a paratype specimen of *Raffaellia sidneyi* while in Australia. In other cases, original descriptions were checked or specimens identified by reputable workers were examined. In a few instances, the synonymies must be accepted on the faith that a previous worker was correct.

Copidosoma Ratzeburg, 1844

Copidosoma Ratzeburg, 1844: 157. Type species: *Copidosoma boucheanum* Ratzeburg, by monotypy. [presumed lost, type not examined].

Litomastix Thomson, 1876: 171. Type species: *Encyrtus chalconotus* Dalman, designated by Ashmead (1900). [SMNH, type not examined]. Synonymized by Peck (1951).

Pentacnemus Howard, 1892: 366. Type species: *Pentacnemus bucculatricis* Howard, by monotypy. [USNM, examined]. Synonymized with *Litomastix* by Trjapitzin and Gordh (1978a). Synonymized by Noyes and Hayat (1984).

Berecyntus Howard, 1898: 237. Type species: *Berecyntus bakeri* Howard, by monotypy. [USNM, examined]. Synonymized by Girault (1920).

Parapsilophrys Howard, 1898: 233. Type species: *Parapsilophrys gelechiae* Howard, by monotypy. [USNM, examined]. Synonymized by Trjapitzin (1972).

Pseudencyrtella Girault, 1913: 113. Type species: *Pseudencyrtella fasciata* Girault, by original designation. [SAMA, type not examined]. Synonymized by Noyes and Hayat (1984).

Zaomencyrtus Girault, 1915: 107. Type species: *Zaomencyrtus lepidopterophagus* Girault, by original designation. [NMVM, type not examined]. Synonymized by Noyes and Hayat (1984).

Paracaenocercus Girault, 1915: 116. Type species: *Paracaenocercus perseverans* Girault, by monotypy. [QMB, type not examined]. Synonymized by Noyes and Hayat (1984).

Paracopidosomopsis Girault, 1916: 49. Type species: *Berecyntus floridanus* Ashmead, by original designation. [USNM, examined]. Synonymized by Peck (1951).

Verdunia Mercet, 1917: 203. Type species: *Verdunia gloriosa* Mercet, by original designation. [MNM, examined]. Synonymized by Mercet (1921).

Litomastiellus Mercet, 1921: 443. Type species: *Litomastix claviger* Mercet, designated by Peck (1951). [MNM, examined]. Synonymized by Peck (1951).

Limastotix Mercet, 1921: 443. Type species: *Litomastix hispanicus* Mercet, by monotypy. [MNM, examined]. Synonymized by Peck (1951).

Paralitomastix Mercet, 1921: 438. Type species: *Encyrtus varicornis* Nees, by monotypy. [type not examined]. **New synonomy.**

Angeliconana Girault, 1922a: 150. Type species: *Angeliconana eja* Girault, by monotypy. [type not examined]. Synonymized by Noyes and Hayat (1984).

Raffaellia Girault, 1922b: 205. Type species: *Raffaellia sidneyi* Girault, by monotypy. [QMB, type not examined]. **New synonomy.**

Parasteropaeus Girault, 1923: 49. Type species: *Parasteropaeus lotae* Girault, by monotypy. [QMB, type not examined]. Synonymized by Noyes and Hayat (1984).

Neocopidosoma Ishii, 1923: 101. Type species: *Neocopidosoma komabae* Ishii, by original designation. [type not examined]. Synonymized by Ishii (1928).

Mesocopidosomyiia Girault, 1925: 93. Type species: *Mesocopidosomyiia variventris* Girault, by monotypy. [type not examined]. Synonymized by Noyes and Hayat (1984).

Mesencyrtus Timberlake, 1941: 228. Type species: *Mesencyrtus insularis* Timberlake, by original designation. [type not examined]. Synonymized by Noyes and Hayat (1984).

Berecyntiscus Ghesquière, 1946: 368. Unnecessary replacement name for *Berecyntus* Howard.

Raffaellisca Ghesquière, 1946: 369. Unnecessary replacement name for *Raffaellia* Girault. Synonymized with *Raffaellia* by Noyes and Hayat (1984).

Arrenoclavus Doutt, 1948: 145. Type species: *Copidosoma koehleri* Blanchard, by original designation. [UNLP, type not examined]. Synonymized by Peck (1951).

Apsilophrys De Santis, 1963: 296. Type species: *Copidosoma oeceticola* De Santis, by monotypy. [UNLP, examined]. **New synonomy.**

Copidosoma was described by Ratzeburg in 1844, and 13 species were known from Europe by 1876 (Mayr 1876). Howard (1885) described the first Nearctic species. Although Peck (1951) synonymized *Litomastix* with *Copidosoma*, European workers (Hoffer 1955, 1970a, b, Erdös and Novicky 1955, Peck et al. 1964, Trjapitizin 1973b, 1987) continued to regard these names as distinct because differences in Palearctic species were clear enough to separate the two. However, combinations of characters for species from other regions of the world make clear separation of species assigned to these genera difficult to impossible. Noyes and Hayat (1984) treated the two genera as the same, and Trjapitizin (1989) broke with European tradition by recognizing the Palearctic species of *Litomastix* as belonging to *Copidosoma*.

As discussed in the Phylogenetic Analysis chapter, species of three genera were found to be phylogenetically indistinguishable from species of *Copidosoma*. *Paralitomastix* has been distinguished from *Copidosoma* mainly on the basis of the white color of the proximal funicular segments. In all other respects, including genitalia, biology, and hosts, species under these two names are identical and there is no justification for separating them. Species of *Raffaellia* and *Copidosoma* from Australia can be separated only by the number of funicular segments, but species of *Copidosoma* from other regions can have five funicular segments. Although the host and biology are unknown, in all morphological respects species of*Raffaellia* are identical to those of *Copidosoma* and the two names cannot be maintained as separate genera. Species of *Apsilophrys* have been distinguished from *Copidosoma* on the basis of several characters discussed earlier. Although these differences can be used to separate species assigned to the two names in the Neotropics, they do not stand when compared to species of *Copidosoma* from other regions. *Apsilophrys* may represent a distinct lineage within *Copidosoma*, but there are no differences that justify their separation.

Diagnosis. Species of *Copidosoma* are distinguished from other genera of Encyrtidae by the following characters: occipital margin sharp, rarely slightly rounded, malar sulcus absent, toruli usually separated from mouth margin by their length or less (Fig. 402), mandible with 3 subequal teeth (Fig. 406) or with the dorsal tooth greatly reduced and the ventral tooth longest (Fig. 405), stigmal vein without an uncus and with the sensilla arranged in a square (Fig. 6), and paratergites absent.

Other Encyrtinae that may be confused with *Copidosoma* are *Copidosomopsis*, *Bothriothorax*, *Ooencyrtus*, *Parablastothrix*, and *Paratetracnemoidea*. *Copidosomopsis* differs in having only 5 funicular segments (uncommon in *Copidosoma*), divided sternites

(Fig. 13, present in only 1 species of *Copidosoma*), the claws of the male digiti are not inserted in sockets (Fig. 436), and New World species have the propodeal spiracles elongate (Fig. 428). Species of *Bothriothorax*, *Parablastothrix*, and *Paratetracnemoidea* may have similar wing venation or the sensilla of the stigmal vein arranged in a square, but *Bothriothorax* has conspicuous piliferous punctures on the frontovertex and mesosoma, *Parablastothrix* has enlarged eyes and a reduced malar space (Fig. 401), and *Paratetracnemoidea* has the interantennal prominence strongly produced into a spatulate projection. Species of *Ooencyrtus* have the stigmal vein sensilla not arranged in a square, the axillae separated by the mesoscutum, and the mandibles nearly always with one tooth and a broad truncation.

Female. Length 0.9-3.2 mm, excluding ovipositor, but most Nearctic species are 1-2 mm. Body dark brown to black or green with brassy or coppery blue and purple highlights; forewing varying from completely hyaline, hyaline with an infuscate area around marginal and stigmal veins, to completely but lightly infuscate.

Occipital margin nearly always sharp; frontovertex with reticulate sculpture; toruli separated from mouth margin by their length or less; scape cylindrical, funicle 6-segmented, rarely 5-segmented, the segments varying from transverse to much longer than broad, club unsegmented or 3-segmented, occasionally 2-segmented, club apex varying from rounded to strongly oblique; malar sulcus absent; mandible with 3 subequal teeth or with the dorsal tooth greatly reduced and the ventral tooth longest.

Notaular lines absent; mesoscutum and scutellum usually with reticulate or elongate reticulate, rarely striate, sculpture; axillae meeting, very rarely not, and slightly to greatly elevated above scutellum; linea calva interrupted or not by a dorsal line of setae, marginal vein punctiform to 3-4x longer than broad, stigmal vein without an uncus and with 4 sensilla arranged in a square, postmarginal vein equal to or shorter than stigmal vein.

Length of metasoma varying from subequal to mesosoma to several times longer; paratergites absent; hypopygium reaching from middle 1/3 of metasoma to slightly past apex; ovipositor not exserted to exserted several times length of metasoma.

Male. Similar to female but usually slightly smaller. Toruli usually slightly further from mouth margin, funicle 6-segmented, the segments similar to female or very different, but with setae usually more prominent than in female, pectinate or subpectinate in some species, club unsegmented, rarely 2-segmented; phallobase with at least 6 pairs of elongate

setae, often with 10 or more pairs, occasionally with only 3 pairs, parameres usually well developed, digiti with 2-5 claws, rarely with 1.

Biology. Reared as polyembryonic, egg-larval parasites from species of 13 families of Lepidoptera (Table 2). More complete information is presented in the Biology chapter.

Distribution. Cosmopolitan, but unlike many encyrtids, species diversity of *Copidosoma* appears greatest in the northern latitudes and the genus has a predominantly Holarctic distribution. The Palearctic fauna is well known (Hoffer 1970a, 1970b, 1980, Trjapitzin 1989) and presently contains 114 species. Gordh (1979) listed 11 species present in America north of Mexico but current work shows 57 species present in the Nearctic region. Twenty-nine species are known from the Indo-Pacific region, including Australia and New Zealand (Noyes and Hayat 1984, Noyes 1988b). In contrast, Prinsloo (1983) listed host data for only four Afrotropical species of *Copidosoma* and Noyes (1980) listed only eight species from the Neotropics. It is unknown whether the low number of species from these regions represent natural phenomena or reflect a lack of collection and study of material. Luis De Santis (pers. comm.) believes the Neotropical region has been well-collected for copidosomatines.

Key to females of species of Nearctic *Copidosoma* Ratzeburg

1 Funicle 5-segmented.....2
-- Funicle 6-segmented.....3

2 (1) Scutellum with shallow, elongate reticulate sculpture; postmarginal vein shorter than stigmal vein (Fig. 282); scape tan to light brown and usually lighter than black-brown radicle ..... *C. mutabilis* n. sp.
-- Scutellum with deep striate sculpture in anterior 2/3, posteriorly with shallow reticulate sculpture; postmarginal vein as long as stigmal vein (Fig. 347); radicle and scape dark brown .....*C. rima* n. sp.

3 (1) Club unsegmented.....4
-- Club 2- or 3-segmented.....23

4 (3) All funicular segments longer than broad.....5

-- At least 1 funicular segment quadrate or wider than long 10

5 (4) Apex of club obliquely truncate, sensory area at most 0.7x club length, usually 0.5x or less (as in Fig. 264) 6

-- Apex of club rounded, sensory area varying from 0.8x to entire club length (as in Fig. 204) 8

6 (5) Sensory area of club less than 0.4x club length (Fig. 271); hypopygium reaching less than 0.7x length of metasoma; scutellum green with deep elongate reticulate sculpture (as in Fig. 414)..... ..... *C. melanocerum* (Ashmead)

-- Sensory area of club at least 0.5x club length; hypopygium reaching apex of metasoma; scutellum brown or black with shallow reticulate sculpture..... 7

7 (6) Metasoma elongate, at least 1.8x length of mesosoma; frontovertex relatively flat, head more or less rectangular in dorsal view; midtibia dark brown to black, tan only at base, midtarsi brown to black..... *C. masoni* n. sp. (part)

-- Metasoma and mesosoma subequal in length; frontovertex convex, head forming a semicircle in dorsal view; midtibia brown in middle 1/2, tan-white in proximal and distal 1/4, midtarsi 1-4 tan-white..... ..... *C. bucculatricis* (Howard) (part)

8 (5) Ovipositor exserted at least 0.5x length of metasoma; syntergum completely or partially divided (as in Fig. 160); midtibia entirely orange-yellow or tan..... .....*C. horneri* n. sp.

-- Ovipositor at most slightly exserted; syntergum not divided; midtibia with some dark color..... 9

9 (8) Club narrow and elongate, at least 5x longer than broad and at least 0.9x funicular length (Fig. 245); mesoscutum and scutellum with reticulate sculpture; toruli separated from mouth margin by 0.5x their width..... ..... *C. longiclava* n. sp.

-- Club at most 4x longer than broad and about 0.6x funicular length (Fig. 199); mesoscutum and scutellum with deep elongate reticulate sculpture; toruli separated from mouth margin by 1.5x their width .....

..... *C. grahami* n. sp. (part)

10 (4) Hypopygium reaching apex of metasoma.....11
-- Hypopygium reaching at most 0.8x length of metasoma 14

11 (10) Tegulae white; forecoxa white or tan; sensory area of club extending nearly full length of club (Fig. 29); occipital margin broadly rounded; exserted portion of ovipositor usually lighter in color than metasoma.....
..... *C. auriceps* (Ashmead)
-- Tegulae dark; forecoxa dark; sensory area of club at most 0.6x club length; occipital margin sharp or well defined; exserted portion of ovipositor not lighter than metasoma.....12

12 (11) Metasoma at least 1.8x longer than mesosoma..... *C. masoni* n. sp. (part)
-- Metasoma and mesosoma subequal in length.....13

13 (12) Ovipositor exserted at least 0.3x metasomal length; scutellum with elongate reticulate sculpture; forewing infuscate around marginal and stigmal veins; frontovertex flat, head in lateral view barely wider than eye.....
.....*C. compressa* n. sp.
-- Ovipositor barely exserted; scutellum with reticulate sculpture; forewing hyaline; frontovertex convex, head in lateral view distinctly wider than eye.....
..... *C. bucculatricis* (Howard) (part)

14 (10) Apex of club rounded (Fig. 325) or slightly obliquely truncate (Fig. 183).....15
-- Apex of club strongly obliquely truncate (Fig. 287).....16

15 (14) Apex of club rounded, with sensory area extending nearly entire club length (Fig. 325); axillae greatly elevated above scutellum (as in Fig. 420); linea calva not interrupted by dorsal setae .....*C. pseudocervius* n. sp.
-- Apex of club slightly obliquely truncate, with sensory area extending at most 0.25x club length (Fig. 183); axillae elevated slightly above scutellum (as in Fig. 424); linea calva interrupted by dorsal setae..... *C. globata* n. sp. (part)

16 (14) All coxae white; anterior mouth margin produced into a broad lobe (Fig. 23); anterior metasomal segments white or tan, contrasting with dark posterior segments..... *C. albicoxae* n. sp.

-- At least mid- and hind coxae dark; mouth margin not produced into a broad lobe; metasoma without light segments.....17

17 (16) Linea calva not interrupted by dorsal setae; mandible clearly 3-toothed, although anterior and middle teeth may be shorter than posterior tooth (Fig. 378)..... 18

-- Linea calva interrupted by dorsal setae; mandible appearing 1- or 2-segmented with anterior tooth minute and middle tooth reduced (Fig. 405).....20

18 (17) Club large (Figs. 287, 412), dark brown to black, usually distinctly darker than tan funicle; fore- and midtibiae tan to light brown; forecoxa usually white in distal 1/2; posterior mandibular seta short and bladelike (as in Fig. 406) .... *C. noyesi* n. sp.

-- Club smaller (Figs. 147, 411) and same color as funicular segments; all tibiae dark brown to black, lighter at the apices; forecoxa never with white; posterior mandibular seta not short and bladelike 19

19 (18) First and second funicular segments subequal in width (Figs. 147, 411); stigmal vein shorter than, or subequal in length to, marginal vein (Fig. 150), mesoscutum green, contrasting with purple-black scutellum .... *C. floridanum* (Ashmead)

-- First funicular segment distinctly narrower than second (Fig. 376); stigmal vein longer than marginal vein (Fig. 380); mesoscutum and scutellum similar in color..... *C. truncatellum* (Dalman)

20 (17) Ovipositor exserted 0.15-0.25x length of metasoma and readily visible from above.....21

-- Ovipositor not, or barely exserted, and not visible from above 22

21 (20) Scutellum with deep, elongate reticulate sculpture that is black with purplish reflections; frontovertex black with dull white or purple highlights; posterior margin of hypopygium shallowly emarginate (Fig. 123).....

.....*C. cuproviridis* Springate & Noyes

-- Scutellum with elongate reticulate sculpture that is green with brassy highlights; frontovertex shiny green; posterior margin of hypopygium deeply emarginate (Fig. 115).....*C. confusa* n. sp.

22 (20) Head, mesoscutum, and scutellum shiny green or blue-green; scutellum with elongate reticulate sculpture (Fig. 414).....*C. bakeri* (Howard)

-- Head and scutellum black with purple highlights, contrasting with the green mesoscutum; scutellum with fine elongate reticulate sculpture ....*C. celaenae* Howard

23 (3) Club completely or incompletely 2-segmented.....24

-- Club 3-segmented.....25

24 (23) Club clearly 2-segmented and with sensory area restricted to extreme apex (Fig. 357); mesoscutum and scutellum with reticulate sculpture; axillae greatly elevated above scutellum and with posterior surface shiny; marginal vein punctiform, postmarginal vein absent (Fig. 359)..... .....*C. tamaulipasensis* n. sp.

-- Club incompletely 2-segmented and with sensory area extending 0.8x club length (Fig. 199); mesoscutum and scutellum with elongate reticulate sculpture; axillae only slightly elevated above scutellum; marginal vein longer than broad, postmarginal vein present (Fig. 202)..... .....*C. grahami* n. sp. (part)

25 (23) Sensory area of club restricted to apex of distal segment, extending at most 0.3x club length, septa between club segments vertical, apex of club never strongly obliquely truncate (as in Figs. 103, 365).....26

-- Sensory area always extending at least 0.4x club length, frequently extending to middle club segment, at least 1 septum of club oblique, apex of club variable (as in Figs. 164, 208).....48

26 (25) Forecoxa white, yellow, or with some light color.....27

-- Forecoxa dark in color.....34

27 (26) Scape elongate (Fig. 365), reaching well above ocelli ..... *C. tigrinum* n. sp.
-- Scape not reaching above ocelli 28

28 (27) Linea calva not interrupted by a line of dorsal setae 29
-- Linea calva interrupted by a line of dorsal setae 31

29 (28) Hypopygium reaching at most 0.9x length of metasoma ..... *C. schauffi* n. sp.
-- Hypopygium reaching or exceeding apex of metasoma 30

30 (29) Forewing infuscate around marginal and stigmal veins; marginal vein barely as long as broad (Fig. 104); midfemur with dark brown ring in distal 1/2, remainder white-tan; hind tibia dark brown except for base, hind tarsi dark brown ..... *C. cheranae* n. sp.
-- Forewing hyaline; marginal vein at least twice as long as broad (Fig. 69); midfemur entirely white-tan, without dark ring; hind tibia and at least hind tarsi 1-3 white or tan ..... *C. capsicum* Burks

31 (28) Hypopygium reaching 0.8-0.9x length of metasoma; ovipositor not, or barely, exserted ..... *C. pseudoinnocuellae* n. sp.
-- Hypopygium reaching apex of metasoma; ovipositor exserted at least 0.2x length of metasoma 32

32 (31) Postmarginal vein subequal in length to stigmal vein (Fig. 145); scutellum with elongate reticulate, or nearly striate, sculpture ..... *C. evansi* n. sp.
-- Postmarginal vein shorter than stigmal vein (Fig. 28); scutellum with reticulate sculpture 33

33 (32) Hind femur dark brown, or dark brown in distal 1/2, hind tibia with dark brown area in proximal 1/2; hypopygium simple, without median lobe (Fig. 233); posterior mandibular seta short and bladelike (as in Fig. 406); tegulae dark brown, or yellow in proximal 1/3 with remainder dark brown ..... *C. innocuellae* Barron
-- Hind femur and tibia white or tan; hypopygium with anterior median lobe (Fig. 28); posterior mandibular seta elongate, not bladelike; tegulae never with yellow color ..... *C. alexanderi* n. sp.

34 (26) Apex of club obliquely truncate (Figs. 183, 253).....35
-- Apex of club rounded, pointed, or truncate (Figs. 304, 385).....37

35 (34) At least first three funicular segments white, fourth funicular segment white, tan, or brown, remainder of flagellum dark brown; scutellum with elongate reticulate, almost striate, sculpture that contrasts strongly with the reticulate sculpture of the mesoscutum (Fig. 416).....*C. pyralidis* (Ashmead)
-- All funicular segments and club identical in color, never white; scutellum and mesoscutum with similar reticulate sculpture 36

36 (35) Club 3-segmented, first funicular segment shorter than second, sixth funicular segment longer than broad (Fig. 253); scutellum convex; frontovertex less tha.. 0.5x head width..... *C. lymani* Howard
-- Club incomp[illegible]ly 3-segmented, first and second funicular segments subequal in l[illegible]ngth, sixth funicular segment quadrate or broader than long (Fig. 183); sc[illegible]um relatively flat; frontovertex 0.5x head width .....
..... *C. globata* n. sp. (part)

37 (34) Ovipositor not exserted and not visible from above 38
-- [illegible]positor exserted and readily visible from above.....39

38 (37) [illegible]egment of club widest, remaining segments tapered distally to form a pointed apex (Fig. 304); frontovertex 0.5x or more head width; eye separated from occipital margin by a distance equal to the diameter of 2 facets; scutellum flat..... *C. picra* n. sp.
-- Segments of club subequal in diameter and not tapered (Fig. 361); frontovertex less than 0.5x head width; eye reaching occipital margin; scutellum convex..
..... *C. tejana* n. sp.

39 (37) A[illegible]nicu[illegible]egments at least 4x longer than broad.....40
-- N[illegible] segments 4x longer than broad.....42

40 (39) Marginal vein at least 2x longer than broad (Fig. 387); scutellum with elongate reticulate, or nearly striate, sculpture (as in Fig. 421); linea calva not interrupted by dorsal setae..... *C. vagum* Howard (part)

-- Marginal vein at most 1.5x longer than broad; scutellum with reticulate sculpture (as in Fig. 415); linea calva interrupted by dorsal setae.....41

41 (40) Scape elongate and reaching well above ocelli; epiproct absent..... ..... *C. charisoma* n. sp.

-- Scape not reaching above ocelli; epiproct present..... *C. psephae* n. sp. (part)

42 (39) Cerci inserted in posterior 1/4 of metasoma; eye separated from occipital margin by the width of a posterior ocellus; entire forewing infuscate..... ..... *C. brandysae* n. sp.

-- Cerci inserted in proximal 3/4 of metasoma; eye reaching, or nearly reaching, occipital margin; forewing hyaline, or infuscate areas restricted to base of wing and around marginal and stigmal veins 43

43 (42) Length of postmarginal vein 0.5x or more stigmal vein (Fig. 138).....44

-- Length of postmarginal vein less than 0.5x stigmal vein (Fig. 130).....45

44 (43) First funicular segment shorter than pedicel (Fig. 135); forewing with basal infuscate streak, and infuscate around marginal and stigmal veins; mesoscutum with reticulate sculpture..... *C. desantisi* Annecke & Mynhardt

-- First funicular segment longer than pedicel (Fig. 385); forewing hyaline; mesoscutum with elongate reticulate, or nearly striate, sculpture (as in Fig. 421)..... *C. vagum* Howard (part)

45 (43) Hypopygium not reaching apex of metasoma.....46

-- Hypopygium reaching apex of metasoma.....47

46 (45) Sixth funicular segment subquadrate or slightly longer than broad (Fig. 237); hind tibia dark brown except at base; scutellum with reticulate sculpture that has larger, shallower cells than that of mesoscutum ....*C. koehleri* Blanchard

-- Sixth funicular segment at least 1.5x longer than broad (Fig. 127); hind tibia white or tan in distal 1/4; scutellum with sculpture similar to that of mesoscutum..... *C. deceptor* Miller

47 (45) Forefemur white, or tan with small brown area along inner edge; ovipositor exserted 0.1-0.3x length of metasoma; posterior mandibular seta short and bladelike (as in Fig. 406)..... *C. peckorum* n. sp.

-- Forefemur dark brown, tan only at apex; ovipositor exserted 0.3-0.4x length of metasoma; posterior mandibular seta not short and bladelike..... .... *C. psephae* n. sp. (part)

48 (25) Tegulae light, either white, yellow, or clear, or with proximal 1/2 yellow and remainder dark.....49

-- Tegulae completely dark in color.....53

49 (48) Forecoxa and femur white, yellow, or tan.....50

-- Forecoxa dark in color, forefemur with light or dark color.....51

50 (49) Ovipositor exserted length of metasoma or more; club short (Fig. 204); syntergum not divided; scutellum with reticulate sculpture (Fig. 415); hind tibia dark brown except light area at base..... *C. howardi* replacement name

-- Ovipositor exserted no more than 0.25x length of metasoma; club elongate (Fig. 164); syntergum divided (as in Fig. 160); scutellum with elongate reticulate sculpture; hind tibia white or tan in distal 1/2.....*C. geniculatum* (Dalman)

51 (49) Ovipositor exserted 0.3x or more length of metasoma; scutellum with reticulate sculpture (as in Fig. 415)..... *C. hypenapurpura* n. sp.

-- Ovipositor exserted at most 0.25x length of metasoma; scutellum with elongate reticulate sculpture (as in Fig. 417) 52

52 (51) Tegulae yellow in proximal 1/3, remainder dark; first and second funicular segments equal in length; first club segment wider than second and third, giving club a distinct shape (Fig. 191)..... *C. gnorimoschemae* n. sp.

-- Tegulae white; first funicular segment shorter than second; club segments subequal in diameter (Fig. 175) ..... *C. glandiferellae* Barron & Bisdee

53 (48) Forecoxa white; funicular segments uniform in width (Fig. 309) .... *C. polyporusi* n. sp.

-- Forecoxa dark; funicular segments not uniform in width, proximal segments either wider or narrower than distal segments 54

54 (53) Linea calva not interrupted by dorsal setae; postmarginal vein long (Fig. 84)..... 55

-- Linea calva interrupted by dorsal setae; postmarginal vein shorter.....56

55 (54) First funicular segment 1.5-2x longer than broad, shorter than pedicel (Fig. 80); hypopygium with posterior emargination (Fig. 82); body length 1.3-1.6 mm..... *C. cervius* (Walker)

-- First funicular segment 2.5-3x longer than broad, longer than pedicel (Fig. 87); hypopygium without posterior emargination (Fig. 92); body length 1.8-2 mm..... *C. chalconotus* (Dalman)

56 (54) Sensory area of club restricted to ventral surface of apical segment, giving club distinctive shape (Fig. 4); mesoscutum and scutellum with reticulate sculpture (as in Fig. 413); syntergum not divided.....57

-- Sensory area of club extending along ventral surface of middle and apical segments (Fig. 155); mesoscutum and scutellum with deep elongate reticulate sculpture (Figs. 417-418); syntergum partially or completely divided (Fig. 160).....59

57 (56) Scape tan, contrasting with the brown or dark brown flagellum; fore- and midfemora tan..... *C. incisum* n. sp.

-- Scape with some dark color; fore- and midfemora with some dark color.....58

58 (57) Ovipositor exserted 0.3-0.5x length of metasoma; hind tibia tan; hypopygium bilobed anteriorly (Fig. 49); metasomal sternites 5-6 with narrow anterior lobe (Fig. 48)..... *C. beckeri* n. sp.

-- Ovipositor slightly exserted; hind tibia dark brown at least in proximal 1/2; hypopygium with broad anterior lobe (Fig. 397); metasomal sternites 5-6 incised anteriorly (Fig. 396) ..... *C. whartoni* n. sp.

59 (56) Club not distinctly widest at junction of first and second segments, dorsal and ventral surfaces of club more or less parallel (Fig. 370).....60

-- Club distinctly widest at junction of first and second segments, dorsal and ventral surfaces of club not parallel (Fig. 155) 61

60 (59) First funicular segment shorter than either pedicel and second funicular segment (Fig. 370); frontovertex and scutellum nearly black with purple reflections that contrast with the green mesoscutum; foretibia and at least distal 1/2 of hind tibia tan .....*C. timberlakei* n. sp.

-- First funicular segment equal in length to both pedicel and second funicle segment (Fig. 261); frontovertex and mesoscutum nearly black with purple highlights that contrast with the green scutellum; fore- and hind tibiae dark brown.....*C. masneri* n. sp.

61 (59) Forefemur and tibia and midfemur light in color, either tan, yellowish, or orangish .....*C. gelechiae* Howard

-- Fore- and mid femora mostly dark brown, foretibia with some dark color.....62

62 (61) Frontovertex, mesoscutum, and scutellum green-blue; club short, 0.7x funicle length (Fig. 172) ..... *C. gibsoni* n. sp.

-- Frontovertex and mesoscutum with green highlights that contrast with the purple highlights of the scutellum; club elongate, 0.9x funicle length (Fig. 195)..... *C. gordhi* n. sp.

Key to males of species of Nearctic *Copidosoma* Ratzeburg

1 Funicular segments 1-5 pectinate, each branch much longer than the length of each corresponding funicular segment (Fig. 58) ....*C. bucculatricis* (Howard)

-- Funicular segments not pectinate, or if with short branches, funicular segments at most as broad as long (Fig. 392).....2

2 (1) Club 2-segmented.....3

-- Club unsegmented.....8

3 (2) Tegulae light, either yellow, white, or clear, or yellow in proximal 1/2 with remainder brown; forecoxa, forefemur, and midfemora yellow, white, or tan ..... *C. innocuellae* Barron (part)

-- Tegulae completely dark in color; forecoxa dark, fore- or midfemora with some dark color 4

4 (3) Linea calva not interrupted by dorsal setae; postmarginal vein elongate (as in Fig. 54); parameres elongate and well separated from each other (Figs. 55, 85) 5

-- Linea calva interrupted by dorsal setae; postmarginal vein short (as in Fig. 240); parameres convergent or closely spaced (Figs. 141, 323) 6

5 (4) Apex of club strongly obliquely truncate (Fig. 81); first funicular segment at least 2x longer than broad; parameres elongate and subparallel (Fig. 85); forewing hyaline, or occasionally slightly infuscate around marginal and stigmal veins ..... *C. cervius* (Walker) (part)

-- Apex of club rounded or pointed (Fig. 51); first funicular segment at most 1.5x longer than broad; parameres shorter and divergent (Fig. 55); forewing always strongly infuscate ..... *C. brandysae* n. sp.

6 (4) Scape as long as first 3 funicular segments (Fig. 318); funicular segments 2.5-3x longer than broad; scutellum with fine deep reticulate sculpture; foretibia tan ..... *C. psephae* n. sp. (part)

-- Scape shorter than first 3 funicular segments (Fig. 238); at least some funicular segments less than 2.5x longer than broad; scutellum with shallow, widely spaced reticulate sculpture; foretibia dark brown 7

7 (6) First and second funicular segments at least 2x longer than broad (Fig. 136); postmarginal vein about as long as marginal (Fig. 138); forewing with basal infuscate streak (difficult to see except in slide-mounted material) and slightly infuscate around marginal and stigmal veins ..... *C. desantisi* Annecke & Mynhardt (part)

-- First and second funicular segments not 2x longer than broad (Fig. 238); postmarginal vein shorter than marginal (Fig. 240); forewing hyaline .....

..... *C. koehleri* Blanchard (part)

8 (2) Tegulae light in color, either white, yellow, or clear, or with proximal 1/3 yellow and remainder dark 9

-- Tegulae completely dark in color 14

9 (8) Forecoxa dark in color and either forefemur or tibia with some dark color 10

-- Forecoxa, femur, and tibia light in color, either white, yellow, or tan 12

10 (9) Sensory area of club extended ventrally at least 0.5x club length (Fig. 218); midfemur yellow or tan; scutellum with fine deep reticulate sculpture (as in Fig. 415) ..... *C. hypenapurpura* n. sp.

-- Sensory area of club restricted to apex of club (Fig. 165); midfemur brown in at least proximal 1/2; scutellum with elongate reticulate sculpture (as in Fig. 418) 11

11 (10) Digiti short and relatively wide (Fig. 180).... *C. glandiferellae* Barron & Bisdee

-- Digiti elongate (Fig. 170) ..... *C. geniculatum* (Dalman)

12 (9) Club with sensory area extending ventrally at least 0.4x club length (Figs. 209-210); setae of flagellum short and recumbent (Fig. 209) ..... *C. howardi* replacement name

-- Apex of club rounded or pointed with sensory area restricted to extreme apex; setae of flagellum elongate and erect, giving it a brushy appearance (Fig. 30) 13

13 (12) Occipital margin broadly rounded; mesoscutum and scutellum with elongate reticulate sculpture; eye separated from occipital margin by about the width of an ocellus; midtibia brown ..... *C. auriceps* (Ashmead)

-- Occipital margin sharp and well defined; mesoscutum and scutellum with reticulate sculpture; eye reaching, or nearly reaching, occipital margin; midtibia white or yellow, dark color, if present, restricted to proximal 1/3 ... . *C. innocuellae* Barron (part)

14 (8) Apex of club obliquely truncate (Figs. 81, 148).....15

-- Apex of club rounded, pointed, or truncate (Fig. 280).....21

15 (14) Linea calva not interrupted by dorsal setae; mandible clearly 3-toothed, though anterior and middle teeth may be shorter than posterior tooth (Fig. 378)..... 16

-- Linea calva interrupted by dorsal setae; mandible with anterior tooth minute and middle tooth reduced, giving mandible a 1- or 2-toothed appearance (Fig. 405).....18

16 (15) First funicular segment at least 1.5x longer than broad (Fig. 81); postmarginal vein relatively long (Fig. 84); axillae greatly elevated above scutellum; parameres and digiti elongate (Fig. 85).....:*C. cervius* (Walker) (part)

-- First funicular segment at most slightly longer than broad; postmarginal vein short; axillae slightly elevated above scutellum; parameres and digiti short... 17

17 (16) First and second funicular segments subequal in size (Fig. 148); stigmal vein shorter than, or subequal in length to, marginal vein (Fig. 150), mesoscutum green, contrasting with purple-black scutellum; aedeagus without paired median hooks (Fig. 154) .....*C. floridanum* (Ashmead)

-- First funicular segment shorter and narrower than second (Fig. 377); stigmal vein longer than marginal vein (Fig. 380); mesoscutum and scutellum similar in color; aedeagus with paired median hooks (Fig. 383) ....*C. truncatellum* (Dalman)

18 (15) Frontovertex with white and purple highlights that contrast with the blue-green mesoscutum; aedeagus straight, not deflected; phallobase relatively short, strongly tapered proximally, and with 18-21 pairs of setae (Fig. 117)..... .....*C. confusa* n. sp.

-- Frontovertex and mesoscutum similar in color; aedeagus abruptly deflected in distal portion (Fig. 437); phallobase relatively longer and not as tapered proximally, usually with fewer than 10-12 pairs of setae (Fig. 43).....19

19 (18) Digiti elongate and curved, each with 2 apical claws, inner claw usually smaller than the outer (Figs. 42, 438), but occasionally subequal.....

..... *C. bakeri* (Howard)

-- Digiti short, each with 3-4 claws, one of which may be subapical (Figs. 77, 124).....20

20 (19) Funicular segments relatively long, second funicular segment at least 2x longer than broad (Fig. 272)..... *C. melanocerum* (Ashmead)

-- Funicular segments relatively short, second funicular segment less than 2x as long as broad (Figs. 73, 120)..... ..... *C. celaenae* Howard, *C. cuproviridis* Springate & Noyes

21 (14) Forecoxa white.....22

-- Forecoxa dark in color 26

22 (21) Hind coxa white; axillae not meeting medially ..... *C. mutabilis* n. sp.

-- Hind coxa dark in color; axillae meeting medially 23

23 (22) Hind femur and tibia mostly brown, light only at the apices; phallobase with 15 or more pairs of setae (Fig. 315)..... *C. polyporusi* n. sp.

-- Hind femur white or tan in at least proximal 1/2; phallobase with 5 or fewer pairs of setae 24

24 (23) Antennal scrobes not confluent dorsally, interantennal prominence uninterrupted and merging into frontovertex (Fig. 402); digiti short and curved, each with 3 claws (Fig. 335); mesoscutum with reticulate sculpture..... ..... *C. pseudoinnocuellae* n. sp.

-- Antennal scrobes confluent dorsally, interantennal prominence not extending to frontovertex (Fig. 403); digiti elongate and straight, each with 2 claws (Fig. 70); mesoscutum with elongate reticulate, or nearly striate, sculpture 25

25 (24) Hind femur brown in distal 1/2; scutellum with elongate reticulate sculpture in a whorled pattern (Fig. 421).....*C. capsicum* Burks

-- Hind femur white; scutellum with elongate reticulate sculpture that is not in a whorled pattern (Fig. 413).....*C. schauffi* n. sp.

26 (21) Linea calva not interrupted by dorsal setae.....27

-- Linea calva interrupted by dorsal setae 32

27 (26) All funicular segments at least 3x longer than broad and joined by their centers (Fig. 246); scape reaching above posterior ocelli..... *C. longitlava* n. sp.

-- Not all funicular segments 3x longer than broad, funicle segments joined ventrally (Fig. 200); scape not reaching above posterior ocelli 28

28 (27) Scutellum with elongate reticulate, or nearly striate, sculpture (as in Figs. 417, 421).....29

-- Scutellum with reticulate sculpture (as in Figs. 415, 420).....30

29 (28) Mesoscutum and scutellum with elongate reticulate sculpture (as in Fig. 417); postmarginal vein less than 0.5x length of stigmal vein (Fig. 202); phallobase with 10 or more pairs of setae, parameres well developed, digiti not projecting well beyond parameres .....*C. grahami* n. sp.

-- Mesoscutum with reticulate sculpture that contrasts with the elongate reticulate sculpture of the scutellum (as in Fig. 421); postmarginal vein more than 0.5x length of stigmal vein (Fig. 387); phallobase with 3 pairs of setae, parameres reduced, digiti projecting well beyond parameres (Fig. 390) .... *C. vagum* Howard

30 (28) Axillae greatly elevated above scutellum (as in Fig. 420); first funicular segment at least 3x longer than broad (Fig. 88); parameres divergent (Fig. 93)..... ..... *C. chalconotus* (Dalman)

-- Axillae slightly elevated above scutellum (as in Fig. 424); first funicular segment at most 2.5x longer than broad; parameres not divergent (Fig. 294) 31

31 (30) Flagellum white or tan ventrally, dark brown dorsally; first funicular segment less than 2x longer than broad (Fig. 288); stigmal vein subequal in length to marginal vein (Fig. 290); phallobase without midrib (Fig. 294) .... *C. noyesi* n. sp.

-- Flagellum uniformly colored brown; first funicular segment 2x longer than broad (Fig. 305); stigmal vein at least 2x longer than marginal vein (Fig. 307); phallobase with midrib (as in Fig. 70)..... *C. picra* n. sp.

32 (26) Midfemur and tibia white or tan.....33
-- At least 1/2 of midfemur dark in color, midtibia variable 34

33 (32) All funicular segments at least 2.5x longer than broad (Fig. 96); scape elongate, reaching above median ocellus; frontovertex less than 0.5x head width; posterior ocelli closer to eye than to occipital margin .... *C. charisoma* n. sp.
-- Funicular segments at most 2x longer than broad (Fig. 297); scape short, not reaching level of median ocellus; frontovertex 0.5x or more head width; posterior ocelli equidistant between eye and occipital margin..... ..... *C. peckorum* n. sp.

34 (32) At least second and third funicular segments strongly expanded dorsally, triangular in lateral view (Fig. 392).....*C. whartoni* n. sp.
-- Funicular segments not as above, evenly cylindrical or not strongly triangular (Figs. 45, 156) 35

35 (34) Mesoscutum and scutellum with elongate reticulate sculpture (Fig. 417).....36
-- Sculpture of mesoscutum and scutellum not as above.....37

36 (35) First funicular segment at least 3x longer than broad and longer than second funicular segment (Fig. 156); digiti with a single pore near apical claws (Fig. 161) .....*C. gelechiae* Howard
-- First funicular segment at most 1.5x longer than broad and shorter than second funicular segment (Fig. 371); digiti without pores (Fig. 375)..... ..... *C. timberlakei* n. sp.

37 (35) Midfemur without a proximal well defined hyaline ring, light color at base of femur without dark color proximal to it; posterior mandibular seta short and bladelike (Fig. 406) 38
-- Proximal 1/3 of midfemur with a narrow, well defined hyaline ring that is surrounded by dark color; posterior mandibular setae not bladelike 39

38 (37) Scutellum with elongate reticulate or nearly striate sculpture that contrasts with the reticulate sculpture of the mesoscutum (Fig. 416); interantennal prominence wide, 3x toruli width ..... *C. pyralidis* (Ashmead)

-- Scutellum and mesoscutum with similar reticulate sculpture; interantennal prominence narrow, 2x toruli width ..... *C. lymani* Howard

39 (37) Forewing hyaline 40

-- Forewing infuscate around marginal and stigmal veins or evenly suffused with faint color 44

40 (39) Aedeagus ventrally with 2 median rows of small hooks, with larger hooks laterally (Figs. 134, 439) ..... *C. deceptor* Miller

-- Aedeagus without hooks 41

41 (40) Marginal vein punctiform, not or barely meeting wing margin, postmarginal vein absent (Fig. 364) ..... *C. tejana* n. sp.

-- Venation not as above 42

42 (41) Mesoscutum and scutellum black, mesoscutum without green or blue-green highlights, scutellum without purple or green highlights ..... *C. masoni* n. sp.

-- Mesoscutum with green or blue-green highlights, scutellum with purple or green highlights 43

43 (42) All funicular segments at least 2.2x longer than broad (Fig. 318); hind tibia dark brown in proximal 1/2, remainder tan; posterior ocelli equidistant between occipital margin and eye ..... *C. psephae* n. sp. (part)

-- Funicular segments at most 1.5x longer than broad (Fig. 238); hind tibia dark brown or black, tan only at the apices; posterior ocelli closer to occipital margin than to eye ..... *C. koehleri* Blanchard (part)

44 (39) Phallobase with midrib (Fig. 189), each digitus with a single apical pore (Fig. 188) ..... *C. globata* n. sp.

-- Phallobase without midrib, digiti without pores 45

45 (44) Scape shorter than first 2 funicular segments, not reaching median ocellus; at least 2 funicular segments with distal portion dorsally expanded (Fig. 45) and tan or brown, lighter in color than scape .....*C. beckeri* n. sp.

-- Scape longer than first 2 funicular segments, reaching median ocellus; each funicular segment uniform in diameter and not dorsally expanded (Fig. 136), funicle and scape both dark brown or black .... *C. desantisi* Annecke & Mynhardt (part)

Copidosoma albicoxae new species

(Figs. 20-24)

Diagnosis. Females of *Copidosoma albicoxae* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 20), lower margin of face produced into a broad lobe (Fig. 23), and all coxae white or tan. It is most similar to *C. floridanum* and *C. noyesi*, which do not have the lower margin of the face produced into a lobe and have at least the mid- and hind coxae dark.

Female. Length 0.94-0.98 mm. Body dark brown; frontovertex with mixed pale green and purple highlights, scrobal area and genae with light purple reflections; scape and flagellum tan or brown; mesoscutum with light green highlights, axillae and scutellum with purple highlights, scutellum posteriorly with green highlights, propodeum laterally with pale purple highlights and translucent setae lateral to propodeum, mesopleuron with pale purple highlights; legs white or tan, hind tarsi slightly darker; forewing slightly infuscate, darkest around marginal and stigmal veins; anterior metasomal tergites and sternites tan, remainder dark brown.

Frontovertex 0.4x head width and with shallow reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth rounded and shorter than others (Fig. 24); eye reaching occipital margin, eye height 2.5x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; lower margin of face produced into a broad lobe (Fig. 23); toruli separated from occipital margin by their width, funicular segments subquadrate or wider than long, club unsegmented and strongly obliquely truncate, 0.8x funicular length, sensory area 0.5x club length (Fig. 20).

Mesoscutum with shallow reticulate sculpture similar to that of frontovertex; axillae barely meeting and slightly elevated above scutellum; scutellum with deep elongate reticulate sculpture in anterior 2/3, remainder nearly polished; forewing 2.25x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein about as long as marginal vein, postmarginal vein 0.5x length of stigmal vein (Fig. 21).

Metasoma subequal in length to mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium simple, reaching 0.6x length of metasoma; ovipositor 0.6x midtibia length, and barely exserted, second valvifer fused to third valvula.

Male. Unknown.

Variation. Very little, other than size, in the specimens available.

Biology and hosts. Unknown.

Distribution. Known only from Maryland, Michigan, and Trinidad.

Etymology. A combination of Latin *albi*, white, and coxa, referring to the white coxae.

Holotype ♀ mounted on a card, "U.S.A.: Maryland/Patuxent Wildlife" "Reserve vii.82/Fitton & Quinlan". Red label "HOLOTYPE/Copidosoma/albicoxae/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. CANADA: same data as holotype (1 ♀, CNC); **USA**: **Michigan**: Ann Arbor, vii.82, Fitton & Quinlan (2 ♀, CNC); **TRINIDAD**: St. George, Gasparillo 5-15.XI. 1987, R. Borneo, Malaise (1 ♀, ROM). Paratypes to be deposited in BMNH, ROM, and USNM.

Copidosoma alexanderi new species

(Figs. 25-28)

Diagnosis. Females of *Copidosoma alexanderi* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and rounded at the apex, sensory area restricted to apex of distal segment (Fig. 25), funicular segments 1.5-2x

longer than broad, foreleg entirely white or tan, and ovipositor exserted 0.4-0.6x length of metasoma. This species is similar to *Copidosoma tigrinum*, which has very elongate funicular segments that are 3-5x longer than broad (Fig. 365) and the ovipositor exserted at most 0.25x length of metasoma.

Female. Length 0.99-1.1 mm, excluding ovipositor. Body brown to dark brown; frontovertex with light green and purple highlights, scrobal area and genae with purple highlights; radicle dark brown, dorsal surface of scape brown, remainder yellow-tan, funicular segments brown dorsally and yellow-tan ventrally, club uniformly brown; mesoscutum with green and purple highlights, axillae and scutellum with purple highlights, scutellum with green highlights posteriorly, propodeum laterally with green highlights and silver setae lateral to spiracle; mesopleuron with pale green highlights anteriorly and purple-blue highlights posteriorly; foreleg, midfemur and tarsi, and hind tibia white-tan, midtibia white-tan except for small brown area in proximal 1/3, hind femur white-tan except for small brown area in distal 1/3, hind tarsi 1-4 tan, tarsus 5 darker; forewing hyaline; ovipositor white-tan, lighter than metasoma.

Frontovertex 0.5x head width and with reticulate sculpture that is elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly shorter and more rounded than others; eye separated from occipital margin by the diameter of a facet, eye height 2x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; toruli separated from mouth margin by their width, funicular segments 1.5-1.9x longer than broad, club 3-segmented and 0.65x funicular length, sensory area restricted to apex of distal segment (Fig. 25).

Mesoscutum with reticulate sculpture similar to that of frontovertex; axillae meeting and elevated above scutellum; scutellum with sculpture similar to that of mesoscutum but shallower, nearly polished at the apex; forewing 2.3x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein about as long as marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 27).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma and with anterior lobe (Fig. 28); ovipositor 1.8-1.9x length of midtibia and exserted 0.4-0.6x length of metasomal, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430), epiproct present.

Male. Unknown.

Variation. Very little, other than size, in the material available.

Biology and hosts. Unknown.

Distribution. Known only from Quebec, Georgia, New Hampshire, and South Carolina.

Etymology. Named for my son, Alexander.

Holotype ♀ mounted on a card, "S.C.: Anderson Co./Pendleton 225m/21-27.VIII. 1987" "BRC Hym Team/Malaise". Red label "HOLOTYPE/Copidosoma/alexanderi/ Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: same data as holotype (1 ♀, TAMU); **USA: Georgia**: McIntosh Co., Sapelo Island, 15.ix-15.xi.1987, BRC Hym Team, oak forest (1 ♀, BMNH); **New Hampshire**: Rock Co., Odiorne Point, IX-3/8-1983, D.S. Chandler, window trap (1 ♀, BMNH); **South Carolina**: Pickens Co., Clemson, Cherrys Crossing, 25.VIII-3.IX.1987, J. Johnson (1 ♀, TAMU); **CANADA: Quebec**: Gatineau Park, Luskville Falls, Denis & Dumouchel, vii.1986 (1 ♀, BMNH). Paratypes to be deposited in BMNH, TAMU, and USNM.

Copidosoma auriceps (Ashmead)

(Figs. 29-35)

Sphæropisthus auriceps Ashmead, 1900: 369. [USNM, ♀ holotype examined].
Transferred to *Baeocharis* by Peck (1951). Transferred to *Copidosoma* by Noyes and Woolley (1994).

Type Material. Holotype ♀ mounted on a point with a card underneath, "FtGeorge/Fla" "Type/No. 4849/U.S.N.M." [red label] "Sphaeropisthus/auriceps/♀ Type Ashm" [handwritten in ink]. The head is mounted separately on the point and the following parts missing: antennae, forelegs beyond the coxae, left midtarsi, right midleg beyond the coxa, right hind leg, left hind leg beyond the middle of the femur, right hind wing, and posterior tergites. The forewings are damaged and the metasoma is separated from the mesosoma.

Diagnosis. Females of *Copidosoma auriceps* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and distinctly shaped (Fig. 29), occipital margin not sharp, more or less rounded, tegulae white, forewing narrow and infuscate, and ovipositor exserted 0.25-0.4x length of metasoma. No other species has this combination of characters.

Female. Length 1.52-1.58 mm, excluding ovipositor. Color brown to dark brown; head with mixed green and purple highlights, scape and pedicel tan to dark brown and usually lighter in color than brown to dark brown funicular segments and club; mesoscutum with green highlights, tegulae white, axillae and scutellum with green, and occasionally purple, highlights, propodeum laterally with pale green and purple highlights and translucent setae lateral to spiracle, mesopleuron with pale green highlights anteriorly and purple highlights posteriorly; coxae and fore- and midfemora tan or light brown, foretibia and tarsi darker, midtibia brown to dark brown, mid- and hind tarsi 1-4 white-tan, mid- and hind tarsus 5 dark brown, hind femur tan to dark brown, hind tibia dark brown; forewing infuscate, darkest around marginal and stigmal veins and distal to linea calva, basal cell hyaline; anterior 1-2 metasomal segments usually lighter in color than remainder, ovipositor usually lighter than darkest portion of metasoma.

Frontovertex slightly less than 0.6x head and with fine deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the width of 3 facets, eye height 1.6x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin and far from both, OOL:OPL:POL 4:4:6; toruli 1.5x their width from mouth margin, funicular segments quadrate to 1.4x longer than broad, club unsegmented and 0.85x funicle length, sensory area 0.8x club length (Fig. 29).

Mesoscutum with elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with reticulate sculpture that is shallower at the apex, forewing 2.7-2.85x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein about 2x longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 32).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe; ovipositor 1.5-1.6x length of

midtibia and exserted 0.25-0.4x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.46-1.52 mm. Similar to female but ocelli larger, OOL:OPL:POL 3:3:6; toruli 2x their width from mouth margin, antenna tan, funicular segments 1.6-2x longer than broad, club 0.37x length of funicle (Fig. 30); mid- and hind coxae brown, contrasting with the tan-white forecoxae; forewing infuscation restricted to area around marginal and stigmal veins and filum spinosum; phallobase 0.95x length of midtibia and with 25 pairs of setae (Fig. 33), each digitus with 4 apical claws and without pores (Fig. 34), aedeagus (Fig. 35) with a pair of sensilla.

Variation. Specimens are remarkably uniform in length, varying only in relative darkness and length the ovipositor is exserted. A single specimen from New Mexico has the light portions of the body tawny yellow and the forewing infuscate only around the marginal and stigmal veins.

Biology and hosts. Reared from a species of *Haimbachia* Dyar (Pyralidae: Crambinae) in grass, and possibly a parasite of *Eoreuma* Ely (Pyralidae: Crambinae) (R. Wiedenman pers. comm.).

Distribution. Found in the U.S. from Maryland south to Florida, and west to Missouri and New Mexico, but not commonly collected.

Other material examined. **USA**: **Florida**: Sugarloaf Key, 25.iii.1945, Griswold Ex. *Haimbachia* sp. in grass stem (1 ♀, USNM); Alachua Co., Gainesville, 27.v.1991 91/013, Woolley & Zolnerowich (1 ♀, TAMU); **Kentucky**: Bernheim For., viii.1982, Fitton & Quinlan (3 ♀, BMNH); **Maryland**: Prince George's Co., Patuxent Res Sta, 15-29.vi.1986, D.B. Whal [sic] (15 ♀, BMNH); Patuxent Wildlife Reserve, vii.82, Fitton & Quinlan (3 ♀, 2 ♂, BMNH); **Missouri**: Williamsville, 14.vii-8.viii.1988, J.T. Becker (4 ♀, BMNH); **New Mexico**: Karr Canyon, Lincoln Nat. For., 28.vii.1977, L. Masner (1 ♀, CNC); **North Carolina**: Macon Co., Wayah Gap, 29.vii.1957, J.G. Chillcott, 4000 to 4150 ft. (1 ♀, CNC); **Texas**: Burnet Co., Inks Lake St. Park, 8-15.viii.1988, Heraty & Solis (1 ♀, 1 ♂, TAMU); Comal Co., Guadalupe River St. Pk., 18.vii.88, J. Heraty, sweep grass (1 ♀, TAMU); Guadalupe River St. Park 88/010, 18.viii.1988, J.B. Woolley (1 ♀, TAMU).

Copidosoma bakeri (Howard)

(Figs. 36-44, 405, 408, 414, 434, 437-438))

Berecyntus bakeri Howard, 1898: 238. [USNM, holotype ♀ examined]. Transferred to *Copidosoma* by Peck (1951).

Berecyntus bakeri var. *arizonensis* Girault, 1916: 50. [USNM, holotype ♀ examined]. Transferred to *Copidosoma* by Peck (1951). Synonymized by Peck (1963).

Berecyntus bakeri var. *eutoae* Strickland, 1916: 21. [USNM, holotype ♂ examined]. Additional description by Girault (1917c). Transferred to *Copidosoma* by Peck (1951). Synonymized by Peck (1963).

Copidosoma naevia Sæther, 1966: 103. [CNC, paratype ♀, ♂ examined]. **New synonomy.**

Type Material. Holotype ♀ mounted on a point with a card underneath, "Colo/866" "Coll./CFBaker." "Head/mounted" [blue label] "Berecyntus/bakeri/How. type" [handwritten in ink] "Type/No. 5030/U.S.N.M." [red label]. Holotype ♀ head, antennae, right forewing, and a tibia with tarsi mounted on a slide labelled "Copi [marked out]/ Berecyntus/bakeri How/♀ type." [handwritten in ink, 'type' torn off of label] "5030 4850" [handwritten in ink on red label with '4850' marked out].

Copidosoma naevia Sæther. The holotype of *Copidosoma naevia* Sæther was deposited in the CNC but apparently is lost. A search of CNC material revealed 2 females and 1 male in alcohol. The females have a single handwritten label "Copidosoma (Litomastix)/naevia n.sp./paratypes/ North Boulder Creek, Colorado./July 9.1960 3500-3800 m/DET O.A. SÆTHER 1965". The male specimen has a single handwritten label "Copidosoma (Litomastix)/naevia n.sp./allotype ♂/North Boulder Creek, Colorado./July 9.1960 3800m./DET. O.A. SÆTHER 1965". The specimens were dried and mounted at the BMNH, and the label data were handwritten onto smaller labels. The females bear the label "PARATYPE/Copidosoma/naevia/SÆTHER" [yellow label] and the male bears the label "Copidosoma/naevia/SÆTHER/ALLOTYPE". These specimens are clearly *C. bakeri*.

Diagnosis. Females of *Copidosoma bakeri* may be distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 36), head and mesoscutum shiny green or blue-green, mesoscutum with reticulate sculpture, scutellum with elongate reticulate sculpture (Fig. 414), forewings large and

infuscate, reaching well beyond the apex of the metasoma. This species is most similar to *Copidosoma celaenae* Howard, which is smaller, has the head and mesoscutum dark brown or black, not shiny, and the forewings not reaching well past the apex of the metasoma.

Female. Length 1.3-1.6 mm. Body dark brown; head bright green or blue-green, occasionally with purple highlights, interantennal prominence or scrobes occasionally purple; scape and pedicel dark brown with green or blue-green highlights, funicular segments and club dark brown; mesoscutum similar to frontovertex, axillae with pale blue or green highlights, scutellum brassy green or blue-green mixed with purple, propodeum laterally with blue or green highlights and silvery setae lateral to spiracle, mesopleuron with blue-green highlights anteriorly and purple highlights posteriorly; coxae, femora, and tibiae dark brown with blue or green highlights, femora and tibia tan or brown at extreme apices, midfemur with proximal hyaline ring, fore- and midtarsi 1-4 tan or brown, tarsus 5 darker, hind tarsi similar to midtarsi or completely brown; forewing infuscate, darkest around marginal and stigmal veins.

Frontovertex slightly less than 0.5x head width and with fine deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, anterior tooth shortest and posterior longest (Fig. 405); eye separated from occipital margin by about the width of a facet, eye height 1.5x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 1:0.5:8; toruli separated from mouth margin by their width, funicular segments broader than long to 1.1x longer than broad, club unsegmented and strongly obliquely truncate, 0.75-0.8x length of funicle, sensory area 0.6x club length (Fig. 36).

Mesoscutum with reticulate sculpture (Fig. 414), the cells larger than those of frontovertex; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with elongate reticulate sculpture that is shallower at apex; forewing 2.3x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein about 1.5x longer than broad, stigmal vein 1.5x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 39).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching 0.6-0.7x length of metasoma and emarginate posteriorly (Fig. 41); ovipositor 0.9x length of midtibia and not, or barely exserted, second valvifer fused to third valvula, with a transverse cluster of spicules (as in Fig. 432); epiproct present (Fig. 434).

Male. Length 1.15-1.35 mm. Similar to female but funicular segments 1.1-2x longer than broad, club 0.45x length of funicle, sensory area 0.4x length of club (Fig. 37); forewing usually less darkly infuscate; phallobase 0.8x length of midtibia length, with medial flanges and 8-9 pairs of setae (Figs. 43, 437), each digitus with 2 claws, the inner claw usually smaller than the outer, and a single pore near claws (Figs. 42, 438), aedeagus with a pair of hooks and a pair of sensilla (Figs. 44, 437-438).

Variation. Specimens vary between green and blue-green, even within a series. Specimens from California are somewhat smaller, and males have the digital claws subequal in size, instead of the inner claw smaller.

Biology and hosts. Reared from the following species of Noctuidae: *Crymodes devastator* (Brace) (Amphipyrinae); *Agrotis venerabilis* Wlk., *Euxoa auxiliaris* (Grt.), *E. detersa* (Wlk.), *E. drewseni* (Staud.), *E. flavicollis* (Sm.), *E. messoria* (Harr.), *E. tristicula* (Morr.), *Feltia jaculifera* (Gn.), *F. subgothica* (Haw.), and *Lacinipolia renigera* (Steph.) (Noctuinae). This is the species identified as *Copidosoma* sp. in a description of male mating swarms in California (Nadel, 1987). It frequently occurs with *C. celaenae* and has been collected at elevations up to 14,000 feet.

Copidosoma bakeri is an important parasite of cutworms in Canada, although parasitized cutworms feed on crops longer than normal cutworms (Schaaf 1972, Cheng 1977).

Distribution. From Nebraska west to California and Washington, and from Alberta and Saskatchewan south to Texas. Reported in Argentina, Brazil, Chile, and Venezuela (De Santis 1981, 1989).

Other material examined. Several hundred specimens from Alberta, Saskatchewan, Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, New Mexico, Oregon, Texas, Utah, and Wyoming.

Copidosoma beckeri new species

(Figs. 4, 45-49)

Diagnosis. Females of *Copidosoma beckeri* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and distinctly shaped (Fig. 4).

sternites 5-6 with an anterior lobe (Fig. 48), and ovipositor exserted 0.3-0.5x length of metasoma. This species is most likely to be confused with *Copidosoma whartoni* and *C. incisum*, which differ in having sternites 5-6 incised anteriorly (Figs. 227, 396) and the ovipositor only slightly exserted.

Female. Length 1.15-1.4 mm. Body dark brown; frontovertex with purple-green highlights, scrobal area and genae with purple highlights; scape dorsally mottled brown-yellow and yellow-tan ventrally, flagellum dark brown; mesoscutum with mixed brassy green and purple highlights, axillae and scutellum with purple highlights, scutellum with green highlights laterally and posteriorly, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae dark brown, forefemur dark brown in proximal 1/2, remainder tan, foretibia and tarsi tan, midfemur dark brown in middle 1/2, remainder tan, midtibia tan except for a small brown area in the proximal portion, midtarsi tan, hind femur dark brown with distal apex tan, hind tibia and tarsi tan; forewing slightly infuscate.

Frontovertex 0.4-0.45x head width and with deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye reaching occipital margin, eye height 2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:6; toruli separated from mouth margin by their width, first funicular segment quadrate or slightly longer than broad, remaining segments 1.1-1.4x longer than broad, club 3-segmented and slightly shorter than length of funicle, sensory area 0.55x length of club and restricted to third segment (Fig. 4).

Mesoscutum with sculpture similar to but shallower than frontovertex; axillae barely meeting and elevated above scutellum; scutellum slightly flat and with shallow reticulate sculpture, apex nearly polished; forewing 2.5x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.5x length of stigmal vein (Fig. 46).

Metasoma slightly longer than mesosoma; cerci inserted 1/3 from anterior end of metasoma; sternites 5-6 with a narrow anterior lobe (Fig. 48); hypopygium reaching apex of metasoma and bilobed anteriorly (Fig. 49); ovipositor 1.6x length of midtibia and exserted 0.3-0.5x length of metasoma, second valvifer not fused to third valvula, with several short longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.2 mm. Similar to female but frontovertex 0.55x head width; toruli 2x their width above mouth margin, scape and pedicel dark brown, funicular segments and club tan, all funicular segments 1.5-2x longer than broad, club 0.35x length of funicle (Fig. 45); forefemur dark brown except apices, dorsal surface of foretibia and tarsi brown, midtibia brown fading to tan at apices, hind femur, tibia, and apical tarsal segments dark brown; forewing color restricted to a small area surrounding marginal and stigmal veins; phallobase 0.6-0.7x length of midtibia, each digitus with 4 apical claws, aedeagus without sensilla.

Variation. Specimens vary in overall darkness, some being more brown than black. Several specimens have the hind tarsi dark brown instead of the usual tan.

Biology and hosts. Unknown.

Distribution. Ontario and Quebec south to Florida, and west to Missouri and Texas.

Etymology. Named in honor of J. T. Becker, who collected many of the specimens used in this study.

Holotype ♀ mounted on a card, "USA: Missouri/Williamsville/VI.1987" "J. T. Becker/BM 1988-119". Red label "HOLOTYPE/Copidosoma/beckeri/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **USA**: same data as holotype (2 ♀, BMNH); **USA**: **Florida**: Alachua Co., Gainesville, Doyle Conner Bldg., 8-14, 24-28.iii, 9-13.vi.1975, E. E. Grissell, pan trap (Moericke trap) (4 ♂, 1 ♂, FSCA); Gainesville, Doyle Conner Bldg., 12-16.iv, 4-9.v. 1976 E. E. Grissell, pan trap (Moericke trap) (2 ♂, FSCA); Gainesville, 24.iv.1989, J.S. Noyes (1 ♀ BMNH); **Missouri**: Williamsville, v.1970, J.T. Becker (13 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. **USA**: **Louisiana**: Stuart N.I., 3km. s.w. Pollock, 13.v-3.vi.1985, H. Howden & C. Scholz (1 ♀, BMNH); **Maryland**: Prince George's Co., Patuxent Res. St., D.B Wahl, 15-29.vi.1986 (1 ♀, BMNH), 29.vi-5.vii.1986 (1 ♀, BMNH); **South Carolina**: Anderson Co., Pendleton, 250m, hardwood forest, BRC Hym Team, 1-7, 17-27.vii.1987 (5 ♀, BMNH); Columbia, 11-12.v.1985, T. Phillips (1

♀, BMNH); **Texas**: Anderson Co., Engeling WMA, 5 mi NE Tennessee Colony, 13.v.1993, J.B. Woolley (6 ♀, TAMU); Bastrop Co., Buescher St. Prk., 19-29.iv.1990, Wharton & Zolnerowich, malaise (3 ♀, TAMU), Buescher St. Park, 10-23.v.1990, R. Wharton (2 ♀, TAMU); Robertson Co., 8 mi E Hearne, 27.iv-18.v.1991, M. Hallmark, malaise (10 ♀, TAMU); San Jacinto Co., 5 km S Coldspring, Double Lk. Cpgd., v.1983, M. Kaulbars (1 ♀, BMNH); **West Virginia**: Pocahontas Co., E. Richwood, 23-28.vii.1983, L. Huggert (1 ♀, BMNH); **CANADA: Ontario**, Constance Bay, 29.vi-10.vii.1983, M. Sanborne (9 ♀, BMNH); Clayton, vii.1981, H. Goulet, S. J. Miller (1 ♀, BMNH); Hamilton, viii.1981, M. Sanborne (1 ♀, BMNH); Heckston, 20Km S.E. Kemptville, 24.vi-21.vii.1984, M. Kaulbars (1 ♀, BMNH); Shirleys Bay, Merivale Gardens, vii.1985, H. Goulet (1 ♀, BMNH); **Quebec**: Gatineau Park, Luksville Falls, vi-vii.1986, Denis & Dumouchel (6 ♀, BMNH); Rigaud, 17.vii.1985, H. Goulet (1 ♀, BMNH).

Copidosoma brandysae new species

(Figs. 50-56)

Diagnosis. Females of *Copidosoma brandysae* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 50), dorsal arms of tentorium absent, and forewing strongly infuscate. This species most closely resembles *Copidosoma cervius* and *C. chalconotus*, which differ in the shape of the club (Fig. 80), and by having dorsal tentorial arms and hyaline wings.

Female. Length 1.51 mm. Body dark brown; frontovertex with faint green and purple highlights, scrobal area and genae with purple highlights; antenna uniformly dark brown, but apex of pedicel tan; mesoscutum with green-blue highlights, axillae and scutellum with purple highlights, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with white reflections; coxae and hind leg dark brown, forefemur dark brown, lighter at apex, foretibia tan at base and in distal 1/3, remainder dark brown, foretarsi 1-4 tan, tarsus 5 brown, midfemur tan in proximal 1/2 and apex, remainder dark brown, midtibia brown dorsally in proximal 1/2, remainder tan, midtarsi 1-4 tan, tarsus 5 darker; forewing infuscate, darkest around venation and distal edge of linea calva.

Frontovertex 0.6x head width and with reticulate sculpture that is elongate on lower face and genae; dorsal arms of tentorium absent; mandible with 3 subequal teeth, dorsal

tooth broadly rounded; eye separated from occipital margin by about the diameter of 3 facets, eye height 1.7x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 4:1:8; toruli separated from mouth margin by their width, funicular segments 1.2-1.5x longer than broad, club 3-segmented and 0.66x length of funicle, sensory area restricted to apex of distal segment (Fig. 50).

Mesoscutum with sculpture similar to frontovertex but finer; axillae meeting and greatly elevated above scutellum; scutellum convex and with sculpture similar to mesoscutum but shallower; forewing 2.4x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about 1.5x longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein as long as stigmal vein (Fig. 53).

Metasoma subequal to length of mesosoma; cerci inserted in posterior 1/5 of metasoma; hypopygium simple (Fig. 52), reaching apex of metasoma; ovipositor subequal to length of midtibia length and slightly exserted, second valvifer not fused to third valvula, with short oblique rows of spicules (as in Fig. 431).

Male. Length 1.38-1.46 mm. Similar to female but toruli 2x their width above mouth margin, funicular segments 1.1-1.5x longer than broad, club 2-segmented, 0.45x length of funicle (Fig. 51); dark areas of legs more extensive; phallobase 0.6x length of midtibia and with 6-10 pairs of setae (Fig. 55), each digitus with 1 apical claw and 2 pores (Fig. 56), aedeagus with 2-3 pairs of sensilla.

Variation. Very little, other than size, in the specimens available.

Biology and hosts. Unknown.

Distribution. Known only from southern New Mexico.

Etymology. Named in honor of my wife, Brandys.

Holotype ♀ mounted on a card, "USA: N. Mexico/Otero Co./Cloudcroft 8600'" "24.vii.1982/G. Gibson/BM 1984-337". Red label "HOLOTYPE/Copidosoma/ brandysae/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: same data as holotype (1 ♀, 12 ♂, BMNH); **USA: New Mexico**: Lincoln N.F., Kar Cyn., VII.1977, L. Masner (1 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, USNM.

Copidosoma bucculatricis (Howard)

(Figs. 57-64)

Pentacnemus bucculatricis Howard, 1892: 366. [USNM, ♀ lectotype examined]. Transferred to *Litomastix* by Trjapitzin and Gordh (1978a). Transferred to *Copidosoma* by Noyes and Hayat (1984).

Type Material. Lectotype here designated, ♀ mounted on a point with a card underneath, "4982♀" [handwritten in ink] "Type/No.1488/U.S.N.M" [red label]. "Copidosoma/ bucculatricis/Howard, 1892/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype with head partially collapsed and left forewing missing .

Two additional females and 3 male syntypes were examined. One female labelled identically to lectotype, second female missing metasoma and antennae, labelled "4982♀/Iss/May 20 '91" "Type/No.1488/U.S.N.M" [red label] "Pentacnemus (n.g.)/bucculatricis/How. MS. ♀" [handwritten in ink]. The 3 males have similar label data, but only 1 has the "Pentacnemus(n.g.)/bucculatricis/How. MS. ♂" label. My label "Copidosoma/bucculatricis/Howard, 1892/PARALECTOTYPE/det. G. Zolnerowich" added to specimens. Three females labelled "4982♀/ Iss/May 23.91" [handwritten in ink] may be part of the type series but do not bear type labels.

Diagnosis. Females of *Copidosoma bucculatricis* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 57), eyes small, forewing hyaline, marginal and postmarginal veins very short (Fig. 61), and cerci inserted in posterior 1/3 of metasoma. No other species has this combination of characters.

Female. Length 1.1-1.49 mm. Color brown to dark brown; frontovertex with pale green and purple highlights, scrobal area and genae with purple highlights; scape and pedicel brown or dark brown, lighter at the apex, funicular segments and club brown; mesoscutum with purple highlights anteriorly , remainder with brassy green or blue-green highlights, axillae and scutellum with pale purple highlights, propodeum laterally with pale

green highlights and translucent setae lateral to spiracle, mesopleuron with blue and purple highlights; coxae brown, forefemur, hind femur and hind tibia brown, tan-white at the apices, foretibia tan-white at apices and along outer edge, remainder brown, midfemur brown in proximal 3/4 except for proximal hyaline ring, distal 1/4 tan-white, midtibia brown in middle 1/2, tan-white in proximal and distal 1/4, tarsi 1-4 of each leg tan-white, tarsus 5 darker; forewing hyaline.

Frontovertex 0.6x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by about the diameter of 2 facets, eye height 1.5x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:7; toruli separated from mouth margin by their width, funicular segments quadrate to 1.4x longer than broad, club unsegmented and strongly obliquely truncate, 0.7-0.77x length of funicle, sensory area 0.55x length of club (Fig. 57).

Mesoscutum with reticulate sculpture, the cells much larger than those of frontovertex; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with reticulate sculpture much shallower than mesoscutum, apex nearly polished; forewing 2.4x longer than wide, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein very short, as long as broad, stigmal vein 3x length of marginal vein, postmarginal vein about 0.2x length of stigmal vein (Fig. 61).

Metasoma subequal to length of mesosoma; cerci inserted in posterior 1/3 of metasoma; hypopygium simple (Fig. 59) and reaching apex of metasoma; ovipositor about 0.8x length of midtibia and not, or barely, exserted, second valvifer fused to third valvula, with short oblique rows of spicules (as in Fig. 431).

Male. Length 1.05-1.43 mm. Similar to female but toruli 1.5-2x their width above mouth margin, funicular segments 1-5 with elongate branches, club 0.4x length of funicle (Fig. 58); phallobase 0.6x length of midtibia length and with 11-14 pairs of setae (Fig. 62), each digitus with 3 apical claws and a single pore near claws (Fig. 63), aedeagus (Fig. 64) with a pair of sensilla.

Variation. Most females are 1.1-1.3 mm long, but several specimens from Oregon and California reared from *Argyresthia libocedrella* Bsk. (Lepidoptera: Aryresthiidae) on *Libocedrus decurrens* (Cupressaceae) reach 1.49 mm in length. Otherwise, variation is confined to relative darkness of overall coloration.

Biology and hosts. Reared from the following Lepidoptera: *Argyresthia aureoargentella* Brower, *A. freyella* Wlsm., *A. libocedrella* Bsk., *A. thuiella* (Pack.), (Argyresthiidae); *Coleophora ulmifoliella* McD. (Coleophoridae); *Coleotechnites gibsonella* (Kft.), *C. thujaella* Kft. (Gelechiidae); and *Zeiraphera* Tr. (Tortricidae) (label data, Peck 1963, Gordh 1979).

Distribution. Most collections have been made in the northeastern U.S. and in Canada, but specimens are also known from Oregon, California, and New Mexico.

Other material examined. CANADA: New Brunswick: Fredericton, 20.vii.1927, R.P. Gorham, cedar tip borer (2 ♂, CNC); Fredericton, *Argyresthia* leaf miner on Arborvitae, 6.vii.1950 (1 ♂, CNC); Fredericton, *Argyresthia thuiella* Pack., 25.vii.1950 (1 ♀, CNC); Fredericton, *Argyresthia freyella* Wlshm., 15, 16, 24.vii.1951 (1 ♀, 3 ♂, CNC); McAdam, *Argyresthia freyella* Wlshm., vii.1950 (3 ♀, 5 ♂, CNC); McAdam, *Argyresthia freyella* Wlshm., F.I.Survey, vii. 1951 (20 ♀, 28 ♂, CNC); McAdam, *Argyresthia freyella* Wlshm., F.I.Survey, vii.1952 (21 ♀, 20 ♂, CNC); **Ontario**: Melrose, 21.vii.1944, Belleville Parasite Lab., (2 ♂, CNC); Ottawa: 10103^0 on miner on *Thuja*, iss 17.vi.1906 (1 ♂, CNC); Ottawa, Parasites from *Argyresthia thuiella*, 1907 (2 ♀, CNC); Ottawa, viii.1978, L. Masner (1 ♀, BMNH); Oxford Mills, vi.1978, G.A.P. Gibson (1 ♂, BMNH); Oxford Mills, vii.1978, L. Masner (1 ♂, BMNH); Picton, 18.vi.1975, Ex. *Pulicalvaria gibsonella* (1 ♂, CNC); Lake Erie, Ravenswood, Ex. *Argyresthia thuiella*, 6-7.vi.1955 (4 ♀, 4 ♂, CNC); Riverdale, Ex *Argyresthia thuiella*, 9.VII (2 ♀, 3 ♂, CNC); Simcoe, 27.v.55, T.N. Freeman (4 ♀, 6 ♂, CNC); Stittsville, 26.vi.1989, K. Bolte, ex. pupa of *Argyresthia aureoargentella* Brower on *Thuya* (2 ♀, CNC); White River, Ex. *Argyresthia*, 11vii.1949 (6 ♀, CNC); Williamsford, ex. *Argyresthia thuiella*, 29.vi.1951 (13 ♀, 5 ♂, CNC); **Quebec**: Lucerne, 28.v.68, ex: *Recurvaria thujaella* (3 ♀, CNC, 4 ♀, TAMU); **USA: California**: Volcans Mts., 30.11.1916, F.P. Keen, 13280fx Hopk.US., *Libocedrus decurrens*, Par. *Argyresthia libocedrella* (3 ♀, 1 ♂, USNM); **Connecticut**: New Haven, 5.vi.1921, MP Zappe, reared from *Argyresthia thuiella* material (1 ♂, UCR); **Maine**: Bar Harbor, 17.vii.1933, Pars. lep. Arborvitae leaf miner (1 ♀, USNM); Mt. Desert Is., 8.vii.1933 (1 ♂, UCR); **New Mexico**: Karr Canyon, Lincoln Nat. For., 28.vii.1977, L. Masner (1 ♀, CNC); **Oregon**: Ashland, 7-9-14, *Libocedrus decurrens*, P.D. Sergent, Hopk. U.S. 12565gg (2 ♀, 2 ♂, USNM).

Copidosoma capsicum Burks

(Figs. 65-71, 403, 421-422)

Copidosoma capsicum Burks, 1967: 54. [USNM, ♀ holotype examined]. Transferred to *Apsilophrys* by Noyes (1980).

Type Material. Holotype ♀ mounted on a point, "Curepe, Trinidad/W.I., Jan. 1966/ Gnorimoschema/capsica. Bennett" "Type No./69076/U.S.N.M." [red label]. Seven additional paratypes examined.

Diagnosis. *Copidosoma capsicum* was well described by Burks (1967) and is distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with the sensory area restricted to the apex of the distal segment (Fig. 66), foreleg white, linea calva not interrupted by dorsal setae, postmarginal vein more than 0.5x length of the stigmal vein (Fig. 69), and scutellum with elongate reticulate to striate sculpture (Figs. 421-422). This species is most similar to *C. peckorum*, which differs in having the forecoxa brown, the linea calva interrupted by dorsal setae, the postmarginal vein less than 0.5x the length of the stigmal vein (Fig. 298), and the scutellum with reticulate sculpture.

Variation. Specimens vary in the relative darkness of the flagellum, with brown most common but tan in some specimens. The length and color of the brown area at the distal end of the hind femur ranges from tan to dark brown, and can extend from the distal 1/4 to 1/2 of the femur. The ovipositor varies from being exserted 0.2-0.4x the length of the metasoma.

Biology and hosts. Reared from *Gnorimoschema capsicum* Bradley and Povolny, *G. gudmanella*, *Phthorimaea operculella* (Zell.) (Gelechiidae: Gelechiinae), and *Diatraea* Guilding and *Lineodes* Gn. (Pyralidae).

Distribution. Found in the Caribbean, Neotropics, and southern Nearctic region.

Other material examined. Brazil: Araras, 1974, J.R. Araujo, ex "milho" (1 ♀, BMNH); **Cuba**: Prov. Habana, 15.iv.1937, L.C. Scaramuzza, *Lineodes* sp. (3 ♀, 1 ♂, USNM); **Mexico**: **Jalisco**: Tuxpan, 4.iv., McCrendon (1 ♂, ANSP); **San Louis**

Potosí: Plan de Ayala La Primavera, 18.ii.1986, C.M. Riess H., *Diatraea* sp. on corn (13 ♀, TAMU); **Peru**: Cañete, 6.ix.1964, A. Silveira-Guido (1 ♀, TAMU, 1 ♀, 1 ♂, USNM); Lima, 9.v.1967, D. Sarmiento (2 ♀, UCR, 4 ♀, 1 ♂, USNM); **Puerto Rico**: Rio Pedras, *Gnorimoschema* in pepper, F. Sein, 1940 (1 ♀, UCB); **USA**: **California**: Albany Quarantine, 72-6 (2 ♀, 1 ♂, UCB); **Florida**: Alachua Co., Gainesville, 28.viii.1976, Z. Boucek (1 ♀, BMNH); Monroe Co., Big Pine Key, vi-viii.1986, S.&J. Peck (2 ♀, BMNH); Big Torch Key, ii-iv, viii-xi. 1985-ii.1986, S.&J. Peck (10 ♀, BMNH); Fat Deer Key, viii.1985-ii.1986, vi-xii.1986 (4 ♀, BMNH, 1 ♀, TAMU); No Name Key, ii-vi, viii-xi.1985, vi-viii.1986 (4 ♀, BMNH); Stock Island, 26.iii.1931, Griswold, Gelechidae [sic] nr *Aroga*, leaves *Coccolobis uvifera* (7 ♀, 4 ♂, USNM); **Georgia**: McIntosh Co., Sapelo Island, 15.ix-15.xi.1987, BRC Hym Team, oak forest (1 ♀, BMNH).

Copidosoma celaenae Howard

(Figs. 72-79, 410)

Copidosoma celaenae Howard, 1885: 11. [USNM, lectotype ♀ examined].

Berecyntus bakeri var. *gemma* Girault, 1916: 49. [USNM, holotype ♀ examined].

Transferred to *Copidosoma* by Peck (1951). Synonymized with *Copidosoma bakeri* (Howard) by Peck (1963). **New synonomy.**

Type Material. Lectotype here designated, ♀ mounted on a strip of paper with 7 points and 7 specimens, 2 of which are missing and represented only by the remains of legs, "637 P." [handwritten] "Type/No. 2030/U.S.N.M." [red label] "Copidosoma/celaenae/How. ty." [handwritten, the letter(s) after 'ty' are illegible]. "Copidosoma/celaenae/ Howard, 1885/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype specimen designated with a red ink mark on the point bearing the specimen. Lectotype with head collapsed and missing right antenna.

Two additional 7-point mounts with identical labels from the type series were examined. Of the 21 specimens in this type series, 9 are represented only by leg fragments. The remaining 12 are in very poor condition, with most missing antennae, heads, or other parts. "Copidosoma/celaenae/Howard, 1885/PARALECTOTYPE/det. G. Zolnerowich" added to specimens.

Berecyntus bakeri var. *gemma* Girault, holotype ♀ mounted on a point, "Berecyntus bakeri/gemma Gir." [handwritten in ink on upper side] "gemma Gir./ ♀" [handwritten in

ink on the underside, along with 3 words that are marked out and illegible] "Type No./19318/ U.S.N.M." [red label]. This subspecies was synonymized with *Copidosoma bakeri* (Howard) by Peck (1963). Examination of the type shows it to be *C. celaenae*.

Diagnosis. Females of *Copidosoma celaenae* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Figs. 72, 410), head dark brown-black, mesoscutum with reticulate sculpture, scutellum with deep elongate reticulate sculpture (as in Fig. 414), and ovipositor not, or barely, exserted. This species is most similar to *Copidosoma bakeri* (Howard), *C. confusa*, and *C. cuproviridis* Springate & Noyes. *Copidosoma bakeri* differs by having a bright green or blue-green head and forewings that are 1.3x larger than those of *celaenae*. Both *C. confusa* and *C. cuproviridis* have the ovipositor exserted and readily visible from above.

Female. Length 1.1-1.4 mm. Body dark brown-black; frontovertex and genae with purple or green and purple highlights, lower face between toruli and mouth margin with green highlights; scape with dark brown-black with green highlights, flagellum dark brown-black; mesoscutum with brassy green highlights, axillae with purple highlights, scutellum varying from black with purple highlights to black with mixed purple and green highlights, apex green, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue-green highlights anteriorly and purple highlights posteriorly; coxae dark brown, fore- and hind femora and tibiae and midfemur dark brown with light green highlights, tan at the extreme apices, midfemur with proximal hyaline ring, midtibia dark brown with tan apices, occasionally brown or tan, fore- and hind tarsi brown to dark brown, midtarsi 1-3 tan, tarsi 4-5 darker; forewing infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.5x head width or slightly less and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth shortest and posterior longest (as in Fig. 405); eye separated from occipital margin by about the diameter of a facet, eye height 1.4-2x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 1:0.5:8; toruli separated from mouth margin by their width, funicular segments broader than long to 1.3x longer than broad, club unsegmented and strongly obliquely truncate, 0.8-1x length of funicle, sensory area 0.5x length of club (Figs. 72, 410).

Mesoscutum with reticulate sculpture with cells larger than those of frontovertex; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with deep

elongate reticulate sculpture that is shallower at the apex; forewing 2.3-2.4x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein 2x longer than broad, stigmal vein 1.5x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 75).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching 0.6-0.7x length of metasoma and posteriorly emarginate (Fig. 76); ovipositor 0.9-1x length of midtibia and not, or barely exserted, second valvifer fused to third valvula, with a transverse cluster of spicules (as in Fig. 432); epiproct present.

Male. Length 1.1-1.25 mm. Similar to female but head with brassy green highlights; funicular segments 1-1.6x longer than broad, club 0.5x length of funicle, sensory area 0.4x length of club (Fig. 73); phallobase 0.7-0.85x length of midtibia, with medial flanges and 7-9 pairs of setae (Fig. 78), each digitus with 3 apical claws or 2 apical and 1 proximal claw, a single pore present near claws or absent (Fig. 77), aedeagus with a pair of hooks and a pair of sensilla (Fig. 79).

Variation. Specimens vary most in the length of the malar space, depth of the mesoscutal sculpture, and degree of infuscation of the forewing. Males usually have 3 apical claws on each digitus, but specimens with 2 apical and 1 proximal claw have been observed.

Biology and hosts. Reared from the following species of Noctuidae: *Eupsilia* Hbn. (Amphipyrinae); *Lacinipolia renigera* (Steph.), *Polia purpurissata* Grt. (Hadeninae); *Agrotis orthogonia* Morr., *Anomogyna mustellina* (Sm.), *Euxoa declarata* (Wlk.), *E. messoria* (Harr.), *E. ochrogaster* (Gn.), *E. perpolita* (Morr.), *E. scholastica* McD., *E. tristicula* (Morr.), *Feltia jaculifera* (Gn.), *Peridroma saucia* Hbn., *Protolampra rufipectus* Morr., and *Rhynchagrotis cupida* (Grt.) (Noctuinae).

Distribution. Alaska to New Brunswick, and south to California, Texas, and Florida.

Discussion. Males are indistinguishable from those of *C. cuproviridis*. *Copidosoma celaenae* is frequently collected with *Copidosoma bakeri* and *C. cuproviridis*. Although it is commonly collected in large series in mountainous states and at elevations above 9,000 feet, specimens from low elevations in Texas and Florida are known.

Graham (1969) noted the similarity of *Copidosoma auricollis* (Thomson), 1876 and *C. agrotis* (Fonscolombe), 1832. Comparison of *C. celaenae* with a paralectotype of *C.*

agrotis and the lectotype of *C. auricollis* confirms the similarity to these European species. Additional study with fresh material and slide-mounted specimens of the European species may indicate that these names represent a single species.

Other material examined. Approximately 1,000 specimens from 34 U.S. states and 7 Canadian provinces.

Copidosoma cervius (Walker)
(Figs. 80-86, 404, 409)

Encyrtus cervius Walker, 1846a: 177. [BMNH, ♂ lectotype examined]. Transferred to *Litomastix* by Graham (1969). Transferred to *Copidosoma* by Trjapitzin (1989).

Litomastix truncatulus Thomson, 1876: 173. [type not examined]. Synonymized by Graham (1969).

Litomastix tvediensis Bakkendorf, 1965: 137. [type not examined]. Treated as a junior synonym by Trjapitzin (1989).

Type Material. Graham (1969) designated a male lectotype and female paralectotype from the 2 specimens of *cervius* in Walker's type series.

Graham (1969) stated the description and figures of *Litomastix tvediensis* Bakkendorf, 1965 are very similar to *cervius*, but did not synonymize the two. Trjapitzin (1989) lists *tvediensis* as a junior synonym of *cervius*, but I cannot find any work formally establishing *tvediensis* as a synonym.

Diagnosis. Females of *Copidosoma cervius* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and strongly obliquely truncate (Fig. 80), linea calva not interrupted, postmarginal vein relatively long (Fig. 84), and hypopygium emarginate posteriorly (Fig. 82). This species is most similar to *C. chalconotus*, which differs in having a longer flagellum (Fig. 87) and hypopygium without a posterior emargination (Fig. 92).

Female. Length 1.3-1.62 mm. Body dark brown or nearly black; frontovertex with green or blue-green highlights, scrobal area and genae with purple highlights; antenna dark brown to nearly black; mesoscutum with brassy green or blue-green highlights, occasionally with purple mixed in, axillae and scutellum with pale purple highlights,

scutellum with green highlights laterally and at apex, propodeum laterally with light green highlights and silver setae lateral to spiracle, mesopleuron with white or pale blue and purple highlights. "Dark" in the following section on leg color can refer to dark brown or nearly black. Coxae dark, forefemur dark, tan at the apices, foretibia dark, tan at the apices and along anterior edge, foretarsi dark, midfemur dark except proximal hyaline ring and tan base and distal 1/4, midtibia completely tan or brown, or dark with tan apices, midtarsi 1-4 tan, tarsus 5 darker, hind femur, tibia, and tarsi dark; forewing nearly always hyaline, rarely infuscate around venation; distal end of ovipositor usually tan or lighter in color than proximal portion and metasoma.

Frontovertex 0.5x head width or slightly greater, and with reticulate sculpture that is more elongate and shallower on lower face and genae; mandible with 3 subequal teeth, posterior tooth slightly shorter; eye separated from occipital margin by the width of 1 or 2 facets, eye height 1.6-1.7x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:7; toruli 1-1.5x their width above mouth margin, funicular segments subquadrate to 1.8x longer than broad, club 3-segmented and strongly obliquely truncate, 0.5-0.6x length of funicle, sensory area 0.7-0.8x length of club (Fig. 80).

Mesoscutum with reticulate sculpture, anterior cells larger than posterior cells; axillae meeting and greatly elevated above scutellum; scutellum slightly flat and with reticulate sculpture shallower than mesoscutum; forewing 2.2-2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about 1.5x longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein about 0.75x length of stigmal vein (Fig. 84).

Metasoma subequal to length of mesosoma; cerci inserted 2/3 from anterior end of metasoma; hypopygium reaching 0.8-0.85x length of metasoma and posteriorly emarginate (Fig. 82); ovipositor 0.7-0.8x length of midtibia and slightly exserted, second valvifer not fused to third valvula and without spicules; epiproct present.

Male. Length 1.33-1.67 mm. Similar to female but toruli 1.5x their width above mouth margin, funicular segments 1.1-2.4x longer than broad, club 1- or 2-segmented and 0.3-0.4x length of funicle, sensory area 0.7-0.8x length of club (Fig. 81); phallobase 0.55-0.63x length of midtibia length and with 9-12 pairs of setae, midrib usually present (Fig. 85), digiti variable, either with 1 apical claw and 1-3 pores, or with 1 apical and 1 subapical claw and a single pore between claws, aedeagus (Fig. 86) without sensilla.

Variation. Specimens are variable in size, especially the relative lengths of the funicular segments, which may be an effect of the many different hosts this species utilizes. Male genitalia are especially variable. The phallobase has a midrib that is sometimes only weakly expressed. Each digitus may have 1 or 2 claws, if with 2 claws a single pore is present between them. If a single claw is present, a single pore may be present some distance proximal to the claw, or 1 or 2 additional pores may occur.

Biology and hosts. Reared from the following Nearctic Geometridae (Larentiinae); *Eupithecia annulata* Hulst, *E. gibsonata* Tayl., *E. luteata* Pack., *E. niphadophilata* (Dyar), *E. palpata* Pack., *E. transcanadata* MacKay, *E. unicolor* Hulst, *Thera contractata* (Pack.), *T. otisi* (Dyar), and *Venusia pearsalli* (Dyar). One label lists *Choristoneura fumiferana* (Clem.) (Tortricidae: Tortricinae) as host. European specimens are recorded from *Eupithecia* (label data) and *Cydia strobilella* (L.) (Tortricidae) (Trjapitzin 1989).

Distribution. Found in Europe and from Newfoundland to British Columbia, south to Oaxaca, Mexico.

Discussion. A single female examined from the Japanese island of Honshu is larger than other specimens of *C. cervius* and has the axillae less elevated, a longer marginal vein and shorter postmarginal vein, an infuscation around the venation, and the midleg, except the coxa, tan-brown. This may be an undescribed but closely related species.

Other material examined. CANADA: Alberta: Banff, 2-4.viii.1948, *Thera contractata* (1 ♀, 2 ♂, NFC), Banff, 29.i.1952, E. spruce cone (1 ♀, 2 ♂, NFC); Banff N.P., 4.viii.48, ex: *Eupithecia* (29 ♂, CNC); Banff N.P., Johnston's Canyon, 4.viii.1948, ex: *Thera contractata* (25 ♂, CNC); Blaimore, 7.viii.1953, ex. *Eupithecia* (2 ♀, 36 ♂, CNC); Coleman, 24.vii.1950, ex. *Eupithecia* (3 ♀, 9 ♂, CNC); Coleman, 28.vii.1955, ex: *Eupithecia* (12 ♀, CNC); Waterton Lake N.P. nr. Crandell, 49 06N, 113 58W, G. Goulet, montane prairie (1 ♀, TAMU); Waterton, vi.1980, W. Mason (1 ♀, BMNH); **British Columbia**: Alert Bay, 3-1-50 (1 ♀, CNC); Anarchist Mtn., 3.vii.1952 (3 ♀, CNC); Arrowhead, 16.iii.1950, *Eupithecia palpata* (1 ♀, CNC); Australian Creek, 10-12.iii.1951 (5 ♀, 1 ♂, CNC); Campbell R., 11-13.i.1950 (4 ♀, CNC); Dawson Falls, 24.ii.1951 (4 ♀, CNC); Falls Creek, 8.iii.1951 (4 ♀, CNC); Joakin Creek, Kamloops, 19.iii.1941 (4 ♀, CNC); **New Brunswick**: Kouchibouguac N.P., 18.v.1977, G.A.P. Gibson (1 ♀, CNC); Kouchibouguac N.P., 7.vii.1977, J.R. Vockeroth (1 ♀, CNC);

Kouchibouguac N.P., 11.vii.1977, M. Ivanochko (2 ♀, CNC); Kouchibouguac N.P., 3-30.viii.1977, S.J. Miller (4 ♀, CNC); Mitchell Rest. Co., Host *C. fumiferana*, 12.iii.1954 (1 ♀, CNC); **Newfoundland**: South Branch, vii.1974, Heinrich (1 ♀, BMNH); **Ontario**: Buckhams Bay, 5.iii.51, Ex. *Eupithecia palpata* (2 ♀, CNC); Constance Bay, 29.vi-10.vii.1983, M. Sanborne (1 ♀, BMNH); Constance Bay, 8-13.iii.1950, *Eupithecia palpata* (7 ♀, CNC); Hamilton, viii.1981, M. Sanborne (2 ♀, BMNH); Metcalfe, 31.v.1983, B.E. Cooper (1 ♀, BMNH); Milton, viii.81, M. Sanborne (3 ♀, BMNH); Oxford Mills, vi.1973, L. Masner (1 ♀, BMNH); Oxford Mills, vi.1978, G.A.P. Gibson & L. Masner (3 ♀, BMNH); **Quebec**: Gatineau Park, Luskville Falls, 300m, 2-8.vii.1986, Denis & Dumouchel (1 ♀, BMNH); Payne Bay, 22.viii.1958, W.R.M. Mason (1 ♀, CNC); **Saskatchewan**: Meadow Lake, 27.ii47, Geometrid sp., dogwood (4 ♀, NFC); Meadow Lake, 28.ii.1975, *Picea glauca* cones (3 ♀, NFC); **USA**: **California**: Kern. Co., Tehachapi Mts., Antelope Cyn., 4800-5200 ft. elev., 12.ix.1975, S. Frommer (2 ♀, UCR); Marin Co., Paradise Beach Co. Park, 3:xi.1964, P. H. Arnaud, Jr. (1 ♀, CAS); Orange Co., Cleveland SF, 31.iii.1989, J.S. Noyes (1 ♂, BMNH); Placer Co., Big Tree nr. Forest Hill, 22.vi.1985, dead trees, D.C. Darling (5 ♀, 1 ♂, ROM); Riverside Co., Whitewater Cyn., 27.xii.79, K.W. Cooper (5 ♂, UCR); San Bernadino Co., Providence Mts., Gilroy Canyon, 30.iii.1984, 4,500', J.D. Pinto (2 ♀, 3 ♂, TAMU); San Bernadino Mts., 27.viii.81, J.T. Huber (3 ♂, UCR); 7 mi. N. Fish Creek Trail; **Colorado**: Huerfano Co. 8000', n. of N. LaVeta Pass, 17-18.vi.1982, G.A.P. Gibson (1 ♀, BMNH); **Idaho**: Fremont Co., St. Anthony Dunes, 5400' 1-2.vii.1980, M.S. Wasbauer (1 ♀, CDFA); **Michigan**: Ann Arbor vii.82, Fitton & Quinlan (1 ♀, BMNH); **New York**: Tompkins Co., Ithaca, vi.1980, D.C. Darling (5 ♀, DCD); **North Carolina**: McDowell Co., 37°00'N 81°30'W, BRC Hym Team, ix-xi. 1987 (1 ♀, BMNH); **Oregon**: Benton Co., Philomath, Mary's Peak, 14.vii.1985, I.M.Smith (1 ♀, BMNH); Douglas Co., 6N Gardiner, 21.vi.1986, Paul Hanson (1 ♀, 3 ♂, BMNH); Joseph Co., Squaw Mountain, 30.vi.1985, DiGiulio & Hanson (1 ♀, 1 ♂, BMNH); Lane Co., J.J. Andrews Exp. For., Frissell Point, 15.viii.1984, Schauff & Grissell, meadow (1 ♀, BMNH); Lincoln Co., Eddyville, 8 mi E Hwy. 20, 6.viii.1985, Finnamore & Thormin (7 ♀, TAMU); **West Virginia**: Pocahontas Co., E. Richwood, 23-28.vii.1983, L. Huggert (6 ♀, BMNH); Hills Creek Falls, 22-26.vii.1983, L. Huggert (4 ♀, BMNH); **Mexico**: **Oaxaca**: 1.4 miles NE La Cumbre, 18-vii-1985, J. Woolley, G. Zolnerowich, 85/075 (1 ♀, TAMU); **ENGLAND**: Gloucester, ix.25 (1 ♀, BMNH); **Cumbs.**: Lake Thirlmere, ix.1975, M. Britten, ex. *Eupithecia ?trisignaria* on cow parsley (1 ♀, 4 ♂, BMNH); **Kent**: Chislehurst, x.72-vi.73, M. Shaw, ex. *Eupithecia subnotata* on *Cheropodium* (2 ♂, TAMU);

Northumberland: Kyloe Wood, ix.84-vii.85 B. Skinner, *Eupithecia abietaria*: spruce cones (4 ♀, 2 ♂, BMNH); **Oxford**: x.72-iv.73 M. Shaw, ex. *Eupithecia linarata* on *Linaria vulgaris* (2 ♀, TAMU); **NORWAY**: Steinkjer, viii.1952, A. Bakke, Ex: spruce cones (1 ♀, CNC); **JAPAN**: **Honshu**: Iwate, Mt. Hayachine, 27.vi-5.vii.1989, 400m Makihara & Sharkey (1 ♀, TAMU).

Copidosoma chalconotus (Dalman)

(Figs. 87-94)

Encyrtus chalconotus Dalman, 1820: 169. [SMNH, type not examined]. Transferred to *Copidosoma* by Mayr (1876). Transferred to *Litomastix* by Thomson (1876). Treated as *Copidosoma* by Trjapitizin (1989).

Encyrtus mitreus Walker, 1837: 35. [BMNH, ♂ syntype examined]. Synonymized by Walker (1846b).

Type Material. Graham (1958) designated the lectotype and paralectotype from the 2 females of *chalconotus* in Dalman's collection. Comparison of Nearctic specimens with the male syntype of *mitreus*, and with European specimens that have been compared to the types of *chalconotus*, show they are the same.

Diagnosis. Females of *Copidosoma chalconotus* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and strongly obliquely truncate, first funicular segment 2.5x or more longer than broad (Fig. 87), postmarginal vein relatively long (Fig. 90), linea calva not interrupted, and hypopygium simple (Fig. 92). This species is very similar to *C. cervius*, which differs by having shorter funicular segments (Fig. 80) and the hypopygium with a posterior emargination (Fig. 82).

Female. Length 1.8-2 mm. Body dark brown-black; frontovertex with green highlights, with purple highlights along occipital margin and eyes, face from top of scrobes to mouth margin with purple or white highlights, genae with white or purple-blue highlights; antenna dark brown-black; mesoscutum with brassy green or blue-green highlights, anteriorly purplish, axillae with white or pale green highlights, scutellum with purple highlights, laterally and posteriorly with green highlights, propodeum laterally with purple and green highlights and silver setae lateral to spiracle, mesopleuron with white or pale purple highlights. "Dark" in the following section on leg color can refer to dark brown or nearly

black. Coxae dark with faint green highlights, forefemur dark, tan in distal 1/4, foretibia completely dark, or tan at apices and along anterior edge with remainder dark, foretarsi brown or dark, midfemur, tibia, and tarsi 1-4 tan or brown, tarsus 5 darker, hind femur dark, tan at distal apex, hind tibia dark except for tan at base, hind tarsi dark; forewing hyaline; ovipositor usually tan-white at apex, lighter than proximal portion and metasoma.

Frontovertex 0.5x head width and with reticulate sculpture that is more shallow and elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly truncate (Fig. 91); eye separated from occipital margin by about the width of a facet, eye height 1.3-1.5x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:8; toruli 1.5x their width above mouth margin, funicular segments 1.1-3x longer than broad, club 3-segmented and strongly obliquely truncate, 0.55x length of funicle, sensory area 0.75-0.82x length of club (Fig. 87).

Mesoscutum with reticulate sculpture similar to frontovertex; axillae meeting and greatly elevated above scutellum; scutellum slightly flat and with reticulate sculpture that is shallower than mesoscutum; forewing 2.3-2.5x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about 2x longer than broad, stigmal vein about 1.5x length of marginal vein, postmarginal vein subequal to length of stigmal vein (Fig. 90).

Metasoma subequal to length of mesosoma; cerci inserted 2/3 from anterior end of metasoma; hypopygium reaching 0.75-0.8x length of metasoma and simple (Fig. 92); ovipositor 0.65x length of midtibia and slightly exserted, second valvifer not fused to third valvula and without spicules; weakly sclerotized epiproct present.

Male. Length 1.67-1.83 mm. Similar to female but toruli 2x their width above mouth margin, funicular segments 1.8-3.4x longer than broad, club 0.25x length of funicle (Fig. 88); midfemur and tibia dark brown-black, tan at the apices; phallobase 0.5x length of midtibia and with 6-9 pairs of setae, each digitus with 1 apical and 1 subapical claw, a single pore present or absent between claws (Fig. 93), aedeagus without sensilla (Fig. 94).

Variation. Very little, other than size. Most females have the apex of the ovipositor white or tan. Males may or may not have a pore between the claws of the digiti.

Biology and hosts. Reared from the following Nearctic Geometridae: *Dysstroma citrata* (L.), *D. truncata* (Hufn.), and *Plemyria georgii* Hulst (Larentiinae). Recorded from the

following European hosts: *Epirrita dilutata* (Den. & Schiff.), *Eupithecia centaureata* Den. & Schiff., *E. pimpinellata* Hb., *E. lariciata* Freyer, *E. succenturiata* L. (Geometridae: Larentiinae); *Geometra* (Geometridae: Geometrinae); *Depressaria caucella* Den & Schiff., *D. nervosa* Haw. (Oecophoridae: Depressarinae); and *Tortrix* (Tortricidae: Tortricinae) (Hoffer 1970a, Trjapitzin 1989).

Distribution. Occurs in Europe and in the Nearctic region from Newfoundland to Alaska, south to the Mexican state of Oaxaca.

Discussion. Several specimens examined from Taiwan are extremely close to the Nearctic and Palearctic material studied. A single specimen from Taiwan has a distinctly shorter marginal vein and longer postmarginal vein than the Holarctic or other Taiwanese material, and may represent an undescribed but closely related species. A single male from Ecuador has antennae and wing venation similar to *C. chalconotus*, but has the middle tooth much longer than the others, infuscate forewings, very different genitalia, and is undoubtedly an undescribed species.

Other material examined. CANADA: Alberta: Allison Creek, 2.viii.1955, ex *Plemyria geo*. (1 ♀, CNC); Athabasca, 8.vii.1954, ex: *Dysstroma truncata* (16 ♂, CNC); Athabasca, 30.vi.1952, ex: *Dysstroma truncata* (25 ♂, CNC); Colinton, 9.vii.1954, ex: *Dysstroma truncata* (13 ♀, CNC); Elkwater L., 20.vii.1956, O. Peck (1 ♀, 1 ♂, CNC); Pridis, 17.vii.1954, ex: *Dysstroma citrata* (15 ♀, 2 ♂, CNC); **Newfoundland: Labrador**: Kenemich River, 2.viii.1958 B.S.E.S. Expedition (1 ♀, BMNH); **Nova Scotia**: Cape Breton Highlands National Park, Pleasant Bay, 24.vii.1983, L. Masner (3 ♀, CNC); **Quebec**: Old Chelsea, Hing. Mt 1150', 1.viii.1969 (1 ♀, BMNH); **Saskatchewan**: Meadow Lake, 27.ii.47 (1 ♂, NFC); **USA: Alaska**: Naknek R., King Salmon, 13.vii.1952, J.B. Hartley (1 ♀, CNC); Cold Bay, 163° W, 21.viii.1952, W.R. Mason (1 ♂, CNC); 3 mi W Valdez, 24.viii.1948, R.I. Sailer (1 ♂, USNM); **Arizona**: Cococino Co., Flagstaff 7100', 18-25.vii.1979, S.&J. Peck (1 ♂, TAMU); Graham Co., Graham Mts. 270m, Big Creek-Grant Creek, 22.viii.1990, L. Masner (3 ♀, 2 ♂, BMNH); **Colorado**: Clear Cr. Co., Chicago Cr. 8800', 2.viii.1961, S.M. Clark (1 ♂, CNC); Teller Co., 7 m N Woodland Park, South Meadows Camp, 21-28.vii.1977, 8000', S. Peck (4 ♀, 5 ♂, TAMU); **Oregon**: Benton Co., Philomath, Mary's Peak, 14.vii.1985, I.M. Smith (2 ♀, BMNH); **MEXICO: Oaxaca**: Llano de las Flores, 15 mi NE Ixtlan de Juarez, 21-vii-1985, J. Woolley G. Zolnerowich 85/082 (1 ♀, TAMU); **ECUADOR**:

Napo Baeza, 2000m, 20-25.ii.1979, Swept W. Mason (1 ♂, CNC); **ITALY**: Valsavaranche-Eaux Rousses, 1700m, 31.viii.69, Boucek (1 ♀, BMNH); **TAIWAN**: Meifeng, 2150m, 26.iv-22.v.1983, H. Townes (6 ♀, 1 ♂, AEI); Nantou Hsien, Meifeng, 22.v.1982, R. Wharton (1 ♀, TAMU); Nantou Hsien E of Shan Kan, 28.v.1990, 2000-2200m, J. Heraty H90/096, deciduous pine forest (1 ♀, TAMU).

Copidosoma charisoma new species

(Figs. 95-102)

Diagnosis. Females of *Copidosoma charisoma* are distinguished from other species of *Copidosoma* by the following characters: antenna elongate, with scape reaching well above top of head and all funicular segments 4-6x longer than broad, club 3-segmented with sensory area restricted to apex of distal segment (Fig. 95), coxae dark, and ovipositor exserted 0.3-0.4x length of metasoma. This species is most similar to *Copidosoma tigrinum* and *C. psephae*. *Copidosoma tigrinum* differs in being smaller and having the forecoxa white and *C. psephae* has a shorter scape that does not reach above the top of the head.

Female. Length 1.9-2.15 mm, excluding ovipositor. Body dark brown; frontovertex with green or blue-green highlights, with some purple mixed in, scrobes and genae with purple highlights, scape dark brown with green highlights, lighter in distal 1/3, pedicel dark brown, lighter at the apex, funicular segments and club uniformly dark brown; mesoscutum, with mixed green and purple highlights, axillae and scutellum with purple highlights, scutellum laterally and posteriorly with green highlights, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with green-blue highlights anteriorly and purple-blue highlights posteriorly; coxae dark brown, forefemur dark brown in proximal 1/3 with remainder tan, or entirely tan, foretibia and tarsi tan, midfemur tan, midtibia tan or with proximal 1/2 brown that fades to tan, midtarsi 1-4 tan, tarsus 5 darker, hind femur dark brown, lighter at apices, hind tibia brown or dark brown in proximal 1/2 that fades to tan, hind tarsi tan, or tan with tarsus 5 brown; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.35-0.4x head width and with fine reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye reaching occipital margin, or separated by less than the diameter of a facet, eye height 2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL;

POL 1:2:7; toruli 0.5x their width from mouth margin, scape elongate, reaching well above top of head, funicular segments 4-6x longer than broad, club 3-segmented and 0.35x length of funicle, sensory area restricted to apex of distal segment (Fig. 95).

Mesoscutum with fine reticulate sculpture similar to frontovertex but shallower; axillae meeting and greatly elevated above scutellum; scutellum convex and with sculpture similar to frontovertex but more elongate laterally and shallower posteriorly; forewing 2.5x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein about 2.5x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 98).

Metasoma 1.3-1.5x length of mesosoma; cerci inserted 1/3-1/2 from anterior end of metasoma; hypopygium reaching apex of metasoma, bilobed anteriorly and emarginate posteriorly (Fig. 99); ovipositor 1.9x length of midtibia and exserted 0.3-0.4x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.36-1.53 mm. Similar to female but toruli 2x their width from mouth margin, funicle and club tan, contrasting with brown scape and pedicel, funicular segments 2.5-4x longer than broad, club 0.3x length of funicle (Fig. 96); axillae not as elevated; scutellum less convex; metasoma subequal to length of mesosoma; phallobase 0.8x length of midtibia and with 24-27 pairs of setae (Fig. 101), each digitus with 3 apical claws and without pores (Fig. 100), aedeagus without sensilla (Fig. 102).

Variation. Specimens vary in the extent of dark color on the fore femur and mid and hind tibia. Those from northern localities are darker, while those from are Florida lighter.

Biology and hosts. Unknown.

Distribution. Present in the eastern USA, from Pennsylvania to Florida.

Etymology. A combination of Greek *char*, meaning graceful, and *soma*, body.

Holotype ♀ mounted on a card, "USA: Florida/Tallahasee/V.1986" "H. Howden/BM 1986-330". Red label "HOLOTYPE/Copidosoma/charisoma/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **CANADA**: same data as holotype (2 ♀, 3 ♂, BMNH); **USA**: **Florida**: Alachua Co., 4 mi SW Gainesville, Hogtown Ck., V-27-1983, R.M. Reeves, pitfall (1 ♀, BMNH); Gainesville, V.1986, H. Howden (4 ♀, 2 ♂, BMNH); Tallahassee, 18-23.V.1986, H. Howden, FIT (1 ♀, TAMU). Paratypes to be deposited in BMNH, CNC, TAMU, and USNM.

Other material examined. **USA**: **North Carolina**: Highlands, Skittle Creek, 18.vii.1957, W.R. Richards (1 ♀, CNC); **Pennsylvania**: Centre Co., University Park, 17.vii.1989, R. Wharton (1 ♀, TAMU); **Virginia**: Bedford Co., Blue Ridge, 1500', 31.v-21.viii.81, S.B. Peck (4 ♀, 1 ♂, BMNH).

Copidosoma cheranae new species

(Figs. 103-106)

Diagnosis. Females of *Copidosoma cheranae* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 103), dorsal tentorial arms present but reduced, forecoxae white, hind tibia and tarsi dark brown, and epiproct present. This species is most similar to *Copidosoma innocuellae* and *C. pseudoinnocuellae*. These species have extensive white-tan areas on the hind leg and lack an epiproct.

Female. Length 1.35-1.48 mm. Body dark brown; frontovertex brassy green with purple highlights, scrobal area and genae with purple highlights; scape dark brown, tan at apex, pedicel and funicular segments dark brown dorsally and laterally, yellow-tan ventrally, club dark brown; mesoscutum brassy green with some purple highlights, axillae and scutellum with purple highlights, scutellum with green highlights laterally and posteriorly, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with green and blue highlights anteriorly and purple highlights posteriorly; forecoxa, femur, and tibia white-tan, foretarsi brown, midcoxa dark brown, midfemur white-tan except for dark brown patch in distal 1/2, midtibia with dark brown area in proximal 1/2, remainder tan, midtarsi tan, hind coxa dark brown, hind femur white in proximal 1/2-2/3, remainder dark brown, hind tibia and tarsi dark brown; forewing slightly infuscate, darkest around venation.

Frontovertex slightly more than 0.5x head width and with reticulate sculpture that is elongate on lower face and genae; dorsal arms of tentorium reduced to fine filaments;

mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of a facet, eye height 1.7x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:8; toruli 1.5x their width from mouth margin, funicular segments 1.5-1.8x longer than broad, club 3-segmented and 0.6x length of funicle, sensory area restricted to apex of distal segment (Fig. 103).

Mesoscutum with sculpture similar to frontovertex but finer; axillae meeting and greatly elevated above scutellum; scutellum convex and with sculpture similar to mesoscutum but shallower, nearly polished at apex; forewing 2.2x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein barely longer than broad, stigmal vein 3x length of marginal vein, postmarginal vein about 0.3x length of stigmal vein (Fig. 104).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma and with short anterior lobe (Fig. 106); ovipositor slightly shorter than length of midtibia and barely exserted, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Unknown.

Variation. Very little, other than size, in the specimens available.

Biology and hosts. Unknown.

Distribution. Known only from Guerrero and Michoacan, Mexico.

Etymology. Named for the type locality near Cheran, Michoacan.

Holotype ♀ mounted on a point with a card underneath, "MEXICO: Michoacan/6 miles N. Cheran/7-8-VII-1985, J. Woolley/G. Zolnerowich 85/034". Red label "HOLOTYPE/ Copidosoma/cheranae/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. MEXICO: same data as holotype (12 ♀, TAMU); **MEXICO: Guerrero**: 6.4 mi SW Filo de Caballo, 9000', 8.VII.1987, Woolley & Zolnerowich (1 ♀, TAMU). Paratypes to be deposited in BMNH, CNC, TAMU, and USNM.

Copidosoma compressa new species

(Figs. 107-110)

Diagnosis. Females of *Copidosoma compressa* are distinguished from other species of *Copidosoma* by the following characters: head very narrow in lateral view, body dorsoventrally compressed, club unsegmented and strongly obliquely truncate (Fig. 107), hypopygium reaching apex of metasoma, and ovipositor exserted at least 0.3x length of metasoma. This species is most similar to *Copidosoma melanocerum*, which has all the funicular segments longer than broad (Fig. 271) and the hypopygium reaching 0.6x or less the length of the metasoma.

Female. Length 0.92-1.05 mm, excluding ovipositor. Color dark brown to black; frontovertex with green highlights, scrobal area and genae with purple highlights; scape nearly black, flagellum dark brown; mesoscutum with brassy green highlights, axillae and scutellum with bronze purple-green reflections, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; legs entirely dark brown or black, but midfemur with proximal hyaline ring, occasionally tarsi and extreme apices of femora and tibiae slightly lighter in color, forewing infuscate around marginal and stigmal veins.

Frontovertex 0.5x head width and with shallow reticulate sculpture that is more shallow and elongate on lower face and genae; mandible with 3 teeth, dorsal tooth shortest and posterior longest (as in Fig. 405); eye separated from occipital margin by the diameter of a facet, eye height 2x malar space; ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 1:2:7; toruli separated from mouth margin by their width, funicular segments subquadrate, club unsegmented and strongly obliquely truncate, 0.75x length of funicle, sensory area 0.45x length of club (Fig. 107).

Mesoscutum with reticulate sculpture, the cells larger and deeper than those of the frontovertex; axillae meeting and barely elevated above scutellum, scutellum flat and with elongate reticulate sculpture, apex nearly polished, forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein about 2x longer than broad, stigmal vein slightly longer than marginal vein, postmarginal vein about 0.3x length of stigmal vein (Fig. 109).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma, hypopygium elongate (Fig. 110) and reaching apex of metasoma; ovipositor 2x length of

midtibia and exserted 0.3-0.5x length of metasoma, second valvifer fused to third valvula, and with a transverse cluster of spicules (as in Fig. 432); epiproct present.

Male. Unknown.

Variation. Specimens differ mostly in relative darkness of color, ranging from dark brown to black. Although specimens have a distinct postmarginal vein, some have the vein nearly absent.

Biology and hosts. Unknown.

Distribution. Alberta and Quebec south to North Carolina and Texas.

Etymology. From Latin *compressus*, referring to the distinctive flattened head and body.

Holotype ♀ mounted on a card, "USA.: Virginia/Montgomery County/8km NW. Blacksburg" "1000m 1-17.ix.1987/BRC Hym. Team./BM 1989-149". Red label "HOLOTYPE/Copidosoma/compressa/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **USA**: same data as holotype (2 ♀, BMNH, 1 ♀, TAMU); **USA**: **Virginia**: Montgomery Co., 8Km NW Blacksburg, 1-8.IX.1987, BRC Hym Team Malaise, forest edge (8 ♀, TAMU); 8Km NW Blacksburg, ix.1987, BCR Hym. Team (2 ♀, BMNH); **North Carolina**: McDowell Co., 37° 00'N, 81° 30'W, 4.VII-17.IX.1987, BRC Hym Team (5 ♀, BMNH); McDowell Co., 37° 00'N, 81° 30'W, 9.IX-24.XI.1987, BRC Hym Team (17 ♀, TAMU); McDowell Co., 37° 00'N, 81° 30'W, ix-xi.1987, BRC Hym Team (11 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. **USA**: **Delaware**: 24.viii.1931, L.A. Stearnes (1 ♀, USNM); **Maryland**: Calvert Co., Port Republic, viii-ix.1986, M. Sharkey & S. Monroe (1 ♀, BMNH); **Michigan**: Kalamazoo Co., Gull Lake Bio. Sta., 12viii.1972, Roland L. Fischer (1 ♀, MSUE); Ann Arbor, viii.1976, I. Gauld (1 ♀, BMNH); Ann Arbor, ix.76, Gauld (1 ♀, BMNH); Ann Arbor vii.82, Fitton & Quinlan (2 ♀, BMNH); **Minnesota**: Winona Co., 30.viii.1936, H.R. Dodge (1 ♀, UMSP); **Missouri**: Wayne Co., Williamsville, 1-19.vi.1988, J.T. Becker (8 ♀, TAMU); **North Carolina**: Horse Cove,

Highlands 3000', ix.1980, L.Masner (1 ♀, BMNH); **Ohio**: Hocking Co., Pine Creek, Rt. 11, 5.ix.1987, J. Whitfield (3 ♀, TAMU); **Texas**: Travis Co., Austin, Zilker Park, 8-x-1983, J.B. Woolley 83/002 (1 ♀, TAMU); **Wisconsin**: Milwaukee, Fox Point (suburb), 2.ix.1983, J.T. Huber (1 ♀, CNC); **CANADA**: **Alberta**: Medicine Hat, viii.1980, G.A.P. Gibson (7 ♀, TAMU); **Ontario**: Hamilton, 22.viii.1981, M. Sanborne (4 ♀, BMNH); Ottawa, viii.1987, H. Goulet (1 ♀, BMNH); Quebec: Lac Roddick, 1.ix.1985 Noyes (1 ♀, BMNH).

Copidosoma confusa new species
(Figs. 111-118)

Diagnosis. Females of *Copidosoma confusa* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 111), scutellum with shallow, wide elongate reticulate sculpture, and hypopygium with a deep posterior emargination (Fig. 115). This species is most similar to *Copidosoma celaenae* Howard and *C. cuproviridis* Springate & Noyes, which have deep, elongate reticulate, nearly striate, sculpture on the scutellum (as in Fig. 414).

Female. Length 1.1-1.22 mm, excluding ovipositor. Body dark brown; head with brassy green or blue-green highlights; scape similar to head, flagellum uniformly dark brown; mesoscutum similar to head, axillae and scutellum with brassy green and purple highlights, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae and hind leg dark brown, fore- and midfemora dark brown but slightly lighter at distal end, midfemur with proximal hyaline ring, fore- and midtibiae dark brown, lighter at the apices, fore- and midtarsi 1-4 brown, tarsi 5 darker; forewing infuscate around marginal and stigmal veins, infuscation occasionally extending to filum spinosum.

Frontovertex slightly more than 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth shortest and posterior longest (as in Fig. 405); eye separated from occipital margin by about the width of a facet, eye height 2x malar space; ocelli forming an obtuse angle, posterior ocelli much closer to occipital margin than to eyes, OOL:OPL:POL 4:1:6, or posterior ocelli touching occipital margin; toruli separated from mouth margin by their width, funicular segments broader than long or quadrate, club unsegmented and subequal to length of funicle, sensory area 0.5x length of club (Fig. 111).

Mesoscutum with deep reticulate sculpture that is more elongate anteriorly and laterally; axillae meeting and slightly elevated above scutellum; scutellum flat and with elongate reticulate sculpture; forewing 2.2-2.3x longer than wide, apex of submarginal vein with apical break, linea calva interrupted by dorsal setae, marginal vein 1.5x longer than broad, stigmal vein about 1.5x length of marginal vein, postmarginal vein about 0.5x length of stigmal vein (Fig. 114).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching about 0.7x length of metasoma and with deep posterior emargination (Fig. 115); ovipositor 1.4x length of midtibia and exserted 0.15x length of metasoma, second valvifer fused to third valvula, with a transverse cluster of spicules (as in Fig. 432); epiproct present.

Male. Length 0.96-1.1 mm. Similar to female; frontovertex and scutellum with white and purple highlights, mesoscutum with blue-green highlights; funicular segments slightly longer than broad, club 0.5x length of funicle (Fig. 112); midtarsi 1-4 tan; phallobase 0.7x length of midtibia and with 18-21 pairs of setae (Fig. 117), each digitus with 2 apical and 1 proximal claw and a single pore near apical claws (Fig. 116), aedeagus with a pair of hooks and a pair of sensilla (Fig. 118).

Variation. Specimens differ mostly in extent of blue versus green highlights.

Biology and hosts. Unknown, but given membership in the clade with that includes *C. bakeri* and *C. celaenae*, the host is likely Noctuidae.

Distribution. Known from the central and northern US and Alberta and Ontario.

Etymology. From Latin *confus*, confused, because this species perplexed me for a long time.

Holotype ♀ mounted on a point with a card underneath, "Neb. Sioux Co./Agate Fossil/Beds Nat. Mon/31Aug85 Hanson". Red label "HOLOTYPE/Copidosoma/ confusa/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: Iowa: Dickinson, Cayler Prairie, 9 Sep. 1985, Paul Hanson (1 ♀, BMNH); **Kansas**: Mitchell Co., 2 mi W Glen Elder, 28.VIII.1985, J.D. Pinto (6 ♂,

TAMU); **Minnesota**: Swift Co., Chippewa Prair., 3mi. SE Appleton, 3Sep85 Hanson (2 ♀, BMNH); Wilkin Co., TownHall Prair., 5mi. SW Rothsay, 4Sep85 Hanson (1 ♀, BMNH); **Ohio**: Oak Harbor, Aug. 25 '25, on sunflowers, W.V. Balduf coll., 6263 HM (11 ♀, 6 ♂, USNM, 1 ♂, INHS); Oak Harbor, Aug. 25, 1925, on sunflowers, W.V.B. coll. (10 ♀, 4 ♂, INHS); **Utah**: Logan Canyon, 25.ix.1975, off flower of Chrysothamnus nauseosus, G.F. Knowlton (1 ♀, BMNH); Salt Lake City, 8.IX.1983, J.T. & D.E. Huber (1 ♀, CNC); **CANADA**: **Alberta**: Writing-On-Stone Prov. Prk, viii.1981, D. McCorquadale (2 ♀, BMNH); **Ontario**: Morrisburg, viii.1985 Noyes (1 ♀, BMNH); Ottawa, 20-27.IX. 1985, L. Masner (2 ♀, TAMU); Ottawa, Merivale gdns., 29. viii.1985, J.S. Noyes (1 ♀, BMNH); Ottawa, Mer Bleue, 4-12.ix.1983, L. Huggert (4 ♀, BMNH); Ottawa, Shirley's Bay, 28.VII.1985, H. Goulet (1 ♀, TAMU); nr Ottawa, Constance Bay, 18.viii.1985, J.S. Noyes (1 ♀, BMNH); **Quebec**: Gatineau Park, Ridge Rd., viii.1985, J.S. Noyes (6 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, INHS, TAMU. UCR, and USNM.

Copidosoma cuproviridis Springate & Noyes
(Figs. 119-126)

Copidosoma cuproviridis Springate & Noyes, 1990: 219. [BMNH, ♀, ♂ paratypes examined].

Type Material. Holotype data "WALES: W. Glam./Whitford Burrows NNR/1.viii.1984 J. Noyes".

Diagnosis. This species was well described by Springate and Noyes (1990) and is distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 119), mesoscutum with reticulate sculpture, scutellum with deep elongate reticulate sculpture (as in Fig. 414), and ovipositor exserted about 0.2x length of metasoma. It is most similar to *Copidosoma celaenae*, which does not have the ovipositor exserted.

Variation. Specimens vary mostly in the depth of the sculpture on the frontovertex and mesoscutum and the ratio of green or blue-green and purple highlights.

Biology and hosts. Unknown.

Distribution. Described from Wales, England. Present in the Nearctic from Quebec west to Alberta, and south to Arizona, Colorado, and Nebraska.

Discussion. Springate and Noyes' (1990) original description does not mention the epiproct that is present and states the hypopygium reaches just less than 1/2 the length of the metasoma. Measurements of 2 paratypes and additional material shows it reaches 0.6-0.68x the length of the metasoma. This species is frequently collected with *C. celaenae*.

Other material examined. USA: Arizona: Cococino Co., Flagstaff 7100', 18-25. vii.1979, S.&J. Peck (5 ♀, 3 ♂, TAMU); **Colorado**: Teller Co., Florissant, Petrified Forest Area, 2530m 11.viii.1973, Paul H. Arnaud, Jr. (2 ♀, CAS); **Idaho**: Fremont Co., St. Anthony Dunes, 5400' 1-2.vii.1980, M.S. Wasbauer (3 ♀, 5 ♂, CDFA); **Illinois**: Mason Co., Sandridge St. Forest, 6.vii.80, S. Heydon (1 ♀, BMNH); **Michigan**: Wexford Co., 21-28.vii.1965, J.H. Shaddy, Pit trap in planted Jack Pine Plantation (1 ♀, MSUE); **Nebraska**: Sioux Co., Agate Fossil Beds Nat. Mon., 31.viii.1985 Hanson (1 ♀, BMNH); **Oregon**: Indian Ford, 6m. W Sisters, Deschutes N.F., viii.1965, E.&I. Munroe (1 ♀, BMNH); **CANADA: Alberta**: Edmonton, vii.1984, Finnamore (1 ♀, TAMU); Lethbridge Ag. Res. St., 9-15.vii.1980, G.A.P. Gibson (2 ♀, BMNH); Writing-on-Stone Prov. Prk., viii-ix.1981, D. McCorquodale (1 ♀, BMNH, 2 ♀, TAMU); **Ontario**: Ottawa, Merivale gdns., 29.viii. 1985, J.S. Noyes (24 ♀, BMNH); East Carleton Place, 10.ix.1983, L. Huggert (1 ♀, BMNH); Manitoulin Island, 17.viii.82, M. Sharkey (2 ♀, 1 ♂, BMNH); nr. Ottawa, Constance Bay, 18.viii.1985, J.S. Noyes (2 ♀, BMNH); Constance Bay, 22.ix-8.xi.1983, M. Sanborne (1 ♀, BMNH); 15km W. Ottawa, Shirley's Bay, 10.ix.1985, J.S. Noyes (1 ♀, BMNH); Rainy River, 3.viii.1960, S.M. Clark (2 ♀, CNC); **Quebec**: Hwy 201, 8 Km SW Rigaud, 9.ix.1985, J.S. Noyes (46 ♀, BMNH); Hwy 201, 8 Km SW Rigaud, 9.ix.1985, L. Masner (4 ♀, TAMU); Gatineau Park, King Mt., 24.viii.1985, J.S. Noyes (2 ♀, BMNH); Lac Roddick, 1.ix.1985 Noyes (4 ♀, BMNH); Saskatchewan, Mt. Nebo, 25.vii.1990 (1 ♀, 2 ♂, TAMU).

Copidosoma deceptor Miller

(Figs. 127-134, 439)

Copidosoma deceptor Miller, 1958: 57. [CNC, ♂ holotype examined].

Type Material. Holotype ♂ on a point, "HOLOTYPE/Copidosoma/deceptor Miller/No. 6516" [red label] "Slide/No. 217" [blue label] "Cascade Valley/22M. N.E. Banff/Alta./ Alc./Lot 52-280" [handwritten in ink] "ex-/Recurvaria/sp." [handwritten in ink]. Holotype missing left antenna, which was apparently mounted on a slide that is missing. Seventy-four additional paratypes examined.

Diagnosis. *Copidosoma deceptor* was well described by Miller (1958) and is distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with the sensory area restricted to apex of distal club segment, first funicular segment about 0.6x length of the second funicular segment (Fig. 127), hypopygium reaching 0.9x length of the metasoma, and epiproct present. No other species has this combination of characters.

Variation. Specimens range from 1.15-1.5 mm, with the ovipositor exserted 0.25-0.35x length of metasoma. A series reared from a species of *Coleotechnites* (Gelechiidae) in Louisiana has funicular segments much shorter than other typical specimens.

Biology and hosts. Reared from the following Lepidoptera: *Argyresthia thuiella* (Pack.) (Argyresthiidae); *Coleotechnites apicitripunctella* (Clem.), *C. atrupictella* (Dietz), *C. canusella* (Free.), *C. gibsonella* (Kft.), *C. huntella* (Keif.), *C. milleri* (Bsk.), *C. moreonella* (Heinr.), *C. piceaella* (Kft.), *C. resinosae* (Free.), *C. starki* (Free.), *C. thujaella* Kft., *Exoteleia dodecella* (L.), *E. pinifoliella* (Cham.) (Gelechiidae: Gelechiinae); *Zeiraphera condenses* Mutuura & Free. (Tortricidae: Olethreutinae); *Acleris* (Fern.), *Archips* Hbn., *Aethes* Billberg (Tortricidae: Tortricinae); and *Dioryctria* Mutuura & Mun. (Pyralidae: Phycitinae) (label data, Miller 1958). Gordh (1979) also lists *Argyresthia aureoargentella* Brower (Argyresthiidae), *Battaristis vittella* (Bsk). (Gelechiidae: Anacampsinae), and *Epinotia nanana* (Treit.) (Tortricidae: Tortricinae) as hosts. Peck (1963) includes *Recurvaria nanella* (D. & S.) (Gelechiidae: Gelechiinae) as a host.

Several unusual or anomalous hosts are listed on labels. These include a single specimen reared from *Choristoneura fumiferana* (Clem.) (Tortricidae: Tortricinae) and specimens labelled as reared from *Pseudeva purpurigera* (Wlk.) (Noctuidae: Plusiinae). In addition, 3 specimens reared by Dr. E. Eveleigh in New Brunswick list *Glypta* Gravenhorst (Hymenoptera: Ichneumonidae) and *Meteorus* Haliday (Hymenoptera: Braconidae) as hosts. Both of these genera parasitize Lepidoptera larvae.

Distribution. Found from Newfoundland to British Columbia, and south to Louisiana.

Discussion. For a number of years, this species was confused with *C. nanellae* Silvestri, a species found in Europe. Literature referring to *C. nanellae* in the Nearctic actually refers to *C. deceptor*.

Other material examined. USA: **Arizona**: Cochise Co., Chiricahua Mts., 9.ix.1979, 5400m, V. Roth (1 ♀, BMNH); Cococino Co., Grand Canyon N.P. north rim, el. 8300', Thompson Canyon, 12-16.ix.1977, S.&J. Peck (1 ♀, TAMU); **California**: Tenaya L., 10.vii.1953, J.H. McCleod, Host *Recurvaria* sp., Lodgepole pine (5 ♀, 2 ♂, CNC); Lake Tenaya, 5.viii.49, *Recurvaria milleri* Busck (2 ♀, CNC); Lake Tenaya, 7.1.1953, *Pinus contorta*, G.R. Struble (1 ♂, USNM); Yosemite Nat. Park, 31.vii.1917, J.E. Patterson, reared from *Pinus murrayana* (4 ♀, 5 ♂, USNM); Yosemite Nat. Park, 25.v.1919, J.E. Patterson, *Pinus murrayana*, Ex *Recurvaria milleri* (2 ♀, 2 ♂, USNM); Yosemite Nat'l. Pk., 9.vii.1953, J.H. McCleod, Host white pine needle miner (1 ♀, CNC); Calaveras Co., West Point, v.21.1935, reared from *Azalea eucordylea* 19.vi.1935 (7 ♀, CDFA); Riverside Co., Pinyon Flat, 3 mi. W. on Hwy. 74, 24.vi.1964, E.F. Riek, G.I.Stage (5 ♀, LACM); **Idaho**: 17.viii.49, *Recurvaria milleri* Busck (1 ♀, CNC); **Louisiana**: Melder, ex *Evagora* sp. on red cedar, J.G. Chillcot, v.1960 (17 ♀, 3 ♂, BMNH); **Maine**: iv.1971, D. Leonard, ex. *Choristoneura fumiferana* (1 ♀, MSU); **Michigan**: Ann Arbor, vii.82, Fitton & Quinlan (2 ♀, 4 ♂, BMNH); **Montana**: Arlee, 15.vii.1977, S. Tunnock, needle miner Ponderosa pine (6 ♀, 8 ♂, USNM); **New York**: Tompkins Co., Ithaca, 6-mile Ck., 15.vii.1981, D.C. Darling (1 ♀, DCD); **Oregon**: Brookings, 8.v.1940, C.F. Doucette, Ex. *Eucordylea huntella* on *Rhododendron* (2 ♀, 2 ♂, USNM); Lakeview, 30.vii.1954, D. Peters, ex. *Recurvaria* (1 ♀, USNM); Portland, vi.1971, Rhododendron bud moth, Schuh (1 ♀, USNM); Benton Co, vic. of Corvallis, 19.vii.1984, D.C. Darling (1 ♀, DCD); Deschutes Co., 2 mi. E Sisters, 1.vii.1986, P. Hanson (1 ♀, BMNH); **Pennsylvania**: Westchester, iv.1964, ex *Pulicalvaria* Hemlock (11 ♀, 6 ♂, BMNH); **South Carolina**: Anderson Co., Pendleton, 250m, 24.vi-1.vii.1987, BRC Hym Team (1 ♀, BMNH); **Utah**: Murray, 23.vii.1913, on willow, Timberlake (1 ♀, UCR); **West Virginia**: Pocahontas Co., E. Richwood, 23-28.vii.1983, L.Huggert (1 ♀, BMNH); **Wisconsin**: Two Rivers, 12.vii.1963, T. Torgersen (1 ♂, USNM); **CANADA**: **Alberta**: Banff, 10-16.vii.1962, ex. *Evagora starki* (15 ♀, 5 ♂, NFC); Banff, summer 1944, G.R. Hopping (2 ♀, 1 ♂, NFC); Mi. 8 E. Banff, 25.vii.1949 (2 ♂, NFC); Hillsdale, 27.vii.1948 (1 ♀, NFC); Jasper, 22.ix.1948, Host: *Recurvaria starki* (1 ♀, NFC); Mt. Norguay, 10-

12.viii.1962, Ex. *Evagora starki* (2 ♀, 3 ♂, NFC); **British Columbia**: near Vermillion Summit, 18.viii.1942 (5 ♀, CNC); **Manitoba**: Spruce Woods, 13.vii.1946, ex. Olethreutid sp. (6 ♀, NFC); **New Brunswick**: Fredericton, *Argyresthia* leaf miner on *Arborvitae*, 15.vii.1950 (1 ♀, CNC); St. Quentin, 12.vii.1990, Host *Glypta* sp. (2 ♀, TAMU); Acadia, 28.vii.1988, Host: *Meteorus* sp. (1 ♀, TAMU); **Newfoundland**: 1 Km West Doyles, 25.vi.1985, ex: *Coleotechnites piceaella* Kft., on balsam fir (2 ♀, CNC); Hopeall, 4.vii.1984, ex: *Coleotechnites piceaella* Kft., on balsam fir (1 ♀, 1♂, CNC); **Ontario**: Alfred Bog, 17.ix.1984, M. Sanborne (2 ♀, BMNH); Bell's Corners, 17.vi.1954, T.N. Freeman, Ex: *Recurvaria*, spruce (9 ♀, CNC); 3Km N. Almonte, 2-9.vii.1986, Denis & Dumouchel (5 ♀, BMNH); Almonte, 23.vii.1986, J.T. Huber (1 ♀, BMNH); Gloucester, McCarty Wood, 11.vii.1986, L. Masner (1 ♀, BMNH); Kemptville, 12-7-56, ex. *Recurvaria thujaella* (7 ♂, CNC); Innisville, Carleton Place, 10.viii.1985, J.S. Noyes (1 ♀, BMNH); Lac Midhurst, 23.vi.1962, L. Simcoe, ex: *Evagora piceaella* (4 ♀, 1 ♂, CNC); Merivale, 11.vi.1939, G.S. Walley, *Recurvaria* on hemlock (1 ♀, CNC); Midhurst, 4.vi.1962, L.Simcoe, ex. *Evagora piceaella* (11 ♀, 21 ♂, CNC); Nipigon, 7.viii.1950, ex *Zeiraphera* (3 ♀, CNC); Ottawa, 6.vii.1986, H. Goulet (1 ♂, TAMU); Ottawa, Constance Bay, 29.vi-10.vii.1983, M. Sanborne (2 ♂, BMNH); Oxford Mills, vii.1978, Tulsiram (1 ♂, BMNH); Valora, 17.vii.1956, Ex *Recurvaria* (18 ♀, 7 ♂, CNC); Vermilion Bay, 2.viii.1950, ex *Zeiraphera* (1 ♀, 2 ♂, CNC); **Quebec**: Berthierville, 29.vi.1943, *Recurvaria* (1 ♀, CNC); Fairy Lake, 6.vi.1954, T.N. Freeman (7 ♀, 4 ♂, CNC); Gatineau Park, Champlain Overlook, 22.vii.1989, Woolley & Zolnerowich (1 ♀, 1 ♂, TAMU); **Saskatchewan**: Whitewood, 28.vii.1944 (1 ♂, NFC).

Copidosoma desantisi Annecke & Mynhardt

(Figs. 135-142)

Copidosoma desantisi Annecke & Mynhardt, 1974: 31. [UNLP, type not examined].

Type Material. Holotype ♀, 164 ♀ and 119 ♂ paratypes labelled "CALIFORNIA: Albany, L. Caltagirone, lab. stock F25 of parents from Limache, Chile, ex Phthorimaea operculella" (Annecke & Mynhardt 1974).

Diagnosis. Females of *Copidosoma desantisi* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with the sensory area restricted to apex of the distal club segment (Fig. 135), forewing infuscate at base and around

venation, postmarginal vein 0.5x length of the stigmal vein (Fig. 138), hypopygium not reaching apex of metasoma, and ovipositor exserted about 0.2x length of the metasoma. This species is most similar to *Copidosoma tamaulipasensis* and *C. koehleri*. *Copidosoma tamaulipasensis* differs in having a 2-segmented club that is pointed at the apex (Fig. 357), and *C. koehleri* has a hyaline forewing and the postmarginal vein less than 0.5x length of the stigmal vein (Fig. 240).

Variation. Very little, other than overall size, in the material studied.

Biology and hosts. Reared only from *Phthorimaea operculella* (Zell.) (Gelechiidae: Gelechiinae).

Distribution. Native to South America, but introduced into the U.S. and many other countries as *C. koehleri* for control of the potato tuber moth (Annecke & Mynhardt 1974, Clausen 1978).

Discussion. This species is very similar to *C. koehleri*, which utilizes the same host. Under the species name *koehleri*, both *desantisi* and *koehleri* were introduced into a number of countries for control of the potato tuber moth (Annecke & Mynhardt 1974, Clausen 1978). Not recognizing there were two species involved, Doutt (1948) erected the genus *Arrenoclavus* to include *koehleri*, and De Santis (1963) redescribed the species. Tachikawa (1968) recognized there were two distinct species with the same name, and using the species concept of *koehleri* as it was understood at that time and without examining the types, described *C. uruguayensis* as new and provided a detailed comparison of characters between it and *C. koehleri*.

Annecke and Mynhardt (1974) studied the relevant type material and found *C. uruguayensis* was actually *C. koehleri*, and the "*koehleri*" referred to in Doutt (1948), De Santis (1963), and Tachikawa (1968) was the second, and undescribed, species. Annecke and Mynhardt described this species as *desantisi*. Though *C. desantisi* and *C. koehleri* are very similar, the comparison provided by Tachikawa (1968) remains valid, though in that paper *uruguayensis* is actually *koehleri*, and *koehleri* is actually *desantisi*.

Other material examined. CHILE: La Cruz, UC Berkeley, received 10.x.1970 (14 ♀, 8 ♂, TAMU); **BERMUDA**: Southhampton, vi-vii.1948, M.C. Silva, ex. potato tubers (2

♀, 4 ♂, USNM); USA: California: UC Berkeley Culture, 25.vii.1988 (12 ♀, 10 ♂, TAMU).

Copidosoma evansi n. sp.
(Figs. 143-146)

Diagnosis. Females of *Copidosoma evansi* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with the sensory area restricted to the apex (Fig. 143), forecoxa white, scutellum with elongate reticulate sculpture, postmarginal vein as long as stigmal vein (Fig. 145), and the ovipositor exserted 0.3-0.5x length of the metasoma. *Copidosoma charisoma* and *C. psephae* are similar but have the forecoxa dark brown, reticulate sculpture on the scutellum, and the postmarginal vein less than 0.5x length of the stigmal vein (Fig. 98).

Female. Length 1.2-1.8 mm, excluding ovipositor. Body dark brown; frontovertex with pale green, purple, and white highlights, scrobal area and genae with pale purple highlights; antenna brown to dark brown, pedicel lighter at the apex; mesoscutum with green and purple highlights, axillae and scutellum with purple highlights, scutellum laterally with green highlights, propodeum laterally with purple highlights and translucent setae lateral to spiracle, mesopleuron with green and blue highlights anteriorly and purple highlights posteriorly; forecoxa white, forefemur, tibia, and tarsi 1-3 tan, foretarsi 4-5 brown, midcoxa dark brown, midfemur white or tan, midtibia and tarsi 1-4 tan, midtarsus 5 brown, hind coxa dark brown, hind femur white in proximal 1/3-1/2, remainder dark brown, hind tibia and tarsi 1-3 tan, hind tarsi 4-5 brown; forewing hyaline.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of a facet, eye height 2x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; toruli separated from mouth margin by 0.5x their width, funicular segments 2-3.5x longer than broad, club 3-segmented and rounded at the apex, 0.3-0.38x length of funicle, sensory area restricted to apex (Fig. 143).

Mesoscutum with reticulate sculpture, the cells shallower than those of frontovertex; axillae greatly elevated above scutellum; scutellum convex and with elongate reticulate sculpture; forewing 2.3-2.5x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein about 2x longer than broad,

stigmal vein 1.5x length of marginal vein, postmarginal vein subequal to length of stigmal vein (Fig. 145).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma or beyond and with an anterior lobe (Fig. 146); ovipositor 1.8-2x length of midtibia and exserted 0.3-0.5x length of metasoma, second valvifer not fused to third valvula, with longitudinal spicules (as in Fig. 430); epiproct present.

Male. Unknown.

Variation. Specimens are variable in body size and length of the flagellum. The dark area in the distal portion of the hind femur varies from 1/2 to 2/3 the length of the femur.

Biology and hosts. Reared from *Blastobasis glandulella* (Blastobasidae) in acorns.

Distribution. Maine south to Sinaloa, Mexico, and west to British Columbia and Arizona.

Etymology. Named in honor of E. Evans, my friend and first fishing partner.

Holotype ♀ mounted on a card, "Texas: Bastrop Co./Beuscher [sic] St. Park/10-23.v.1990/R. Wharton". Red label "HOLOTYPE/Copidosoma/evansi/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. USA: same data as holotype (2 ♀, TAMU); TX: Bastrop Co., Buescher St. Prk., 19-29.IV.1990, Wharton & Zolnerowich, malaise (10 ♀, TAMU); Bastrop St. Park, 7-21.X.1990, R. Wharton (1 ♀, TAMU). Paratypes to be deposited in BMNH, CNC, TAMU, and USNM.

Other material examined. USA: **Arizona**: Canoa, 21.vi.1960, G. Butler, suck/cotton (1 ♀, UA); Sunnyside, Huachuca Mts., 10.viii.1977, L. Masner (1 ♀, CNC); Tucson, 30.iii.1958 (1 ♀, LACM); Graham Co., Graham Mts., 270m, Big Creek-Grant Creek, 22. viii.1990, L. Masner (1 ♀, BMNH); Colorado: 21 Km NW Redfeather, 28.viii.1972, R.B. Penfield, *Arceuthobium cyanocarpum* (1 ♀, USNM); **Florida**: Alachua Co., Gainsville [sic]. 24.iv.1989, J.S. Noyes (1 ♀, BMNH); Putnam Co., 2 mi W

Interlachen, 30.v.1991, J.B. Woolley (1 ♀, TAMU); **Maine**: Mariaville, 28.vii.1971 (1 ♀, MSU); **Michigan**: Lake Co., Branch, 20-22.vii.1974, T.A. Bowling, malaise trap (1 ♀, MSUE); **Mississippi**: Oktibbeha Co., 13.xi.1988, D. Adamski, *Blastobasis glandullela* larva in acorn (2 ♀, USNM); **Virginia**: Warren Co., Shenandoah N.P., Compton Gap, 800m, vii-23.viii.1987, BRC Hym Team (1 ♀, TAMU); **Canada**: **British Columbia**: 14.viii.1951, microlep (2 ♀, CNC); **Ontario**: Ottawa, 8-13.vii.1987, J.M. Cumming (1 ♀, BMNH); St. Lawrence Is. Nat. Park, McDonald Is. (1 ♀, CNC); **Mexico**: **Sinaloa**: Culiacan, 13.xi. 1982, W.H. Cross (1 ♀, MSU).

Copidosoma floridanum (Ashmead)
(Figs. 147-154, 411)

Berecyntus floridanus Ashmead, 1900: 365. [USNM, syntypes examined].

Copidosoma japonicum Ashmead, 1904: 154. [USNM, ♀ lectotype examined]. Synonymized by Noyes (1988a).

Litomastix argentinus Brèthes, 1913: 102. [MBA, type not examined]. Synonymized by De Santis (1957).

Holcencyrtus calypso Crawford, 1914: 88. [USNM, ♀ lectotype examined]. Synonymized by Noyes (1988a).

Paracopidosomopsis javae Girault, 1917a: 5. [USNM, ♂ lectotype examined]. Synonymized by Noyes (1988a).

Paracopidosomopsis japonicus nippon Girault, 1917b: 12. [USNM, ♀ lectotype examined]. Synonymized by Noyes (1988a).

Prionomitus brasiliensis Brèthes, 1920: 288. [MBA, type not examined]. Synonymized by Noyes (1988a).

Litomastix walshi Mercet, 1922: 154. [IEE, type not examined]. Synonymized by Noyes (1988a).

Litomastix maculata Ishii, 1928: 115. [NIAS, type not examined]. Synonymized by Noyes (1988b).

Litomastix brethesi Blanchard, 1936: 15. [UNLP, type not examined]. Synonymized by De Santis (1963).

Litomastix daccaensis Mani, 1941: 28. [IARI, type not examined]. Synonymized by Noyes (1988a).

Type Material. Three syntypes mounted on a single point, "BISC. BAY, FLA." "Head mounte" [blue label] "Type/No. 4850/U.S.N.M." [red label] "Barecyntus[sic]/floridanus/♀ Ashm." [handwritten in ink]. One specimen is missing the wings, leg parts, and posterior metasoma, the second specimen is mounted upside down and missing the antennae, and the third specimen is missing the head. A crushed head and antennal parts are on a slide labelled "Berecyntus/floridanus/Ashm./♀ type." [handwritten in ink] "USNM Type No./ 4850/Berencyrtus[sic]/floridanus Ashm." [handwritten in ink on red label]. The sex of these specimens is difficult to determine, but females were the sex described. Because 2 of the point-mounted specimens are missing parts and it is impossible to determine which specimen the slide-mounted parts are from, a lectotype is not designated.

Diagnosis. Females of *Copidosoma floridanum* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate (Fig. 147), scutellum with purple highlights that contrast with the green highlights of the mesoscutum, and the stigmal vein shorter than, or subequal to, the marginal vein (Fig. 150). This species is most similar to *Copidosoma albicoxae*, *C. noyesi*, and *C. truncatellum*. *Copidosoma albicoxae* differs in having all coxae white, *C. noyesi* has a much larger club (Figs. 287, 412) and the forecoxae with some white color, and *C. truncatellum* has the first funicular segment narrower than the second (Fig. 376) and the marginal vein shorter than the stigmal (Fig. 380).

Variation. Very little, despite the large amount of material examined. The mesoscutum is occasionally more blue than green.

Biology and hosts. Reared from the following plusiine Noctuidae: *Pseudoplusia* McD., *Rachiplusia* Hamp., *Syngrapha* Hbn., and *Trichoplusia ni* (Hbn.). Though believed to be exclusively parasites of plusiines, *C. floridanum* has reportedly been reared from the following hosts: *Anomogyna eliminata* (Gn.) (Noctuidae: Noctuinae); *Zale* Hbn. (Noctuidae: Catocalinae); *Anisota* Hbn. (Saturniidae); *Spilosoma canescens* (Butler) (Arctiidae); *Calpodes* Hbn. (Hesperiidae); and a bagworm (Psychidae) (label data, Noyes 1988a).

Distribution. Cosmopolitan.

Discussion. *Copidosoma floridanum* has been frequently identified as *C. truncatellum*, though apparently no worker ever formally synonymized the two species. Noyes (1988a) provides a detailed taxonomic history and redescriptions of these two species. A narrow epiproct is present and heretofore unreported in *C. floridanum*.

Other material examined. Approximately 2200 specimens from 20 U.S. states, 6 Canadian provinces, England, El Salvador, Mexico, New Zealand, Panama, and Venezuela.

Copidosoma gelechiae Howard
(Figs. 155-163, 417-418, 427)

Copidosoma gelechiae Howard, 1885: 10. [USNM, ♀ lectotype examined].

Copidosoma intermedium Howard, 1885: 12. [USNM, ♂ lectotype examined]. **New synonomy.**

Psilophrys hyalinipennis Howard, 1885: 21. [USNM, ♂ holotype examined]. Synonymized by Peck (1951).

Psilophrys pallipes Ashmead, 1888b: v. [Type missing, not examined]. Synonymized by Peck (1951).

Copidosoma gelechiae var. *saga* Girault, 1920: 188. [USNM, ♂ lectotype examined]. Synonymized by Peck (1963).

Type Material. Lectotype here designated, ♀ mounted on a point with a card underneath, "from Larva/on Solidago/Oct 19.82" [handwritten in ink] "Copidosoma gelechiae ♀/How. type" [handwritten in ink] "Type/No. 2628/U.S.N.M." [red label]. "Copidosoma/ gelechiae/Howard, 1885/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype missing antennae and left forewing.

There are 3 males and 1 female from the type series with labels identical to the lectotype. The female is represented only by the mesosoma, the male specimens are relatively undamaged. Two females and 1 male from the type series are missing. "Copidosoma/ gelechiae/Howard, 1885/PARALECTOTYPE/det. G. Zolnerowich" added to specimens.

Copidosoma intermedium Howard. Lectotype ♂ here designated, the middle specimen mounted on a strip of paper with 7 points and 7 specimens, marked with red ink and labelled "427L° Lep./gall on aster" [handwritten in ink] "Copidosoma/intermedia/ How.

typ." [handwritten in ink] "Type/No. 2631/U.S.N.M." [red label]. "Copidosoma/ intermedium/Howard, 1885/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype missing sixth funicular segment and club from left antenna.

There are 3 additional multiple point cards with the same labels as the lectotype. These bear 20 specimens, many of which are damaged. A single balsam slide with a crushed head and 1 antenna is labelled "Copidosoma/intermedia/How./♀ type." [handwritten in ink]. "Copidosoma/intermedium/Howard, 1885/PARALECTOTYPE/det. G. Zolnerowich" added to specimens. Comparison of these specimens with the types of *gelechiae* show they are identical.

Psilophrys pallipes Ashmead. Described by Ashmead (1988b) from 2 females from Kansas, Ashmead (1900) later listed this species as *P. pallidipes* with the USNM as the depository for the types. However, two searches there and inquiries to the University of Kansas and Kansas State University have failed to produce the them, and these types must be considered as lost.

Copidosoma gelechiae var. *saga* Girault. Lectotype here designated, ♂ mounted a card with 4 other males, labelled "Ottawa/Can" "Type/21019/U.S.N.M." [red label] "Copidosoma/gelechiae ♂ ♀ types/saga/flavipes gir." [handwritten]. The lectotype is the second specimen from the right and marked with a red ink spot posterior to the metasoma. "Copidosoma/gelechiae var. saga/Girault, 1920/PARALECTOTYPE/det. G. Zolnerowich" added to specimens. Girault's description (1920) states there is another card with an additional 5 specimens and a slide-mounted head, but I was unable to locate them.

Diagnosis. Females of *Copidosoma gelechiae* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with proximal club segment widest, giving the club a distinct shape (Fig. 155), mesoscutum and scutellum with deep elongate reticulate sculpture (Figs. 417-418), fore- and midfemora and tibiae light in color, and syntergum divided (Fig. 160). This species is most similar to *Copidosoma gibsoni* and *C. gordhi*, which differ in having the fore- and midfemora dark brown, and the foretibia with some dark color.

Female. Length 1.4-1.65 mm, excluding ovipositor. Body dark brown to black; head with white or mixed pale green and purple highlights; scape dark brown or black with green highlights, pedicel dark brown or black with tan apex, funicular segments and club brown or dark brown, usually slightly lighter than scape; mesoscutum with green highlights, occasionally with purple or blue mixed in, axillae with pale green and purple highlights,

scutellum with purple and blue-green highlights dorsally and green highlights laterally, propodeum laterally with green and purple highlights and silvery setae lateral to spiracle, mesopleuron with green highlights anteriorly and blue and purple highlights posteriorly. "Light" in the following description of leg color can refer to tan, orangish, or yellowish. Coxae dark brown with light purple highlights, fore- and midfemora and tibiae light, hind femur varying from dark brown in proximal 1/2 with remainder light to nearly entirely dark brown with apex light, hind tibia entirely light or brown in proximal 1/2 with remainder light, tarsi 1-4 on each leg light, tarsus 5 dark brown; forewing slightly infuscate, darkest around venation.

Frontovertex 0.5x head width or slightly less and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the width of a facet, eye height 1.2-1.3x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 2:2:7; toruli their width above mouth margin, funicular segments 1.1-2.3x longer than broad, club 3-segmented and 0.6-0.75x length of funicle, sensory area 0.7-0.8x length of club (Fig. 155).

Mesoscutum with elongate reticulate sculpture (Fig. 417); axillae meeting and elevated above scutellum; scutellum slightly flat and with elongate reticulate sculpture finer than that of mesoscutum (Fig. 418); forewing 2.3-2.5x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein about slightly longer than broad, stigmal vein 2-2.5x length of marginal vein, postmarginal vein about 0.3x length of marginal vein (Fig. 158).

Metasoma subequal to length of mesosoma; cerci inserted at midpoint of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and posterior emargination (Fig. 159); ovipositor 0.9-1.1x length of midtibia length and exserted 0.15-0.2x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); syntergum completely or partially divided (Fig. 160); epiproct present.

Male. Length 1.6-1.7 mm. Sculpture similar to female; head bright brassy green or green with mixed blue-purple, in lateral view narrower than that of female; ocelli larger and forming an obtuse angle, OOL:OPL:POL 2:1:8; toruli 1.5-2x their width above mouth margin, funicle segments 2.2-3.5x longer than broad, club 0.3x length of funicle (Fig. 156); scutellum color similar to that of frontovertex and much brighter than in female; coxae dark brown with light green reflections, femora and mid- and hind tibiae brown or dark brown with light apices, foretibia brown on posterior edge, remainder light; phallobase

0.65x length of midtibia and with 18-25 pairs of setae (Fig. 162), each digitus with 3 apical claws and a pore near claws (Fig. 161), aedeagus with a pair of sensilla (Fig. 163); syntergum not divided.

Variation. Females differ primarily in the light color of the legs and the degree of dark color on the hind legs, with the light colors varying between tan, yellow, and orange. Critical-point dried specimens tend to have tan legs while air-dried specimens have more orange or yellow color. Very old specimens may have the legs reddish-orange. Males vary between green and blue-green.

Biology and hosts. Reared from the following Lepidoptera: *Coleotechnites atrupictella* (Dietz), *Gnorimoschema gallaeasterella* (Kellicott), *G. gallaesolidaginis* (Riley), and *G. gibsoniella* Bsk. (Gelechiidae: Gelechiinae). Also reported from *Epiblema scudderiana* (Clem.) (Tortricidae: Olethreutinae) and *Gnorimoschema salinaris* Bsk. (Gordh 1979).

Distribution. Found from Nova Scotia to British Columbia, and south to Texas.

Other material examined. CANADA: **Alberta**: 0.5km E. Writing-on-Stone PP., 22-30.viii.1980, D. McCorquodale (21 ♀, 4 ♂, BMNH); Writing-on-Stone Prov. Prk., viii.1981, D. McCorquadale (2 ♀, BMNH, 2 ♀, 2 ♂, TAMU); **British Columbia**: Blind Bay, Shusway Lake, 31.viii.1986, C.C. Elsey (1 ♀, BMNH); Fernie, 7.viii.1934, Hugh B. Leech (11 ♀, CNC, 2 ♀, USNM); **New Brunswick**: Kedgwick, 11.viii.1961, ex: *Eucordylea atrupictella* on: W. spruce (9 ♀, 11 ♂, CNC); Kouchibouguac N.P., 30.viii. 1977, S.J. Miller (1 ♀, CNC); **Nova Scotia**: Halifax, 23.viii.51, J. McDunnough, Solidago, Host *Gnorimoschema gallaeasterella* (14 ♂, CNC); **Ontario**: Dunn TWP, 15.ix.1961, W.W. Judd, ex: *Solidago* (10 ♂, CNC); Hamilton, ix.1981, M. Sanborne (1 ♀, BMNH); Ottawa, Constance Bay, ix.1983, M. Sanborne (4 ♀, BMNH); Ottawa, Mer Bleue, bog, 16-22.viii.1982, H. Goulet (1 ♀, BMNH); Ottawa, Mer Bleue, 5.ix.1974, L. Masner (1 ♀, BMNH); Ottawa, Merivale gdns., 29.viii.1985, J.S. Noyes (1 ♀, BMNH); Vineland Station, 9.ix.1936, W.L. Putman (9 ♂, CNC); **Quebec**: Hwy 201, 8 Km SW Rigaud, 9.ix.1985, J.S. Noyes (4 ♀, BMNH); **Saskatchewan**: Saskatoon, ix.1938, L.G. Saunders (17 ♀, 3 ♂, CNC); USA: **Colorado**: s. of Meeker, 11.vii.1984, 8500', H. Goulet (1 ♀, BMNH); Eagle Co., White River Nat. Forest, 7.5 mi S Minturn, el. 8840', 19.vii.1990, G. Zolnerowich (1 ♀, TAMU); **Kansas**: Riley Co., Marlatt, ix (3 ♀, 3 ♂, USNM); **Kentucky**: Louisville, vi.82, S. Riegler (1 ♀, BMNH); **Maryland**: Calvert

Co., Port Republic, viii-ix.1986, M. Sharkey, S. Monroe (3 ♀, BMNH); **Massachusetts**: Cuttyhunk Is., Elizabeth Is., 17.ix.1972, C.T. Parsons, sweeping *Solidago* (1 ♀, 2 ♂, MCZ); **Michigan**: Ann Arbor, vii.82, Fitton & Quinlan (5 ♀, BMNH); Ann Arbor, 3-16.ix.1975, M.G. Fitton (1 ♀, BMNH); Ann Arbor, ix-x.1975, M.G. Fitton (1 ♂, BMNH); Erie, 8-6-30, L.G. Jones, Ex *Gnorimoschema gallaesolidaginis* (5 ♀, 3 ♂, USNM); **Minnesota**: St. Paul, St.Anthony Park, 13.ix.1908, H.J. Franklin, galls on goldenrod (1 ♀, UMSP); Goodhue Co., 31.viii.1936, H.R. Dodge (2 ♀, 1 ♂, UMSP); **Missouri**: Williamsville, 21.x-11.xi.1988, J.T. Becker (1 ♀, BMNH); **New York**: Tompkins Co., Ithaca, 16.ix.1979, D.C. Darling, ex: *Gnorimoschema gallaesolidaginis* in *Solidago* gall (8 ♀, DCD, 1 ♀, BMNH); **Texas**: Brazos Co., College Station, TAMU, 19.x.1986, J. Heraty, goldenrod, ex: *Gnorimoschema* (2 ♀, TAMU); **Virginia**: Shenandoah N.P., Skyline Parkways S., 610-915m, 20.ix.1980, Masner & Bowen (1 ♀, 2 ♂, CNC); **Wisconsin**: Door Co., 15.vii.1988, J.A. Johnson (5 ♀, 5 ♂, TAMU).

Copidosoma geniculatum (Dalman)

(Figs. 164-171)

Encyrtus geniculatus Dalman, 1820: 361. [SMNH, type not examined]. Transferred to *Copidosoma* by Mayr (1876).

Diagnosis. Females of *Copidosoma geniculatum* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area extending nearly full length of club (Fig. 164), tegulae white or clear, entire foreleg and midleg beyond coxa white-tan or yellow, mesoscutum and scutellum with deep elongate reticulate sculpture, and syntergum divided (as in Fig. 160). This species is most similar to *C. glandiferellae*, which differs in having the foreleg with some dark color and the syntergum not divided.

Female. Length 1.45-1.7 mm, excluding ovipositor. Body dark brown; frontovertex and lower face brassy green or blue-green, lower portion of eyes connected by transverse purple band, genae with coppery purple and green highlights; scape dark brown with green highlights, pedicel dark brown with tan apex, funicular segments and club brown or dark brown; mesoscutum and axillae with green highlights, some purple mixed in, tegulae white or clear, scutellum with purple highlights, laterally and posteriorly with green highlights,

propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron anteriorly with green and blue highlights, posteriorly with purple highlights. "Light" in the following description of leg color can refer to white-tan or yellow. Forecoxa and femur light, foretibia and tarsi very slightly darker, midcoxa dark brown, midfemur, tibia, and tarsi 1-4 light, tarsus 5 brown, hind coxa dark brown, hind femur light at base and in distal 1/3-1/2, remainder dark brown, hind tibia light at base and in distal 1/2-2/3, remainder dark brown, hind tarsi 1-3 light, tarsi 4-5 brown; forewing hyaline.

Frontovertex slightly less than 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by about the width of a facet, eye height 1.5-1.6x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, or equidistant between them, OOL:OPL:POL 1:2:6 or 2:2:6; toruli their width above mouth margin, funicle segments 1.8-3x longer than broad, club 3-segmented and 0.6-0.7x length of funicle , sensory area 0.85-0.9x length of club (Fig. 164).

Mesosoma with elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with elongate reticulate sculpture finer than mesoscutum; forewing 2.25-2.35x longer than wide, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein 2-2.5x length of marginal vein, postmarginal vein at most 0.3x length of stigmal vein (Fig. 167).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and posterior emargination (Fig. 168); ovipositor 1.3-1.4x length of midtibia and exserted 0.15-0.25x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); syntergum divided (as in Fig. 160).

Male. Length 1.33-1.48 mm. Similar to female but frontovertex 0.5-0.57x head width; ocelli larger and forming a slightly obtuse angle, OOL:OPL:POL 2:1:7; toruli 2x their width above mouth margin, funicular segments tan or brown, lighter than scape and pedicel and 2-2.7x longer than broad, club 0.3x length of funicle (Fig. 165); forecoxa dark brown, forefemur dark brown in proximal 1/2, or with small brown area along medial edge, midfemur brown proximal 1/2, fading to tan, hind femur and tibia dark brown with light apices; phallobase 0.65x length of midtibia and with 16-21 pairs of setae (Fig. 169), each digitus with 3 apical claws and 1 pore proximal to claws (Fig. 170), aedeagus with a pair of sensilla (Fig. 171).

Variation. Older air-dried specimens have the legs and tegulae more yellow than white. Critical-point dried material tends to lose the purple band on the front of the face and have more brown color, a lighter flagellum, and the legs more white-tan.

Biology and hosts. Reared from *Rhyacionia buoliana* (D. & S.) (Tortricidae: Olethreutinae) and *Exoteleia dodecella* (L.) (Gelechiidae: Gelechiinae). In Europe, reared from *Rhyacionia frustrana* (Comst.) and *Choristoneura fumiferana* (Clem.) (Tortricidae: Tortricinae) (Trjapitzin 1989). This species was introduced into the USA and Canada in the 1930's and 1950's for control of the European pine shoot moth, *Rhyacionia buoliana*. Though it became established, *Exoteleia dodecella* appears to be the preferred host (McLeod 1962).

Distribution. Native to Europe, and introduced into eastern Canada and the northeastern U.S.

Other material examined. CANADA: New Brunswick: Queen's Co., Douglas Harbour, 22.vii.1968, ex: *Rhyaciona* (13 ♀, 2 ♂, CNC); **Ontario**: Belleville, Ex. Europe, reared at Belleville, 27.vi.1936, *Rhyacionia buoliana* Schiff. (7 ♀, 5 ♂, CNC); Colbourne, Lindsay, 24.vi.65, ex. *Exoteleia* sp. (7 ♀, 2 ♂, BMNH); Kemptville, ex. *Exotela dodocella* (2 ♀, UCR); London, vii.1981, L. Masner (12 ♀, 4 ♂, BMNH, 3 ♀, 2 ♂, CNC); Newcastle, Host *Exotelia dodecella* (4 ♀, 2 ♂, CNC); Ottawa, 9.vii.1959, S.M. Clark (1 ♀, CNC); Port Burwell, 26.vi.64, ex. *Exoteleia* (9 ♀, BMNH); Rideau, Winchester, 29.vi-16-vii.1956, Ex. *Exotelia dodecella* (7 ♀, 13 ♂, CNC); **USA: Michigan**: Ann Arbor, vii.82, Fitton & Quinlan (2 ♀, BMNH); **BELGIUM**: near Ghent, 13.vii.55, Host *Rhyacionia buoliana* (Schiff) (7 ♀, 6 ♂, CNC); **SWEDEN**: Blekinge, 1936, I. Trägårdh, from pine shoots infested by *Evetria buoliana* (1 ♀, 1 ♂, BMNH).

Copidosoma gibsoni new species

(Figs. 172-174)

Diagnosis. Females of *Copidosoma gibsoni* are distinguished from other species of *Copidosoma* by the green frontovertex, mesoscutum, and scutellum, and the relatively short club (Fig. 172). It is most similar to *C. gnorimoschemae*, which has a differently shaped club (Fig. 191).

Female. Length 1.64 mm, excluding ovipositor. Body dark brown; frontovertex green with blue and purple along eyes, face from top of scrobes to mouth margin with purple and green highlights, genae coppery purple, band of purple-blue extending along ventral and posterior margins of eye; scape with green highlights, pedicel tan at the apex, funicular segments and club uniformly dark brown; mesoscutum, axillae, and scutellum similar to frontovertex, propodeum laterally with blue and purple highlights and silvery setae lateral to spiracle, mesopleuron with blue-purple highlights anteriorly and purple highlights posteriorly; coxae and fore- and hind femora dark brown, foretibia with posterior surface dark brown in proximal 1/2, remainder tan, foretarsi 1-4 tan, tarsus 5 darker, midfemur dark brown in proximal 3/4, remainder tan, and with proximal hyaline ring, midtibia and tarsi 1-3 tan, tarsi 4-5 dark brown dorsally and tan ventrally, hind tibia dark brown with tan apices, hind tarsi 1-4 tan, tarsus 5 darker; forewing slightly infuscate.

Frontovertex 0.4x head width and with fine reticulate sculpture that is more elongate on lower face and genae; eye reaching occipital margin, eye height 1.6x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL: POL 1:2:7; toruli separated from mouth margin by their width, funicular segments 1.5-1.6x longer than broad, club 3-segmented and 0.58x length of funicle, sensory area 0.7x length of club (Fig. 172).

Mesoscutum with deep elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with deep elongate reticulate sculpture slightly finer than that of mesoscutum, forewing 2.3x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein about 2x longer than broad, stigmal vein slightly longer than marginal vein, postmarginal vein about 0.5x length of stigmal vein (Fig. 173).

Metasoma subequal to length of mesosoma; hypopygium reaching apex of metasoma; ovipositor exserted about 0.17x length of metasoma; syntergum divided (as in Fig. 160).

Male. Unknown.

Biology and hosts. Unknown.

Distribution. Known only from central Colorado.

Etymology. Named for Dr. G. A. P. Gibson, who collected the holotype.

Holotype ♀ mounted on a card, "USA: Col. Douglas Co./N. Greenland/Hwy. 87 rest area" "6700ft. 17.vi.82/BM 1984-267/G.A.P. Gibson". Left antenna and right forewing slide-mounted in balsam. Red label "HOLOTYPE/Copidosoma/gibsoni/Zolnerowich" added to specimen. Deposited in CNC.

Copidosoma glandiferellae Barron & Bisdee
(Figs. 175-182)

Copidosoma glandiferellae Barron & Bisdee, 1984: 1353. [CNC, ♀ holotype examined].

Type Material. Holotype ♀ mounted a point, "Ottawa, Ont./Expt. Farm/21-V-80/Barron & Bisdee" [handwritten in ink] "Telphusa/glandiferella/Zell./on/Lonicera sp." [handwritten in ink] "HOLOTYPE/Copidosoma/glandiferellae/Barron & Bisdee/CNC No. 17791" [red label]. Twenty-four additional paratypes examined.

Diagnosis. *Copidosoma glandiferellae* was well described by Barron and Bisdee (1984) and is distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area extending nearly full length of club (Fig. 175), forecoxa dark, tegulae white, mesoscutum and scutellum with deep elongate reticulate sculpture, and syntergum undivided. This species is most similar to *Copidosoma geniculatum*, which differs in having the forecoxae white and a divided syntergum (as in Fig. 160).

Variation. Very little in the material examined. The forefemur varies from entirely yellowish or white-tan to nearly entirely dark brown with the distal apex light.

Biology and hosts. Reared only from *Deltophora glandiferella* (Zell.) (Gelechiidae: Gelechiinae) on honeysuckle (Caprifoliaceae: *Lonicera*) and an unspecified Tortricidae on willow (Salicales: *Salix*). Not frequently collected and males are uncommon.

Distribution. Known only from Alberta, Ontario, and Quebec.

Other material examined. CANADA: Alberta: Castor, 28.vi.1985, Ex. Tortricid on *Salix* (4 ♀, NFC, 1 ♀, CNC); **Ontario**: Gloucester, 5-7.vii.1977, Malaise trap (1 ♀, CNC); Gloucester, vii.1977, M. Sanborne (2 ♀, BMNH); Hamilton, vii.1981, M.

Sanborne (1 ♀, BMNH); Manotick, vi.1980, Barron (45 ♀, CNC); Ottawa, Expt. Farm, *Telphusa glandiferella* on *Lonicera* sp., Barron & Bisdee, 21.v-10.vi.1980 (180 ♀, 1 ♂, CNC); Ottawa, 6.vii.1986, H. Goulet (1 ♀, TAMU); **Quebec**: Gatineau Park, Luskville Falls, 17-24.vi.1986, L. Masner (1 ♀, BMNH); Gatineau Park, Luskville Falls, vii.1986, Denis & Dumouchel (1 ♀, BMNH).

Copidosoma globata new species

(Figs. 183-190)

Diagnosis. Females of *Copidosoma globata* are distinguished from other species of *Copidosoma* by the following characters: head rounded in lateral view, occipital margin narrowly rounded, eye separated from occipital margin by at the width of 3 facets, and club unsegmented or weakly 3-segmented and slightly obliquely truncate (Fig. 183). No other Nearctic species resembles *C. globata*.

Female. Length 1.06-1.37 mm. Body dark brown, occasionally nearly black; frontovertex, scrobal area, and genae with mixed green and purple highlights; antenna dark brown, flagellum slightly lighter than scape; mesoscutum with green-blue reflections, axillae and scutellum with green and purple highlights, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron anteriorly with blue highlights and posteriorly with purple highlights; coxae, fore- and hind femora, and mid- and hind tibiae dark brown with tan apices, foretibia dark brown with anterior edge tan, midfemur dark brown with light apices, and with proximal hyaline ring, fore- and hind tarsi brown to dark brown, midtarsi 1-3 tan, tarsi 4-5 dark brown; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae, head rounded in lateral view, occipital margin narrowly rounded; mandible with 3 subequal teeth; eye separated from occipital margin by the width of 3 facets, eye height 1.5x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 2:2:6; toruli separated from mouth margin by their width, first 4 funicle segments 1.3-1.4x longer than broad, remainder barely longer than broad or quadrate, club unsegmented or weakly 3-segmented, 0.55x length of funicle, sensory area 0.25x length of club (Fig. 183).

Mesoscutum with deep reticulate sculpture that is elongate medially; axillae barely meeting and slightly raised above scutellum; scutellum relatively flat and with reticulate

sculpture that is shallower than that of mesoscutum; forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.4x length of stigmal vein (Fig. 186).

Metasoma longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium with weak posterior emargination (Fig. 187), reaching 0.7x length of metasoma; ovipositor 1.4x length of midtibia and slightly exserted, second valvifer not fused to third valvula, with several short longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.12-1.44 mm. Similar to female but ocelli forming a right angle; toruli 1.5x their width above mouth margin, all funicular segments 1.5-2x longer than broad, club 0.35x length of funicle (Fig. 184); phallobase 0.7x length of midtibia, and with 16-18 pairs of setae and a midrib (Fig. 189), each digitus with 3 apical claws and a single pore near claws (Fig. 188), aedeagus with a pair of lateral sensilla (Fig. 190).

Variation. Very little, other than size, in the specimens available.

Biology and hosts. Reared from *Coleophora* Hbn. (Lepidoptera: Coleophoridae) on *Juncus* (Juncaceae).

Distribution. Eastern Canada south to Florida, and west to Texas.

Etymology. From Latin *glob*, ball or globe, referring to the very rounded head.

Holotype ♀ mounted on a point with a card underneath, "TEXAS: Brazos Co./College Station/Lick Creek Park/17-IV-1987/J.B. Woolley 87/002". Red label "HOLOTYPE/ Copidosoma/globata/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. **USA**: same data as holotype (2 ♀, 1 ♂, TAMU); **USA**: **Texas**: Brazos Co., College Station, Lick Creek Park, 19-20.IV.1989, J.S. Noyes (2 ♀, 1 ♂, BMNH). Paratypes to be deposited in BMNH and TAMU.

Other material examined. **USA**: **Florida**: Alachua Co., Gainesville, 16-19.iv.1986, M. Sharkey (2 ♀, TAMU); **Georgia**: Forsyth, v.1971, F. Naumann, (1 ♀, BMNH); **West Virginia**: Pocahontas Co., Cranberry Glades, 28.vii.1983, L. Huggert (3 ♀, 3 ♂,

BMNH); **CANADA**: **New Brunswick**, Kouchibouguac N.P., 17vii.1977, I. Smith, (1 ♀, CNC); **Nova Scotia**: vii.1983, Cape Breton Nat. Pk., Beulach Ban Falls, L. Lesage (1 ♀, BMNH); **Ontario**: Gloucester, vii.1977, M. Sanborne (1 ♀, BMNH); Tweed, v.1945, G.S. Walley, Host *Coleophora* sp. on *Juncus* (4 ♀, CNC).

Copidosoma gnorimoschemae new species
(Figs. 191-194)

Diagnosis. Females of *Copidosoma gnorimoschemae* are distinguished from other species of *Copidosoma* by the following characters: proximal 1/2 of tegulae yellow, remainder dark brown, mesoscutum and scutellum with deep elongate reticulate sculpture, and syntergum completely, or almost completely, divided (as in Fig. 160). This species is similar to *Copidosoma gelechiae*, *C. timberlakei*, and *C. gordhi*. These species have similar sculpture on the mesoscutum and scutellum and the divided syntergum but lack the yellow color on the tegulae.

Female. Length 1.5-1.62 mm, excluding ovipositor. Frontovertex bright green or green-blue, face from top of antennal scrobes to mouth margin and genae mixed purple and green; scape and pedicel with mixed green and purple highlights, funicle and club uniformly brown; mesoscutum green, anteriorly and laterally with some purple, tegulae yellow in proximal 1/2 with remainder dark brown, axillae and scutellum with mixed green, purple, and bluish highlights, propodeum laterally with green highlights and silver setae lateral to spiracle, mesopleuron with green highlights anteriorly and blue and purple highlights posteriorly; coxae dark brown with green highlights, forefemur dark brown in proximal 1/3-2/3, remainder tan to orangish, foretibia tan or orangish with posterior surface brown, foretarsi light to dark brown, midfemur dark brown at base, with hyaline ring, remainder tan or orangish, midtibia and tarsi 1-3 tan or orangish, tarsi 4-5 dark brown, hind femur dark brown with light apices, hind tibia dark brown in proximal 3/4, remainder tan or orangish, hind tarsi 1-3 tan or orangish, tarsi 4-5 dark brown; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.4x head width and with fine, deep reticulate sculpture that is more elongate on genae; mandible with 3 subequal teeth, dorsal tooth slightly shorter than others; eye reaching occipital margin, eye height 1.8-2.2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than occipital margin, OOL:OPL:POL 1:2:8; toruli separated

from mouth margin by their width, funicular segments 1.2-2x longer than broad, club 3-segmented and 0.7x length of funicle, sensory area 0.8x length of club (Fig. 191).

Mesoscutum with deep elongate reticulate sculpture; axillae meeting and elevated above scutellum; scutellum relatively flat and with sculpture similar to mesoscutum but finer; forewing 2.3x longer than wide, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein about 3x length of marginal vein, postmarginal vein nearly absent to 0.25x length of stigmal vein (Fig. 192).

Metasoma subequal in length to mesosoma; cerci inserted 1/3 from anterior end of metasoma; hypopygium reaching apex of metasoma, with anterior median lobe and weak posterior emargination (Fig. 194); ovipositor subequal to length of midtibia and exserted 0.2x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); syntergum partially or completely divided (as in Fig. 160).

Male. Unknown.

Variation. Specimens vary mostly in the color of the light portions of the legs, which range from tan to orangish.

Biology and hosts. Reared from species of *Gnorimoschema* Bsk. (Lepidoptera: Gelechiidae).

Distribution. Known from Arizona and California.

Etymology. The species name is taken from *Gnorimoschema*, the host genus.

Holotype ♀ mounted on a card, "Jawbone Cyn./Kern Co. Cal." "18-X-80/coll. G. Gordh". Red label "HOLOTYPE/Copidosoma/gnorimoschemae/Zolnerowich" added to specimen. Holotype missing front right tibia and tarsi. Holotype from UCR, to be deposited in CAS.

Paratypes. **USA**: same data as holotype (4 ♀, UCR); **USA**: **California**: Calaveras Co., West Point Dist., v.21.35, Reared from Gnorimoschema, vii.0.35, HH Keifer, Collector (6 ♀, CDFA); **Arizona**: Cococino Co., Tuba City, Sept 24 14, Timberlake (1 ♀, UCR). Paratypes to be deposited in CDFA and UCR.

Copidosoma gordhi new species

(Figs. 195-198)

Diagnosis. Females of *Copidosoma gordhi* are distinguished from other species of *Copidosoma* by the following characters: dorsal and ventral surfaces of club not parallel, club widest at joint of first and second club segments (Fig. 195), and scutellum with very narrow elongate reticulate sculpture that contrasts with the elongate but wider sculpture of the mesoscutum. This species most resembles *C. timberlakei*, which differs in the shape of the club (Fig. 370) and has narrower sculpture on the mesoscutum.

Female. Length 1.17-1.27 mm, excluding ovipositor. Body dark brown; frontovertex with light green highlights, scrobal area and genae with purple reflections; scape with green highlights, pedicel dark brown with apex tan, funicular segments and club uniformly brown; mesoscutum with light green or blue-green highlights, axillae and scutellum with mixed purple and green highlights, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with green highlights anteriorly, blue highlights medially, and purple highlights posteriorly; coxae dark brown, femora and hind tibia dark brown with tan apices, midfemur with proximal hyaline ring, foretibia tan-orangish or dark brown with dorsal edge tan-orangish, foretarsi brown, midtibia orange-brown, midtarsi 1-3 tan, tarsi 4-5 darker, hind tarsus 1 tan, tarsi 2-5 becoming progressively darker; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex slightly less than 0.5x head width and with wide reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly shorter than others; eye reaching occipital margin, eye height 1.4x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; toruli separated from mouth margin by their width, funicle segments 1.2-2x longer than broad, club 3-segmented and 0.9x length of funicle, sensory area 0.7x length of club (Fig. 195).

Mesoscutum with wide elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with deep, narrow elongate reticulate sculpture that contrasts with the wider cells of the mesoscutum; forewing 2.6x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein about 0.5x length of stigmal vein (Fig. 197).

Metasoma equal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and weak posterior emargination (Fig. 198); ovipositor 1.3x length of midtibia and exserted 0.3x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); syntergum partially or completely divided (as in Fig. 160).

Male. Unknown.

Variation. Differences in the type series are limited to the extent of dark color on the foretibiae and shades of tan-orange on the legs.

Biology and hosts. Unknown.

Distribution. Known only from Kern Co., California.

Etymology. Named for the collector of the type series, Dr. G. Gordh.

Holotype ♀ mounted on a card, "Jawbone Cyn/Kern Co. Cal." "18.X.80/coll. G. Gordh". Red label "HOLOTYPE/Copidosoma/gordhi/Zolnerowich" added to specimen. Holotype from UCR, to be deposited in CAS.

Paratypes. USA: same data as holotype (9 ♀, UCR). Paratypes to be deposited in UCR.

Copidosoma grahami new species

(Figs. 199-203)

Diagnosis. Females of *Copidosoma grahami* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented or incompletely 2-segmented (Fig. 199) and mesoscutum and scutellum with deep elongate reticulate sculpture. This combination of characters is not found in any other Nearctic species.

Female. Length 1.3-1.5 mm, excluding ovipositor. Body dark brown, almost black; frontovertex with blue-green reflections, scrobal area and genae similar to frontovertex or with blue and purple reflections; scape similar to head, flagellum lighter in color, uniformly

brown; mesoscutum with blue-green reflections, axillae and scutellum with purple reflections, propodeum laterally with pale green highlights and translucent s e lateral to spiracles, mesopleuron with green-blue reflections anteriorly and purple reflections posteriorly; coxae dark brown, femora dark brown with white-tan apex, midfemur with proximal hyaline ring, foretibia and tarsi tan to brown, midtibia dark brown, white-tan at apices, midtarsi 1-2 white or tan, remainder darker, hind tibia dark brown, tan at extreme apices, hind tarsi dark brown; forewing hyaline.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth slightly shorter than others; eye separated from occipital margin by the diameter of 3 facets, eye height 1.4x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:7; toruli 1.5x their width above mouth margin, funicular segments 1.1-1.8x longer than broad, club unsegmented or incompletely 2-segmented, about 0.6x length of funicle, sensory area 0.8x length of club (Fig. 199).

Mesoscutum with elongate reticulate sculpture; axillae just meeting and slightly elevated above scutellum; scutellum relatively flat and with elongate reticulate sculpture that is finer than that of mesoscutum; forewing 2.3x longer than broad, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein about 0.4x length of stigmal vein (Fig. 202).

Metasoma subequal to length of mesosoma; cerci inserted at 1/2 length of metasoma; hypopygium reaching apex of metasoma and with anterior lobe and posterior emargination (Fig. 203); ovipositor subequal to length of midtibia and slightly exserted, second valvifer not fused to third valvula, with several oblique rows of spicules (as in Fig. 431).

Male. Length 1.7 mm. Similar to female but larger; ocelli larger and forming a more obtuse angle; toruli 2x their width above mouth margin, funicular segments 1.5-2.6x longer than broad, club 0.25x length of funicle (Fig. 200).

Variation. Specimens vary only in the relative darkness of leg color.

Biology and hosts. Unknown.

Distribution. Alberta and British Columbia, Canada.

Etymology. Named in honor of M. W. R. de V. Graham.

Holotype ♀ mounted on a card, "Canada: BC/Kentucky-Allene/Prov. P. Kwy 5/57Km Princeton" "49°45'N 120°40'W/10.VII.1986/H. Goulet/BM 1987-349". Red label "HOLOTYPE/Copidosoma/grahami/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. CANADA: same data as holotype (2 ♀, 1 ♂, BMNH); **Canada**: **Alberta**: Waterton Lake N.P. nr. Crandell, 49 06N, 113 58W, 5.VII.1991 1450m, H. Goulet, montane prairie (3 ♀, TAMU). Paratypes to be deposited in BMNH, CNC, and USNM.

Copidosoma horneri new species

(Figs. 204-207)

Diagnosis. Females of *Copidosoma horneri* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented, with apex rounded and sensory area 0.8x length of club (Fig. 204), mesoscutum and scutellum with reticulate sculpture, ovipositor exserted 0.4-0.6x length of metasoma, and syntergum divided (as in Fig. 160). *Copidosoma gelechiae*, *C. gibsoni*, *C. gordhi*, *C. masneri*, and *C. timberlakei* are similar in habitus, forewing shape and venation, and also possess a divided syntergum. These species can be differentiated from *C. horneri* by their 3-segmented clubs and the deep elongate reticulate sculpture of the mesoscutum and scutellum.

Female. Length 1.32-1.77 mm, excluding ovipositor. Body brown to dark brown; frontovertex with white or green reflections, scrobal area and genae with mixed white, purple, or green highlights; antenna uniformly brown, except apex of pedicel tan; mesoscutum with blue and green reflections, axillae and scutellum with purple reflections, tegulae brown, occasionally yellowish in basal 1/3, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with green highlights anteriorly and blue and purple highlights posteriorly. "Light" in the following description of leg color can mean orangish, yellowish, or tan. Coxae brown, forefemur with proximal 1/3-2/3 dark and remainder light, foretibia and tarsi light, midfemur, tibia,and tarsi 1-4 light, tarsus 5 dark, hind femur light at apices, remainder dark brown, hind tibia and tarsi 1-3 light, tarsus 4 light or dark, tarsus 5 dark; forewing infuscate, darkest around venation and linea calva.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of 2 facets, eye height 1.4-1.6x malar space; ocelli forming a slightly acute angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 3:2:6; toruli separated from mouth margin by their width, funicular segments 1.2-2x longer than broad, club unsegmented and rounded at the apex, 0.75x length of funicle , sensory area 0.85x length of club (Fig. 204).

Mesoscutum with reticulate sculpture, the cells larger than those of frontovertex and slightly elongate; axillae barely meeting, elevated above scutellum; scutellum relatively flat, with sculpture similar to that of mesoscutum but with smaller cells; forewing 3x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein 2.5x length of marginal vein, postmarginal vein 0.7x length of stigmal vein (Fig. 205).

Metasoma 1.3x length of mesosoma; cerci inserted at 0.4x length of metasoma; hypopygium extending beyond apex of last tergite and with anterior lobe and posterior lobes (Fig. 207); ovipositor 2.0-2.3x length of midtibia and exserted 0.4-0.6x length of length, second valvifer not fused to third valvula, and with longitudinal rows of spicules (as in Fig. 430); syntergum divided (as in Fig. 160).

Male. Unknown.

Variation. The light colors on the legs varies from orangish, yellowish, to tan, even within a series. The dark color on the forefemur can extend from the basal 1/3 to nearly the full length of the femur. Tegulae are completely brown or with a yellow patch in the basal 1/3.

Biology and hosts. Unknown.

Distribution. Alberta and Ontario in Canada; Colorado, Nebraska, and Montana in the U.S.

Etymology. Named in honor of my friend and first major professor, Dr. N. V. Horner.

Holotype ♀ mounted on a card, "CANADA: Alberta/Medicine Hat/11.v.1980" "G.A.P. Gibson/B.M. 1984-267". Red label "HOLOTYPE/Copidosoma/horneri/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. CANADA: same data as holotype (36 ♀, BMNH); **Canada**: **Alberta**: Medicine Hat, 13.v.1980, coll. G. Gibson (8 ♀, CNC). Paratypes to be deposited in CNC, BMNH, TAMU, UCR, and USNM.

Other material examined. CANADA: Alberta: 13 mls. s. Orion, 14.vi.1982, G.A.P. Gibson (2 ♀, BMNH); Writing-On-Stone Prov. Pk., v.1981, D. McCorquodale (1 ♀, BMNH); **Ontario**: Oxford Mills, vii.1978, Tulsiram (1 ♀, BMNH); **USA**: **Colorado**: Eagle Co., White River Nat. Forest, 7.5 mi S Minturn, el. 8840', 19.vii.1990 Z90-061, G. Zolnerowich (5 ♀, TAMU); Durango 10,000', Junction Creek, vii.1968, E.C. Becker (1 ♀, BMNH); s. of Meeker, 11.vii.1984, 8500', H. Goulet (1 ♀, BMNH); S. Meeker 8500', vii.1984, H. Goulet (1 ♀, BMNH); Hewlett Gulch, Larimer Co., 6000 ft., viii-ix.1978, Malaise trap, H.E. Evans (1 ♀, CSU); **Montana**: 1.5 mi. S., 5 W. Winnett, Petroleum Co., Montana, 30.vii.1969, A.G. Hamilton (1 ♀, MSU); **Nebraska**: Sioux Co., Agate Fossil Beds Nat. Mon., 31.viii.1985 Hanson (1 ♀, BMNH).

Copidosoma howardi new name
(Figs. 208-216, 415)

Parapsilophrys gelechiae Howard, 1898: 232. [USNM, ♀ lectotype examined]. Transferred to *Copidosoma* by Trjapitzin (1972). Preoccupied by *Copidosoma gelechiae* Howard, 1885.

Copidosoma howardi **New name** (not *gelechiae* Howard, 1885).

Type Material. Lectotype here designated, ♀ mounted on a point above host remains and cocoon, "57869/June.17.93." [handwritten in ink] "Gelechia/on cottonwood/Jetsam Wyo." [handwritten in ink] "Type/No.5023/U.S.N.M." [red label] "Parapsilophrys/ gelechiae/ How type" [handwritten in ink]. "Copidosoma/howardi/LECTOTYPE/ det. G. Zolnerowich" added to specimen. Lectotype missing left flagellum beyond pedicel, right antenna beyond first funicle segment, and ovipositor sheaths broken at about 1/2 their exserted length.

Although Howard (1898) did not designate a type, he stated the species was described from 2 females and 1 male, but there are apparently three additional specimens from the type series, a female mounted on a point and 2 males mounted on the same point above host remains. These are labelled "57869/June.17.93." [handwritten in ink] "PARATYPE/ PARAPSILOPHRYS/GELECHIAE/HOW.". The paratype labels are of recent origin and are in G. Gordh's handwriting. Transfer of *Parapsilophrys gelechiae* to Copidosoma (Trjapitzin 1972) created a secondary junior homonym of *Copidosoma gelechiae* Howard, 1885. Therefore, I propose the replacement name *Copidosoma howardi* (new name).

Diagnosis. Females of *Copidosoma howardi* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and relatively short (Fig. 208), tegulae white, forecoxa and all femora tan-yellow, and ovipositor exserted 1-2.3x length of the metasoma. This species is most similar to *C. hypenapurpura*, which differs in the length and shape of the club (Fig. 217), has the forecoxa and hind femur dark, and the ovipositor exserted 0.3-0.5x length of the metasoma.

Female. Length 1.8-3.09 mm, excluding ovipositor. Body green; frontovertex and face from top of scrobes to mouth margin brassy green, occasionally blue-green, lower portion of eyes connected by transverse band of purple-blue that crosses tops of scrobes, purple-blue occasionally extending onto interantennal prominence or genae, genae with brassy green and coppery purple highlights, scape dark brown-black with green highlights, flagellum dark brown-black; mesoscutum similar to frontovertex, tegulae white, axillae, scutellum, and lateral propodeum similar to mesoscutum but with more copper highlights, propodeum with silver setae lateral to spiracle, mesopleuron with brassy green or blue-green highlights; forecoxa and femur tan-yellow, foretibia tan, or tan with dark brown along outer edge, foretarsi brown to dark brown, mid- and hind coxae brown with green highlights, mid- and hind femora tan-yellow, midtibia tan or brown, midtarsi 1-3 tan, tarsi 4-5 dark brown, hind tibia brown or dark brown, hind tarsi 1 or 2 tan-yellow, remainder darker; forewing hyaline.

Frontovertex 0.37-0.42x head width and with fine reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, posterior tooth slightly shorter than others; eye separated from occipital margin by about the width of a facet, eye height 1.55-1.7x malar space; ocelli forming a right or slightly acute angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:3:7; toruli separated from mouth

margin by their width or less, funicular segments 1.5-4x longer than broad, club 3-segmented and 0.35x length of funicle, sensory area 0.8x length of club (Fig. 208).

Mesoscutum with fine elongate reticulate sculpture (Fig. 415); axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with finely reticulate sculpture similar to frontovertex but with slightly larger cells; forewing 2.7-2.85x longer than wide, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein about 1.5x longer than broad, stigmal vein 2.5x length of marginal vein, postmarginal vein about 0.3x length of stigmal vein (Fig. 212).

Metasoma 1.3-1.7x length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, or extending slightly past apex, and with anterior and posterior lobes (Fig. 213); ovipositor 4-4.7x length of midtibia and exserted 1.0-2.3x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.6-1.96 mm. Similar to female but frontovertex 0.5x head width, OOL:OPL:POL 2:3:8; scape tan or brown, with very few green highlights, flagellum tan or brown, funicular segments 1.8-3.7x longer than broad, club dorsoventrally compressed and 0.3x length of funicle, sensory area 0.45x length of club (Figs. 209-210); metasoma subequal to length of mesosoma; phallobase 0.7x length of midtibia and with 21-28 pairs of setae (Fig. 215), each digitus with 3 apical claws and a single pore proximal to claws (Fig. 214), aedeagus with a pair of sensilla (Fig. 216).

Variation. This species exhibits a great range in size and degree to which the ovipositor is exserted. Specimens collected long ago have more extensive purple areas on the head and mesosoma. Two specimens from Arizona have the mesopleuron orange-tan, with green highlights in the anterior 1/3, and the mid- and hind coxae orange-tan with faint green highlights.

Biology and hosts. Reared from the following Lepidoptera: *Gelechia lynceella* Zell., *Recurvaria* Haw. (Gelechiidae: Gelechiinae), *Anacampsis niveopulvella* (Cham.) (Gelechiidae: Anacampsinae); *Acleris* Hbn., *Archips* Hbn., *Pandemis canadana* Kft. (Tortricidae: Tortricinae); *Apotomis* (Tortricidae: Olethreutinae), and possibly *Telphusa* Cham. (Gelechiidae).

Distribution. Found from New Brunswick to California and south to Iowa.

Other material examined. CANADA: Alberta: Burmis Lake, ex. *C. niveopulvella*, aspen, 22.vii.1955 (4 ♀, CNC); Hillcrest, 20.vii.1955 (1 ♀, CNC); Medicine Hat, 21-28.vii.1980, G. Gibson, pan trap (1 ♀, CNC); Lethbridge Ag. Res. St., 9-15.vii.1980, G.A.P. Gibson (1 ♂, BMNH); **British Columbia**: Mt. Douglas, ?*Acleris emargana*, 15.vii.1950 (1 ♀, CNC); Roberts Lake, 2.vii.1950 (1 ♀, CNC); Tudyak L., 21.vii.1952 (2 ♀, CNC); **Manitoba**: Bird's Hill, 6.vi.1968, ex. tortricid on *Salix* (5 ♂, NFC); Cowan, 12.vii.1954, Olethreutid sp. on willow (3 ♀, NFC); Pine Ridge, 28.v.1968 (1 ♀, NFC); Spr.Wds.For.Res. Man., 4.vii.1947, tortricid sp (W. spruce) (5 ♂, NFC); Whitemouth, 16.vi.1953, tortricid sp. (W. poplar) (4 ♂, NFC); **New Brunswick**: Kouchibouguac N.P., 18.vii.1978, D.B. Lyons (1 ♀, CNC); **Ontario**: vii.1960, ex *Recurvaria* sp. (17 ♂, CNC); 3 km NE Almonte, vii.1986, Denis & Dumouchel (6 ♀, BMNH); Bells Corners, 18.vi.1945, J. McD. (5 ♀, CNC); Gloucester, vii.1977, M. Sanborne (1 ♀, BMNH); Ottawa, 20-27.viii.1987, J.M. Cumming (1 ♀, BMNH); Ottawa, Upplands airport, 17-29.vii.1990, J.M. Cumming (1 ♀, BMNH); Silver Lk., 20.ix.1982, L. Dumouchel (1 ♀, CNC); Upper Canada Village, 25.vi.1978, L. Masner (1 ♀, CNC); **Quebec**: Gatineau Co., Lake Duncan, vii.1979, A.C. Pont (1 ♂, BMNH); **Saskatchewan**: Birchland, 24.vi.1955, tortricid sp. (willow) (3 ♀, NFC); Delmas, 27.vi.1960, Ex. *Pantemis canadana* (3 ♂, NFC); Ft. à la Corner, 11.vi:53, *Aphania* sp. (2 ♂, NFC); Lintlaw, 26.vi.1961, ex *Acleris* sp., J.C. Malvin (9 ♀, BMNH); Madge Lake, 12.vii.1951 (4 ♀, NFC); Meadow Lake, 16-vi-53 (2 ♀, 4 ♂, NFC); Nisbett P.F., 4-7-63 (5 ♂, NFC); Old Battleford, 20.vi.1955 (3 ♀, NFC); Pelly, 9.vii.1954 (4 ♀, NFC); Rosetown, 30.vi.1955, *Acleris* sp. on willow (2 ♀, NFC); **USA: Arizona**: Patagonia, 27.vi.1953, W.W. Wirth (1 ♀, USNM); Cochise Co., Chiricahua mts., 5500ft. 31.vii.82, Hwy.181 6km. s.e. Pinery Cyn., G. Gibson (1 ♀, BMNH); **California**: Lake Co., Kelseyville, 29.v.49, H.B. Leech, ?*Telphusa* sp. on *Alnus rubra* (12 ♂, LACM); Placer Co., 4 mi.s. Rocklin, 26.v.1979, Wasbauer, Adams (2 ♂, CDFA); Sacramento Co., Sacramento, 27.vi.1976 (1 ♀, UCR); **Colorado**: Loveland Pass, W. slope 9850', 28.vii.1961, B.H. Poole (1 ♀, CNC); Teller Co., 7 m N Woodland Park, South Meadows Camp, 21-28.vii.1977, 8000' S. Peck (11 ♀, 2 ♂, TAMU); **Iowa**: Ames, 27.vi.1923 (1 ♀, ISU); **Illinois**: Burlington, 25.vi.1940, H.&M. Townes (1 ♀, AEI); **Michigan**: Ann Arbor, vi.1976 Gauld (1 ♂, BMNH); Gratiot Co., 21.vi.1952, R.R. Dreisbach (2 ♂, USNM); **Minnesota**: Plummer, Par. of *Gelechia lynceella* in catkins of poplar (1 ♀, 1 ♂, CNC); Hubbard Co., 20.vi.1980, L.W. Hepner (1 ♂, MSU); Ramsey Co., St. Paul, 16.vi.1980, B. Cutler (1 ♀, FSCA); **Utah**: Utah Co., 4mi. N Aspen Grove, 1.xii.1975, J.L. Petty (1 ♀, CNC).

Copidosoma hypenapurpura new species
(Figs. 217-223)

Diagnosis. Females of *Copidosoma hypenapurpura* are distinguished from other species of *Copidosoma* by the white tegulae, dark coxae, and ovipositor exserted 0.3-0.5x length of the metasoma. This species is similar to *Copidosoma howardi*, which differs in the size and shape of the club (Fig. 208), has the forecoxae white or tan, and the ovipositor exserted 1-2.3x length of the metasoma.

Female. Length 2.07-2.4 mm, excluding ovipositor. Body dark brown to black; frontovertex and lower face dark metallic green, lower portion of eyes connected by transverse purple band bordered with blue, purple occasionally extending onto interantennal prominence, posterior portion of genae and area between eyes and occipital margin dark brown with purple and green highlights, scape dark brown or black, flagellum dark brown, distal end of pedicel tan; mesoscutum, axillae, and scutellum dark brown or black with mixed green-blue and purple highlights, propodeum laterally green and with silvery setae lateral to spiracle, mesopleuron with green highlights anteriorly and blue and purple highlights posteriorly; coxae with green highlights, coxae dark brown, forecoxae occasionally tan at distal end, forefemur tan with medial edge darker, foretibia tan, foretarsi brown, midfemur tan, midtibia tan with outer surface slightly darker, midtarsus 1 tan, tarsi 2-5 darker, hind femur and tibia brown, tan at apices, hind tarsi varying from tan to dark brown; forewing hyaline.

Frontovertex 0.4x head width and with very fine reticulate sculpture that is more elongate on genae and between eyes and occipital margin; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of a facet, eye height 1.5x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:3:8; toruli 0.5x their width from mouth margin, funicular segments 1.5-3.8x longer than broad, club 3-segmented and 0.5x length of funicle, sensory area 0.85x length of club (Fig. 217).

Mesoscutum with deep, fine, elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum and with fine shallow reticulate sculpture; scutellum flat and with fine reticulate sculpture similar to that of frontovertex but with slightly larger cells; forewing 2.4x longer than wide, apex of submarginal vein with weak hyaline break, linea calva

interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein about 0.3x length of stigmal vein (Fig. 219).

Metasoma longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma and with anterior lobe; ovipositor 1.9x length of midtibia and exserted 0.3-0.45x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.43-1.7 mm. Similar to female but frontovertex 0.5x head width; ocelli forming a slightly obtuse angle, OOL:OPL:POL 1:2:8; toruli separated from mouth margin by their width, funicular segments 1.7-3.7x longer than broad, club 0.33x length of funicle, sensory area 0.75x length of club (Fig. 218); metasoma subequal to length of mesosoma; phallobase 0.73x length of midtibia and with 19-26 pairs of setae (Fig. 222), each digitus with 3 apical claws and a single pore proximal to claws (Fig. 221), aedeagus with a pair of lateral sensilla (Fig. 223).

Variation. Specimens differ slightly in the extent of dark color on the forelegs and hind tarsi. Specimens stored in alcohol lose much of their green color and become brown.

Biology and hosts. Reared from species of *Archips* Hbn. (Tortricidae) and an unspecified tortricid, and found in a *Hylaeus* (Hymenoptera: Colletidae) gall.

Distribution. Known only from Alberta, British Columbia, Utah, and California.

Etymology. A combination of Greek *hypen*, mustache, and Latin *purpur*, purple, referring to the purple band of color across the lower face.

Holotype ♀ mounted on a card, "W.L.N.P./Pass Creek Cabin/2.VIII.1952" "52A657C/ ex. Tort.". Red label "HOLOTYPE/Copidosoma/hypenapurpura/Zolnerowich" added to specimen. "W.L.N.P." most likely stands for Waterton Lakes National Park in the southwest corner of Alberta, Canada. Deposited in CNC.

Paratypes. **CANADA**: same data as holotype (9 ♀, CNC, 8 ♀, TAMU); **CANADA: Alberta**: Medicine Hat, viii.1980, G.A.P. Gibson (2 ♀, BMNH); **British Columbia**: No. 52-882, Date 6-VIII, F.I.S. 1952, Archips sp., Bridesville, B.C. (1 ♀, CNC); Spences Bridge, 28-VI-62, 62-5027-01-i, Microlepidoptera (2 ♂, CNC); **USA**:

California: Alpine Co., 1 mi S. Monitor Pass, 8200' VIII-22-23-1979, Malaise Trap 9A-5P, M. Wasbauer, P. Adams (1 ♂, CDFA); **Utah**: N. Logan, 4.VI.1952, in Hylaeus gall (3 ♀, USNM). Paratypes to be deposited in BMNH, CDFA, CNC, TAMU, UCR, and USNM.

Copidosoma incisum new species

(Figs. 224-228)

Diagnosis. Females of *Copidosoma incisum* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and distinctly shaped (Fig. 224), flagellum darker in color than the scape, fore- and midfemora tan, sternites 5-6 incised anteriorly (Fig. 227), and the ovipositor slightly exserted. Of the two species with a similar club, *Copidosoma whartoni* differs by having the scape and flagellum the same color and the fore- and midfemora dark. *Copidosoma beckeri* is larger, has the ovipositor exserted 0.25-0.50x length of the metasoma, and sternites 5-6 lobed anteriorly (Fig. 48).

Female. Length 1.0-1.1 mm. Body dark brown; frontovertex with bluish highlights, scrobal area and genae with purple reflections; radicle and flagellum brown to dark brown, distinctly darker than the tan or brown scape; mesoscutum with green highlights, axillae and scutellum with purple highlights, scutellum with green highlights laterally and posteriorly, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae brown, fore- and midfemur, all tibiae and all tarsi tan, hind femur varying from tan to dark brown; forewing hyaline.

Frontovertex slightly less than 0.5x head width and with deep reticulate sculpture that is elongate on lower face and genae; mandible with 3 subequal teeth; eye less than the diameter of a facet from occipital margin, eye height 2x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:8; toruli 0.5x their width from mouth margin, first funicular segment quadrate, remainder about 1.2x longer than broad, club 3-segmented and slightly less than length of funicle, sensory area 0.6x length of club and restricted to third segment (Fig. 224).

Mesoscutum with reticulate sculpture that is shallower than that of frontovertex; axillae just meeting and greatly elevated above scutellum; scutellum slightly flat and with very shallow reticulate sculpture, apex nearly polished; forewing 2.2x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae,

marginal vein slightly longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein very short (Fig. 226).

Metasoma slightly shorter than mesosoma; cerci inserted at 1/3-1/2 from anterior end of metasoma; sternites 5-6 incised anteriorly (Fig. 227); hypopygium reaching apex of metasoma and with a broad anterior lobe (Fig. 228); ovipositor 1.3x length of midtibia and slightly exserted, second valvifer not fused to third valvula, with several short longitudinal rows of spicules (as in Fig. 430).

Male. Unknown.

Variation. Very little, except for specimens with a darker scape and dark brown hind femur.

Biology and hosts. Unknown.

Distribution. Known only from southern Florida.

Etymology. From Latin *incis*, referring to the notch incised on the anterior margins of sternites 5-6.

Holotype ♀ mounted on a card, "USA: Florida/Monroe Co./No Name Key" "vi-viii.1986/S+J. Peck/BM 1986-330". Red label "HOLOTYPE/Copidosoma/incisum/ Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **USA**: same data as holotype (17 ♀, BMNH); **USA**: **Florida**: Monroe Co., No Name Key, 3.VI-27.VIII.1986, S.&J. Peck (3 ♀, TAMU, 1 ♀, CNC); Dade Co., Everglades NP, Long Pine Key, 31.viii-9.xii.1986, S.&J. Peck (4 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Copidosoma innocuellae Barron

(Figs. 229-236)

Copidosoma innocuellae Barron, 1970: 1337. [CNC, ♀ holotype examined].

Type Material. Holotype ♀ mounted on a point, "HOLOTYPE/Copidosoma/innocuella [sic]/Barron/CNC No. 11437" [red label] "Parkers Ridge/York Co., N.B./10 Aug. 64" [handwritten in ink] "64P952" [handwritten in ink] "64-0262-01/Anacampsis/innocuella Z." [handwritten in ink on underside of previous label] "Copidosoma/innocuella/Barron '70/Det./J.R. Barron" [handwritten in ink].

A single male is labelled "ALLOTYPE/ CNCNo. 11437/Copidosoma/innocuellae/ Barron" [red label] "Skead/#76/Em. 8-VIII-57/F.I.S." [handwritten in ink] "S57-1986-01-02/Ex ANACAMPSIS/INNOCUELLA" [handwritten in ink] "148" [pink label]. Sixty-one additional paratypes are listed in the original description, of which 18 were examined.

Diagnosis. Females of *Copidosoma innocuellae* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 229), foreleg yellowish or white, hind femur dark brown with yellowish-white apices, hind tibia dark brown in proximal 1/2 with the remainder yellowish-white, tegulae either completely dark brown or basally yellow-white with remainder dark brown, hypopygium simple (Fig. 233) and reaching the apex of the metasoma, ovipositor exserted at least 0.2x length of metasoma, and epiproct absent. This species is most similar to *Copidosoma cheranae*, *C. peckorum*, and *C. pseudoinnocuellae*. *Copidosoma cheranae* differs in having an epiproct and the hind tibia completely dark brown. *Copidosoma peckorum* has the forecoxa dark and the hypopygium with an anterior lobe and posterior emargination (Fig. 300). *Copidosoma pseudoinnocuellae* has the hind femur white-tan in the proximal 1/2, the hypopygium not reaching the apex of the metasoma, and the ovipositor barely exserted.

Variation. Specimens vary in the color of the tegulae and antennae. Females have tegulae that are either completely dark or yellow-white in the proximal 1/3 with the remainder dark, but never completely light. Males have the tegulae either completely yellow-white, or yellow-white in the proximal 1/3 with the remainder dark brown, but never completely dark. Older specimens have the base of the tegulae yellow-white and the distal portion clear. Females may have the flagellum uniformly brown or dark brown, or each segment may be lighter in the distal 1/3. Males may have the club unsegmented, or partially or completely 2-segmented.

Biology and hosts. Reared from the following Lepidoptera: *Anacampsis innocuella* (Zell.), *A. niveopulvella* (Cham.) (Gelechiidae: Anacampsinae); *Epinotia solandriana* (L.),

Pseudosciaphila duplex (Wlsm.) (Tortricidae: Olethreutinae); *Coleophora viburniella* Clem. (Coleophoridae); and *Holcocera modestella* Clem. (Blastobasidae: Blastobasinae). A single male specimen lists *Choristoneura conflictana* (Wlk.) (Tortricidae: Tortricinae) as the host.

Distribution. Found in the Canadian provinces of New Brunswick, Quebec, Ontario, Manitoba, Saskatchewan, Alberta, British Columbia. Much more sparsely collected in the U.S., with records from California, Michigan, New Jersey, New Mexico, Massachusetts, and Maine.

Other material examined. Approximately 400 specimens from the states and provinces listed above.

Copidosoma koehleri Blanchard

(Figs. 237-244)

Copidosoma koehleri Blanchard, 1940: 107. [UNLP, type not examined].

Copidosoma uruguayensis Tachikawa, 1968: 115. [type not examined]. Synonymized by Annecke and Mynhardt (1974).

Type Material. Lectotype ♀ and 6 ♀ paralectotypes labelled "Argentina, Tandil, January 1938, Koehler" (Noyes 1988b). Blanchard (1940) did not formally describe *koehleri* and merely listed it in a key as a new species. Noyes (1988b) provides a redescription.

Diagnosis. Females of *Copidosoma koehleri* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with the sensory area restricted to apex of the distal segment (Fig. 237), forewing hyaline, postmarginal vein less than 0.5x length of the stigmal vein (Fig. 240), hypopygium not reaching apex of metasoma, and ovipositor exserted about 0.2x length of the metasoma. This species is most similar to *Copidosoma tamaulipasensis* and *C. desantisi*. *Copidosoma tamaulipasensis* differs in having a 2-segmented club that is pointed at the apex (Fig. 357) and *C. desantisi* has an infuscate streak at the base of the forewing (difficult to see except in slide-mounted material) and an infuscation around the venation, and the postmarginal vein 0.5x the length of the stigmal vein (Fig. 138).

Variation. Very little, other than overall size, in the material studied.

Biology and hosts. Reared only from *Phthorimaea operculella* (Zell.) (Gelechiidae: Gelechiinae).

Distribution. Native to South America, but introduced into the U.S. and many other countries for control of the potato tuber moth (Tachikawa 1963, Clausen 1978).

Discussion. This species is very similar to *C. desantisi*, which utilizes the same host, and for years these two species were referred to as *C. koehleri*. The resolution of this problem is discussed in the section dealing with *C. desantisi*.

Other material examined. ARGENTINA: Alvarez, 16-20.iii.1965, A.S. Guido (7 ♀, 2 ♂, UCR); Santa Fe, 30.iv.1965, A.S. Guido (13 ♀, 6 ♂, UCR); Santa Fe, ex: *Gnorimoschema operculella* on potato (7 ♀, 16 ♂, UCR); Lab culture, 19.v.1965 (18 ♀, 4 ♂, UCR); **URUGUAY**: 15.i.1963, Silvera, *Gnorimoschema operculella* (15 ♀, 8 ♂, UCR); **USA**: **California**: Riverside, 19.vi.1945, reared in insectary, from Chile, *Gnorimoschema operculella* (4 ♀, 1 ♂, UCR); UC Berkeley Insectary Culture, ex. potato tuberworm, parent stock Uruguay, 4.i.1966, D.C. Lloyd (7 ♀, 7 ♂, TAMU); UC Riverside insectary cultured, Santa Fe, Argentina, parent stock collected April 1965, D.C. Lloyd (3 ♀, 3 ♂, UCR).

Copidosoma longiclava new species

(Figs. 245-252)

Diagnosis. Females of *Copidosoma longiclava* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented, elongate, nearly as long as funicle, with sensory area extending nearly the entire length of the club (Fig. 245).

Female. Length 1.0-1.17 mm. Body dark brown; frontovertex with green and purple reflections, scobal area and genae with purple reflections; antenna uniformly brown, except small tan area at apex of pedicel; mesoscutum with mixed brassy green and purple reflections, axillae with purple highlights, scutellum with purple highlights, laterally with green highlights, propodeum with pale green highlights laterally and translucent setae lateral to spiracle, mesopleuron with pale white and purple highlights; coxae brown, femora brown with tan at their apices, midfemur with proximal hyaline ring, foretibia brown to

dark brown, tan at the apex, foretarsi 1-4 tan to brown, tarsus 5 darker, midtibia varying from completely tan to dark brown in proximal 1/2 that fades to tan, mid- and hind tarsi 1-4 tan to brown, mid- and hind tarsi 5 darker, hind tibia varying from brown-tan to completely dark brown with tan at the extreme apices; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex slightly less than 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth slightly shorter and more rounded than others; eye separated from occipital margin by less than the diameter of a facet, eye height 1.5x malar space; ocelli forming a slightly obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:5; toruli 0.5x their width above mouth margin, funicular segments 1.3-1.5x longer than broad, club unsegmented and 0.9-1.0x length of funicle, sensory area extending nearly full length of club (Fig. 245).

Mesosoma with sculpture similar to that of frontovertex; axillae just meeting, elevated above scutellum; scutellum slightly flat and with sculpture similar to but shallower than mesoscutum; forewing 2.5x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva not interrupted by dorsal setae, marginal vein 2x longer than broad, stigmal vein and marginal vein subequal in length, postmarginal vein 0.5x length of stigmal vein (Fig. 247).

Metasoma slightly longer than mesosoma; cerci inserted at abbut 1/3 from anterior end of metasoma; hypopygium reaching apex of metasoma and with broad anterior lobe (Fig. 249), ovipositor slightly longer than midtibia and slightly exserted, second valvifer not fused to third valvula, with several longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.0 mm. Similar to female but frontovertex 0.5x width of head; ocelli larger; toruli 2x their width above mouth margin, funicular segments at least 3x longer than broad, club 0.3x length of funicle (Fig. 246); phallobase 0.7x length of midtibia and with 13-14 pairs of setae, 3 pairs of distinctive, longer setae along distal outer edge of phallobase (Fig. 251), each digitus with 3 claws and without pores (Fig. 250), aedeagus with a pair of sensilla (Fig. 252).

Variation. Very little, except for size and as noted in leg color.

Biology and hosts. Unknown.

Distribution. Quebec and Ontario in Canada; Maryland, Michigan, Missouri, North Carolina, Texas, and Virginia in the U.S.

Etymology. A combination of Latin *longi*, elongate, and *clava*, in reference to the distinct, elongate club.

Holotype ♀ mounted on a card, "USA: Virginia/Page Co./Shenandoah NP" "8.VII.1987/el. 1300 m/L. Dumouchel/BM 1988-284". Red label "HOLOTYPE/ Copidosoma/longiclava/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **USA**: same data as holotype (17 ♀, 6 ♂, BMNH; 3 ♀, TAMU); **USA: Virginia**: Page Co., Shenandoah N.P., Big Meadow 1300m, 8.VII-20.VIII.1987, BRC Hym Team, Malaise (5 ♀, TAMU). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. **USA**: **Maryland**: Patuxent Wildlife Reserve, vii.82, Fitton & Quinlan (1 ♀, BMNH); Prince George's Co., Patuxent Res. St., 27.vii-3.viii.1986, D.B. Wahl (1 ♀, BMNH); **Michigan**: vii.1973, 38km S. Grayling, C.M. Yoshimoto (1 ♀, BMNH); **Missouri**: Williamsville, viii.1987, J.T. Becker (8 ♀, BMNH); Williamsville, 14.vii-8.viii.1988, J.T. Becker (1 ♀, BMNH); **N. Carolina**: McDowell Co., 37° 00' N, 81° 30' W', 4.vii-17.ix.1987 (2 ♀, BMNH); **Texas**: Brewster Co., Big Bend Nat'l Park, No. Rosillos Mtns., 29 32 30N 103 12 10W, 22.iii-8.iv.1991, Whitefield+Wharton, malaise BB91/007 (2 ♀, TAMU); Big Bend Nat'l Park, No. Rosillos Mtns., 29 32 30W 102 12 03N, 23.iv.1991 malaise, R.A. Wharton BB91/015 (1 ♀, TAMU); Val Verde Co., Seminole Cyn. State Park, 15.iv.1989, J.S. Noyes (1 ♀, BMNH). **CANADA: Ontario:** 3 km NE Almonte, v.1986, H. Goulet (1 ♀, BMNH); 3 km NE Almonte, vii.1986, Denis & Dumouchel (1 ♀, BMNH); 3 Km N. Almonte, 2-9.vii.1986, Denis & Dumouchel (2 ♀, BMNH); 5 Km NE Almonte, 3-10.vi.1986, H. Goulet (1 ♀, BMNH); **Quebec**: Gatineau Park, Luksville Falls, Denis & Dumouchel, vi.1986 (1 ♀, BMNH); Luskville Falls, Denis, Dumouchel, vii.1986, 300m (4 ♀, BMNH).

Copidosoma lymani Howard

(Figs. 253-260)

Copidosoma lymani Howard, 1907: 102. [USNM, ♀ holotype examined].

Type Material. Holotype ♀ mounted on a point with a card underneath, "Montreal/Can" [handwritten in ink] "Bred from/no.4075"H H Lyman" [handwritten in ink] "Type/No. 9779/U.S.N.M." [red label] "Copidosoma/Lymani/♀ type Howard" [handwritten in ink] "Copidosoma/lymani How/type ♀" [handwritten in pencil]. Holotype missing left antenna and last tarsal segment of left hind leg.

Howard recorded 9 specimens in the original description but only 7 other specimens from the type series could be found. They have the same label data as the holotype, but with a mixture of printed and handwritten labels. Three specimens are female, 3 are male, and all are damaged or missing various appendages. The remaining specimen has been broken off the point and is represented only by legs. Howard (1907) stated the original specimens were reared in Toronto, but all the type specimens are clearly labelled "Montreal". Two males labelled "Toronto/VI/1901 Ont" "Bred from/No 4075/H H Lyman", and 2 females and 2 males labelled by O. Peck as from the original Lyman collection may have been part of the original series but bear no type labels or numbers.

Diagnosis. Females of *Copidosoma lymani* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented and slightly obliquely truncate (Fig. 253) and hypopygium simple (Fig. 257). This species is similar to *Copidosoma beckeri*, *C. incisum*, and *C. whartoni*, which differ in the shape of the club (Fig. 4) and have an anterior lobe on the hypopygium (Fig. 49).

Female. Length 0.94-1.15 mm. Body dark brown; frontovertex with white or pale green or blue highlights, lower face and genae with purple highlights; scape light brown or brown with tan apices, funicular segments tan, or brown with the ventral surface tan, club dark brown; mesoscutum anteriorly with purple highlights, posteriorly with green highlights, axillae and scutellum with purple highlights, scutellum with green highlights laterally and posteriorly, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with blue and purple highlights; coxae dark brown, fore- and hind femora dark brown with tan-white apices, foretibia dark brown with tan-white apices or with a proximal dark brown area that fades to tan, foretarsi brown or white-tan, midfemur dark brown except for proximal hyaline ring and distal 1/4, midtibia tan-white at base and in distal 1/2, remainder dark brown, midtarsi 1-4 tan-white, tarsus 5 darker, hind tibia tan-white at base and in distal 1/2-1/3, remainder dark brown, hind tarsi brown or tan-white; forewing hyaline, or slightly infuscate around marginal vein on large specimens.

Frontovertex 0.4x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly larger than others; eye reaching occipital margin, eye height 1.7-2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:5; toruli 0.5x their width from mouth margin, funicular segments subquadrate to 1.5x longer than broad, club 3-segmented and slightly obliquely truncate, 0.75-0.87x length of funicle, sensory area about 0.2x length of club (Fig. 253).

Mesoscutum with reticulate sculpture similar to frontovertex but with larger cells; axillae meeting and elevated above scutellum; scutellum convex and with reticulate sculpture that is more elongate laterally, apex nearly polished; forewing 2.25-2.35x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein barely longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.5x length of stigmal vein (Fig. 255).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching 0.8-0.9x length of metasoma and simple (Fig. 257); ovipositor 0.65-0.75x length of midtibia and not, or barely exserted, second valvifer fused to third valvula, with oblique rows of spicules (as in Fig. 431).

Male. Length 0.96-1.1 mm. Sculpture similar to female; head with brighter green and purple highlights; toruli 1.5x their width above mouth margin, funicular segments 1.3-1.5x longer than broad, club 0.4x length of funicle (Fig. 254); phallobase 0.5x length of midtibia and with 5-6 pairs of setae (Fig. 259), each digitus with 3 apical claws and a single pore near claws (Fig. 258), aedeagus with a pair of sensilla (Fig. 260).

Variation. Some specimens have the ovipositor exserted about 0.1x the length of the metasoma, others not at all. Specimens from Arizona, Georgia, and Texas have more extensive dark areas on the midfemur and mid- and hind tibiae than those from Canada.

Biology and hosts. Reared from *Anacampsis lupinella* Bsk, *A. tristrigella* (Wlsm.), *Battaristis vittella* (Bsk.) (Gelechiidae: Anacampsinae); *Argyresthia goedartella* (L.) (Argyresthiidae) (label data) and *Rhyacionia buoliana* (D. & S.) (Tortricidae: Olethreutinae) (label data, Gordh 1979).

Distribution. Not commonly collected, but present from New Brunswick to Manitoba and south to Arizona and Florida.

Other material examined. CANADA: Manitoba: Ashern, 4.viii.1947, Ex. Tortricid sp., Willow (2 ♀, NFC); **New Brunswick**: Kouchibouguac N.P., 20.ix.1977, S.J. Miller (1 ♀, CNC); **Ontario**: Innisville, viii.1982, WRM Mason, R. Wharton, Malaise (1 ♀, TAMU); Kearney, 24.vi.1957, ex. *Argyresthia goedartella* (1 ♀, CNC); Ottawa, Constance Bay, 29.vi-vii.1983, M. Sanborne (1 ♀, BMNH); Sarnia, 25.vii.58 A. Suave, ex. *Comsolechia tristrigella* (15 ♀, BMNH); **Quebec**: Luskville Falls, 22-24.vii.1986, Denis & Dumouchel (7 ♂, TAMU); **USA: Arizona**: Cococino Co., W Flagstaff, Bonito Park 6-8.viii.1984, pan traps BV Brown (2 ♀, LDC); Colorado: Pueblo Co., San Isabel Nat. Forest, 6 mi S Beulah, 4.viii.1987. 24440m, J.D. Pinto (1 ♂, TAMU); **Florida**: Alachua Co., Gainsville, 24.iv.1989, J.S. Noyes (1 ♀, BMNH); **Georgia**: Forsyth, vii.1971, F. Naumann (1 ♀, BMNH); McIntosh Co., Sapelo Island, BRC Hym Team, vii.1987 (1 ♀, BMNH); **Texas**: Bastrop Co., Bastrop St. Park, 10-22.viii.1990, Geiselbrecht & Wharton (2 ♀, TAMU); Brazos Co., Lick Creek Park, College Station, 4-26.viii.1987, Heraty-Woolley, Malaise/Interc. (1 ♀, TAMU); Brewster Co., Big Bend Nat'l Park, No. Rosillos Mtns., 29 33 00N 103 13 32W, 17.vi.1991, R.A. Wharton BB91/047 (1 ♀, TAMU); Big Bend Nat'l Park, No. Rosillos Mtns., 29 32 30N 103 12 10W, 22.iii-8.iv.1991, Whitefield & Wharton BB91/007 (1 ♀, TAMU).

Copidosoma masneri new species

(Figs. 261-263)

Diagnosis. Females of *Copidosoma masneri* are distinguished from other species of *Copidosoma* by the following characters: frontovertex and mesoscutum purple, forewing infuscate around marginal and stigmal veins, legs dark brown, and syntergum divided (as in Fig. 160). This species superficially resembles *Copidosoma timberlakei*, which has a green mesoscutum, a narrower and more extensively infuscate wing, and tibiae with extensive tan areas.

Female. Length about 1.9 mm. Body dark brown; frontovertex with light purple highlights, face from top of toruli to mouth margin mixed blue, green, and purple, genae mixed coppery purple, blue-green band extending from top of toruli to ventral and posterior margins of eyes; scape with green highlights, funicular segments and club uniformly dark brown; mesoscutum with dark purple reflections, with some blue-green highlights anteriorly and laterally, axillae with purple and green highlights, scutellum bronze green,

with some coppery purple anteriorly and medially, propodeum laterally with green highlights and silver setae lateral to spiracle, mesopleuron with green highlights anteriorly, blue highlights medially, and purple highlights posteriorly; coxae and fore- and hind femora dark brown with blue-green reflections, foretibia dark brown with medial surface lighter, foretarsi dark brown, midfemur dark brown with proximal hyaline ring, midtibia dark brown, fading to tan at apex, midtarsus 1 and ventral surfaces of tarsi 2-4 tan, remainder dark brown, hind tibia and tarsi dark brown; forewing infuscate around marginal and stigmal veins.

Frontovertex 0.5x head width and with fine reticulate sculpture that is more elongate on lower face and genae; mandible with middle and posterior teeth subequal, dorsal tooth obscured by setae; eye separated from occipital margin by the diameter of a facet, eye height 1.4x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 2:2:9; toruli separated from mouth margin by their width, funicular segments 1.6-2x longer than broad, club 3-segmented and 0.65x length of funicle, sensory area 0.8x length of club (Fig. 261).

Mesoscutum with elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with deep elongate reticulate sculpture narrower than that of mesoscutum; forewing 2.25x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein not reaching anterior wing margin, about as long as broad, stigmal vein 3x length of marginal vein, postmarginal vein nearly absent (Fig. 262)

Metasoma distorted but hypopygium apparently reaching apex of metasoma; ovipositor exserted about 0.25x length of metasoma, second valvifer not fused to third valvula; syntergum divided medially (as in Fig. 160).

Male. Unknown.

Biology and hosts. Unknown.

Distribution. Known from a single specimen from southeastern Arizona.

Etymology. Named in honor of the collector, Dr. L. Masner.

Holotype ♀ mounted on a card, "USA: Arizona/Graham Co./Graham Mts, 270m" "Big Creek-Grand Creek./22.viii.1990/L. Masner". Left antenna and right forewing slide-

mounted in balsam. Red label "HOLOTYPE/Copidosoma/masneri/Zolnerowich" added to specimen. Deposited in CNC.

Copidosoma masoni new species

(Figs. 264-270)

Diagnosis. Females of *Copidosoma masoni* are distinguished from other species of *Copidosoma* by the following characters: metasoma elongate, 1.8-2.0x length of the mesosoma, club unsegmented and strongly obliquely truncate (Fig. 264), and forewing shorter than metasoma.

Female. Length 1.87-2.27 mm, excluding ovipositor. Body dark brown to black; frontovertex with light reflections, lower face and genae with light green and purple reflections; antennae uniformly dark; mesoscutum, axillae, and scutellum with mixed pale green, purple, and blue highlights, propodeum with mixed pale green and purple highlights laterally and translucent setae lateral to spiracle, mesopleuron with white highlights anteriorly and purple-blue highlights posteriorly; coxae dark brown and black, femora and tibiae dark brown or black and tan at the apices, midfemur with a proximal hyaline ring, midtibial spur white-tan, much lighter than tibia and tarsi, tarsi brown to black; forewing hyaline.

Frontovertex slightly more than 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth slightly shorter than the others; eye separated from occipital margin by about the diameter of 3 facets, eye height 1.4x malar space; ocelli forming a right angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:13; toruli separated from mouth margin by their width, funicular segments 1.5x longer than broad, club unsegmented and strongly obliquely truncate, 0.5-0.6x length of funicle, sensory area 0.5x length of club (Fig. 264).

Mesoscutum with deeper, more elongate reticulate sculpture than frontovertex, axillae slightly elevated above scutellum, scutellum relatively flat, with sculpture similar to mesoscutum but shallower; forewing 2.4x longer than wide, submarginal vein with incomplete apical hyaline break, linea calva interrupted dorsally by setae, marginal vein 1.5x longer than broad, stigmal vein 1.5x length of marginal vein, postmarginal vein at most 0.3x length of stigmal vein (Fig. 267).

Metasoma 1.8-2x length of mesosoma; cerci inserted about 2/3 from anterior end of metasoma; hypopygium reaching apex of metasoma, with one anterior lobe and two

posterior lobes (Fig. 268); ovipositor 2.4x length of midtibia and exserted 0.1-0.2x length of metasoma, second valvifer not fused to third valvula, with several longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.34-1.47 mm. Similar to female but metasoma subequal in length to mesosoma; torŭli 2x their width above mouth margin, funicular segments 1.5-2x longer than broad, club 0.3x length of funicle (Fig. 265); phallobase 0.85x length of midtibia and with 28-32 pairs of setae (Fig. 270), each digitus with 3 claws and without pores (Fig. 269), aedeagus with a pair of sensilla.

Variation. Specimens vary from dark brown to black, with corresponding variation in the legs. Several females have the metasoma extended to 3x or more the length of the mesosoma.

Biology and hosts. Unknown.

Distribution. Known only from Palm Springs and White Water in Riverside County, California.

Etymology. Named in honor of Dr. W. R. M. Mason, who collected most of the known specimens.

Holotype ♀ mounted on a point with a card underneath, "White Water, Cal./13.III-1955/W.R.M. Mason". Red label "HOLOTYPE/Copidosoma/masoni/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: same data as holotype (2 ♀, 1 ♂); USA: **California**: White Water, 17.III, 19.III, and 27.III-1955, W.R.M. Mason (12 ♀, 9 ♂); White Water, 16-III-1955, W.R. Richards (1 ♀); White Water, 27.III-1955, W.R. Richards (1 ♀); Murray Canyon, Palm Springs, 20.III-1955, W.R.M. Mason (1 ♀). Paratypes to be deposited in CNC, BMNH, TAMU, and USNM.

Copidosoma melanocerum (Ashmead)
(Figs. 271-278, 435)

Liothorax melanocera Ashmead, 1900: 363. [USNM, lectotype ♀ examined]. Treated as *Copidosoma* by Mercet (1923).

Type Material. Lectotype here designated, ♀ mounted on a point with a card underneath, "Washington/DC" "Liothorax/melanocera/Ashm." [handwritten in ink] "Type/No. 4738/U.S.N.M" [red label]. "Copidosoma/melanocerum/Ashmead, 1900/LECTOTYPE/ det. G. Zolnerowich" added to specimen. Lectotype missing right funicular segments 4-6 and club, right fore- and hind wings, and ovipositor sheaths. This female is the only syntype available that matches the information given in Ashmead's original description (Ashmead 1900).

A female syntype with the same U.S.N.M. type number collected in Arlington, Virginia, has the head missing but all 4 wings intact. A slide labelled "Liothorax/ melanocera/Ashmead/ ♀ type." [handwritten in ink] "Liothorax/melanocera/ Ashmead/USNM Type No. 4738" [handwritten on a red label] has a crushed head, 2 antennae, and a right forewing. Mercet (1923) observed this species belonged in *Copidosoma* but apparently did not formally transfer it.

Diagnosis. Females of *Copidosoma melanocerum* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented with apex obliquely truncate, all funicular segments longer than broad (Fig. 271), scutellum with elongate reticulate sculpture, hypopygium reaching 0.5-0.6x length of metasoma, and ovipositor exserted 0.15-0.25x length of metasoma. It is most similar to *Copidosoma compressa*, which differs by having shorter funicular segments, a strongly oblique club (Fig. 107), and the body dorsoventrally compressed.

Female. Length 1.25-1.4 mm, excluding ovipositor. Body dark brown-black; head with blue-green or brassy green highlights; scape dark brown-black with green highlights, flagellum uniformly dark brown-black; mesoscutum and axillae brassy green, scutellum with green and coppery purple highlights, propodeum laterally green or blue-green and with translucent setae lateral to spiracle, mesopleuron with blue-green highlights anteriorly and purple highlights posteriorly; coxae dark brown, fore- and midfemora dark brown-black with green highlights, tan at apex, midfemur with proximal hyaline ring, fore- and

midtibiae dark brown-black with green highlights, tan at base, foretarsi dark brown, midtarsi 1-4 tan or brown, tarsus 5 darker, hind femur and tarsi dark brown-black with green highlights, hind tarsi dark brown; forewing infuscate around marginal and stigmal veins, infuscation occasionally reaching to filum spinosum.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, anterior tooth shortest and posterior longest (as in Fig. 405); eye separated from occipital margin by the diameter of a facet, eye height 1.5-1.7x malar space; ocelli forming a right angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 1:0.5:7; toruli separated from mouth margin by their width, funicle segments 1.7-2.5x longer than broad, club unsegmented and obliquely truncate, 0.5x length of funicle, sensory area about 0.2x length of club (Fig. 271).

Mesoscutum with reticulate sculpture similar to frontovertex; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with elongate reticulate sculpture that is shallower at apex; forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein 2x longer than broad, stigmal vein 1.5x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 274)

Metasoma 1.2-1.4x length of mesosoma; cerci inserted at 0.25-0.4x length of metasoma; hypopygium simple (Fig. 275), reaching 0.5-0.6x length of metasoma; ovipositor 1.8x length of midtibia and exserted 0.15-0.25x length of metasoma, second valvifer fused to third valvula, with a transverse cluster of spicules (as in Fig. 432); epiproct present (Fig. 435).

Male. Length 1.2-1.3 mm. Similar to female but ocelli forming a slightly obtuse angle, OOL:OPL:POL 1:0.5:8; toruli 1.5x their width from mouth margin, funicular segments 1.2-1.9x longer than broad, club 0.4x length of funicle (Fig. 272); metasoma subequal to length of mesosoma; phallobase 0.9x length of midtibia, with medial flanges and 7-8 pairs of setae (Fig. 277), each digitus with 3-4 apical claws and without pores (Fig. 276), aedeagus with a pair of hooks and a pair of sensilla (Fig. 278).

Variation. Color of the head and mesoscutum varies from green to blue-green, and the habitus varies from dark brown to nearly black. Older specimens have more purple highlights on the head and mesosoma.

Biology and hosts. Reared from *Feltia subgothica* (Haw.) (Noctuidae: Noctuinae) (Peck 1963), and *Crymodes devastator* (Brace) (Noctuidae: Amphipyrinae).

Distribution. Generally east of the Rocky Mountains, from Alberta to Texas and east to the Atlantic states. The westernmost record is from Flagstaff, Arizona.

Other material examined. USA: **Arizona**: Flagstaff, 23, 27.ix.1968, G.W. Forister (3 ♀, 2 ♂, UCD); **Georgia**: Clarke Co., Athens, 1.x-23.xi.1987, BRC Hym Team (1 ♀, TAMU, 1 ♀, BMNH); **Kansas**: Riley Co., 26.ix.1961, J.R. McCoy (19 ♀, MSU); **Illinois**: McClean Co., Towanda, 10.ix.1987, J.D. Pinto (1 ♀, BMNH); **Maryland**: Takoma Pk., 22.ix.1945, H.&M. Townes (1 ♀, 5 ♂, AEI); Calvert Co., Port Republic, viii-ix.1986, M. Sharkey & S. Monroe (5 ♀, BMNH); **Massachusetts**: Cuttyhunk Is., Elizabeth Is., 15.ix.1972, C.T. Parsons (1 ♀, MCZ); **Michigan**: Montmorency Co., 5 ix.1966, P.C. Kennedy, EX: Window pane trap (1 ♀, MSUE); Ann Arbor, viii.1982, M. Sharkey (4 ♀, BMNH); Ann Arbor, viii.76 Gld (1 ♀, BMNH); Ann Arbor, ix.76 Gld (1 ♀, BMNH); Gun Lake, viii.76 Gld (2 ♀, BMNH); Livingston Co., Edwin S. George Res., 11.ix.1973, G. Gibson (1 ♀, CNC); **Minnesota**: Hennepin Co., Minneapolis, Industr. Blvd. Area, B. Cutler, 29.viii.1976, Sweeping *Solidago* flowers (3 ♀, FSCA); Swift Co., Chippewa Prair. 3mi. SE Appleton, 3.ix.1985 Hanson (6 ♀, BMNH); Wilkin Co., TownHall Prair., 5mi. SW Rothsay, 4.ix.1985 Hanson (1 ♀, BMNH); **Missouri**: Wayne Co., Williamsville, x-xi. 1968, J.T. Becker (1 ♀, BMNH); Williamsville, viii.1969, J.T. Becker (1 ♀, BMNH); Williamsville, vii.1987, J.T. Becker (1 ♀, BMNH); Williamsville, 10-26.ix.1987, J.T. Becker (2 ♀, TAMU, 7 ♀, BMNH); Williamsville, x1987, J.T. Becker (1 ♀, 1 ♂, BMNH); Williamsville, 1-19.vi.1988, J.T. Becker (4 ♀, 4 ♂, TAMU); **Nebraska**: Sioux Co., Agate Fossil Beds Nat. Mon., 31.viii.1985 Hanson (19 ♀, 6 ♂, BMNH); **New York**: Madison Co., Chittenango, 12.ix.1970, R.C. Miller (1 ♀, SUNY); **North Carolina**, Jackson Co., Whiteside MT., 13.ix.1987, L. Masner (2 ♀, BMNH); McDowell Co., 37'00N 81'30W, BRC Hym Team, ix-xi.1987 (7 ♀, BMNH, 3 ♀, TAMU); Horse Cove, Highlands 3000', ix.1980, L. Masner (1 ♀, BMNH); **Texas**: Cameron Co., Southpoint Nursery, G.A.P. Gibson (1 ♀, BMNH); Travis Co., Austin, Zilker Park, 8.x.1983, J.B. Woolley 83/002 (1 ♀, TAMU); **Virginia**: Albemarle Co., 3.x.1980, T. Williams (1 ♀, VPI); Montgomery Co., 8 km NW Blacksburg, 1-8.ix.1987, BRC Hym Team, Malaise forest edge (1 ♀, TAMU); 8km NW Blacksburg, ix.1987 1000m, BRC Hym Team (1 ♀, 1 ♂, BMNH); Shenandoah N.P., Skyline Parkway S., 610-915m, 20.ix.1980, Masner & Bowen (2 ♀, CNC); **West Virginia**: Lost River S.P.,

9-13.x.1950, B.D. Burks (1 ♀, UCR); **Wisconsin**: Milwaukee, Fox Point (suburb), 2.ix.1983, J.T. Huber (2 ♀, CNC); **CANADA**: **Alberta**: Medicine Hat, viii.1980, G.A.P. Gibson (1 ♀, TAMU); 0.5km E. Writing-on-Stone PP., 22-30. viii. 1980, D. McCorquadale (1 ♀, BMNH); 0.5km e. Writing-On-Stone prov. prk. (pan), 2-13.ix.1981, D. McCorquadale (3 ♀, BMNH); Writing-On-Stone Prov. Prk., viii.1981, D. McCorquadale (3 ♀, BMNH); **New Brunswick**: Kouchibouguac N.P., 30.viii.1977, S.J. Miller (5 ♀, CNC, 1 ♀, BMNH); **Ontario**: Innisville, Carleton Place, 10.viii.1985, J.S. Noyes (26 ♀, BMNH); Ottawa, ix.1970, A. Suave (1 ♀, BMNH); Ottawa 20.viii-3.ix.1985, Dumouchel & Perkins, pantraps (1 ♀, TAMU); nr. Ottawa, Constance Bay, 18.viii.1985, J.S. Noyes (6 ♀, BMNH); 5km NW Almonte, 14.viii.1985 (2 ♀, BMNH); Ottawa, Merivale gdns., 29.viii. 1985, J.S. Noyes (5 ♀, BMNH); Ottawa, Mer Bleue, bog, 16-22.viii.1982, H. Goulet (1 ♀, BMNH); Ottawa, Mer Bleue, bog, 23-30.viii.1982, H. Goulet (1 ♀, BMNH); Ottawa, Mer Bleue, 4-12.ix.1983, L.Huggert (8 ♀, 2 ♂, BMNH); Mer Bleue, 5.ix.1974, L. Masner (2 ♀, TAMU); Alfred Bog, viii.1984, M. Sanborne (2 ♀, BMNH); Hamilton, 22.viii.1981, M. Sanborne (1 ♀, BMNH); Hamilton, ix.1982, M. Sanborne (1 ♀, BMNH); 15km W. Ottawa, Shirley's Bay, 10.ix.1985, J.S. Noyes (1 ♀, BMNH); **Quebec**: Aylmer, 17.viii.1942, O. Peck (4 ♀, CNC); Gatineau Park, Ridge Road, viii.1985, J.S. Noyes (2 ♀, BMNH); Hwy 201, 8 Km SW Rigaud, 9.ix.1985, J.S. Noyes (3 ♀, BMNH).

Copidosoma mutabilis new species

(Figs. 279-286)

Diagnosis. Females of *Copidosoma mutabilis* are distinguished from other species of *Copidosoma* by the following characters: funicle 5-segmented (Fig. 279), axillae not meeting, scutellum with shallow reticulate sculpture, fore- and hind coxae white, and midcoxae dark. The only other species with 5 funicular segments is *Copidosoma rima*, which has similar coxae but deep striate sculpture in the anterior 2/3 of the scutellum. Species of *Copidosomopsis* also have 5 funicular segments, but all New World species have dark coxae, obliquely truncate clubs, and elongate propodeal spiracles (Fig. 428).

Female. Length 0.96-1.12 mm. Body dark brown; frontovertex with pale green reflections, scrobal area and genae with purple reflections; radicle dark brown, scape tan to light brown and usually lighter than radicle and flagellum, flagellum uniformly brown; mesoscutum dark brown with green and purple highlights, axillae and scutellum dark

brown with purple reflections, propodeum and mesopleuron dark brown, propodeum with translucent setae lateral to spiracle; fore- and hind coxae white, midcoxa dark brown, base of forefemur white, remainder tan, foretibia and tarsi 1-4 tan, tarsus 5 brown, midfemur white-tan in basal 1/2-2/3 and at apex, remainder dark brown, midtibia white-tan proximally, with a brown area in proximal 1/3 that fades to tan, midtarsi tan, hind leg similar to midleg but tibia and tarsi slightly darker; forewing infuscate around marginal and stigmal veins, remainder hyaline.

Frontovertex 0.5x head width and with shallow reticulate sculpture that is more elongate on lower face and genae; mandible with 3 teeth, dorsal tooth slightly shorter and more rounded than the others; eye separated from occipital margin by about the diameter of a facet, eye height 1.3-1.7x malar space; ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL: OPL: POL 2:1:14; toruli separated from mouth margin by their width, funicle segments 1.2-2.7x longer than broad, club 3-segmented and 0.8-1.0x length of funicle, sensory area 0.7-0.9x length of club (Fig. 279).

Mesoscutum with sculpture similar to that of frontovertex but deeper; axillae not meeting, slightly elevated above scutellum; scutellum convex and with sculpture shallower and more longitudinally elongate than mesoscutum, apex nearly polished; forewing 2x longer than wide, submarginal vein with apical hyaline break, linea calva interrupted dorsally by setae, marginal vein 1.5x longer than broad, stigmal vein subequal to length of marginal vein, postmarginal vein 0.75x length of stigmal vein (Fig. 282).

Metasoma slightly longer than mesosoma, cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe (Fig. 283); ovipositor 1.1-1.4x length of midtibia and slightly exserted, second valvifer fused to third valvula and anteriorly with several short longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.0 mm. Similar to female but with sculpture of head and mesosoma deeper; toruli 1.5x their width above mouth margin, radicle, scape, and pedicel dark brown, funicular segments 1-2 mostly brown, tan ventrally, remaining funicular segments and club becoming lighter in color, brown only in proximal 1/2 with the remainder tan, funicular segments 1.7-2x longer than broad, club 0.3x length of funicle (Fig. 280); phallobase 0.67x length of midtibia and with 10 pairs of setae (Fig. 285), each digitus with 3 apical claws and without pores (Fig. 284), aedeagus without sensilla (Fig. 286).

Variation. This species shows a large amount of variation in the lengths of the funicular segments and club, as shown in Fig. 279. Specimens from the same series may have the

funicular segments slightly longer than broad to nearly twice as long as broad. While the largest specimen is only 14% longer than the smallest, the funicular segments may be twice as long as those in the smallest specimens. Specimens with the shortest antennae are found in Florida, Georgia, and Maryland; those with the longest antennae are from Texas. However, specimens with such different antennae can be alike in every other respect. Though the host is unknown, this may be an example of host-induced variation. Such variation, particularly in antennal segments, is known to occur in Chalcidoidea and other parasitic Hymenoptera (Johnson et al. 1987, Meyerdirk and Moratorio 1987, Huber and Rajakulendran 1988). Specimens collected long ago, or those that are not critical-point dried, have the light areas tan instead of white. Larger specimens tend to have darker scapes and a very small dark area at the base of the front coxae. Several small specimens from Florida have the forecoxa brown and the sculpture of the scutellum lighter than in other specimens.

Biology and hosts. Unknown.

Distribution. Known from southern Ontario to Florida, west to Missouri and Texas, and with 1 collection record from the Mexican state of Puebla.

Etymology. From Latin *mutabilis*, variable or changeable, referring to the striking antennal variation.

Holotype ♀ mounted on a card, "USA: S. Carolina./Anderson Co./Pendleton 225m/ Tanglewood Spring" "34 38 N. 82 47 W./16-29.vii.1987/J. Morse BM 197-149". Red label "HOLOTYPE/Copidosoma/mutabilis/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. **USA**: same data as holotype (8 ♀, BMNH); **USA**: **South Carolina**: Anderson Co., Pendleton, 225m, 15-22.VII.1987, BRC Hym Team, Malaise (2 ♀, TAMU); Pendleton, 225m, 23.VII-5.VIII.1987, BRC Hym Team (3 ♀, TAMU); Pendleton, 225m, 6-14.VIII.1987, BRC Hym Team, Malaise (2 ♀, TAMU); Pendleton, 225m, 21-27.VIII.1987, BRC Hym Team (3 ♀, TAMU); Pendleton, 225m, 29.VIII-2.IX.1987, BRC Hym Team (4 ♀, TAMU); Pendleton, 225m, 5-9.IX.1987, BRC Hym Team, Malaise (1 ♀, TAMU); Pendleton 250m, hardwood forest, 13-19.v.1987, BRC Hym Team, (1 ♀, BMNH); Pendleton 250m, hardwood forest, 5-10.vi.1987, BRC Hym

Team (1 ♀, BMNH); Pendleton 250m, hardwood forest, 1-7.vii.1987, BRC Hym Team (1 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. USA: Florida: Dade Co., Everglades NP, Long Pine Key, vi.1986, S.&J. Peck (1 ♀, BMNH); Everglades NP, Long Pine Key, 28,31.viii-5, 9.ix.1986, S.&J. Peck (3 ♀, 1♂, BMNH); S. Miami, 21.ii-v.1986, S.&J. Peck (1 ♀, BMNH); Chekkika SRA, 50 Km SW Miami, xi.1985-ii.1986, Grossman Hammock, S.&J. Peck (1 ♀, BMNH); Alachua Co., Gainesville, 1-7.xii.1986, W.R. Mason (1 ♀, BMNH); Gainesville, 5.ix-18.xi.1987, oak forest, BRC Hym Team (3 ♀, BMNH); Gainesville (AEI), 1.vi-20.viii.1988, D.B. Wahl (1 ♀, BMNH); Highlands Co., Archbold Biol. St., 15.viii-1.ix.1987, D.B. Wahl (2 ♀, TAMU); Monroe Co., No Name Key, 23.ii-3.vi.1986, S.&J. Peck (1 ♀, BMNH); Big Pine Key, Watson's Hammock, 1.viii-17.xi.1985, S.&J. Peck (1 ♀, TAMU); Sugarloaf Key, 5.viii-19.xi.1985, S.&J. Peck (1 ♀, TAMU); **Georgia**: McIntosh Co., Sapelo Island, BRC Hym Team, 28.iv-9.v.1987, live oak forest (2 ♀, BMNH); Sapelo Island, 20.vi-18.vii.1987, live oak forest, BRC Hym Team (2 ♀, BMNH); Sapelo Island, 26.vi-18.vii.1987, sand dunes, BRC Hym Team (3 ♀, BMNH); Sapelo Island, 18.vii.1987, J.T. Huber (2 ♀, BMNH); Sapelo Island, 15.ix-15.xi.1987, BRC Hym Team, oak forest, (1 ♀, BMNH); **Kentucky**: Bernheim For., viii.1982, Fitton & Quinlan (1 ♀, BMNH); **Maryland**: Patuxent Wildlife Reserve, vii.1982, Fitton & Quinlan (15 ♀, 1 ♂, BMNH); Calvert Co., 5 km. S. Prince Frederick, Scientist's Cliffs, 22.vii-5.viii.1987, BRC Hym Team (3 ♀, BMNH); 7 km S. Prince Frederick, 24.ix-14.xi.1987, Hardwood Forest, BRC Hym Team (3 ♀, BMNH); **Michigan**: Ann Arbor, vii.1982, Fitton & Quinlan (5 ♀, BMNH); **Missouri**: Williamsville, vi.1970, J.T. Becker (1 ♀, BMNH); Williamsville, v.-viii.1987, J.T. Becker (11 ♀, BMNH); Williamsville, 1-19.vi.1988, J.T. Becker (1 ♀, TAMU); Williamsville, 14.vii-8.viii.1988, J.T. Becker (5 ♀, BMNH, 1 ♀, TAMU); **New Hampshire**: Durham, 16, 25.viii.1954, R.L. Blickle, Collr. (2 ♀, USNM); **North Carolina**: Jackson Co., Whiteside Mt. ix-23.xi.1987, BRC Hym Team, Malaise oak forest, 1600m (3 ♀, TAMU); McDowell Co., 37° 00' N, 81° 30' W, 4.vii-17.ix.1987, BRC Hym Team (4 ♀, BMNH); **Ohio**: Hocking Co., Pine Creek Rt. 11, 12.viii.1987, J.Whitefield (1 ♀, TAMU); **South Carolina**: Dorchester Co., Francis Beidler Forest, 10 Km NE Harleyville, 15.iv-11.vi.1987. BRC Hym Team (4 ♀, BMNH.2 ♀, TAMU); Francis Beidler Forest nr. Harleyville, 1-10.ix.1987, BRC Hym Team, Malaise (3 ♀, TAMU); Jackson Co., Whiteside Mt., nr Highlands, vii.1987, 1600m, oak forest, BRC Hym Team (2 ♀, BMNH); Pickens Co., Clemson, vii.1987,J. Johnson, (1 ♀, BMNH);

Clemson, Cherrys Crossing, 25.viii-3.ix.1987, J. Johnson (1 ♀, TAMU); **Texas**: Bastrop Co., Bastrop St. Pk., v.1983, M. Kaulbars (1 ♀, BMNH); Bastrop St. Park, 16-30.iv.1990, Wharton (1 ♀, TAMU); Bastrop St. Park, 7-21.x. 1990, R. Wharton (2 ♀, TAMU); Brazos Co., Lick Creek Park, College Station, 7-30.iv.1987, Heraty-Woolley, Malaise/Interc. (2 ♀, TAMU); College Station, Lick Creek Park, 9-20.ix, 18-31.x.1987, R. Wharton, Malaise trap (2 ♀, TAMU); College Station, Lick Creek Park, 4-31.vii, 3-9.x.1988, R. Wharton, (3 ♀, TAMU); Hidalgo Co., Bentsen-Rio Grande St. Prk., 6.iv.1989, J.S. Noyes (1 ♀, BMNH); Montgomery Co., Jones State Forest, 8 mi S Conroe, 19.ix-4.x.1987, Wharton, Carroll, Praetorius (1 ♀, TAMU); **Virginia**: Compton Gap, Shenandoah N.P., BRC Hym Team, vii-ix.1987 (1 ♀, BMNH); **CANADA**: **Ontario**: Pt. Pelee.8.viii.1984, A. Borkent (7 ♀, BMNH, 4 ♀, TAMU); Point Peele, vii.1986, A. Borkent (1 ♀, BMNH); **MEXICO**: **Puebla**: 4.7 mi SW La Cumbre, el. 5100', 23.vii.1987, Woolley & Zolnerowich 87/055 (2 ♀, TAMU).

Copidosoma noyesi new species

(Figs. 287-295, 412)

Diagnosis. Females of *Copidosoma noyesi* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented, strongly obliquely truncate, and as long or longer than funicle (Figs. 287, 412), forecoxa with some light color, and midfemur tan. *Copidosoma floridanum* differs by having a smaller club (Figs. 147, 411) and dark coxae, and *C. albicoxae* differs by having all coxae white and the mouth margin produced into a broad lobe (Fig. 23).

Female. Length 0.88-1.0 mm. Body dark brown; frontovertex with pale green highlights, scrobal area and genae with purple highlights; scape varying from tan to dark brown with tan apices, funicular segments tan ventrally and darker brown above, club dark brown, usually conspicuously darker than funicular segments; mesoscutum with green and purple reflections, axillae and scutellum with pale purple reflections, scutellum posteriorly with green reflections, propodeum laterally with pale purple highlights and translucent setae lateral to spiracle, mesopleuron with bluish highlights anteriorly and purple highlights posteriorly; forecoxa dark brown in proximal 1/2-2/3, remainder white-tan, forefemur varying from tan to brown with light apices, foretibia and tarsi 1-4 tan, tarsus 5 dark brown, midcoxa dark brown, midfemur varying from tan to brown with light apices, midtibia and tarsi tan, hind coxa dark brown, hind femur varying from mostly tan with an

apical brown spot to dark brown with light apices, outer surface of hind tibia tan, inner surface darker brown, hind tarsi 1-4 tan, tarsus 5 dark brown; forewing slightly infuscate, darkest around venation.

Frontovertex slightly less than 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth distinctly rounded (Fig. 291); eye separated from occipital margin by the diameter of a facet or less, eye height 1.3x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin; OOL:OPL:POL 1:1:5; toruli separated from mouth margin by their width, funicle segments subquadrate, club unsegmented and strongly obliquely truncate, as long or longer than funicle, sensory area 0.7x length of club (Figs. 287, 412).

Mesoscutum with reticulate sculpture similar to that of frontovertex; axillae just meeting and slightly elevated above scutellum; scutellum convex with elongate reticulate sculpture in anterior 1/2, posteriorly with shallow reticulate sculpture or nearly polished; forewing 2.25x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about 2x longer than broad, stigmal vein subequal to length of marginal vein, postmarginal vein 0.6x length of stigmal vein (Fig. 290).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium simple (Fig. 292), reaching 0.7x length of metasoma; ovipositor 0.6x length of midtibia and barely exserted, second valvifer fused to third valvula, with a transverse cluster of spicules (as in Fig. 432); epiproct present.

Male. Length 1.0-1.18 mm. Similar to female but slightly larger; ocelli larger and forming an obtuse angle; toruli 2x their width above mouth margin, flagellum tan or white ventrally, brown dorsally, all funicular segments longer than broad, club 0.4x length of funicle (Fig. 288); forecoxa and hind leg entirely dark brown; forewing hyaline; phallobase 0.5x length of midtibia and with 5 pairs of setae (Fig. 294), each digitus with 3 apical claws and without pores (Fig. 293), aedeagus with a pair of lateral sensilla (Fig. 295).

Variation. Specimens are variable in relative darkness of the antennae and femora, even within a series. Color of the scape and funicle ranges from tan to dark brown, as does the extent of dark color on the fore- and hind femur.

Biology and hosts. Unknown, but given membership in the same clade as *C. floridanum*, the host is probably a Noctuidae.

Distribution. Ontario and Quebec south to Florida, and west to Missouri, Texas, and into Mexico. Also known from 3 specimens from Kyushu, Japan.

Etymology. Named in honor of Dr. J. S. Noyes.

Holotype ♀ mounted on a card, "CAN: Quebec/Luskville Falls/5-12.VIII.1986/Denis & Dumouchel". Red label "HOLOTYPE/Copidosoma/noyesi/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: same data as holotype (1 ♂, TAMU); **CANADA: Quebec**: Luskville Falls, 8-15.VII.1986, Denis & Dumouchel (2 ♀, 3 ♂, TAMU); Luskville Falls, 17-24.VII.1986, Denis & Dumouchel (2 ♀, 1 ♂, TAMU); Luskville Falls, 22-24. VII.1986, Denis & Dumouchel (4 ♀, TAMU); Luskville Falls, VII.1986, Denis & Dumouchel (5 ♀, BMNH); **Ontario**: Constance Bay, 29.VI-29.VIII.1983, M. Sanborne (6 ♀, 1 ♂, TAMU); Constance Bay, 29.VI-10.VII.1983, M. Sanborne (17 ♀, 1 ♂, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. CANADA: Ontario: Ottawa, vii.1978, L. Masner (6 ♀, TAMU); Ottawa, viii.1978, L. Masner (6 ♀, BMNH); Ottawa, 6.vii.1986, H. Goulet (1 ♀, BMNH); Ottawa, 5.vii.1987, J. Cumming (1 ♀, BMNH); Ottawa, 8.13.vii.1987, J.M. Cumming (2 ♀, BMNH); Ottawa, 16-20.vii.1982, L. Masner (2 ♀, BMNH); Ottawa, 2.vii-13.viii.1983, L. Huggert, (8 ♀, BMNH); Constance Bay, 6-13, 13-20.vii.1973, G. Gibson, Yellow Pan Tr. (7 ♀, CNC); Constance Bay, 20-27.vii. 1973, L. Masner (7 ♀, CNC); Constance Bay, vii.1983, M. Sanborne (1 ♀, BMNH); Constance Bay, 3-8.viii.1983, M. Sanborne (1 ♀, BMNH); 15km W. Ottawa, Shirley's Bay, vii.1984, M. Kaulbars, FIT (10 ♀, BMNH); Alfred Bog, 17.ix.1984, M. Sanborne (9 ♀, 1 ♂, BMNH); 3 km NE Almonte, vii.1986, Denis & Dumouchel (1 ♀, BMNH); Clayton, vii.1981, Goulet & Miller (2 ♀, BMNH, 1 ♀, TAMU); Gloucester, x.1984, M. Sanborne (5 ♀, BMNH); Hamilton, vii.1981, M. Sanborne (1 ♀, BMNH); Hamilton, 23.vii.80. M. Sanborne, Malaise trap (1 ♀, CNC); Heckston, 20Km S.E. Kemptville, 24.vi-21.vii.1984, M. Kaulbars (1 ♀, BMNH); Innisville, 12.vii.1963, W.R.M. Mason (1 ♀, CNC); Pt. Pelee, 8.viii.1984, A. Borkent (1 ♀, BMNH); Scotch Corners, Steve Miller Farm, 11-

16.vii.1980 (2 ♀, TAMU); St. Lawrence Is. Nat. Park, McDonald Is., 19.vii.1976, G. Gibson (1 ♂, CNC); St. Lawrence Is. Nat. Park, McDonald Is., C. Yoshimoto (1 ♀, CNC); St. Lawrence Is. Nat. Park, McDonald Is., 20.vii.1976, G. Thompson (1 ♂, CNC); **Quebec**: Gatineau Park, 24.vii.1982, L. Masner (1 ♀, BMNH); Gatineau Park nr. Ridge Road, 1-15.vii.1986, D. Myles (1 ♀, TAMU); Gatineau Park, Champlain Overlook, 22.vii.1989 89/011, Woolley & Zolnerowich (30 ♀, TAMU); Hull, vii.1965, Malaise trap (2 ♀, CNC); **USA**: **Florida**: Alachua Co., San Felasco Hammock, 4.v.1987, L. Masner (1 ♀, TAMU); Gainesville, 5.ix-20.x.1987, Oak forest, BRC Hym Team (1 ♀, BMNH); **Kentucky**: Louisville, vi.1982, S. Riegler (2 ♀, BMNH); Bernheim For., viii.1982, Fitton & Quinlan (2 ♀, BMNH); **Maryland**: Calvert Co., Port Republic, viii-ix.1986, M. Sharkey & J. Monroe (2 ♀, BMNH); 7km S. Prince Frederick, hardwood forest, vii-ix.1987, BRC Hym Team (10 ♀, BMNH); 24.ix-14.xi.1987 (1 ♀, BMNH); **Michigan**: Ann Arbor, vii.1982, Fitton & Quinlan (23 ♀, BMNH); Van Buren Co., Bangor, J8.vii.1964, T. Burger (1 ♀, MSUE); Kalamazoo Co., Gull Lake Bio. Sta., 11.vii.1970, Roland L. Fischer (1 ♀, MSUE); 23 mi S Grayling, vii.1973, C.M. Yoshimoto (1 ♀, TAMU); Lake Odessa, vi.1976, I. Gauld (1 ♀, BMNH); **Missouri**: Wayne Co., Williamsville, vi-viii.1987, J.T. Becker (15 ♀, BMNH,18 ♀, TAMU); Williamsville, 10-26.ix.1987, J.T. Becker (1 ♀, BMNH); Williamsville, x.1987, J.T. Becker (1 ♀, TAMU); **North Carolina**: McDowell Co., 37' 00'N, 81' 30'W, 4.vii-24.xi, BRC Hym Team (12 ♀, BMNH, 1 ♀, TAMU); Jackson Co., Whiteside Mt. nr. Highlands, oak forest, ix-23.xi.1987, BRC Hym Team (1 ♀, BMNH); **South Carolina**: Anderson Co., Pendleton 250m, Hardwood forest, BRC Hym Team, 17.vii.1987 (1 ♀, BMNH); Pendleton 225m, 21.viii-2.xi.1987, BRC Hym Team, Malaise (4 ♀, TAMU); Pendleton, Tanglewood Spring, 1-9.ix.1987, J. Morse (1 ♀, BMNH); **Texas**: Tyler Co., 3 mi. S. Warren, 22.v.1984, J.B. Woolley 84/010 (1 ♀, TAMU); **Virginia**: Montgomery Co., 8Km NW Blacksburg, viii-ix.1987, 1000m, BRC Hym Team (2 ♀, BMNH, 4 ♀, TAMU); Warren Co., Shenandoah N.P., Compton Gap 800m, 23.vii.-viii.1987, BRC Hym Team, Malaise (5 ♀, TAMU); Shenandoah N.P., Big Meadow 1300m, 8..vii-20.viii.1987, BRC Hym Team, Malaise (6 ♀, TAMU); **MEXICO**: Chis. 7200ft., S. Crist. las Casas, 27.v.1969, Malaise Trap (1 ♀, CNC); **JAPAN**: Kyushu, Fukouka, Mt. Hiko, 18-25.ix.1989 700m, Takeno & Sharkey (4 ♀, TAMU).

Copidosoma peckorum new species

(Figs. 296-303)

Diagnosis. Females of *Copidosoma peckorum* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 296), forecoxa dark brown, forefemur white-tan except medial edge, which is brown, and hypopygium with an anterior lobe (Fig. 300). This species is most similar to *Copidosoma innocuellae* and *C. pseudoinnocuellae*, which differ in having the forecoxae white and a simple U-shaped hypopygium (Fig. 233).

Female. Length 1.4-1.57 mm, excluding ovipositor. Body dark brown; head with mixed dark green and pale purple highlights; scape brown or dark brown with tan apices, pedicel dark brown, tan ventrally and at the apex, funicular segments brown in dorsal and lateral 1/2, tan in distal 1/2 and along ventral surface, club dark brown; mesoscutum with mixed purple and pale green highlights, axillae dorsally with purple highlights, posterior surface green, scutellum with purple highlights, laterally and posteriorly with green highlights, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with green highlights anteriorly and blue and purple highlights posteriorly; coxae dark brown, forefemur white-tan except for brown along medial edge, remainder of leg white-tan, midfemur tan, midtibia white-tan at base and in distal 1/2, remainder tan, midtarsi white-tan, hind femur dark brown, lighter at apices, hind tibia brown or dark brown in proximal 1/2, fading to white-tan in distal 1/2, hind tarsi 1-3 white, tarsi 4-5 darker; forewing hyaline.

Frontovertex about 0.4 head width and with fine reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, posterior tooth slightly shorter than others; eye reaching, or nearly reaching, occipital margin, eye height 2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:8; toruli separated from mouth margin by their width, funicular segments 1.3-2x longer than broad, club 3-segmented and 0.5x length of funicle, sensory area restricted to apex of distal segment (Fig. 296).

Mesoscutum with fine reticulate sculpture similar to frontovertex but shallower; axillae meeting and greatly elevated above scutellum; scutellum convex and with reticulate sculpture, apex nearly polished; forewing 2.2x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer

than broad, stigmal vein 2x length of marginal vein, postmarginal vein at most 0.3x length of stigmal vein (Fig. 298).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and posterior emargination (Fig. 300); ovipositor 1.4x length of midtibia and exserted 0.1-0.3x length of metasoma, second valvifer not fused to third valvula, with short longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.22-1.5 mm. Similar to female but frontovertex slightly more than 0.5x head width; posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:7; toruli 2x their width above mouth margin, scape tan, or middle 1/2 brown with tan apices, pedicel brown, funicular segments and club tan, funicular segments 1.3-1.8x longer than broad, club 0.35x length of funicle (Fig. 297); phallobase 0.8x length of midtibia and with 13-15 pairs of setae (Fig. 302), each digitus with 3 apical claws and without pores (Fig. 301), aedeagus without sensilla (Fig. 303).

Variation. Specimens vary in the darkness of color on the legs.

Biology and hosts. Unknown.

Distribution. Known only from southern Florida.

Etymology. Named for the collectors, S. and J. Peck.

Holotype ♀ mounted on a card, "USA: Florida/Dade Co./Chekkika SRA/50Km SW Miami" "xi.1985-ii.1986/Grossman Hammock/S+J. Peck/BM 1986-78". Red label "HOLOTYPE/Copidosoma/peckorum/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: Florida: Dade Co., Miami, Deering Est. Pk., 21.II-1.V.1986, S.&J. Peck (2 ♀, 2 ♂, BMNH); Miami, Deering Est. Prk., 1.VI-25.VIII.1986, S.&J. Peck (17 ♀, 5 ♂, BMNH); Ckekikast Rec. area, 50km SW Miami, iii-iv.1985, S.&J. Peck (1 ♀, BMNH); Monroe Co., No Name Key, 23.ii-3.vi.1986, S.&J. Peck (1 ♀, BMNH); No Name Key, ix-xii.1986, S.&J. Peck (4 ♀, 1 ♂, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Copidosoma picra new species

(Figs. 304-308)

Diagnosis. Females of *Copidosoma picra* are distinguished from other species of *Copidosoma* by the 3-segmented club with the second and third segments tapered apically to form a narrow point (Fig. 304). *Copidosoma tamaulipasensis* has a similar, but two-segmented, club (Fig. 357).

Female. Length 1.25 mm. Body brown; head with pale purple and green highlights; antenna light brown; mesoscutum with green highlights, axillae and scutellum with purple highlights, scutellum with green highlights at the apex, propodeum laterally with light highlights and translucent setae lateral to spiracle, mesopleuron with faint purple highlights; coxae brown, forefemur brown with tan apex, foretibia brown with tan apices, foretarsi 1-4 tan, tarsus 5 brown, midfemur brown, tan at the apex and with proximal hyaline ring, midtibia brown in proximal 1/2, fading to tan in distal 1/2, midtarsi tan, hind femur and tibia brown, tan at the apices, hind tarsi 1-4 tan, tarsus 5 brown; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex about 0.6x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly shorter than others; eye separated from occipital margin by the diameter of 2 facets, eye height 1.6x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin or closer to occipital margin than to eye, OOL:OPL:POL 2:2:8 or 2:1:8; toruli separated from mouth margin by their width, funicle segments 1.2-1.5x longer than broad, club 3-segmented and 0.54x length of club, apex forming an acute point, sensory area restricted to apex of distal segment (Fig. 304)

Mesoscutum with reticulate sculpture similar to frontovertex; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with shallow elongate reticulate sculpture; forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein 2.5-3x length of marginal vein, postmarginal vein 0.3x length of stigmal vein (Fig. 307).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium simple (Fig. 308); ovipositor 0.75x length of midtibia length and not, or barely, exserted, second valvifer fused to third valvula.

Male. Length 1.48 mm. Similar to female but toruli 2x their width above mouth margin, funicular segments 1.6-2.5x longer than broad, club 0.35x length of funicle (Fig. 305), posterior ocelli much closer to occipital margin than to eyes, OOL:OPL:POL 3:1:8; phallobase with midrib.

Variation. Very little in the material available.

Biology and hosts. Unknown.

Distribution. Known only from Cococino Co., Arizona.

Etymology. From Greek *picros*, pointed, referring to the unusual antennal club.

Holotype ♀ mounted on a point with a card underneath, "USA, AZ: Cococino Co./W Flagstaff, Bonito/Park 6-8 AUG 1984/Malaise pan BV Brown". Red label "HOLOTYPE/ Copidosoma/picra/Zolnerowich" added to specimen. Holotype from LDC, to be deposited in ROM.

Paratypes. USA: same data as female (1 ♂, LDC), USA: **Arizona**: Flagstaff 7100', 18-25.VII.1979, S. & J. Peck (1 ♀, TAMU). Paratypes to be deposited in ROM and USNM.

Copidosoma polyporusi new species
(Figs. 309-316, 430)

Diagnosis. Females of *Copidosoma polyporusi* are distinguished from other species of *Copidosoma* by the following characters: all funicular segments 2-3x longer than broad (Fig. 309), foreleg, midfemur, midtibia, and hind tibia white or tan, and ovipositor exserted 0.15-0.2x length of the metasoma.

Female. Length 1.5-2 mm, excluding ovipositor. Color dark brown; frontovertex with pale green or blue-green highlights, scrobal area and genae with purple highlights; antenna uniformly dark brown; mesoscutum with purple highlights anteriorly and brassy green highlights posteriorly, axillae with purple highlights, scutellum with purple highlights

anteriorly and green highlights posteriorly, propodeum laterally with pale green highlights and silvery setae lateral to spiracle, mesopleuron with blue and purple highlights; forecoxa white, remainder of foreleg tan, midcoxa dark brown, remainder of midleg tan, hind coxa dark brown, hind femur dark brown, tan in proximal 1/3 and apex, hind tibia and tarsi tan; forewing hyaline.

Frontovertex about 0.5x head width and with fine reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the width of facet, eye height 1-1.3x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; toruli 0.5x their width above mouth margin, funicular segments 2-3x longer than broad, club 3-segmented and 0.5-0.6x length of funicle, sensory area 0.8x length of club (Fig. 309).

Mesoscutum with reticulate sculpture that is more elongate laterally; axillae meeting and elevated above scutellum; scutellum convex and with elongate reticulate sculpture that is shallower posteriorly; forewing 2.5x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein 1.5x longer than broad, stigmal vein 1.5x length of marginal vein, postmarginal vein 0.5x length of stigmal vein (Fig. 311).

Metasoma longer than mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium extending slightly beyond apex of metasoma, with anterior lobe and bilobed posteriorly (Fig. 313); ovipositor 1.7-2x length of midtibia and exserted 0.15-0.2x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.9-2 mm. Similar to female but toruli 1.5x their width above mouth margin, funicular segments and club lighter than the dark brown scape, funicular segments 1.7-2.5x longer than broad, club 0.33 length of funicle (Fig. 310); proximal 1/2 and apex of midfemur tan, remainder dark brown, hind femur dark brown, lighter at apices, hind tibia dark brown, lighter ventrally, hind tarsi brown; metasoma shorter than mesosoma; phallobase 0.8x length of midtibia length and with 18-21 pairs of setae (Fig. 315), each digitus with 3 apical claws and 1 pore near claws (Fig. 314), aedeagus with a pair of sensilla (Fig. 316).

Variation. Females are variable in size, even within a series, with specimens from Florida being the shortest. Specimens from New Mexico have the hind femur and tibia darker than other specimens.

Biology and hosts. Specimens have been reared from the pore fungi *Polyporus adustus*, *P. betulinus*, and *P. dryophilus* (Basidiomycetes: Polyporaceae) that probably harbor lepidopteran larvae.

Distribution. Quebec, Ontario, and Manitoba south to Florida and New Mexico.

Etymology. Named for *Polyporus*, the genus of fungi from which the species has been reared.

Holotype Holotype ♀ mounted on a card, "CANADA: Quebec/Gatineau Park/9-16.viii. 1982" "L. Masner/B.M. 1982-347". Red label "HOLOTYPE/Copidosoma/polyporusi/ Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. CANADA: same data as holotype (12 ♀, BMNH); **CANADA: Quebec**: Gatineau Park, 1-8.viii. 1982 and 16-22.viii.1982, L. Masner (17 ♀, BMNH); Gatineau Park, Ex Polyporus betulinus, 8-VII 1966 D.P. Pielou G-48 (7 ♀, CNC); Gatineau Park, Ex Polyporus betulinus, 18-VII 1966 D.P. Pielou A 287 (7 ♂, CNC); Gatineau Park, 16.vi.67 D. Pielou, ex. Polyporus betulinus (8 ♀, BMNH); Gatineau Park, 2.vi.68 D. Pielou, ex. Polyporus betulinus (6 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. CANADA: **Manitoba**: Agassiz F.R., 9.vi.1967, J.C. Melvin, Host *Polyporus adustus* on White Poplar (1 ♀, CNC); **Ontario**: Algonquin Park, 8.viii.1966, D.P. Pielou, Ex. P.b. (2 ♀, CNC); Algonquin Park, 18.vii.1966, D.P. Pielou, Ex. *Polyporus betulinus* (4 ♀, CNC); Clayton, vii.1981, H. Goulet, S.J. Miller (1 ♀, BMNH); Ottawa, Constance Bay, 29.vi-10.vii.1983, M. Sanborne (1 ♀, BMNH); Ottawa Airport, v-vii.1987, J. Cummings (1 ♀, BMNH); St. Lawrence Is. Nat. Park, Grenadier I. Centre, 10.vi.1975, G.T. Hall (1 ♀, CNC); **Quebec**: Gatineau Park, Lake Meech, 10.vii.1983, L. Huggert (1 ♀, BMNH); Parc Gatineau, Lac Meech, on logs 29.vii.1984, L. Huggert (2 ♀, BMNH); Gatineau Park, Ridge Road, vi.1986, L. Masner (1 ♀, BMNH); **USA**: **Florida**: Alachua Co., Gainesville, Pierce's Homestead,

31.xii.1975, W.H. Pierce, Malaise Trap (1 ♀, FSCA); Gainesville, Pierce's Homestead, 26-29.i.1976, W.H. Pierce, Malaise Trap (1 ♀, FSCA); Gainesville, 8-15.iii.1987, W.R.M. Mason (1 ♀, BMNH); Gainesville, AEI, 17-24.vii.1987, BRC Hym Team (1 ♀, TAMU); **Missouri**: Wayne Co., Williamsville, v-viii.1987 J.T. Becker, (4 ♀, BMNH); **New Mexico**: Catron Co., 9 mi. S Luna, 31.vii.1961, J.F. Lawrence, ex *Polyporus dryophilus* (10 ♀, MCZ); **Virginia**: Essex, x.1991, D. Smith (1 ♀, TAMU); Essex, v. 1992, D. Smith (2 ♀, CNC, 2 ♀, TAMU).

Copidosoma psephae new species

(Figs. 317-324)

Diagnosis. Females of *Copidosoma psephae* are distinguished from other species of *Copidosoma* by the following characters: funicular segments longer than broad, club 3-segmented with sensory area restricted to apex of distal segment (Fig. 317), mesoscutum sculpture very finely reticulate, the cells about the size of an eye facet or smaller, setae proximal to posterior end of linea calva very fine, and epiproct present. *Copidosoma psephae* is most similar to *C. charisoma*, which differs by having an elongate scape that reaches well above the top the head.

Female. Length 1.3-2.15 mm, excluding ovipositor. Body dark brown; frontovertex with mixed green and purple highlights, scrobal area and genae with purple highlights, scape, pedicel, and funicular segments dark brown, each tan at the distal apex, club dark brown; mesoscutum with mixed green and purple highlights, axillae with purple highlights dorsally and green highlights on posterior surface, scutellum with purple highlights, with green highlights laterally and posteriorly, propodeum laterally green and with silver setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae dark brown, forefemur dark brown, tan at the apex, foretibia and tarsi tan, midfemur dark brown in middle 1/2-3/4, tan at apices, midtibia with base and distal 3/4 white-tan, remainder dark brown, midtarsi white-tan, hind femur dark brown, white-tan at extreme apex, hind tibia with base and distal 1/2 white-tan, remainder dark brown, hind tarsi 1-4 tan, tarsus 5 brown; forewing hyaline.

Frontovertex 0.4-0.45x head width and with very fine reticulate sculpture that is more elongate on genae; mandible with 3 subequal teeth; eye separated from occipital margin by less than the diameter of a facet, eye height 1.8x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:7; toruli

separated from mouth margin by their width, funicular segments 1.7-2.8x longer than broad, first funicular segment distinctly shortest, club 3-segmented and 0.5x length of funicle, sensory area restricted to apex of distal segment (Fig. 317b).

Mesoscutum with very fine reticulate sculpture that is shallower than frontovertex; axillae meeting and greatly elevated above scutellum; scutellum convex and with reticulate sculpture similar to mesoscutum but with slightly larger cells, sculpture more elongate laterally; forewing 2.2x longer than wide, apex of submarginal vein with weak hyaline break, linea calva interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein 3x length of marginal vein, postmarginal vein about 0.3x length of stigmal vein (Fig. 320).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and posterior emargination (Fig. 321); ovipositor 1.5x length of midtibia and exserted 0.3-0.4x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.8 mm. Similar to female but funicular segments brown with tan at the apex; ocelli forming a slightly obtuse angle; toruli 2x their width from mouth margin, funicular segments 2.5-3x longer than broad, club 1- or 2-segmented and 0.35x length of funicle (Fig. 318); phallobase 0.75x length of midtibia length and with 17-18 pairs of setae (Fig. 323), each digitus with 3-4 apical claws and without pores (Fig. 322), aedeagus without sensilla (Fig. 324).

Variation. This species is represented by 2 distinct forms that differ in overall size, leg color, and length of the funicular segments. The larger form form has the funicular segments uniformly dark brown and 3-4.3x longer than broad, club 0.4x length of funicle (Fig. 317a); ocelli forming a right or slightly obuse angle; foretarsus 5 dark brown, midfemur and tibia and hind tibia with more extensive dark coloration; and metasoma 1.1-1.3x length of mesosoma.

Biology and hosts. Reared from species of *Proteoteras* Riley (Lepidoptera: Tortricidae) and *Gelechia* Hbn. (Gelechiidae).

Distribution. Quebec west to Alberta and Utah, and south to Florida and Texas.

Etymology. From Greek *pseph*, pebble, referring to the sculpture of the head and mesoscutum, which appears to finely impressed by pebbles.

Holotype ♀ mounted on a card, "CANADA: P. Quebec/Gatineau Parc/Luskville Falls" "Denis & Dumouchel/ix.1986, 300m/B.M.1986-330". Red label "HOLOTYPE/ Copidosoma/psephae/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. CANADA: **Quebec**: Luskville Falls, Gatineau Park, Denis & Dumouchel, 12-19.viii.1986 (2 ♂, BMNH); Luskville Falls, Gatineau Park, Denis & Dumouchel, 23.ix-2.x.1986 (1 ♀, BMNH); Gatineau Park, Luskville Falls, 24.viii. 1985, J.S. Noyes (10 ♀, 1 ♂, BMNH); Gatineau Park, Luskville Falls, 11.ix.1985, J.S. Noyes (3 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, and USNM.

Other material examined. CANADA: **Alberta**: Edmonton, 24.ix.1986, Jorgensen & Andrews (1 ♀, BMNH); Erskin, ex. *Proteoteras*, viii.1981 (2 ♀, NFC); **Manitoba**: Turtle Mnt. For. R., 11.vi.53, Ex. Gelechiid sp. (W. Poplar) (1 ♀, NFC); **Ontario**: Hamilton, vii.1980, M. Sanborne (2 ♀, BMNH); Hamilton, vii-viii.1981, M. Sanborne (2 ♀, BMNH); Hamilton, 9-19.ix.1981, M. Sanborne (1 ♀, BMNH); Ottawa, McCarty Woods, 18.ix.1986, L. Masner (3 ♀, BMNH); **Quebec**: Gatineau Park, Harrington Lk., 26.x.1960, G.E. Shewell (1 ♀, CNC); Gatineau Park, 30.ix.1973, Boucek (2 ♀, BMNH); Gatineau Park, 13.x.81, L. Masner (2 ♀, BMNH); Gatineau Park, Ridge Road, 26.vii.1985, J.S. Noyes, L. Masner (1 ♀, BMNH); Luskville Falls, 23.ix-2.x.1986, Denis & Dumouchel (3 ♀, BMNH); Mt. Ste. Marie, Low, 1800', 20.ix.1965, J.R. Vockeroth (1 ♀, CNC, 2 ♀, BMNH); **Saskatchewan**: Bolt Arm, 4.viii-55, Ex. Tortricid sp., (Man. Maple) (2 ♀, NFC); **USA**: **Florida**: Alachua Co., Gainesville, AEI, 26-27.v.1991 YPT, Woolley & Zolnerowich, Z91-024 (1 ♀, TAMU); **Massachusetts**: Middlesex Co., Cambridge, 9.vii.1981, N.W. Woodley (1 ♀, MCZ); **Minnesota**: Pope Co., 20.ix.1929, D.G. Denning (1 ♀, UMSP); **Mississippi**: Starkville, Oktibbeha Co., 19.vii.1981, W. H. Cross, White pan trap on ground (2 ♀, MSU); **New Hampshire**: Wht. Mts., Gulf Timberline, 9-5.30, A.B. Proper (1 ♀, MCZ); **North Carolina**: Jackson Co., Whiteside Mt. nr Highlands, viii.1987, 1600m, BRC Hym Team (1 ♀, BMNH); **Pennsylvania**: Centre Co., University Park, 17.viii.1989, R. Wharton (1 ♀, TAMU); **Texas**: Bandera Co., Lost Maples St. Park, 26.v.1985, Jones & Kovarik (2 ♀, TAMU); **Utah**: Salt Lake Co., Mt. Dell Canyon Watershed, 22.viii.1985 Hanson, ex Gambel oak (1 ♀, BMNH).

Copidosoma pseudocervius new species
(Figs. 325-329)

Diagnosis. Females of *Copidosoma pseudocervius* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented, with sensory area extending nearly entire club length, first funicular segment smaller than the second (Fig. 325), propodeum elongate medially, and ovipositor pale at the apex. This species is similar to *Copidosoma cervius*, which has a 3-segmented club and the first and second funicular segments subequal in length (Fig. 80).

Female. Length 1.5 mm. Body dark brown-black; frontovertex with blue-green highlights, scobal area and genae with purple reflections; antenna dark brown to black; mesoscutum with mixed green and purple highlights, axillae and scutellum with pale purple highlights, scutellum with green highlights posteriorly, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with purple highlights; coxae and entire hind leg dark brown, forefemur and tibia dark brown with tan apices, foretarsi brown to dark brown, midfemur dark brown in middle 1/2 with remainder tan, midtibia dark brown with tan apices, midtarsi 1-4 tan, tarsus 5 dark brown; forewing hyaline; apex of ovipositor tan-white, lighter than proximal portion and metasoma.

Frontovertex 0.56x head width and with deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth truncate (Fig. 326); eye separated from occipital margin by the length of 2 facets, eye height 1.75x malar space; ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 3:1:8; toruli 2x their width above mouth margin, first 4 funicular segments slightly longer than broad, remainder subquadrate, club unsegmented and 0.6x length of funicle, sensory area 0.8x length of club (Fig. 325).

Mesoscutum with sculpture similar to frontovertex; axillae barely meeting and greatly elevated above scutellum; scutellum slightly flattened and with very shallow reticulate sculpture, apex nearly polished; forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva not interrupted by dorsal setae, marginal vein about as long as broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.5x length of stigmal vein (Fig. 328).

Metasoma slightly longer than mesosoma; cerci inserted in apical 1/4 of metasoma; hypopygium simple (Fig. 329), reaching 0.8x length of metasoma; ovipositor 0.6x length of midtibia and barely exserted, second valvifer not fused to third valvula, spicules absent.

Male. Unknown.

Biology and hosts. Unknown.

Distribution. Known only from the mountains of Guerrero, Mexico.

Etymology. A combination of Greek *pseud*, false, and *cervius*, the species it most resembles.

Holotype ♀ mounted on a point with a card underneath, "MEX: Guerrero/6.4 mi SW Filo/de Caballo 9000'/8.VII.1987 Woolley/& Zolnerowich". Red label "HOLOTYPE/ Copidosoma/pseudocervius/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. MEXICO: Guerrero, 7 mi SW Filo de Caballo, 12-VII-1985, J. Woolley G. Zolnerowich, 85/051 (1 ♀, TAMU). Deposited in TAMU.

Copidosoma pseudoinnocuellae new species

(Figs. 330-327)

Diagnosis. Females of *Copidosoma pseudoinnocuellae* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 330), forecoxae white, hind femur white-tan in proximal 1/3-3/4, hypopygium reaching 0.8-0.9x length of metasoma, and ovipositor barely exserted. This species is most similar to *Copidosoma cheranae* and *C. innocuellae*. *Copidosoma cheranae* differs by having the hind leg entirely dark brown and the hypopygium reaching the apex of the metasoma. *Copidosoma innocuellae* has the hind femur mostly dark brown, lighter only at the apices, the hypopygium reaching the apex of the metasoma, and the ovipositor exserted at least 0.25x the length of the metasoma.

Female. Length 1.1-1.3 mm. Body dark brown; frontovertex with light green and purple highlights, or only with purple highlights, scrobal area and genae with purple highlights; scape brown with distal 1/4-1/3 tan, or with dorsal and lateral surfaces brown and ventral surface tan, funicular segments brown dorsally and laterally, tan ventrally, club brown; mesoscutum anteriorly with purple highlights, remainder with green highlights, axillae and

scutellum with purple highlights, scutellum posteriorly with green highlights, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with green and blue highlights anteriorly and purple highlights posteriorly; foreleg and mid- and hind tarsi white-tan, midfemur white-tan in proximal 2/3 and distal apex, remainder brown, midtibia white-tan except for brown area in proximal 1/3, hind femur white-tan in proximal 1/2 and distal apex, remainder brown, hind tibia white-tan at base and distal 2/3, remainder brown; forewing slightly infuscate.

Frontovertex 0.42x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, anterior tooth slightly rounded; eye reaching, or nearly reaching, occipital margin, eye height 1.6-2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:5; toruli 0.5x their width from mouth margin, funicular segments 1.5-2x longer than broad, club 3-segmented and 0.6x length of funicle, sensory area restricted to apex of distal segment (Fig. 330).

Mesoscutum with reticulate sculpture similar to that of frontovertex; axillae meeting and elevated above scutellum; scutellum convex with sculpture similar to mesoscutum, laterally with more elongate reticulate sculpture, apex nearly polished; forewing 2.3-2.4x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein barely longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.6x length of stigmal vein (Fig. 332).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma, hypopygium reaching 0.8-0.9x length of metasoma and broadly U-shaped (Fig. 334); ovipositor 0.6-0.7x length of midtibia and not, or barely, exserted, second valvifer fused to third valvula, spicules absent.

Male. Length 1.04-1.14 mm. Similar to female but frontovertex 0.5x head width; toruli 1.5x their width above mouth margin; funicular segments 2.3-3x longer than broad, club 0.35 length of funicle (Fig. 331); phallobase about 0.5x length of midtibia and with 5 pairs of setae (Fig. 336), each digitus with 3 apical claws and a single pore (Fig. 335), aedeagus with a pair of sensilla (Fig. 337).

Variation. Other than size, specimens vary in the length of the dark areas on the legs and the degree of infuscation of the forewing.

Biology and hosts. Reared from *Anacampsis agrimoniella* (Clem.) (Lepidoptera: Gelechiidae).

Distribution. Ontario and Quebec south to Missouri and North Carolina.

Etymology. A combination of Greek *pseudo*, false, and *innocuellae*, the species it closely resembles.

Holotype ♀ mounted on a card, "USA: Missouri/Williamsville/VII.1987" "J.T. Becker/BM1987-349". Red label "HOLOTYPE/Copidosoma/pseudoinnocuellae/ Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: Kentucky: Bernheim For., viii.1982, Fitton & Quinlan (1 ♀, BMNH); **Missouri**: Williamsville, vii.1969, J.T. Becker (1 ♀, BMNH); Williamsville, vi.1970, J.T. Becker (2 ♀, BMNH); Williamsville, VII.1987, J.T. Becker (2 ♀, BMNH); Williamsville, viii.1987, J.T. Becker (1 ♀, BMNH); Williamsville, 14.vii-8.viii.1988, J.T. Becker (1 ♀, BMNH); **North Carolina**: Jackson Co., Whiteside Mt. nr Highlands, viii.1987 1600m, oak forest, BRC Hym Team (1 ♀, BMNH); **CANADA: Ontario**: Alfred Bog, viii.1984, M. Sanborne (1 ♀, BMNH); Hamilton, vii.1981, M. Sanborne (3 ♀, BMNH); Mer Bleu, bog, 27.vii-4.viii.1982, H. Goulet (1 ♀, BMNH); Milton, viii.81, M. Sanborne (1 ♀, BMNH); Ottawa, Constance Bay, 29.VI-10.VII.1983, M. Sanborne (1 ♀, BMNH); **Quebec**: Gatineau Park, Meach Lake, 7.viii.1985, L. Masner (3 ♀, BMNH); Gracefield, 16-VII-1937, O. Peck (24 ♀, 12 ♂, CNC); Lac Roddick, 20.viii-12.ix.1982, L. Masner (5 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. CANADA: Quebec: Gracefield, 16-VII-1937, O. Peck (7 ♀, 1 ♂, CNC). These specimens are from the same series as the paratypes listed above, but are in very poor condition.

Copidosoma pyralidis (Ashmead)

(Figs. 338-345, 406, 416, 432)

Eucyrtus pyralidis Ashmead, 1888a: 15. [USNM, ♀ lectotype examined]. Transferred to *Copidosoma* by Ashmead (1900). Transferred to *Paralitomastix* by Maple (1947).

Copidosoma variegatum Howard, 1888: 366. [USNM, ♀ lectotype examined].
Synonymized by Schmiedechnecht (1909).

Type material. Lectotype here designated, ♀ mounted on a card with 3 other female specimens, "From Peach/Pyralid/Sept. 29/79./[illegible writing that is possibly a name]" "Type/No. 4739/U.S.N.M." [red label] "Encyrtus/pyralidis/♀ Ashm." [handwritten]. "Copidosoma/pyralidis/Ashmead, 1888/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype marked with a spot of red ink on the card posterior to metasoma. The second specimen on the card is missing the left antenna and has a broken right club, the third specimen is embedded in a large drop of glue, and the fourth is mounted on the dorsal side and missing the left antenna.

Copidosoma variegatum Howard. Lectotype ♀ here designated, the middle specimen on a card with two other syntypes marked with a red ink spot behind the metasoma, and labelled "Type No./1478/U.S.N.M." [red label] "Encyrtus/pyralidis/How. tyh." [handwritten] "Copidosoma variegatum/How./Type/=C. pyralidis/ Ashm." [handwritten]. "Copidosoma/variegatum/Howard, 1900/LECTOTYPE/ det. G. Zolnerowich" added to specimen. The specimen on the left side of the card is missing the left antenna and the specimen on the right is missing the right flagellum.

The other 3 syntypes of *C. variegatum* are mounted on a single card labelled "D.C./Oct. 11/79" "Paratype No./1478/U.S.N.M." [red label] "Copidosoma variegatum/How./ Paratypes" [handwritten]. All of these specimens are missing their heads, and various other parts, but none of them appear to be *Copidosoma*. The poor condition of the specimens makes it impossible to correctly identify them. Howard (1888) stated that the 6 specimens comprising the type series were all reared from a single larva of *Anarsia lineatella*, but there must have been an error in labeling the correct specimens.

Diagnosis. Females of *Copidosoma pyralidis* are distinguished from other species of *Copidosoma* by the proximal 3-4 funicular segments being white and contrasting with the remainder of the flagellum, and the elongate reticulate to striate sculpture on the scutellum (Fig. 416). No other Nearctic species has the striking white funicular segments.

Female. Length 1-1.18 mm. Body dark brown to black; frontovertex with brassy green and purple highlights, scrobal area and genae with coppery purple highlights; scape and pedicel dark brown to black, scape occasionally lighter in distal 1/4, funicular segments 1-4 white, fourth segment occasionally tan or brown, remainder of flagellum dark brown to

black; mesoscutum with brassy green highlights, axillae with faint purple highlights, scutellum dorsally with faint green and purple highlights, posteriorly and laterally mixed blue-green and purple; propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae and fore- and hind femora dark brown, tibiae and midfemur varying from tan to dark brown, tarsi tan, occasionally brown; forewing hyaline.

Frontovertex 0.35-0.42x head width and with very shallow, reticulate sculpture, nearly polished, sculpture deeper and more elongate on lower face and genae, mandible with 3 subequal teeth; eye height 1.3-1.6x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:5; toruli separated from mouth margin by 0.5x their length, funicular segments quadrate or barely broader than long, club 3-segmented and subequal to length of funicle, the apex slightly obliquely truncate, sensory area 0.1-0.18x length of club (Fig. 338).

Mesoscutum with shallow reticulate sculpture, the cells larger than those of frontovertex; axillae slightly elevated above scutellum; scutellum slightly flat and with deep elongate reticulate or nearly striate sculpture, apex shallowly reticulate, nearly polished (Fig. 416); forewing 2x longer than wide, submarginal vein with apical hyaline break, linea calva interrupted dorsally by setae, marginal vein as long as broad, stigmal vein 2.5x length of marginal vein, postmarginal vein at most 0.5x as long as marginal (Fig. 341).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma, hypopygium with a short anterior lobe (Fig. 342) and reaching 0.7-0.8x length of metasoma; ovipositor subequal to length of midtibia and not, or barely exserted, second valvifer fused to third valvula and with a transverse cluster of spicules (Fig. 432); epiproct present.

Male. Length 0.88-0.95 mm. Similar to female but toruli 0.6x their length above mouth margin, flagellum tan to brown, funicular segments 1.7-2x longer than broad, club 3.4x longer than broad and 0.4x length of funicle (Fig. 339); phallobase 0.65x length of midtibia and with 11-14 pairs of setae ((Fig. 343), each digitus with 2 claws and a single pore near claws (Fig. 344), aedeagus with a pair of sensilla (Fig. 345).

Variation. Specimens from the same series may have the fourth funicular segment white, tan, or brown. The tibiae and midfemur may vary from tan to dark brown.

Biology and hosts. Reared from *Anarsia lineatella* Zell., *Trichotaphe flavocostella* (Clem.), and *T. setosella* Clem. (Gelechiidae: Anacampsinae) and *Argyrotaenia citrana* (Fern.) (Tortricidae: Tortricinae).

Distribution. Found throughout the Nearctic, but not common in the Southwest.

Other material examined. USA: California: San Bernadino Co., Chino, vii.1932; *Anarsia lineatella*, A.J. Basinger (2 ♀, 3 ♂, UCR); Yuba City, 27.vi.1961, A.C. Perrin, *Anarsia lineatella* (4 ♀, CDFA); Sutter Co., ii.1965, W.W. Barnett, *Anarsia lineatella* on peach (6 ♀, 2 ♂, TAMU); **Louisiana**: Stuart N.I., 3km SW Pollock, 13.v-3.vi.1985, H. Howden & C. Scholz (1 ♀, BMNH); **Michigan**: Ann Arbor, vii.1982, Fitton & Quinlan (2 ♀, BMNH); **Missouri**: Wayne Co., Williamsville, v-vi.1987, J.T. Becker (2 ♀ BMNH, 1 ♀ TAMU); Williamsville, 1-19.vi.1988, J.T. Becker (1 ♀, TAMU); **New Jersey**: *Anarsia lineatella* (5 ♀, 3 ♂ UCR); **New York**: Tompkins Co., Ithaca, 20-26.vii.1977, N.F. Johnson (1 ♀, CNC); Ithaca, 6-mile Ck., 21.viii.1981, D.C. Darling (1 ♀, DCD); **North Carolina**: Jackson Co., Whiteside Mt. nr. Highlands, viii.1987, 1600m, oak forest, BRC Hym Team (2 ♀, BMNH); **South Carolina**: Oconee Co., Clemson, 26.v-24.vi.1987, BRC Hym Team (1 ♀, TAMU); Pennsylvania: Chambersburg, J.R. Stear, *Anarsia lineatella* (1 ♀, USNM); **Texas**: Bastrop Co., Bastrop St. Park, 19-29.iv.1990, Wharton & Zolnerowich, malaise (3 ♀, TAMU), Bastrop St. Park, 12-27.iv.1991, Wharton & Geiselbrecht (7 ♀, TAMU); Buescher St. Park, 19-29.iv.1990, Wharton & Zolnerowich, malaise (3 ♀, TAMU); Brazos Co., College Station, Lick Creek Park, 22.v-27.vi.1987, Heraty & Woolley, malaise (1 ♀, TAMU); Montgomery Co., Jones State Forest, 8 mi S Conroe, 11-24.v.1987, Wharton, Wang, Praetorius (8 ♀, TAMU); 8 mi S Conroe, 1.vi-13.vii.1987, Wharton, Wang, Praetorius (2 ♀, TAMU); **Utah**: Bountiful, 1929, G.F. Knowlton, peach twig borer (3 ♀, USNM); **CANADA**: **New Brunswick**: Hwy 112, 26km W Canaan Forks, viii.1984, M. Kaulbars (1 ♀, BMNH); Kouchibouguac N. P., 30.viii, 20.ix.1977, S.J. Miller (7 ♀, CNC, 1 ♀, BMNH); **Ontario**: Alfred Bog, 17.ix.1984, M. Sanborne (2 ♀, BMNH); Nepean, Slack Road, vii.1985, L. Masner (2 ♀, BMNH); Constance Bay, 29.vi-29.viii.1983, M. Sanborne (3 ♀, BMNH, 1 ♀, TAMU); **Quebec**: Gatineau Park, Luskville Falls, 2-8.vii, 5-12.viii.1986 (3 ♀, BMNH); Gatineau Park, Champlain Overlook, 22.vii.1989, 89/011, Woolley & Zolnerowich (22 ♀, TAMU).

Copidosoma rima new species

(Figs. 346-348)

Diagnosis. Females of *Copidosoma rima* are distinguished from other species of *Copidosoma* by the following characters: funicle 5-segmented (Fig. 346), fore- and hind coxae white, and anterior 2/3 of scutellum with deep striate sculpture. The only other species with 5 funicular segments and similar coxae is *C. mutabilis*, which differs in having shallow reticulate sculpture on the scutellum. Species of *Copidosomopsis* also have 5 funicular segments, but all New World species have dark coxae and elongate propodeal spiracles (Fig. 428).

Female. Length 1.28 mm. Body dark brown; frontovertex with light green reflections, genae with purple reflections; antenna dark brown; mesoscutum dark brown with purple highlights in anterior 1/2 and brassy green highlights in posterior 1/2, axillae and anterior 2/3 of scutellum nearly black, posterior 1/3 of scutellum with green reflections, propodeum with white highlights and translucent setae lateral to spiracle, mesopleuron with white and pale purple highlights; forecoxa brown in proximal 1/3, remainder white, midcoxa dark brown, hindcoxa white, fore- and mid emora and tibiae brown-tan, foretarsi 1-4 brown-tan, tarsus 5 dark brown, midtarsus 1 brown-tan, remainder dark brown, hind femur and tibia tan in proximal 1/3, remainder dark brown, hind tarsi dark brown; forewing infuscate around marginal and stigmal veins, remainder suffused with pale brown.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of 2 facets, eye height 1.3x malar space, ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:7; toruli separated from mouth margin by about their width, funicular segments 2-3x longer than broad, club 3-segmented and 0.73x length of funicle, sensory area 0.74x length of club (Fig. 346).

Mesoscutum with deep reticulate sculpture; axillae slightly elevated above scutellum; scutellum moderately convex, with deep striate sculpture in anterior 2/3, becoming very shallowly reticulate in posterior 1/3; forewing 2.3x longer than wide, submarginal vein with apical hyaline break, linea calva interrupted dorsally by setae, marginal vein 2x longer than broad, stigmal and postmarginal veins 1.5x longer than marginal vein (Fig. 347).

Metasoma slightly longer than mesosoma; cerci inserted in middle 1/3 of metasoma.

Male. Unknown.

Biology and hosts. Unknown.

Distribution. Known only from the type locality in Arizona.

Etymology. From Latin *rima*, meaning fissure, referring to the deep fissurelike sculpture of the scutellum.

Holotype ♀ mounted on a card, "USA: Arizona/Cochise Co./12 km S. Sierra Vista" "Ramsey Canyon, 1300m/25.v.1987/B.V. Brown, BM 1988-119". Right antenna and right forewing slide-mounted in balsam. Red label "HOLOTYPE/Copidosoma/rima/ Zolnerowich" added to specimen. Deposited in BMNH.

Copidosoma schauffi new species

(Figs. 349-356, 413)

Diagnosis. Females of *Copidosoma schauffi* are distinguished from other species of *Copidosoma* by the white forecoxa, elongate postmarginal vein (Fig. 352), hypopygium reaching 0.75-0.85x the length of the metasoma, and the ovipositor not, or barely, exserted. *Copidosoma capsicum* has the foreleg white and an elongate postmarginal vein, but the hypopygium reaches the apex of the metasoma and the ovipositor is exserted.

Female. Length 1.14-1.3 mm. Body brown; frontovertex with pale green and purple reflections, lower face with purple reflections; antenna uniformly colored but varying from tan to brown; mesoscutum with pale green and purple reflections, axillae and scutellum with purple reflections, propodeum laterally with purple highlights and translucent setae lateral to spiracle, mesopleuron with purple reflections; forecoxa and femur white, foretibia and tarsi white or tan, midcoxa brown, midfemur white, midtibia and tarsi white or tan, hind coxa brown, hind femur white, hind tibia tan or brown, tarsi tan; forewing hyaline.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of a facet, eye height 1.6-1.7x malar space; ocelli forming a slightly obtuse angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:6; toruli 0.5x their width from mouth margin, funicular segments 1.3-2.5x longer than broad,

club 3-segmented and 0.4-0.5x length of funicle, sensory area restricted to apex of club (Fig. 349).

Mesoscutum with reticulate sculpture (Fig. 413), the cells slightly larger than those of frontovertex; axillae meeting and elevated above scutellum; scutellum slightly flattened and with elongate reticulate sculpture; forewing 2.2x longer than wide, apex of submarginal vein without hyaline break, linea calva not interrupted by dorsal setae, marginal vein 1.5 longer than broad, stigmal vein 2x length of marginal vein, postmarginal vein about 0.7x length of stigmal vein (Fig. 352).

Metasoma 0.8-0.9x length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching 0.75-0.85x length of metasoma and with anterior lobe (Fig. 353); ovipositor 0.8x length of midtibia length and not, or barely, exserted, second valvifer fused to third valvula, with longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.3-1.43 mm. Similar to female but larger; head and mesoscutum with bright green reflections; frontovertex 0.5-0.6x head width; posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:8; toruli separated from mouth margin by 2x their width, funicular segments 1.5-2.1x longer than broad, club 0.3x length of funicle (Fig. 350); metasoma subequal to length of mesosoma; phallobase 0.4-0.5x length of midtibia and with 3 pairs of setae, midrib present (Fig. 356), each digitus with 2 claws and 2 pores near claws (Fig. 354), aedeagus without lateral sensilla (Fig. 355).

Variation. Specimens vary in the darkness of the antennae, and the fore- and midtibiae and tarsi and hind tibiae vary from white to tan.

Biology and hosts. Unknown, but specimens have been reared from lepidopteran larva in the bark of *Pinus* and collected on *Purshia tridentata* (Rosaceae). One series lists *Glirira* as the host, but I am unable to find this name in the literature.

Distribution. Known only from Arizona, Colorado, Nevada, and New Mexico.

Etymology. Named in honor of Dr. M. E. Schauff.

Holotype ♀ mounted on a point with a card underneath, "Pinus/ponderosa" "CapitanMts/ NM" "JLWebb/Colr" "Hopk. U.S./5664". Red label "HOLOTYPE/Copidosoma/schauffi/ Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. USA: same data as holotype (48 ♀, USNM). Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. USA: **Arizona**: Brushy Corral, reared 6.viii.1915, Hopk. U.S. 12183[1], W.D. Edmonston (14 ♂, USNM); **Colorado**: Manitou, Hopk. U.S. 13907[a1], reared 16.vii.1915, W. Middleton, *Pinus scopulorum*, B.T. Harvey (23 ♀, USNM); Waldo Canon, Hopk. U.S. 10764g, 4.vi.1916, W. D. Edmonston, par. on *Glirira* sp., *Pinus echinata* (14 ♀, USNM); **Nevada**: Reno, reared 30.iii.1923, *Purshia tridentata*, H. Barber (25 ♀, USNM).

Copidosoma tamaulipasensis new species

(Figs. 357-360)

Diagnosis. Females of *Copidosoma tamaulipasensis* are distinguished from other species of *Copidosoma* by the distinct 2-segmented club that is apically pointed with the sensory area restricted to the extreme apex (Fig. 357). *Copidosoma desantisi* and *Copidosoma koehleri* are similar in habitus but have 3-segmented clubs of a different shape (Fig. 135). *Copidosoma picra* has a pointed club that is 3-segmented (Fig. 304).

Female. Length 1.3 mm. Body dark brown, nearly black; frontovertex with green reflections, scrobal area and genae with purple reflections; radicle, scape, and pedicel dark brown, scape and pedicel tan at apex, funicular segments mostly brown, tan at distal end of each, club uniformly dark brown; mesoscutum with mixed green and purple highlights, axillae dorsally with light highlights, posterior surface shiny green, scutellum with purple highlights, laterally and posteriorly with green or blue-green highlights, propodeum laterally with green highlights and silvery setae lateral to spiracle, mesopleuron with blue reflections anteriorly and purple reflections posteriorly; coxae dark brown, tarsi white-tan, each apical tarsus slightly darker, forefemur dark brown, white at the apex, foretibia white or tan except for a dark patch in the proximal 1/2, midfemur dark brown except for white-tan bands in proximal 1/2 and at apex, midtibia dark brown except base and distal 1/2 white-tan , hind femur dark brown with white apices, hind tibia dark brown except base and distal 1/4 white-tan; forewing hyaline; distal end of ovipositor tan, lighter than proximal area and metasoma.

Frontovertex 0.5x head width and with reticulate sculpture that is elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by less than the diameter of a facet, eye height 2.25x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL: POL 1:2:9; toruli separated from mouth margin by the width of a torulus, funicular segments 1.2-1.4x longer than broad, club 2-segmented and pointed at the apex, 0.5x length of funicle, sensory area restricted to extreme apex (Fig. 357).

Mesoscutum with sculpture similar to but shallower than on frontovertex; axillae just meeting and greatly elevated above scutellum; scutellum convex and with reticulate sculpture similar to frontovertex, laterally more elongate, apex almost polished; forewing 2.2x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae, marginal vein punctiform, stigmal vein 3x length of marginal vein, postmarginal vein absent (Fig. 359).

Metasoma subequal to length of mesosoma; hypopygium with broad anterior lobe (Fig. 360); ovipositor 1.3x length of midtibia and slightly exserted, second valvifer not fused to third valvula, spicules absent.

Male. Unknown.

Variation. None noted in the 2 available specimens.

Biology and hosts. Unknown.

Distribution. Known only from the type locality in Tamaulipas, Mexico.

Etymology. From the Mexican state of Tamaulipas.

Holotype ♀ mounted on a point with a card underneath, "MEX: Tamaulipas/Punta Piedras/25 Sept. 1981/W.H. Cross" "blacklight/trap". Red label "HOLOTYPE/ Copidosoma/tamaulipasensis/Zolnerowich" added to specimen. Holotype missing left hind leg beyond coxa. Deposited in MSU.

Paratypes. MEXICO: same data as holotype (1 ♀, MSU). Deposited in MSU.

Copidosoma tejana new species
(Figs. 361-364)

Diagnosis. Females of *Copidosoma tejana* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to apex of distal segment (Fig. 361), marginal vein about as broad as long and not, or barely, reaching wing margin, postmarginal vein rudimentary (Fig. 364), and ovipositor not exserted. No other species has this combination of characters.

Female. Length 1.15 mm. Body black-brown; frontovertex with pale blue-green highlights, scrobal area and genae with purple highlights; scape nearly black with pale blue highlights, tan at the apex, flagellum dark brown; mesoscutum with mixed green and purple highlights, axillae and scutellum with purple highlights, scutellum laterally and posteriorly with green highlights, propodeum with translucent setae lateral to spiracle, mesopleuron with blue and purple highlights; coxae black-brown, forefemur black-brown, white at the apex, foretibia black-brown, white-tan at the apices, foretarsi 1-4 brown, tarsus 5 nearly black, midfemur black-brown in proximal 3/4, remainder white, midtibia white at base and distal 1/4, remainder black-brown, midtarsi 1-3 white, tarsi 4-5 dark brown, hind femur and tibia black-brown, white at the apices, hind tarsi 1-3 white, tarsi 4-5 dark brown; forewing hyaline.

Frontovertex 0.42x head width and with reticulate sculpture that is elongate on lower face and almost striate on genae; eye reaching occipital margin, eye height 2x malar space; ocelli forming a right angle, posterior ocelli closer to eyes than to occipital margin, OOL:OPL:POL 1:2:8; toruli separated from mouth margin by their width, funicular segments broader than long to 1.4x longer than broad, club 3-segmented and 0.7x length of funicle, sensory area restricted to apex of distal segment (Fig. 361).

Mesoscutum with reticulate sculpture similar to frontovertex but shallower; axillae meeting and greatly elevated above scutellum; scutellum convex and with reticulate sculpture similar to mesoscutum, laterally elongate; forewing 2.1x longer than wide, apex of submarginal vein with hyaline break, linea calva interrupted by dorsal setae, marginal vein punctiform and not, or barely, reaching anterior margin of wing, stigmal vein 2.5x length of marginal vein, postmarginal vein rudimentary (Fig. 364).

Metasoma slightly shorter than mesosoma; cerci inserted in middle 1/3 of metasoma; ovipositor not exserted.

Male. Length 1.08 mm. Similar to female but mesosoma longer and more robust; frontovertex 0.5x head width; ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 1:0.5:9; toruli 1.5x their width above mouth margin, funicular segments quadrate to 1.5x longer than broad, club 0.36x length of funicle (Fig. 362); axillae slightly elevated above scutellum.

Biology and hosts. Unknown.

Distribution. Known only from Starr Co. in south Texas.

Etymology. From *Tejas*, the original Spanish name for Texas.

Holotype ♀ mounted on a card, "USA: Texas/Starr Co./Falcon Lake/State Park" "3.IV.1989/J.S. Noyes". Left antenna slide-mounted in balsam. Red label "HOLOTYPE/ Copidosoma/tejana/Zolnerowich" added to specimen. Deposited in BMNH.

Paratypes. USA: same data as holotype (1 ♂, BMNH). Paratype to be deposited in BMNH.

Copidosoma tigrinum new species

(Figs. 365-369)

Diagnosis. Females of *Copidosoma tigrinum* are distinguished from other species of *Copidosoma* by the following characters: scape elongate, reaching well above top of head, funicular segments elongate, 3-5.7x longer than broad, club 3-segmented with sensory area restricted to apex of distal segment (Fig. 365), forecoxa, femur, and tibia white-tan, and the ovipositor exserted 0.1-0.2x length of the metasoma. This species is similar to *Copidosoma alexanderi* and *C. charisoma*. *Copidosoma alexanderi* differs in having a much shorter scape and flagellum (Fig. 25) and the ovipositor exserted 0.4-0.6x the length of the metasoma. *Copidosoma charisoma* also has elongate antennal segments but is larger, has the forecoxa and hind femur dark brown, and the ovipositor exserted 0.3-0.4x the length of the metasoma.

Female. Length 1.43-1.7 mm, excluding ovipositor. Body dark brown; frontovertex with green highlights, scrobal area and genae with purple highlights; scape varying from

entirely dark brown to mostly yellow-tan with some brown dorsally, pedicel brown, lighter at the apex, funicular segments and club uniformly brown or dark brown; mesoscutum with mixed green and purple highlights, axillae and scutellum with purple highlights, scutellum posteriorly with green highlights, propodeum laterally with pale green highlights and translucent setae lateral to spiracle, mesopleuron with white reflections anteriorly and purple highlights posteriorly; forecoxa, femur, and tibia white-tan, foretarsi tan to brown, midcoxa dark brown, midfemur white-tan in proximal 1/2 and distal 1/4, remainder dark brown, midtibia white-tan at base and distal 3/4, remainder dark brown, midtarsi tan, hind coxa dark brown, hind femur white-tan in proximal 1/3-1/2 and at apex, remainder dark brown, hind tibia tan at base and distal 3/4, remainder dark brown, hind tarsi tan to brown; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth (Fig. 369); eye reaching occipital margin, or less than the diameter of a facet from it, eye height 1.7x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:7; toruli 0.5x their width from mouth margin, scape elongate, reaching well above top of head, funicular segments 3-5.7x longer than broad, club 3-segmented and 0.4x length of funicle, sensory area restricted to apex of distal segment (Fig. 365).

Mesoscutum with sculpture similar to that of frontovertex but finer; axillae meeting and greatly elevated above scutellum; scutellum convex with sculpture similar to frontovertex but much shallower, apex nearly polished; forewing 2.3x longer than wide, apex of submarginal vein with hyaline break, linea calva sometimes interrupted by dorsal setae, marginal vein as long as broad, stigmal vein 2x length of marginal vein, postmarginal vein 0.4x length of stigmal vein (Fig. 366).

Metasoma 1.25-1.5x length of mesosoma; cerci inserted about 1/3 from anterior end of metasoma; hypopygium reaching apex of metasoma, with anterior median lobe and posterior emargination (Fig. 368); ovipositor 1.35x length of midtibia, and exserted 0.1-0.2x length of metasoma, second valvifer not fused to third valvula.

Male. Unknown.

Variation. Specimens vary in the darkness of the antennae.

Biology and hosts. Unknown.

Distribution. Known from Ontario south to North Carolina and Missouri.

Etymology. From Latin *tigr*, tiger, referring to the striped legs.

Holotype ♀ mounted on a card, "USA: N. Carolina/McDowell Co./37'00'N 81' 30W" "9.vii-17.ix.1987/BRC Hym Team/BM 1988-119". Red label "HOLOTYPE/Copidosoma/ tigrinum/Zolnerowich" added to specimen. Deposited in CNC.

Paratypes. USA: same data as holotype (1 ♀, BMNH); **USA**: **Maryland**:Patuxent Wildlife Reserve, vii.82, Fitton & Quinlan (1 ♀, BMNH); **Missouri**: Williamsville, vii.1987, J.T. Becker (2 ♀, BMNH); **Virginia**: Louisa Co., 4 mi. S. Cuckoo, 1-12-VII-1988, J. Kloke & D.R. Smith, Malaise trap (1 ♀, USNM); Louisa Co., 4 mi. S. Cuckoo, 13-27-VII-1988, J. Kloke & D.R. Smith, Malaise trap (1 ♀, USNM); **CANADA**: **Ontario**: Hamilton, 6.VIII. 80, M. Sanborne, Malaise trap (1 ♀, CNC); Hamilton, vii.1981, M. Sanborne (1 ♀, BMNH); Ontario, Point Peele, vii.1986 A. Borkent (1 ♀, BMNH). Paratypes to be deposited in BMNH, CNC, and USNM.

Copidosoma timberlakei new species

(Figs. 370-375)

Diagnosis. Females of *Copidosoma timberlakei* are distinguished from other species of *Copidosoma* by the following characters: head and scutellum dark brown, nearly black, with purple highlights that contrast with the green mesoscutum, dorsal and ventral surfaces of club subparallel (Fig. 370), and syntergum divided (as in Fig. 160). This species most resembles *C. gordhi*, which differs by having green highlights on the head and a differently shaped club (Fig. 195).

Female. Length 1.14-1.64 mm, excluding ovipositor. Color dark brown; head nearly black and with light reflections; scape dark brown with green highlights, flagellum uniformly dark brown; mesoscutum with brassy green highlights, axillae and scutellum with purple highlights, scutellum posteriorly with green highlights, propodeum laterally with pale green and purple highlights and silver setae lateral to spiracle, mesopleuron with purple highlights anteriorly and posteriorly, with green and blue highlights medially; coxae dark brown, femora dark brown with tan at distal apices, midfemur with proximal hyaline ring, foretibia and tarsi 1-4 tan, tarsus 5 darker, midtibia dark brown in proximal 2/3 with

remainder tan, or tan with a dark brown area in proximal 1/3 that fades to tan, midtarsi 1-4 tan, tarsus 5 brown, hind tibia with dark brown area in proximal 1/3-1/2, remainder tan, hind tarsi 1-3 tan, tarsi 4-5 darker; forewing slightly infuscate, darkest around marginal and stigmal veins.

Frontovertex 0.45x head width and with deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth, dorsal tooth slightly shorter than others; eye reaching occipital margin, eye height 1.5x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 2:2:6; toruli separated from mouth margin by their width, funicular segments 1.3-2.2x longer than broad, club 3-segmented and 0.85x length of funicle, sensory area 0.9x length of club (Fig. 370).

Mesoscutum with deep elongate reticulate sculpture; axillae meeting and slightly elevated above scutellum; scutellum relatively flat and with deep elongate reticulate sculpture finer than that of mesoscutum; forewing 2.6x longer than wide, apex of submarginal vein without hyaline break, linea calva interrupted by dorsal setae, marginal vein about 1.5x longer than broad, stigmal vein about 2x length of marginal vein, postmarginal vein nearly absent to 0.4x length of stigmal vein (Fig. 373).

Metasoma subequal in length to mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma, with anterior lobe and posterior emargination (Fig. 374); ovipositor 1.1x length of midtibia and exserted 0.2x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); syntergum partially or completely divided (as in Fig. 160).

Male. Frontovertex 0.5x head width, ocelli forming a slightly obtuse angle; toruli 2x their width above mouth margin, funicular segments 1.5-2x longer than broad, club 0.33x length of funicle (Fig. 371); phallobase 0.7x length of midtibia and with 13-14 pairs of setae, each digitus with 3 apical claws and without pores (Fig. 375), aedeagus with a pair of sensilla; syntergum not divided.

Variation. There is a great deal of variation in the size of specimens from different localities. The largest specimens are from California and have the infuscation of the wings fairly dark, while small specimens, such as from Utah, have the wings nearly hyaline. Specimens from Alberta, Canada, and San Bernadino County, California, have shallower sculpture on the head, and the sculpture of the mesoscutum is broad and shallow instead of

deep and elongate. I am reluctant to describe them as a separate species, for they are otherwise indistinguishable from *C. timberlakei*.

Biology and hosts. Reared from *Aroga websteri* Cl. and *Gelechia* Hbn. (Lepidoptera: Gelechiidae) on sagebrush, and collected from pines and firs.

Distribution. Known from Arizona, California, Idaho, and Utah.

Etymology. Named in honor of P. H. Timberlake, who collected many of the paratypes.

Holotype ♀ mounted on a card, "Calif: San Bern. Co./Fish Creek/2 mi. N. Trailhead" "28.viii.1981 81/057/coll. J.B. Woolley/Sweeping firs". Red label "HOLOTYPE/ Copidosoma/timberlakei/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. USA: Arizona: Cococino Co., W Flagstaff, Bonito Park, 5-8 AUG 1984, Malaise Ponderosa Pine, BV Brown (1 ♀, LDC); **California**: San Bern. Co., Fish Creek, 81/053 28.VIII.1981, J.B. Woolley (3 ♀, TAMU); **Idaho**: Rogerson, July 24, 1963, Hopk. 507080, Honing-Flake (1 ♀, UCR); **Utah**: Murray, Jl. 14, '93, Timberlake, No 442a (17 ♀, 1 ♂, UCR); Murray, Jl. 30, '13, Bred from Gelechia, PH Timberlake, Collector (6 ♀, UCR); Salt Lake, Jl. 7, '14, Bred from Gelechia, Bred from No 442B, Timberlake, Collector (11 ♀, UCR). Paratypes to be deposited in ROM, TAMU, UCR, and USNM.

Other material examined. USA: California: San Bern. Co., 8 mi E. Phelan, Baldy Mesa, 29.v.1980, J.B. Woolley 80/033d (1 ♀, TAMU); Baldy Mesa, 16-22.v.1981, J. Huber, In: Pan trap (1 ♀, UCR); Badly [sic] Mesa Rd., 10km. e. Phelan, 13.v.1981, G.A.P. Gibson (3 ♀, BMNH); **Utah**: Murray, 14.vii.1913, Timberlake (13 ♀, UCR); Salt Lake, 17.vii.1914, Bred from *Gelechia*, Timberlake (3 ♀, UCR); **Canada: Alberta**: Medicine Hat, 11.v.1980, G.A.P.Gibson (5 ♀, BMNH). Non-type specimens from Utah are from the same series as the paratypes but are in very poor condition.

Copidosoma truncatellum (Dalman)

(Figs. 376-384)

Encyrtus truncatellum Dalman, 1820: 168. [SMNH, type not examined]. Transferred to *Litomastix* by Thomson (1876). Listed as *Copidosoma* by Trjapitzin (1989).

Litomastix aestivalis Mercet, 1921: 447. [IEE, ♀ lectotype examined]. Synonymized by Graham (1969).

Type Material. The types of *C. truncatellum* consist of a lectotype female and paralectotype male (Graham 1958). Though these types were not examined, Nearctic material was compared to the types of *C. aestivalis* and additional material determined as *C. truncatellum* by M. Graham and J. S. Noyes.

Diagnosis. Females of *Copidosoma truncatellum* are distinguished from other species of *Copidosoma* by the following characters: club unsegmented and strongly obliquely truncate, first funicular segment distinctly narrower and shorter than second (Fig. 376), marginal vein shorter than stigmal vein (Fig. 380), and mesoscutum and scutellum the same color. This species is most similar to *C. floridanum*, which differs by having the first and second funicular segments subequal in size (Fig. 147), the stigmal vein is not longer than the marginal (Fig. 150), and the scutellum is purple and contrasts with the metallic green mesoscutum.

Variation. Specimens vary in size and can be more greenish than the typical blue-green.

Biology and hosts. Reliably recorded only from *Apamea monoglypha* (Hufnagel) (Noctuidae: Amphipyrinae) (Noyes 1988).

Distribution. Previously known from Europe and Ontario, the range is extended to the Pacific coast and south to Virginia.

Discussion. Noyes (1988a) provides a detailed taxonomic history and a redescription of this species. An narrow epiproct is present and heretofore unreported in *C. truncatellum*.

Other material examined. USA: California: Lassen Co., Hallelujah Jct., 13.vii. 1972, S.F. Casey, (3 ♀, UCD); Nevada Co., Sagehen Crk, 17.vii.1968, R.M. Bohart (1

♀, UCD); Boca, 23.vii.1970, E.E. Grissell, Great Basin Desert (2 ♀, FSCA); Sagehen Creek, 13 mi. N. Truckee, 25.vii.1970, E.E. Grissell, mtn. meadows 6500 ft. (6 ♀, FSCA); Sierra Co., 7 mi E Sattley, 5.vii.1971, E.E. Grissell (1 ♀, UCD); **Colorado**: Eagle Co., White River Nat. Forest, 7.5 mi S Minturn, el. 8840', 19.vii.1990 Z90-061, G. Zolnerowich (27 ♀, 1 ♂, TAMU); White River Nat. Forest, 9.2 mi S Minturn, el. 9080', 19.vii.1990 Z90-062, G. Zolnerowich (4 ♀, TAMU); White River Nat. Forest, 3.9 mi S Minturn, el. 9380', 19.vii.1990 Z90-063, G. Zolnerowich (6 ♀, 32 ♂, TAMU); Minturn 7800, 1.v.1987 J.D. Pinto (1 ♀, BMNH); Gunnison Co., Cottonwood Pass, 29.vii.1961 12100', B.H. Poole (1 ♀, CNC); Rio Blanco Co., S Meeker 8,500', vii.1984 H. Goulet (2 ♀, TAMU); s. of Meeker, 11.vii. 1984, 8500', H. Goulet (1 ♀, BMNH); **Michigan**: 23 mi S Grayling, vii.1973, C.M. Yoshimoto (5 ♀, TAMU); Isle Royale, 22.vii.1957, R.W. Hodges (1 ♀, MSUE); **Minnesota**: Swift Co., Chippewa Prair., 3mi. SE Appleton, 3.ix.1985 Hanson (1 ♂, BMNH); **Montana**: Petroleum Co., 1.5 mi. S., 5 mi W. Winnett, 30.vii.1969, A.G. Hamilton (1 ♀, MSU); **New Hampshire**: Mt. Washington, 3.ix.1929 5000 ft., Lakes of the Clouds, On Surface of Water, A.B. Proper (4 ♀, MCZ); Mt. Washington, 5.vii.1982, D. Chandler (1 ♀, BMNH); **North Carolina**: Macon Co., Clear Ck., sw Highlands, 29.vii.1981, D.J. Bickel (1 ♀, DCD); McDowell Co., Lat.37 00'N Long. 81 30'W, 9.vii-17.ix.1987, BRC Hym Team, Oak-rhododendron (2 ♀, TAMU); **Pennsylvania**: Allegheny Mts., 8 mls N. McAlveys Fort, 24.viii.1979, A.C. Pont (1 ♀, BMNH); **Oregon**: Forest Grove, 6.vii.1918, Ex *Parastichtis albina* Grote (3 ♀, UCR); Benton Co., Botkin Road, 12W Corvallis, 5.vii.1986 Hanson (2 ♀, BMNH); Corvallis, Chip Ross Park, 3.viii.1981 Hanson (1 ♀, BMNH); vic. of Corvallis, 19.vii.1984, D.C. Darling (1 ♀, DCD); NE Corvallis, wet area, 11.vii.1985 Hanson (5 ♀, BMNH); Jefferson Co., Candle Creek, 19N 5W Sisters, 19.vii.1986 Hanson (1 ♀, BMNH); Lincoln Co., Eddyville, 8 mi E Hwy. 20, 6.viii.1985, Finnamore & Thormin (3 ♀, TAMU); Linn-Lane Co., Andrews Exp. Forest, Frissell Ridge, 15.viii.1985, D.C. Darling (1 ♀, ROM); **South Dakota**: Lawrence Co., Cheyenne Crossing, Black Hills ntl. For., 13-14.vii.1974, R.L. Fischer (1 ♀, MSUE); **Virginia**: Page Co, Shenandoah N.P., Big Meadows, 8.vii.1987, G. Gibson (5 ♀, TAMU); Shenandoah N.P., 8.vii. 1987 1300m, L. Dumouchel (38 ♀, TAMU, 5 ♀, BMNH); Shenandoah N.P., Big Meadow 1300m, 8.vii-20.viii.1987, BRC Hym Team (4 ♀, TAMU); **Wisconsin**: Milwaukee, viii.1984, J. Huber (1 ♀, BMNH); **Wyoming**: Albany Co., Medicine Bow Ntl. For., Curtis Gulch Campgrnd., 8-10.vii.1974, R.L. Fischer (1 ♀, MSUE); Johnson Co., Bighorn Ntl. Forest, 11-12.vii.1974, R.L. Fischer (1 ♀, MSUE); Yellowstone N.P., 6.8mi N S. Entrance, 7.ix.1990, Malaise heavy burn (1 ♀, UW); **Washington**: Mt.

Ranier, 2700 ft., 13.viii.1940, H.&M. Townes (1 ♀, AEI); Okanogan Co., Okanogan Nat. For. nr. Wauconda, 25.vii.1985, Finnamore & Thormin (8 ♀, TAMU); Longmire Marsh, Mt Rainier NP, vii.1985 1000m, L. Masner (3 ♀, BMNH); **CANADA**: **Alberta**: Scandia, 11.vi.1956, O. Peck, swept from alfalfa (1 ♀, 1 ♂, CNC); Edmonton, vii.1984, Finnamore (5 ♀, 2 ♂, TAMU); 0.5 km E Writing-on-Stone Prov. Prk., 20-30.vii.1981, D. McCorquodale, pan trap (1 ♀, TAMU); **British Columbia**: Allison Lake, Hwy. 5, 24.vii.1985, Finnamore & Thormin (35 ♀, TAMU, 7 ♀, BMNH); Bella Col. Valley, Tweedsmuir N.P., 28.vii.1983, I.M. Smith (15 ♀, 1 ♂, TAMU, 3 ♀, BMNH); Blind Bay, 11.viii-10.ix.1987, C.A. Elsey (2 ♀, TAMU, 1 ♀, BMNH); **Manitoba**: 5mi. S.W. Shilo, 2.vii.1958, R.L. Hurley (1 ♀, CNC); **New Brunswick**: Kochibouguac N.P., 20.ix.1977, S.J. Miller (5 ♀, CNC); Hwy 112, 26 Km W Canaan Fork, viii.1984, M. Kaulbars (1 ♀, BMNH); **Nova Scotia**: N.S.C.B.H.N.P., Pleasant Bay, 24.vii.1983, L. Masner (2 ♀, CNC); **Ontario**: Arkell, C.R. Ellis (1 ♀, LDC); Bells Corners, 20.vii.1959, S.M. Clark (1 ♀, 1 ♂, CNC); Guelph, 26.vii-5.viii.1980, Barber (2 ♀, TAMU); Ottawa, Fallowfield, 3.viii.1985, J.S. Noyes (2 ♀, BMNH); Hamilton, viii.1984, M. Sanborne (4 ♀, BMNH); Innisville, Carleton Place, 10.viii.1985, J.S. Noyes (12 ♀, BMNH); Manitoulin Island, 17.viii.82, M. Sharkey (2 ♀, BMNH); Marmora area, Crowlake, 20.viii.1975, L. Masner & R. Longani (4 ♀, TAMU); Morrisburg, 4.viii.85, C. Yoshimoto (8 ♀, BMNH); Morrisburg, viii.1985, Noyes (19 ♀, BMNH); Ottawa, 14-24.vi.1986, H. Goulet (3 ♀, 2 ♂, TAMU); Ottawa, 6.vii.1986, H. Goulet (15 ♂, TAMU); **Prince Edward Island**: Harrington, 2-8.viii. 1988, M.E.M. Smith (1 ♀, TAMU); **Quebec**: Gatineau N. Park, 30.ix.1973, Boucek (1 ♂, BMNH); Gatineau Park, Champlain Overlook, 22.vii.1989, 89/011, Woolley & Zolnerowich (3 ♂, TAMU); Gatineau Park, Ridge Road, viii.1985, J.S. Noyes (3 ♂, BMNH); Lac Roddick, 14-28.viii.1983, L. Masner (3 ♂, CNC); Luskville Falls, 8-15.vii.1986, Denis & Dumouchel (6 ♂, TAMU); **ENGLAND**: Cambs, Woodwalton Fen NNR, 19-28.vii. 1978, M.G. Fitton & J.S. Noyes (2 ♀, 2 ♂, BMNH); **WALES**: Pembs, Newgate, 24.vi.1977, J.S.&M.E. Noyes (8 ♀, 3 ♂, TAMU).

Copidosoma vagum Howard

(Figs. 385-391)

Copidosoma vagum Howard, 1885: 11. [USNM, ♀ lectotype examined]. Transferred to *Apsilophrys* by Noyes and Woolley (1994).

Psilophrys armata Ashmead, 1888a: 16. [USNM, ♀ lectotype examined]. Transferred to *Apsilophrys* by Noyes and Woolley (1994). **New synonymy.**

Type Material. Lectotype here designated, ♀ mounted on a card with 7 points and 7 specimens, 1 of which is missing and represented by fragments, "286ºL" [handwritten] "Type/No. 2629/U.S.N.M." [red label] "Copidosoma/vaga How. typ." [handwritten]. "Copidosoma/vagum/Howard, 1885/LECTOTYPE/det. G. Zolnerowich" added to specimen. Lectotype second specimen from the right and designated with a red ink mark on the point bearing the specimen. Lectotype with left antenna missing and distal portion of forewings torn.

The type series consists of 6 cards with multiple points, which hold 4 ♀ and 32 ♂ specimens. The 35 paralectotypes are in poor condition, with most missing parts or represented by fragments. One ♀ was removed and slide-mounted in balsam. "Copidosoma/vagum/Howard, 1885/ PARALECTOTYPE/det. G. Zolnerowich" added to specimens.

Psilophrys armata Ashmead was described from 2 ♀ and 2 ♂ specimens, but only 2 type specimens were located. Lectotype ♀ mounted on a point, "Jacksonville/Fla" "Type/No. 4736/U.S.N.M." [red label] "Psilophrys/armatus/Ashm" [handwritten] "LECTOTYPE/PSILOPHRYS/ARMATA ASH./By GORDH 82". The lectotype is missing the head, but in all other respects is identical to specimens of *C. vagum*. A ♂ specimen is similarly labelled by G. Gordh as paralectotype. This specimen is not a species of *Copidosoma* and is missing the antennae, which makes correct identification difficult.

Diagnosis. Females of *Copidosoma vagum* are distinguished from other species of *Copidosoma* by the following characters: club 3-segmented with sensory area restricted to the apex (Fig. 385), scutellum with elongate reticulate, or nearly striate, sculpture (as in Fig. 421), postmarginal vein 0.75x length of the stigmal vein (Fig. 387), and ovipositor exserted 0.4-0.6x length of the metasoma. *Copidosoma charisoma* and *C. psephae* are similar but have reticulate sculpture on the scutellum and the postmarginal vein less than 0.5x the length of the stigmal vein (Fig. 98).

Female. Length 1.33-1.85 mm, excluding ovipositor. Body dark brown or nearly black; frontovertex with pale purple, green, and white highlights, scrobal area and genae with purple and green highlights; antenna uniformly colored, but varying from brown to dark brown, pedicel lighter at the apex; mesoscutum with green and purple highlights, axillae

and scutellum with purple and green highlights, propodeum laterally with green highlights and translucent setae lateral to spiracle, mesopleuron with green and blue highlights anteriorly and purple highlights posteriorly; all coxae dark brown, all femora dark brown except at apices, midfemur with proximal hyaline ring, foretibia and tarsi varying from tan to brown, midtibia tan at base, with a dark brown area in the proximal 1/5 that fades to tan in the distal 1/2, midtarsi 1-4 tan, tarsus 5 darker, hind tibia brown in proximal 1/3-1/2, remainder tan, hind tarsi 1-3 tan, tarsi 4-5 dark brown; forewing hyaline.

Frontovertex 0.45-0.5x head width and with reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye separated from occipital margin by the diameter of a facet, eye height 1.5-1.8x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:7; toruli separated from mouth margin by 0.5x their width, funicular segments 2-6x longer than broad, club 3-segmented, apically rounded and 0.3-0.4x length of funicle, sensory area restricted to apex of third segment (Fig. 385).

Mesoscutum with reticulate sculpture similar to but shallower than frontovertex; axillae meeting and greatly elevated above scutellum; scutellum convex and with elongate reticulate sculpture; forewing 2.4-2.5x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae, marginal vein 2x longer than broad, stigmal vein about 1.5x length of marginal vein, postmarginal vein 0.75x length of stigmal vein (Fig. 387).

Metasoma subequal to length of mesosoma; cerci inserted in middle 1/3 of metasoma; hypopygium reaching apex of metasoma and with anterior lobe (Fig. 389); ovipositor 1.4-1.8x length of midtibia and exserted 0.4-0.6x length of metasoma, second valvifer not fused to third valvula, with longitudinal rows of spicules (as in Fig. 430); epiproct present.

Male. Length 1.28-1.65 mm. Similar to female but smaller; frontovertex 0.5-0.6x head width; ocelli forming an obtuse angle, posterior ocelli closer to occipital margin than to eyes, OOL:OPL:POL 2:1:18; toruli 1.5x their width above mouth margin, funicular segments 2-3x longer than broad, club 0.3x length of funicle (Fig. 386); phallobase 0.45-0.55x length of midtibia and with 3 pairs of setae, midrib present, each digitus with 2 claws and 2 pores near claws (Fig. 390), aedeagus without lateral sensilla (Fig. 391).

Variation. Most variation is found in body size, length of the flagellum, and degree of dark color on the foretibia and tarsi and hind tibia.

Biology and hosts. Reared from *Hofmannophila pseudospretella* (Staint.) (Oecophoridae), *Aroga trialbamaculella* (Cham.), *Filatima pseudacaciella* (Cham.), *Gelechia* (Gelechiidae), and *Argyrotaenia querifoliana* (Fitch) (Tortricidae).

Distribution. Known from eastern Canada to California, and south to Texas.

Other material examined. USA: Arizona: Bullhead City, 2.iv.1956, Werner & Butler, swept/alfalfa (1 ♀, UA); Camp Verde, 30.iii.1956, Werner & Butler, swept/alfalfa (1 ♀, UA); Continental, 1.vii.1960, G. Butler, suck/ cotton (2 ♀, UA); Sahuarita, 4.vi.1957, G.D. Butler, swept/mesquite (2 ♀, UA); S. Wickieup, 1.iv.1956, Werner & Butler, swept/alfalfa (1 ♀, 2 ♂, UA); Sahuarita, 1.vi.1960, G. Butler, suck/alfalfa (1 ♂, UA); Santa Rita Range Res., 12.viii.1957, G. Bulter & F. Werner, mesquite (6 ♀, 14 ♂, UA); Wilcox, 21.vi.1970, S. Kozloski, UV trap (2 ♀, UA); Graham Co., Graham Mts., 270 m, Big Creek-Grant Creek, 22.viii.1990, L. Masner (2 ♀, BMNH); Pinal Co., Aravaipa Cn, nr. mouth, 12.vii.1973, F. Werner, *Prosopis fl.* (1 ♀, UA); Yuma Co., Upper Gila Val., 3.iv.1956, F. Werner, G. Butler (1 ♀, UA); **Arkansas**: Washington Co., 29.vi.1971, W.D. Wylie, ex. wild cherry (3 ♀, UCR); **California**: Riverside Co., Pinyon Flat, 3 mi W on Hwy. 74, 24.vi.1964, E.F. Riek & G.I. Stage (2 ♀, LACM); Sonoma Co., vi-vii.1931, H.H. Kiefer, ex *Gelechia demissae* Kief. (2 ♀, 1 ♂, USNM, 1 ♂, CDFA); Mark West Spr., vi-vii.1931, ex *Gelechia demissae* Kief., H.H. Kiefer (2 ♀, CDFA); Tulare Co., Ash. Mtn. Pwr. Sta., 1.x.1982, J.A. Halstead (1 ♂, CNC, 2 ♀, BMNH); Ash. Mtn. Pwr. Sta., 18.x.1983, J.A. Halstead (1 ♀, CNC); **Colorado**: 1159, C.F. Baker (1 ♀, BMNH, 2 ♀, USNM); **Florida**: Levy Co., 3 km W Archer, 25.iv.1989, J.S. Noyes (2 ♀, BMNH); **Maryland**: Cabin John, viii.1916, R.M. Fouts (1 ♀, USNM); **Michigan**: Montmorency Co., 5.ix.1966, P.C. Kennedy (4 ♀, MSUE); **New Jersey**: New Lisbon, 20.vii.1934, E.P. Darlington, *Gelechia* on blueberry (5 ♀, USNM, 2 ♀, CNC); Pemberton, 30.ix.1914, H.B. Scammel, *Gelechia trialbamaculella* (2 ♀, USNM); **New York**: Powder Mills (18 ♀, USNM); **North Carolina**: Bladen Co., 6 mi N White Lake, 20.vi.1962, H.H. Neunzig, G.A. Matuza, *Aroga trialbamacuelella* on wild *Vaccinium* (6 ♀, 15 ♂, SUNY); **Texas**: Brewster Co., Big Bend N.P., 23-28.vi.1982, G.A.P. Gibson (2 ♀, BMNH); Big Bend Ranch SNA, Lat. 29 28 09, Long. 103 46 07, el. 3980, 12.v.1990, G. Zolnerowich (1 ♀, TAMU); Culberson Co., Guadalupe Springs, 20-22.vii.1982, G.A.P. Gibson (3 ♂, BMNH); Presidio Co., Big Bend Ranch SNA, 2 mi N La Sauceda, 17.v.1990, R. Wharton (1 ♂, TAMU); Big Bend Ranch SNA, 2.5 mi W La Sauceda, 29 17 00N, 103 54 52W, 9.viii.1991, J.B. Woolley (1 ♀, TAMU); Big Bend

Ranch SNA, McGuirks Tanks, 12.v.1990, R. Wharton, on desert willow (3 ♀, TAMU); **Virginia**: Page Co., Shenandoah N.P., 8.vii.1987, 1300m, L. Dumouchel (1 ♀, TAMU); **CANADA: Alberta**: 27 mi NW Sundre, pyralid sp. (1 ♂, CNC); Ft. McMurray, 21.ii.1944, tortricid on aspen (6 ♂, CNC); **British Columbia**: Oliver, vi.1951, D.A. Chant (8 ♂, CNC); Victoria, 17.vii.1959, *Hoffmannophila* [sic]*pseudospretella* (3 ♂, CNC); **Manitoba**: Arnès, 14.iii.1961, ex. gelechiid (8 ♂, CNC); Turtle Nat. For., 11.vi.1953, gelechiid on W. poplar (1 ♂, CNC, 1 ♂, NFC); **Ontario**: Hamilton, ix.1982, M. Sanborne (1 ♀, BMNH); Point Peele, vii.1986, A. Borkent (1 ♀, BMNH); St. Davids, 9.vii.1937, W.L. Putnam (5 ♂, USNM); **Quebec**: Beechgrove, 29.vi.1962, J.R. Vockeroth (1 ♀, BMNH); Gatineau Park, Luskville Falls, Denis & Dumouchel, vii.1986 (1 ♀, BMNH);

Copidosoma whartoni new species

(Figs. 392-400, 420, 429)

Diagnosis. Females of *Copidosoma whartoni* are distinguished from other species of *Copidosoma* by the following characters: antenna uniformly colored, club 3-segmented and distinctly shaped (Fig. 393), fore- and midfemora dark brown, scutellum convex, sternites 5-6 incised anteriorly (Fig. 396), and ovipositor barely exserted. Of the bther 2 species with a similar club, *Copidosoma incisum* differs by having the flagellum darker than the scape, fore- and midfemora light, and a less convex scutellum. *Copidosoma beckeri* is larger, sternites 5-6 have an anterior lobe (Fig. 48), and the ovipositor is exserted 0.25-0.50x the length of the metasoma.

Female. Length 0.95-1.12 mm. Body dark brown; frontovertex, scrobal area, and genae with light purple reflections; antenna uniformly colored, but varying from light to dark brown; mesoscutum with brassy green and purple highlights, axillae and scutellum with purple highlights, scutellum with green highlights laterally and posteriorly, propodeum laterally with pale green highlights and translucent setae lateral to spiracle, mesopleuron with blue highlights anteriorly and purple highlights posteriorly; coxae and femora dark brown, midfemur with proximal hyaline ring, foretibia and tarsi tan, midtibia brown to dark brown in proximal 1/2, distal 1/2 tan, midtarsi tan, hind tibia dark brown in proximal 1/2 with remainder tan or dark brown nearly full length, hind tarsi tan to brown; forewing slightly infuscate.

Frontovertex slightly less than 0.5x head width and with deep reticulate sculpture that is more elongate on lower face and genae; mandible with 3 subequal teeth; eye reaching occipital margin, eye height 2x malar space; ocelli forming a right angle, posterior ocelli equidistant between eyes and occipital margin, OOL:OPL:POL 1:1:8; toruli separated from mouth margin by their width, first funicular segment quadrate, remainder 1.1-1.3x longer than broad, club 3-segmented, apically rounded and slightly less than length of funicle, sensory area 0.6x length of club and restricted to third segment (Fig. 393).

Mesoscutum with reticulate sculpture similar to but shallower than frontovertex; axillae just meeting and greatly elevated above scutellum; scutellum convex and anteriorly with sculpture similar to that of mesoscutum, laterally more elongate, apex nearly polished; forewing 2.4x longer than wide, apex of submarginal vein with incomplete hyaline break, linea calva interrupted by dorsal setae, marginal vein slightly longer than broad, stigmal vein about 2x length of marginal vein, postmarginal vein at most 0.4x length of stigmal vein (Fig. 394).

Metasoma subequal to length of mesosoma; cerci inserted 1/3 from anterior end of metasoma; sternites 5-6 incised anteriorly (Fig. 396); hypopygium reaching apex of metasoma and with broad anterior lobe (Fig. 397); ovipositor slightly longer than midtibia and slightly exserted, second valvifer not fused to third valvula, with several short longitudinal rows of spicules (as in Fig. 430).

Male. Length 1.12 mm. Similar to female but frontovertex slightly more than 0.5x head width; ocelli forming an obtuse angle; toruli 2x their width above mouth margin, flagellum distinctly lighter in color than the dark brown scape and pedicel, funicular segments longer than broad, at least second and third subramose and triangular in lateral view (Fig. 392), club 0.35x length of funicle; forewing hyaline; phallobase 0.6-0.7x length of midtibia and with 14-16 pairs of setae (Fig. 399), each digitus with 3-4 apical claws and without pores (Fig. 398), aedeagus without sensilla (Fig. 400).

Variation. Most variation is found in the relative darkness of antennal and leg color.

Biology and hosts. Unknown. Specimens from Texas were collected over a period of several months in Malaise traps erected in mixed pine and hardwood forest.

Distribution. Known from eastern Texas and the Mexican states of Guerrero and Oaxaca.

Etymology. Named in honor of Dr. R. A. Wharton.

Holotype ♀ mounted on a card, "TEXAS: Montgomery Co./Jones State Forest/8 mi S Conroe/1-7.VI.1987 Wharton/Steck, Carroll, Wang". Red label "HOLOTYPE/ Copidosoma/wharton/Zolnerowich" added to specimen. Deposited in USNM.

Paratypes. USA: Texas: Montgomery Co., Jones State Forest, 8 mi S Conroe, 1.IV-7.VI.1987 [6 separate collections], Wharton, Wang, Praetorius (39 ♀, 14 ♂); Jones State Forest, 8 mi S Conroe, 7-14.VI.1987 Wharton, Steck, Carroll, Wang (4 ♀, 1 ♂); Jones State Forest, 8 mi S Conroe, 14-21.VI.1987 Wharton, Steck, Carroll (2 ♀); Brazos Co., Lick Creek Park, July 25-31 1988, R. Wharton, Malaise (1 ♀); College Station, Lick Creek Park, 19-IX-2-X-1988, R. Wharton (3 ♀, 1 ♂); College Station, Lick Creek Park, 3-9-X-1988, R. Wharton (1 ♀, 1 ♂). All specimens from TAMU. Paratypes to be deposited in BMNH, CNC, TAMU, UCR, and USNM.

Other material examined. MEXICO: Guerrero, 32 mi. se. Petatlan, 24.vii.1984, J.B. Woolley 84/032 (1 ♀); **Oaxaca**, 6 miles NE Mitla, 20.viii.1985, J. Woolley, G. Zolnerowich 85/077 (1 ♀). All specimens from TAMU.

CONCLUSIONS

Copidosomatini are recognized as a monophyletic group comprised of four distinct subtribes: Coelopencyrtina, Parablastotrichina, Ageniaspidina, and Copidosomatina. Two recent additions to the tribe, *Coagerus* (Noyes and Hayat) and *Paratetracnemoidea* (Girault), are removed from the tribe based on arguments presented in the Introduction. A phylogenetic analysis left Trjapitzin's (1973b) concept of the tribe largely intact, although several generic names have been synonymized, Copidosomatina has been expanded to include *Neapsilophrys* Noyes, and the limits of Ageniaspidina have been expanded to include *Ethoris* Noyes and Hayat and *Zelencyrtus* Noyes.

Morphologically, the tribe has been distinguished from other Encyrtidae on a suite of variable characters, with each subtribe being more clearly definable than the tribe as a whole. The strongest evidence for monophyly of the tribe is based on hosts in non-butterfly Lepidoptera and aculeate Hymenoptera, and polyembryonic development, although this has been demonstrated only in Copidosomatina and Ageniaspidina. Despite the large number of characters employed, the phylogenetic analysis indicates that morphological support for the tribe rests only on an increase in the number of digital claws from one to two.

A number of new characters and characters important in identification were evaluated for their phylogenetic utility. Many characters were found to be homoplastic, but several, such as the spicules of the second valvifers and shape of the fifth and sixth sternites, were found to be very informative at the subtribal or species-group level. Weighting characters through successive approximations was found to reduce the number of cladograms in an analysis, and using various reduced datasets produced results very different from the full dataset.

The phylogenetic analysis showed Coelopencyrtina to be paraphyletic and basal to the other subtribes. Paraphyly of Coelopencyrtina is most likely a result of missing data. *Coelopencyrtus* was found to be a monophyletic genus based on use of aculeate Hymenoptera as host and the number and arrangement of pores on the digiti. *Nathismusia* is placed as the next most derived taxon but was missing a number of characters that could not be evaluated. As further biological or morphological information concerning *Nathismusia* becomes available its relationships will need to be reassessed.

Parablastotrichina, the most basal subtribe and one whose species parasitize Lepidoptera, was found to be a monophyletic lineage based on the enlarged eyes, peglike anterior mandibular setae, and pectinate male antennae. Species of *Parablastothrix* may have the arrangement of the stigmal vein sensilla similar to that of Copidosomatina but are polymorphic for this trait.

Monophyly of Ageniaspidina is supported by the elongate postmarginal vein and found to be comprised of two clades. The first clade, *Paraleurocerus+Holcothorax+Ageniaspis*, represents the traditional concept of the subtribe, with monophyly resting mostly on divided sternites and loss of the dorsal tentorial arms. The sister clade, *Ethoris+Zelencyrtus*, is based solely on the middle tooth of the mandible being longest. The biology of species of these genera is unknown, and males are unknown for *Ethoris*. Their relationships may change as further information becomes available.

Monophyly of Copidosomatina is supported by the sensilla of the stigmal vein arranged in a square and enlargement of the anterior mandibular setae, although both these characters undergo a reversal in some species. Several clades within *Copidosoma* are well supported by characters, but a number of lineages that appear to be stable are based on reversals or convergences.

Species of *Apsilophrys*, *Paralitomastix*, and *Raffaellia* were found to be phylogenetically indistinguishable from species of *Copidosoma* and these names are treated as junior synonyms. Because males and host information are unknown for *Neapsilophrys*, this name was not synonymized with Copidosma, although this renders the latter genus paraphyletic.

The biology of the tribe is reviewed and host data are presented based on published host records and label data. There is a strong congruence between the phylogenies of Parablastotrichina, Ageniaspidina, and Copidosomatina and Lepidoptera. This congruence suggests that ancestral copidosomatines utilized leaf-mining monotrysian Lepidoptera as hosts. Species of Parablastotrichina, *Paraleurocerus*, and *Holcothorax* continue to use plesiomorphic hosts, but those of *Ageniaspis* and Copidosomatina have expanded their host ranges into a number of more derived Lepidoptera families.

If species of Coelopencyrtina and Parablastotrichina prove to not be polyembryonic, reports of polyembryony in one species of *Pseudorhopus* and one species of *Epiencyrtus* would indicate that polyembryony must have evolved a minimum of three times in Encyrtidae. If members of Coelopencyrtina are indeed polyembryonic and Parablastotrichina are not, polyembryony could have evolved independently four times in Encyrtidae.

A revision of Nearctic species of *Copidosoma* was conducted, the first comprehensive treatment of this taxon. Fifty-seven species were found to be present in the region, with 35 of those being described as new. Keys for males and females are provided, along with 13 redescriptions, numerous illustrations, and distribution and host information. While over 10,000 specimens were examined in this study, I am confident that many more species await description, particularly from the western portion of the Nearctic region.

While this represents the end of one study, I hope this work will serve as a firm foundation for future research. Other avenues that can be explored are correlations between host biology and parasite morphology, particularly in the ovipositor, finer scales of correlation between host and parasite phylogenies, continued collection and examination of undescribed species, and the never-ending search for more information so that we may better understand these wasps.

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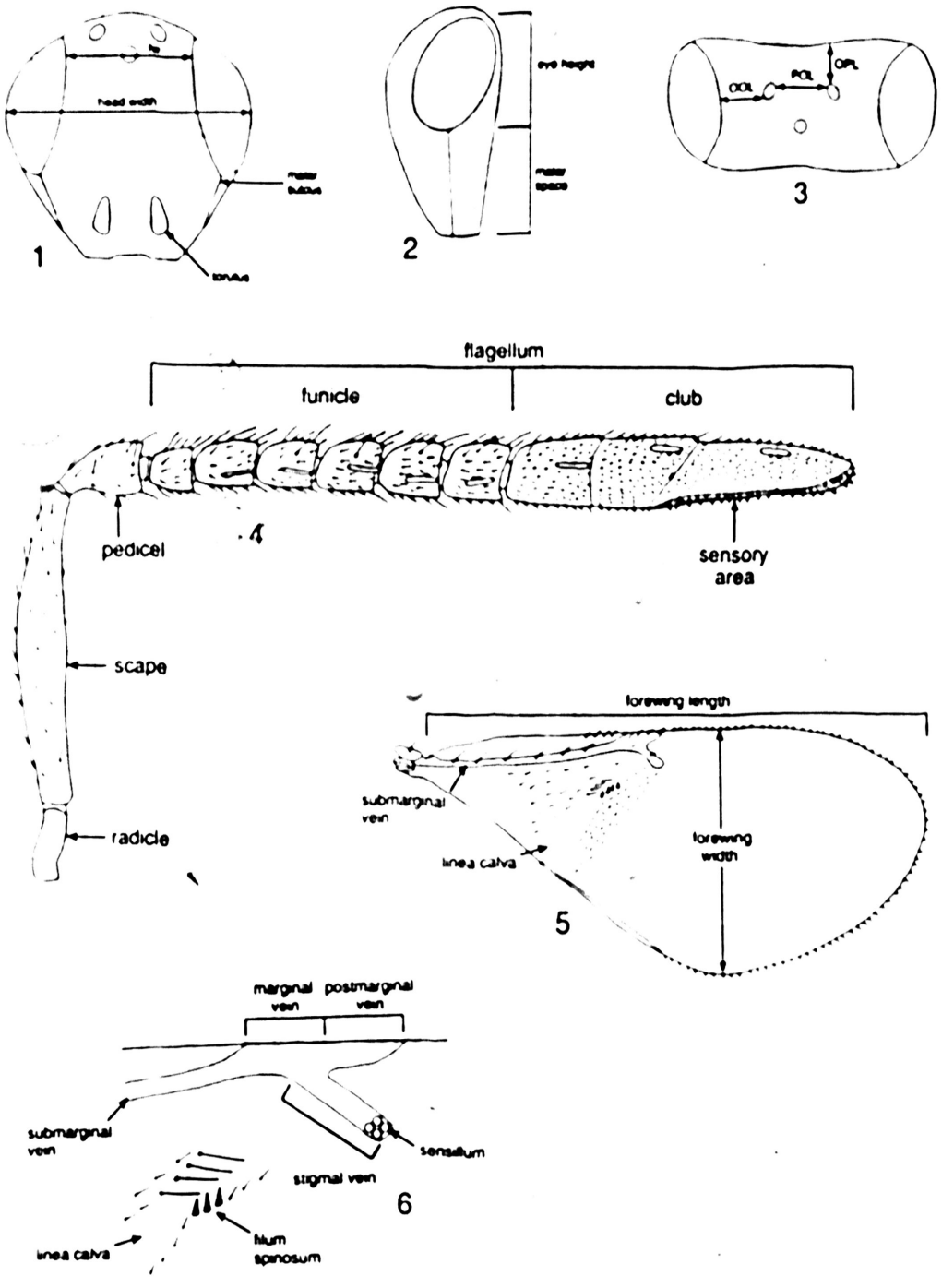
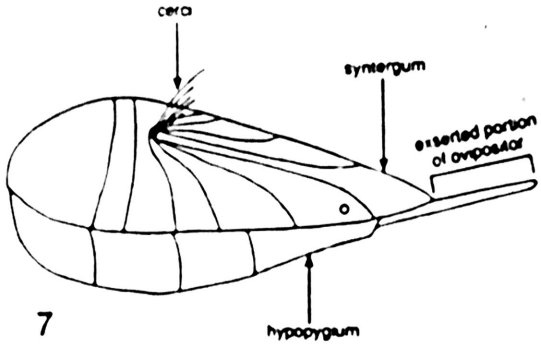
APPENDIX 1
FIGURES



Figs. 1-6. 1-3, generalized encyrtid head: 1, frontal view; 2, lateral view; 3, dorsal view. 4, *Copidosoma beckeri*, antenna, female. 5-6, generalized encyrtid wing; 5, forewing; 6, venation. fw = frontovertex width.



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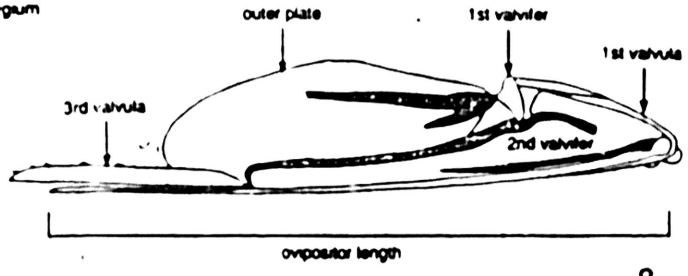

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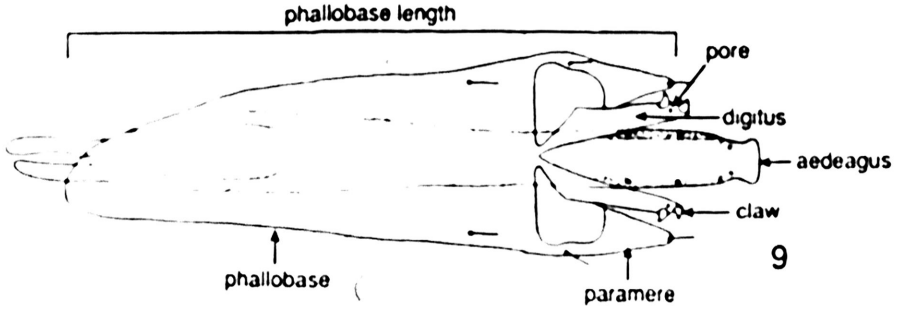

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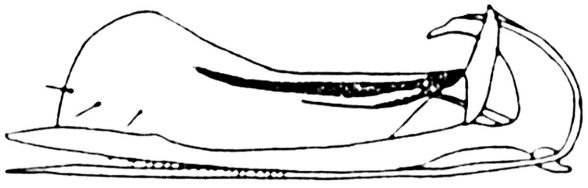

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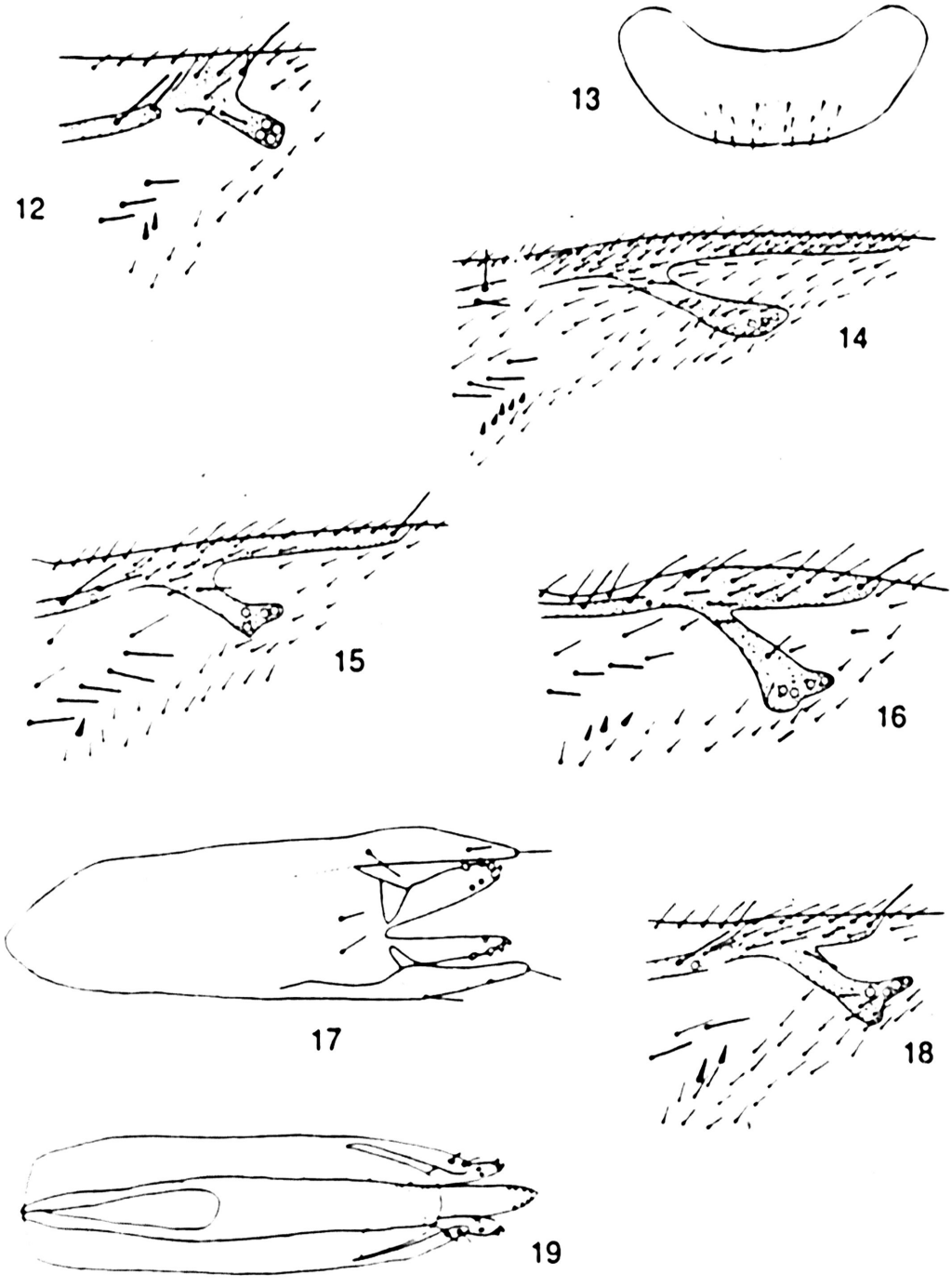
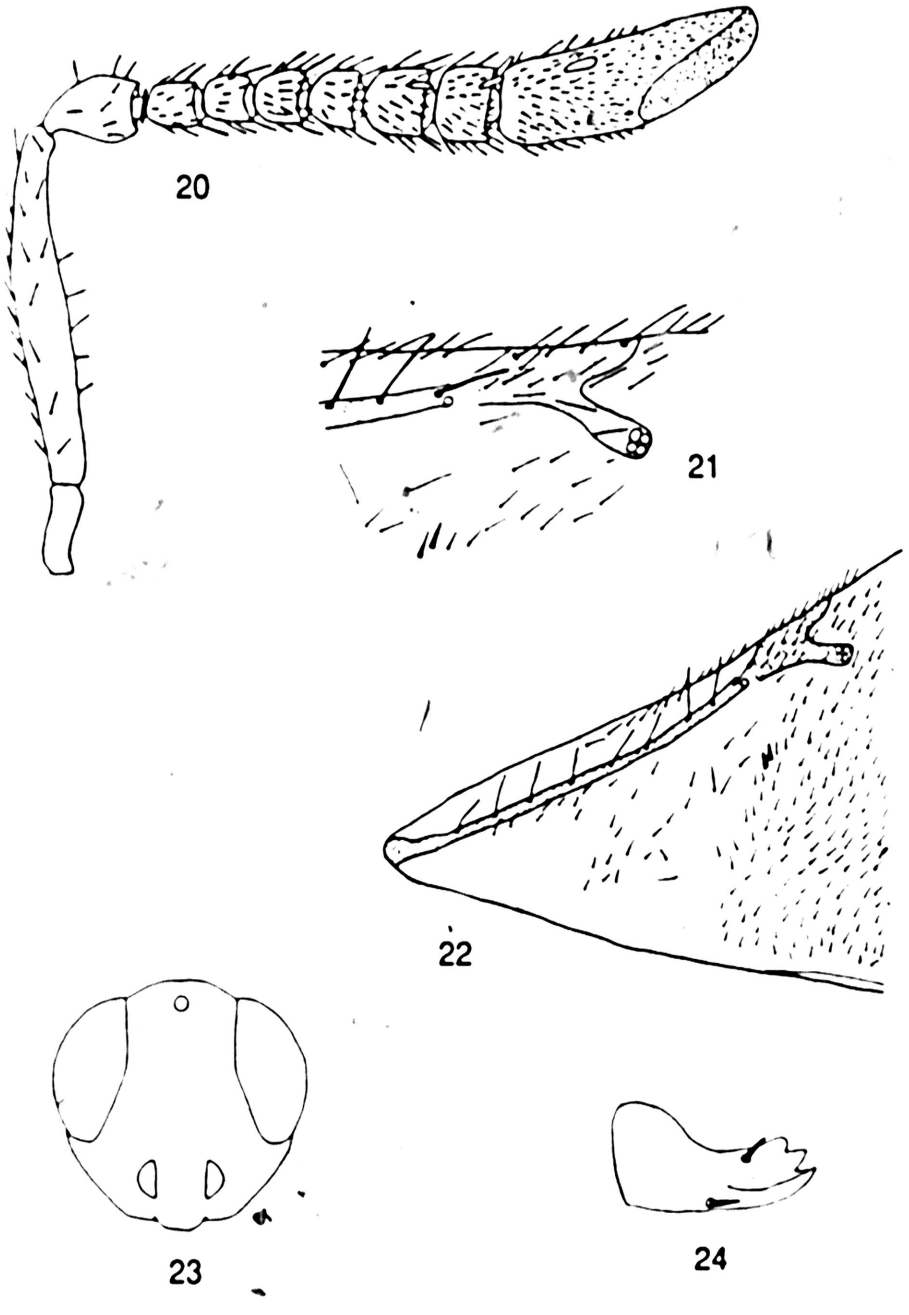
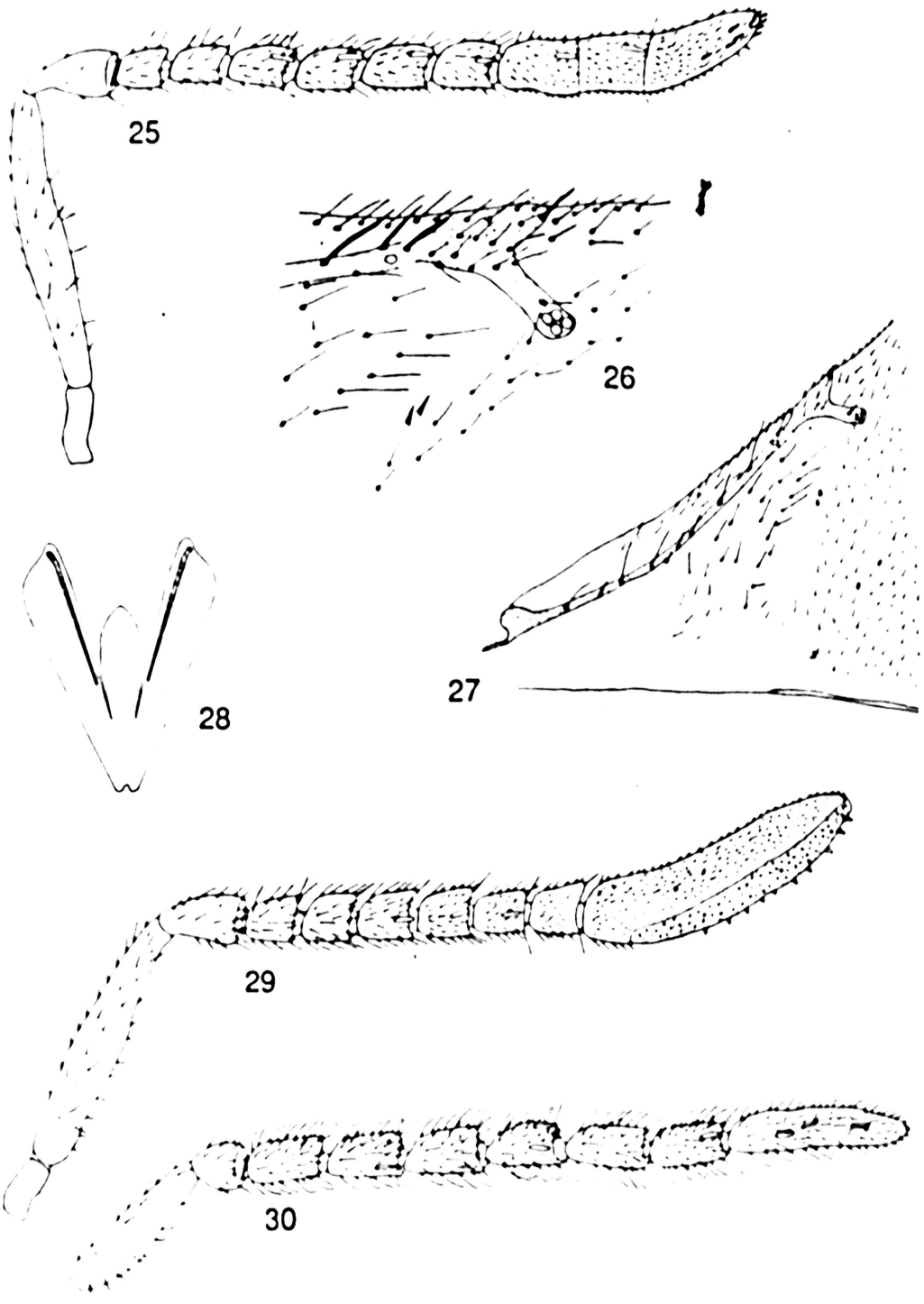
Figs. 7-11. 7, generalized encyrtid metasoma. 8, *Copidosoma gelechiae*, ovipositor. 9, *Ageniaspis atricollis*, male genitalia. 10, *Paratetracnemoidea malenotti*, ovipositor. 11, *Paratetracnemoidea*, hypopygium.



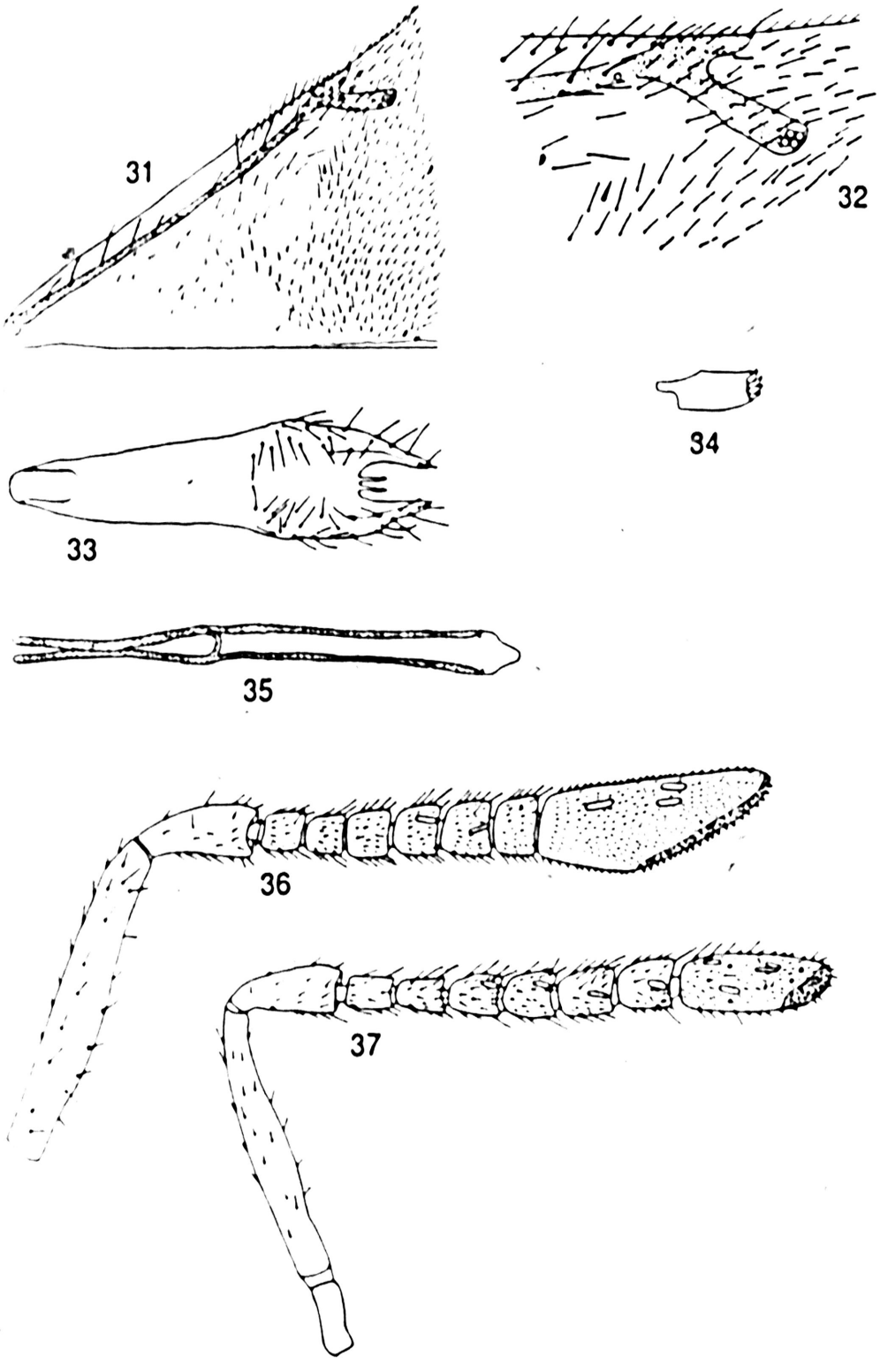
Figs. 12-19. 12-13, *Copidosomopsis plethoricus*: 12, forewing venation; 13, sixth sternite. 14, *Neapsilophrys flavipes*, forewing venation. 15, *Ageniaspis fusicollis*, forewing venation. 16-17, *Zelencyrtus latifrons*: 16, forewing venation; 17, phallobase



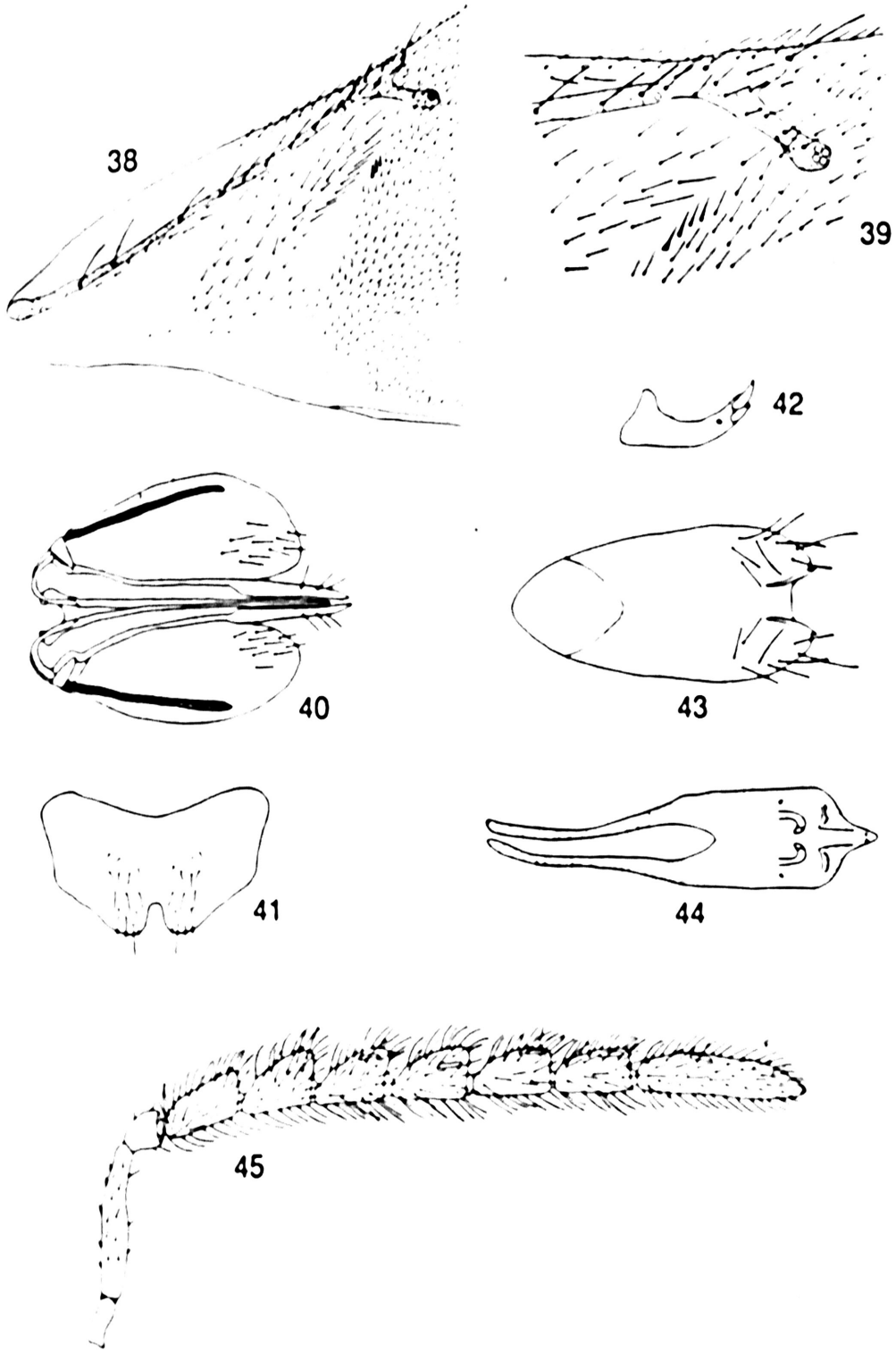
Figs. 20-24. *Copidosoma albicoxae*, female: 20, antenna; 21, forewing venation; 22, base of forewing; 23, head, frontal view; 24, left mandible, posterior view.



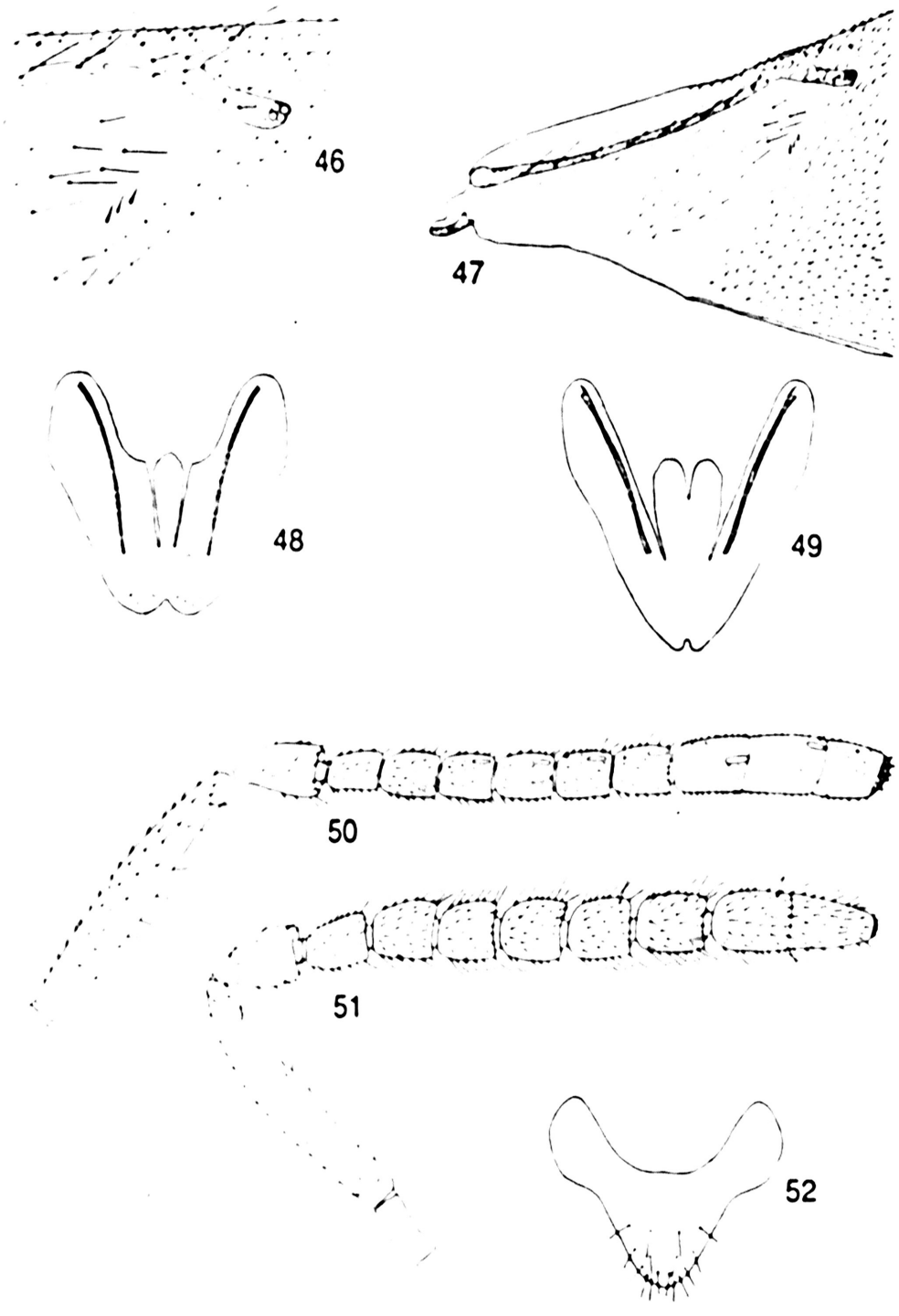
Figs. 25-30. 25-28, *Copidosoma alexanderi*, female: 25, antenna; 26, forewing venation; 27, base of forewing; 28, hypopygium. 29-30, *Copidosoma auriceps*: 29, antenna, female; 30, antenna, male.



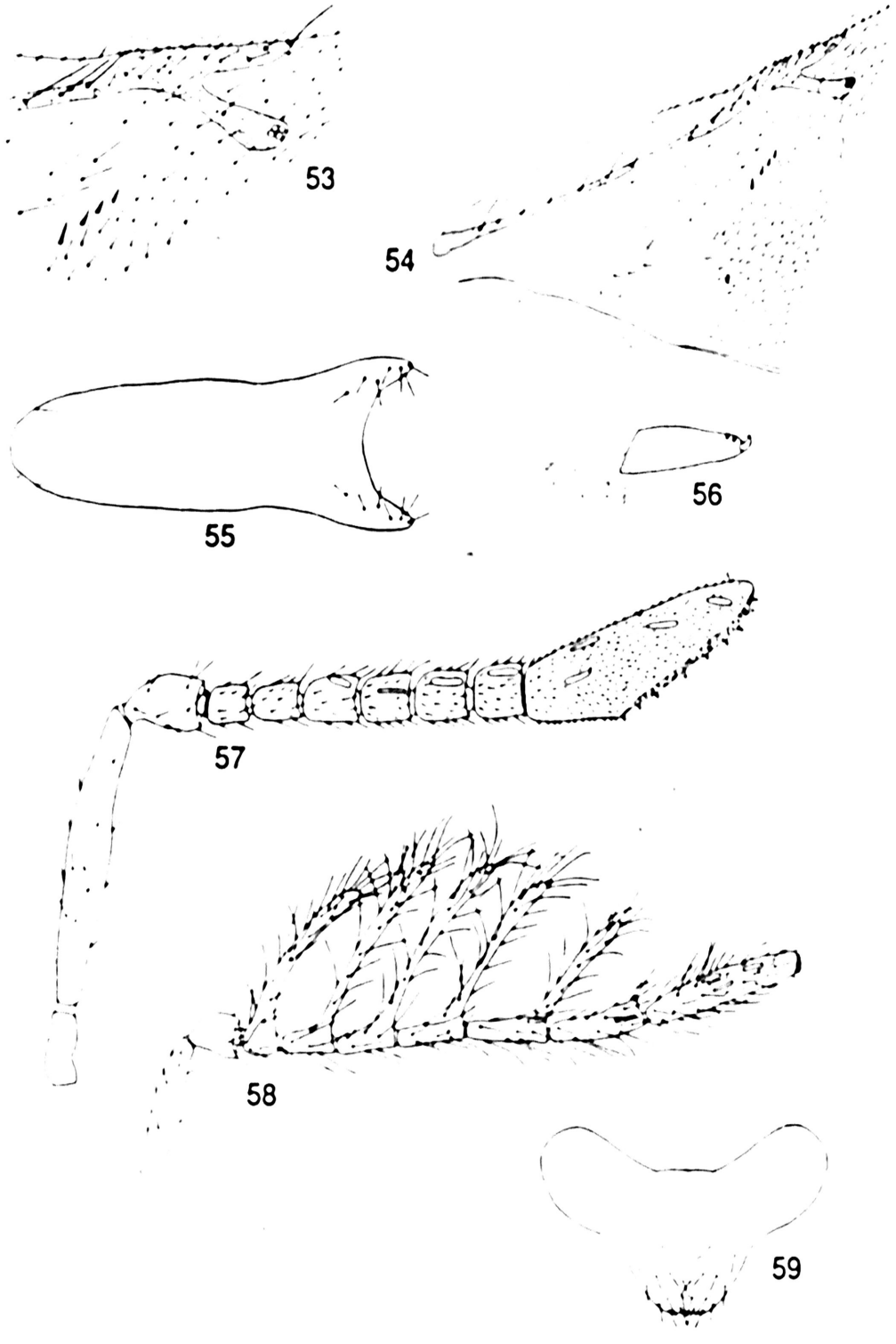
Figs. 31-37. 31-35, *Copidosoma auriceps*: 31, base of forewing; 32, forewing venation; 33, phallobase; 34, digitus; 35, aedeagus. 36-37, *Copidosoma bakeri*: 36, antenna, female; 37, antenna, male.



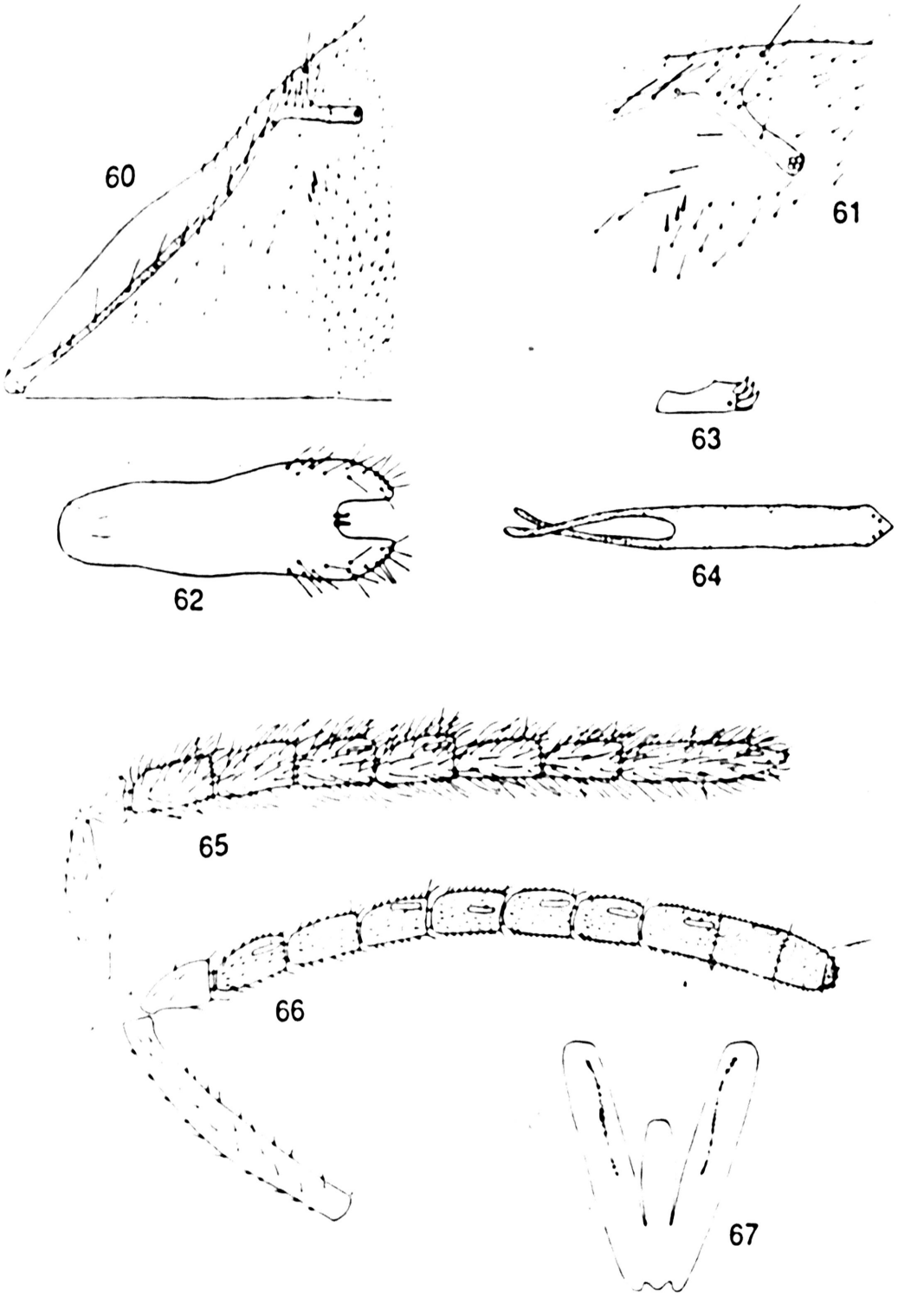
Figs. 38-45. 38-44, *Copidosoma bakeri*: 38, base of forewing; 39, forewing venation; 40, ovipositor; 41, hypopygium; 42, digitus; 43, phallobase, 44, aedeagus. 45, *Copidosoma beckeri*, antenna, male.



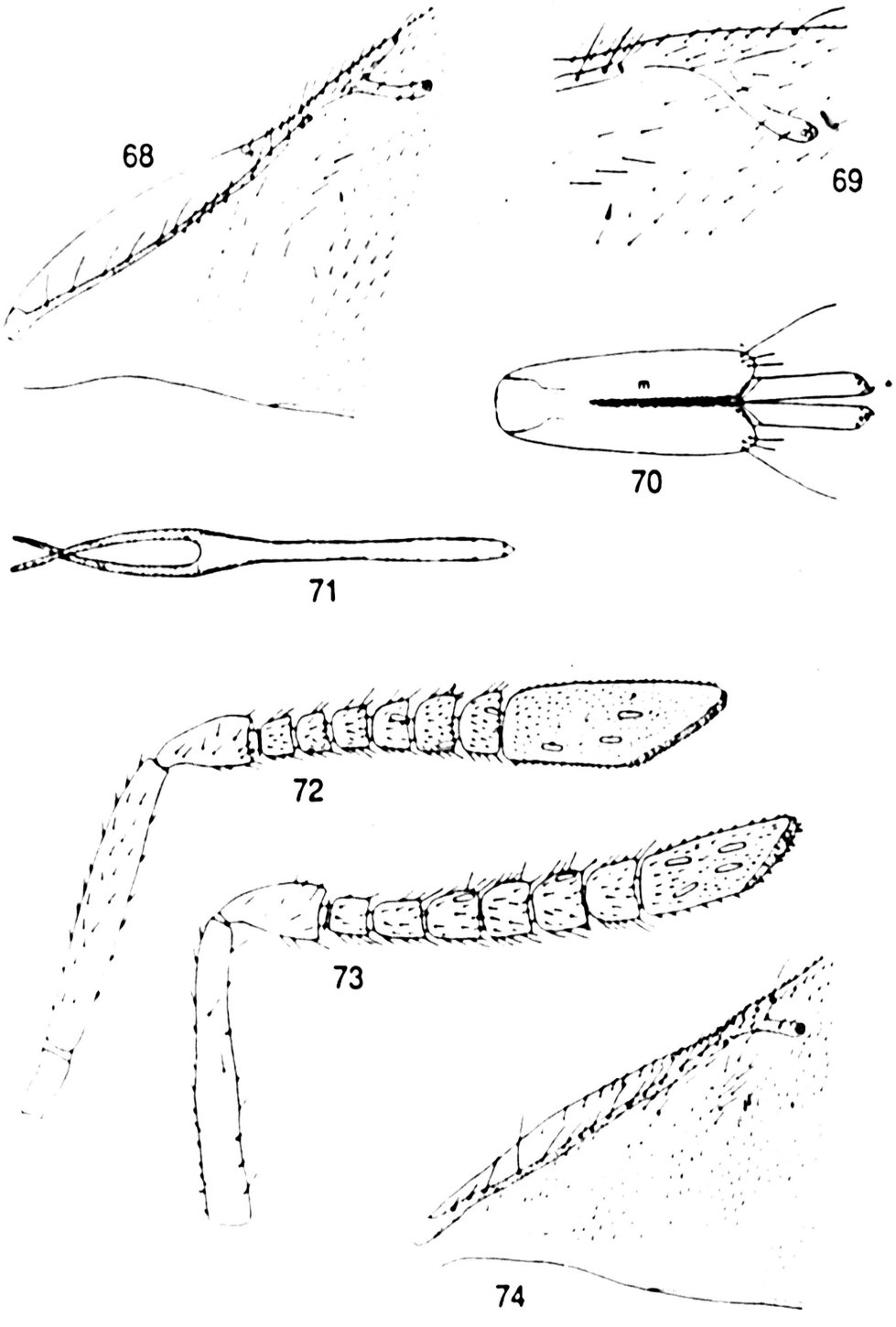
Figs. 46-52. 46-49, *Copidosoma beckeri*: 46, base of forewing; 47, forewing venation; 48, sixth sternite; 49, hypopygium. 50-52, *Copidosoma brandysae*: 50, antenna, female; 51, antenna, male; 52, hypopygium.



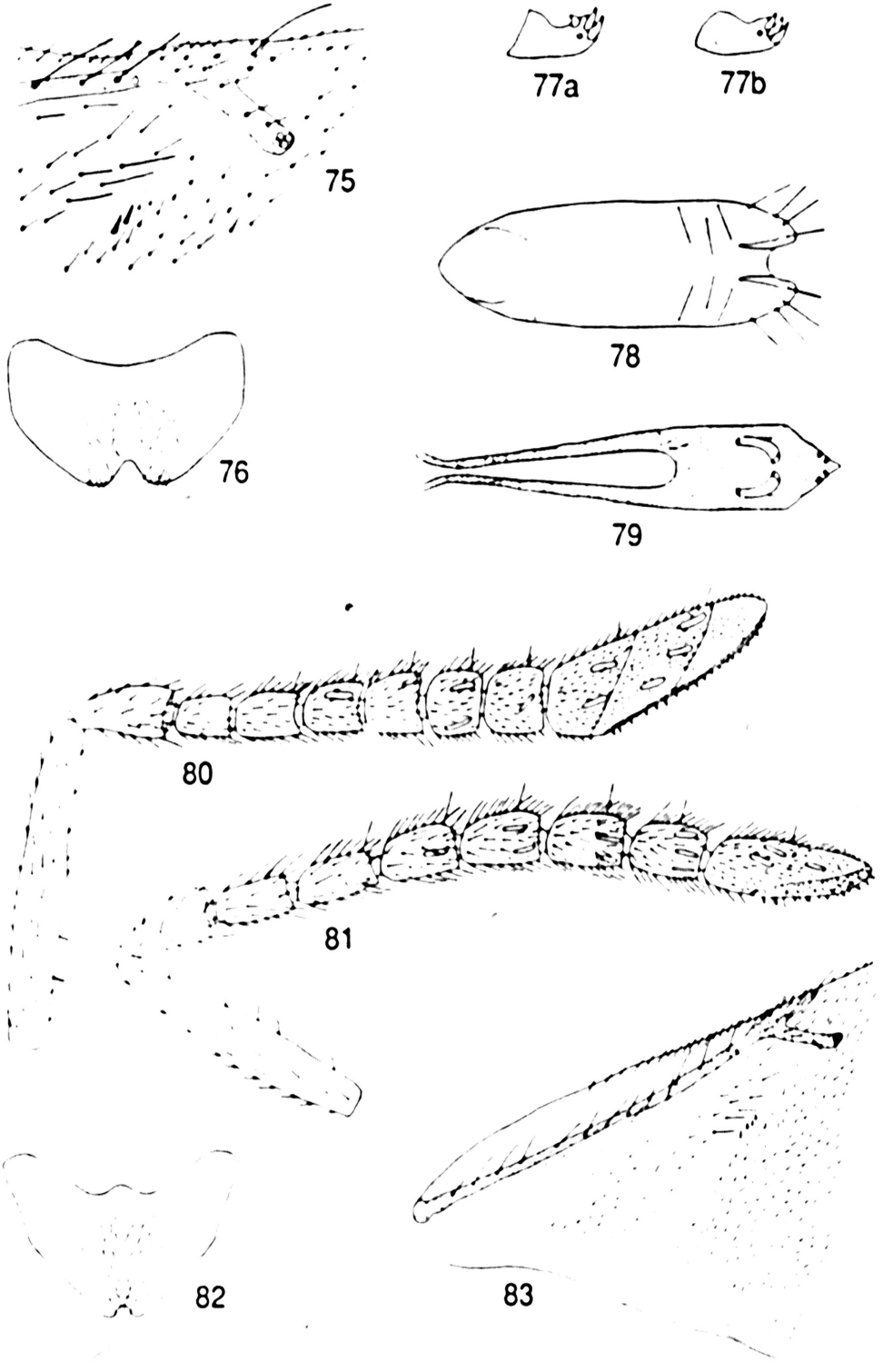
Figs. 53-59. 53-56, *Copidosoma brandysae*: 53, base of forewing; 54, forewing venation; 55, phallobase; 56, digitus. 57-59, *Copidosoma bucculatricis*: 57, antenna, female; 58, antenna, male; 59, hypopygium.



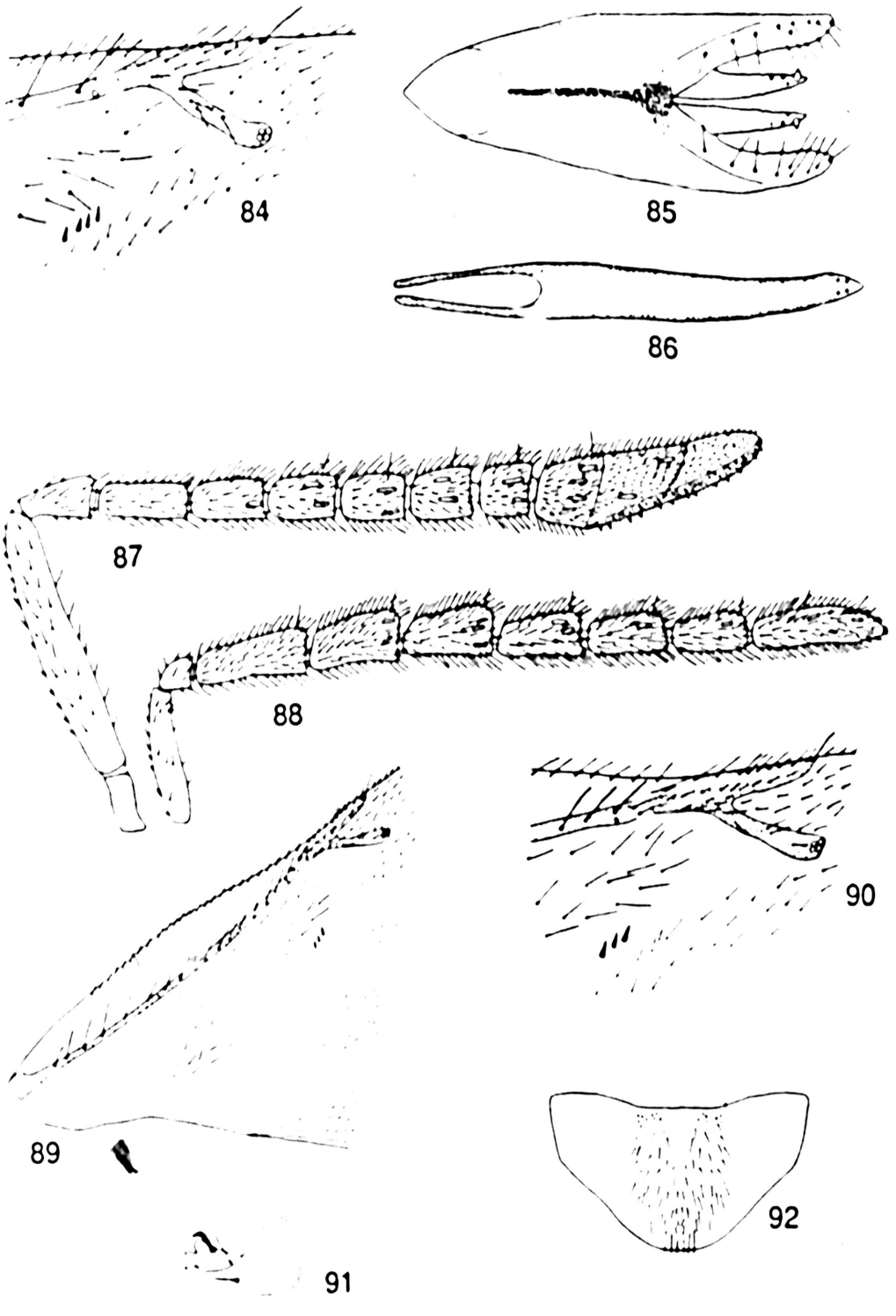
Figs. 60-67. 60-64, *Copidosoma bucculatricis*: 60, base of forewing; 61, forewing venation; 62, phallobase; 63, digitus; 64, aedeagus. 65-67, *Copidosoma capsicum*: 65, antenna, male; 66, antenna, female; 67, hypopygium. .



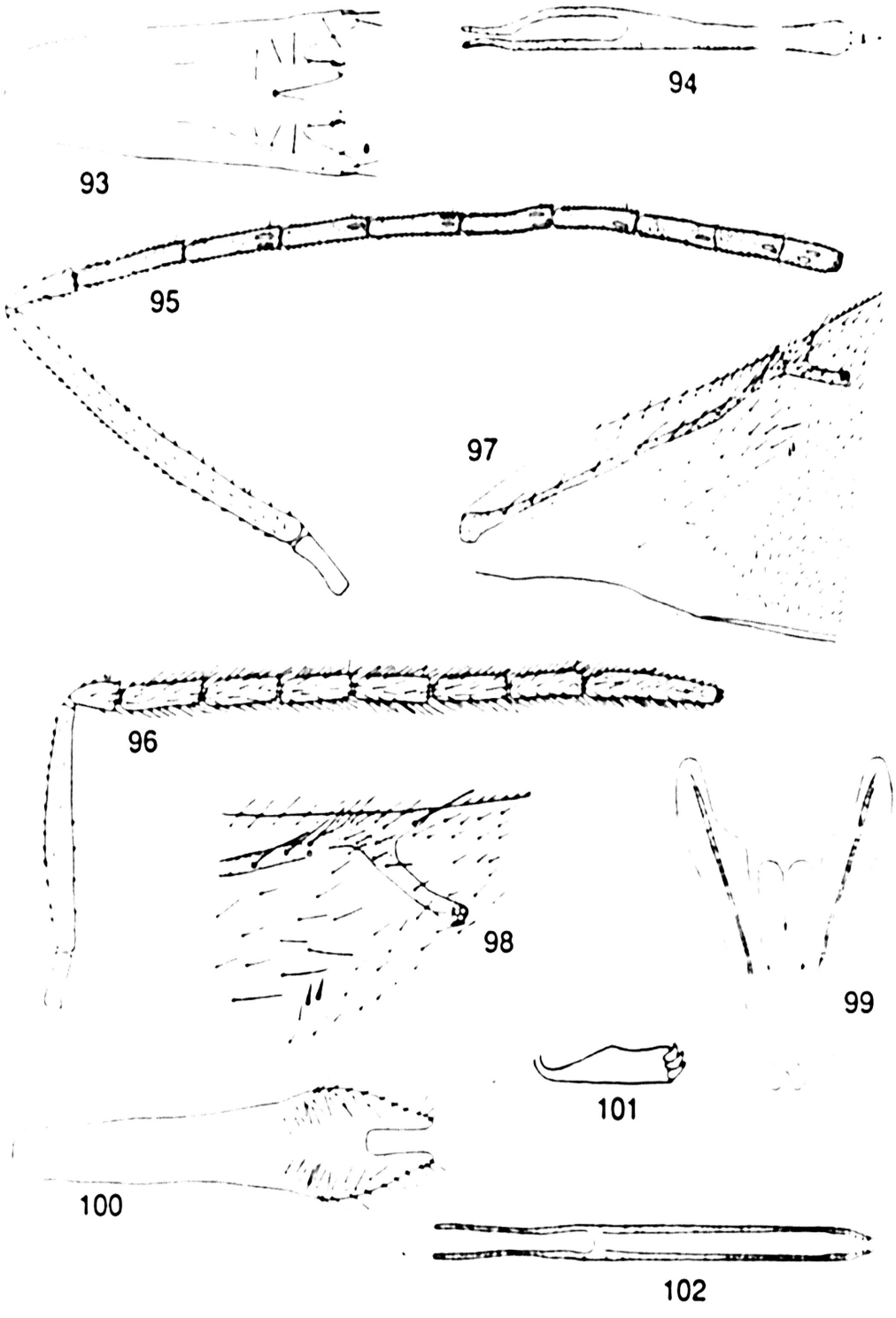
Figs. 68-74. 68-71, *Copidosoma capsicum*: 68, base of forewing; 69, forewing venation; 70, phallobase and digiti; 71, aedeagus. 72-74, *Copidosoma celaenae*: 72, antenna, female; 73, antenna, male; 74, base of forewing. m = midrib



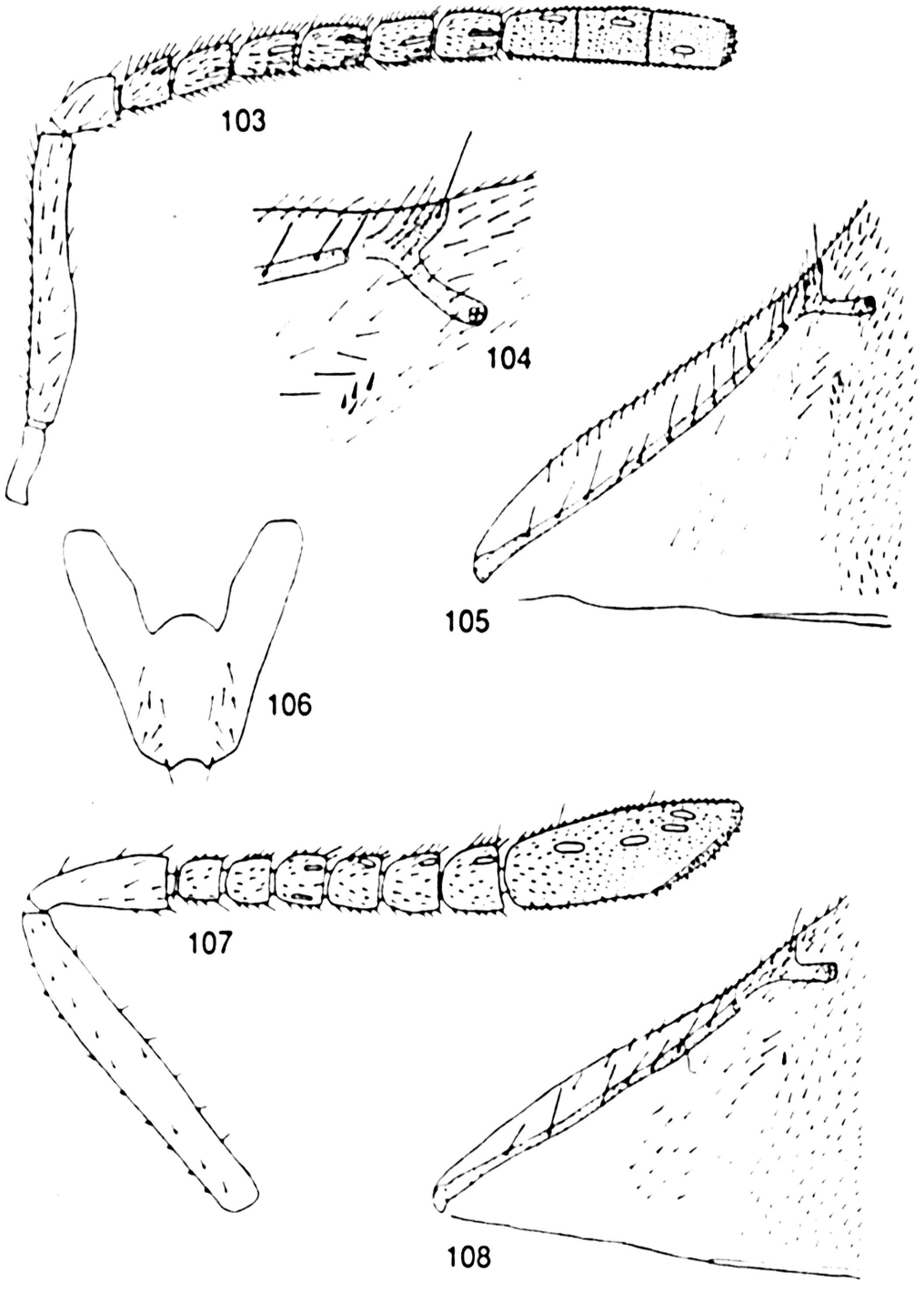
Figs. 75-83. 75-79, *Copidosoma celaenae*: 75, forewing venation; 76, hypopygium; 77a, b, digitus; 78, phallobase; 79, aedeagus. 80-83, *Copidosoma cervius*: 80, antenna, female; 81, antenna, male; 82, hypopygium; 83, base of forewing.



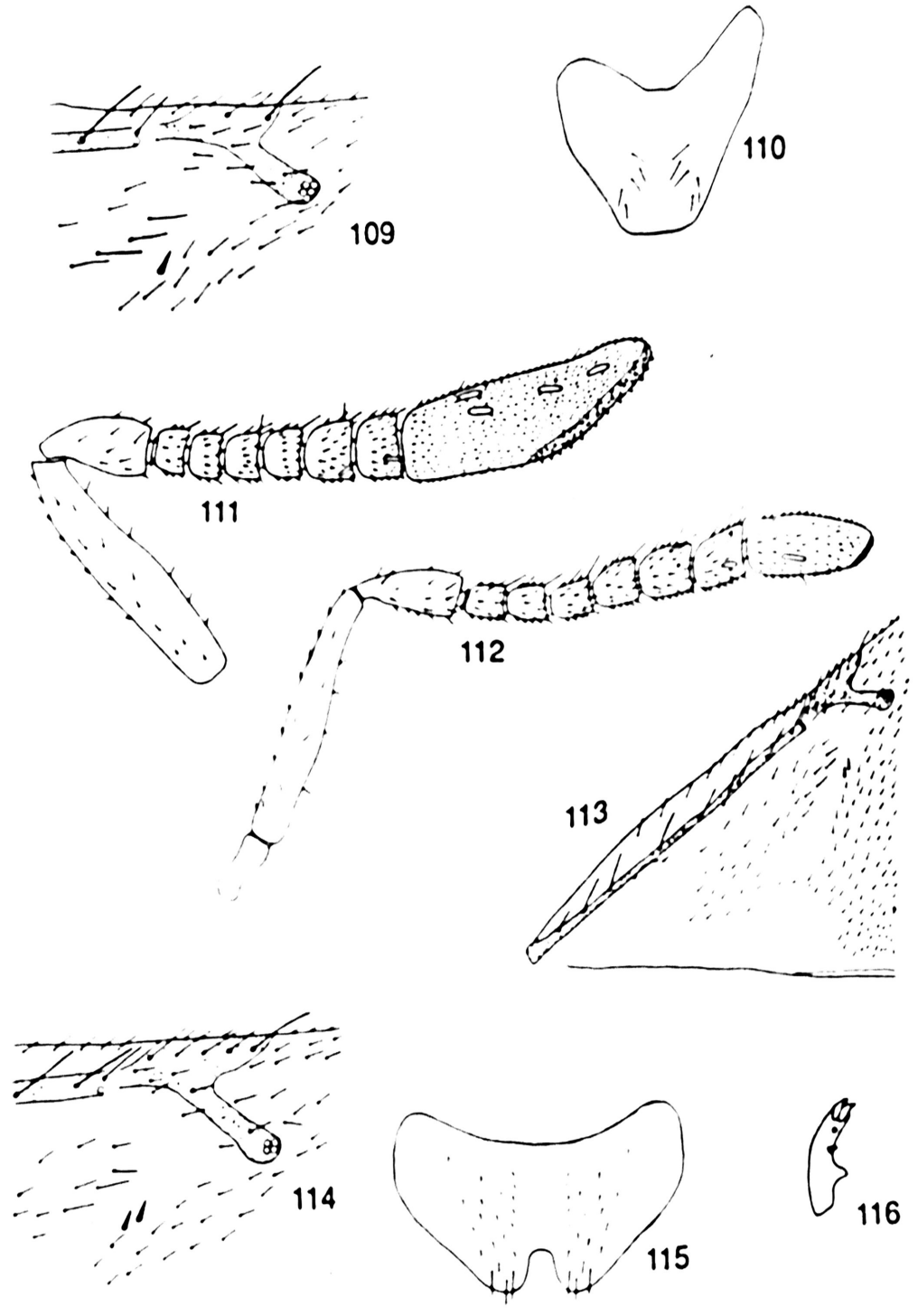
Figs. 84-92. 84-86, *Copidosoma cervius*: 84, forewing venation; 85, phallobase and digiti; 86, aedeagus. 87-92, *Copidosoma chalconotus*: 87, antenna, female; 88, antenna, male; 89, base of forewing; 90, forewing venation; 91, right mandible, posterior view; 92, hypopygium.



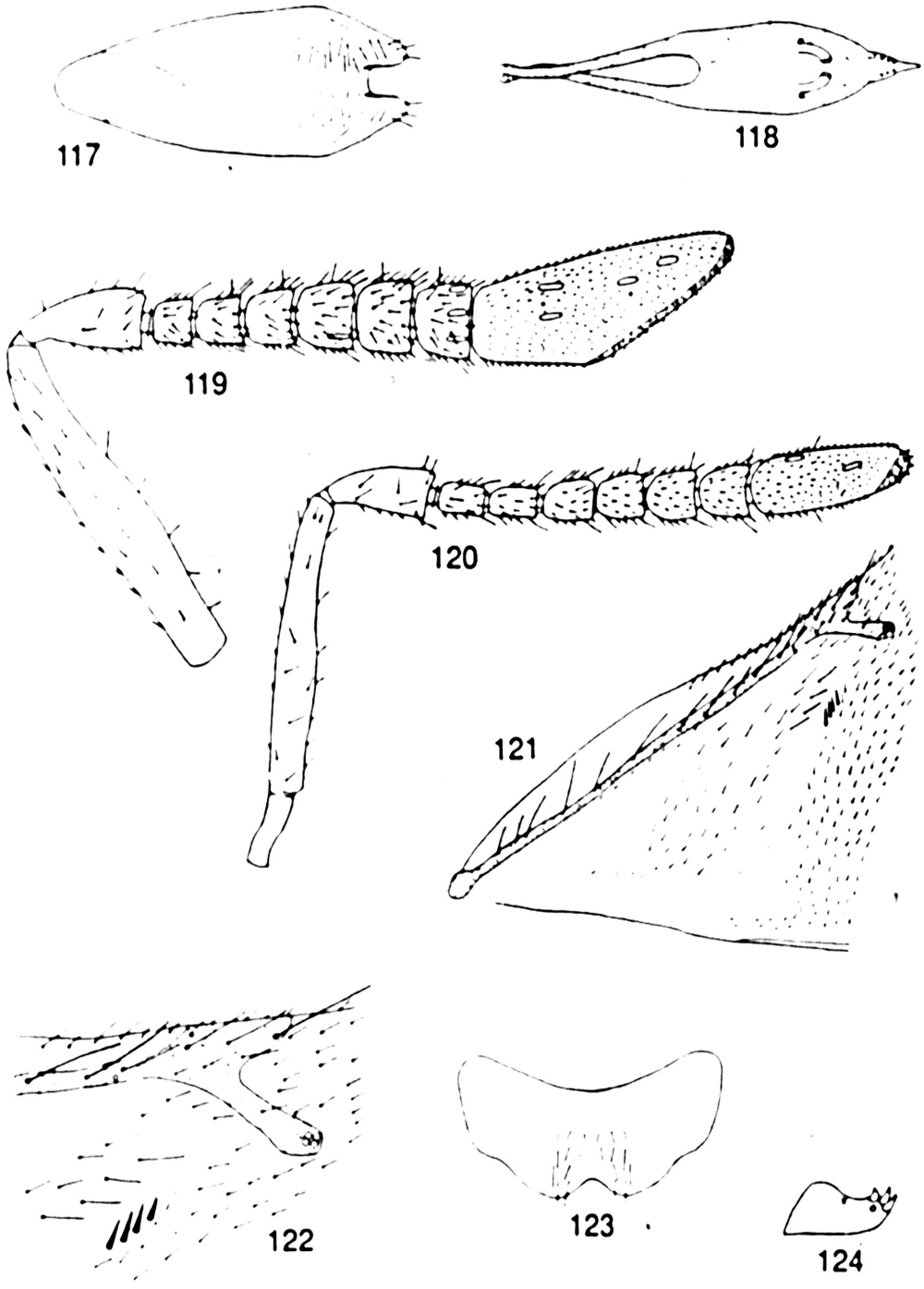
Figs. 93-102. 93-94, *Copidosoma chalconotus*: 93, phallobase and digiti; 94, aedeagus. 95-102, *Copidosoma charisoma*: 95, antenna, female; 96, antenna, male; 97, base of forewing; 98, forewing venation; 99, hypopygium; 100, digitus; 101, phallobase; 102, aedeagus.



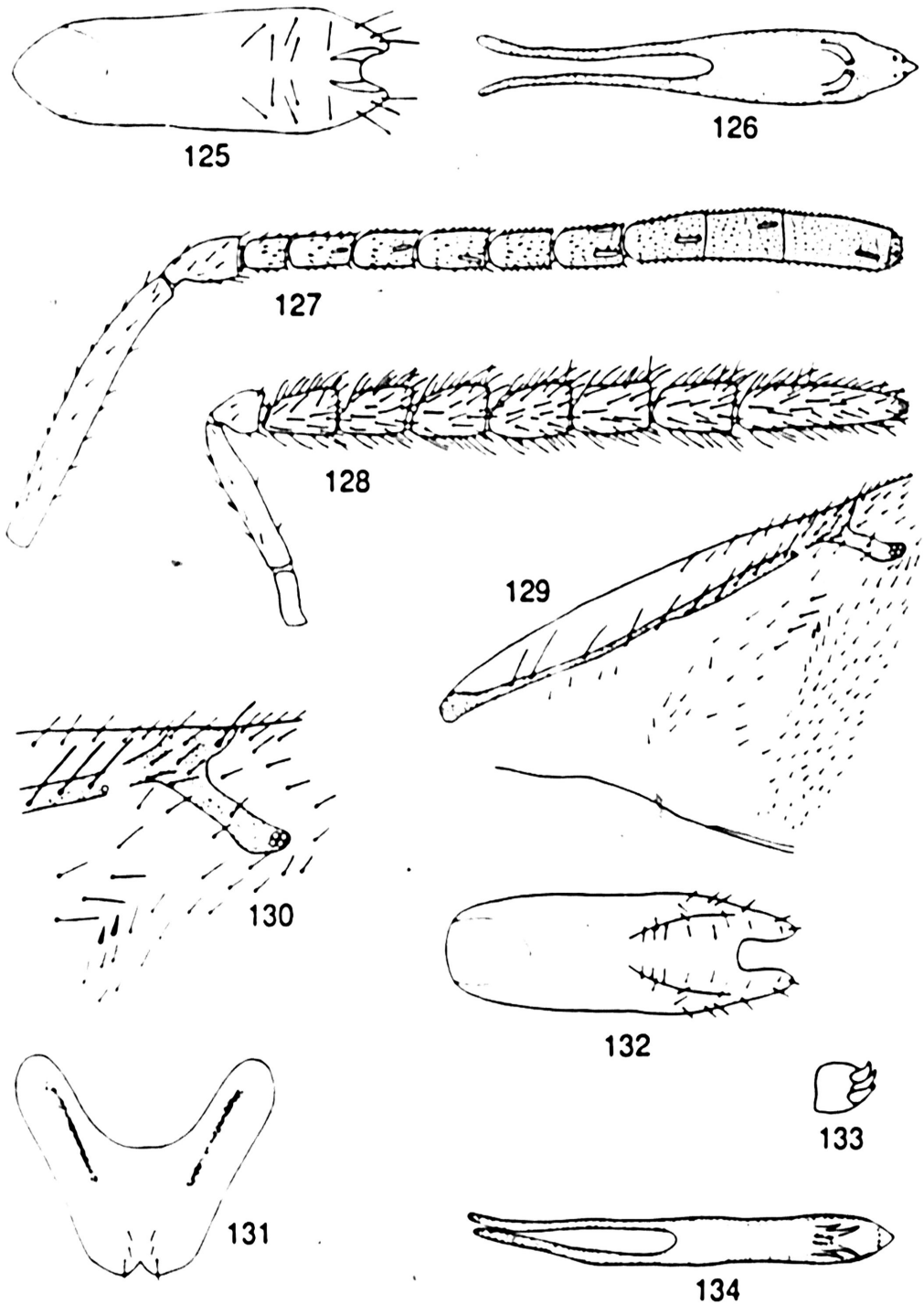
Figs. 103-108. 103-106, *Copidosoma cheranae*, female: 103, antenna; 104, forewing venation; 105, base of forewing; 106, hypopygium. 107-108, *Copidosoma compressa*, female: 107, antenna; 108, base of forewing.



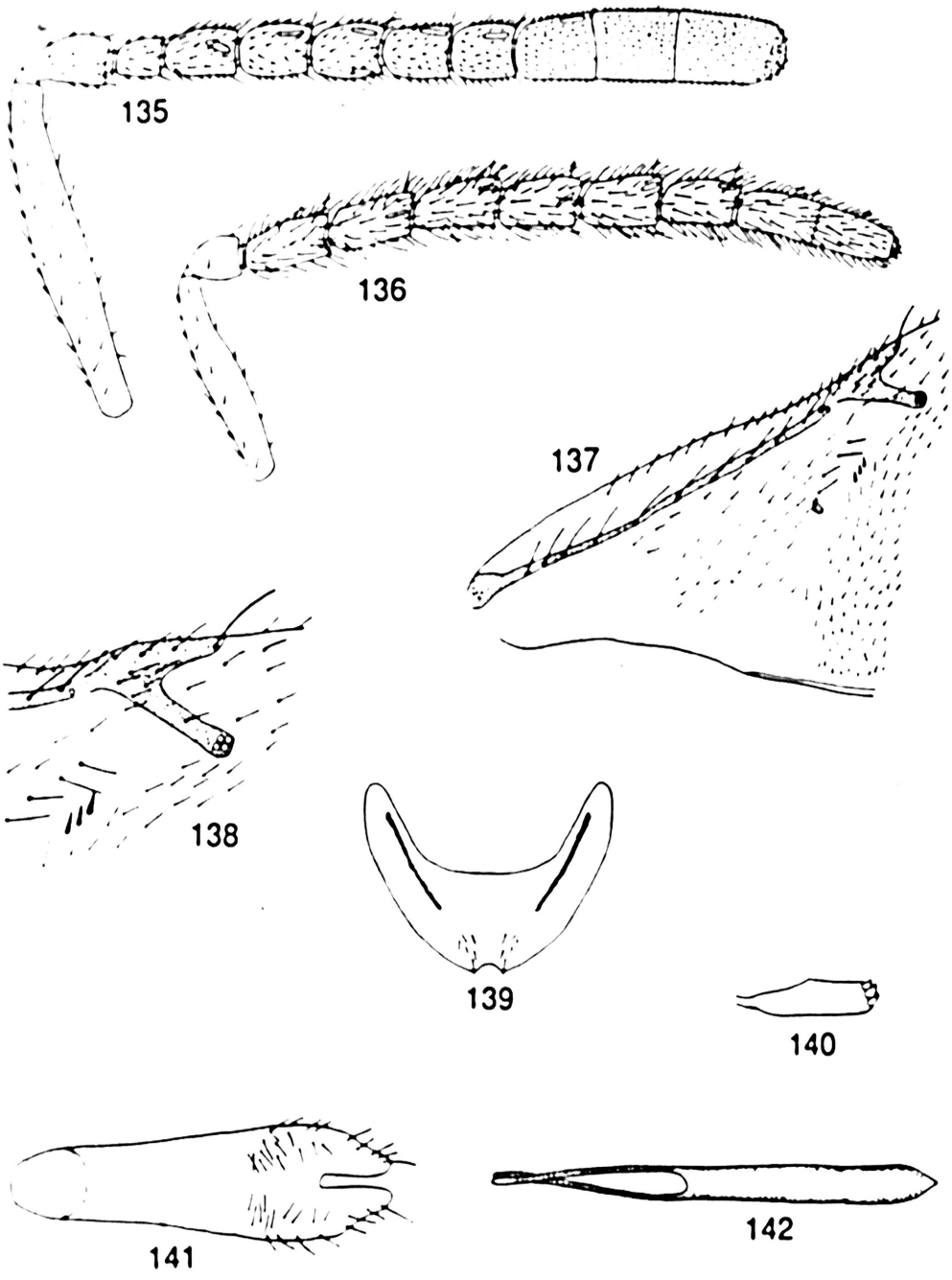
Figs. 109-116. 109-110, *Copidosoma compressa*, female: 109, forewing venation; 110, hypopygium. 111-116, *Copidosoma confusa*: 111, antenna, female; 112, antenna, male; 113, base of forewing; 114, forewing venation; 115, hypopygium; 116, digitus.



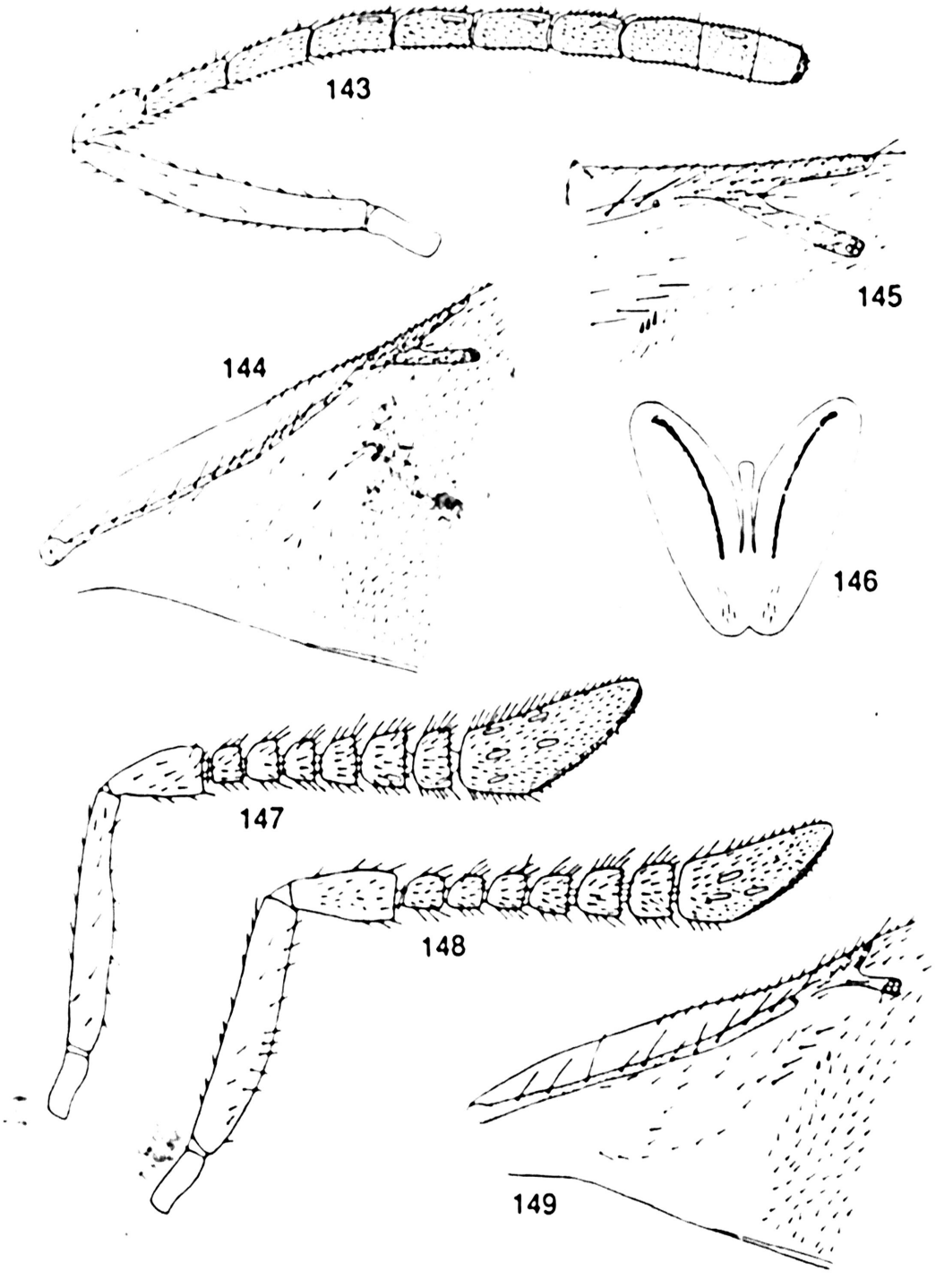
Figs. 117-124. 117-118, *Copidosoma confusa*: 117, phallobase; 118, aedeagus. 119-124, *Copidosoma cuproviridis*: 119, antenna, female; 120, antenna, male; 121, base of forewing; 122, forewing venation; 123, hypopygium; 124, digitus.



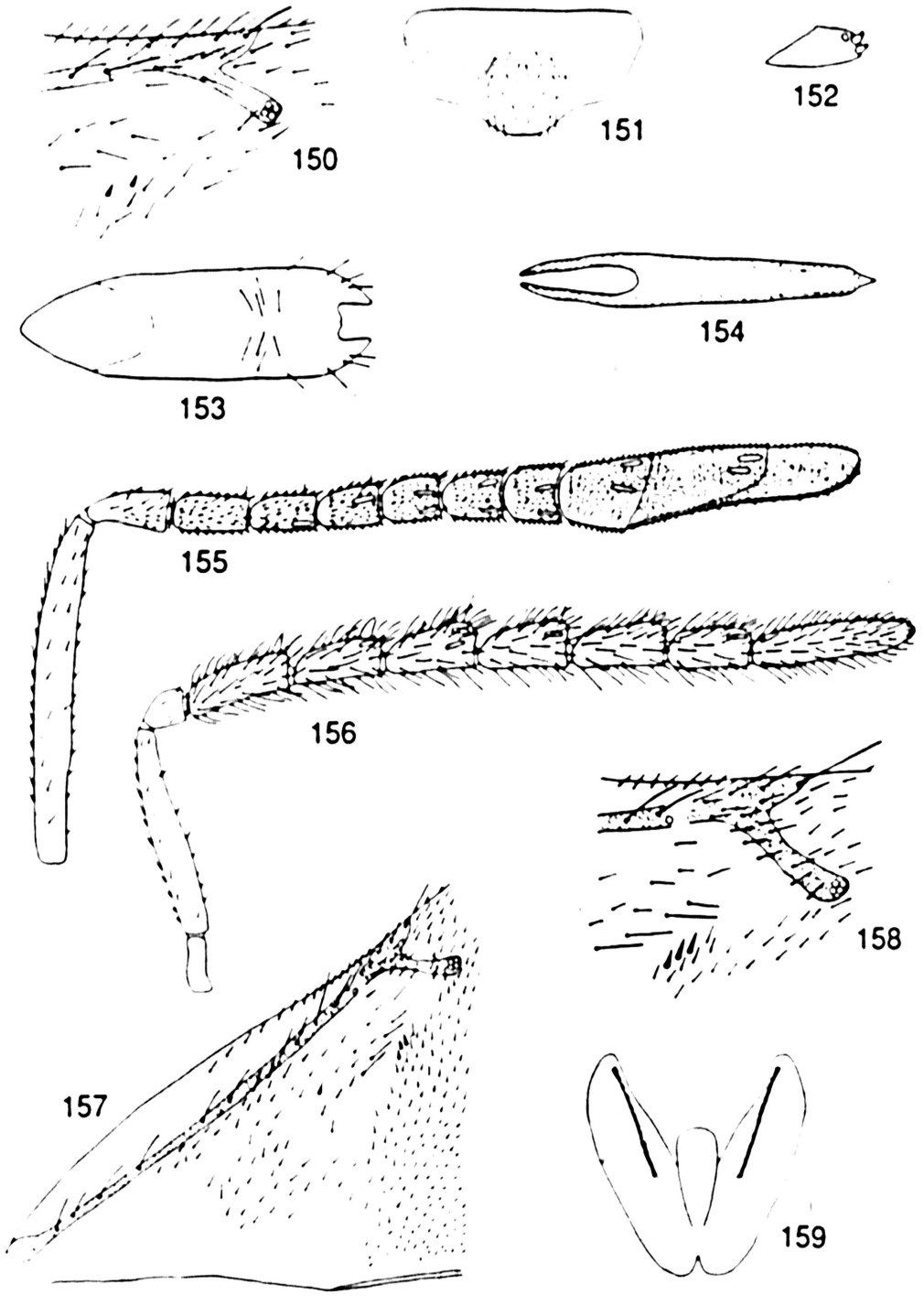
Figs. 125-134. 125-126, *Copidosoma cuproviridis*: 125, phallobase; 126, aedeagus. 127-134, *Copidosoma deceptor*: 127, antenna, female; 128, antenna, male; 129, base of forewing; 130, forewing venation; 131, hypopygium; 132, digitus, 133, phallobase; 134, aedeagus.



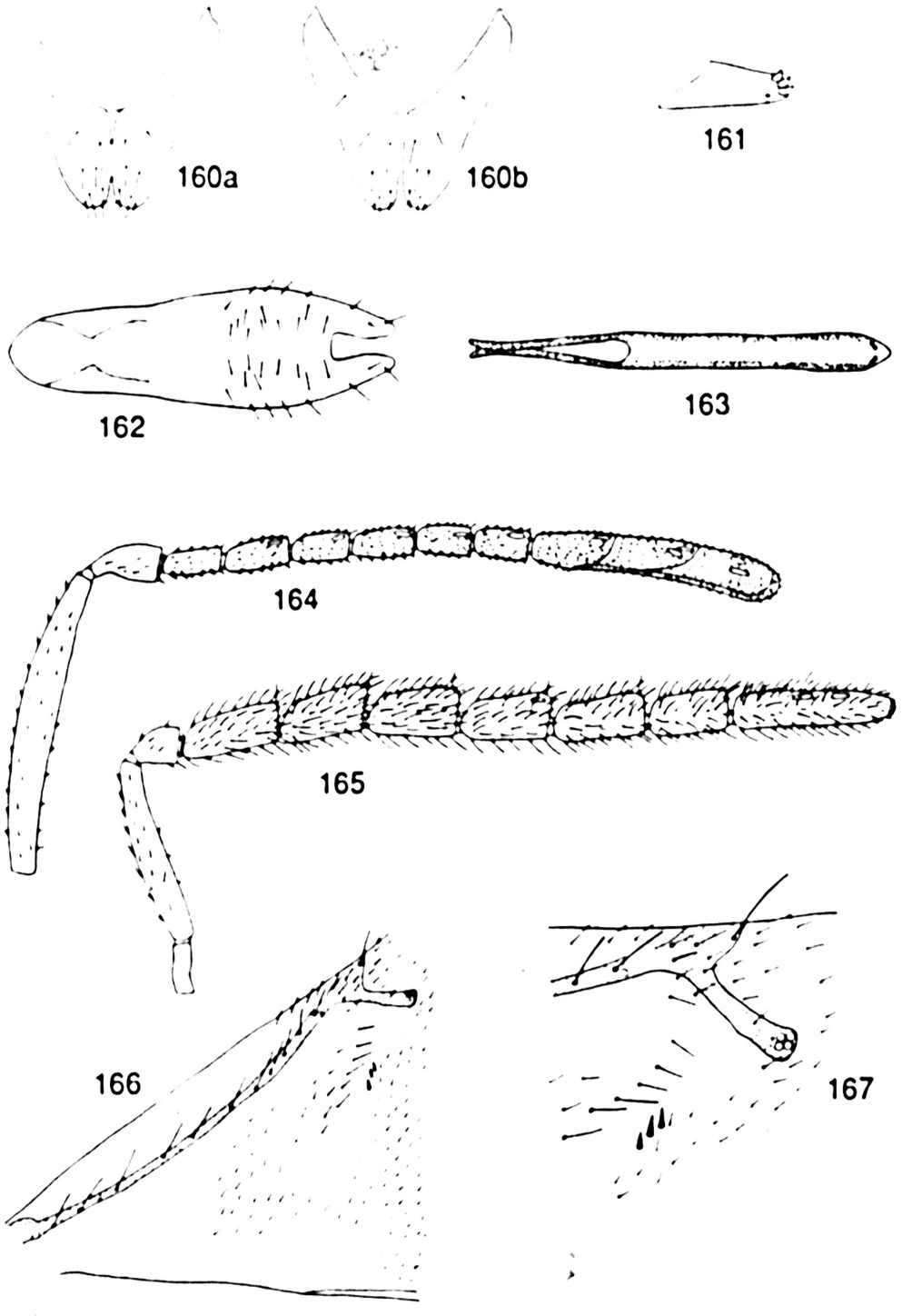
Figs. 135-142. 135-142, *Copidosoma desantisi*: 135, antenna, female; 136, antenna, male; 137, base of forewing; 138, forewing venation; 139, hypopygium; 140, digitus; 141, phallobase; 142, aedeagus.



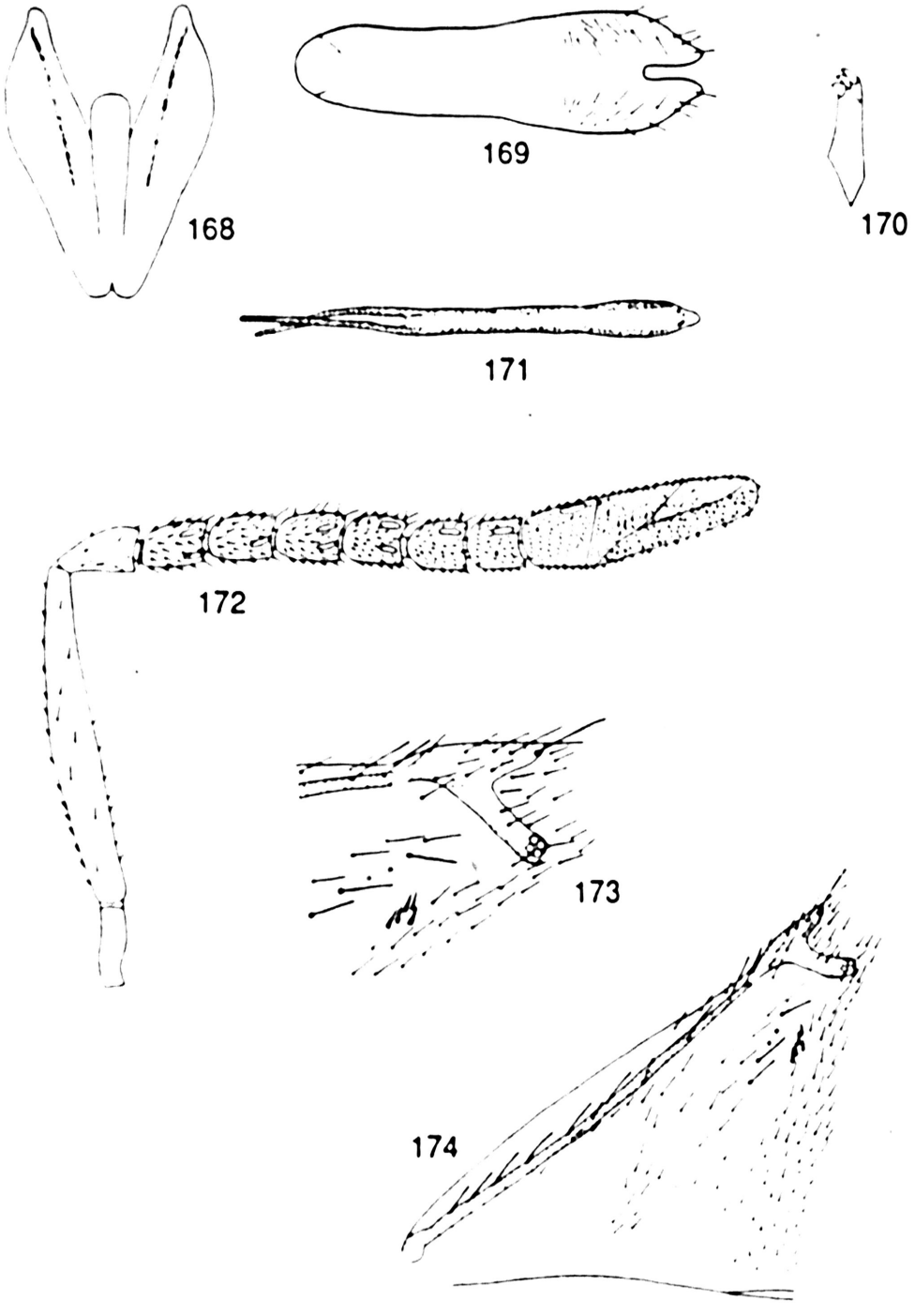
Figs. 143-149. 143-146, *Copidosoma evansi*, female: 143, antenna; 144, base of forewing; 145, forewing venation; 146, hypopygium. 147-149, *Copidosoma floridanum*: 147, antenna, female; 148, antenna, male; 149, base of forewing.



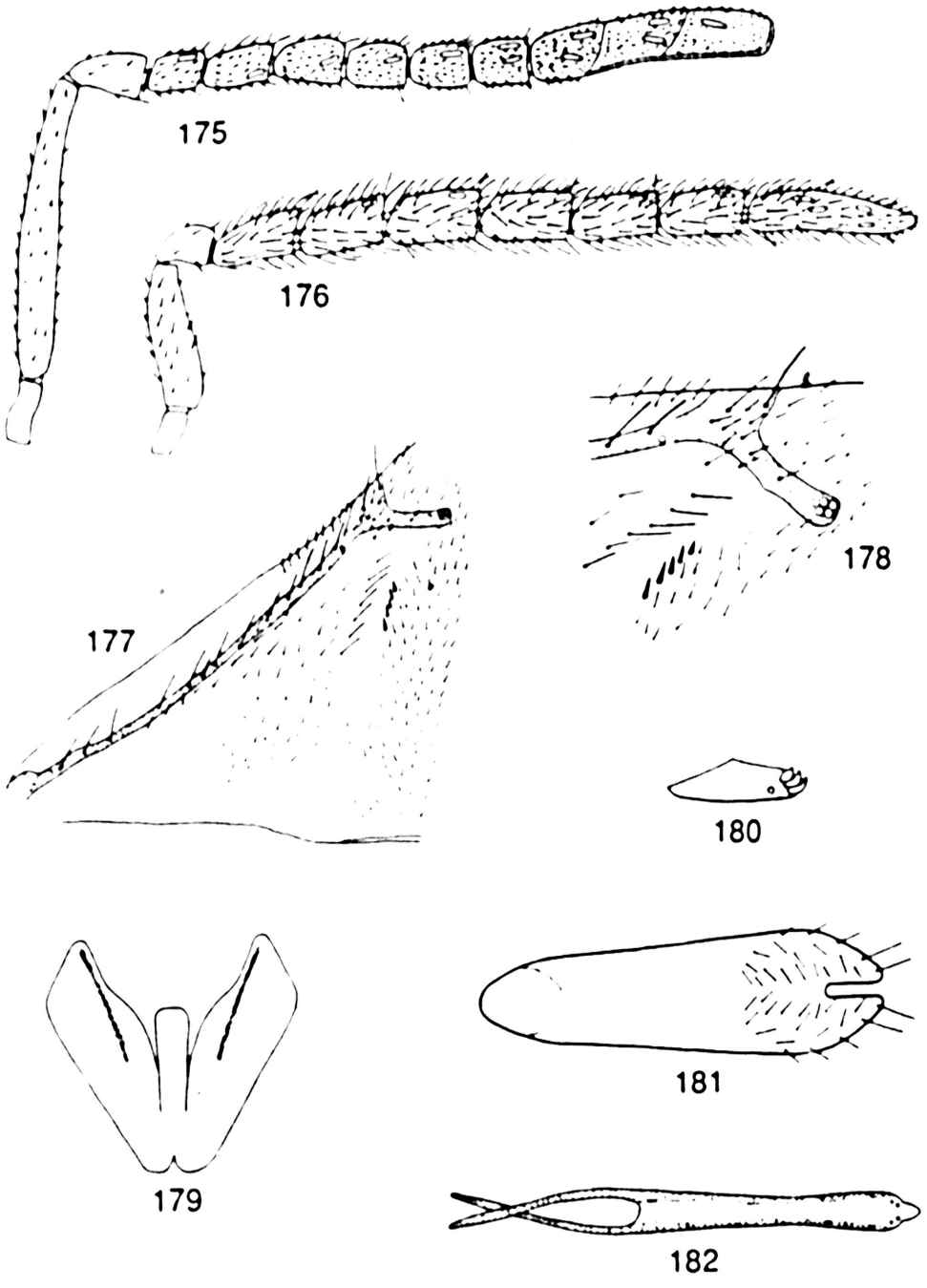
Figs. 150-159. 150-154, *Copidosoma floridanum*: 150, forewing venation; 151, hypopygium; 152, digitus; 153, phallobase; 154, aedeagus. 155-159, *Copidosoma gelechiae*: 155, antenna, female; 156, antenna, male; 157, base of forewing; 158, forewing venation; 159, hypopygium.



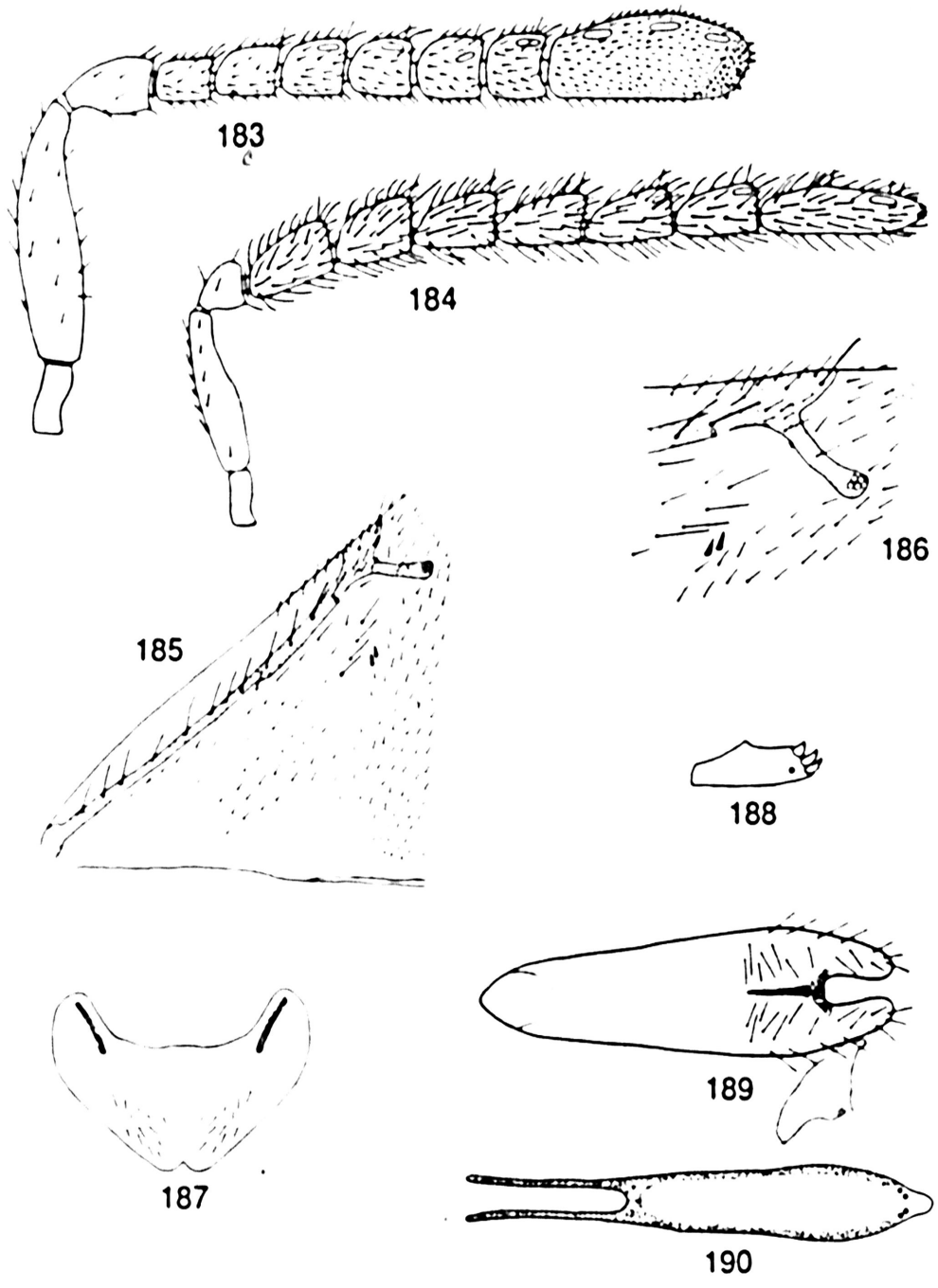
Figs. 160-167. 160-163, *Copidosoma gelechiae*: 160a, b, syntergum; 161, digitus; 162, phallobase; 163, aedeagus. 164-167, *Copidosoma geniculatum*: 164, antenna, female; 165, antenna, male; 166, base of forewing; 167, forewing venation.



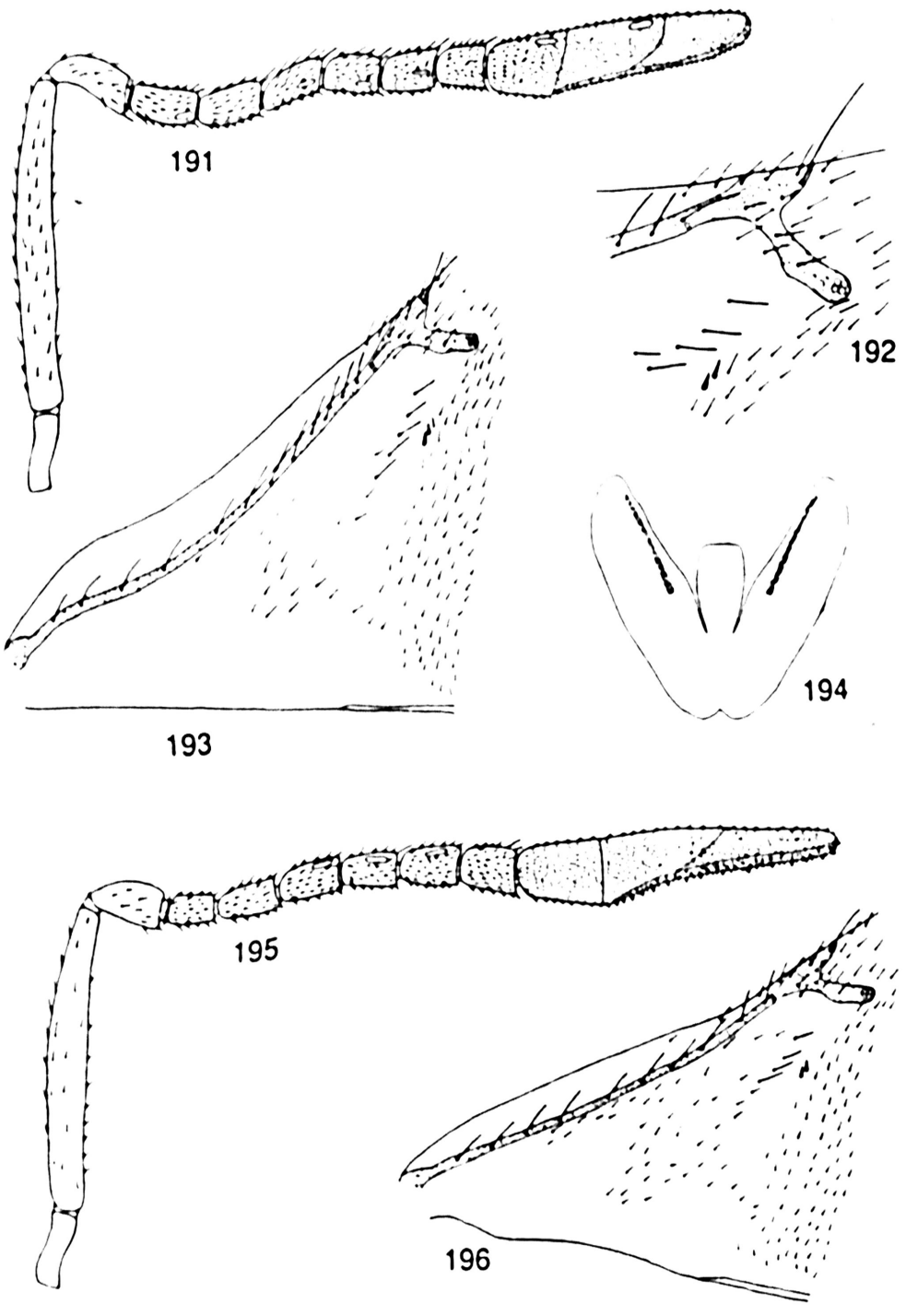
Figs. 168-174. 168-171, *Copidosoma geniculatum*: 168, hypopygium; 169, phallobase; 170, digitus; 171, aedeagus. 172-174, *Copidosoma gibsoni*, female: 172, antenna; 173, forewing venation; 174, base of forewing.



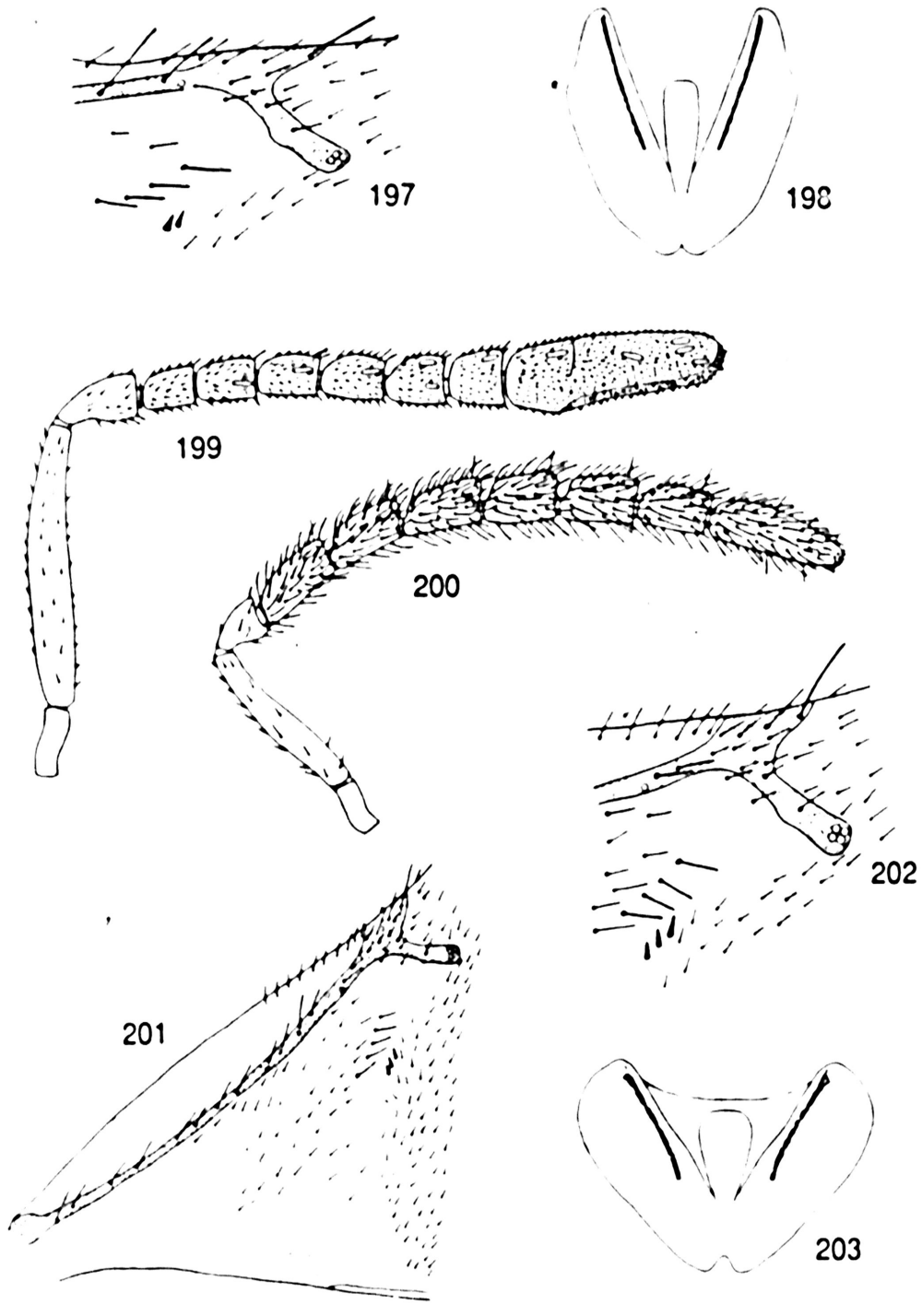
Figs. 175-182. *Copidosoma glandiferellae*: 175, antenna, female; 176, antenna, male; 177, base of forewing; 178, forewing venation; 179, hypopygium; 180, digitus; 181, phallobase; 182, aedeagus.



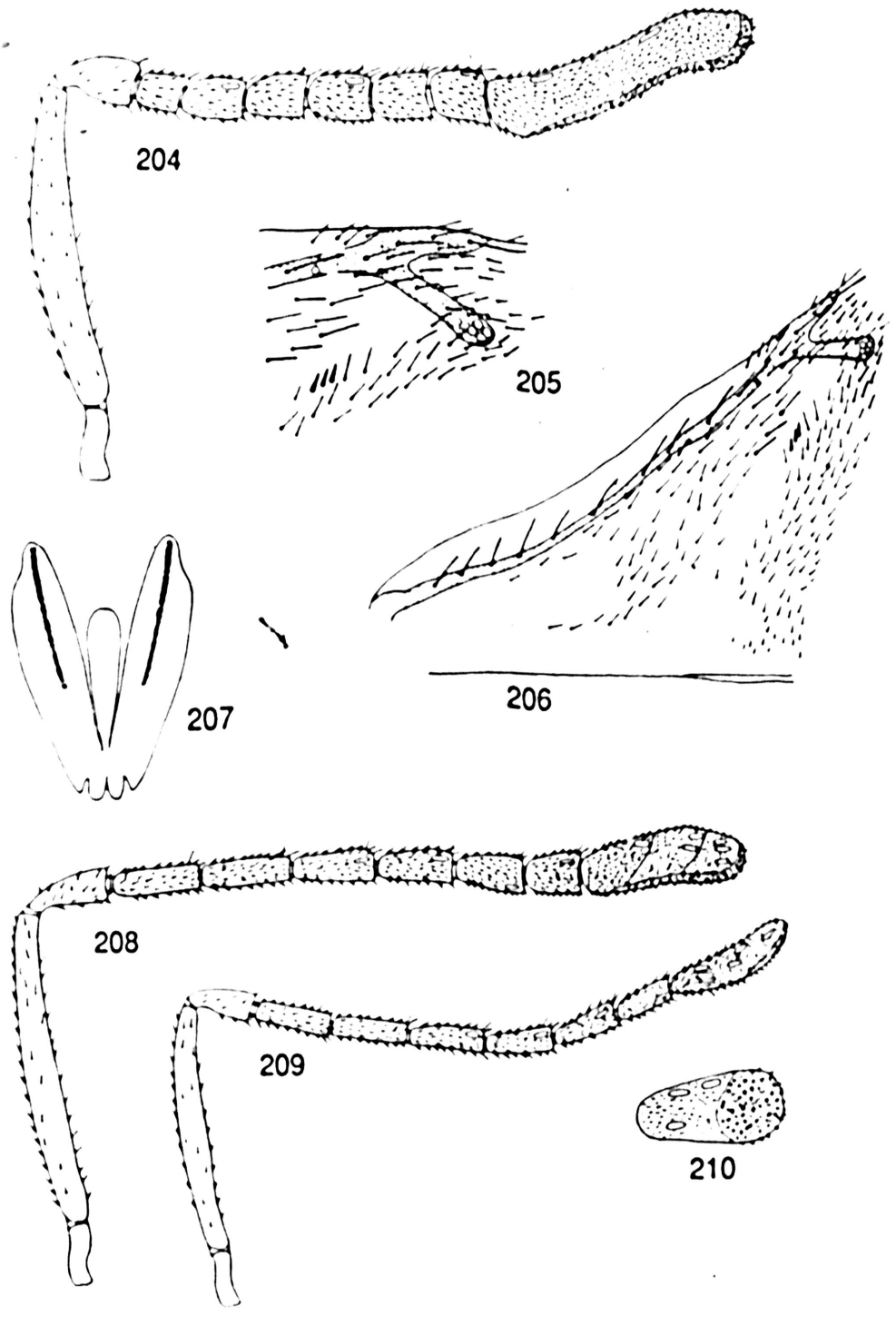
Figs. 183-190. *Copidosoma globata*: 183, antenna, female; 184, antenna, male; 185, base of forewing; 186, forewing venation; 187, hypopygium; 188, digitus; 189, phallobase; 190, aedeagus.



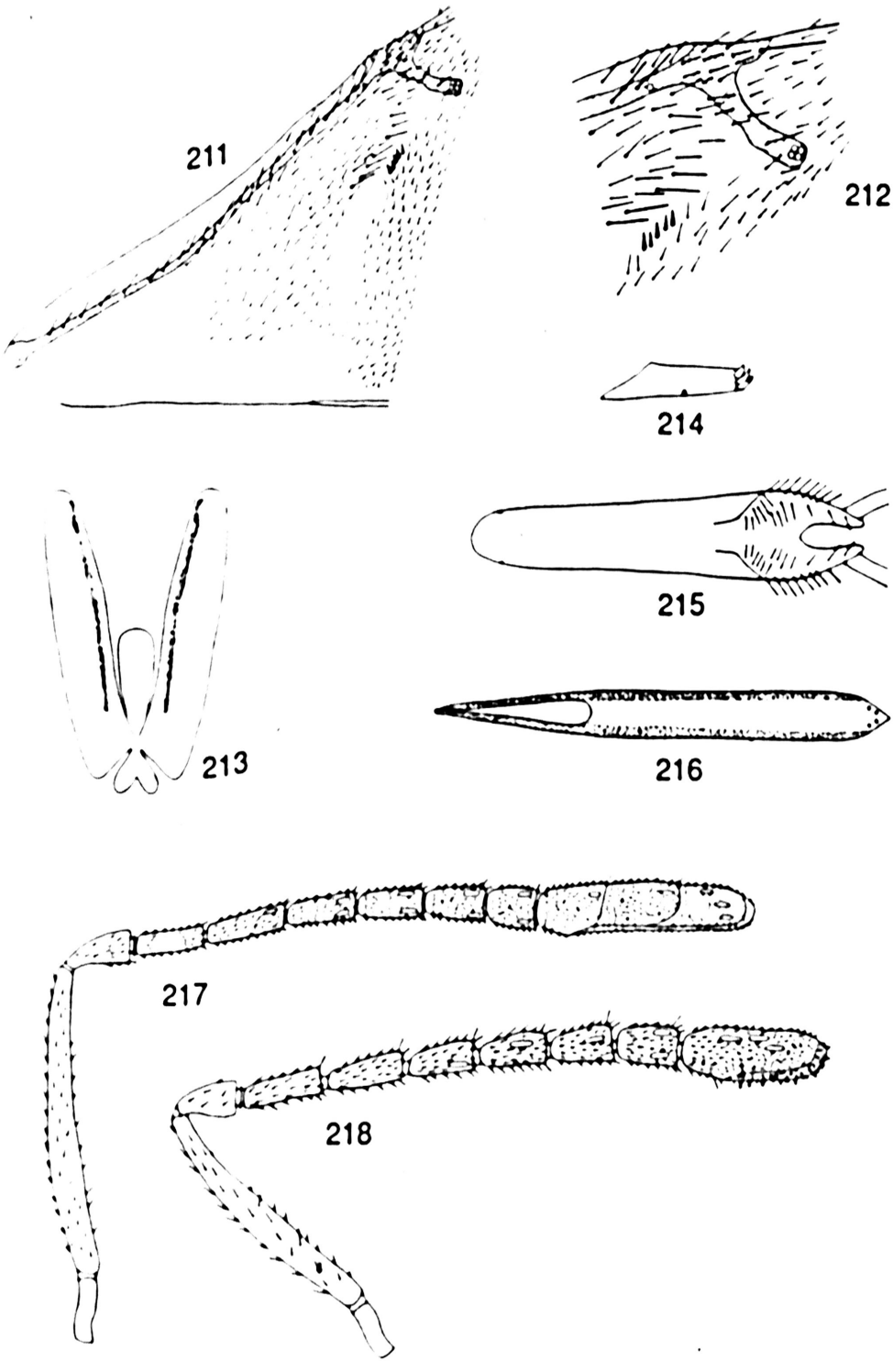
Figs. 191-196. 191-194, *Copidosoma gnorimoschemae*, female: 191, antenna; 192, forewing venation; 193, base of forewing; 194, hypopygium. 195-196, *Copidosoma gordhi*, female: 195, antenna; 196, base of forewing.



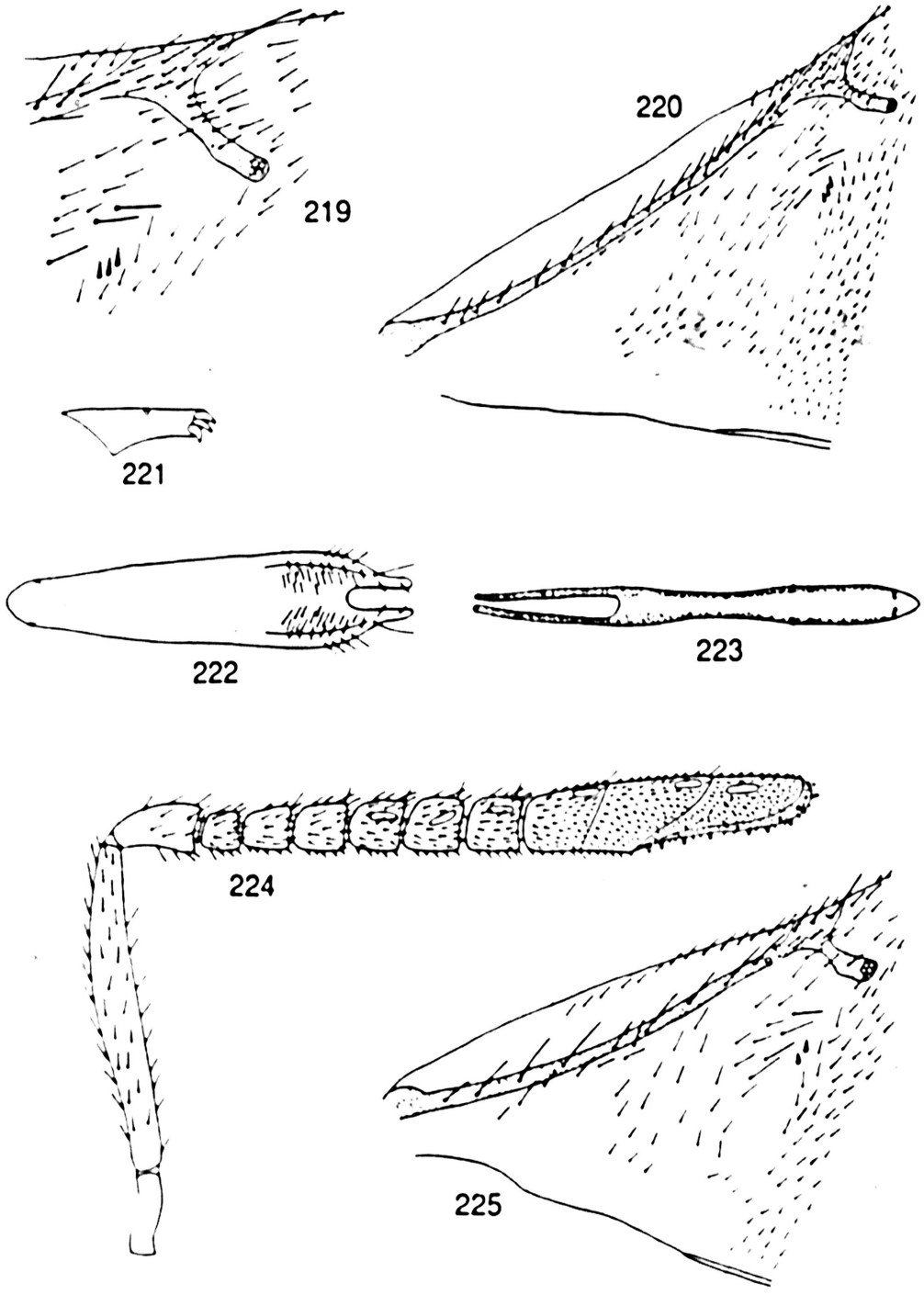
Figs. 197-203. 197-198, *Copidosoma gordhi*, female: 197, forewing venation; 198, hypopygium. 199-203, *Copidosoma grahami*: 199, antenna, female; 200, antenna, male; 201, base of forewing; 202, forewing venation; 203, hypopygium.



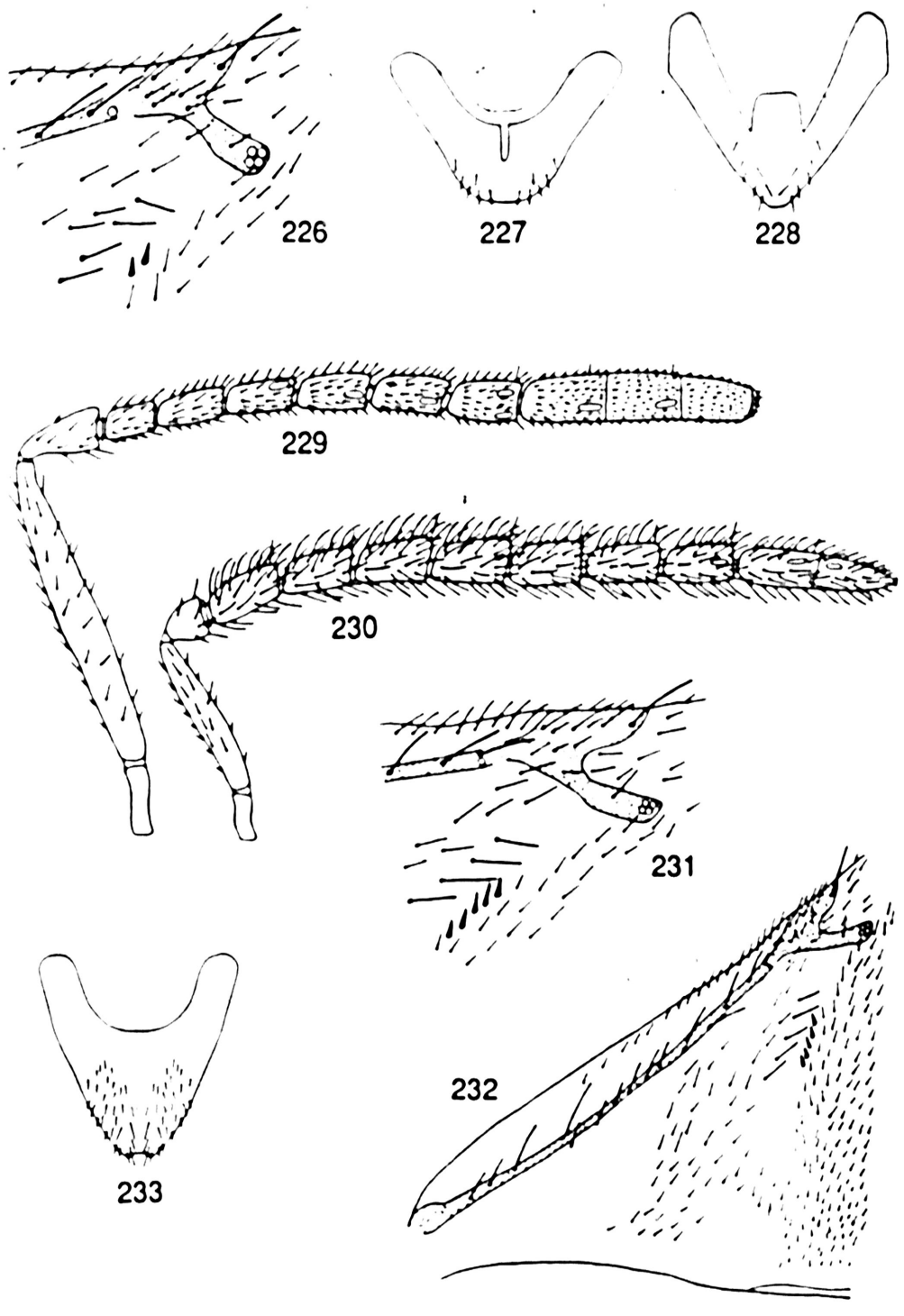
Figs. 204-210. 204-207, *Copidosoma horneri*, female: 204, antenna; 205, forewing venation; 206, base of forewing; 207, hypopygium. 208-210, *Copidosoma howardi*: 208, antenna, female; 209, antenna, male; 210, club, male, ventral view.



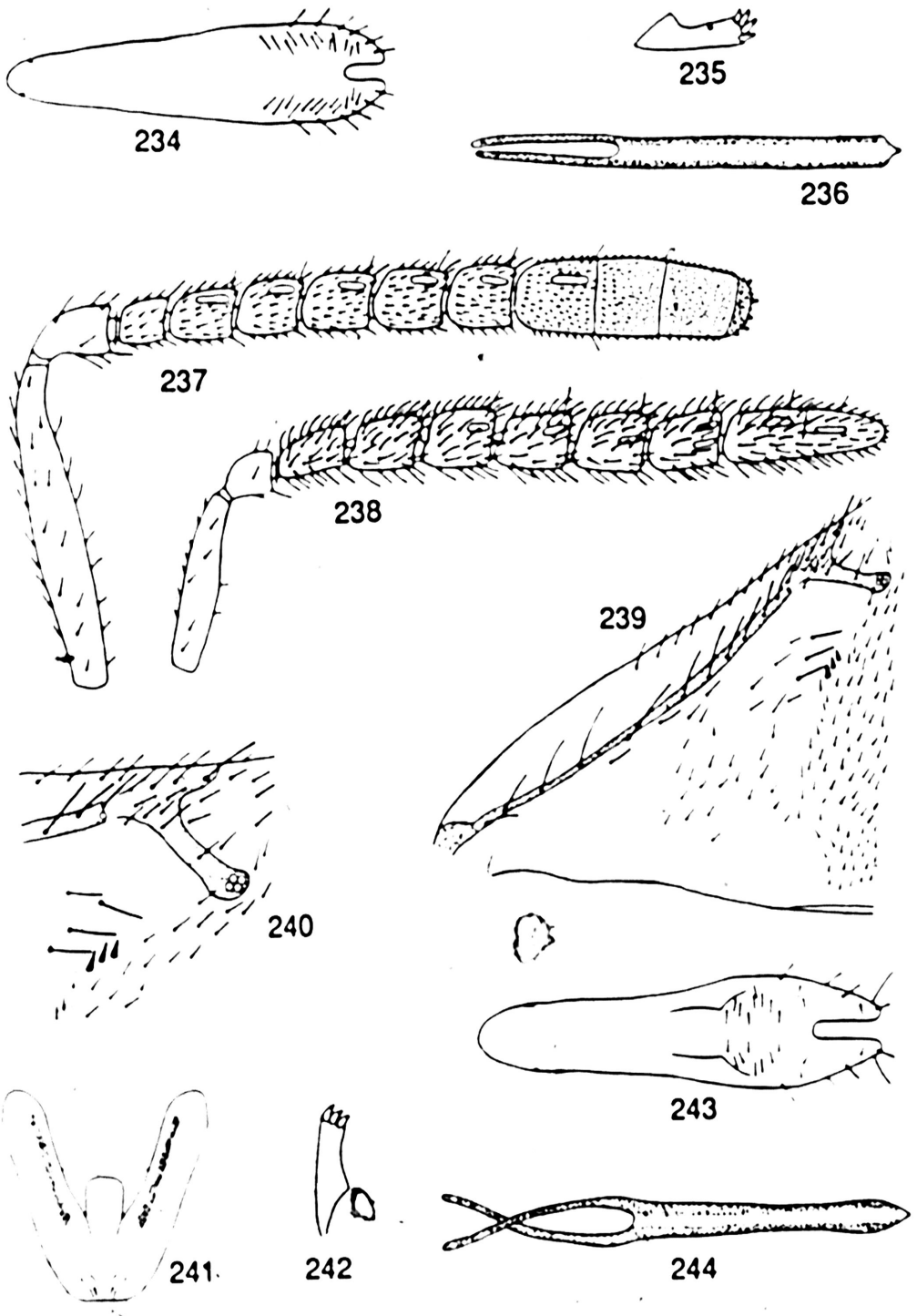
Figs. 211-218. 211-216, *Copidosoma howardi*: 211, base of forewing; 212, forewing venation; 213, hypopygium; 214, digitus; 215, phallobase; 216, aedeagus. 217-218, *Copidosoma hypenapurpura*: 217, antenna, female; 218, antenna, male.



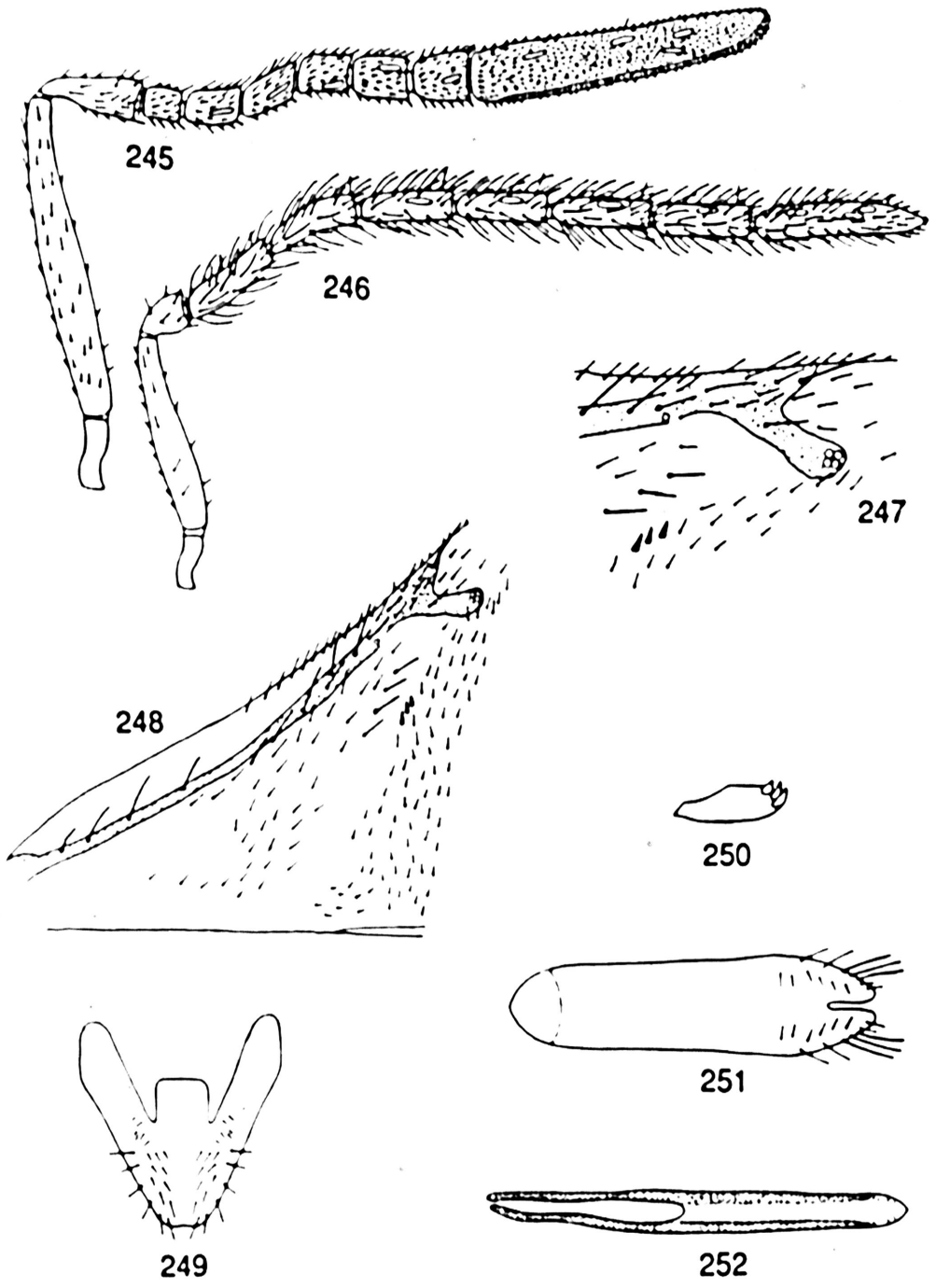
Figs. 219-225. 219-223, *Copidosoma hypenapurpura*: 219, forewing venation; 220, base of forewing; 221, digitus; 222, phallobase; 223, aedeagus. 224-225, *Copidosoma incisum*, female: 224, antenna; 225, base of forewing.



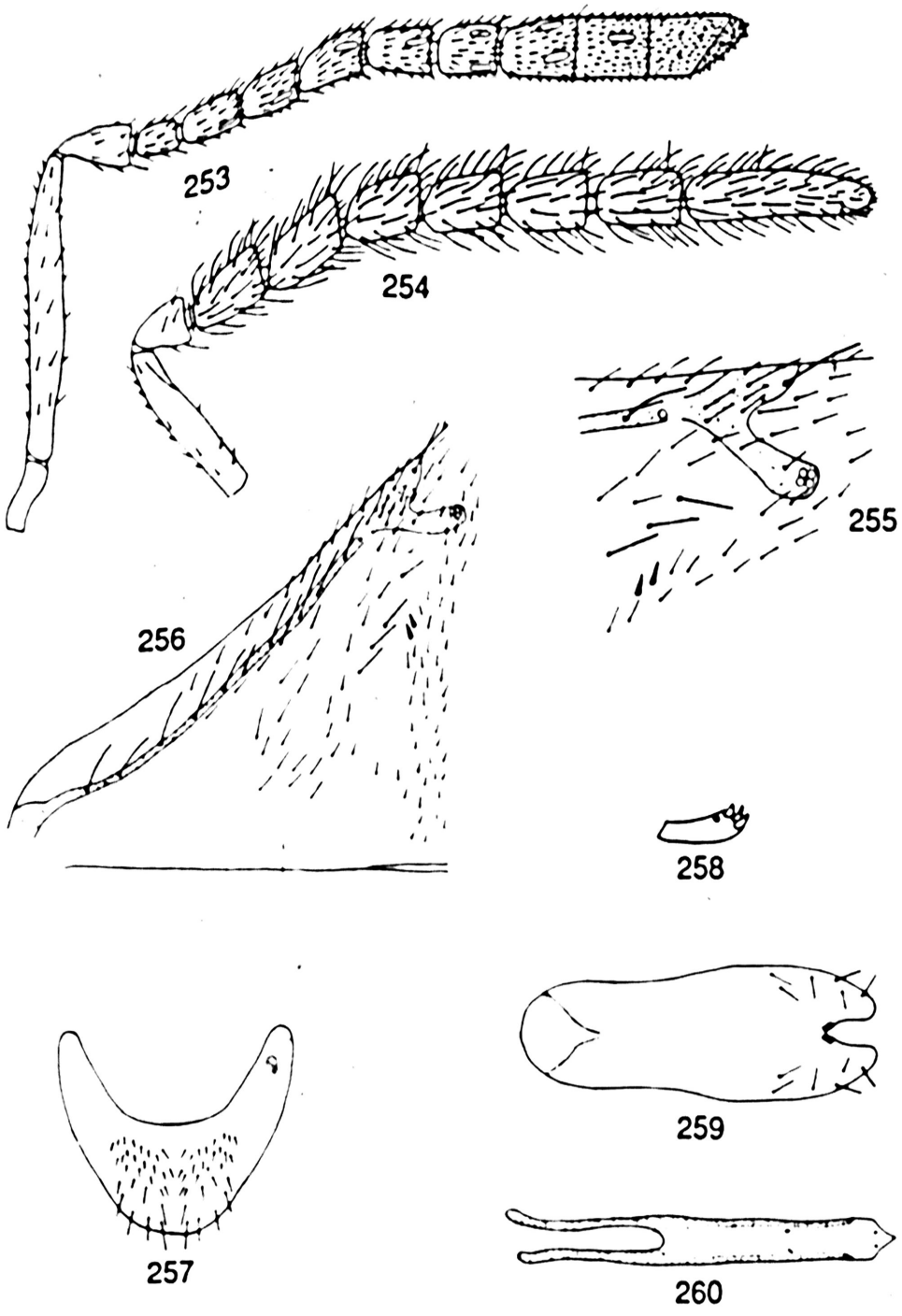
Figs. 226-233. 226-228, *Copidosoma incisum*: 226, forewing venation; 227, sixth sternite; 228, hypopygium. 229-233, *Copidosoma innocuellae*: 229, antenna, female; 230, antenna, male; 231, forewing venation; 232, base of forewing; 233, hypopygium.



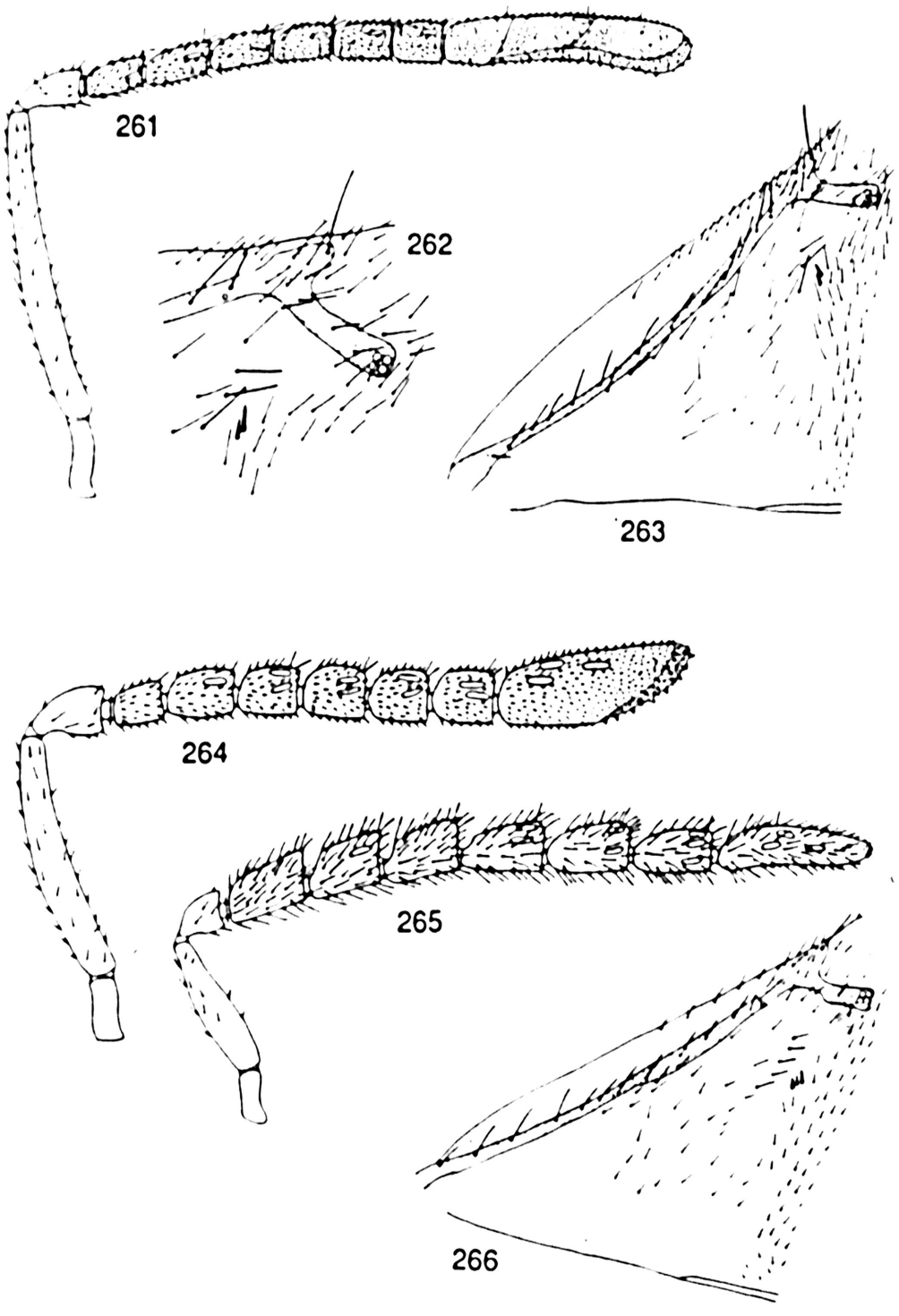
Figs. 234-244. 234-236, *Copidosoma innocuellae*: 234, phallobase; 235, digitus; 236, aedeagus. 237-244, *Copidosoma koehleri*: 237, antenna, female; 238, antenna, male; 239, base of forewing; 240, forewing venation; 241, hypopygium; 242, digitus; 243, phallobase; 244, aedeagus.



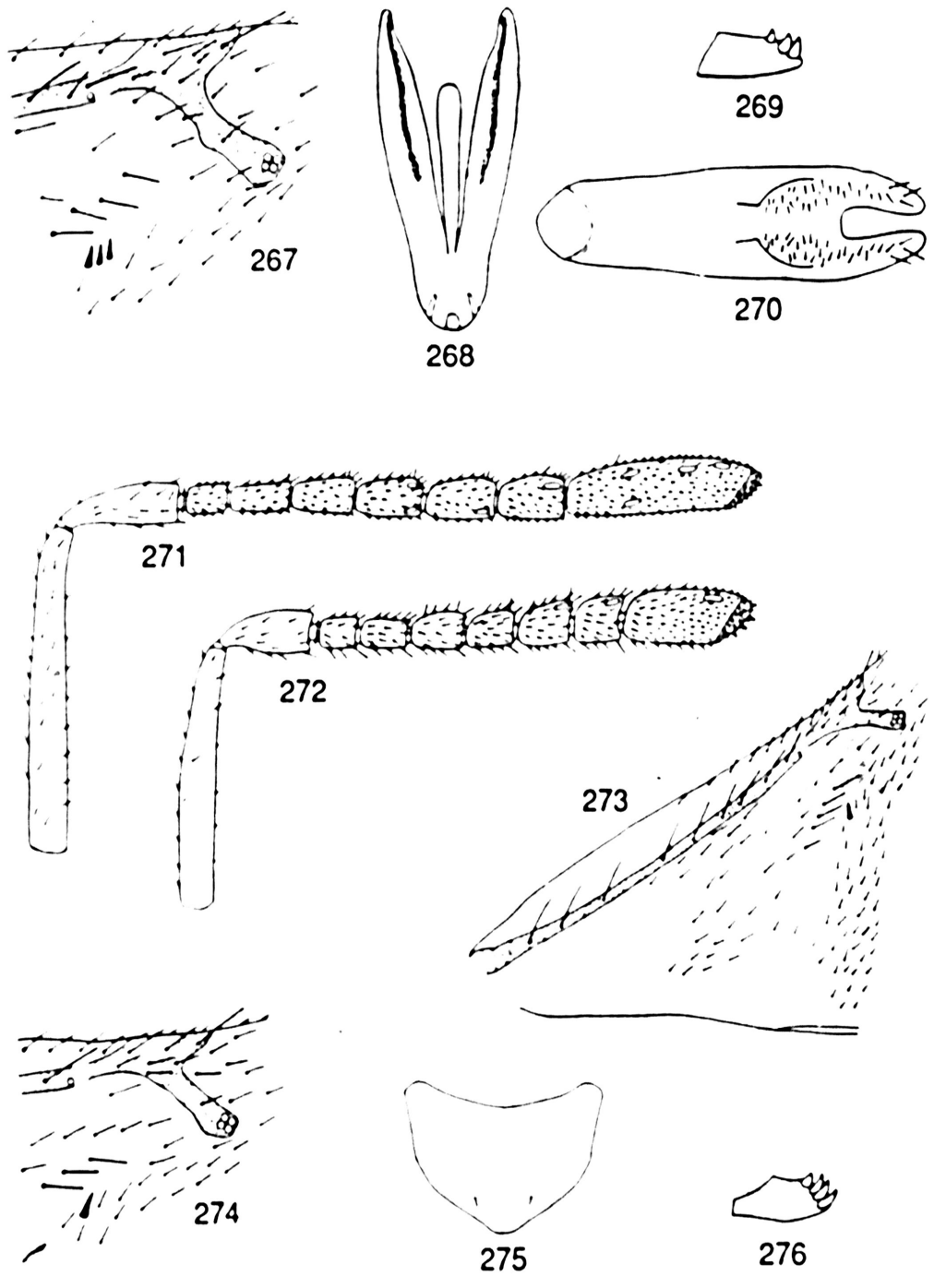
Figs. 245-252. *Copidosoma longiclava*: 245, antenna, female; 246, antenna, male; 247, forewing venation; 248, base of forewing; 249, hypopygium; 250, digitus; 251, phallobase; 252, aedeagus.



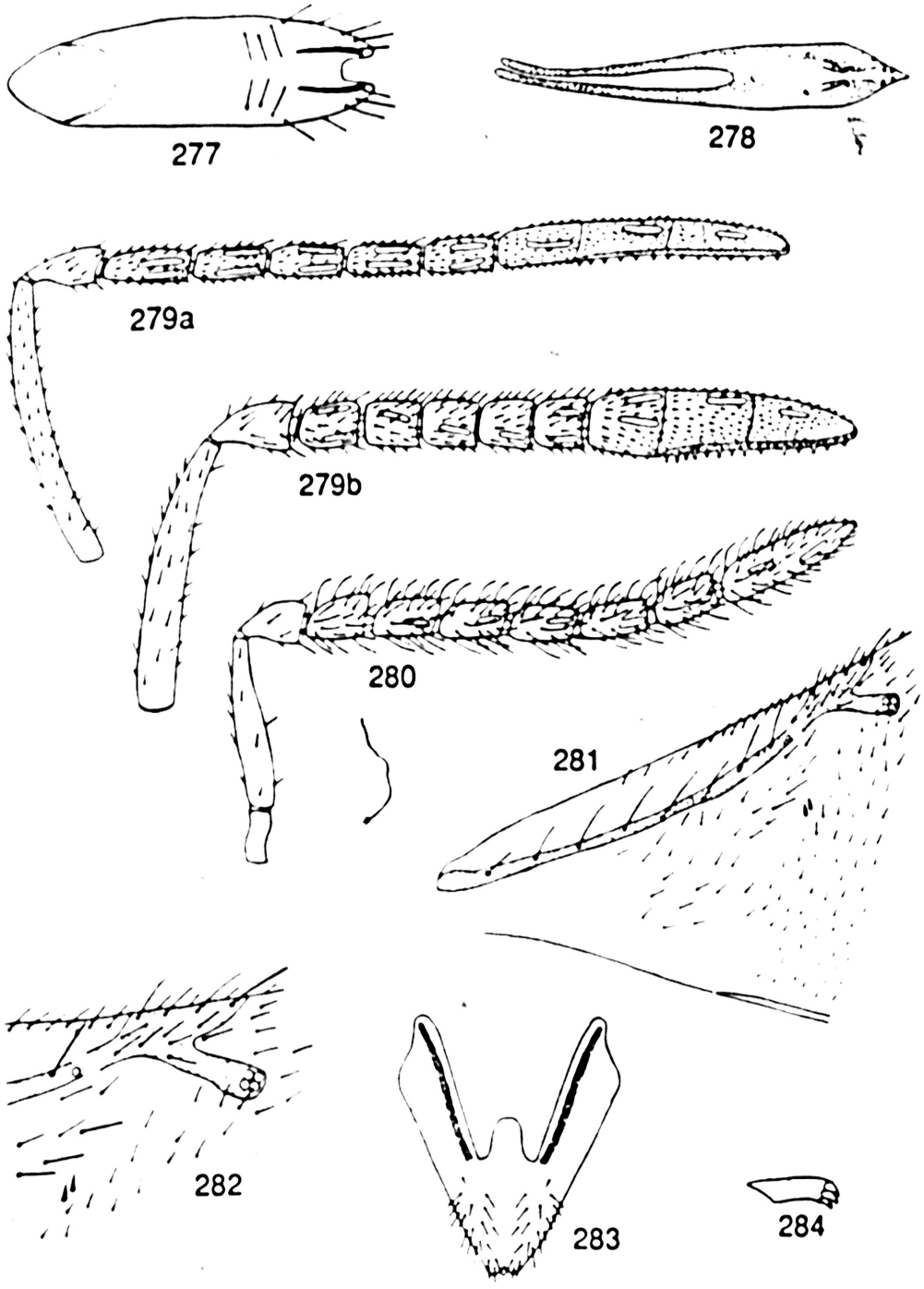
Figs. 253-260. *Copidosoma lymani*: 253, antenna, female; 254, antenna, male; 255, forewing venation; 256, base of forewing; 257, hypopygium; 258, digitus; 259, phallobase; 260, aedeagus.



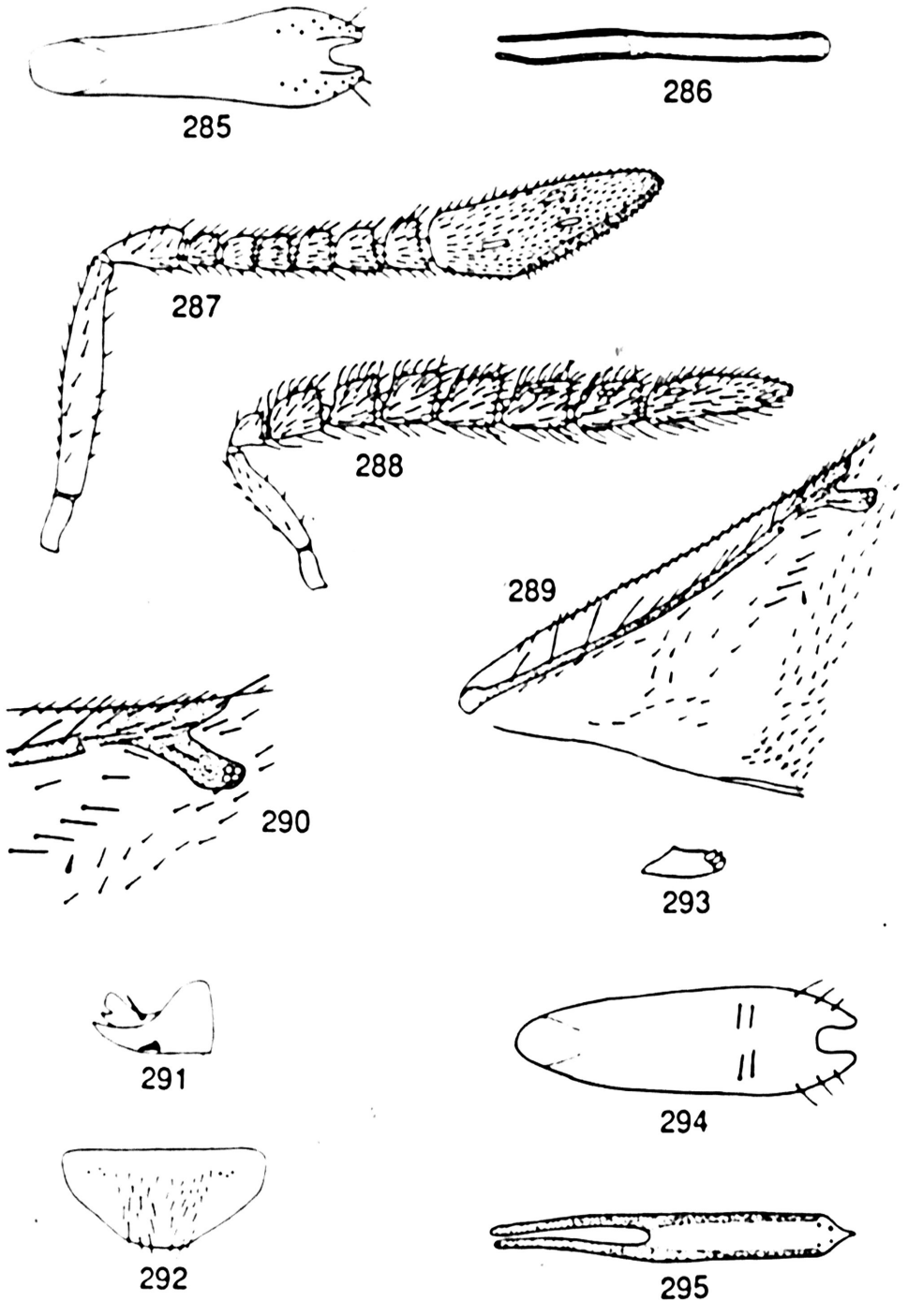
Figs. 261-266. 261-263, *Copidosoma masneri*, female: 261, antenna; 262, forewing venation; 263, base of forewing. 264-266, *Copidosoma masoni*: 264, antenna, female; 265, antenna, male; 266, base of forewing.



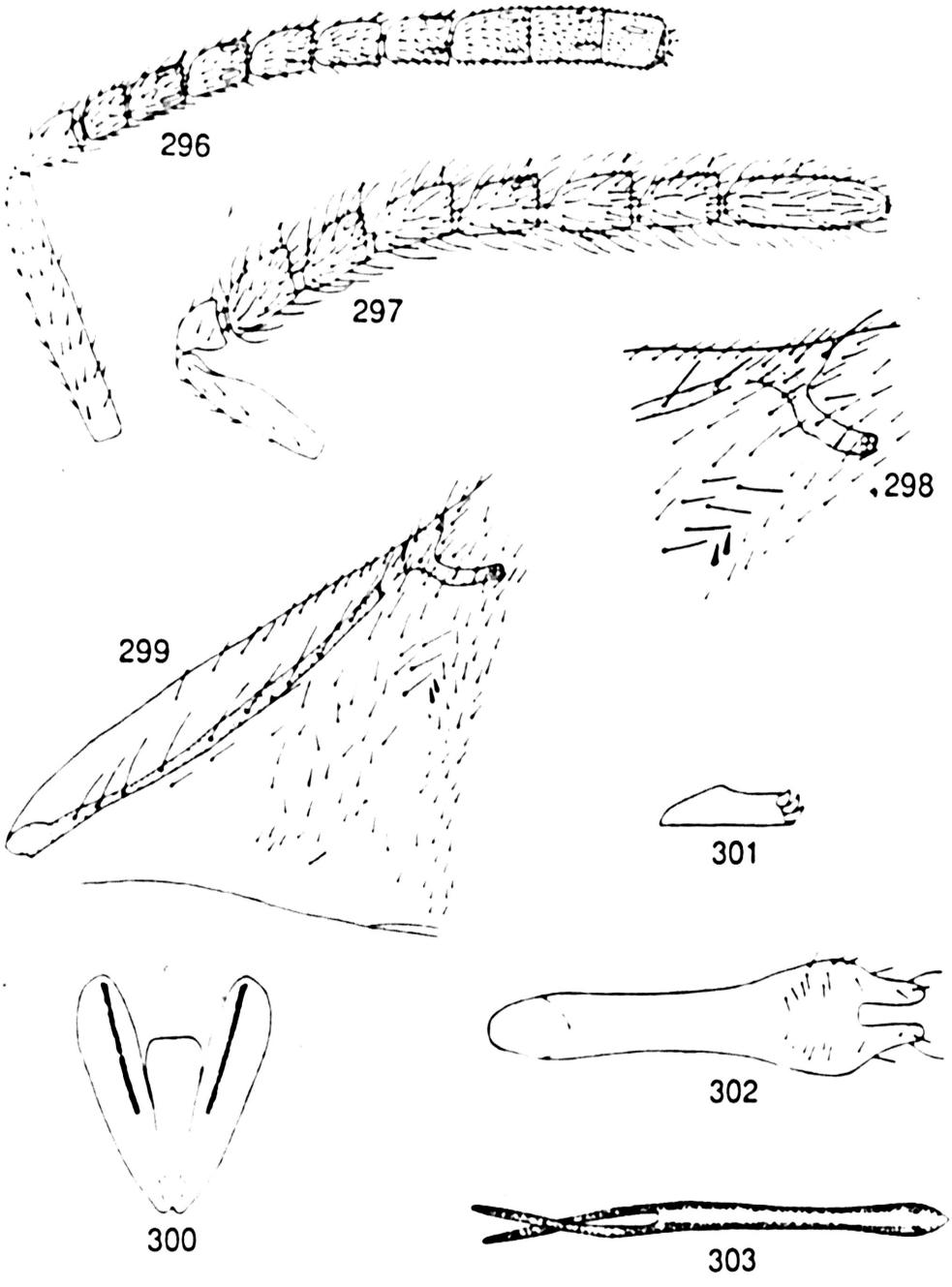
Figs. 267-276. 267-270, *Copidosoma masoni*: 267, forewing venation; 268, hypopygium; 269, digitus; 270, phallobase. 271-276, *Copidosoma melanocerum*: 271, antenna, female; 272, antenna, male; 273, base of forewing; 274, forewing venation; 275, hypopygium; 276, digitus.



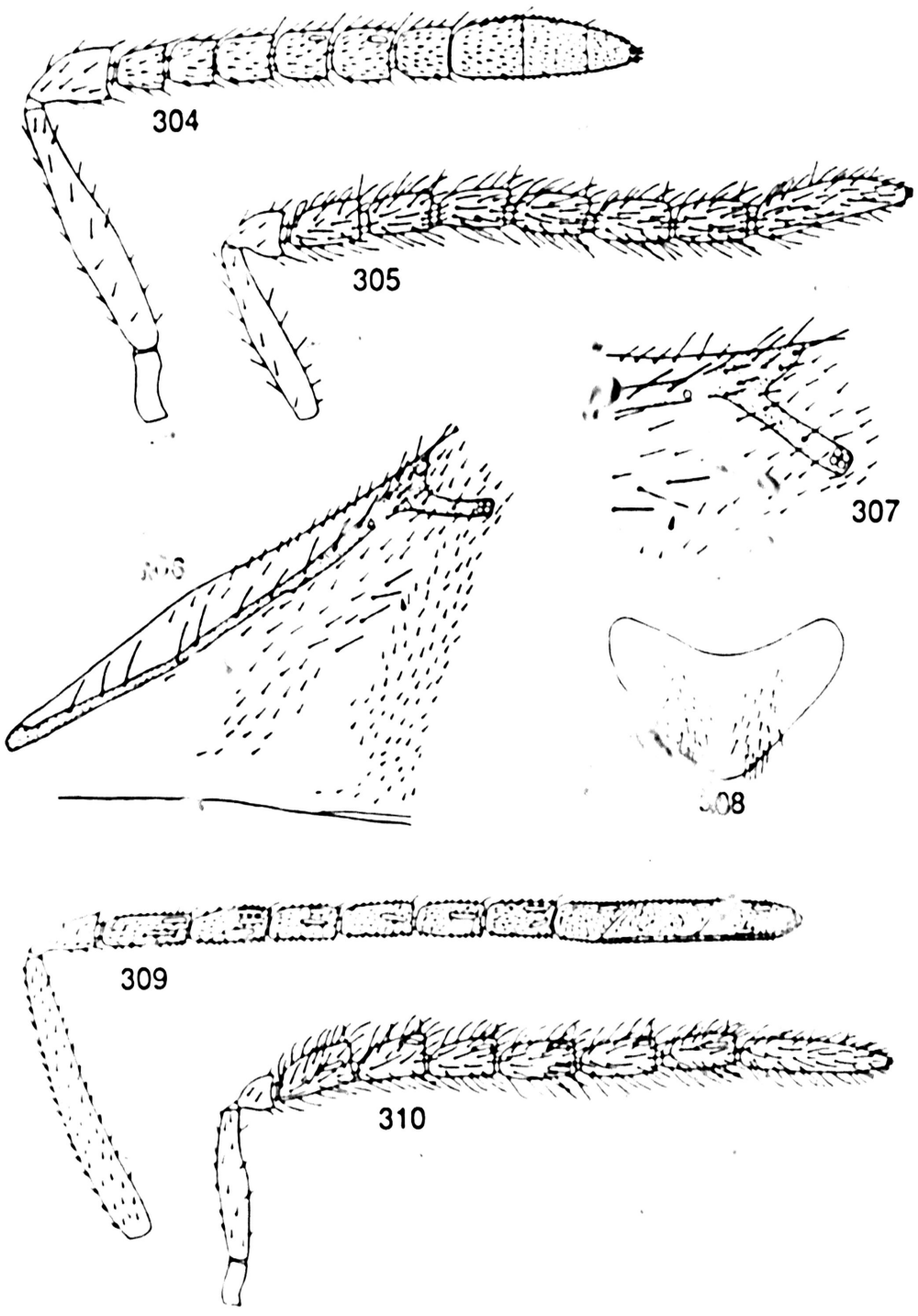
Figs. 277-284. 277-278, *Copidosoma melanocerum*: 277, phallobase; 278, aedeagus. 279-284, *Copidosoma mutabilis*: 279a, b, antenna, female; 280, antenna, male; 281, base of forewing; 282, forewing venation; 283, hypopygium; 284, digitus.



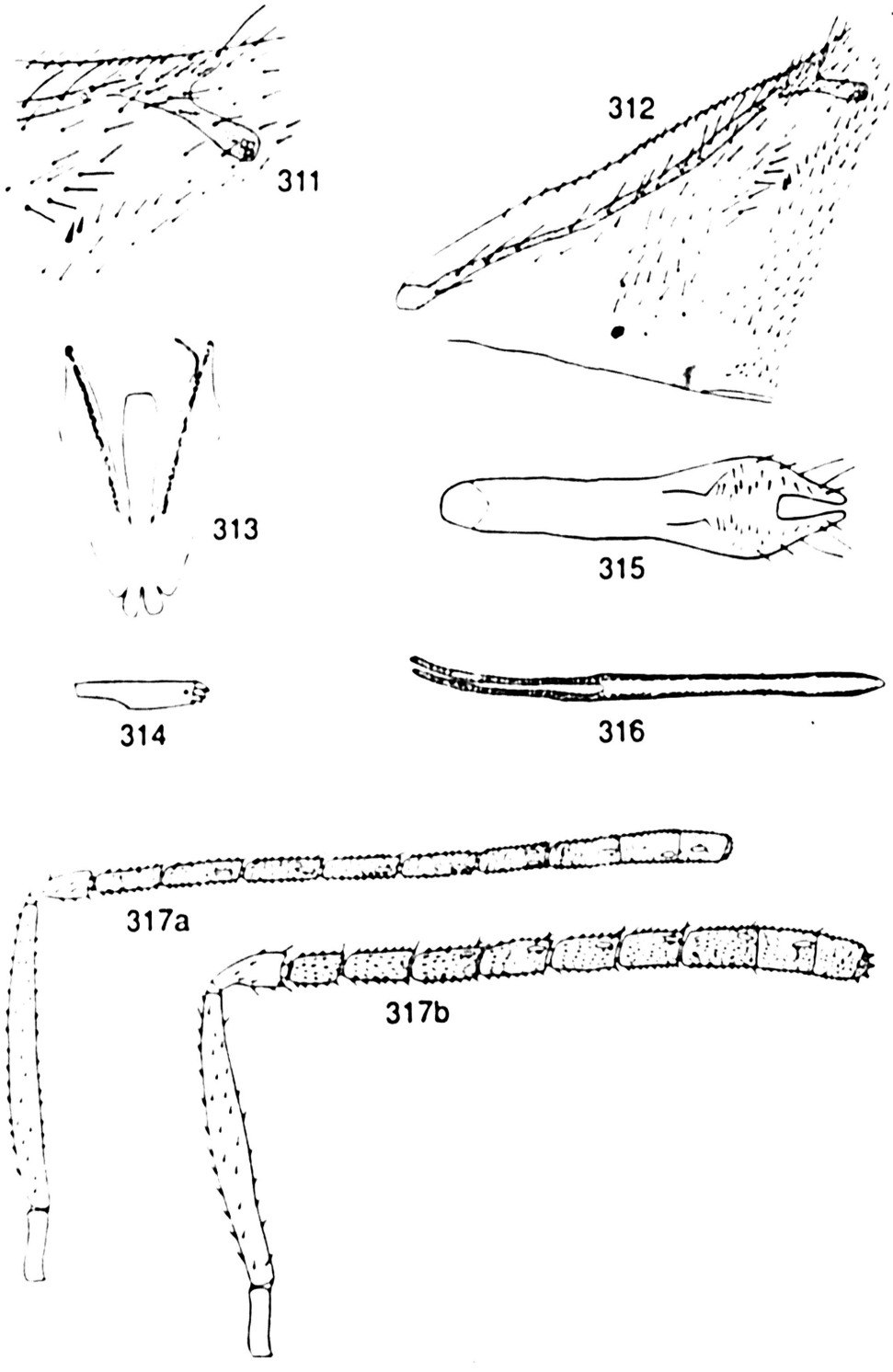
Figs. 285-295. 285-286, *Copidosoma mutabilis*: 285, phallobase; 286, aedeagus. 287-295, *Copidosoma noyesi*: 287, antenna, female; 288, antenna, male; 289, base of forewing; 290, forewing venation; 291, mandible, posterior view; 292, hypopygium; 293, digitus; 294, phallobase; 295, aedeagus.



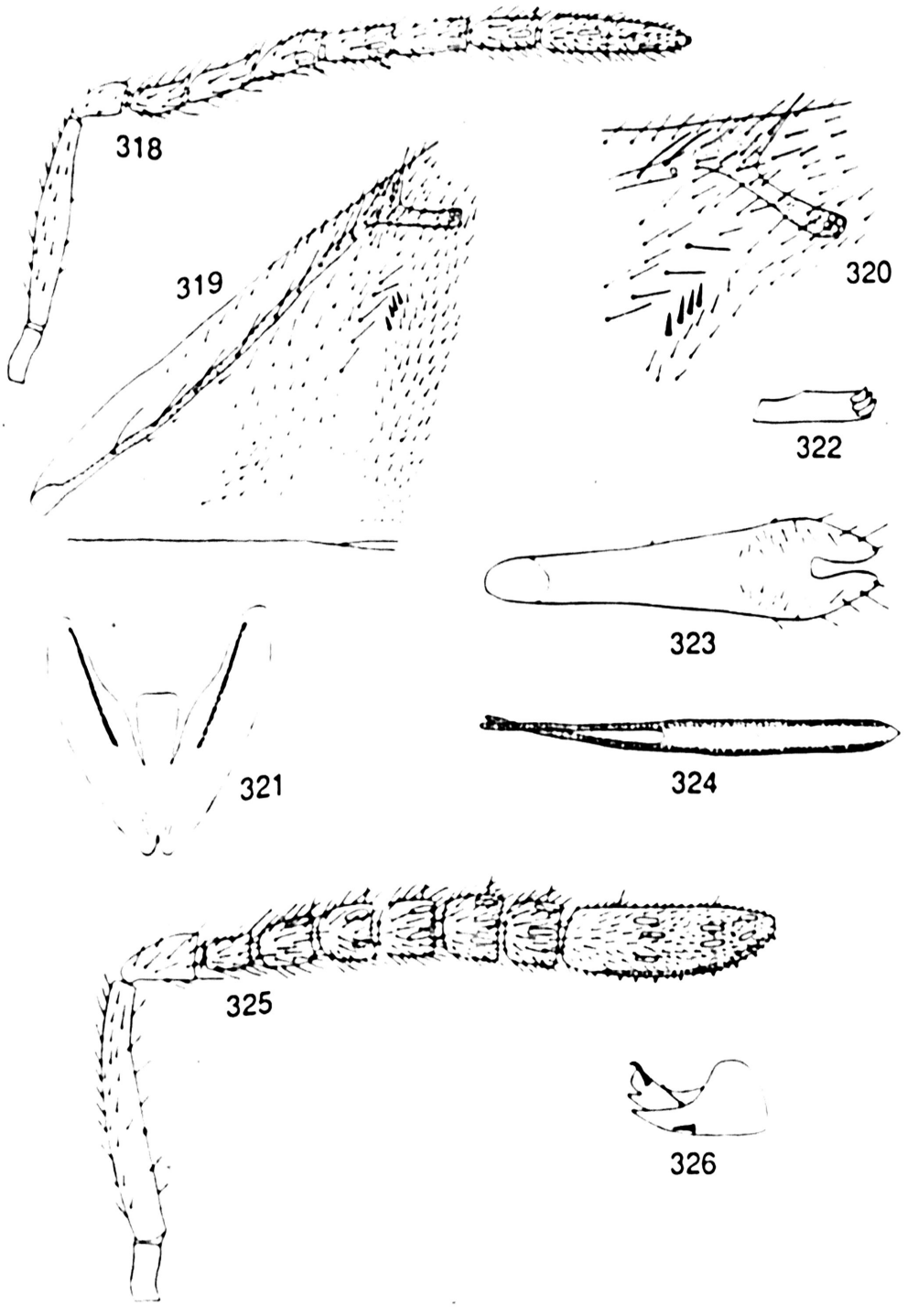
Figs. 296-303. *Copidosoma peckorum*: 296, antenna, female; 297, antenna, male; 298, base of forewing; 299, forewing venation; 300, hypopygium; 301, digitus; 302, phallobase; 303, aedeagus.



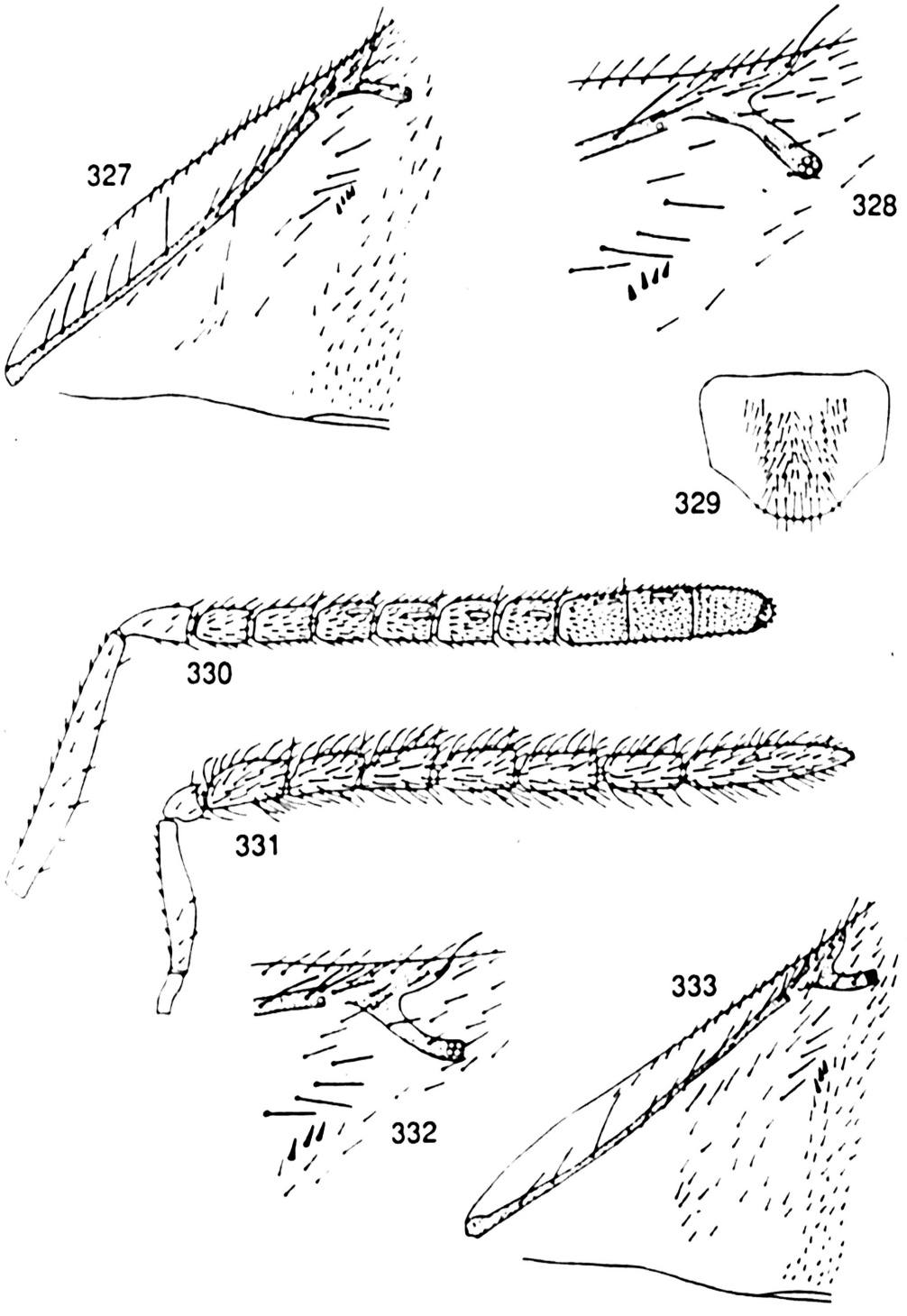
Figs. 304-310. 304-308, *Copidosoma picra*: 304, antenna, female; 305, antenna, male; 306, base of forewing; 307, forewing venation; 308, hypopygium. 309-310, *Copidosoma polyporusi*: 309, antenna, female; 310, antenna, male.



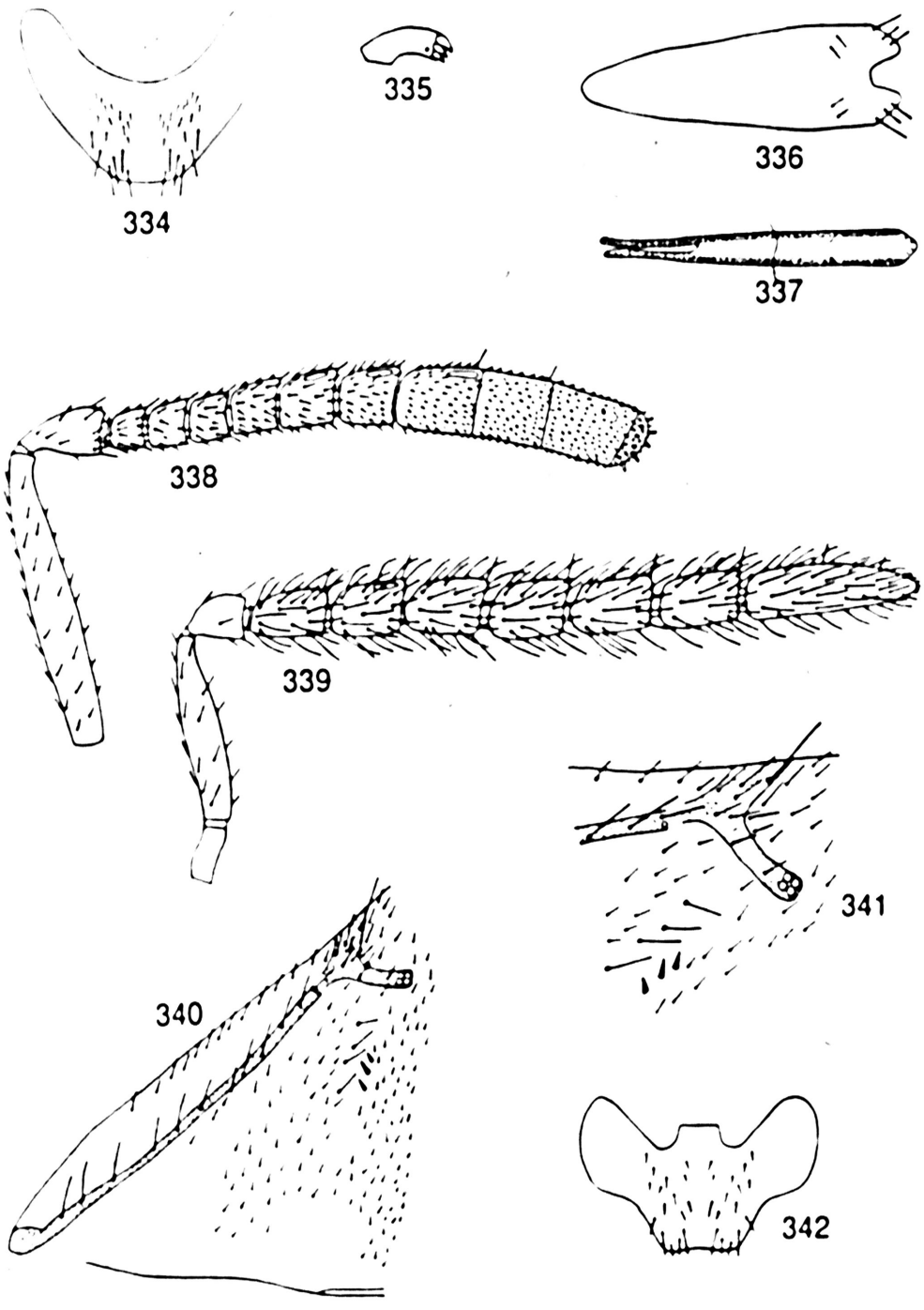
Figs. 311-317. 311-316, *Copidosoma polyporusi*: 311, forewing venation; 312, base of forewing; 313, hypopygium; 314, digitus; 315, phallobase; 316, aedeagus. 317a, b, *Copidosoma psephae*, antenna, female.



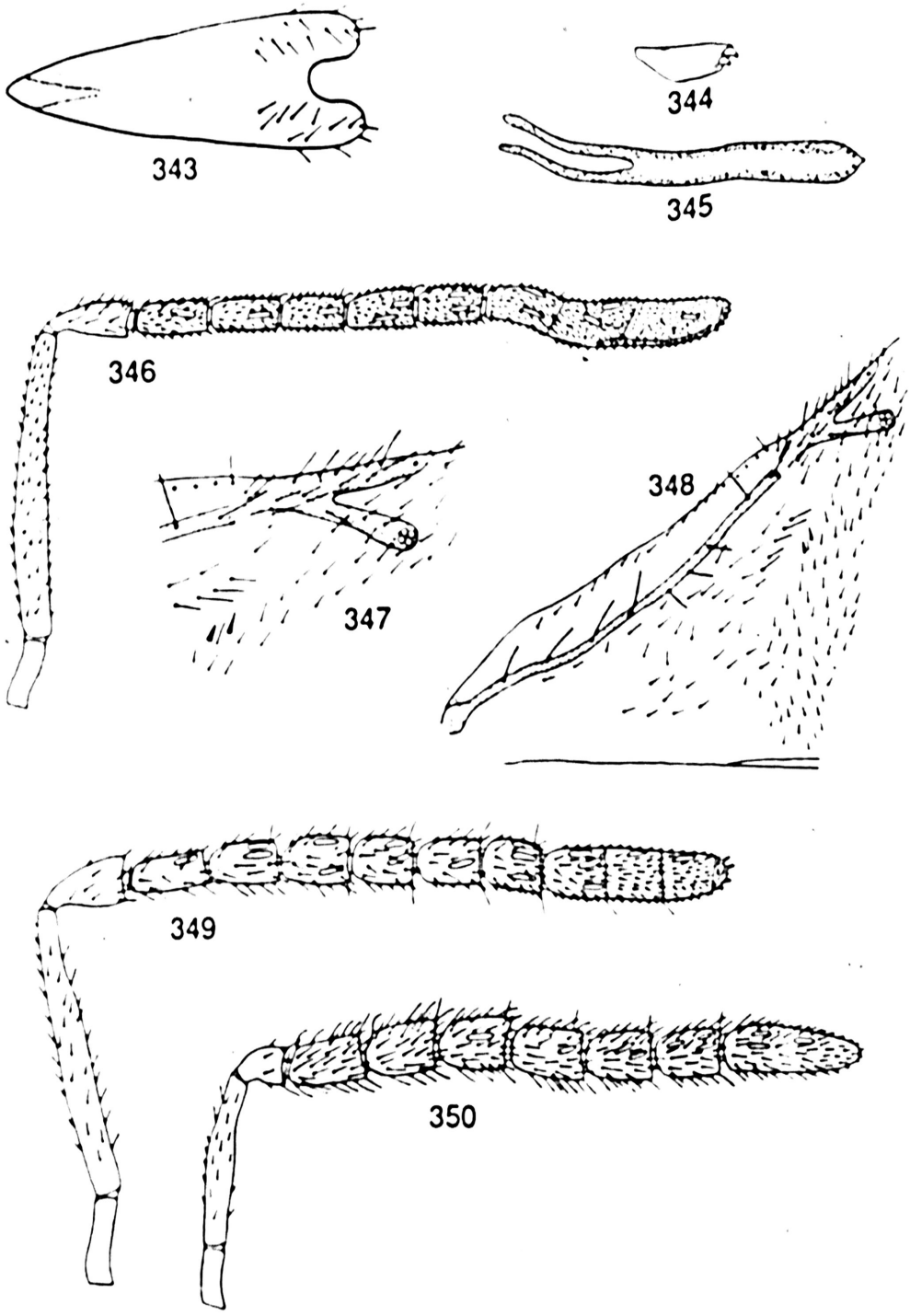
Figs. 318-326. 318-324, *Copidosoma psephae*: 318, antenna, male; 319, base of forewing; 320, forewing venation; 321, hypopygium; 322, digitus; 323, phallobase; 324, aedeagus. 325-326, *Copidosoma pseudocervius*, female: 325, antenna; 326, mandible, posterior view.



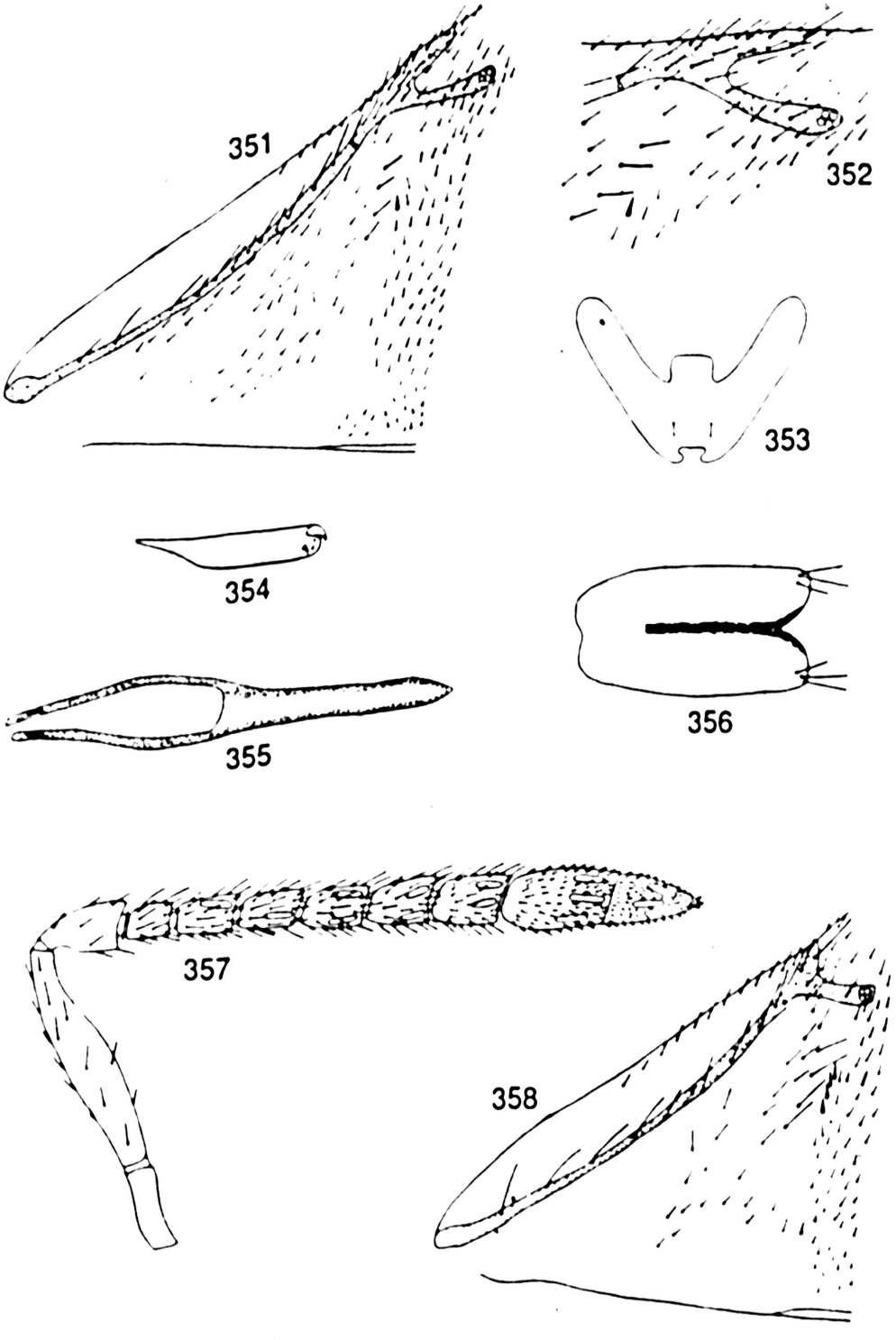
Figs. 327-333. 327-329, *Copidosoma pseudocervius*, female: 327, base of forewing; 328, forewing venation; 329, hypopygium. 330-333, *Copidosoma pseudoinnocuellae*: 330, antenna, female; 331, antenna, male; 332, forewing venation; 333, base of forewing.



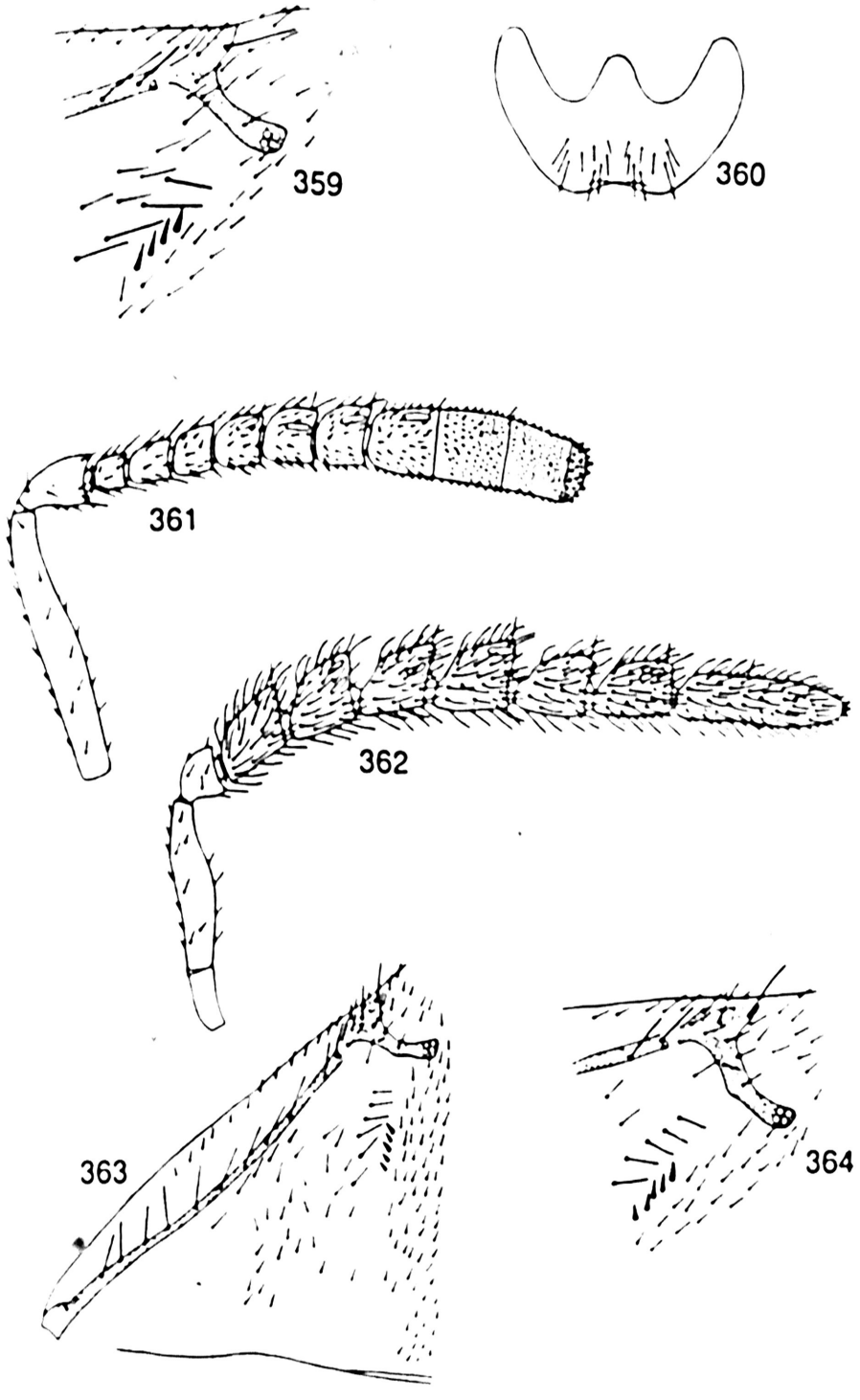
Figs. 334-342. 334-337, *Copidosoma pseudoinnocuellae*: 334, hypopygium; 335, digitus; 336, phallobase; 337, aedeagus. 338-342, *Copidosoma pyralidis*: 338, antenna, female; 339, antenna, male; 340, base of forewing; 341, forewing venation; 342, hypopygium.



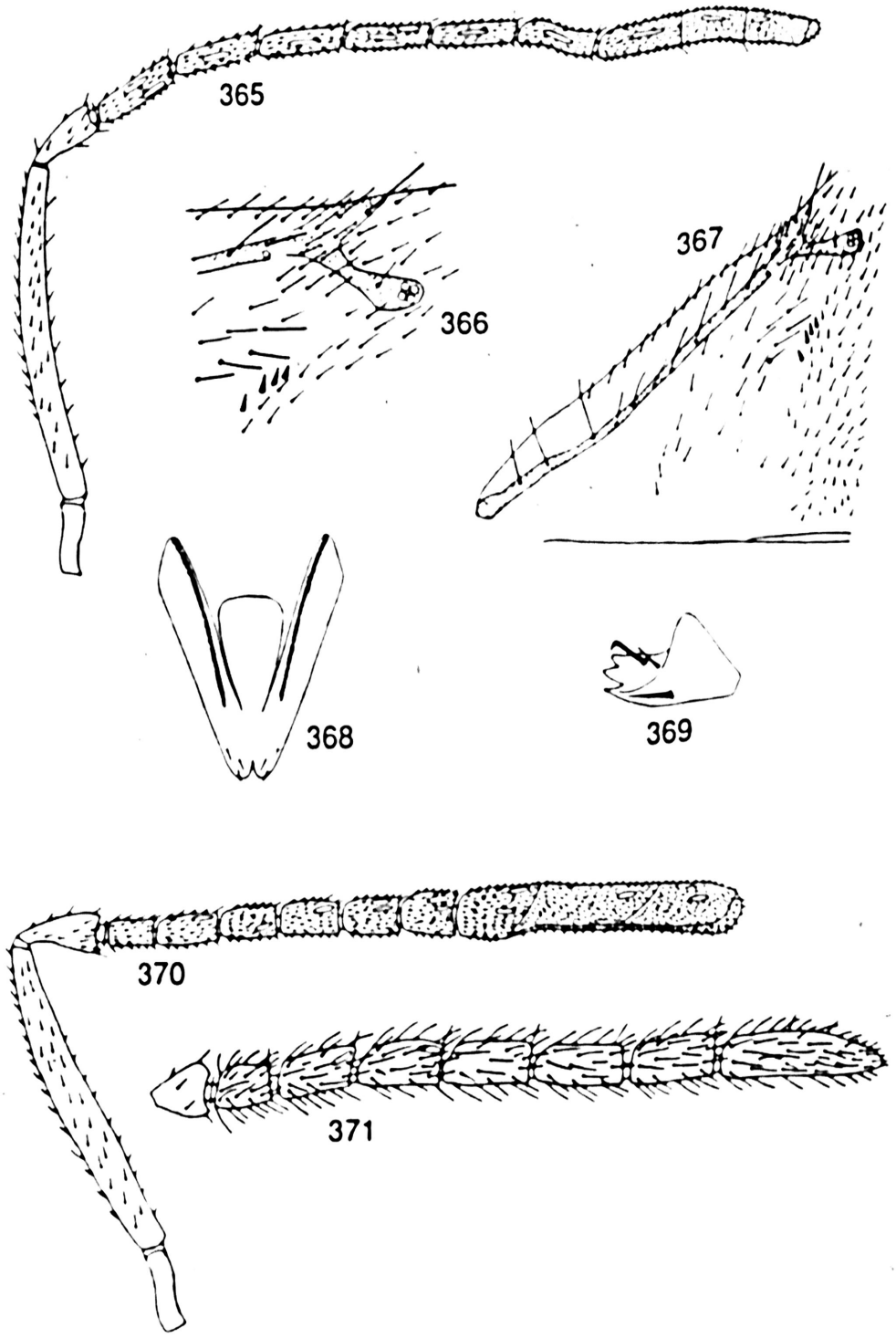
Figs. 343-350. 343-345, *Copidosoma pyralidis*: 343, phallobase; 344, digitus; 345, aedeagus. 346-348, *Copidosoma rima*, female: 346, antenna; 347, forewing venation; 348, base of forewing. 349-350, *Copidosoma schauffi*: 349, antenna, female; 350, antenna, male.



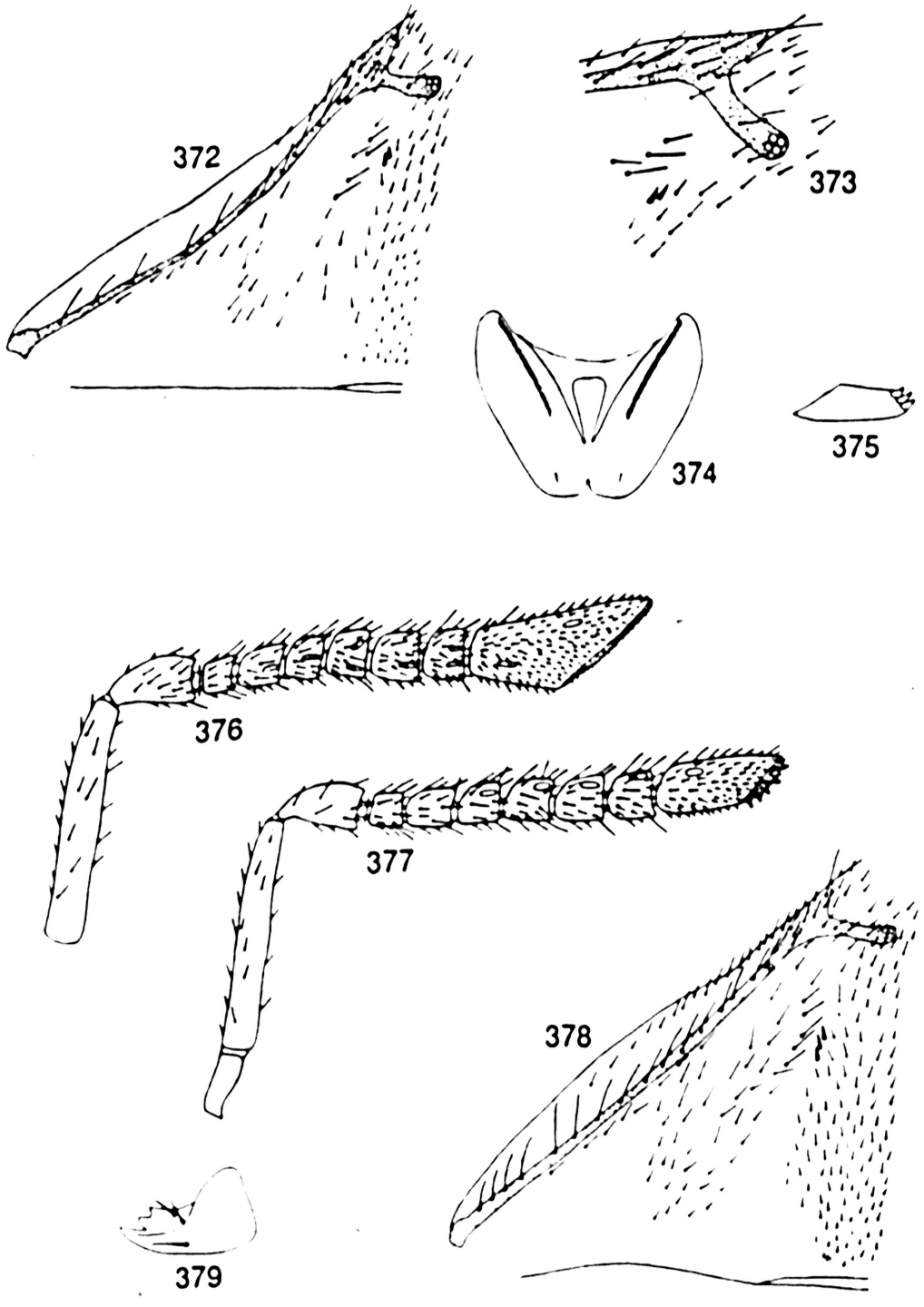
Figs. 351-358. 351-356, *Copidosoma schauffi*: 351, base of forewing; 352, forewing venation; 353, hypopygium; 354, digitus; 355, aedeagus; 356, phallobase. 357-358, *Copidosoma tamaulipasensis*, female: 357, antenna; 358, base of forewing.



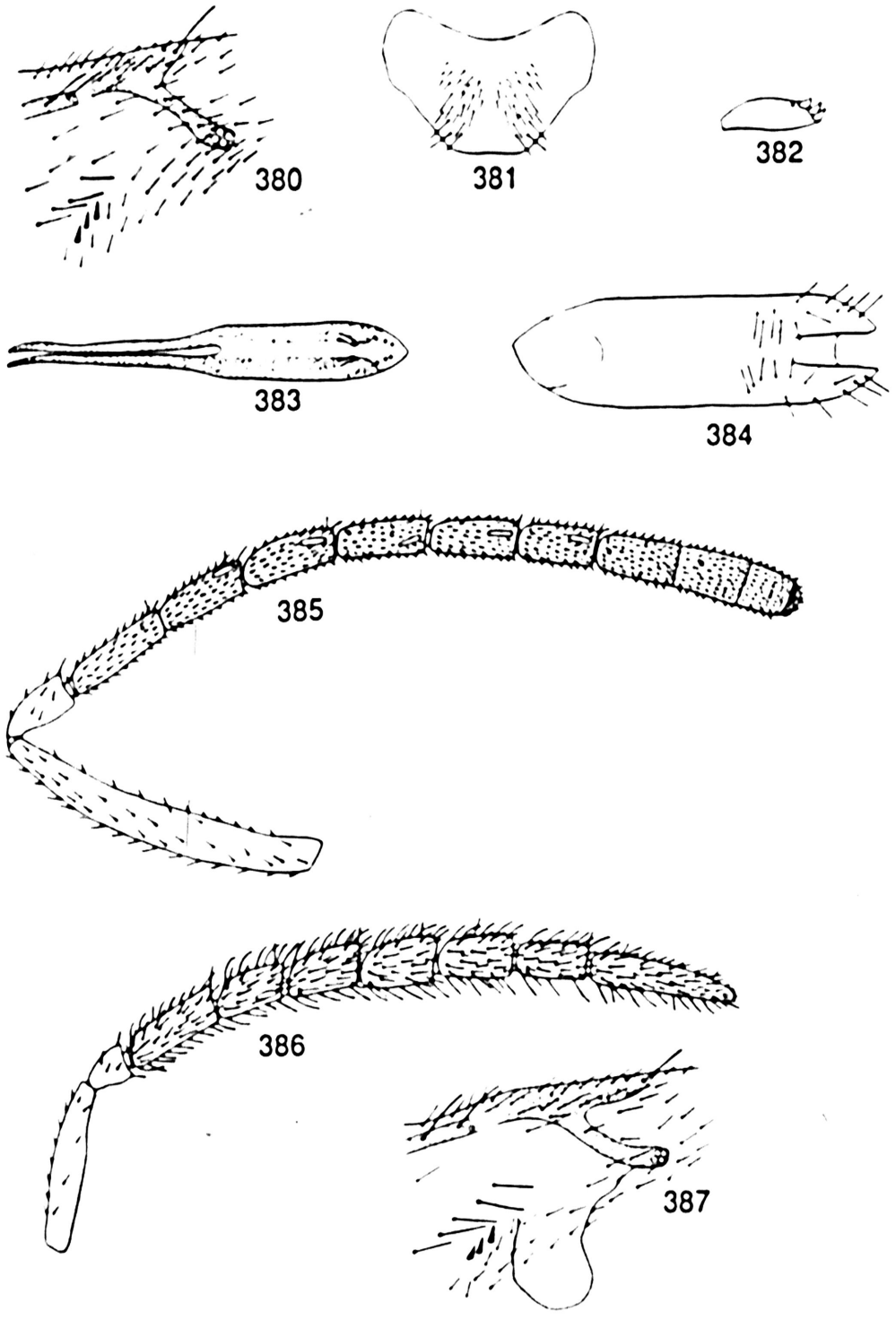
Figs. 359-364. 359-360, *Copidosoma tamaulipasensis*, female: 359, forewing venation; 360, hypopygium. 361-364, *Copidosoma tejana*: 361, antenna, female; 362, antenna, male; 363, base of forewing; 364, forewing venation.



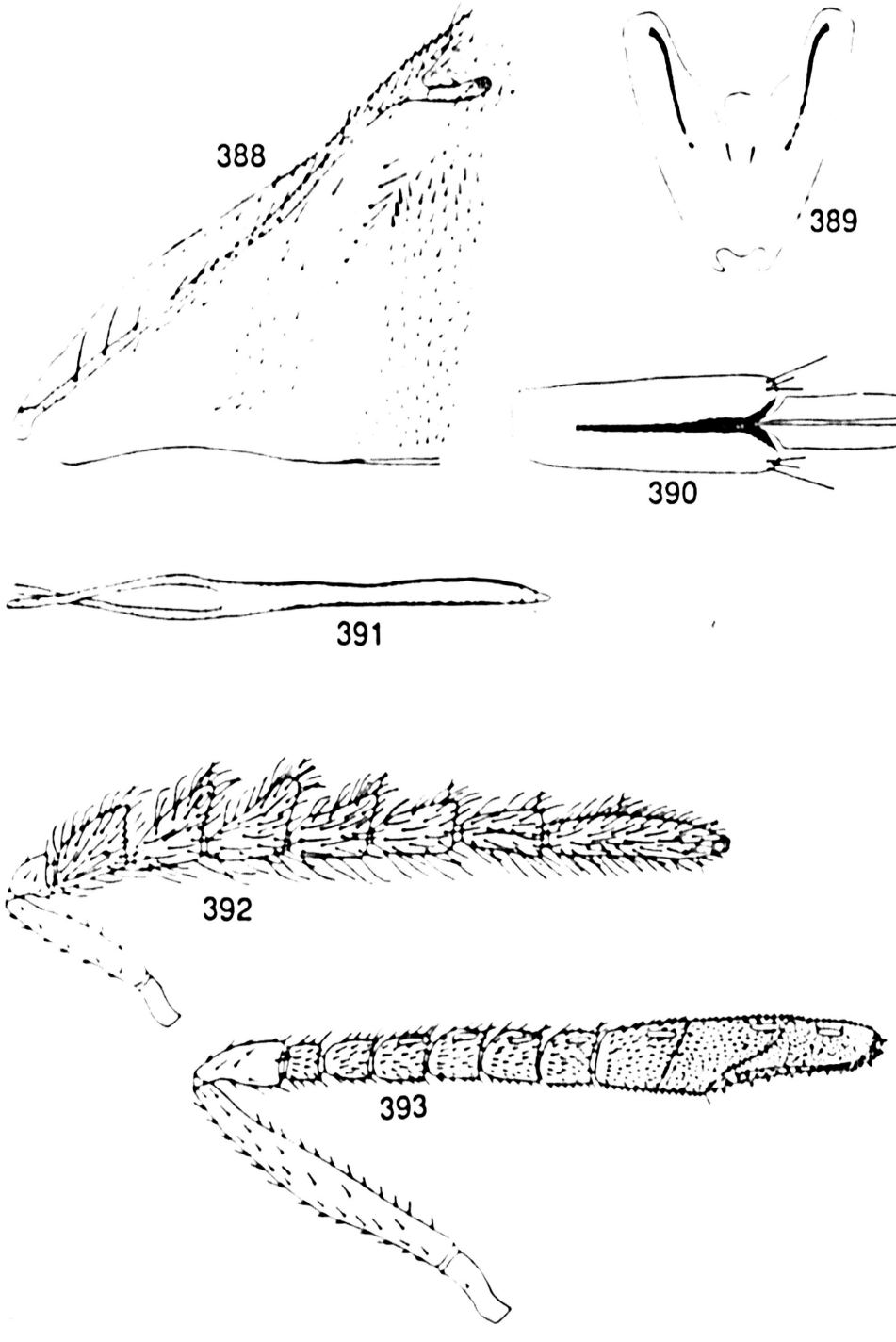
Figs. 365-371. 365-369, *Copidosoma tigrinum*, female: 365, antenna; 366, forewing venation; 367, base of forewing; 368, hypopygium; 369, mandible, posterior view. 370-371, *Copidosoma timberlakei*: 370, antenna, female; 371, flagellum, male.



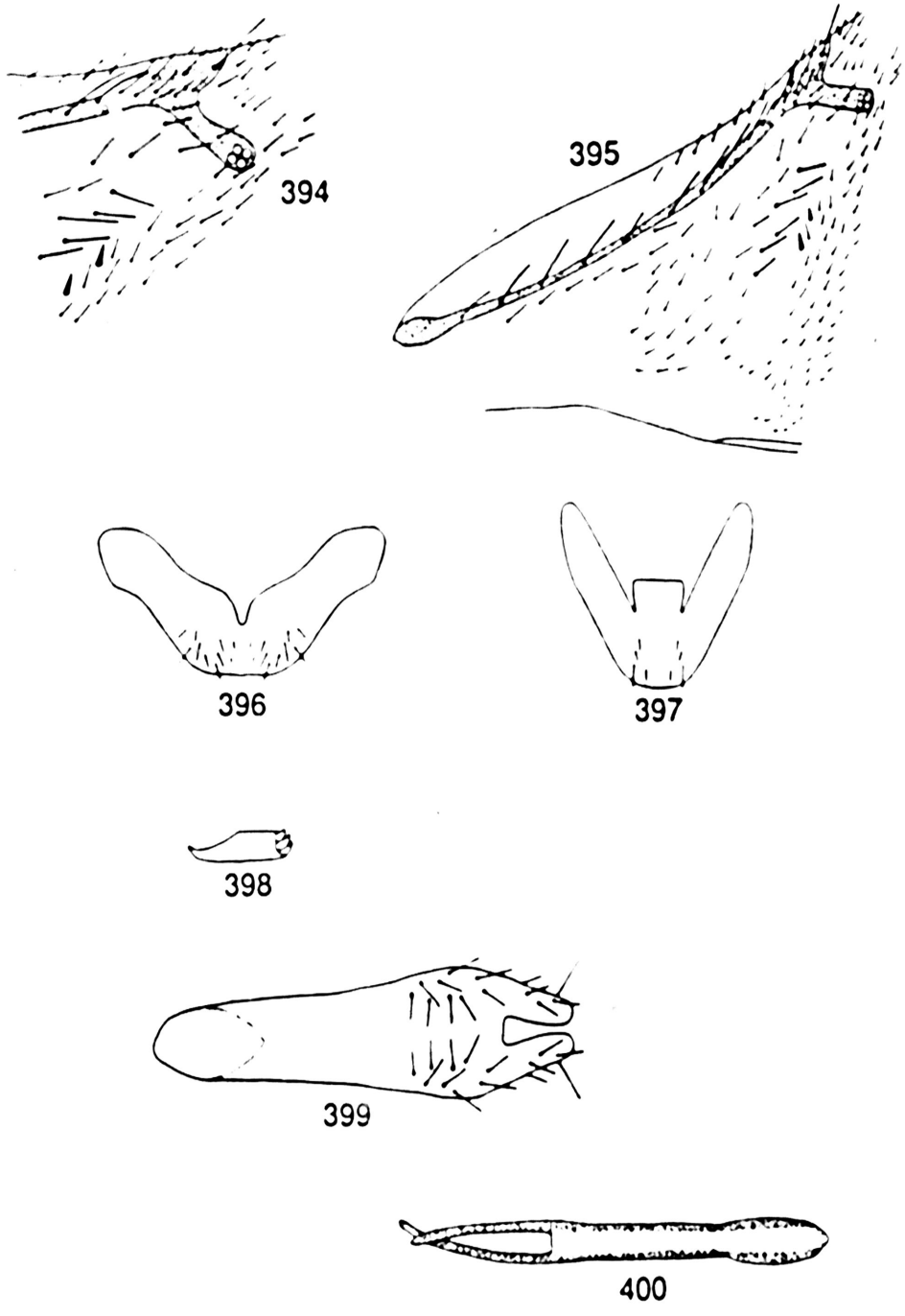
Figs. 372-379. 372-375, *Copidosoma timberlakei*: 372, base of forewing; 373, forewing venation; 374, hypopygium; 375, digitus. 376-379, *Copidosoma truncatellum*: 376, antenna, female; 377, antenna, male; 378, mandible, posterior view; 379, base of forewing.



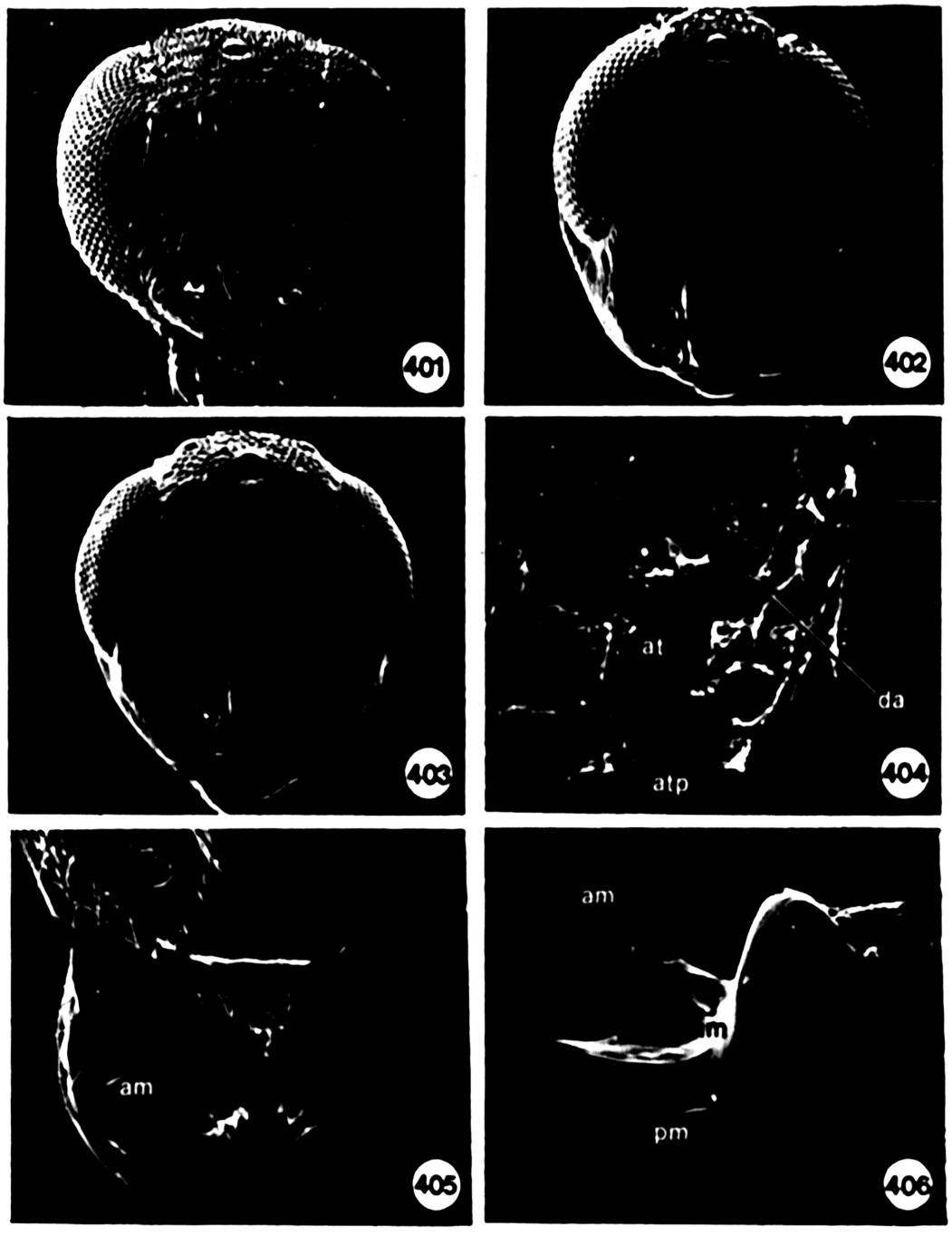
Figs. 380-387. 380-384, *Copidosoma truncatellum*: 380, forewing venation; 381, hypopygium; 382, digitus; 383, aedeagus; 384, phallobase. 385-387, *Copidosoma vagum*: 385, antenna, female; 386, antenna, male; 387, forewing venation.



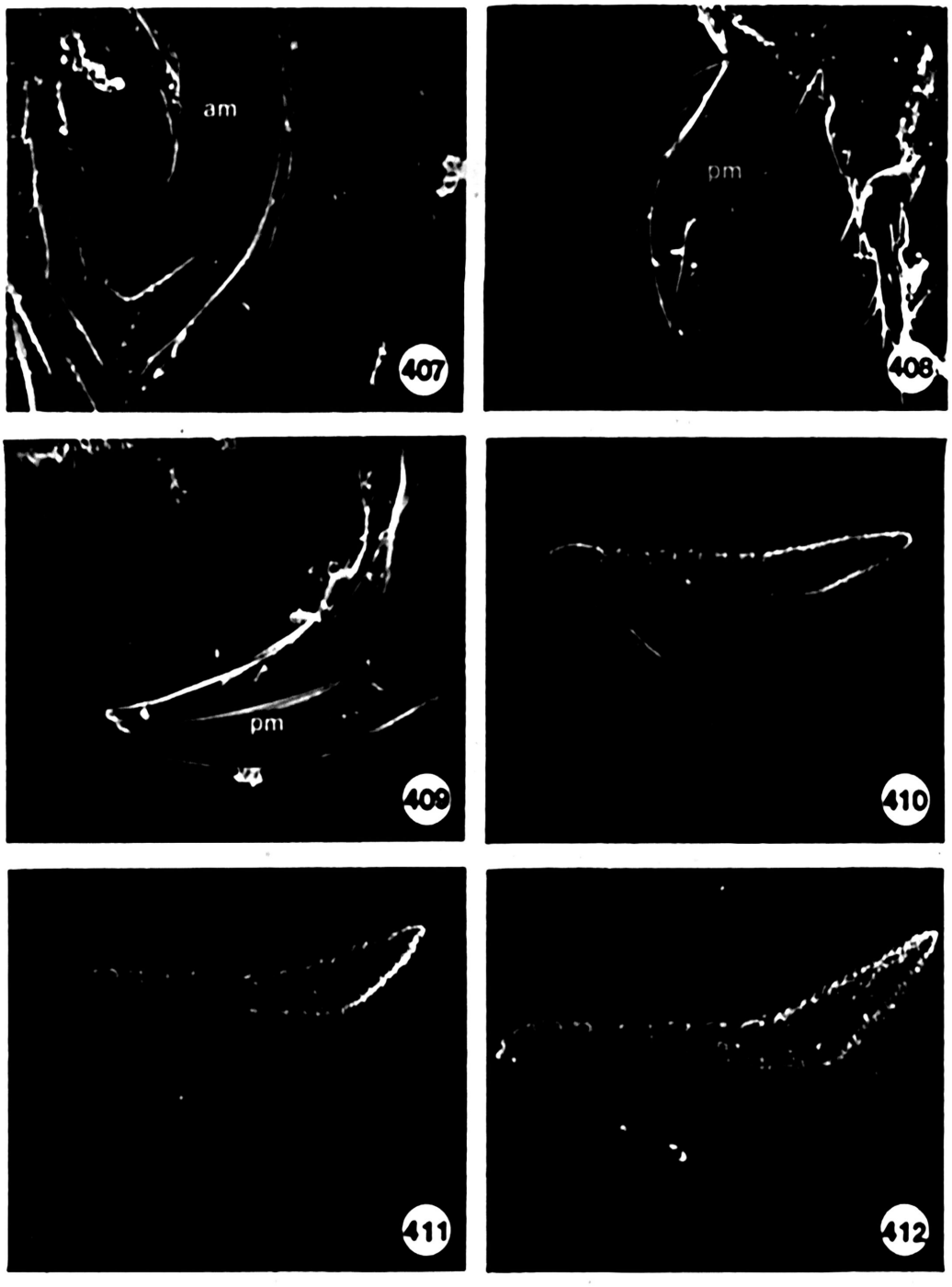
Figs. 388-393. 388-391, *Copidosoma vagum*: 388, base of forewing; 389, hypopygium; 390, phallobase and digiti; 391, aedeagus. 392-394, *Copidosoma whartoni*: 392, antenna, male; 393, antenna, female.



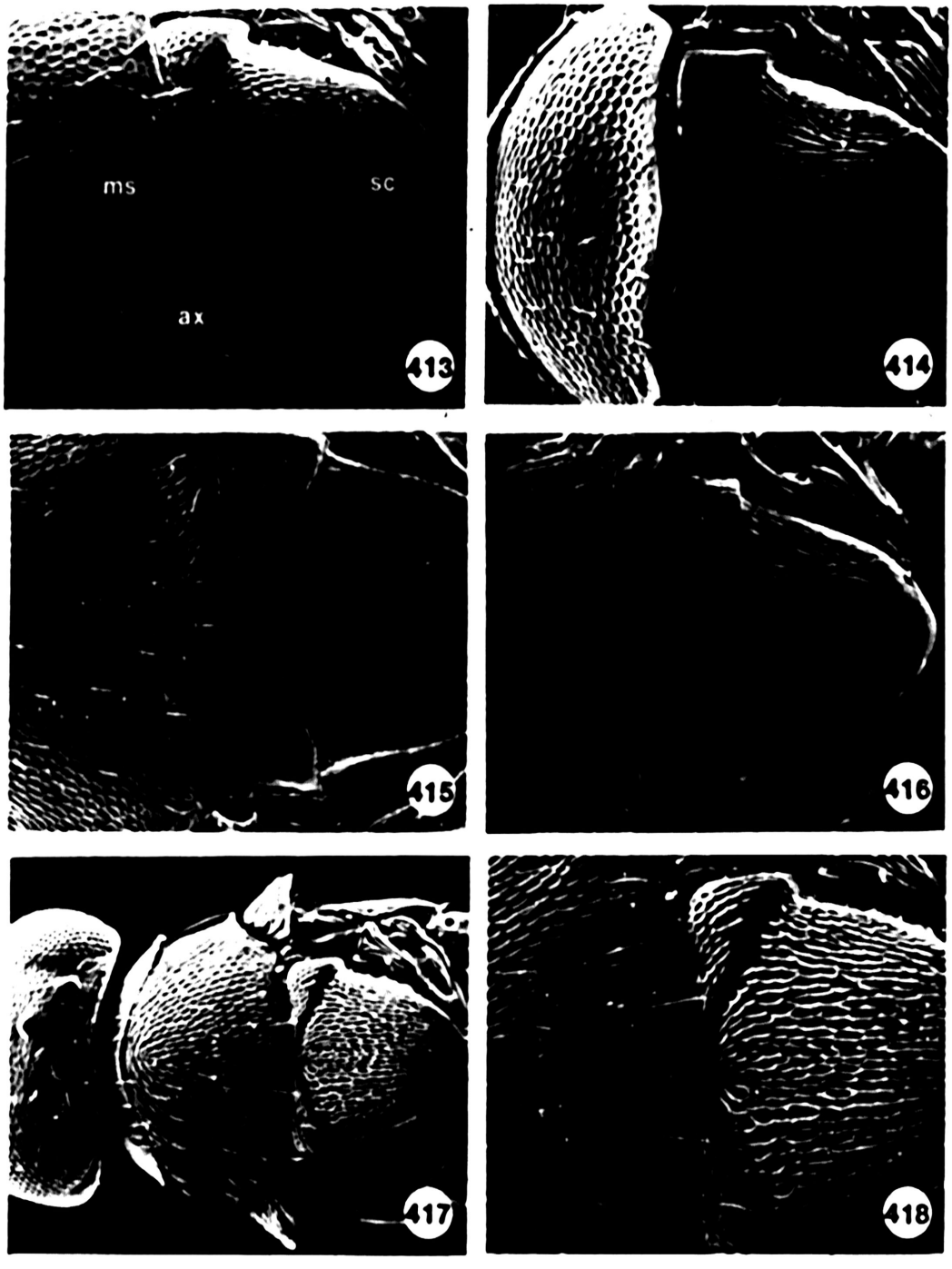
Figs. 394-400. *Copidosoma whartoni*: 394, forewing venation; 395, base of forewing; 396, sixth sternite; 397, hypopygium; 398, digitus; 399, phallobase; 400, aedeagus.



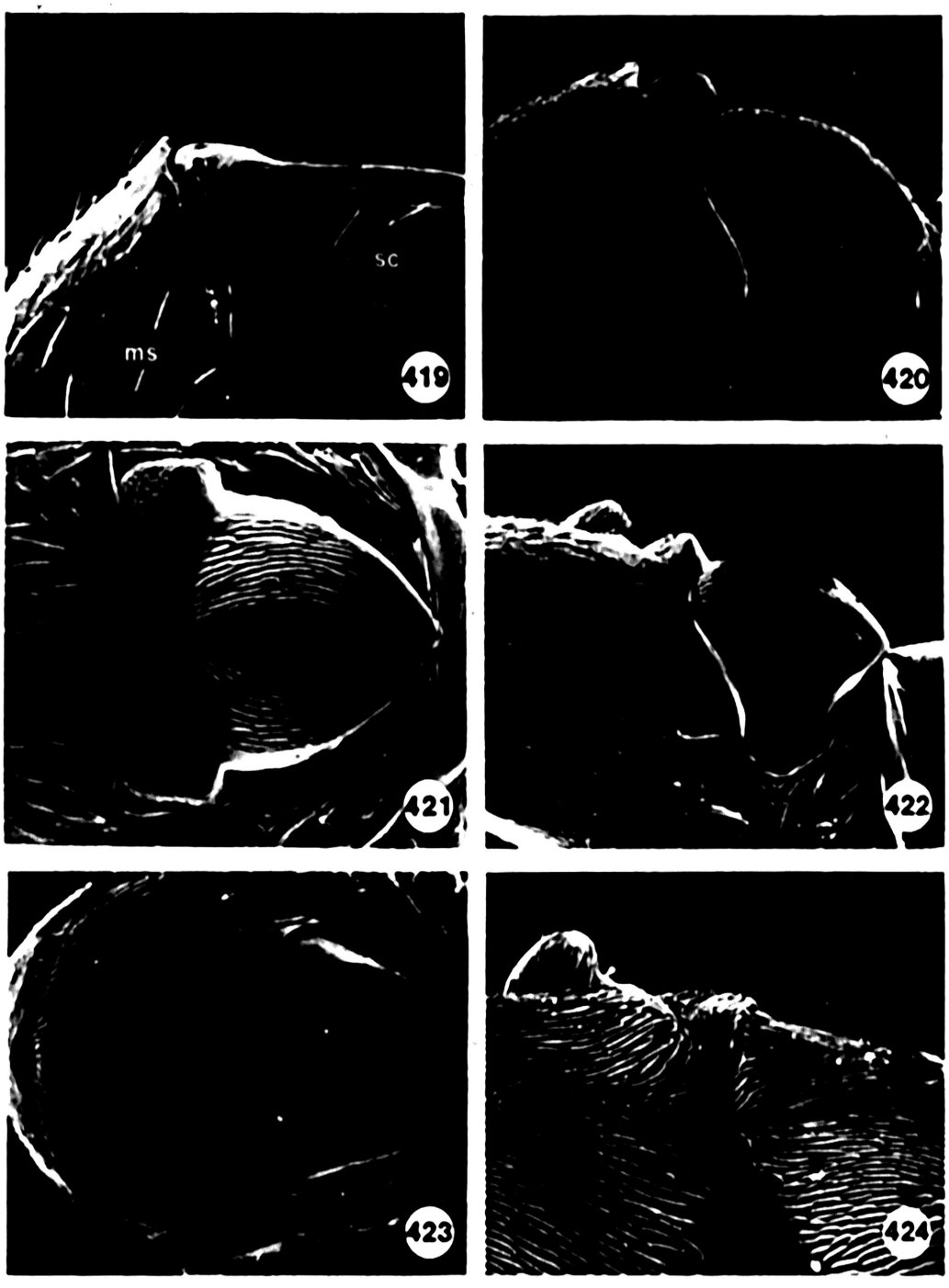
Figs. 401-406. 401-405, head in frontal view: 401, *Parablastothrix*; 402, *Copidosoma pseudoinnocuellae*; 403, *Copidosoma capsicum*; 404, *Copidosoma cervius*; 405, *Copidosoma bakeri*. 406, *Copidosoma pyralidis*, mandible, posterior view.
am = anterior mandibular seta, at = anterior tentorial arm, atp = anterior tentorial pit; da = dorsal arm of tentorium, mm = medial mandibular seta, pm = posterior mandibular seta.



Figs. 407-412. 407-409, mandible: 407, *Parablastothrix*, anterior view; 408, *Copidosoma bakeri*, posterior view; 409, *Copidosoma cervius*, posterior view. 410-412, antenna, female: 410, *Copidosoma celaenae*; 411, *Copidosoma floridanum*; 412, *Copidosoma noyesi*. am = anterior mandibular seta, pm = posterior mandibular seta.



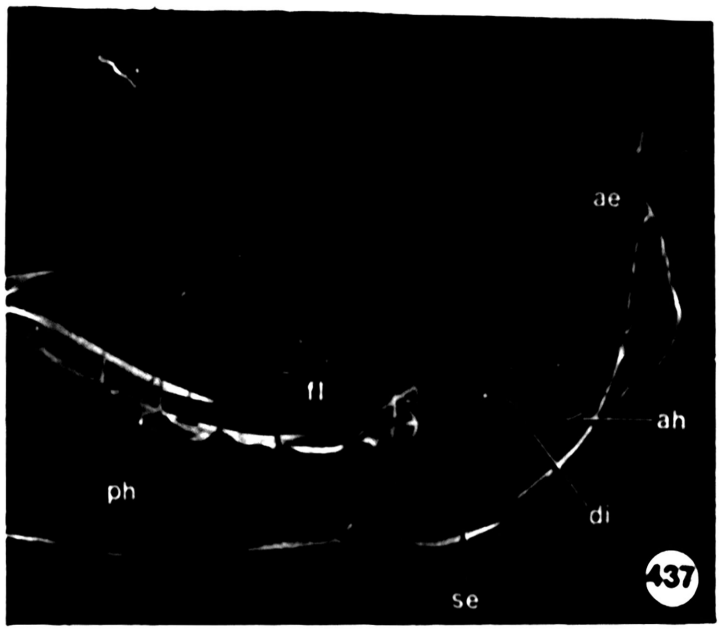
Figs. 413-418. Mesosoma, dorsal view: 413, *Copidosoma schauffi*; 414, *Copidosoma bakeri*; 415, *Copidosoma howardi*; 416, *Copidosoma pyralidis*; 417-418, *Copidosoma gelechiae*. ax = axilla, ms = mesoscutum, sc = scutellum.

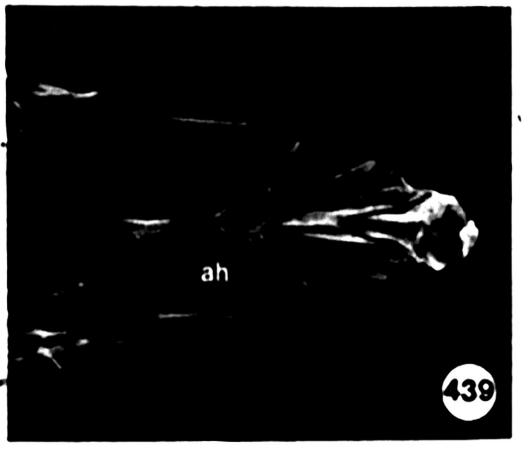


Figs. 419-424. Mesosoma: 419, *Copidosomopsis plethoricus*, dorsolateral view; 420, *Copidosoma whartoni*, dorsolateral view; 421-422, *Copidosoma capsicum*, dorsal and dorsolateral view; 423-424, *Holcothorax testaceipes*, dorsal and dorsolateral view.
ax = axilla, ms = mesoscutum, sc = scutellum.

Figs. 425-430. 425-426, *Coelopencyrtus hyaeoleter*: 425, mesosoma; 426, mesoscutum. 427-428, propodeal spiracle: 427, *Copidosoma gelechiae*; 428, *Copidosomopsis plethoricus*. 429-430, ovipositor: 429, *Copidosoma whartoni*; 430, *Copidosoma polyporusi*. ax = axilla, ms = mesoscutum, op = outer plate, pr = propodeum, sc = scutellum, sp = spicules, 1vf = first valvifer, 1vl = 1st valvula, 2vf = second valvifer.

Figs. 431-436. 431-433, ovipositor: 431, *Copidosoma innocuellae*; 432, *Copidosoma pyralidis*; 433, *Coelopencyrtus hyaeoleter*. 434-435, apex of metasoma: 434, *Copidosoma bakeri*; 435, *Copidosoma melanocerum*. 436, *Copidosomopsis plethoricus*, male genitalia. ae = aedeagus, di = digitus, ep = epiproct, sp = spicules, sy = syntergum, 1vf = first valvifer, 2vf = second valvifer.





Figs. 437-439. Male genitalia: 437-438, *Copidosoma bakeri*; 439, *Copidosoma deceptor*. ae = aedeagus, ah = aedeagal hook, di = digitus, fl = flange, ph = phallobase, se = sensillum.

Fig. 440. Strict consensus cladogram of 1,032 equally parsimonious cladograms from Analysis 1 prior to implementing successive approximations. *Syrphophagus* and *Parablastothrix* + (*Nathismusia*+*Coelopencyrtus*) are collapsed due to space limitations.

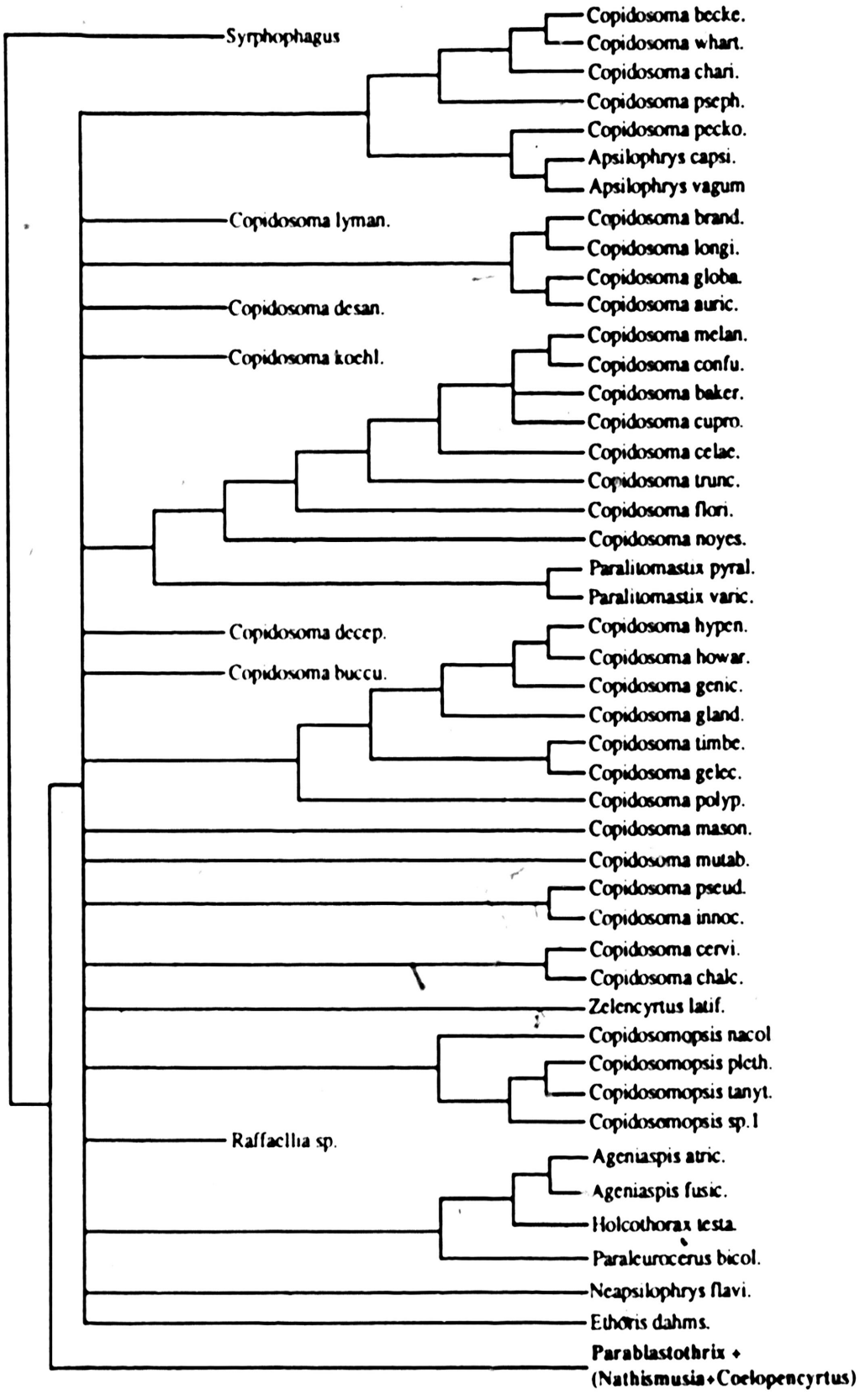

Syrphophagus
Copidosoma lyman.
Copidosoma desan.
Copidosoma kochl.
Copidosoma decep.
Copidosoma buccu.
Raffaellia sp.
Copidosoma becke.
Copidosoma whart.
Copidosoma chari.
Copidosoma pseph.
Copidosoma pecko.
Apsilophrys capsi.
Apsilophrys vagum
Copidosoma brand.
Copidosoma longi.
Copidosoma globa.
Copidosoma auric.
Copidosoma melan.
Copidosoma confu.
Copidosoma baker.
Copidosoma cupro.
Copidosoma celae.
Copidosoma trunc.
Copidosoma flori.
Copidosoma noyes.
Paralitomastix pyral.
Paralitomastix varic.
Copidosoma hypen.
Copidosoma howar.
Copidosoma genic.
Copidosoma gland.
Copidosoma timbe.
Copidosoma gelec.
Copidosoma polyp.
Copidosoma mason.
Copidosoma mutab.
Copidosoma pseud.
Copidosoma innoc.
Copidosoma cervi.
Copidosoma chalc.
Zelencyrtus latif.
Copidosomopsis nacol
Copidosomopsis pleth.
Copidosomopsis tanyt.
Copidosomopsis sp.1
Ageniaspis atric.
Ageniaspis fusic.
Holcothorax testa.
Paralcurocerus bicol.
Neapsilophrys flavi.
Ethoris dahms.
Parablastothrix +
(Nathismusia+Coelopencyrtus)

Fig. 441. One of seven final cladograms from Analysis 1, following successive approximations on the full data. Most Copidosomatina are collapsed and appear in Fig. 442. Character states are listed and described in Tables 2 and 3. Characters with unit CI < 0.4 are marked with an asterisk, characters undergoing a reversal are boldfaced, and those which show parallelisms on the cladogram are marked with a "+". Superscripted values refer to character state. Each character and its state plotted are identical on all seven final cladograms and have a single model of state change except character 47, which is marked in italics and discussed in the text. Length with characters reweighted to 1 = 353, CI excluding uninformative characters and characters reweighted to 1 = 0.363, RI = 0.685.

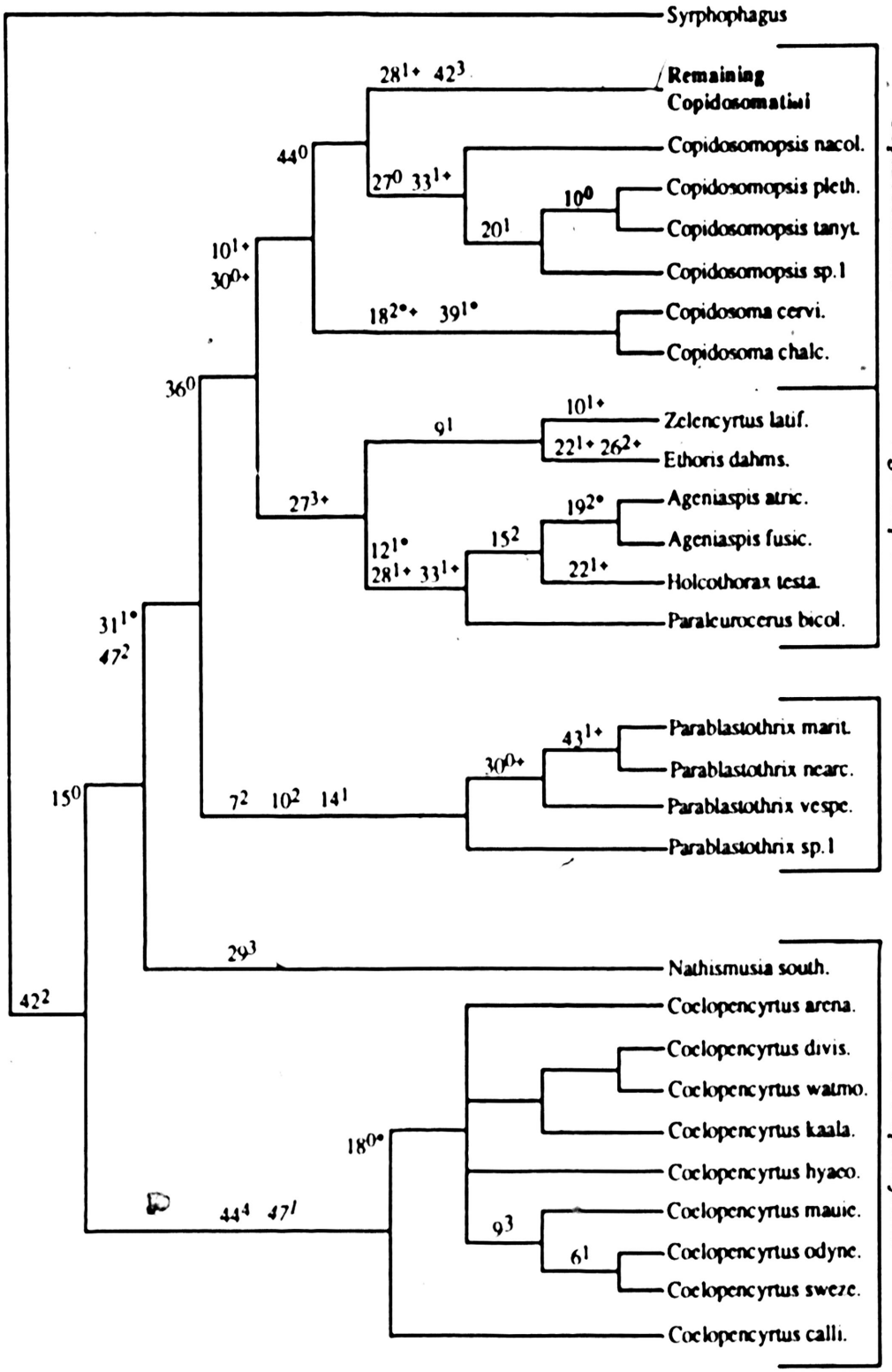

Syrphophagus
Remaining Copidosomatini
Copidosomopsis nacol.
Copidosomopsis pleth.
Copidosomopsis tanyt.
Copidosomopsis sp.1
Copidosoma cervi.
Copidosoma chalc.
Zelencyrtus latif.
Ethoris dahms.
Ageniaspis atric.
Ageniaspis fusic.
Holcothorax testa.
Paralcurocerus bicol.
Parablastothrix marit.
Parablastothrix nearc.
Parablastothrix vespe.
Parablastothrix sp.1
Nathismusia south.
Coelopencyrtus arena.
Coelopencyrtus divis.
Coelopencyrtus watmo.
Coelopencyrtus kaala.
Coelopencyrtus hyaco.
Coelopencyrtus mauic.
Coelopencyrtus odyne.
Coelopencyrtus sweze.
Coelopencyrtus calli.
Copidosomatina
Ageniaspidina
Parablastothrichina
Coelopencyrtina

Fig. 442. One of seven final cladograms from Analysis 1, following successive approximations on the full data. Taxa basal to *Copidosomopsis* appear in Fig. 441. Character states are listed and described in Tables 2 and 3. Character notation is the same as for Fig. 441. Each character and its state plotted have a single model of state change and are identical on all seven final cladograms. Length with characters reweighted to 1 = 353, CI excluding uninformative characters and characters reweighted to 1 = 0.363, RI = 0.686.

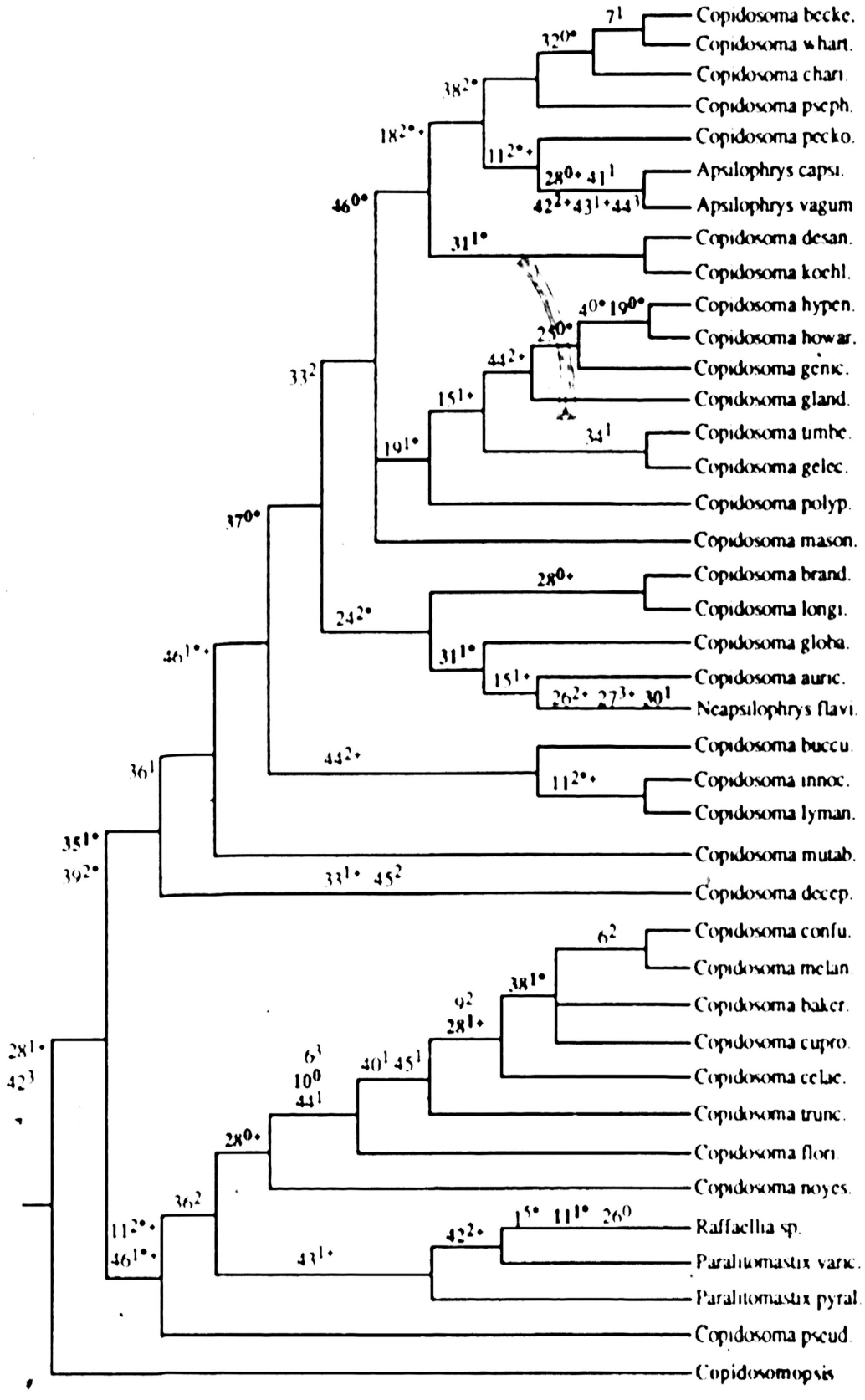

Copidosoma becke.
Copidosoma whart.
Copidosoma chari.
Copidosoma pseph.
Copidosoma pecko.
Apsilophrys capsi.
Apsilophrys vagum
Copidosoma desan.
Copidosoma kochl.
Copidosoma hypen.
Copidosoma howar.
Copidosoma genic.
Copidosoma gland.
Copidosoma umbe.
Copidosoma gelec.
Copidosoma polyp.
Copidosoma mason.
Copidosoma brand.
Copidosoma longi.
Copidosoma globa.
Copidosoma auric.
Neapsilophrys flavi.
Copidosoma buccu.
Copidosoma innoc.
Copidosoma lyman.
Copidosoma mutab.
Copidosoma decep.
Copidosoma confu.
Copidosoma melan.
Copidosoma baker.
Copidosoma cupro.
Copidosoma celae.
Copidosoma trunc.
Copidosoma flori
Copidosoma noyes.
Raffaellia sp.
Paralitomastix varic.
Paralitomastix pyral.
Copidosoma pseud.
Copidosomopsis

Fig. 443. Strict consensus cladogram of 12 equally parsimonious cladograms resulting from Analysis 4, which utilized a reduced number of taxa. Most Copidosomatina appear in Fig. 444. Character states are listed and described in Tables 2 and 3. Character notation is the same as for Fig. 441. Each character plotted has an identical distribution and a single model of state change on all 12 final cladograms. Length with characters reweighted to 1 = 274, CI excluding uninformative characters and characters reweighted to 1 = 0.342, RI = 0.657.

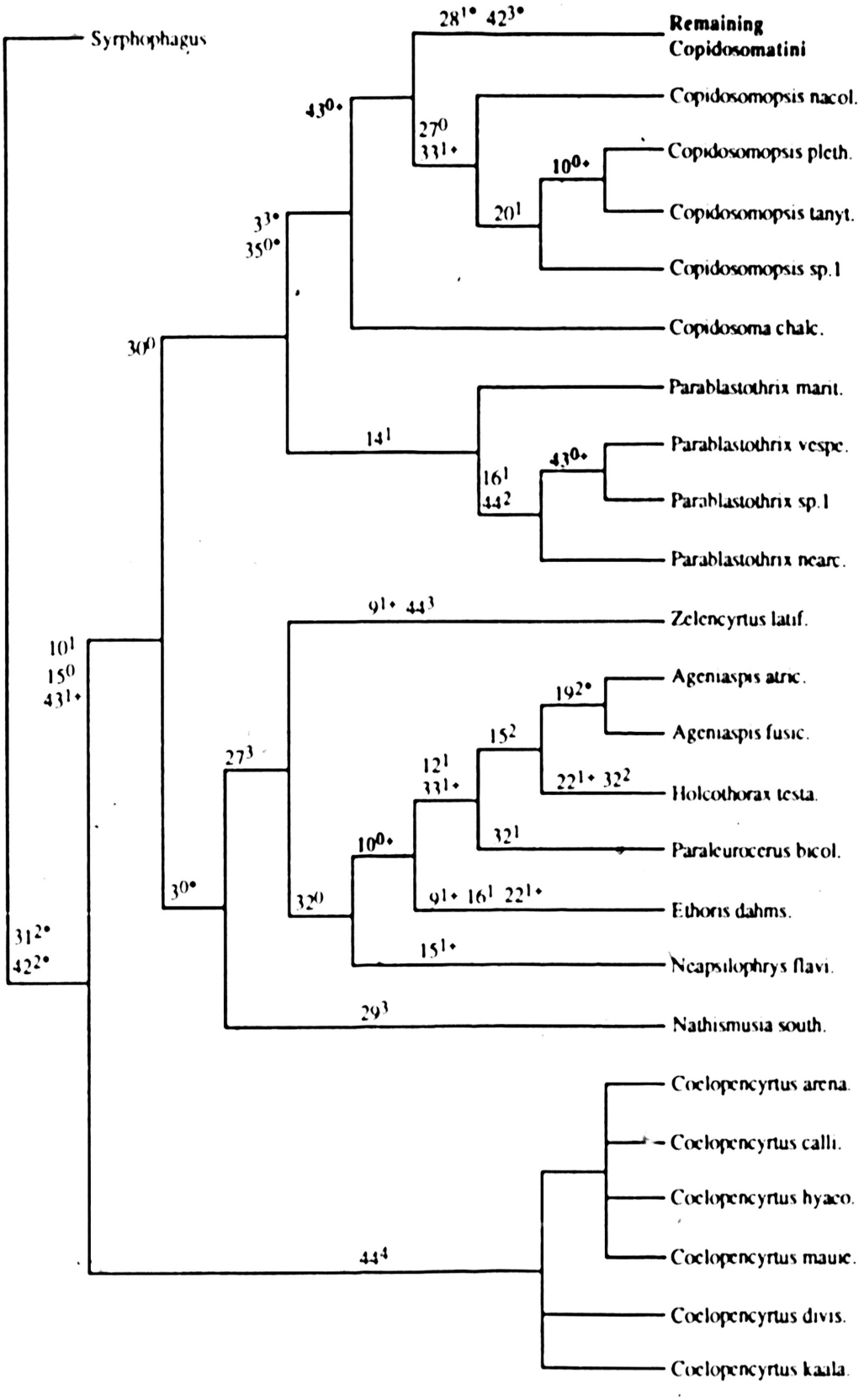

Syrphophagus
28[1•] 42[3•]
Remaining Copidosomatini
43[0•]
27[0] 33[1•]
Copidosomopsis nacol.
10[0•]
Copidosomopsis pleth.
20[1]
Copidosomopsis tanyt.
33[•] 35[0•]
Copidosomopsis sp.1
Copidosoma chalc.
30[0]
Parablastothrix mant.
14[1]
Parablastothrix vespe.
43[0•]
16[1] 44[2]
Parablastothrix sp.1
Parablastothrix neare.
91[•] 44[3]
Zelencyrtus latif.
10[1] 15[0] 43[1•]
Agentaspis atric.
19[2•]
Agentaspis fusic.
15[2]
27[3]
12[1] 33[1•]
22[1•] 32[2]
Holcothorax testa.
32[1]
Paraleurocerus bicol.
10[0•]
30[•]
32[0]
91[•] 16[1] 22[1•]
Ethoris dahms.
15[1•]
31[2•] 42[2•]
Neapsilophrys flavi.
29[3]
Nathismusia south.
Coelopencyrtus arena.
Coelopencyrtus calli.
Coelopencyrtus hyaco.
44[4]
Coelopencyrtus mauic.
Coelopencyrtus divis.
Coelopencyrtus kaala.

Fig. 444. Strict consensus cladogram of 12 equally parsimonious cladograms resulting from Analysis 4, which utilized a reduced number of taxa. Taxa basal to *Copidosomopsis* appear in Figure 443. Character states are listed and described in Tables 2 and 3. Character notation is the same as for Fig. 441. Each character and its state plotted have a single model of state change and are identical on all 12 final cladograms. Length with characters reweighted to 1 = 274, CI excluding uninformative characters and characters reweighted to 1= 0.342, RI = 0.657.

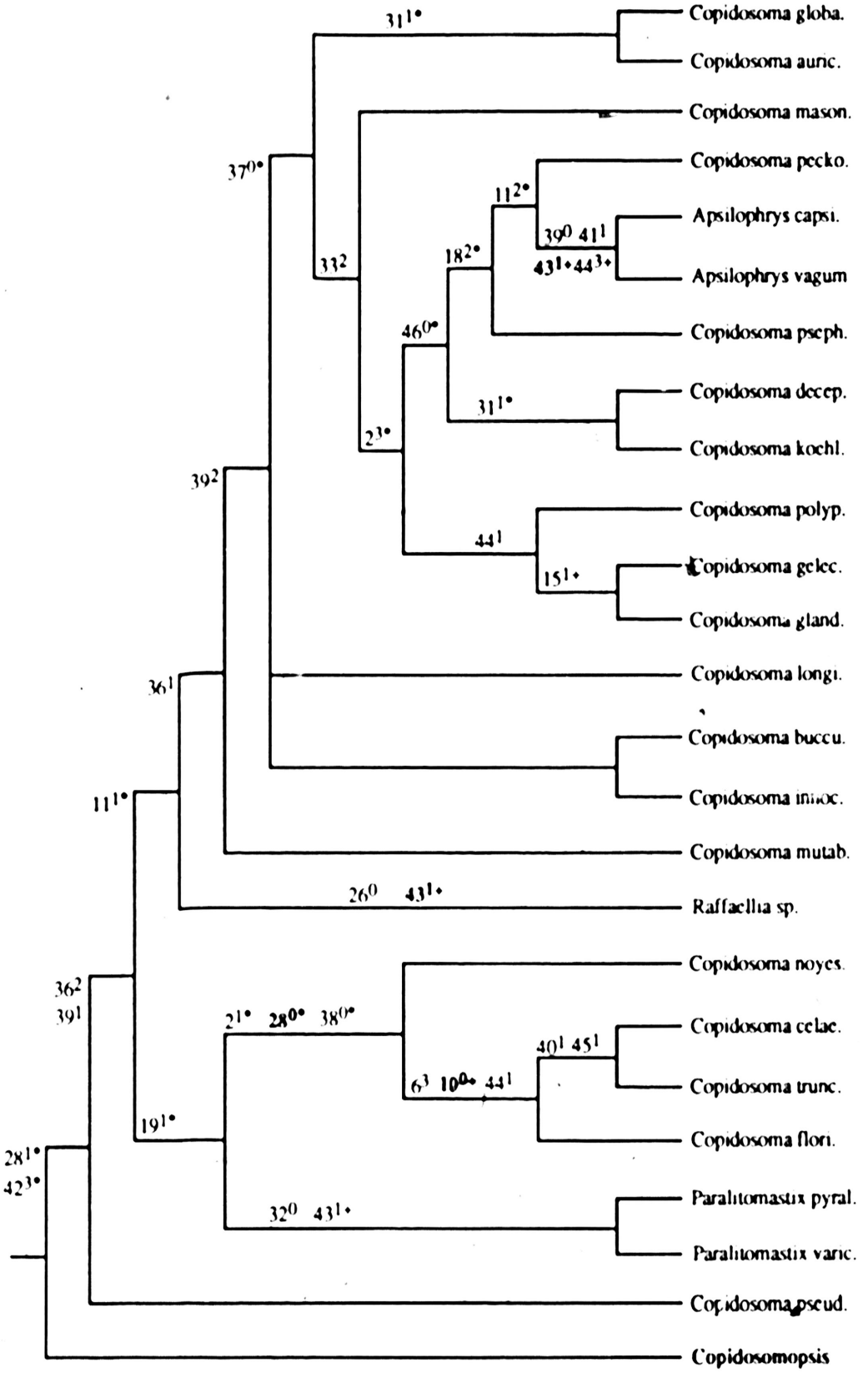

Copidosoma globa.
Copidosoma aunc.
Copidosoma mason.
Copidosoma pecko.
Apsilophrys capsi.
Apsilophrys vagum
Copidosoma pseph.
Copidosoma decep.
Copidosoma kochl.
Copidosoma polyp.
Copidosoma gelec.
Copidosoma gland.
Copidosoma longi.
Copidosoma buccu.
Copidosoma inioc.
Copidosoma mutab.
Raffaellia sp.
Copidosoma noyes.
Copidosoma celae.
Copidosoma trunc.
Copidosoma flori.
Paralitomastix pyral.
Paralitomastix varic.
Copidosoma pseud.
Copidosomopsis

Fig. 445. Strict consensus cladogram of 1269 equally parsimonious cladograms resulting from Analysis 5, which utilized a reduced number of characters. Most Copidosomatina are collapsed and appear in Figure 446. Cladograms used to construct the consensus cladogram have length = 115 when the characters are reweighted to 1, CI excluding uninformative characters and characters reweighted to 1 = 0.497, RI = 0.811.

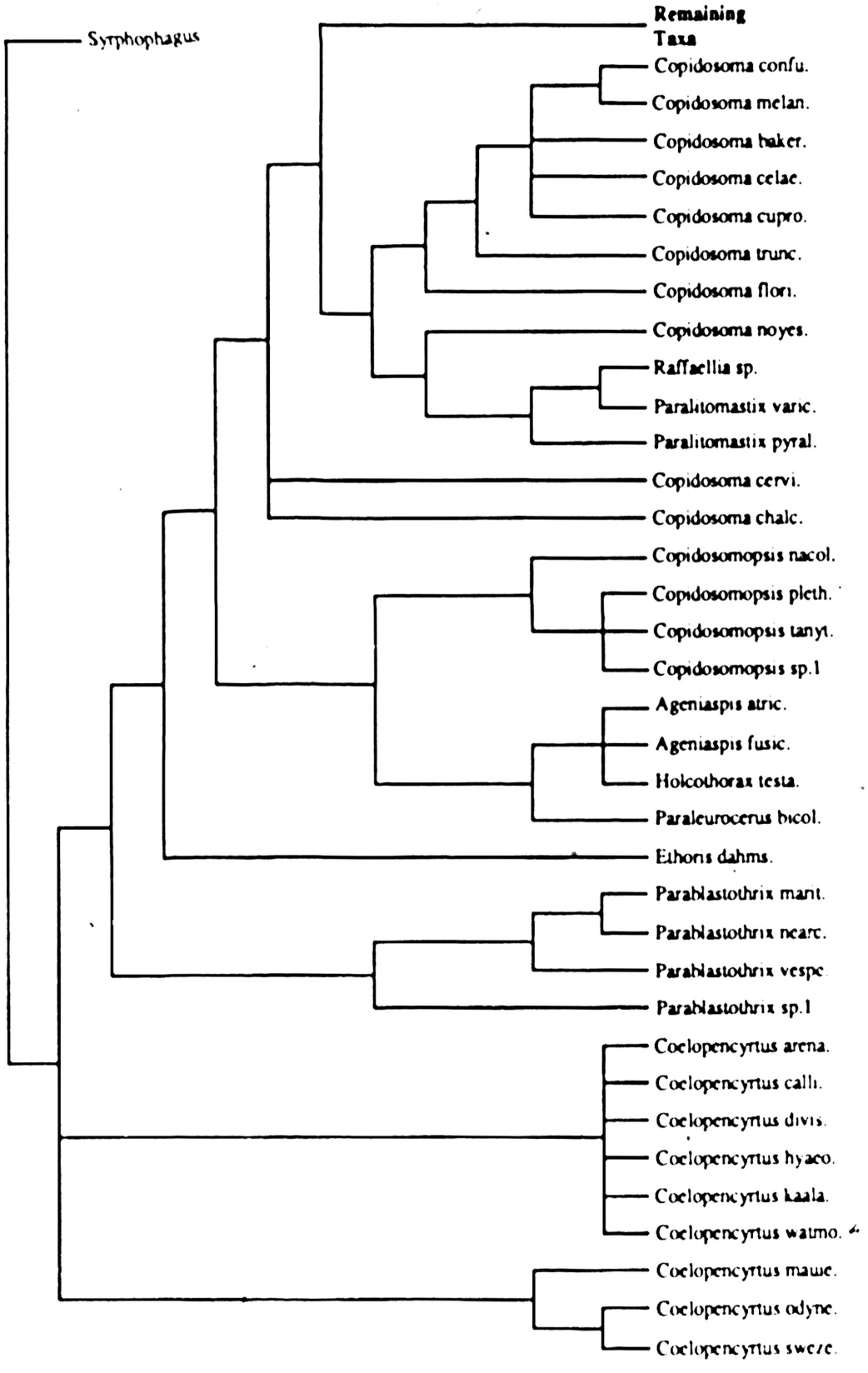

Syrphophagus
Remaining
Taxa
Copidosoma confu.
Copidosoma melan.
Copidosoma baker.
Copidosoma celae.
Copidosoma cupro.
Copidosoma trunc.
Copidosoma flori.
Copidosoma noyes.
Raffaellia sp.
Paralitomastix varic.
Paralitomastix pyral.
Copidosoma cervi.
Copidosoma chalc.
Copidosomopsis nacol.
Copidosomopsis pleth.
Copidosomopsis tanyt.
Copidosomopsis sp.1
Ageniaspis atric.
Ageniaspis fusic.
Holcothorax testa.
Paraleurocerus bicol.
Ethoris dahms.
Parablastothrix mant.
Parablastothrix neare.
Parablastothrix vespe
Parablastothrix sp.1
Coelopencyrtus arena.
Coelopencyrtus calli.
Coelopencyrtus divis.
Coelopencyrtus hyaco.
Coelopencyrtus kaala.
Coelopencyrtus watmo.
Coelopencyrtus mawe.
Coelopencyrtus odyne.
Coelopencyrtus sweze.

Fig. 446. Strict consensus cladogram of 1269 equally parsimonious cladograms resulting from Analysis 5, which utilized a reduced number of characters. Taxa basal to *Copidosoma pseudoinnocuellae* appear in Figure 445. Cladograms used to construct the consensus cladogram have length = 115 when the characters are reweighted to 1, CI excluding uninformative characters and characters reweighted to 1 = 0.497, RI = 0.811.

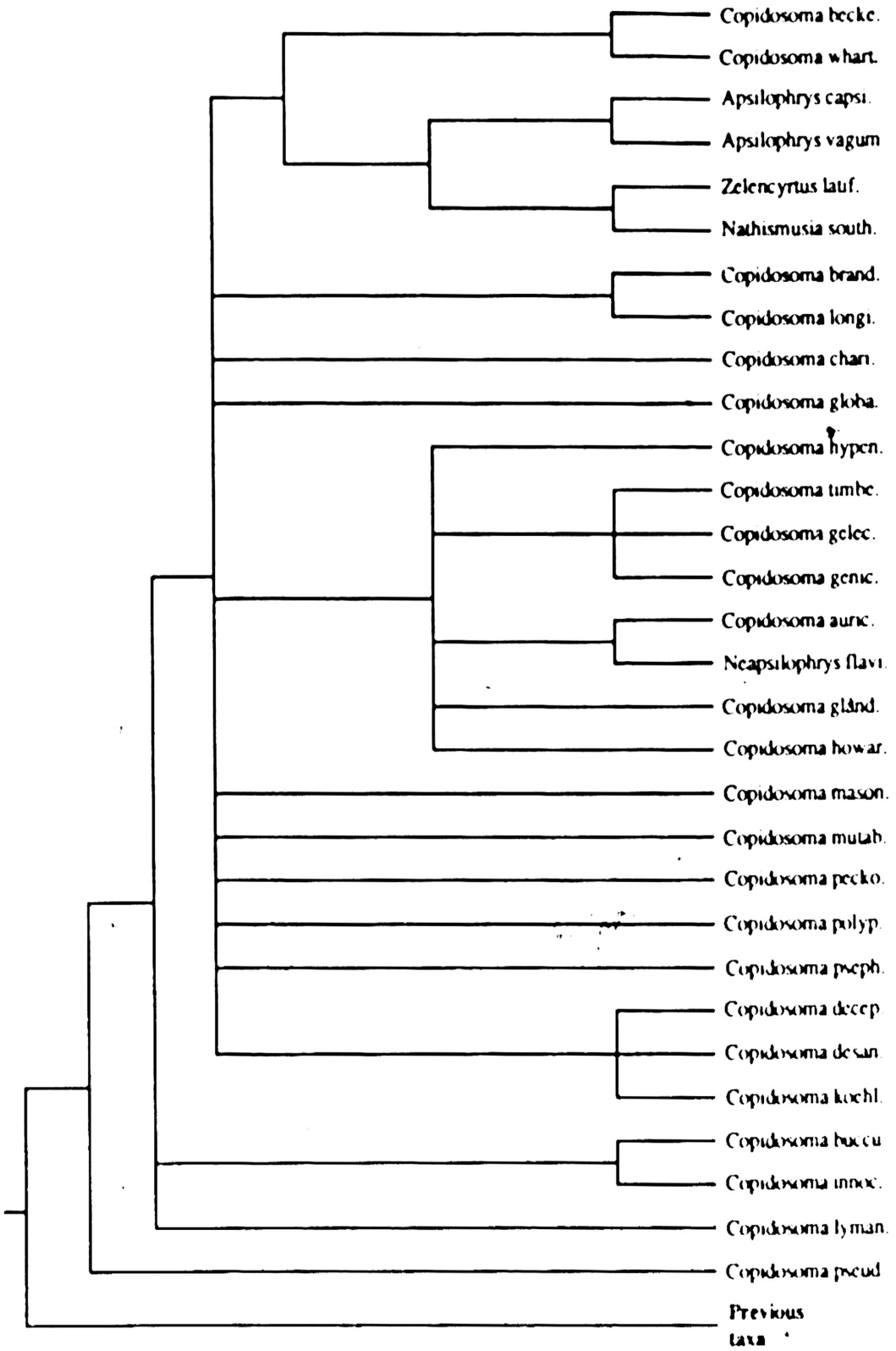

Copidosoma becke.
Copidosoma whart.
Apsilophrys capsi.
Apsilophrys vagum
Zelencyrtus lauf.
Nathismusia south.
Copidosoma brand.
Copidosoma longi.
Copidosoma chari.
Copidosoma globa.
Copidosoma hypen.
Copidosoma timbe.
Copidosoma gelec.
Copidosoma genic.
Copidosoma auric.
Neapsilophrys flavi.
Copidosoma gland.
Copidosoma howar.
Copidosoma mason.
Copidosoma mutab.
Copidosoma pecko.
Copidosoma polyp.
Copidosoma pseph.
Copidosoma decep.
Copidosoma desan.
Copidosoma koehl.
Copidosoma bucci
Copidosoma innoc.
Copidosoma lyman.
Copidosoma pseud
Previous
taxa

Fig. 447. Strict consensus cladogram of 8 equally parsimonious cladograms resulting from Analysis 6, which utilized a reduced number of taxa and characters. Most Copidosomatina are collapsed and appear in Fig. 448. Character states are listed and described in Tables 2 and 3. Character notation is the same as for Fig. 441. Each character and its state plotted have a single model of state change and are identical on all 12 final cladograms. Length with characters reweighted to 1 = 4733, CI excluding uninformative characters and characters reweighted to 1 = 0.457, RI = 0.798.

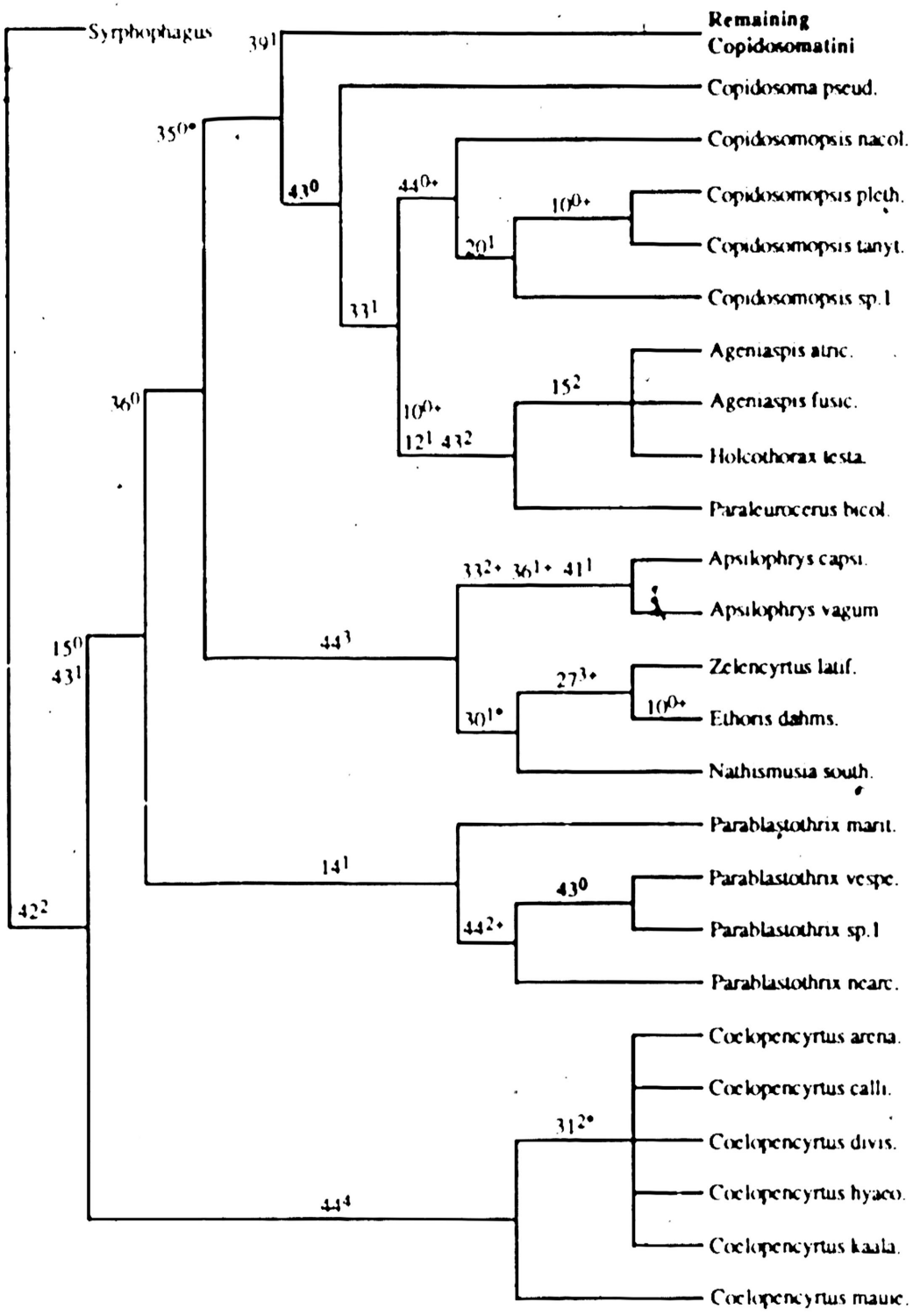
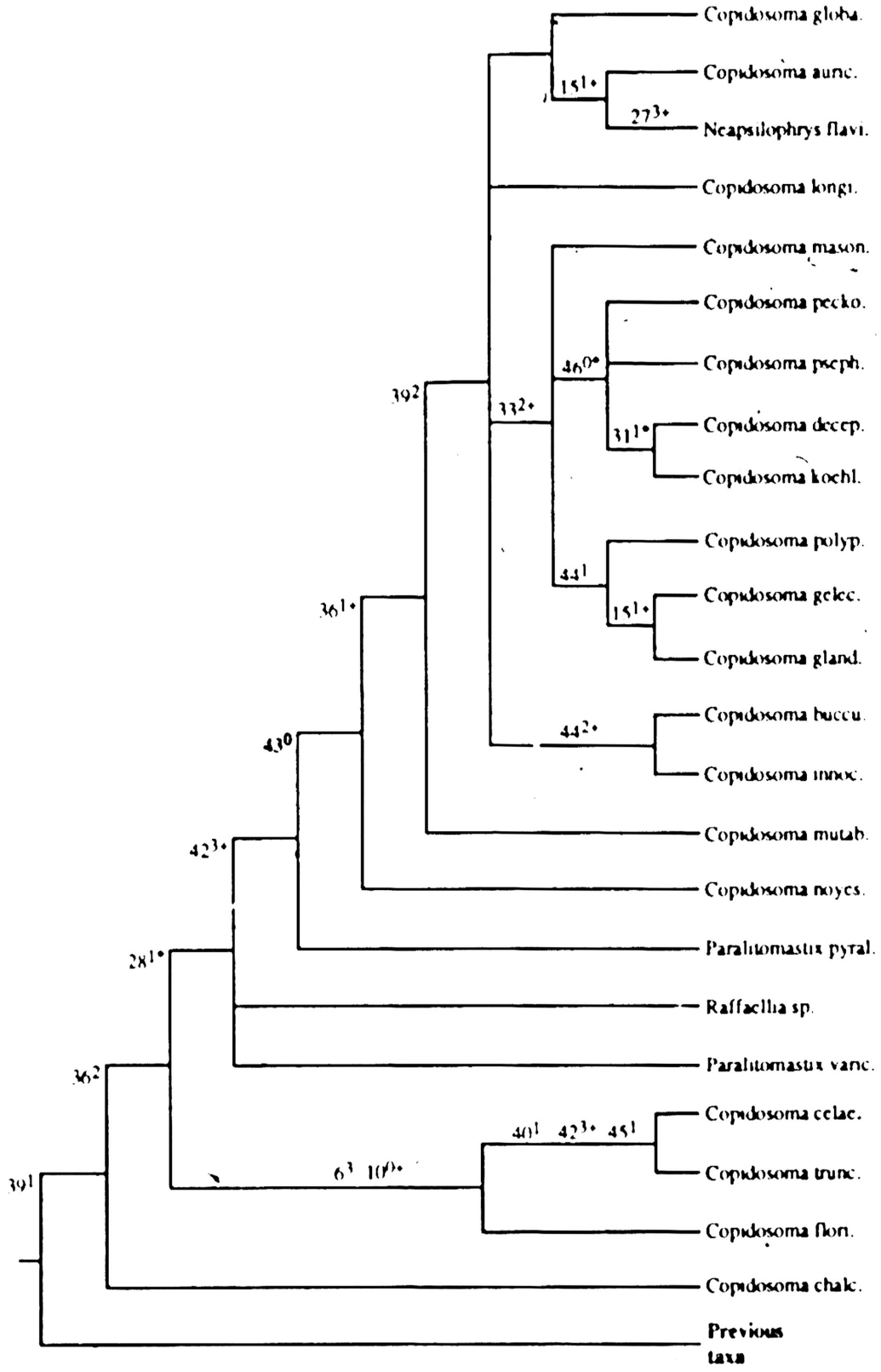

Symphoptagus
391
Remaining
Copidosomatini
Copidosoma pseud.
350*
Copidosomopsis nacol.
430
440+
100+
Copidosomopsis pleth.
201
Copidosomopsis tanyt.
331
Copidosomopsis sp.1
Ageniaspis atric.
152
360
Ageniaspis fusic.
100+
121 432
Holcothorax testa.
Paraleurocerus bicol.
332+ 361+ 411
Apsilophrys capsi.
Apsilophrys vagum
150
431
443
Zelencyrtus latif.
273+
100+
301*
Ethoris dahms.
Nathismusia south.
Parablastothrix marit.
141
Parablastothrix vespe.
430
422
442+
Parablastothrix sp.1
Parablastothrix nearc.
Coelopencyrtus arena.
Coelopencyrtus calli.
312*
Coelopencyrtus divis.
444
Coelopencyrtus hyaco.
Coelopencyrtus kaula.
Coelopencyrtus mauic.

Fig. 448. Strict consensus cladogram of 8 equally parsimonious cladograms resulting from Analysis 6, which utilized a reduced number of characters. Taxa basal to *Copidosoma chalconotum* appear in Figure 447. Character states are listed and described in Tables 2 and 3. Character notation is the same as for Fig. 441. Each character and its state plotted have a single model of state change and are identical on all 12 final cladograms. Length with characters reweighted to 1 = 4733, CI excluding uninformative characters and characters reweighted to 1 = 0.457, RI = 0.798.


Copidosoma globa.
Copidosoma aunc.
Neapsilophrys flavi.
Copidosoma longi.
Copidosoma mason.
Copidosoma pecko.
Copidosoma pseph.
Copidosoma decep.
Copidosoma koehl.
Copidosoma polyp.
Copidosoma gelec.
Copidosoma gland.
Copidosoma buccu.
Copidosoma innoc.
Copidosoma mutab.
Copidosoma noyes.
Paralitomastix pyral.
Raffaellia sp.
Paralitomastix varic.
Copidosoma celae.
Copidosoma trunc.
Copidosoma flori.
Copidosoma chalc.
Previous taxa
151*
273*
460*
392
332*
311*
441
361*
151*
442*
430
423*
281*
362
401 423* 451
63 100*
391

APPENDIX 2
TABLES

TABLE 1. Historical changes in the tribe Copidosomatini.

Hoffer (1955)	Erdös and Novicky (1955)	Triapitzin (1973b)
Tribe Copidosomini	Tribe Copidosomini	Tribe Copidosomatini Hoffer
Copidosoma, Litomastix, Paralitomastix, Verdunia, Sectiliclava, Cerchysius	Subtribe Copidosomina *Copidosoma, Litomastix, Paralitomastix*	Subtribe Copidosomatina Hoffer *Copidosoma, Litomastix, Paralitomastix, Pentalitomastix, Apsilophrys, Copidencyrtus*
Tribe Ageniaspidini *Ageniaspis, Holcothorax, Eustrius, Geniaspidius, Parageniaspis*	Subtribe Ageniaspidina *Ageniaspis, Holcothorax, Athesmus Geniaspidius, Parageniaspis*	Subtribe Ageniaspidina Hoffer *Ageniaspis, Holcothorax, Paraleurocerus*
Tribe Microteryni Subtribe Pentacnemii *Pentacnemus, Parablasthothrix, Calometopia*	Tribe Microteryni Subtribe Parablastothrichina *Parablastothrix, Calometopia*	Subtribe Pentacnemina Hoffer *Pentacnemus, Parablasthothrix, Calometopia*
	Tribe Bothriothoracini Subtribe Tetralophidea *Pentacnemus*	
		Subtribe Coelopencyrtina *Coelopencyrtus, Giraultella, Xylencyrtus*

TABLE 2. Tribe Copidosomatini.

Subtribe	Genus	# Species	Distribution	Host
Coelopencyrtina	*Coelopencyrtus*	25	Cosmopolitan	Anthophoridae, Colletidae, Vespidae
	Nathismusia	1	Indo-Pacific	Unknown
	Xylencyrtus	2	Ethiopian	Anthophoridae
Parablastotrichina	*Parablastothrix*	16	Cosmopolitan	Nepticulidae, Heliozelidae, Lyonetiidae, Gracillariidae
Ageniaspidina	*Ageniaspis*	9	Cosmopolitan	Tineidae, Lyonetiidae, Gracillariidae, Yponomeutidae, Argyresthiidae, Tortricidae, Pterophoridae
	Ethoris	1	Indo-Pacific	Unknown
	Holcothorax	2	Holarctic	Nepticulidae, Gracillariidae
	Paraleurocerus	3	New World	Gracillariidae
	Zelencyrtus	1	New Zealand	Unknown
Copidosomatina	*Copidosoma*	200	Cosmopolitan	Oecophoridae, Blastobasidae, Coleophoridae, Momphidae, Gelechiidae, Plutellidae, Yponomeutidae, Argyresthiidae, Cossidae, Tortricidae, Geometridae, Pyralidae, Noctuidae

TABLE 2 continued.

Subtribe	Genus	# Species	Distribution	Host
Copidosomatina	*Copidosomopsis*	7	Australasian, Holarctic, Neotropical	Tortricidae, Pyralidae
	Neapsilophrys	1	Neotropical	Unknown

TABLE 3. Character coding used for character states in the phylogenetic analysis of Copidosomatini as presented in Table 4. Numbers in parentheses indicate the unit consistency index, unit retention index, and weight used in the final iteration for the cladogram shown in Figs. 441-442.

Antenna

1. Number of female funicular segments: 5-6 (0.250, 0.500, 13).
2. Number of female club segments: 1; 3 (0.300, 0.588, 18).
3. Female club apex: 0, rounded; 1, truncate; 2, obliquely truncate, less than 0.25x club length; 3, strongly obliquely truncate, more than 0.25x club length (0.167, 0.583, 10).
4. Male funicular segments: 0, joined in center; 1, joined off center (0.200, 0.765, 15).
5. Number of male club segments: 1; 2 (1.000, 0/0, 100).
6. Male club apex: 0, rounded; 1, truncate; 2, obliquely truncate, less than 0.25x club length; 3, strongly obliquely truncate, more than 0.25x club length (0.600, 0.750, 45).
7. Male funicle pectinate: 0, without branches; 1, with incipient branches; 2, with elongate branches (0.400, 0.571, 23).

Head

8. Toruli: 0, at mouth margin; 1, within own length of mouth margin; 2, greater than own length from mouth margin (0.154, 0.500, 8).
9. Mandibular teeth: 0, 3 subequal teeth; 1, middle tooth longest; 2, anterior tooth shortest, posterior longest; 3, posterior tooth largest, remaining smaller and subequal (0.750, 0.857, 64).
10. Anterior mandibular seta: 0, normal; 1, enlarged; 2, peglike (0.500, 0.880, 44).
11. Posterior mandibular seta: 0, normal; 1, enlarged; 2, bladelike (0.214, 0.656, 14).
12. Dorsal arms of tentorium: 0, present; 1, absent (0.333, 0.600, 20).
13. Malar sulcus: 0, present; 1, absent (0.250, 0.571, 14).
14. Eye size: 0, normal; 1, enlarged (1.000, 1.000, 100).

Mesosoma

15. Mesoscutum sculpture: 0, polygonal reticulate; 1, elongate reticulate; 2, striate; 3, imbricate (0.750, 0.947, 71).
16. Tegula color: 0, dark; 1, with some light color (0.333, 0.500, 17).
17. Axillae meeting: 0, separate; 1, meeting (1.000, 0/0, 100).

TABLE 3 continued.

18. Axillae height: 0, flat; 1, slightly elevated above scutellum; 2, greatly elevated above scutellum (0.250, 0.700, 17).
19. Scutellum sculpture: 0, polygonal reticulate; 1, elongate reticulate; 2, striate; 3, imbricate (0.250, 0.679, 17).
20. Propodeal spiracle: 0, round; 1, elongate (1.000, 1.000, 100).
21. Forecoxa color: 0, dark; 1, with light color (0.083, 0.0, 0).
22. Midcoxa color: 0, dark; 1, with light color (0.500, 0.0, 0).
23. Hind coxa color: 0, dark; 1, with light color (0.250, 0.0, 0).
24. Forewing color: 0, hyaline; 1, infuscate around marginal and stigmal veins; 2, more extensively infuscate (0.111, 0.429, 5).
25. Hyaline break of submarginal vein: 0, without hyaline break; 1, with hyaline break (0.200, 0.333, 7).
26. Marginal vein length: 0, as broad as long; 1, 1-3x longer than broad; 2, more than 3x longer than broad (0.400, 0.0, 0).
27. Postmarginal vein length: 0, absent or rudimentary; 1, shorter than stigmal vein; 2, as long as stigmal vein; 3, longer than stigmal vein (0.600, 0.800, 48).
28. Linea calva: 0, not interrupted; 1, interrupted by dorsal setae (0.462, 0.682, 31).
29. Number of stigmal vein sensilla: 3-4 (1.000, 0/0, 100).
30. Shape of stigmal vein sensilla: 0, square; 1, other (0.500, 0.895, 45)

Metasoma

31. Hypopygium position: 0, in middle 1/3 of metasoma; 1, in apical 1/3 of metasoma; 2, at apex of metasoma; 3, extending beyond apex of metasoma (0.286, 0.706, 20).
32. Cerci position: 0, in anterior 1/3 of metasoma; 1, in middle 1/3 of metasoma; 2, in posterior 1/3 of metasoma (0.389, 0.214, 8).
33. Sternites 5-6: 0, simple; 1, divided medially; 2, lobed; 3, incised (0.600, 0.913, 55).
34. Syntergum: 0, not divided medially; 1, divided medially (0.500, 0.500, 25).
35. First valvifer articulation: 0, first valvifer with dorsal articulation to syntergum ; 1, with medial articulation (0.250, 0.875, 22).
36. Second valvifer spicules: 0, absent; 1, individual spicules in longitudinal or oblique rows; 2, transverse spicules with common base; 3, compound spicules (1.000, 1.000, 100).
37. Second valvifer fused to third valvula: 0, not fused; 1, fused (0.200, 0.810, 16).

TABLE 3 continued.

38. Third valvulae exserted: 0, not exserted; 1, exserted less than 0.25x length of metasoma; 2, exserted 0.25-0.5x length of metasoma; 3, exserted 0.5-1.0x length of metasoma; 4, exserted more than length of metasoma (0.200, 0.304, 6).
39. Phallobase setation: 0, with 1-5 pairs setae; 1, with 6-10 pairs setae; 2, with 11 or more pairs setae (0.250, 0.829, 21).
40. Phallobase flange: 0, absent; 1, present (1.000, 1.000, 100).
41. Phallobase midrib: 0, absent; 1, present (0.667, 0.500, 33).
42. Number of digital claws: 1-5 (0.444, 0.688, 31).
43. Position of digital claws: 0, transverse at apex; 1, offset at apex; 2, both proximal and apical (0.533, 0.500, 27).
44. Pores of digiti: 0, absent; 1, with 1 apical pore; 2, with 1 proximal pore; 3, with 2 apical pores; 4, with proximal and apical pores (0.400, 0.545, 22).
45. Aedeagal hooks: 0, absent; 1, with 1 pair of hooks; 2, with multiple rows (1.000, 1.000, 100).
46. Aedeagal sensilla: 0, absent; 1, with 1 pair; 2, with more than 1 pair (0.286, 0.853, 24).
47. Host: 0, Aphididae; 1, aculeate Hymenoptera; 2, Lepidoptera (1.000, 1.000, 100).

TABLE 4. Data matrix used for phylogenetic analysis. Numbers correspond to character states listed in Table 3. Question marks denote missing data and stacked values indicate a species polymorphic for that character.

| | Character | | |

TABLE 4 continued.

Taxon	Character 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
Copidosoma celaenae	6 1 3 0 1 3 0 1 2 0 0 0 1 0 0 0 1 1 1 0 0 0 0 2 1 1 1 1 4 0 0 2 0 0 0 2 1 0 1 1 0 3 0 0 1 1 2 1 1 2
Copidosoma cervius	6 3 3 0 1 3 0 1 0 1 1 0 1 0 0 0 1 2 0 0 0 0 0 0 0 1 1 1 0 4 0 1 1 0 0 0 0 0 1 1 0 0 1 0 1 0 0 2 2 2 1 2 2 2 3 4
Copidosoma chalconotus	6 3 3 1 1 0 0 1 0 1 1 0 1 0 0 0 1 2 0 0 0 0 0 0 0 1 1 1 0 4 0 1 1 1 0 0 0 0 0 1 1 0 0 2 1 0 0 0 2 2 1
Copidosoma cuproviridis	6 1 3 0 1 3 0 1 2 0 0 0 1 0 0 0 1 1 1 0 0 0 0 2 1 1 1 1 4 0 0 1 0 0 0 2 1 1 1 1 0 3 0 0 1 1 ? 1 1 2
Copidosoma deceptor	6 3 0 1 1 0 0 1 0 1 1 0 1 0 0 0 1 1 0 0 0 0 0 0 1 1 1 1 4 0 1 1 1 0 1 0 0 1 2 0 0 3 0 0 2 0 2
Copidosoma desantisi	6 3 0 1 1 0 0 1 0 1 1 0 1 0 0 0 1 1 0 0 0 0 0 0 1 1 1 1 4 0 1 0 2 0 1 1 0 1 2 0 0 3 0 0 0 0 2 2
Copidosoma floridanum	6 1 3 0 1 3 0 1 0 0 0 0 1 0 0 0 1 1 0 0 0 0 0 2 1 1 1 0 4 0 0 1 0 0 0 2 1 0 1 0 0 2 0 1 0 1 2 1
Copidosoma gelechiae	6 3 0 1 1 0 0 1 0 1 1 0 1 0 1 0 1 1 1 0 0 0 0 2 1 1 1 1 4 0 2 1 2 1 1 1 0 1 2 0 0 3 0 1 0 1 2 4
Copidosoma geniculatum	6 3 0 1 1 0 0 1 0 1 1 0 1 0 1 1 1 1 1 0 1 0 0 0 0 1 1 1 4 0 2 1 2 1 1 1 0 1 2 0 0 3 0 2 0 1 2
Copidosoma glandiferellae	6 3 0 1 1 0 0 1 0 1 1 0 1 0 1 1 1 1 1 0 0 0 0 0 1 1 1 1 4 0 2 1 2 0 1 1 0 1 2 0 0 3 0 2 0 1 2
Copidosoma howardi	6 3 0 0 1 3 0 1 0 1 1 0 1 0 1 1 1 1 0 0 1 0 0 0 0 1 1 1 4 0 2 1 2 0 1 1 0 4 2 0 0 3 0 2 0 1 2
Copidosoma innocuellae	6 3 0 1 1 0 0 0 0 1 2 0 1 0 0 0 1 1 0 0 1 0 0 0 1 1 1 1 4 0 2 1 0 0 0 1 1 2 2 0 0 4 0 2 0 1 2 2 1 5
Copidosoma koehleri	6 3 0 1 1 0 0 1 0 1 1 0 1 0 0 0 1 1 0 0 0 0 0 0 1 1 1 1 4 0 1 0 2 0 1 1 0 1 2 0 0 3 0 0 0 0 2 2 1
Copidosoma lymani	6 3 2 1 1 0 0 0 0 1 2 0 1 0 0 0 1 1 0 0 0 0 0 0 1 1 1 1 4 0 2 2 0 0 0 1 1 1 1 0 0 3 0 1 0 1 2

TABLE 4 continued.

Taxon	Character 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
Copidosoma melanocerum	6 1 2 0 1 2 0 1 2 0 0 0 1 0 0 0 1 1 1 0 0 0 0 1 1 1 1 1 4 0 0 0 0 0 0 2 1 1 1 1 0 3 0 0 1 1 2
Copidosoma truncatellum	6 1 3 0 1 3 0 1 0 0 0 0 1 0 0 0 1 1 1 0 0 0 0 1 1 1 1 0 4 0 1 1 0 0 0 2 1 0 1 1 0 3 1 1 1 1 2
Apsilophrys capsicum	6 3 0 1 1 0 0 0 0 1 2 0 1 0 0 0 1 2 1 0 1 0 0 0 1 1 1 0 4 0 2 1 2 0 1 1 0 1 0 0 1 2 1 3 0 0 2
Apsilophrys vagum	6 3 0 1 1 0 0 0 0 1 2 0 1 0 0 0 1 2 1 0 0 0 0 0 1 1 2 0 4 0 2 2 2 0 1 1 0 2 0 0 1 2 1 3 0 0 2
Zelencyrtus latifrons	6 1 0 1 1 0 0 1 1 1 0 0 0 0 0 ? 1 ? 0 0 0 0 0 2 1 1 3 0 4 1 2 1 ? ? ? ? ? 1 0 0 0 4 1 3 0 0 ?
Copidosomopsis nacoleiae	5 1 3 1 1 0 0 1 0 1 2 0 1 0 0 0 1 1 0 0 0 0 0 1 1 1 0 0 4 0 1 1 1 0 0 0 1 0 0 0 0 1 0 0 0 2 2
Copidosomopsis plethoricus	5 3 2 1 1 0 0 1 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 1 0 0 0 4 0 1 1 1 0 0 0 1 0 0 0 0 2 0 0 0 2 2
Copidosomopsis tanytmemus	5 3 3 1 1 0 0 0 0 0 0 0 1 0 0 0 1 0 0 1 0 0 0 1 1 1 0 0 4 0 2 1 1 0 0 0 1 1 0 0 0 3 0 0 0 2 2
Copidosomopsis sp1	5 1 3 1 1 0 0 1 0 1 1 0 1 0 0 0 1 0 0 1 0 0 0 1 1 1 0 0 4 0 1 1 1 0 0 0 1 1 0 0 0 2 0 0 0 2 ?
Raffaellia sp	5 3 0 1 1 0 0 1 0 1 1 0 1 0 0 0 1 1 0 0 0 0 0 1 1 0 1 1 4 0 1 1 0 0 0 2 1 1 1 0 0 2 1 0 0 1 ?
Paralitomastix pyralidis	6 3 2 1 1 0 0 1 0 1 2 0 1 0 0 0 1 1 1 0 0 0 0 0 1 1 1 1 4 0 1 0 0 0 0 2 1 1 1 0 0 3 1 0 0 1 2
Paralitomastix varicornis	6 3 1 1 1 0 0 1 0 1 2 0 1 0 0 0 1 1 2 0 0 0 0 0 1 1 1 1 4 0 1 0 0 0 0 2 1 1 1 0 0 2 1 ? 0 1 2
Ageniaspis atricollis	6 1 0 1 1 0 0 1 0 0 0 1 0 0 2 0 1 1 2 0 0 0 0 0 1 1 3 1 4 1 1 0 1 0 0 0 1 2 0 0 0 2 2 1 0 2 2
Ageniaspis fusicollis	6 1 2 1 1 0 0 2 0 0 0 1 0 0 2 0 1 1 2 0 0 0 0 0 1 1 3 1 4 1 1 0 1 0 0 0 0 0 0 0 0 2 2 1 0 2 2
Paraleurocerus bicoloripes	6 1 2 1 1 0 0 1 0 0 0 1 0 0 0 0 1 1 1 0 0 0 0 0 1 1 3 1 4 1 1 1 1 0 0 0 0 1 0 0 0 2 2 1 0 2 2
Holcothorax testaceipes	5 1 2 1 1 0 0 1 0 0 0 1 1 0 2 0 1 1 1 0 1 1 1 0 1 1 3 1 4 1 1 2 1 0 0 0 0 0 0 0 0 2 2 1 0 2 2
Neapsilophrys flavipes	6 3 0 ? ? ? ? 1 0 1 0 0 1 0 1 0 1 1 2 0 1 0 0 0 1 2 3 1 4 1 1 0 ? 0 1 1 0 3 ? ? ? ? ? ? ? ? ?
Ethoris dahmsi	6 3 0 ? ? ? ? 2 1 0 ? 0 0 0 0 0 1 1 1 0 0 1 1 1 0 1 2 3 0 4 1 1 0 0 0 1 0 0 0 ? ? ? ? ? ? ? ? ?
Parablastothrix maritima	6 3 2 ? 1 0 2 2 0 ? ? 1 1 1 0 0 1 1 0 0 0 0 0 2 0 1 1 1 4 0 1 1 ? 0 ? ? 0 1 0 0 0 2 1 1 0 0 2
Parablastothrix vespertina	6 3 2 ? 1 0 2 2 0 2 2 0 0 1 0 1 1 1 0 0 0 0 0 0 0 1 1 1 0 4 0 1 1 ? 0 1 ? 0 1 0 0 0 2 0 ? 0 0 2
Parablastothrix nearctica	6 3 2 ? 1 0 2 2 0 2 2 0 0 1 0 1 1 1 0 0 1 0 1 2 1 1 1 0 4 0 1 1 0 0 1 3 0 1 0 0 0 2 1 2 0 0 2
Parablastothrix sp1	6 3 2 ? 1 0 2 2 0 2 2 0 0 1 0 1 1 1 0 0 0 0 0 0 0 1 1 1 4 1 0 1 0 0 1 3 0 1 0 0 0 2 0 2 0 0 ?
Nathismusia southwoodi	6 3 0 ? ? ? ? ? 2 ? ? ? ? 1 0 0 0 1 0 0 0 0 0 0 2 1 1 1 ? 3 1 2 1 ? 0 ? ? ? 0 ? ? ? ? ? ? ? ? ?

TABLE 4 continued.

| | Character | | |

TABLE 5. Comparison of CI and RI values from Analyses 1 and 4-6. The first analysis utilized the full dataset and employed successive approximations with the characters reweighted to the mean value of the rescaled consistency index, the second analysis excluded 18 taxa, the third analysis used the 25 best characters as determined by the first analysis, and the fourth analysis used the same taxa as the second and the same characters as the third. Each analysis using a reduced dataset employed successive approximations with the characters reweighted to the maximum value of the rescaled consistency index. The overall CI and RI values in the upper portion are based on reweighting the characters to a value of 1.

	Full data		Reduced taxa		Reduced characters		Reduced taxa & characters	
Final number of cladograms	7		12		1269		8	
CI excluding uninformative characters	0.363		0.342		0.497		0.457	
Retention index	0.685		0.657		0.811		0.798	
Character	CI	RI	CI	RI	CI	RI	CI	RI
1. no. of female funicular segments	0.250	0.500	0.250	0.500	--	--	--	--
2. number of female club segments	0.300	0.588	0.333	0.538	--	--	--	--
3. female club apex	0.167	0.583	0.231	0.615	--	--	--	--
4. male funicular segments	0.200	0.765	0.333	0.750	--	--	--	--
5. number of male club segments	1.000	0/0	1.000	0/0	--	--	--	--
6. male club apex	0.600	0.750	1.000	1.000	0.600	0.750	1.000	1.000
7. male funicle pectinate	0.400	0.571	0.333	0.600	0.400	0.571	0.333	0.600
8. toruli	0.154	0.500	0.167	0.412	--	--	--	--
9. mandibular teeth	0.750	0.857	0.750	0.0	0.600	0.714	1.000	1.000
10. anterior mandibular setae	0.500	0.880	0.500	0.833	0.500	0.880	0.429	0.778
11. posterior mandibular setae	0.214	0.656	0.300	0.708	--	--	--	--
12. dorsal arms of tentorium	0.333	0.600	0.500	0.750	0.333	0.600	0.500	0.750
13. malar sulcus	0.250	0.571	0.250	0.571	--	--	--	--

TABLE 5 continued.

	Full data		Reduced taxa		Reduced characters		Reduced taxa & characters	
Character	CI	RI	CI	RI	CI	RI	CI	RI
14. eye size	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
15. mesoscutum sculpture	0.750	0.947	0.600	0.833	1.000	1.000	0.750	0.917
16. tegula color	0.333	0.500	0.400	0.400	--	--	--	--
17. axillae meeting	1.000	0/0	1.000	0/0	--	--	--	--
18. axillae height	0.250	0.700	0.286	0.615	--	--	--	--
19. scutellum sculpture	0.250	0.679	0.300	0.632	--	--	--	--
20. propodeal spiracle	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
21. forecoxa color	0.083	0.000	0.100	0.000	--	--	--	--
22. midcoxa color	0.500	0.000	0.500	0.000	--	--	--	--
23. hind coxa color	0.250	0.000	0.250	0.000	--	--	--	--
24. forewing color	0.111	0.429	0.143	0.294	--	--	--	--
25. hyaline break of submarginal vein	0.200	0.333	0.333	0.000	--	--	--	--
26. marginal vein length	0.400	0.000	0.400	0.000				
27. postmarginal vein length	0.600	0.800	1.000	1.000	0.429	0.600	0.600	0.778
28. linea calva	0.462	0.682	0.273	0.600	0.462	0.682	0.300	0.650
29. number of stigmal vein sensilla	1.000	0/0	1.000	0/0	--	--	--	--
30. stigmal vein sensilla shape	0.500	0.895	0.667	0.938	0.333	0.789	0.333	0.750
31. hypopygium position	0.286	0.706	0.333	0.619	0.308	0.735	0.333	0.619
32. cerci position	0.389	0.214	0.500	0.375	--	--	--	--

TABLE 5 continued.

Character	Full data		Reduced taxa		Reduced characters		Reduced taxa & characters	
	CI	RI	CI	RI	CI	RI	CI	RI
33. sternites 5-6	0.600	0.913	0.500	0.875	0.600	0.913	0.500	0.875
34. syntergum	0.500	0.500	1.000	0/0	1.000	1.000	1.000	0/0
35. 1st valvifer articulation	0.250	0.875	0.250	0.833	0.500	0.958	0.333	0.889
36. 2nd valvifer spicules	1.000	1.000	0.500	0.885	0.750	0.971	0.600	0.923
37. 2nd valvifer fused to 3rd valvulae	0.200	0.810	0.333	0.875	--	--	--	--
38. 3rd valvulae exserted	0.200	0.304	0.188	0.235	--	--	--	--
39. phallobase setation	0.250	0.829	0.500	0.900	0.286	0.857	1.000	1.000
40. phallobase flange	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
41. phallobase midrib	0.667	0.500	0.500	0.500	0.667	0.500	0.500	0.500
42. number of digital claws	0.444	0.688	0.385	0.619	0.471	0.719	0.455	0.714
43. digital claw position	0.533	0.500	0.417	0.462	0.571	0.571	0.500	0.615
44. pores of digiti	0.400	0.545	0.429	0.636	0.435	0.606	0.500	0.727
45. aedeagal hooks	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
46. aedeagal sensilla	0.286	0.853	0.333	0.833	0.333	0.882	0.333	0.833
47. host	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

TABLE 6. Lepidoptera hosts of Copidosomatini listed by superfamily.

Host Superfamily	Copidosomatine Genera
MONOTRYSIA	
Nepticuloidea	*Parablastothrix*, *Holcothorax*
Incurvarioidea	*Parablastothrix*
DITRYSIA	
Tineoidea	*Parablastothrix*, *Holcothorax*, *Paraleurocerus*, *Ageniaspis*
Gelechioidea	*Copidosoma*
Yponomeutoidea	*Ageniaspis*, *Copidosoma*
Cossoidea	*Copidosoma*
Tortricoidea	*Copidosoma*, *Copidosomopsis*
Pterophoroidea	*Ageniaspis*
Pyraloidea	*Copidosoma*, *Copidosomopsis*
Geometroidea	*Copidosoma*
Noctuoidea	*Copidosoma*