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Catalog of Parasitoids of Saturniidae of the World

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Abstract. Parasitoids known to attack Saturniidae, and hyperparasitoids reared from Saturniidae, are listed in taxonomic categories; about 350 species of parasitoids are recorded from about 175 species of Saturniidae. These include 105 Ichneumonidae, 21 Braconidae, 3 Trigonalyidae, 115 Tachinidae, 4 Sarcophagidae, 2 Pyralidae, as well as about 100 records for families of Chalcidoidea (Torymidae, Eurytomidae, Perilampidae, Pteromalidae, Chalcididae, Eupelmidae, Encyrtidae, Eulophidae, Trichogrammatidae) and Proctotrupoidea (Diapriidae, Scelionidae). The worldwide phorid *Megaselia scalaris* is occasionally reared from pupae of Saturniidae, but is not a true parasitoid. All records are documented with citations to literature or specific records, many previously unpublished. Nomenclature of parasitoids and hosts is updated as far as possible. An index to the hosts refers back to the taxonomic list of parasitoids, so that all known parasitoids for a particular host can readily be found. The catalog includes several new unpublished records of parasitoids in southern Africa supplied by Rolf G. Oberprieler of the Plant Protection Research Institute, Pretoria.

Key Words: *Anastatus*, *Belvosia*, Braconidae, Chalcidoidea, *Cotesia*, Diptera, *Enicospilus*, Eupelmidae, *Exorista*, Hymenoptera, hyperparasitoids, Ichneumonidae, Lepidoptera, *Lespesia*, moth, parasitism, Proctotrupoidea, Pyralidae, saturniid, Tachinidae

Introduction

The primary purpose of this catalog is to contribute toward understanding the ecology of saturniid moths and to assist the identification of those parasitoids that are reared from saturniids by hundreds of amateurs and professionals around the world. Moreover, I hope that this compilation will enable ecologists to make generalizations about the parasitoid and host groups, in spite of the fact that it is only as complete as was possible by surveying literature and a few institutional collections, collecting in the field myself, and asking colleagues to send me parasitoids. More parasitoids are probably known from Saturniidae than any other family of insects, except the extensive family Noctuidae of which many are economic pests. No previous author has attempted to catalog all known parasitoids of Saturniidae of the world, except a brief preliminary list given by Packard (1914).

There are over 1500 known species of Saturniidae. This catalog gives parasitoid records for only about 175 species of Saturniidae. Specific parasitoids are recorded to attack almost all of the saturniids of Japan, North America and Europe, but comparatively few records are known for all other

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regions. Yet the vast majority of Saturniidae occur in the tropics, so it is clear that we have only begun to scratch the surface of the host-parasitoid-hyperparasitoid relationships that exist. Recent studies by Coffelt & Schultz (1992, 1993a, b) reveal that new parasitoid records await discovery even in the eastern United States. Therefore, this catalog must be viewed as preliminary.

If lepidopterists who use this catalog will send me their new records, and dipterists and hymenopterists will point out to me my oversights and errors, I will endeavor to publish a supplement consisting of additions and corrections in this same journal in about three to five years.

When a parasitoid is reared from a host insect, there is often little hope of getting its name (and therefore learning more about its host range, distribution, and biology), unless one can send the specimen to a specialist in the respective group of Hymenoptera or Diptera. Unfortunately, taxonomists who work with Ichneumonidae, Tachinidae, etc., are frequently unable to provide this identification service to any and all who request it, because large numbers of requests can significantly interfere with research, teaching, or curatorial responsibilities. The alternative is to try to find published keys, descriptions, or figures of the parasitoid. Success on this front will depend on the persistence and training of the person seeking an answer, as well as the availability of a good entomological library at a nearby university or museum. Library skills may be more important here than knowledge of insect morphology. At the very least, a parasitoid should be pinned and labelled properly and deposited in an institutional collection so that eventually its identity and record will be published. This catalog provides minimal or no descriptions of parasitoids, no keys, and only a few figures, yet should be useful as a first step in obtaining an identification of a parasitoid that has been reared from a saturniid, if the host species is known.

There are hundreds of published records of host-parasitoid associations for the Saturniidae and their parasitoids. I have endeavored to cite most current literature containing these records, but obviously there are some in foreign or obscure journals of which I am not aware or could not obtain. Historical literature is either cited here, or well covered in the bibliographies of the major works cited, as for examples Arnaud (1978), Herting (1960), and the works by Townes et al. (1961, 1965, 1966, 1970, 1973, etc.). My approach has been to make use of as many catalogs and revisions available in the parasitoid groups themselves, because those authors have already surveyed collections and compiled records from earlier literature.

The parasitoids that have been reared and labelled with their host data and deposited into major museum or university collections will generally have been located and found by the dipterist or hymenopterist. I urge curators to use a system of cross reference in their collections; whether the parasitoids are kept in the collection with the host species or in their appropriate phylogenetic location, labels should refer to the other place in the collection. In this way, researchers looking at the hosts or the parasitoids will find labels directing them to the other part of the collection, and identities of

hosts can be verified. I believe that there are many parasitoid specimens representing unpublished records kept in Lepidoptera collections, private and institutional, for which the dipterist or hymenopterist does not have access or is not aware, sometimes even within the same institution.

This project is more than a mere compilation of records in literature. I have reared numerous parasitoids from Saturniidae, and specimens or records have been sent to me by lepidopterist colleagues. Some of these records were already published in the papers authored or coauthored by me as cited in the bibliography. Many host-parasitoid associations included in this catalog are previously unpublished. I also include data from rearings that increase our knowledge of the geographical distribution of the host-parasitoid relationship or the parasitoid itself. For example, if a parasitoid has been known for decades to attack a certain host in the northeastern United States based on numerous rearings, that same association discovered in the South or West is well worth documenting. Comments pertaining to certain parasitoids are included where bringing together information from diverse sources has hopefully provided me with a larger perspective than could be derived from the individual publications. For example, rearings of *Enicospilus lebophagus* from *Rothschildia lebeau* in southern Texas and Costa Rica in the 1980s (Gauld 1988a) enabled me to assume with confidence that the unidentified *Enicospilus* reared from the same host in El Salvador by Quezada (1967) must be the same parasitoid. It is frustrating to have to cite records like "*Chetogena* sp. reared from *Hemileuca* sp." where the specific identity of the host and parasitoid are not known, but I include such records because they at least contribute to the overall picture.

It may be surprising that it is still relatively easy to discover new parasitoid records for common and wide ranging saturniids such as *Antheraea polyphemus* or *Saturnia pavonia*. It is true that the Saturniidae are the most commonly reared insects in the world, but let us consider the mechanics of these rearings. When eggs are obtained in captivity, and the eggs, larvae, and pupae are kept indoors (or caged outdoors) throughout the rearing, there is minimal chance to secure parasitoids. A large proportion of the known parasitoids of Saturniidae emerged from host cocoons since this is the most common stage to be collected in the field. If more field work was carried out in which one would secure wild collected eggs and larvae, more records would be available. It often requires a lot of work—hours in the field—to find larvae and particularly eggs. It is much easier to collect females at light or obtain matings in cages of reared moths and rear from the resulting eggs. Likewise, more parasitoids are known for saturniids of which the cocoons are found attached to the hostplants than for those that pupate below ground or have cocoons at ground level well hidden in leaf litter. For genera that are commonly collected as larvae but rarely as pupae, such as *Hemileuca* and *Anisota*, we have few records for those parasitoids that oviposit into the host after it pupates.

Another problem that hinders our knowledge is the fact that many amateur lepidopterists are repulsed by the sight of slimy tachinid maggots,

or wasps which can sting, issuing from a cocoon that held the hope of a beautiful moth for the collection. Killing and discarding these parasitoids, instead of rearing them through (if immature) and pinning and labelling them, may fulfill a psychological need for revenge, but does not contribute to our knowledge of the ecology of the moth which the rearer claims to admire. I advocate here a change in perspective and attitude. Many advanced entomologists begin as amateur lepidopterists, but others do not advance beyond the collection-oriented phase, and in my opinion, deprive themselves of many interesting and rewarding facets of their hobby. Thus, another intended purpose of this catalog is to stimulate interest and professionalism among these amateurs to properly deal with and learn about any parasitoids that they may be *fortunate* enough to rear.

In my judgment, too many authors on Lepidoptera have paid insufficient attention to the subject of parasitism. Many papers have appeared in the past 20 years on various moths giving details on the hostplants, morphology of the immature stages, and other ecological observations, but make no mention of parasitoids. One can only assume that amid all of this collecting and rearing, parasitoids must have been obtained. Another example is the very brief and superficial discussion of parasitoids in the large volume on North American butterflies by Scott (1986), a book which is otherwise excellent in its scientific approach. Scott hardly gave any specific records of butterfly parasitoids, yet the book is promoted as having a focus on the biology of butterflies. By contrast, Powell (1962) cited a very high number of parasitoid records for Tortricinae based on only four years of collecting and rearing observations. A valuable chapter on parasitoids was provided by Stehr & Cook (1968) in their classic treatise of Nearctic *Malacosoma* (Lasiocampidae). The Saturniidae share many of the same parasitoids with the related Lasiocampidae (see below). Among the books available that deal with rearing Saturniidae, Gardiner (1982: 23-24) outlined good instructions for proceeding if parasitoids are obtained. Pinhey (1972), Villiard (1969), and Baxter (1992) gave brief comments indicating that parasitoids are merely something to avoid, and made no suggestions to pin, label, and submit them for identification. Voelschow (1902) referred to parasitoids under several different saturniids, but apparently none were identified. Collins & Weast (1961) devoted an entire chapter on parasitoids of saturniids, which has served well to stimulate interest in many beginners (including me in 1971). Some insect pathologists may be similarly frustrated with loss of data when saturniid larvae fall to diseases, although freezing diseased larvae and preserving pathogens is less easily accomplished than pinning parasitoids.

Many parasitoids of saturniids are named and long known to science but are not included in this catalog because they have never been reared from Saturniidae, or never reared at all. These specimens have been collected at light, on flowers, in malaise traps, or by other means. On the other hand, some parasitoids reared from Saturniidae are sometimes found to be unnamed, particularly tropical species. In any case, one should not automatically assume that a parasitoid obtained from a well known saturniid probably does not represent a new record. It often does.

The word parasite was used in earlier literature exclusively for these insects, and continues to be used today in lieu of the term parasitoid by some authors. The traditional definition of a parasite includes the point that it does not kill its host, but parasitoids almost invariably do cause the death of the host (but see English-Loeb et al. 1990). I have resisted the pressure to use the term parasitoid in most of my earlier publications, preferring instead to simply have a broader definition of the term parasite. However, I use the term parasitoid in this catalog since virtually all entomologists now use it consistently, and I assume the word has acquired a permanent and concise meaning in the entomological literature, and eventually will in the English language. The word hyperparasitoid is also used in this catalog, but I do not use words like parasitoidism and parasitoidic, instead of parasitism and parasitic.

The literature citations consist of a mixture of references on Saturniidae and various groups of Hymenoptera and Diptera. Authors of Lepidoptera literature sometimes did not use the current or correct names of the parasitoids. Authors who are dipterists or hymenopterists sometimes have used incorrect names for the host moths. All these I have corrected as far as could be determined. Therefore, I cite these synonyms of moths and parasitoids, but only those that appeared in the relevant literature, no attempt being made to give full synonymies of any species.

As far as is known, some parasitoid species are host-specific to only Saturniidae, indeed to only a single species of Saturniidae. Examples include species in *Gambrus* and *Enicospilus*. Other genera of parasitoids specialize on, but are not limited to saturniids, such as *Belvosia*. The specializations appear to be more ecological than taxonomic. For example, we might say that the saturniid genus *Agapema* suffers from "Hemileucinae envy" because it is ecologically more like many sympatric Hemileucinae than the Saturniinae, *Agapema* belonging to the latter subfamily taxonomically. For this reason, we find that some parasitoids among Ichneumonidae and Braconidae which routinely attack various hemileucines like *Hemileuca* and *Coloradia*, also attack species of *Agapema*. The reverse is true for *Automeris io* which lives throughout eastern North America and is ecologically more like Saturniinae, than to Hemileucinae to which it actually belongs.

The non-Saturniidae most frequently cited as hosts for the parasitoids commonly reared from saturniids belong to the Lasiocampidae. This does not mean that the two moth families are very closely allied, although most classifications place both in the Bombycoidea. I include within the Saturniidae the two Neotropical groups formerly considered full families, i.e., Cercophanidae and Oxytenidae (see Minet 1994). The host-parasitoid relationships shared by Saturniidae and Lasiocampidae exist because the two have similar ecological characteristics, i.e. hairy larvae feeding externally on foliage of woody plants, pupation in cocoons above ground level, living in the same ecosystems, etc. That the shared ecology is more significant than the shared taxonomy is further illustrated by the fact that some parasitoids (*Enicospilus*, *Lespesia*, etc.) that attack Saturniidae are closely allied to, or the

same as, the ones that attack certain Noctuidae, Lymantriidae, Notodontidae, and Arctiidae.

Our knowledge is based mainly on the Northern Hemisphere fauna, so we naturally compare North American and Eurasian records. We need more data from the tropics to make broader generalizations. There are certainly relationships between the Nearctic and Neotropical regions, such as *Enicospilus americanus* attacking *Rothschildia* in Argentina and other Saturniinae in the United States. Townes & Chiu (1970: 42, 51) and Gauld (1988a: 44) pointed out that some records of a single parasitoid species attacking both saturniids and lasiocampids can now be sorted into two closely allied parasitoid species, each specializing on one family of hosts; historical records were sometimes based on misidentifications. In the present catalog, I cite specific or general host ranges for all parasitoids to indicate whether the parasitoid is narrow or broad in its suite of hosts. Family names are cited for non-saturniid hosts, which are not listed individually in the index to hosts.

It would require too much space to cite data for all material examined or records in literature. However, under the "Remarks" sections of parasitoids, I give some specific data, since many of these are previously unpublished or represent significant range extensions of the host-parasitoid association. Deposition of these specimens is also given so that future workers can locate them and verify identifications. In the 1970s and 1980s I deposited many specimens in museums where entomologists worked who provided the identifications to me. Most of my recent material is in the Denver Museum of Natural History, with duplicates sometimes distributed to other collections. The acronyms used for the collections cited are:

BMNH - The Natural History Museum, London; formerly British Museum (Natural History)
CM - Carnegie Museum of Natural History, Pittsburgh
CNC - Canadian National Collection, Agriculture Canada, Ottawa
CSU - Colorado State University, Fort Collins
CUAC - Clemson University Arthropod Collection, Clemson
CUIC - Cornell University Insect Collection, Ithaca
DMNH - Denver Museum of Natural History, Denver
LACM - Natural History Museum of Los Angeles County, Los Angeles
RMNH - Nationaal Natuurhistorisch Museum, Leiden; formerly Rijksmuseum van Natuurlijke Historie
ROM - Royal Ontario Museum, Toronto
SDNHM- San Diego Natural History Museum, San Diego
TAMU - Texas A&M University, College Station
UCB - University of California, Berkeley
UCM - University of Colorado Museum, Boulder
USNM - National Museum of Natural History, Smithsonian Institution, Washington

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Economic Value of Saturniidae

Saturniids are admired and enjoyed by people throughout the world. Their aesthetic value is reflected in the large number of publications that has appeared about them, as well as depictions in art. Their popularity with collectors and for use in exhibits gives many of them a consistent market value as dried specimens. Although commercial collectors and dealers are increasingly maligned among the entomological and paleontological communities, I believe that they provide a valuable service. In the case of collecting of insects, this rarely has an impact on population decline, which is instead almost always due to habitat destruction. Creating and maintaining a market for insects contributes toward the incentive to protect their habitats, as many people in tropical countries are learning as they seek to fill a demand for preserved or living specimens, the latter for educational facilities commonly called butterfly houses or insect zoos. Along with swallowtail butterflies and giant scarab beetles, Saturniidae are part of the "charismatic megafauna" of the insect world. Some saturniids are mass-

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Color Plate (facing page). **1.** *Xanthopimpla brullei*, female, reared in 1983 from cocoon of *Attacus atlas* from Padangpanjang, Sumatra, Indonesia, by U. Paukstadt. **2.** *Gambrus extrematis*, female, reared 7 June 1988 from cocoon of *Hyalophora cecropia* from Aurora, Arapahoe Co., Colorado, by R. S. Peigler. **3.** *Enicospilus americanus*, female, reared in June 1992 from cocoon of *Antheraea polyphemus* from Spanish Fork, Utah Co., Utah, by J. B. Duncan. **4.** *Hyposoter fugitivus*, female, reared 8 July 1978 from mummified larva of *Anisota pellucida* from Saint Francis Co., Arkansas, by R. S. Peigler. **5.** *Conura maria*, female, reared June 1979 from cocoon of *Rothschildia* from Jocotepec, Jalisco, Mexico, by R. L. Halbert. **6.** *Cotesia* sp., cocoons on *Hyalophora columbia gloveri* from Spanish Fork, Utah Co., Utah, in July 1991, collected by J. B. Duncan. **7.** *Anastatus* sp., reared 8 August 1994 from egg of *Saturnia walterorum* from 8 km west of Escondido, San Diego Co., California, by K. Wolfe. **8.** *Belvosia nigrifrons*, reared 5 July 1994 from cocoon of *Rothschildia cincta guerreronis* from La Mira, Michoacán, Mexico, by K. Wolfe and S. Smoot. **9.** *Exorista sorbillans*, reared November 1995 from cocoon of *Attacus lorquinii* from Laguna, Luzon, Philippines. (Photos 1—5, 9 by Rick Wicker, 6 by Gary D. Hall, 7 & 8 by K. L. Wolfe.)

reared in laboratories for studies of diapause, endocrinology, or other aspects of insect physiology. Field and lab studies of Saturniidae enhance our general knowledge of genetics, evolution, and ecology.

Caterpillars of many saturniids are consumed as food by indigenous peoples in New Guinea and Africa. Some of these are *Cirina forda, Lobobunaea, Pseudobunaea,* and several species of *Imbrasia*. The best known is the "mopane worm," which is the larva of *Imbrasia belina*. These provide significant supplements to the protein in the diet of many people, but with increased habitat loss and exploding human populations, the caterpillars can no longer be regarded as a renewable resource. Larvae and pupae of some saturniids are also eaten by certain Native Americans and by some hill tribes in the Himalayas.

Exploitation of certain Saturniidae as sources of silk dates back many centuries in Asia. The main ones, both historically and today, are tussah silk (*Antheraea pernyi*) in China, tensan silk (*A. yamamai*) in Japan, and muga (*A. assamensis*), tasar (*A. paphia*), and eri (*Samia ricini*) silks in India. Millions of dollars annually are earned by export of these silks from China and India. Wild silk crops are more susceptible to economic loss from parasitism than domestic silk (*Bombyx mori*), which is mainly raised indoors. Parasitoids that are particularly troublesome to sericulture in Asia are the chalcidoid wasps attacking eggs of the wild silk moths and certain tachinid flies that attack the caterpillars.

There are relatively few records of Saturniidae being pests, and in these cases pest status is attained as a result of human interference of the natural ecosystem. (Of course, this is true of virtually all arthropod pests.) Although never agricultural pests, saturniids may cause damage in forestry, horticulture, and range grasslands. *Anisota senatoria* reaches pest status in the northeastern United States for one of the same reasons that the gypsy moth does: there is now an artificial dominance of oaks in those forests that did not previously exist. The Japanese *Antheraea yamamai* is a pest in southeastern Europe because it is introduced, yet the related Chinese *A. pernyi* introduced to the Balearic Islands of Spain is uncommon (V. Sarto i Monteys, pers. comm.). In the high plateaus of New Mexico the "range caterpillar" (*Hemileuca oliviae*) reaches pest levels because of overgrazing by cattle. The insect is not a pest in the disjunct part of its range in Chihuahua to the south.

Fruit trees are sometimes damaged by saturniid caterpillars. Factors contributing to pest situations are urban environments (which lack fewer natural enemies), monocultures of trees, and cultivation of non-native trees. In Israel *Saturnia pyri* causes damage in orchards of *Prunus* such as almond and apricot. *Shabtai hashaked,* the common name of the moth in Hebrew, means "Saturn almond." *Imbrasia tyrrhea* is recorded to damage fruit trees occasionally in South Africa. The "pine emperor" (*Imbrasia cytherea*) attacks pine, which is not native to, but widely grown in, South Africa. Larvae of *Hylesia* strip willows in Brazil and Argentina. Tropical fruit trees like avocado, citrus, star-fruit, guava, and others are attacked by *Attacus* in Indonesia, the Philippines, and mainland Southeast Asia.

Where saturniids are exploited as food or silk producers, parasitoids are highly detrimental. In situations where saturniids are pests, parasitoids are desirable. Virtually all Saturniidae serve as alternate hosts for certain parasitoids with broad host ranges that are valuable in the control other lepidopterous pests.

The Mechanics of Parasitism

Classic works on the topic of parasitic insects include those by Clausen (1940), Askew (1971), and Waage & Greathead (1986), the latter cited in the bibliography under Askew & Shaw. A book by Godfray (1994) is a magnificent synthesis on the ecology of insect parasitoids. The serious student would be well advised to consult any of these books or to take a course in biocontrol to become familiar with the terms and concepts of this fascinating topic. Many active research programs are underway worldwide, but much of the best work in this field comes from entomologists in England. Insight into the origins of parasitism by insects was outlined by Eggleton & Belshaw (1992).

Although the term co-evolution is widely misapplied, there may be true cases where some Saturniidae have co-evolved with certain of their parasitoids (see Timm 1983). Godfray (1994: 244-248, 349-350) discussed co-evolution between parasitoids and hosts from the physiological and ecological aspects, but applied the term co-cladogenesis to what I am writing about when I observe that allied species of *Enicospilus* in America and Asia attack allied host saturniids. It is tempting to assume that some parasitoids in Asia migrated across Beringia into America along with their hosts, for example.

In general, an insect parasitoid locates a host in one of its immature stages, deposits one or more eggs into or onto that potential host, and the larva or larvae of the parasitoid develop in or on the host, eventually killing it. Several terms need to be defined, since some lepidopterist users of this catalog will not be familiar with them.

multiparasitism: more than one species of parasitoid lives within a host. One always wins out; adults of two parasitoids of different species are never produced in a single host individual. It is also called multiple parasitism.

superparasitism: too many parasitoid individuals of a single species develop in a host, resulting in reduced size or even death of the parasitoids. This may be due to a female misjudging the number of eggs to deposit, or from one or more additional females depositing eggs into the same individual (see Hofsvang 1990).

synovigenic parasitoid: an adult female emerges with a full complement of eggs and deposits all of them in a short time.

pro-ovigenic parasitoid: an adult parasitoid female develops eggs over an extended period.

ovarian parasitoid: a parasitoid of insect eggs. The complete metamorphosis occurs within, with an adult wasp emerging from the host egg.

ectoparasitoid: feeds externally on (attached to) the host.

endoparasitoid: feeds internally in the host.

gregarious parasitoid: more than one parasitoid emerges from a single host individual.
solitary parasitoid: one parasitoid emerges from a single host individual.
secondary parasitism: involves a hyperparasitoid; i.e., a parasitoid of a parasitoid, both living within the primary host.
tertiary parasitism: involves a parasitoid of a secondary parasitoid.
obligate hyperparasitoid: a parasitoid that must complete its life cycle within another parasitoid.
facultative hyperparasitoid: a parasitoid that can complete its life cycle as a primary parasitoid, or as a hyperparasitoid.
polyembryonic parasitoids: a single egg is deposited into a host and the resulting divisions give rise to many, sometimes hundreds, of parasitoid larvae.
larval-larval parasitoid: the egg is laid in the larva of the host, and the adult parasitoid emerges before the host pupates.
larval-pupal parasitoid: the egg is laid in the larva of the host, but the adult parasitoid does not emerge until after the host pupates. (In parasitoids that attack Lepidoptera, the adults always emerge before the adult moth develops.)

Two attack strategies provide a model to predict host range. Idiobionts usually kill or permanently paralyze the host at the time of oviposition. This category includes virtually all parasitoids that attack eggs and pupae, and selecting hosts in protected or concealed environments is an obvious advantage in avoiding predation and hyperparasitism. Most ectoparasitoids and some endoparasitoids are idiobionts. By contrast, koinobionts include most endoparasitoids, and they permit the host to continue to feed and grow. Most hyperparasitoids, probably all Tachinidae, and many genera of Hymenoptera are koinobionts. The koinobiont benefits from the continued life of its host, until a critical surge in its own development. Koinobionts in general have a narrower host range (Askew & Shaw 1986, Godfray 1994: 9, 338, 361-363).

Defenses by saturniids against parasitism are varied but limited. Eggs may be covered with scales or even urticating scales that the female rubs off her abdomen after deposition of eggs. Eggs may be covered by a hardened coating as in *Malacosoma* (Lasiocampidae), but this may not deter some parasitoids (see Janzen 1984). Pupae mainly rely on being concealed in soil or cocoons; I am not aware of any saturniid pupae with gin traps (Chinery 1989: 240). For larvae, camouflage is of no benefit against parasitoids which search at night or by odor. Caterpillars may physically thrash when attacked, drop to the ground (Stamp & Bowers 1990), or release toxic fluids (Deml & Dettner 1990). The white waxy powder on larvae of saturniid larvae of the tribe Attacini has been suggested to deter parasitoids, but I disagree. This wax more likely gives the larva the appearance of a patch of mold (Peigler 1989: 90), as it is present only in the middle instars of some species. A caterpillar may escape parasitization if the eggs of a tachinid deposited on the integument are lost if the larva molts before the eggs hatch (Collins &

Weast 1961). For this reason, many tachinids probably only oviposit on mature larvae. Stinging spines, as we see on caterpillars of Ludiinae, some Saturniini, and virtually all Hemileucinae are probably not effective deterents against parasitoids.

Many papers appear in entomological journals every month with new data and conclusions on interactions between parasitoids and their hosts (e.g., Van Driesche et al. 1991, Takabayashi et al. 1991, and English-Loeb et al. 1993). Regarding Saturniidae, a few works stand out as providing insight into the complex ecological interactions that occur between saturniids and their suites of parasitoids and hyperparasitoids. Fiske & Thompson (1909) observed an array of host-parasitoid interactions in large Saturniinae in Massachusetts. Smith (1908), Marsh (1937), and Duncan (1941) studied populations of *Hyalophora*. Coffelt & Schultz (1992, 1993a, b) studied the dynamics of parasitism in pest populations of *Anisota senatoria* in Virginia.

How to Use this Catalog

All data are cited under the parasitoids, which are arranged in phylogenetic order as far as possible following the *Catalog of Hymenoptera in America north of Mexico* (Krombein et al. 1979), B. Herting's (1984) *Catalogue of Palearctic Tachinidae*, Z. Boucek's (1988) Australasian Chalcidoidea, and other works. Each host is listed under every parasitoid that is known to attack it, and hosts are listed alphabeticaly in the index, which will refer the user to all parasitoids for each host. Host moths are also listed as hosts under hyperparasitoids, because it is not always evident when a parasitoid is reared from the host remains of a saturniid that hyperparasitism was involved. Moreover, the hyperparasitoid ultimately derives it nourishment from the saturniid, although it can be argued that it benefits the saturniid population by killing the primary parasitoid. Also, some species of parasitoids occur in Saturniidae as both primary parasitoids and as facultative hyperparasitoids. Family names are cited for hosts which are not Saturniidae. These non-saturniid hosts are included to demonstrate how broad or narrow is the host range of the parasitoid.

HYMENOPTERA

Family Ichneumonidae

This is one of the largest families of insects, with thousands of species worldwide. There are numerous subfamilies, but the classification has not reached a stable consensus. All are parasitic on or in other insects. The mode of parasitization is varied: some are solitary, others gregarious; some are koinobionts, others idiobionts; larvae of some feed as ectoparasitoids, others as endoparasitoids; some attack exposed caterpillars or other insect larvae, others attack concealed larvae (borers, miners) or spiders' eggsacs or insect pupae in cocoons or tunnels or soil. If the ovipositor of the female is retracted or very short, the host is generally exposed; if medium in length (i.e., 1 cm), the host is internally hidden, such as in a cocoon; if very long, we may assume the host tunnels deeply in wood. Thus, the appearance of the adult insect gives a clue to its host. The females of many ichneumons inject venom (i.e., sting) if handled. Stinging is used to paralyze hosts temporarily or permanently at the time of oviposition. Some kinds are attracted to light, but most are diurnal. They are easily collected in malaise traps or by sweeping with nets. Although abundant in the tropics like most insect groups, they appear to be even more common in the northern forests (Janzen 1981, Godfray 1994: 357-360).

The late Dr. Henry Townes and his wife Dr. Marjorie Townes have been the most prolific publishers on this family, cataloging most known species of the world in their monographs. They founded the American Entomological Institute containing their famous collection of parasitic insects which was moved several years ago from Ann Arbor, Michigan, to Gainesville, Florida. The monumental catalog of North American species by Dr. Robert Carlson, formerly of the USNM, has proven indispensible for successful completion of the present catalog.

Ichneumonidae are widely studied because they are important agents of biological control of many groups of insects, including some agricultural, horticultural, and forest pests. We do not know the hosts for most species, because they have never been reared; instead the adults were taken at light or collected in nets or traps.

Subfamily Pimplinae

1. *Pimpla robusta* Rondani
Hosts: *Actias isabellae*
Distribution: Europe
References: Testout (1947), Rougeot (1971: 80), Gómez & Fernández (1976: 73), Ylla (1992)

2. *Acropimpla persimilis* (Ashmead)
Hosts: *Samia cynthia, Samia pryeri*, various other Lepidoptera including Lasiocampidae and Tortricidae
Distribution: Japan, Korea, eastern Russia, China, Kurile Islands
References: Townes et al. (1965: 23-24), Arzone (1970)

3. *Iseropus himalayensis* (Cameron)
Hosts: *Samia pryeri, Samia cynthia, Archaeoattacus edwardsii, Antheraea roylei*, several Lasiocampidae, Bombycidae, and other Lepidoptera
Distribution: Japan, Korea, China, India (Kashmir to Assam), probably also other southeastern Asian countries.
Biology: The parasitoid larvae are gregarious, and spin their cocoons within that of the host. The host is attacked in the pupal stage. Species of hosts that are attacked have exposed cocoons.

References: Townes et al. (1965: 26-27), Arzone (1970), Gupta (1987: 31-32)
Remarks: Townes et al. placed this species in the genus *Gregopimpla*, but Gupta considered *Gregopimpla* to be a subgenus of *Iseropus*. The species of *Samia* that serve as hosts cannot be decided without locality data; if the record for *Samia cynthia* comes from India instead of China, it should be referred to *Samia canningii*. This is possibly the parasitoid of which the cocoons within a cocoon of *Antheraea roylei* were shown by Cotes (1891-1893: pl. 9) (see also remarks under *Gambrus polyphemi* below). This parasitoid was cited by several authors including Arzone under the name *Pimpla attaci*.

4. *Scambus hispae* (Harris)
Hosts: *Dryocampa rubicunda*, several other lepidopterans including Tortricidae, Psychidae, Noctuidae, Lasiocampidae, and hyperparasitic on other Ichneumonidae
Distribution: Nova Scotia to Alaska to California
References: Carlson (1979: 324)

5. *Echthromorpha agrestoria variegata* (Brullé)
Hosts: *Imbrasia wahlbergii, Heteronygmia dissimilis* (Lymantriidae)
Distribution: most of sub-Saharan Africa
Biology: The pupa is the stage of the host from which the parasitoid emerges.
References: Thompson (1944), Townes & Townes (1973: 36-37), Gauld (1984: 64)
Remarks: The nominotypical *E. agrestoria* (Swederus) occurs in Australia.

6. *Echthromorpha nigricornis* (Smith)
Hosts: *Opodiphthera saccopoea*
Distribution: Australia
References: Gauld (1984: 63-64)

7. *Itoplectis conquisitor* (Say)
Hosts: *Hemileuca lucina, Hemileuca oliviae,* hyperasitoid in *Enicospilus americanus* in *Callosamia securifera*; many hosts in Lepidoptera and Hymenoptera
Distribution: across North America, probably into Mexico
Biology: An idiobiont primary parasitoid or a facultative hyperparasitoid. The pupal stage of the host is attacked.
References: Ainslie (1910), Thompson (1944), Askew (1971: 143-144), Carlson (1979: 340), Peigler (1985a)
Remarks: I reared one of these from a cocoon of *Callosamia securifera*. The moth cocoon contained a cocoon of *Enicospilus americanus*, and the emergence hole of the *Itoplectis* was from the side of the ophionine cocoon. The wasp then emerged through the anterior exit valve of the moth cocoon. It is possible that the single female reared by Ainslie was a hyperparasitoid of *Enicospilus texanus* in *Hemileuca oliviae*. These wasps show a wide range in size, the smaller ones developing from smaller hosts.

Specific record: *ex Callosamia securifera*: 8 km W of Awendaw, Charleston Co., South Carolina, emerged indoors 26 February 1979, R. S. Peigler (BMNH).

8. *Itoplectis viduata* (Gravenhorst)
Hosts: *Hemileuca oliviae,* Noctuidae, Lasiocampidae, Lymantriidae, Nymphalidae, Pieridae, and Tortricidae, with mostly one species recorded per family
Distribution: Palaearctic; Northwest Territories and British Columbia to California and New Mexico
References: Carlson (1979: 342)

9. *Ephialtes capulifera* (Kriechbaumer)
Hosts: *Saturnia japonica*, several other Lepidoptera including Lasiocampidae, butterflies and *Lymantria dispar* (L.), Lymantriidae
Distribution: Japan; Korea; Russia; Kurile Islands; China, mostly northern states but also Sichuan and Taiwan; Germany
References: Thompson (1944), Townes et al. (1965: 42-44), Gupta (1987: 76-77)
Remarks: Cited by Thompson as *Pimpla japonica*. The saturniid host was cited by most authors as *Dictyoploca*, which is a junior objective synonym of *Caligula*, which I consider to be a junior subjective synonym of *Saturnia*.

A record cited by Marsh (1937) and repeated by Tuskes et al. (1996) of "*Ephialtes aequalis*" attacking *Hyalophora cecropia* could not be verified in Carlson (1979). Perhaps it is an error in identification of a similar-looking ichneumonid. The name may refer to *Ichneumon nubivagus* (Cresson), of which *aequalis* is a synonym (Carlson 1979: 515).

10. *Coccygomimus disparis* (Viereck)
Hosts: *Samia walkeri*, other Lepidoptera including butterflies and Lasiocampidae
Distribution: Japan, Korea, Russia, China
References: Townes et al. (1965: 48-50)

11. *Coccygomimus indra* (Cameron)
Hosts: *Saturnia pyri*, other Lepidoptera including butterflies, Lymantriidae, and Lasiocampidae
Distribution: China, India, westward into European Russia
References: Townes et al. (1965: 50-52)

12. *Coccygomimus instigator* (Fabricius)
Hosts: *Saturnia pyri, Antheraea yamamai*, other Lepidoptera including Notodontidae, Noctuidae, Lymantriidae, Geometridae, Pieridae, Lasiocampidae, and Arctiidae
Distribution: Germany to China, Japan, and Russia, including on Kurile Islands and Sakhalin
References: Townes et al. (1965: 51), Zivojinovic & Vasic (1963), Pujade & Sarto (1986: 23).
Remarks: Pujade & Sarto (1986: 20) figured both sexes of this wasp in color. It is black, with orange legs and has an ovipositor of moderate length. The record for the Japanese *Antheraea yamamai* is from the introduced population in southeastern Europe.

13. *Coccygomimus luctuosus* (Smith)
Hosts: *Samia walkeri, Samia pryeri, Bombyx mandarina*, several other Lepidoptera including Lasiocampidae, Lymantriidae, and butterflies
Distribution: China including Taiwan, Japan, Korea, Kurile Islands, Russia, and probably west to Poland and Germany
Biology: This wasp is an idiobiont. According to Uedo & Tanaka, females use different host individuals for host-feeding and for oviposition. When they host-feed, it usually kills the host. A single egg is deposited into a host. Males develop in about 17 days, females in about 19. Adult males live about 29 days, females about 38.
References: Townes et al. (1961: 31-32; 1965: 52-54), Arzone (1970), Gupta (1987: 86-87), Uedo & Tanaka (1994)

Remarks: The record cited by Townes et al. as "*Samia cynthia walkeri*" included citations by Morley from both China and Japan so these could refer to *Samia walkeri, Samia cynthia,* or *Samia pryeri.* This parasitoid was cited by Arzone and Uedo & Tanaka under the name *Pimpla luctuosa.*

14. *Coccygomimus parnarae* (Viereck)
Hosts: *Samia pryeri, Bombyx mandarina,* other Lepidoptera including especially Lasiocampidae
Distribution: China including Taiwan, Japan, Korea, Kurile Islands, Ryukyu Islands
References: Townes et al. (1961: 32; 1965: 56)
Remarks: The record of *Samia cynthia* given in Townes et al. came from Japan, so I refer it to *Samia pryeri.*

15. *Coccygomimus sanguinipes erythropus* Viereck
Hosts: *Hemileuca oliviae, Hemileuca* sp., Lasiocampidae, other Lepidoptera
Distribution: western Canada, Mexico, United States
Biology: Probably the pupae of the hosts are attacked by the ovipositing wasp.
References: Ainslie (1910), Packard (1914: 268), Townes & Townes (1966: 27-28), Watts & Everett (1976), Carlson (1979: 345)
Remarks: This wasp is called *Pimpla sanguinipes* by some earlier authors. Ainslie reported that this parasitoid (and/or *Itoplectis conquisitor*) produced hyperparasitoids in the genus *Dibrachys* (Pteromalidae, see below).

16. *Coccygomimus tomyris* Schrottky
Hosts: *Hylesia nigricans, Eudyaria venata,* Papilionidae, Psychidae
Distribution: Argentina, Uruguay, Paraguay, Brazil
Biology: Probably the parasitoids lay eggs into the pupae of the hosts. The hosts listed above all pupate above ground level.
References: Townes & Townes (1966: 28-29)

Genus *Xanthopimpla*

This is a very large genus of several hundred species, some in Africa and South America, but most in the Indo-Australian region. Those of the latter region were revised by Townes & Chiu (1970). They are usually yellow with black markings that are usually species-specific. They are solitary idiobionts. Females locate a suitable host; in the case of Saturniidae, this is a healthy pupa in a cocoon. The ovipositor is inserted, the pupa stung, and an egg laid. Sometimes this leaves a visible mark on the abdomen of the host pupa. To emerge, the wasp eventually bores out the anterior end of the pupa, and chews or pushes its way out of the host cocoon.

17. *Xanthopimpla brullei* Krieger (Figure 1)
Hosts: *Attacus atlas, Samia insularis, Samia luzonica, Cricula trifenestrata, Cricula trifenestrata javana, Cricula trifenestrata kransi*
Distribution: Greater Sunda Islands (Java, Borneo, Sumatra) of Indonesia; Sabah, East Malaysia; West Malaysia; Sulawesi, the Moluccas (eastern Indonesia); the Ryukyus (Japan)
References: Townes & Chiu (1970: 51-53), Gupta 1987: 120), Peigler (1989: 94-95), Paukstadt & Paukstadt (1990), Naumann (1995)
Remarks: The records for "*Philosamia cynthia*" given by Townes & Chiu and earlier

authors must be referred to *Samia insularis* based on the localities in Java for these records.

Specific records: *ex Cricula trifenestrata javana*: Sukabumi, 700m, Jawa Barat, Java, Indonesia, May 1990, U. & L. Paukstadt (DMNH); *ex Attacus atlas*: Padangpandjang, 735m, 775m, and 875m, Sumatera Barat, Sumatra, Indonesia, emergences April 1981, 1983, 10 August 1985, U. & L. Paukstadt (DMNH); Mt. Salak, 600m, Jawa Barat, Java, Indonesia, March 1981, U. & L. Paukstadt (DMNH); Gopeng, Tapah, Perak, West Malaysia, August 1979, U. & L. Paukstadt (DMNH); *ex Samia luzonica*: Boac, Marinduque, Philippines, 22 August 1987, L. & H. Paukstadt (DMNH); *ex Cricula trifenestrata kransi*: Tondano, Sulawesi Utara, Indonesia, August 1994, S. Naumann (Naumann 1995). The latter record gives a range extension for this parasitoid.

18. *Xanthopimpla konowi* Krieger

Hosts: *Attacus atlas, Attacus dohertyi* [possibly a record for *Archaeoattacus staudingeri*; see remarks below], *Antheraea paphia* (=*mylitta*), *Antheraea assamensis, Antheraea frithi, Saturnia pyretorum, Actias maenas* [see remarks under *X. lepcha* below], *Cricula trifenestrata*

Distribution: Orissa and Uttar Pradesh states of India to Taiwan and Ryukyu Islands, down into Sumatra

References: Packard (1914: 268), Jurriaanse & Lindemans (1920), Townes et al. (1961: 50, 62, 72), Townes & Chiu (1970: 48-51), Jolly et al. (1974: 199-200), Jolly et al. (1979: 67, 70), Chowdhury (1981: 79), Gupta (1987: 138-141), Peigler (1989: 94-95)

Remarks: Some of the records cited by Townes & Chiu (1970) under *Xanthopimpla pedator (Fabricius)* (=*predator* Maxwell-Lefroy & Howlett; =*punctator* Vollenhoven) belong under *X. konowi* and *X. lepcha*. These authors explained that there has been much confusion in the past and many misidentifications were made. It now appears that *X. pedator* parasitizes only Lasiocampidae, whereas *X. konowi* parasitizes only Saturniidae. These parasitoids appear much alike. Indian authors cited above have reported this parasitoid as being reared from *Antheraea* under the names *X. predator*, *X. pedator*, and *X. punctator* (Linnaeus). This wasp is considered a pest in India where it damages the wild silk industry. Ulrich Paukstadt sent me a specimen reared from *Attacus atlas* that Robert Wharton ran through the key in Townes & Chiu (1970). It did not key to any known species, but is near *X. pedator*; I donated the specimen to the Taiwan Agricultural Research Institute.

Records for *Xanthopimpla iaponica* Krieger parasitizing Saturniidae also belong under *X. konowi*. Other synonyms are *X. anthereae* Cameron, *X. watsoni* Cameron, *X. grandis* Cushman, and *X. princeps* Krieger.

The host record of *Attacus dohertyi* requires some interpretation, because that moth occurs only in the Lesser Sunda Islands, considerably farther east than the known range of the parasitoid. As explained by Peigler (1989), *Archaeoattacus staudingeri* was figured under the name *dohertyi* in a standard reference on tropical Asian moths, so the host record may have been based on that species or *Attacus atlas*.

Specific record: *ex Attacus atlas*, Hong Kong, emerged 17 March 1992, Stefan Naumann.

19. *Xanthopimpla lepcha* (Cameron)

Hosts: *Actias maenas, Antheraea frithi, Cricula, Erionota thrax* (Linnaeus) (Hesperiidae)

Distribution: widespread in India and mainland of southeastern Asia, Fujian Province in China, on Taiwan, and the islands of Java and Sumatra of Indonesia

References: Townes & Chiu (1970: 37-39), Gupta (1987: 142-143)

Remarks: In his synonymy under this taxon, Gupta indicated that many of the older records of *X. pedator* belong under this species. It is likely that the rearings from *Antheraea frithi* and *Actias maenas* (cited by Gupta as *Sonthonnaxia leto*) belong here instead of under *X. konowi*.

The hymenopterous parasitoids that Watson (1911) referred to as emerging from *Rhodinia newara* cocoons he obtained from India probably belong to this species or an allied one.

Genus *Theronia*

These wasps are closely related to *Xanthopimpla* to which they look similar but smaller. Parasitization is the same: solitary idiobionts attacking hosts in the pupal stage. Many or most may actually be hyperparasitoids that were mistaken as primary parasitoids when reared out. A detailed revision of the Indo-Australian species was published by Gupta (1962).

20. *Theronia atalantae fulvescens* (Cresson)

Hosts: *Hyalophora cecropia, Callosamia promethea,* and several other Lepidoptera including Lymantriidae and Lasiocampidae, as well as being hyperparasitic on *Enicospilus americanus, Gambrus extrematis, Itoplectis conquisitor,* and *Hyposoter fugitivus.*
Distribution: New Brunswick to British Columbia, Virginia to California
References: Thompson (1944: 106), Collins & Weast (1961), Carlson (1979: 346-347)
Remarks: The nominotypical subspecies of this parasitoid is European according to Carlson. Thompson cited the American taxon under the name *T. fulvescens fulvescens.*

21. *Theronia maculosa* Krieger

Hosts: *Opodiphthera astrophela, Anthela acuta* (Walker) (Anthelidae)
Distribution: Australia (New South Wales, Victoria, Queensland, South Australia, Tasmania)
Biology: Gauld indicated that this species may always be a hyperparasitoid of ichneumonids of the tribe Pimplini. Lepidoptera recorded as hosts may have been misinterpreted as primary hosts.
References: Gupta (1987: 183), Gauld (1984: 61)

22. *Theronia steindachneri* Krieger

Hosts: *Opodiphthera astrophela, Teia anartoides* (Lymantriidae), *Pericyma cruegeri* (Noctuidae: Catocalinae), *Hyalarctia huebneri* (Psychidae)
Distribution: eastern Australia, and a possible record from Sulawesi, central Indonesia
Biology: Gauld said that species in this group (subgenus *Theronia*) may all be hyperparasitoids on Pimplini (Ichneumonidae).
References: Townes et al. (1961: 76), Gupta (1987: 186-187), Gauld (1984: 61)

23. *Theronia zebra diluta* Gupta

Hosts: *Saturnia pyretorum, Saturnia japonica,* some Lymantriidae, Lasiocampidae, and butterflies
Distribution: China (Taiwan, Fujian, Guangdong), Japan (Ryukyu Islands), Burma, India
References: Gupta (1962: 18-20), Townes et al. (1965: 67), Gupta (1987: 187-188), Gauld (1984: 61)

Remarks: This species belongs to the subgenus *Poecilopimpla*. The synonym *Theronia rufescens* belongs here.

24. *Theronia zebra zebra* Vollenhoven
Hosts: *Cricula trifenestrata, Cricula trifenestrata javana, Attacus atlas*, Pieridae
Distribution: Karnataka, India; East and West Malaysia; Java, Indonesia
References: Packard (1914: 268), Townes et al. (1961: 77), Gupta (1962: 16-17), Gupta (1987: 189-190), Paukstadt & Paukstadt (1990)
Remarks: Specific record: *ex Attacus atlas*: Sukabumi, 700 m, Jawa Barat, Java, Indonesia, 25 April 1990, L. H. Pauskstadt (DMNH).

25. *Theronia* sp.
Hosts: *Attacus atlas*
Distribution: Java, Indonesia
Biology: One female was reared from a host cocoon, there was an exit hole in the anterior end of the host pupa.
References: Peigler (1989: 94-95)
Remarks: Specific record: *ex Attacus atlas*: Mt. Salak, 600 m, Java, Indonesia, Ulrich Paukstadt. Robert Wharton at Texas A&M University attempted to key the specimen using Gupta (1962), but it did not key to any known species. The specimen was subsequently given to the Taiwan Agricultural Research Institute.

26. *Theronia* sp.
Hosts: *Imbrasia cytherea*
Distribution: South Africa
Biology: A larval parasitoid of the pine emperor, according to van den Berg. However, according to Carlson, other authors, and my own observations, ichneumons of this genus are parasitoids of pupae. Perhaps van den Berg reared this wasp from a pupa and believed it had been attacked as a larva.
References: van den Berg (1974), Carlson (1979: 346)
Remarks: This parasitoid is hyperparasitized by a species of *Eurytoma*. The saturniid primary host was cited by van den Berg under the name *Nudaurelia cytherea clarki* Geertsema.

Subfamily Tryphoninae

27. *Netelia* sp.
Hosts: *Automeris* spp.
Distribution: northern Argentina
References: Townes & Townes (1966: 44), Carlson (1979: 359)
Remarks: Ichneumons in this genus are not otherwise known to parasitize Saturniidae. The adult wasps closely resemble species of nocturnal Ophioninae. It is likely that this record is based on a misidentification of a species of *Enicospilus*. The report was under the name *Paniscus*, a synonym of *Netelia*.

Subfamily Cryptinae

28. *Isdromas lycaenae* (Howard)
Hosts: *Hyposoter fugitivus* in *Anisota pellucida* and *Anisota peigleri*
Distribution: eastern United States, known from Pennsylvania to Alabama west to Iowa and Texas

Biology: This wasp is always a hyperparasitoid of smaller ichneumonids and braconids.
References: Carlson (1979: 396), Riotte & Peigler (1981: 120), Peigler (1985a), Coffelt & Schultz (1993b)
Remarks: Specific records, all hyperparasitoids in *Hyposoter fugitivus*: *ex Anisota peigleri*: Hendersonville, North Carolina, September 1974, D. Montross (DMNH, USNM); Clemson, South Carolina, 3 September 1976, R. S. Peigler (USNM); Greenville, South Carolina, 1 October 1982, 8 September 1984, R. S. Peigler (LACM, DMNH); *ex Anisota pellucida*: Baton Rouge, Louisiana, May 1978, J. E. Eger and R. S. Peigler (DMNH); *ex Anisota*: Stubblefield Lake, Walker Co., Texas, October 1979, G. W. Brooks (LACM).

29. *Gelis tenellus* (Say)
Hosts: Hyperparasitoid in many Hymenoptera including *Enicospilus americanus, Gambrus extrematis, Hyposoter fugitivus,* and *Phobocampe clisiocampae*
Distribution: Québec to Georgia, Alaska to California, also recorded from Hawaii and Argentina
Biology: A solitary idiobiont. In *Hyposoter fugitivus*, the host makes its cocoon in the mummified primary host larval skin, then this cocoon is attacked by the secondary parasitoid. When *P. clisiocampae* serves as the host, the exposed cocoon is probably attacked. Cocoons of *Enicospilus* and *Gambrus* are contained within the primary host cocoon, well hidden. Duncan indicated that the females of *G. tenellus* enter through exit holes in the walls of the moth cocoon to attack the ichneumonid cocoons. This suggests that *Gelis tenellus* is a very opportunistic, since exit holes would be made by those *Gambrus* emerging first, and the others would emerge within only a few days afterwards. This would not explain how a female of *G. tenellus* could gain access to a cocoon of *Enicospilus americanus* within a moth cocoon. Duncan found it in only 20 cocoons of almost 5000 of *Gambrus* that he dissected. He said that only one or two *Gelis* emerge from a single cocoon of *Gambrus*, and that the ovipositing female of *Gelis* may die within the primary host cocoon before it can escape.
References: Patterson (1929: 18), Duncan (1941), Carlson (1979: 409), Riotte & Peigler (1981: 120), Coffelt & Schultz (1993b)
Remarks: Patterson reared only one of these parasitoids, which emerged in May, and did not recognize that it was a hyperparasitoid. His account of its pupation method and site should be discounted. He believed the host to have been *Coloradia pandora*.

Reports by Packard (1914: 268) and repeated by Collins & Weast (1961: 95) of *Hemeteles compactus* Cresson attacking *Callosamia promethea* probably refer to this parasitoid. Carlson (1979: 405) gave no host records for *Gelis compactus* (=*Pezomachus compactus*), and so I assume the original report by Packard was a misidentification for *G. tenellus*, and was also then mistaken to be a primary parasitoid.

Specific record: *ex Hyposoter fugitivus* in *Anisota peigleri*: Hendersonville, Henderson Co., North Carolina, September 1974, D. Montross (DMNH, USNM).

30. *Gelis insolens* (Gravenhorst)
Hosts: *Saturnia pavonia*
Distribution: Europe
References: Rougeot (1971: 107, as *Pezomachus insolens*), Carlson (1979: 403)
Remarks: According to Carlson, *Pezomachus* is a junior synonym of *Gelis*.

31. *Gelis palpator* (Gravenhorst)
Hosts: *Saturnia pavonia*
Distribution: Britain
References: Thompson (1944: 535)
Remarks: A synonym is evidently *Hemiteles palpator*. Thompson listed both names. Possibly this species belongs under the latter generic name.

32. *Mastrus* sp.
Hosts: Hyperparasitic in *Hyalophora columbia gloveri*
Distribution: North America
Biology: This species is probably a hyperparasitoid; see Remarks below.
References: Duncan (1941), Carlson (1979: 410-413)
Remarks: *Aenoplex* is a synonym of *Mastrus* (Carlson 1979: 411). Several specimens of an unidentified species of *Mastrus* were reared in Utah by Bruce Duncan from cocoons of *Hyalophora columbia gloveri*. A pair of these was sent to David Wahl who identified them to the generic level, but gave no species determination. Carlson cited *Gambrus nuncius* as a host of *Mastrus cressoni* (Riley), *Gambrus extrematis* as a host of *M. smithii* (Packard), and *Gambrus* sp. as a host for *M. mucronatus* (Provancher). Duncan has also reared *Gambrus canadensis* from the same saturniid cocoons in the same region, so these may be the true host of this *Mastrus*. The parasitoid is gracile and mainly a coal black color, but somewhat resembling *Gambrus*.

Specific record: Utah, Utah Co., Spanish Fork, 1340 m, reared 1992 from cocoons of *Hyalophora columbia gloveri*, J. B. Duncan (DMNH, AEI).

33. *Gnotus* sp.
Hosts: Hyperparasitoid in *Cotesia* sp. in *Hyalophora cecropia*
Distribution: North Atlantic States and Great Lakes States
Biology: Reared as a hyperparasitoid from *Cotesia* sp. (reported as *Apanteles* sp. by Peigler 1985a) from half-grown larvae of *Hyalophora cecropia* in Aurora, Arapahoe Co., Colorado.
References: Carlson (1979: 421), Peigler (1985a)
Remarks: Material from Colorado sent to me by S. E. Stone was forwarded to K. van Achterberg who determined it as *Gnotus* sp., so voucher material is presumably in RMNH. Only a single species of *Gnotus* is recorded from North America, namely *G. chionops* (Gravenhorst), so this may be the species to which this record belongs. It also may be conspecific with specimens from Europe and Japan.

34. *Agrothereutes fumipennis* (Gravenhorst)
Hosts: *Saturnia pavonia*
Distribution: northern Europe, including Britain
Biology: It is a gregarious idiobiont. Wasps probably oviposit onto larvae as they spin their cocoons, the parasitoids feed as ectoparsitoids, then emerge from the host's cocoon the following spring. This was found to be the case by Kugler of a parasitoid in the same genus attacking a lymantriid.
References: Nordström (1916: 125), Thompson (1944), Kugler (1961), Rougeot (1971: 107), Carlson (1979: 446-447), Ebert (1994: 111)
Remarks: Nordström cited this ichneumon under the generic name *Spilocryptus*, now considered a synonym of *Agrothereutes*. This parasitism record is probably for the same species as the following one. Nordström cited his *tibialis* Thomson as a possible synonym of *zygaenarum* Thomson. Carlson indicated that *zygaenarum*, which is the

type-species of *Spilocryptus*, is believed to be a synonym of *fumipennis*. Therefore, all three names may refer to the same species of parasitoid. Rougeot cited this insect under the name *Cryptus fumipennis*.

This may be the species of parasitoid of which pupae are shown in a color photograph of an opened cocoon of *S. pavonia* by Ebert. This genus is very closely related to *Gambrus* (Townes & Townes 1962: 70).

35. *Agrothereutes incubitor* Strom.
Hosts: *Saturnia pavonia*
Distribution: Britain
References: Thompson (1944: 535, as *Spilocryptus incubitor*)

36. *Agrothereutes tibialis* Thomson
Hosts: *Saturnia pavonia*
Distribution: northern Europe
Biology: Parasitoids emerged through small holes in a host cocoon found on the ground by Nordström in 1915 in Runmarö, Sweden. First 4 males emerged, and then after a week, 14 females emerged. The parasitoid cocoons were tightly packed within the host cocoon.
References: Nordström (1916: 125), Carlson (1979: 447)
Remarks: See remarks under *Agrothereutes fumipennis* above. I assume that the name *A. saturniae* (Boie) is a synonym of this species or the previous one.

Genus *Gambrus*

For parasitism of Saturniinae in North America, this is one of the most frequently reared genera. Specimens may be easily identified using the keys of Townes & Townes (1962: 70-71). They are gregarious idiobionts. These wasps attack hosts as they spin their cocoons. The ovipositing parasitoids are probably attracted to the odor of freshly spun silk. The host is stung, and thus paralyzed, ceases spinning and does not pupate. The wasp larvae feed as ectoparasitoids. Some host cocoons are packed full of those of the parasitoid, while in others there is a dead, blackened, dried host larva, with only a few wasp cocoons clustered within the inner chamber of the host cocoon. Adult wasps do not emerge through the exit valve of the host cocoon; instead they chew one or more holes in the side of the host cocoon. Species in this genus appear in most older literature under the generic names *Cryptus* and *Spilocryptus*.

37. *Gambrus canadensis* (Provancher)
Hosts: *Hyalophora columbia gloveri*, *Orgyia* (Lymantriidae), *Malacosoma* (Lasiocampidae), other smaller moths, and possibly a tenthredinid (Hymenoptera)
Distribution: Most of North America, recorded from Alaska and British Columbia to Arizona, and Nova Scotia to North Carolina
Biology: There are usually four to ten parasitoids per host in *Malacosoma*, and I would expect more to emerge from *Hyalophora*. According to Townes and Townes "the cocoon is elliptic, of moderate length, thin but dense, and with a felt of loose silk on the outside. The color ranges from white to gray-brown."
References: Townes & Townes (1962: 80-85), Carlson (1979: 449)
Remarks: Specific records: *ex Hyalophora columbia gloveri*: Spanish Fork, 1340m, Utah Co., Utah, emerged indoors April 1992, J. B. Duncan (DMNH, AEI). Specimens were identified by David Wahl.

38. *Gambrus extrematis* (Cresson) (Figure 2)
Hosts: *Hyalophora cecropia, Hyalophora euryalus, Hyalophora columbia columbia, Hyalophora columbia gloveri*
Distribution: British Columbia to Nova Scotia, south to Virginia, Kansas, Utah, and California
Biology: According to Marsh, more than 1000 eggs were found in a single host cocoon resulting from oviposition of several females. The maximum number of mature cocoons found in a single host cocoon was 172. Marsh wrote that the larvae move about freely over the dead host, eventually consuming all of it except the most chitinized parts in cases of heavy parasitism, and that cannibalism among the parasitoid larvae seems certain. He said that the wasp is bivoltine in Chicago, completing a life cycle in about 18 days. This should be possible where larvae of the host spin their cocoons over a period of three or more weeks. The parasitoids overwinter in their cocoons within the host's cocoon. About 5—40 wasps of one or both sexes emerge from a single host cocoon.

In the region around Denver, Colorado, I found that this parasitoid is attacked commonly by the facultative hyperparasitoid *Monodontomerus minor*, listed elsewhere in this catalog. I also found that the moth host is usually left as a blackened larva, with only a small mass of *Gambrus* cocoons alongside.
References: Eliot & Soule (1902: 256), Gibson (1906), Marsh (1937), Duncan (1941), Townes & Townes (1962: 87-90), Carlson (1979: 449)
Remarks: Specific records: *ex Hyalophora cecropia*: Aurora, Arapahoe Co., Colorado, May 1982, May 1988, S. E. Stone, R. S. Peigler (DMNH); Littleton, Jefferson Co., Colorado, spring 1993, spring 1994, R. S. Peigler; Easthampton, Hampshire Co., Massachusetts, May 1977, D. Adamski (DMNH); Ithaca, Tompkins Co., New York, emerged June/July 1975, R. Dirig (DMNH).

39. *Gambrus nuncius* (Say)
Hosts: *Samia cynthia, Callosamia angulifera, Callosamia promethea, Callosamia securifera, Antheraea polyphemus*
Distribution: New Brunswick to Northwest Territories, down to Alabama.
Biology: My observations indicate that a brood of this parasitoid almost always consumes the entire host, and form a mass of tightly packed cocoons within that of the host.
References: Townes & Townes (1962: 85-87), Ferguson (1972: 242), Peigler (1977), Carlson (1979: 449), Peigler (1985a),
Remarks: Specific records: *ex Callosamia* hybrids: Greenville, South Carolina, July 1974, July/August 1976, R. S. Peigler (DMNH, USNM); *ex Callosamia angulifera*: Greenville, South Carolina, April-May 1983, May 1984, R. S. Peigler (BMNH, LACM); *ex Callosamia securifera*: Highway 6, Berkeley Co., South Carolina, emerged indoors March 1975, R. S. Peigler.

Peigler (1985a) erroneously reported material of *G. extrematis* from Colorado under the name *G. nuncius*. The record(s) for this parasitoid attacking *Antheraea polyphemus* should be verified, as it may be based on *Gambrus polyphemi*. The two species look much alike. However, no species of *Callosamia* nor *Samia* range into far northern Canada, so if the geographical records are correct for *Gambrus nuncius*, the most likely hosts would be *Antheraea polyphemus* or *Hyalophora columbia*. No saturniid is known to range into the Northwest Territories. I have not seen material reared from *Samia cynthia,* but this host is quite likely, considering that *Samia* is closely related to *Callosamia* and has a hanging cocoon of similar shape and size, found on some of the same hostplants (*Sassafras, Prunus,* etc.).

The rearings by me in central Greenville County indicate that the normal host in that area is *C. angulifera*. *Callosamia promethea* does not exist there, but does occur in northern Greenville County at higher elevations in disturbed forests and along highways. *Callosamia securifera* does not occur within 150 km of Greenville, whereas *C. angulifera* is common throughout Greenville County including some urban areas. Some of the rearings from the hybrids produced smaller wasps in larger numbers, examples of superparasitization. The hosts were parasitized through cloth bags as they spun their cocoons in folds of the bags, covering branches of *Liriodendron tulipifera* and *Magnolia virginiana*, the latter tree not native that far inland in South Carolina. The record for *C. securifera* cited by Ferguson was from northern Charleston County, South Carolina.

40. *Gambrus polyphemi* H. Townes
Hosts: *Antheraea polyphemus*
Distribution: All across southern Canada and over much of United States, corresponding to the range of the host. According to Townes and Townes, it is more common in the East than the West, like its host species. See Remarks below.
Biology: Townes & Townes cited host records of *Hyalophora cecropia* but expressed skepticism. Carlson did not list the doubtful host records. I agree that these records need to be verified before being perpetuated in literature. Townes & Townes wrote that the host cocoon is packed full of parasitoid cocoons, and that about 15 parasitoids, usually of both sexes, emerge from a single host. They reported that this parasitoid is moderately common along edges of deciduous forests. As with other species of *Gambrus*, the host is attacked as it spins its cocoon, and the parasitoids overwinter within. The adults are found mainly from early June through the middle of September, but sometimes into November.
References: Townes & Townes (1962: 90-93), Carlson (1979: 449)
Remarks: Specific record: *ex Antheraea polyphemus*: San Antonio, Bexar Co., Texas, August 1972, T. McGregor (TAMU).

I have never reared it from numerous wild-collected cocoons from South Carolina, Texas, and Colorado, so I suspect this wasp is more common in the Northeast than the Southeast. The map of Townes & Townes shows no records for the Ozarks, the Great Plains, the Rocky Mountains (except in New Mexico), the Great Basin, nor California and Arizona. The host is largely absent from the Great Basin. An unidentified ichneumon which makes cocoons within the host cocoon much like those of *Gambrus* was illustrated by Cotes (1891-1893: pl. 9) in a cocoon of *Antheraea roylei* from northeastern India.

41. *Lymeon orbus* (Say)
Hosts: A hyperparasitoid in other ichneumonids, including *Hyposoter fugitivus*, and a primary parasitoid of other insects
Distribution: eastern half of United States
Biology: Apparently a solitary idiobiont. In Louisiana Khalaf found that *L. orbus* is a hyperparasitoid on the ichneumonid *Lanugo retentor* (Brullé) which in turn is a parasitoid of the megalopygid moth *Megalopyge opercularis* (J. E. Smith).
References: Khalaf (1980), Carlson (1979: 474-475), Riotte & Peigler (1981: 120)
Remarks: Specific record: *ex Anisota fuscosa*: Stubblefield Lake, Walker Co., Texas, 3 November 1976, R. S. Peigler (DMNH, USNM).
Three specimens were obtained, two males and one female, from this rearing (three separate hosts).

There is a record cited by Thompson (1944: 105) of *Acroricnus stylator aequatus* (Say) (=*A. junceus*), an ichneumon related to *Lymeon*, attacking *Callosamia promethea*. This record is erroneous, because all species in this subtribe attack only Hymenoptera such as Sphecidae (Carlson 1979: 476-477).

42. *Trachysphyrus chacorum* Porter
Hosts: *Rothschildia* sp.
Distribution: northern Argentina
Biology: Several specimens emerge from a single host cocoon. The female wasp oviposits into the host cocoon, stinging the pre-pupa or pupa. Thus species of this genus are gregarious idiobionts.
References: Porter (1967: 248-250)
Remarks: The species of *Rothschildia* that occur in this region of northern Argentina are *R. maurus, R. tucumani, R. condor,* and *R. schreiteriana*. Probably all of these serve as hosts.

43. *Trachysphyrus desantis* Porter
Hosts: unidentified saturniid
Distribution: from Cuzco, Peru, to central Argentina
Biology: Based on knowledge of other species in the genus, the parasitoid female oviposits into a host cocoon, laying several eggs. This species inhabits high montane grasslands in the northern part of its range, and lowland pampas in central Argentina.
References: Porter (1967: 242)
Remarks: Porter wrote: "The male and female from Olivos in Buenos Aires Province were reared from an unidentified saturniid moth."

44. *Trachysphyrus horsti* (Brèthes)
Hosts: *Cercophana frauenfeldi, Neocercophana philippi, Macromphalia dedecora* (Lasiocampidae)
Distribution: Chile
Biology: The wasps are very common in forests around Temuco, where they fly slowly among trees. They particularly search on various trees which are hostplants of the two cercophanines. Eggs are laid occasionally into larvae, but most frequently into pupae in cocoons. Several adult parasitoids emerge from a single host cocoon.
References: Porter (1967: 227)
Remarks: Porter cited the above two saturniid hosts based on a literature report on *T. horsti*, and he indicated that there is a possibility that the report actually belongs under a different species of *Trachysphyrus*. The lectotype of *T. horsti* (designated by Porter) was reared from the lasiocampid host. The Cercophaninae are now considered to be a subfamily of Saturniidae (Minet 1994).

45. *Trachysphyrus kinbergi* Holmgren
Hosts: *Automeris coresus, Ormiscodes amphinome lauta*
Distribution: Peru, Chile, Argentina, Bolivia, Uruguay, from the Peruvian and Bolivian Andes all the way south to the Strait of Magellan and the Chilean province of Aisén.
Biology: There is some confusion as to whether larvae or pupae are attacked. Presumably oviposition is into mature host larvae and adult parasitoids emerge from host cocoons. Some of the material in collections labelled as being reared from larvae probably simply means that the hosts were collected as larvae.

References: Porter (1967: 306-309)
Remarks: Porter cited the hosts as *Automeris cresus* and *Catocephala lauta*. The latter host should probably be cited simply as *O. amphinome*, because the subspecies *lauta* is doubfully valid (C. Lemaire, pers. comm.).

46. *Trachysphyrus tucuman* Porter
Hosts: *Rothschildia tucumani*
Distribution: northern Argentina
Biology: Oviposition is into the cocoon of the host, stinging the pupa or pre-pupa. According to Porter (1967: 33), adult wasps of this genus feed in flowers, but not commonly.
References: Schreiter (1925: 15), Porter (1967: 251-253)
Remarks: There is a series of this wasp in the USNM that was reared from the host cited above.

47. *Trachysphyrus* sp.
Hosts: *Rothschildia arethusa*
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 271)

48. *Gotra octocincta* (Ashmead)
Hosts: Saturniidae, *Dendrolimus* spp. (Lasiocampidae)
Distribution: China, including Taiwan, Korea, Japan
References: Townes et al. (1965: 193)
Remarks: No specific saturniids were cited as hosts.

Subfamily Ichneumoninae

49. *Cratichneumon anisotae* Heinrich
Hosts: *Anisota senatoria, Dryocampa rubicunda*
Distribution: southeastern Canada and northeastern United States, as far as Virginia and Wisconsin
Biology: A solitary idiobiont, attacking pupae of hosts. No saturniid pupae are recorded to possess a gin trap to counter attacks by probing ovipositors (Chinery 1989: 240).
References: Carlson (1979: 492)
Remarks: A specimen reared in Ada, Michigan, reputedly from a cocoon of *Callosamia promethea* was sent to me by W. Buttrick in 1993. This fragmentary specimen was identified as *C. anisotae* by David Wahl. Considering that Buttrick was not able to locate the host remains, and had pupae of *Anisota senatoria* at the same time (he sent me cocoons of *C. promethea* and pupae of *A. senatoria* in the same package), it is likely that the latter was the true host.
This anecdote is given to demonstrate the importance of keeping different hosts in separate containers.

50. *Cratichneumon insulae* Heinrich
Hosts: *Hemileuca maia*
Distribution: known only from Rhode Island and New Jersey
Biology: The pupae of hosts are attacked. This parasitoid is a solitary idiobiont. These wasps are not attracted to light.
References: Carlson (1979: 494), Peigler (1985a)

Remarks: I collected a specimen of *C. insulae insignitus* Heinrich in Greenville, South Carolina, 28 May 1977 (DMNH).

Specific record: *ex Hemileuca maia*: Baton Rouge, Louisiana, 7 August 1982, J. E. Eger (BMNH, LACM). If this wasp and related species are specialists on Saturniidae, they would be able to attack pupae of *Hemileuca* in early summer and *Anisota* in late summer, overwintering in the latter.

51. *Cratichneumon unifasciatorius* (Say)
Hosts: *Coloradia pandora, Hemileuca* sp.
Distribution: southern British Columbia to Québec, south to Florida and Arizona
Biology: Less than 1% of pupae of *Coloradia* in northern Arizona were attacked, limited to those near the soil surface.
References: Schmid & Bennett (1988), Carlson (1979: 496)

52. *Cratichneumon w-album* (Cresson)
Hosts: *Anisota senatoria, Dryocampa rubicunda*
Distribution: Québec to Georgia, west to Alabama and Wisconsin
Biology: The pupae are attacked. The wasps emerge from the anterior ends of the host pupae.
References: Hitchcock (1961b), Allen (1976), (Carlson (1979: 497)
Remarks: According to Carlson, *Cratichneumon variegatus* (Provancher) is a synonym of *C. w-album.*

Specific records: Cave Run Lake, Ramey Creek, Daniel Boone National Forest, Rowan Co., Kentucky, 28 May 1993 and 25 May 1994, B. C. Kondratieff (CSU).

53. *Amblyteles armatorius* (Forster)
Hosts: *Saturnia pavonia*
Distribution: Europe, including Britain
References: Thompson (1944: 535), Rougeot (1971: 107), Chinery (1975: pl. 38), Pujade & Sarto (1986: 20).
Remarks: This wasp is black with broad yellow bands on the abdomen and legs. The scutellum and tegulae are also yellow. It was figured in color by Chinery and Pujade & Sarto.

54. *Amblyteles erythronotus* Rondani
Hosts: *Saturnia caecigena*
Distribution: southeastern Europe
References: Lederer (1952: 144), Rougeot (1971: 116)
Remarks: Lederer wrote "Von Rudow wird die Ichneumonide *Amblyteles erythronotus* Rd. (?) als Schmarotzer angegeben." I did not find Rudow cited in his text or bibliography. The host species is usually classified in the genus *Perisomena.*

55. *Amblyteles oratorius* (Fabricius)
Hosts: *Saturnia pavonia*
Distribution: Britain
References: Thompson (1944: 535)

56. *Ichneumon microstictus* Wsm.
Hosts: *Actias isabellae*
Distribution: Europe

References: Ceballos & Agenjo (1943), Testout (1947), Rougeot (1971: 80), Gómez & Fernández (1976: 73), Ylla (1992: 391).
Remarks: I was not able to clarify the current generic placement of this taxon and the next one, because H. Townes and colleagues did not catalog the European ichneumonid fauna in their many monographs.

57. *Ichneumon sulfuripes* Rondani
Hosts: *Actias isabellae*
Distribution: Europe
References: Ceballos & Ajengo (1943: 62), Testout (1947), Rougeot (1971: 80), Gómez & Fernández (1976: 73), Ylla (1992: 391)

58. *Protichneumon grandis* (Brullé)
Hosts: *Dryocampa rubicunda*
Distribution: British Columbia to Québec, Oregon and New Mexico to Florida
Biology: Most species in this Holarctic genus attack Sphingidae. The saturniid host listed above, being a ceratocampine, is "sphingiform".
References: Carlson (1979: 534)

59. *Conocalama quebecensis* (Provancher)
Hosts: *Eacles imperialis*
Distribution: New England, Great Lakes region, Nova Scotia to British Columbia
References: Carlson (1979: 537-538)
Remarks: No other host is recorded for this parasitoid.

60. *Pedinopelte gravenstii* (Guérin)
Hosts: *Automeris* sp., *Papilio* (Papilionidae)
Distribution: South America, including Surinam, Venezuela, Brazil, Boliva, Paraguay, and Argentina.
References: Townes & Townes (1966: 281), d'Araújo e Silva et al. (1968: 263)

Subfamily Metopiinae

61. *Metopius dentatus* (Fabricius)
Hosts: *Saturnia pavonia*
Distribution: Britain, Norway, Russia
References: Thompson (1944: 535), Townes et al. (1965: 347)
Remarks: This parasitoid is placed in the subgenus *Peltocarus*.

62. *Metopius micratorius* (Fabricius)
Hosts: *Saturnia pyri*
Distribution: Europe, including Russia
References: Thompson (1944: 535), Packard (1914: 268)

63. *Metopius pollinctorius* (Say)
Hosts: *Actias luna, Gluphusia septentrionis* (Walker) (Notodontidae), *Acronicta oblinita* (J. E. Smith) (Noctuidae)
Distribution: Nova Scotia to British Columbia to Florida and Illinois
References: Carlson (1979: 553)
Remarks: Carlson cited the saturniid host with a "?" and listed the parasitoid as subspecies *M. pollinctorius pollinctorius*.

Subfamily Banchinae

64. *Glypta erratica* Cresson
Hosts: *Hemileuca maia, Hemileuca lucina*
Distribution: Vermont to northern Georgia, west to eastern South Dakota
References: Schaffner & Griswold (1934), Thompson (1944: 293), Carlson (1979: 565)
Remarks: The original report by Schaffner & Griswold was as "*Hemileuca maia* and/or *lucina*." Carlson did not repeat the host record, so perhaps he believed it needs verification.

65. *Glypta* sp.
Hosts: *Eacles imperialis magnifica*
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 261) Carlson (1979: 564-567)
Remarks: There are numerous species of this genus in North America.

66. *Apophua simplicipes* (Cresson)
Hosts: *Hemileuca* sp., many other Lepidopteria, including Lasiocampidae, Notodontidae, Noctuidae, and Tortricidae.
Distribution: British Columbia to Nova Scotia south to New Mexico, Texas, and Florida. One specimen from California without further locality data.
References: Carlson (1979: 564), Dasch (1988: 16-20), Thompson (1944: 293, as *Glypta simplicipes*).

67. *Exetastes illusor* Gravenhorst
Hosts: *Saturnia pavonia*
Distribution: Europe
References: Rougeot (1971: 107), Carlson (1979: 575-578)
Remarks: There are numerous species in this genus in North America.

68. *Exetastes nigripes* Gravenhorst
Hosts: *Saturnia pavonia*
Distribution: Britain
References: Thompson (1944: 535)

Subfamily Anomaloninae

69. *Podogaster* sp.
Hosts: *Hylesia lineata*
Distribution: Colima, Mexico
Biology: This group of parasitoids lives in humid, lowland forests.
References: Ian Gauld (pers. comm.)
Remarks: The name *Philodrymus* is probably a junior synonym of *Podogaster*.
Specific record: *ex Hylesia lineata*: Chamela Biological Station, 120 km N of Manzanillo, Colima, June 1986 (BMNH).

70. *Anomalon signatum* Gravenhorst
Hosts: *Saturnia pavonia*
Distribution: Europe
Biology: Probably a larval-pupal solitary endoparasitoid.
References: Packard (1914: 268)

Remarks: The record, quite old and in need of verification, was supplied to Packard by an entomologist named Mocsary, so the record probably came from eastern Europe.

71. *Habronyx australasiae* (Morley)
Hosts: *Opodiphthera* sp.
Distribution: New South Wales and Tasmania
References: Morley (1913: 75), Gauld (1976), Gupta (1987: 628-629)
Remarks: The host record was cited as *Antheraea* sp., but this genus does not occur in Australia. Species of *Opodiphthera* and *Syntherata* have often been classified as *Antheraea*. The record is probably based on a rearing of *Opodiphthera eucalypti*.

72. *Habronyx insidiator* (Smith)
Hosts: *Antheraea yamamai, Antheraea pernyi, Saturnia japonica, Saturnia jonasii, Saturnia boisduvalii*
Distribution: China, Taiwan, eastern Russia, Japan, Korea
Biology: Probably a larval-pupal solitary koinobiont parasitoid.
References: Thompson (1944: 50), Townes et al. (1965: 365-366), Sakamoto (1990: 150)
Remarks: Cited by Thompson under the name *Acanthostoma insidiator*.

73. *Habronyx magniceps* (Cresson)
Hosts: *Anisota oslari, Anisota stigma, Anisota virginiensis, Anisota senatoria, Drycampa rubicunda, Hemaris diffinis* (Boisduval) (Sphingidae)
Distribution: Maine to southern Manitoba to eastern Texas and southeastern Arizona; one record for Placer Co., California
Biology: The wasps fly from early July until mid-October, depending on locality.
References: Allen (1976), Carlson (1979: 611), Dasch (1984: 15-17), Peigler (1985a)
Remarks: Dasch cited the specific host records for specific regions: *Anisota oslari* in Arizona, *Anisota virginiensis* in Manitoba, *Anisota stigma* in Michigan and New York, *Anisota senatoria* in Ontario, and *Dryocampa rubicunda* in New Jersey, New York, Ontario, Quebec, and Pennsylvania. He cited with doubt a record for an unidentified species of Geometridae as a host.

Specific records: *ex Anisota oslari*: Guadalupe Mts., Arizona, emerged 9 September 1983, M. J. Smith (DMNH); Peloncillo Mts., Cochise Co., Arizina, M. J. Smith (BMNH); Guadalupe Canyon, 50 km east of Douglas, Cochise Co., Arizona, host on *Quercus turbinella* 15 September 1982, parasitoid emerged 19 August 1983, M. J. Smith (CSU).

74. *Habronyx pyretorus* (Cameron)
Hosts: *Saturnia pyretorum*
Distribution: known from only a few specimens from Hong Kong
Biology: Presumably a solitary koinobiont that oviposits into host larvae and emerges from host pupae.
References: Cameron (1912), Morley (1913), Packard (1914: 268), Townes et al. (1961: 312), Peigler (1985a), Gupta (1987: 629)
Remarks: The spelling of the name of the parasitoid in literature prior to Gupta was *pyretorum*. Two specimens were sent to me by Michael Bascombe in 1980, as follows. Ian Gauld verified the determination.

Specific record: *ex Saturnia pyretorum*: Hong Kong, 1980, M. J. Bascombe (BMNH, LACM).

75. *Therion sassacus* Viereck
Hosts: *Hemileuca eglanterina*, other moths in Arctiidae, Geometridae, etc., and Tenthredinidae (Hymenoptera)
Distribution: British Columbia to Nova Scotia, southern California to northern Alabama, also northern New Mexico and Arizona
Biology: The adults fly mainly from mid-July to late August.
References: Dasch (1984: 376-379)

76. *Agrypon illinois* Dasch
Hosts: *Hyalophora columbia gloveri*
Distribution: known only from Livingston County, Illinois
References: Dasch (1984: 307-308)
Remarks: Dasch described this species from a single male from Fairbury, Illinois, collected by A. H. Lundt. It was reported as a probable parasite of *Hyalophora gloveri*. If the host record is correct, the locality is not, since *gloveri* (the Rocky Mountain form of *Hyalophora columbia*) does not occur further east than far western South Dakota. Other possibilties for the host are *Hyalophora cecropia* (common throughout Illinois) or *Hyalophora columbia* (found in some areas of southern Wisconsin). The host cocoon may have been transported from the original collecting site, or it may have been a misidentification. One other possibility is that Lundt reared *gloveri* in Fairbury, from eggs he received from the Rocky Mountain region. The specimen is over a century old, since it came from the collection of C. V. Riley.

77. *Encardia picta* Tosquinet
Hosts: *Bunaea alcinoe caffra, Bunaea alcinoe, Gynanisa maja, Lobobunaea angasana, Imbrasia petiveri, Imbrasia cytherea, Imbrasia zambesina, Imbrasia tyrrhea, Imbrasia wahlbergii, Tagoropsis flavinata, Gonometa maputana* (Lasiocampidae)
Distribution: central and southern Africa
Biology: All of the saturniid hosts pupate in the ground without a cocoon. The lasiocampid host forms a strong silk cocoon on its hostplant, well above ground.
References: Townes & Townes (1973: 203-204), Gauld (1980), Oberprieler (unpubl.)
Remarks: The nomenclature of the host names *Lobobunaea saturnus, Nudaurelia dione* (=*Imbrasia petiveri*), and *Antheraea ringleri* (=*Imbrasia zambesina*) as cited by Townes & Townes is corrected in the list above.

Subfamily Campopleginae

78. *Campoplex quadrimaculatus* Ratzeburg
Hosts: *Aglia tau*
Distribution: Europe
References: Packard (1914: 268).
Remarks: The record is old and thus in need of verification, especially as regards the identity of the parasitoid.

79. *Phobocampe clisiocampae* (Weed)
Hosts: *Actias luna*, several other Lepidoptera including Sphingidae, Lasiocampidae, and Notodontidae
Distribution: North America, mainly northern, from Nova Scotia to Alberta to Arkansas and upper South Carolina
Biology: The 2nd or 3rd instar larva was attacked while feeding on foliage of *Liquidambar styraciflua*. This larva was then kept in a jar. The wasp larva emerged (and

would have fallen to the ground in nature) from the host larva and made a hard, ovoid, dark brown cocoon. It is difficult to decide if such cases of parasitization of young larvae are koinobiontic or idiobiontic.
References: Carlson (1979: 658-659)
Remarks: Specific record: *ex Actias luna*: Clemson, Pickens Co., South Carolina, September 1974, R. S. Peigler (USNM).

80. *Melalophacharops* sp.
Hosts: *Opodiphthera eucalypti*
Distribution: Australia
References: Gauld (1984: 278)

81. *Hyposoter fugitivus* (Say) (Figure 4)
Hosts: *Anisota senatoria, Anisota finlaysoni, Anisota consularis, Anisota virginiensis, Anisota stigma, Anisota pellucida, Anisota peigleri, Anisota discolor, Anisota fuscosa, Dryocampa rubicunda, Automeris io, Hemileuca lucina, Hemileuca maia,* and several other caterpillars in Arctiidae, Lasiocampidae, and Notodontidae
Distribution: Nova Scotia to Washington, south to central California, eastern Texas, and central Florida
Biology: Small caterpillars are attacked, in saturniids usually in the 2nd instar (never when more than about 10 mm in length). The egg is apparently laid into the host. It is probably an endoparasitic idiobiont. The wasp matures quickly and makes a mummy of the host skin, spinning its elongated and papery white cocoon within, the mummy affixed to the leaf or twig of the host's hostplant. The adult parasitoids emerge within a couple weeks or more. During this time their exposed cocoons are vulnerable to attack from hyperparasitoids.
References: Packard (1914: 268, as *Limnerium fugitivum*), Allen (1976), Carlson (1979: 675-677), Peigler (1985), Riotte & Peigler (1981: 120), Gauld & Janzen (1994: 317-319), Stamp & Bowers (1990), Coffelt & Schultz (1993b)
Remarks: It is almost impossible to collect young larvae of *Anisota* in the southeastern United States without encountering this parasitoid, usually in high numbers. I have found it in populations of *Anisota* in Florida, North Carolina, South Carolina, Arkansas, Texas, and Louisiana. Donald Henne (pers. comm.) has also reared this parasitoid from *Anisota virginiensis* from Belair, on the southeastern shore of Lake Winnipeg, Manitoba.

Specific records: *ex Anisota virginiensis*: 5 km W of Keewatin, Ontario, July 1988, L. Kohalmi (DMNH, CUAC); *ex Anisota pellucida*: Orangeburg, South Carolina, 1968, R. S. Peigler; Saint Francis Co., Arkansas, 8 July 1978, R. S. Peigler (DMNH); Baton Rouge, Louisiana, May 1978, R. S. Peigler & J. E. Eger (TAMU, USNM); *ex Anisota peigleri*: Clemson, South Carolina, 1972 and August 1976, R. S. Peigler (USNM, DMNH); *ex Anisota senatoria*: Stubblefield Lake, Walker Co., Texas, October 1976, October 1979, October 1993, R. S. Peigler & W. G. Alther (USNM, DMNH); *ex Anisota fuscosa, A. discolor*: Stubblefield Lake, Texas, October 1976, October 1977, R. S. Peigler (USNM); *ex Anisota consularis*: Statesboro, Georgia, August 1975, R. S. Peigler & J. W. McCord (USNM).

82. *Hyposoter havrylenkoi* Havrelenko & Winterhalter
Hosts: *Ormiscodes cinnamomea*, other Saturniidae, Lasiocampidae
Distribution: Argentina
References: Townes & Townes (1966: 153)

83. *Cryptophion moragai* Gauld & Janzen
Hosts: *Syssphinx molina*
Distribution: All known specimens are from Guanacaste Province, in northwestern Costa Rica.
Biology: No specimens have ever been collected in malaise traps, probably because they fly in tree tops. The wasp oviposits into first to third instar larvae of the host, and complete their development while the host is in the second or third instar. The parasitoid ranges at 300 m in altitude and lives in seasonally dry tropical forests. No months were given for its emergence by the authors cited below.
References: Gauld & Janzen (1994)
Remarks: This parasitoid belongs to a group of species that attack Sphingidae larvae. The larvae of ceratocampine saturniids are "sphingiform", so the switch to the saturniid host is logical. The genus *Cryptophion* is closely allied to *Hyposoter*, and Gauld & Janzen believed that it may be derived from *Hyposoter* (which would make the latter genus paraphyletic). See also text of *Thyreodon santarosae* below. The name *Cryptophion* may cause confusion since this genus does not belong to the Ophioninae.

Subfamily Phygadeuontinae

84. *Paraphylax* sp.
Hosts: *Opodiphthera* sp.
Distribution: Australia
Biology: Gauld reported that 37 wasps emerged from one host cocoon.
References: Gauld (1984: 128)

Subfamily Ophioninae

Considerable advances in the systematics on this subfamily have been published in recent years by Dr. Ian Gauld and his wife Pamela Mitchell. They have described hundreds of new species and worked out the generic relationships by applying modern cladistic methodology. Some of their monographs are cited in this catalog. See additional remarks below under the genus *Enicospilus*.

85. *Ophion* sp.
Hosts: *Anisota senatoria*
Distribution: northeastern North America
Biology: Oviposition is likely into the larva, and the parasitoid emerges from the pupa.
References: Carlson (1979: 697-698), Gauld (1988b)
Remarks: A female wasp (length 21mm) with light amber wings is in the Carnegie Museum of Natural History. The slender cocoon (8mm X 18mm) of the parasitoid is on the same pin. The labels read as follows: "*Ophion* emerged VI.18.1925 from pupa of *Anisota senatoria*, the larva of which was taken on alder at Squaw Run, Pittsburgh, Pa., September 1924, [B.] Krautwurm" "The cocoon of the *Ophion* was inside the pupa of *Anis. senatoria* when it emerged." This specimen was identified as *Ophion* sp. by H. E. Evans (CSU). A trace of segmentation on the cocoon suggests that it was packed firmly inside the host pupa, of which there are no traces. Alder is not a known host of *Anisota*, although larvae sometimes move from oaks to other trees and begin feeding (Riotte & Peigler 1981). There is a possibility that Krautwurm misidentified the host.

Genus *Thyreodon*

These are very large ichneumons because they have large hosts. They have flattened abdomens like other ophionines, but have black wings, black bodies, and yellow antennae—obvious mimics of Pompilidae. They are day active, so do not come to lights. I have observed them flying near the ground in forests in South Carolina. Most species attack Sphingidae.

86. *Thyreodon santarosae* Porter
Hosts: *Syssphinx molina, Ptiloscola dargei, Othorene purpurascens*
Distribution: Guanacaste Province, Costa Rica
Biology: The parasitoid lives in seasonally dry tropical deciduous forests at altitudes of 250 to 350 m. All known specimens were reared from ceratocampine saturniids collected as larvae between 3 and 20 m above the ground in trees. Emergences were between April and December, coinciding with the wet season. No parasitoids have been collected with hand nets or in malaise traps, probably because they fly high in trees. Most species in this genus attack larvae of Sphingidae. Larvae of ceratocampine saturniids are "sphingiform" and live in tops of trees, so the switch to these hosts is understandable. The parasitoid is a koinobiont.
References: Porter (1986), Gauld (1988b: 61)
Remarks: This parasitoid was named for Santa Rosa National Park, now part of Guanacaste National Park. Porter deposited type material in BMNH, USNM, LACM, and TAMU, among other institutions. See also text of *Cryptophion moragai* above.

87. *Thyreodon* sp.
Hosts: *Eacles imperialis*
Distribution: northeastern North America
Biology: The host larva is attacked, and the adult parasitoid emerges from the host pupa. The emergence exit is not centered on the end of the cocoon and has a ragged edge where the parasitoid chewed its way out. Adults of *Enicospilus* chew a neat circular hole at the end of their cocoons to exit.
References: Carlson (1979: 700), Gauld (1988b)
Remarks: A female is in the Carnegie Museum of Natural History with its plump cocoon (11mm X 24mm) on the same pin. It has solidly back body and legs, dark brown wings, and orange antennae; length 29 mm. The label reads: "From pupae of imperialis, Aug. 10, 1928, B. Krautwurm." This collector apparently lived in the Pittsburgh area (see *Ophion* above). The genus was verified but the species could not be determined by H. E. Evans (CSU).

88. *Stauropoctonus bombycivorus* (Gravenhorst)
Hosts: *Actias artemis, Stauropus fagi* (L.) (Notodontidae)
Distribution: Britain, France, Germany, Switzerland, Russia, China, Japan, possibly also northern India and Nepal
Biology: Although in separate families, the two known hosts have large larvae that feed on beech (*Fagus* sp.). Also, both spin a fairly large cocoon.
References: Townes et al. (1965: 338), Gauld & Mitchell (1981: 90-92), Gauld (1984: 296), Gupta (1987: 493-494), Tang (1990: pl. 18, color pl. 51)
Remarks: Townes et al. cited this parastoid as the subspecies *S. bombycivorus variegatus* (Uchida). Gupta and Gauld did not use the trinomial.

89. *Dicamptus nigropictus* (Matsumura)
Hosts: unidentified Saturniidae, *Dendrolimus spectabilis, Dendrolimus punctatus* (Lasiocampidae)
Distribution: India (Arunachal Pradesh); Korea; China (Guangdong, Guangxi, Taiwan, Yunnan, Guizhou, Zhejiang, Shanghai, Jiangxi. Hunan, Sichuan, Shaanxi, Shanxi, Gansu), Japan including Ryukyu Islands; Laos; Brunei; and Indonesia (Borneo).
References: Townes et al. (1961: 267), Gauld & Mitchell (1981: 98-101), Gupta (1987: 502-503), Tang (1990: pl. 19, color pl. 52), Tang (1993)
Remarks: Gupta cited a record of *Monodontomerus dentipes* (Torymidae) as a hyperparasitoid of this ichneumon.

Genus *Enicospilus*

Parasitoids of this genus are important enemies of Saturniidae, especially in the New World. They are probably also common enemies of Asiatic and African Saturniidae, but only a single rearing record exists! Hundreds of species are known from the tropical and temperate regions of the world, of which most specimens in collections were taken at lights. Hosts are known for relatively few species, but where known, are Lepidoptera. Because they are nocturnally active, most are colored monotonously orange brown, there being no ecological need for markings and varied coloration. They rest by day on plants, and by night mate and search for hosts. The orange ichneumons with flattened abdomens that we see commonly at lights are mostly of this genus, although some are *Netelia* (Tryphoninae), *Ophion*, or even "ophionoid" braconids. Most females of these wasps can deliver a painful sting, but it is easy to see the ovipositors (stingers) to distinguish them from males. The genera *Dicamptus* and *Stauropoctonus* are very closely related to *Enicospilus* (Gauld 1985).

For purposes of identification, it should be noted that most species look identical without magnification; although Figure 3 shows *E. americanus*, the figure would easily pass for many of the larger species like *E. lebophagus, E. aktites, E. plicatus,* or *E. glabratus* (Say). The latter attacks Arctiidae and Lymantriidae and is not included in this catalog, and *E. texanus* is usually smaller and darker. Amateurs rearing these wasps in North America will find the key by Gauld (1988a) to be surprisingly user-friendly. Identification of specimens from other areas can be made using keys by Gauld (1988b), Gauld & Mitchell (1978, 1981), and Tang (1990). Some of the gigantic species of these wasps described by Gauld & Mitchell (1981) from Indonesia and New Guinea are surely parasitoids of Saturniidae, but so far they have only been taken at light.

Hosts are attacked as larvae. The parasitoid remains in the host as a first-instar larva until the hormone change in the host when it is ready to pupate triggers the parasitoid larva to quickly feed and grow. By the time the host has completed its cocoon or pupal chamber it is overcome and devoured by the parasitoid larva. These ichneumons are typical koinobionts. The cocoon of the parasitoid is ovoid, dark brown, with a light tan equatorial band.

Using new rearing records from Costa Rica discovered by D. H. Janzen, Gauld (1988b: 13-14) made an interesting observation. In North America, almost all of the Saturniidae are attacked by two species in this genus; *Enicospilus americanus* hits most Saturniinae and *Automeris* (Hemileucinae), whereas *E. texanus* hits numerous Hemileucinae and *Agapema* (Saturniinae). In the tropics it appears that most species of *Enicospilus* that attack saturniids specialize on a single genus of host. Gauld hypothesized that these specialist parasitoids in the tropics may have been derived

from generalist ancestors to the north, but it is difficult to find synapomorphies to support it.

90. *Enicospilus americanus* (Christ) (Figure 3)

Hosts: *Samia cynthia, Rothschildia orizaba, Rothschildia maurus, Rothschildia schreiteriana, Rothschildia arethusa, Rothschildia cincta, Hyalophora cecropia, Hyalophora euryalus, Callosamia promethea, Callosamia securifera, Antheraea polyphemus, Actias luna, Automeris io, Automeris pamina*

Distribution: Nova Teutonia, Brazil; Cochabamba, Bolivia; Tucumán, Argentina; Nuevo León and Chihuahua south to Chiapas, Mexico; Québec and Ontario, Canada; New England to California, United States

Biology: Host larvae of the early to middle instars are attacked by an egg being inserted into them. The larva of the parasitoid does not begin to mature until the host makes its cocoon, and then it eats all of the host except the cast larval skin which is found in the bottom of the host cocoon. There are no remnants of the host's pupal shell, so the parasitoid larva apparently finishes consuming the host quickly after the host pupates.

References: Trouvelot (1868: 89), Eliot & Soule (1902: 56-57, 256), Voelschow (1902: 54), Stratton-Porter (1912: 76-77), Gibson (1906), Packard (1914: 267-268), Schreiter (1925: 13, pl. 6), Collins & Weast (1961: 95), Townes & Townes (1966: 170, 174), d'Araújo e Silva et al. (1968: 271), Peigler (1977, 1985a), Carlson (1979: 701-702), Gauld (1988a, b), Frank (1986), Tuskes et al. (1996)

Remarks: The record for *Tolype* (Lasiocampidae) in Townes & Townes (166: 174) is probably erroneous; it probably refers to *E. cushmani* Gauld, which attacks Lasiocampidae (Gauld 1988a). *Enicospilus americanus* has appeared in the literature under many names. All of the following names cited by Packard refer to this parasitoid, including the last two names which were misidentifications by Europeans who imported parasitized cocoons and then assigned names of European ophionines to what emerged: *Eremotylus arctiae, Eremotylus macrurus, Ophion bilineatus, Ophion macrurum, Ophion bifoveolatus, Enicospilus purgatus, Allocamptus undulatus, Henicospilus merdarius*. Several of these were repeated by Collins & Weast, Eliot & Soule, and Frank, but this problem was corrected by Tuskes et al., who listed all records only under the one correct name.

The first record listed below was determined by me using the larval head capsule extracted from the vacated cocoon of the parasitoid, sent by M. Collins. The configuration of the head is clearly that of *E. americanus* and not *E. texanus* or *E. lebophagus* as figured by Gauld (1988a).

I observed population fluctuations of this parasitoid and two of its hosts by collecting host cocoons for several consecutive winters. These populations were for *Callosamia securifera* in Berkeley Co., South Carolina, from 1972 to 1982, and *Callosamia promethea* in Walker Co., Texas, 1976 to 1982. It appears that the parasitoid first is not found in samples of host cocoons, then appears in small numbers, then dominates killing most hosts the following winter, and then both the host and parasitoid are rare after that. This cycle of movement of host populations followed by the parasitoid probably takes 7 to 12 years, and is complicated by the fact that other suitable host species (*Automeris io, Antheraea polyphemus*, etc.) are common in the same areas. Resident collectors could make valuable contributions to our understanding of the host-parasitoid interactions by collecting host cocoons in particular areas every winter and keeping records of numbers of cocoons collected, and of moths and wasps that emerge. Data for 20 or more years in habitats with moderate

alteration by human activity would be especially interesting. See similar remarks below for *E. lebophagus*.

Specific records: *ex Rothschildia cincta*: Brown Canyon, Baboquivari Mts., Pima Co., Arizona, January 1963, M. M. Collins; *ex Callosamia promethea*: Chattooga River, Rabun Co., Georgia, emerged 12 May 1976 (DMNH); Jackson and Henderson counties, North Carolina (USNM); Oconee, Pickens, and Berkeley counties, South Carolina; Stubblefield Lake, Walker Co., Texas, March-April 1979, R. S. Peigler, T. & L. Friedlander (DMNH, LACM, BMNH, TAMU); Schuylkill Co., Pennsylvania, emerged June 1989 (DMNH, UCM); *ex Callosamia securifera*: Berkeley Co., South Carolina, 1975 (BMNH, TAMU, USNM); McClellanville, Charleston Co., South Carolina, emerged 7 May 1971, R. S. Peigler (DMNH); *ex Antheraea polyphemus*: Spanish Fork, 1340m, Utah Co., Utah, June 1992, J. B. Duncan (DMNH); Tennessee (DMNH); Ithaca, New York, 20 February 1928 [indoors] (CUIC); *ex Automeris io*: Aurora, Arapahoe Co., Colorado, May 1982, S. E. Stone (DMNH, LACM, BMNH); *ex Automeris pamina*: Granville, Greenlee Co., Arizona, host larva collected 11 September 1938, parasitoid emerged 11 August 1939 (UCM); At light: Punta Gorda, Charlotte Co., Florida, 7 April 1953, H. Ramstadt (Field Museum of Natural History, Chicago); At light: Montgomery Co., Virginia, 9 May 1978 and 10 August 1983, B. C. Kondratieff (CSU); 3 km south of Durango, La Plata Co., Colorado, 1 November 1991, P. A. Opler (CSU); Rocky Face area, Whitfield Co., Georgia, 30 May 1995, James K. Adams (DMNH); Whitfield Co./Murray Co. line, Highway 76, ca. 8 km west of Chatsworth, Georgia, 8 October 1994, J. K. Adams (DMNH).

91. *Enicospilus bozai* Gauld
Hosts: *Copaxa moinieri*
Distribution: Guanacaste and Puntarenas provinces, Costa Rica; Barro Colorado Island, Panama
Biology: There are two emergence peaks in lowland wet forests of Panama where many specimens have been collected at light: May to June and October to November. It is much less common in the dry forests of Santa Rosa National Park (now part of Guanacaste National Park) where adults fly from June to December.
References: Gauld (1988b: 123-124)
Remarks: Gauld (1988b) noted that *C. moinieri* does not occur at the Panama locality, so other species of *Copaxa* may serve as hosts.

92. *Enicospilus lebophagus* Gauld
Hosts: *Rothschildia lebeau, Rothschildia forbesi, Rothschildia cincta*
Distribution: southern tip of Texas, through Mexico including Baja California, Guatemala, Costa Rica, and Panama
References: Peigler (1985a), Gauld (1988a, b)
Remarks: Taxonomists have been unable to decide if the host population in southern Texas known as *forbesi* is a full species or a subspecies of the more southerly and widespread *R. lebeau*. I list *forbesi* separately so that the host record will not be lost in future catalogs assembled by hymenopterists in the event that it is eventually demonstrated to be a full species. Note that *E. lebophagus* appears to be replaced as a parasitoid of *Rothschildia* in southern Arizona (but not western Mexico) by *E. americanus*.

The species was referred to as "*Enicospilus* near, but not *americanus*" by Peigler (1985a). It was formally described by Gauld (1988a) using material from Costa Rica (type-locality: Santa Rosa National Park) collected by D. Janzen, from southern

Texas sent by me, and museum material from places between these northern and southern locales. I collected cocoons of the host moth in the lower Rio Grande Valley each winter from 1976 till 1982. The level of this parasitoid went from "absent" (not found) to abundant (killing more than half of all host pupae), back down to rare. The fluctuation of the host population is certainly related to this parasitoid, but is complicated by cold climate, the Texas populations being at the northern tip of the moth's (and the parasitoid's) range.

Specific records: *ex Rothschildia forbesi*: Hidalgo and Cameron counties, Texas (BMNH, LACM); Bentsen-Rio Grande Valley State Park, Hidalgo Co., Texas, emerged 21 October 1981 and 6 April 1982 (overwintered twice), R. Peigler (DMNH); *ex Rothschildia* sp. (probably *cincta*): Jocotepec, Jalisco, Mexico, 1979, R. Halbert, identified from larval head capsule in cocoon of parasitoid (DMNH); *ex Rothschildia lebeau*: Santa Rosa National Park, Guanacaste, Costa Rica. At light: Rancho San Bernardino, Baja California Sur, Mexico, 13 November 1961, det. H. E. Evans (SDNHM)

93. *Enicospilus plicatus* (Brullé)
Hosts: *Attacus atlas, Trabala vishnou* Lefebvre (Lasiocampidae), and an unidentified lasiocampid
Distribution: China (Guangdong, Guangxi, Fujian, Yunnan, Guizhou, Zhejiang, Anhui, Jiangxi, Hunan, Sichuan, Shaanxi, Xizang (=Tibet), Taiwan); Philippines; Indonesia (Greater Sunda Islands); Thailand; Vietnam; West Malaysia; India; Sri Lanka. See remarks below.
Biology: Tang (1990: pl. 30) showed the larval head capsule.
References: Peigler (1989: 94-95), Nikam (1980: 144-145), Tang (1990, color pls. 41, 48), Gauld & Mitchell (1981: 179-181), Townes
Remarks: There is some confusion regarding this species and its nearest relatives. Gauld & Mitchell (1981) and Tang (1990) cited *malayanus* Cameron as a synonym, but Nikam (1980) listed it as a separate species. Gauld & Mitchell considered *grandis* to be a separate species, giving a range for it in regions further west and north (India, Sri Lanka, and China) than they cited for *plicatus*. Tang listed 13 Chinese provinces for *plicatus*. Nikam gave India and Sri Lanka to Japan and New Guinea as the range of *malayanus*.

Specific record: *ex Attacus atlas*: West Malaysia, 1979, reared by Stefan Kager in Germany and sent to Peigler (BMNH).

94. *Enicospilus robertoi* Gauld
Hosts: *Hylesia lineata*
Distribution: Belize and the following provinces of Costa Rica: Alajuela, Guanacaste, Puntarenas.
Biology: This is a larval endoparasitoid. Larvae of the host collected in the fourth instar yielded the parasitoid larvae when mature, but before becoming pre-pupae. Parasitoid larvae presumably pupate in leaf litter or just below ground level. Adult parasitoids have emerged from hosts or been collected at lights in every month between January and July.
References: Janzen (1984), Gauld (1988b)

95. *Enicospilus texanus* (Ashmead)
Hosts: *Hemileuca oliviae, Hemileuca tricolor, Hemileuca maia, Hemileuca magnifica, Hemileuca slosseri, Hemileuca juno, Hemileuca griffini, Hemileuca peigleri, Hemileuca stonei,*

Hemileuca nevadensis, Agapema anona, Agapema dyari, Agapema platensis, Olceclostera seraphica (Dyar) (Bombycidae)

Distribution: Mexico (Chihuahua), United States (Arizona, California, New Mexico, Texas, Florida, Georgia, North Carolina, Virginia)

Biology: Specimens cited below as reared in January 1995 from cocoons in a screen cage emerged in early evening, after nightfall. I observed a mating of a pair that had emerged earlier the same evening. Mating commenced at 19:46 hours (Mountain Standard Time), and lasted 8 minutes. The female hung motionless from the top inside of the cage; the male hung motionless by his abdomen, straight down, with his legs free, his antennae forming a 90° angle to each other.

Although most of the known hosts pupate "underground", they usually form pupae at ground level below debris, so the wasps would have minimal difficulty emerging from the pupal chamber.

References: Carlson (1979: 703), Fritz et al. (1986), Peigler & Kendall (1993), Peigler & Stone (1989), Gauld (1988a, b), Lemaire (1981), Peigler (1994), Tuskes et al. (1996)

Remarks: The records cited by Gauld (1988a) for this parasitoid attacking *Hemileuca maia* are probably based on *Hemileuca peigleri*, formerly considered to be a Texas subspecies of *H. maia*. However, it is very likely that *E. texanus* attacks *H. maia*, as the locality Gauld cited of Highlands, North Carolina, has granite outcrops that support populations of *H. maia*, and no other suitable host occurs there.

There has been confusion regarding the record of *Olceclostera seraphica* from western Texas. Larvae of this bombycid (formerly in Apatelodidae, see Minet 1994) are found on the same host plant (*Chilopsis*) as the larvae and cocoons of a geometrid *Encaterva variaria* Grote, which resulted in confusion in rearings by Kendall. A specimen of *E. texanus* reared by Kendall from *Olceclostera* in my opinion was mislabeled as being reared from *Encaterva*, and the specimen was donated to the U. S. National Museum. Gauld (1988a) doubted this record, as do I, because the host moth is too small to support this parasitoid. The report of this wasp attacking *O. seraphica* was given by Peigler & Kendall (1993), but unfortunately reported again erroneously as reared from the geometrid by Peigler (1994). The record for *Olceclostera seraphica* is entirely logical; it has a large hirsute larva that pupates in soil, and is phylogenetically related to Saturniidae (*Agapema, Hemileuca*).

The coloration of adult parasitoids ranges from normal orange brown (like Figure 3) to a dark blackish red. The wings may be clear or smoky. Specimens reared from *Agapema anona* are small, very dark, and have smoky wings. Those reared from *Hemileuca juno* are orange brown or darker, with clear or lightly smoky wings. Those reared from *Hemileuca slosseri* have orange brown bodies and smoky wings. Gauld (1988a) noted that material he saw reared from *Hemileuca tricolor* differed from typical *E. texanus*. Tuskes et al. listed the ones reared from *H. tricolor* as "*Enicospilus* near *texanus*." More than one species may be involved.

Specific records: *ex Hemileuca griffini*: Star Springs, Arizona, 1987, K. Hansen, cocoons did not emerge, identified from larval head capsules (DMNH); *ex Hemileuca juno*: Tucson, Arizona, 1987-1988 (BMNH); Tucson, Arizona, emerged April 1987, hosts collected on *Prosopis* in early May 1986, David Hyatt (DMNH); *ex Hemileuca stonei*: 5 km north of Sonoita, Santa Cruz Co., Arizona, emerged 11 June 1989, M. J. Smith (CSU); Molino Basin, Santa Catarina Mts., Pima Co., Arizona, 1987, D. Mullins (BMNH); *ex Hemileuca slosseri*: Kent Co., Texas, 23 May 1983, G. Puterka (DMNH, BMNH); *ex Hemileuca peigleri*: Brown Co., Texas, 1978, R. Peigler, parasitoid cocoon only (DMNH); *ex Agapema platensis*: Kickapoo Cavern State Natural Area, Kinney Co.,

Texas, October 1993, R. Peigler (DMNH); *ex Agapema anona*: Tucson, Arizona, summer 1989 (DMNH); Tucson, emerged 8 September 1988, D. Mullins (BMNH); Patagonia Lake, Pima Co., Arizona, emerged 1 November 1989, M. Curtis (CSU); Ajo, Pima Co., Arizona, host larvae collected March 1994, parasitoids emerged 21, 22, 23 January 1995, R. S. Peigler (DMNH, BMNH, CUAC); *ex Agapema dyari*: Fort Davis, Jeff Davis Co., Texas, October 1993, W. G. Alther & R. S. Peigler (DMNH).

96. *Enicospilus ugaldei* Gauld
Hosts: *Automeris tridens*
Distribution: Guancaste Province, Costa Rica; Chiapas, Quintana Roo, and San Luis Potosí, Mexico
Biology: Specimens from Costa Rica were collected in October to December, in Mexico June to September. The species is not common.
References: Gauld (1988b: 161-164)

97. *Enicospilus* sp.
Hosts: *Hemileuca sororius*
Distribution: Baja California Sur, Mexico
References: Gauld (1988a, b)
Remarks: This wasp was given to me soon after it was reared. I attempted to identify it using the small key in Gauld (1988a); the huge key of Gauld (1988b) was not yet in my hands when I donated the specimen to the BMNH. It keyed to *Enicospilus aktites* Gauld, which is logical since that species belongs to a small group favoring saturniids as hosts, but the distributional data cast some doubt. That parasitoid is known from Costa Rica, Belize, eastern Mexico (Tamaulipas) and the Florida Keys. No other hosts have been recorded for *E. aktites*.

Specific record: *ex Hemileuca sororius*, vicinity of Cabo San Lucas, Baja California Sur, November 1987, Ralph Wells (BMNH).

98. *Euryophion adustus* (Townes)
Hosts: *Pseudobunaea paratyrrhena*
Distribution: West and central Africa, including Zaïre, Malawi, and Nigeria
References: Townes & Townes (1973: 168), Gauld & Mitchell (1978: 26-27)
Remarks: Stated to be rare. Placed under the genus *Primophion* by Townes & Townes (1973)

99. *Euryophion latipennis* (Kirby)
Hosts: *Bunaea alcinoe caffra, Imbrasia macrothyris, Janomima westwoodi* Aurivillius (Eupterotidae)
Distribution: Over much of sub-Saharan Africa, including Zaïre, Uganda, Zimbabwe, Ghana, Gabon, Namibia, Sierra Leone, Nigeria, Angola, and the Central African Republic.
References: Townes & Townes (1973: 169), Gauld & Mitchell (1978: 24-25)

100. *Euryophion nigripennis* Cameron
Hosts: *Imbrasia belina*
Distribution: Africa
Biology: The parasitoid was reared from the host larva at Ndumu, Natal, South Africa by Oberprieler.
References: Townes & Townes (1973: 169), Oberprieler (1990), Gauld & Mitchell (1978: 24)

101. *Euryophion ikuthana* (Kriechbaumer)
Hosts: *Usta terpsichore*
Distribution: Africa
References: Oberprieler (unpubl.), Townes & Townes (1973: 168), Gauld & Mitchell (1978: 27-28), Gauld (1985: 136, 140)
Remarks: Some have referred to this parasitoid as *Rictophion ikuthana*, but Gauld (1985) synonymized that generic name under *Euryophion*. Oberprieler reared what is probably this parasitoid from the same host species.

102. Ichneumonidae, genus undetermined
Hosts: *Saturnia cephalariae*
Distribution: Turkey
References: Romanoff (1885: 18)
Remarks: Romanoff wrote "Ces chenilles sont pour-suivies par une grande espèce d'*Ichneumon* et une grande *Tachina*."

103. Ichneumonidae, genus undetermined
Hosts: *Opodiphthera astrophela*
Distribution: Australia
Biology: Froggatt wrote that this species is "very subject to the attacks of ichneumons."
References: Froggatt (1907: 259)
Remarks: Froggatt used the name *Antheraea simplex* for the host moth.

104. Ichneumonidae, genus undetermined
Hosts: *Hemileuca eglanterina*
Distribution: western Canada
Biology: The parasitoid was reared from a second instar larva and made a white. translucent ovoid cocoon that was 5 mm long.
Remarks: Specific record: *ex Hemileuca eglanterina*: Vasoux Lake, British Columbia, June 1988, Stephen Ife (BMNH). I sent this specimen to BMNH in 1988. It was given to me by S. E. Stone. It is a small species, about the size of *Isdromas*.

105. Ichneumonidae, genus undetermined
Hosts: *Hemileuca electra*
Distribution: southwestern United States
Biology: Two specimens were reared from second instar larvae. The dried larval host remains were alongside light ovoid cocoons attached lengthwise to a twig. Cocoons were 6 mm long. The host larvae were collected in the field 5 km N of Four Peaks Road, Highway 87, Maricopa Co., Arizona, on 19 February 1987 by Patrick Savage, and the two wasps emerged 28 March 1987.
Remarks: I sent these specimens to BMNH in 1988.

Family Braconidae

The braconids are closely related to ichneumons (both are in the superfamily Ichneumonoidea), but are generally smaller. There are many thousands of species, all of which are parasitoids. The records below are comparatively few because most braconids that parasitize saturniids are koinobionts that attack young larvae. As pointed out in the introduction to this catalog, Saturniidae are less often collected as larvae, especially in the early instars.

Most of the species of the Microgastrinae (=Microgasterinae) listed below were formerly classified in the huge, worldwide genus *Apanteles*. The work of Mason (1981) with amendments by Walker et al. (1990) will be useful to anyone trying to key specimens. Some of those listed in that genus below will be assigned to other genera with more study. They are all tiny black wasps that look much alike to the untrained eye and without magnification. Some other Braconidae are brightly colored. Some are diurnal, others nocturnal.

Subfamily Macrocentrinae

106. *Macrocentrus ancylivorus* Rohwer
Hosts: *Eacles imperialis magnifica*
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 261)

Subfamily Microgastrinae

107. *Protapanteles immunis* (Haliday)
Hosts: *Saturnia pavonia, Orgyia antiqua* (Linnaeus) (Lymantriidae), and many other Lepidoptera including mostly Geometridae but also Lycaenidae, Noctuidae, Tortricidae, Plutellidae, and Coleophoridae
Distribution: Europe, including Britain
Biology: The larvae of the hosts are attacked, and the adult parasitoids emerge from host larvae before the latter reach maturity.
References: Thompson (1944: 535), Rougeot (1971: 107), Papp (1990: 186), Mason (1981: 107)
Remarks: This genus is very closely allied to *Glyptapanteles* and *Cotesia*.

108. *Glyptapanteles maculitarsis* (Cameron)
Hosts: *Imbrasia cytherea, Imbrasia zambesina, Imbrasia wahlbergii, Imbrasia tyrrhea, Aurivillius aratus, Bunaea alcinoe, Gynanisa maja, Lechriolepis basirufa* Strand (Lasiocampidae), *Pachypasa* (Lasiocampidae), *Spodoptera exempta* (Walker) (Noctuidae), *Busseola fusca* (Fuller) (Noctuidae)
Distribution: Sierra Leone and Nigeria across to Kenya and south to South Africa
Biology: The very young larvae of the host are attacked. Tooke & Hubbard wrote that eggs are laid on the host, parasitoid larvae feed externally, and the cocoons are attched to the host. There may be a large number on each host. They reported a high incidence of parasitism at the locality of Wolwekloof. According to van den Berg, this braconid caused highest mortality of the pest host among several other parasitoids. Host larvae that feed externally are preferred according to Walker; only the latter host in the above list is an internal feeder.
References: van den Berg (1974), Geertsema (1975), Tooke & Hubbard (1941: 51-52), Walker (1994)
Remarks: Van den Berg cited the host, which is a pest called the pine emperor, under the name *Nudaurelia cytherea clarki* Geertsema. This parasitoid species was not listed by Mason (1981).

109. *Apanteles angaleti* Muesebeck
Hosts: *Antheraea paphia, Ectomyelosis creatoninae* (Pyralidae)
Distribution: northeastern India
Biology: The second instar is the main stage attacked, although third and fourth

instars may also be attacked. The fifth (final) instar is not attacked. Larvae feed internally and then emerge to spin cocoons on the surface of the host. The whitish cocoons are formed on and alongside the host larva in a mass, and measure 3 to 4 mm long. The life cycle is completed in 10 to 15 days. Almost 200 wasps may emerge from a single host. Parasitism of the second brood (i.e., second crop) of tasar larvae in September was found to be as high as 40%.
References: Kole & Chatterjee (1995), Thangavelu et al. (1988)
Remarks: This parasitoid is harmful to the production of tasar silk by destroying larvae of the host before they spin cocoons. Earlier reports by Indian authors of "*Apanteles* sp." and "*Apanteles glomeratus*" attacking *Antheraea paphia* and *A. assamensis* may refer to this species. Probably dozens of species of Microgastrines have been reported under the name *A. glomeratus* in literature. *Antheraea paphia* (=*mylitta*) and *A. assamensis* produce tasar and muga silks, respectively. These parasitoids are thus detrimental to the national economy of India.

110. *Apanteles* spp.
Hosts: *Saturnia mendocino, Automeris* spp.
Distribution: northern California and Brazil
Biology: Tilden reared the Californian ones from larvae of the first cited host collected in the Santa Cruz Mountains in July 1941.
References: Tilden (1945), Ferguson (1972: 181), d'Araújo e Silva et al. (1968: 263)
Remarks: The California parasitoid could be *Cotesia electrae* which attacks the phylogenetically related *Agapema* and the ecologically related *Hemileuca* in western North America. It could also be *Cotesia teleae*, or an undescribed species of *Apanteles* or *Cotesia*. Tuskes et al. (1996) cited it as *Cotesia*. The Brazilian record is probably not for a true *Apanteles*, but for another microgastrine.

111. *Dolichogenidea aethiopica* (Wilkinson)
Hosts: *Holocerina angulata, Imbrasia tyrrhea,* and several other Lepidoptera in Arctiidae, Lasiocampidae, Noctuidae, Nymphalidae, Pyralidae, and Zygaenidae
Distribution: widespread in sub-Saharan Africa
References: Walker (1994)
Remarks: A synonym of this parasitoid is *Apanteles procerae*.

112. *Apanteles* spp.
Hosts: *Antheraea assamensis, Loepa katinka, Samia walkeri, Antheraea yamamai, Attacus atlas*
Distribution: Eastern Asia
Biology: Thangavelu et al. indicated that the first to third instar larvae of *A. assamensis* are attacked.
References: Thangavelu et al. (1988), Peigler (1985a), Sakamoto (1990: 150), Peigler (1989)
Remarks: Several unidentified species of microgastrines were reported as "*Apanteles* sp." by the above authors. The report by Peigler (1989) for *A. atlas* in Taiwan was from Shui-Chen Chiu of the Taiwan Agricultural Research Institute. Mike Bascombe sent specimens reared in Hong Kong from *S. walkeri* and *L. katinka* to me, and I submitted them to K. van Achterberg who gave these general identifications (Peigler 1985a), indicating that there are no good keys to species of the world fauna.

Specific records: *ex Loepa katinka*: Hong Kong, 1981, from mature host larva, M. J. Bascombe (DMNH); *ex Samia walkeri*: Hong Kong, 1981, from young host larva, M. J. Bascombe (DMNH).

113. *Cotesia anisotae* (Muesebeck)
Hosts: *Anisota discolor, Anisota senatoria, Anisota fuscosa, Anisota stigma, Anisota pellucida, Dryocampa rubicunda*
Distribution: New Brunswick and Ontario to Florida and Texas
Biology: Parasitoid cocoons are generally seen on host larvae in the third and fourth instars. Larger host larvae support more parasitoids, but the number rarely exceeds ten. The cocoons are spun on and attached to the integument of the host, and are light yellowish. Hyperparasitism in Texas was by the eulophid *Horismenus floridanus* (see under that species).
References: Muesebeck (1920: 555-556), Schaffner & Griswold (1934), Thompson (1944: 48), Allen (1976), Marsh (1979: 243), Mason (1981: 112), Riotte & Peigler (1981: 120), Coffelt & Schultz (1993b)
Remarks: Surprisingly, I have not encountered this parasitoid in the Carolinas or Georgia, despite the fact that the host genus is abundant in those areas.

Specific records: *ex Anisota pellucida*: Apalachicola River at Interstate Highway 10, Gadsden Co., Florida, 20 July 1992, R. S. Peigler (DMNH); *ex Anisota fuscosa, A. senatoria, A. discolor*: Stubblefield Lake, Walker Co., Texas, 15 October 1976, R. S. Peigler (DMNH, USNM); *ex Anisota fuscosa*: College Station, Brazos Co., Texas, September 1976, R. S. Peigler.

114. *Cotesia electrae* (Viereck)
Hosts: *Agapema anona, Agapema dyari, Agapema platensis, Agapema homogena, Automeris io, Coloradia pandora, Coloradia doris, Hemileuca nevadensis, Hemileuca slosseri, Hemileuca electra, Hemileuca eglanterina, Hemileuca nuttalli, Hemileuca hera, Hemileuca magnifica, Hemileuca chinatiensis conwayae, Hemileuca diana, Hemileuca stonei, Hemileuca tricolor, Hemileuca oliviae, Hemileuca burnsi, Dirphia* sp.
Distribution: western half of United States; British Columbia; Baja California Norte and probably other states in northern Mexico
Biology: Cocoons of the parasitoid are usually seen on the third to fifth instars, sometimes the second. Most species of *Hemileuca* have at least six larval instars.
References: Muesebeck (1920: 554), Essig (1926: 781), Wygant (1941), Tilden (1945), Collins & Weast (1961), Ferguson (1972: 181), Watts & Everett (1976), P. M. Marsh (*in* Krombein et al. 1979: 246), Mason (1981: 112), Peigler (1985a, b), Peigler & Stone (1989), Peigler & Kendall (1993), Stone et al. (1988), Tuskes et al. (1996)
Remarks: Specific records: *ex Coloradia doris*: Horsetooth Reservoir, Larimer Co., Colorado, 10 July 1985, D. Leatherman (CSU, DMNH); *ex Hemileuca electra*: El Pedregoso, 765 m, Baja California Norte, April 1989, K. L. Wolfe (DMNH, CUAC, BMNH); 6 km N of Cataviña, 23 January 1988, P. Savage (DMNH, USNM); *ex Hemileuca nevadensis*: Jacks Canyon, Navajo Co., Arizona, June 1987, M. J. Smith (DMNH, CUAC, USNM, BMNH); 10 km S of Byers, Arapahoe Co., Colorado, June 1991, R. S. Peigler (DMNH, BMNH); Pawnee Buttes, Weld Co., Colorado, 5 July 1985, D. Leatherman (DMNH); *ex Hemileuca magnifica*: Jaroso, Costilla Co., Colorado, September 1985, S. E. Stone (LACM); *ex Hemileuca slosseri*: 10 km SE of Wellman, Terry Co., Texas, May 1981, R. O. & C. A. Kendall (DMNH, BMNH, RMNH); *ex Hemileuca chinatiensis conwayae*: Culberson Co., Texas, April 1981, R. & C. Kendall (RMNH); *ex Agapema homogena*: Tucson, Pima Co., Arizona, 5 April 1988 (DMNH, BMNH); *ex Agapema dyari*: Reeves Co., Texas, April 1981, R. O. Kendall (TAMU); *ex Agapema platensis*: Kinney Co., Texas, 20-22 February 1989, R. O. Kendall (TAMU); *ex Hemileuca diana:* Schnebly Hill overlook, 8 km E of Sedona, Coconino Co., Arizona, 23 May 1987, P. Savage (USNM); Hualapai Mtn. Park, SE of Kingman,

Mohave Co., Arizona, 12 May 1993, M. M. Collins (DMNH); Plum Creek, Douglas Co., Colorado, 18 June 1988, S. E. Stone & R. S. Peigler (DMNH, BMNH); *ex Hemileuca nuttalli*: Cedar Mtn. road, Cedar City, Iron Co., Utah, June 1987, P. Savage (USNM, DMNH, BMNH); *ex Hemileuca stonei*: Santa Catalina Mts., Molino Basin, Pima Co., Arizona, June 1987, M. J. Smith (BMNH, DMNH); *ex Hemileuca eglanterina*: Cow Creek Guard Station, Stanislaus National Forest, Tuolumne Co., California, 25 July 1950, C. Quick (UCB); San Jose, Santa Clara Co., California, 6 July 1921, E. O. Essig (UCB).

It is clear that this parasitoid attacks virtually all species of *Agapema* and Hemileucinae (*Hemileuca, Coloradia*) except *Automeris* in western North America, especially the Southwest. It lives in many diverse habitats including grassland prairies, arid deserts, oak/pine forests, and riparian zones. The saturniid hosts that are used and not used coincide exactly to those of *Enicospilus texanus*, as discussed under that species above.

115. *Cotesia hemileucae* (Riley)
Hosts: *Automeris io, Hemileuca maia*
Distribution: Massachusetts to Florida, Kansas, Missouri, Minnesota, Oregon
References: Cockerell (*in* Packard 1914: 268), Muesebeck (1920: 570), Collins & Weast (1961), P. M. Marsh (*in* Krombein et al. 1979: 248), Mason (1981: 112), Peigler (1985a)
Remarks: Scott Shaw, who gave me the specimens cited below, compared these to specimens I had of *C. electrae* and said the two species are very distinct from one another.

Specific record: *ex Automeris io*: Keys, E9, Florida, 12-10-1967 [October or December?], D. Simberloff (DMNH).

116. *Cotesia melanoscela* (Ratzeburg)
Hosts: *Hemileuca maia*
Distribution: Europe; North Africa; introduced to North America, recorded from eastern Canada and Massachusetts to British Columbia, Washington, and Oregon
References: Thompson (1944: 294), P. M. Marsh (*in* Krombein et al. 1979: 250), Mason (1981: 112)
Remarks: This wasp was apparently introduced to North America from Europe as a control of the gypsy moth. It was cited as attacking *Hemileuca maia* by Thompson, but this record was not repeated by Marsh who probably considered it to be unreliable.

117. *Cotesia teleae* (Muesebeck)
Hosts: *Antheraea polyphemus, Citheronia regalis,* possibly *Actias luna* (see Remarks below)
Distribution: Connecticut, Pennsylvania, Maryland
References: P. M. Marsh (*in* Krombein et al. 1979: 255), Mason (1981: 113)
Remarks: This may be the species which was found to attack small (1st and 2nd instar) larvae of *Actias luna* by Fiske and Thompson (1909: 460); their reference to larvae of *Antheraea polyphemus* being attacked in the same experiments probably refers to this species of parasitoid. The specific name comes from the generic name of the host, *Telea*, a synonym of *Antheraea*.

118. *Cotesia* sp. (Figure 6)
Hosts: *Hyalophora columbia gloveri, Hyalophora cecropia*
Distribution: Utah, California, Colorado

Biology: Numerous cocoons, usually over 50, are seen on the host larva.
References: Duncan (1941: 40), Peigler (1985a)
Remarks: The specimens from Utah and California look identical to me, but I am not able to say with certainty if they represent one or two species. The material from Colorado was reported as *Apanteles* sp. under its hyperparasitoid *Gnotus* by Peigler (1985a).

Specific records: *ex Hyalophora columbia gloveri*: 32 km east of Nevada City, 1525 m, Mono Co., California, 19 August 1995, M. M. Collins (DMNH, CUAC, BMNH) [host is not native to that locality, but *Hyalophora euryalus* is]; Spanish Fork, Utah, August 1991, J. B. Duncan (BMNH, DMNH); *ex Hyalophora cecropia*: Aurora, Colorado, 1982, S. Stone (pers. comm).

Eliot & Soule (1902: 256-257) reported a species of *Cotesia* or *Apanteles* under the name *Microgaster* as parasitizing *Hyalophora cecropia* in Massachusetts. It made white or yellow-brown cocoons on the host larvae. It is possible that all of these records from Massachusetts, Colorado, Utah, and California refer to one widespread species of *Cotesia* that specializes on *Hyalophora*.

119. *Cotesia* sp.
Hosts: *Saturnia pavonia*
Distribution: central Europe
Biology: At least 6 parasitoids were reared from a larva of the host species.
References: Mason (1981), Papp (1990)
Remarks: This material does not appear to me to be of the genus *Protapanteles*. Papp listed numerous European species of *Cotesia*, so perhaps it is one of those.

Specific record: *ex Saturnia pavonia*: Kopernica, Czech Republic [or Slovakia?], July 1988, Michael Klingner (DMNH). The dark yellow cocoons are included with the series of specimens.

120. *Microplitis aduncus* Ruthe
Hosts: *Saturnia pavonia*
Distribution: Germany
References: Thompson (1944: 535)

Subfamily Euphorinae

121. *Meteorus eaclidis* Muesebeck
Hosts: *Eacles imperialis magnifica*
Distribution: Brazil
Biology: Crocomo & Parra reported that 86 parasitoids emerged from the one host larva.
References: Crocomo & Parra (1979: 70), d'Araújo e Silva et al. (1968: 261)
Remarks: Crocomo & Parra erroneously cited this parasitoid as belonging to the Eulophidae. They obtained one rearing from Ouro Fino, Minas Gerais, a Brazilian state north of where the above host is known to occur. The host may have actually been another species of *Eacles*. As parasitoids of *E. i. magnifica*, d'Araújo e Silva et al. cited both *Meteorus* sp. and *M. eaclidis*.

122. *Meteorus hyphantriae* Riley
Hosts: *Hemileuca maia,* many other Lepidoptera
Distribution: Canada to Mexico
References: Thompson (1944: 294)

Remarks: The record listed below under no. 124 probably belongs under this species.

123. *Meteorus luridus* Ruthe
Hosts: *Saturnia pavonia*
Distribution: Europe
Biology: Probably a gregarious primary, larval parasitoid.
References: Rougeot (1971: 107)

124. *Meteorus* sp.
Hosts: *Hemileuca maia, Hemileuca lucina*
Distribution: northeastern United States
References: Schaffner & Griswold (1934), Thompson (1944: 293-294)
Remarks: The host was cited by Schaffner & Griswold as *Hemileuca maia* and/or *lucina*.

125. Subfamily Rogadinae, genus undetermined
Hosts: *Ludia delegorguei*
Distribution: southern Africa
Biology: Reared from the larva of the host.
References: R. Oberprieler (unpubl.)

Superfamily Chalcidoidea

This superfamily is a huge one, consisting of thousands of species worldwide and more than 15 families. Commonly called chalcids (pronounced KAL-sidz), they are among the most important insects in biological control. Some are mass reared in insectaries for use in agroecosystems or to combat forest pests. Some are parasitoids of larvae or pupae, particularly Lepidoptera, but most of the smaller ones attack insect eggs. These egg parasitoids are classic idiobionts. Some are hyperparasitoids. It appears that most are diurnal, and they are rarely collected at lights.

Family Torymidae

126. *Monodontomerus minor* (Ratzeburg)
Hosts: *Gambrus extrematis*
Distribution: Europe; New England to Virginia to California
Biology: This is a hyperparasitoid of *Gambrus extrematis* and possibly tachinids in cocoons of *Hyalophora*.
References: Peck (1963: 938), E. Grissell (*in* Krombein et al. 1979: 761-762), Peigler (1985a)
Remarks: Specific records: *ex Gambrus extrematis* in *Hyalophora cecropia*: Aurora, Colorado, 1980, S. Stone (USNM); Aurora, Colorado, spring 1988, R. S. Peigler (DMNH), Denver, Colorado, 1982. S. Stone (USNM);

Gupta (1987: 503) cited a record for the Holarctic *Monodontomerus dentipes* (Dalman) as a hyperparasitoid of *Dendrolimus* (Lasiocampidae) attacking the ophionine ichneumonid *Dicamptus nigropictus* in Asia.

127. *Microdontomerus fumipennis* Crawford
Hosts: *Hemileuca magnifica, Enicospilus texanus* (Ichneumonidae), *Malacosoma* (Lasiocampidae), *Choristoneura rosaceana* (Harris) (Tortricidae)
Distribution: southwestern United States

Biology: Apparently a facultative hyperparasitoid. It was reared as a primary parasitoid from larvae of *Hemileuca magnifica*, although this should be verified if puparia of tachinids were kept in the same rearing cage. It was also reared from a single cocoon of *Agapema anona* containing a cocoon of *Enicospilus texanus*. The ophionine cocoon had four emergence holes in the side. I do not know if the ovipositing female of *M. fumipennis* oviposited into the larva of *Agapema* or the cocoon of *Enicospilus*.
References: Ferrière (1936), E. Grissell (*in* Krombein et al. 1979: 764), Peigler (1985a), Peigler & Kendall (1993)
Remarks: Specific records: *ex Hemileuca magnifica*: Jaroso, Costilla Co., Colorado, September 1985, S. E. Stone (USNM); *ex Enicospilus texanus* in cocoon of *Agapema anona*: Rosemont Junction, Highway 83, Pima Co., Arizona, 18-21 June 1984, J. Palting (USNM).

Hyperparasitism in cocoons of *Enicospilus* is known in other cases. Ferrière reported an example of a eupelmid hyperparasitoid in *Enicospilus cohacarum* Seyrig in *Borocera* (Lasiocampidae) in Madagascar. Many moth cocoons yielded the eupelmids, all of which contained cocoons of the ophionine. The cocoons of *Borocera* are used to make landibe silk fabrics.

128. *Microdontomerus* sp.
Hosts: *Hemileuca oliviae*
Distribution: Chihuahua
Biology: A parasitoid in eggs of the host. Fritz et al. pointed out that this species may actually be a hyperparasitoid on *Anastatus*, and I agree that this is likely.
References: Fritz et al. (1986)
Remarks: Judging from the distributions of the three North American species listed by E. Grissell (*in* Krombein et al. 1979: 764), the record here from Chihuahua is probably *M. fumipennis*.

129. *Perissocentrus chilensis* Crawford
Hosts: *Cercophana frauenfeldi, Ormiscodes cinnamomea, Tanatopsyche chilensis* Phil. (Psychidae?)
Distribution: Chile
References: De Santis (1979: 25)
Remarks: The second host listed above was cited by De Santis as *Ormiscodes crinata*.

130. *Perissocentrus* sp.
Hosts: Hyperparasitoid in the tachinid *Zygofrontina* in *Rothschildia*
Distribution: Brazil
Biology: A hyperparasitoid, but I do not know whether facultative or obligatory.
References: d'Araújo e Silva et al. (1968: 270)

Family Eurytomidae

131. *Eurytoma* sp.
Hosts: Hyperparasitoid in *Glyptapanteles maculitarsis* and *Theronia* in *Imbrasia cytherea*
Distribution: South Africa
Biology: The eurytomid develops as a hyperparasitoid in cocoons of the braconid *Glyptapanteles maculitarsis* and the ichneumonid *Theronia*. As with the closely related perilampids (see below) it probably oviposits into the primary host, in this case the saturniid.
References: van den Berg (1974), Boucek (1988: 104-110)

Remarks: Eurytomidae are a diverse family that are poorly known taxonomically. It is possible that this parasitoid belongs to a different genus in Eurytomidae. Boucek described several new genera from the Australasian region, yet listed 67 species of under *Eurytoma* from that area. The genus remains a depository for unplaced eurytomids.

Family Perilampidae

These small wasps have a metallic blue coloration. The thorax and propodium are robust, the gaster very small. Some species are always primary endoparasitoids, while others are obligate hyperparasitoids. Apparently all are koinobionts. There are many species in the genus *Perilampus*, including the four species below. B. D. Burks (*in* Krombein et al. 1979: 770) treated this group as a subfamily of Pteromalidae.

132. *Perilampus carolinensis* (Smulyan)
Hosts: *Anisota senatoria*
Distribution: North Carolina to Vermont
Biology: Probably always a hyperparasitoid according to C. Darling (pers. comm.), but available rearing records are not sufficient to be certain.
References: Burks (*in* Krombein et al. 1979: 771), Riotte & Peigler (1981: 121)
Remarks: This and the following species are very closely related.

Specific records: *ex Anisota senatoria*: Patuxent Wildlife Refuge, Bowie, Maryland, 11-6-1945, R. T. Mitchell (ROM).

133. *Perilampus hyalinus* (Say)
Hosts: Hyperparasitoid in tachinids (*Lespesia anisotae* and *Belvosia bifasciata*) in *Anisota senatoria*, and in tachinids in *Hyalophora cecropia*
Distribution: Mexico, Puerto Rico, Peru, Canada (Québec to British Columbia), United States (Florida to California)
Biology: In coastal Virginia, Coffelt and Schultz found that this hyperparasitoid killed 2% of *Lespesia anisotae* and 23.5% of *Belvosia bifasciata*. De Santis cited two non-saturniid hosts.
References: Peck (1963: 938), Coffelt & Schultz (1993b), De Santis (1979: 110), Burks (*in* Krombein et al. 1979: 771-772), Peigler (1985a)
Remarks: The two specimens reported by Peigler (1985a) were reared as hyperparasitoids (I observed these emerging from tachinid puparia). They are likely *hyalinus*, instead of *carolinensis* as I reported there.

Specific records: *ex* tachinid (perhaps *Lespesia anisotae*) in *Anisota peigleri*: Greenville, South Carolina, May-June 1980, T. C. Boozer (LACM); collected in field: 30 km E of Denver, Arapahoe Co., Colorado, 10 July 1988, R. S. Peigler & M. J. Smith (DMNH); County 88, Iowa, 24 July 1939, 9 July 1940, County 70, Iowa, 28 July 1957, W. W. Steinmetz (DMNH). The material from Colorado and Iowa was identified by C. Darling (ROM) in 1995.

134. *Perilampus maurus* (Walker)
Hosts: *Imbrasia tyrrhea*
Distribution: Africa
Biology: Possibly a hyperparasitoid in tachinid or ichneumonid parasitoids of the moth host, or possibly a primary endoparasitoid.
References: Packard (1914: 268)
Remarks: Packard indicated that the host record was cited by Walker, I assume in the original description. Packard cited the host under the name *Thyella tyrrhea*.

135. *Perilampus paraguayensis* (Girault)
Hosts: Hyperparasitoid in the tachinid *Zygofrontina* in *Rothschildia*
Distribution: South America
Biology: A hyperparasitoid in tachinids. De Santis cited two non-saturniid hosts, at least one of which is a dipteran.
References: d'Araújo e Silva et al. (1968: 270), De Santis (1979: 111)

Family Pteromalidae

136. *Pteromalus hemileucae* Gahan
Hosts: *Hemileuca oliviae*
Distribution: Mexico and New Mexico
References: Peck (1963: 938), Burks (*in* Krombein et al. 1979: 809)
Remarks: Peck misspelled the specific name as *semileucae*.

137. *Pteromalus communis* Nees
Hosts: *Saturnia pyri*
Distribution: Europe
References: Rougeot (1971: 92)

138. *Pteromalus* sp.
Hosts: Hyperparasitoid in *Hyposoter fugitivus* in *Anisota senatoria*
Distribution: coastal Virginia
Biology: Reared as a hyperparasitoid of *Hyposoter fugivitus*. It is a gregarious endoparasitoid that may be a primary or secondary parasitoid. A mean number of 1.9 was reared from cocoons of *H. fugitivus*.
References: Coffelt & Schultz (1993b), Burks (*in* Krombein et al. 1979: 809-810)
Remarks: The authors stated that this parasitoid may be *Pteromalus puparium*, according to E. E. Grissell, but species in the group are difficult to identify pending a revision.

A note sent by T. Pergande to Packard (1914: 196) read "A. H. Mundt, of Fairbury, Ill., sent eggs of *T.* [*Tropaea=Actias*] *luna* which were infested with what was supposed to be a species of *Pteromalus*." Considering the mass confusion of the chalcidoid groups by many entomologists, I believe this record could refer to several possible species in several families.

139. *Pteromalus* sp.
Hosts: *Saturnia pavonia*
Distribution: Europe
References: Rougeot (1971: 107)
Remarks: There is a possibility that this record belongs under the following species of European pteromalid.

140. *Eupteromalus arzoneae* Boucek
Hosts: Hyperparasitoid in *Pales pavida* (Tachinidae) in *Samia cynthia*
Distribution: Northern Italy
Biology: Ovipositing females of this hyperparasitoid are able to detect and parasitize larvae of the tachinid within the caterpillars of the primary host. After the tachinid maggots form their puparia, the development of *E. arzoneae* continues. After about 20 days, adults of *E. arzoneae* emerge through a small hole which they chew in the side of the puparium. Nine to 18 individuals emerge from each puparium. These then

exit through a small hole they chew in the side of the moth cocoon, or via the preformed exit at the top of the cocoon.
References: Arzone (1971a)
Remarks: A detailed account of this hyperparasitoid was given by Arzone, along with photographs. See also texts of *Pales pavida* and *Anastatus bifasciatus* in this catalog.

141. *Pachyneuron porteri* (Brèthes)
Hosts: *Ormiscodes rufosignata*
Distribution: Chile
References: De Santis (1979: 164)
Remarks: The host was cited by De Santis under the synonym *Catocephala rufosignata*.

142. *Psychophagus omnivorus* (Walker)
Hosts: *Hyalophora cecropia*, numerous other Lepidoptera, Diptera, and Hymenoptera
Distribution: Europe; introduced to North America in 1890s, now found from Québec to Delaware, west to Wisconsin and Colorado
Biology: A primary and a secondary (hyperparasitoid) parasitoid.
References: Peck (1963: 938), Burks (*in* Krombein et al. 1979: 807)
Remarks: It seems likely that this species of parasitoid can be reared from several Saturniidae, since it is a hyperparasitoid on several of their known primary parasitoids, such as *Compsilura concinnata* (Tachinidae).

143. *Tritneptis doris* Burks
Hosts: *Coloradia doris, Hemileuca* sp.
Distribution: Utah and Wyoming
References: Burks (*in* Krombein et al. 1979: 825)

144. *Dibrachys cavus* (Walker)
Hosts: *Hyalophora cecropia, Hyalophora columbia gloveri, Actias luna*, numerous other Lepidoptera, Hymenoptera, and Diptera
Distribution: worldwide, in North America including Alaska to Florida
Biology: Extremely polyphagous. It can be a primary, secondary, or tertiary parasitoid. Among the more than 100 hosts listed by Burks, there are several which are parasitoids and hyperparasitoids of Saturniidae, including ones in Tachinidae, Ichneumonidae, Braconidae, and Chalcidoidea.
References: Duncan (1941), Peck (1963: 938), Burks (*in* Krombein et al. 1979: 826-828)

145. *Dibrachys* sp.
Hosts: Hyperparasitoid in *Coccygomimus sanguinipes* (Ichneumonidae) in *Hemileuca oliviae*
Distribution: New Mexico
Biology: a hyperparasitoid
References: Ainslie (1910)
Remarks: This record probably belongs under *D. cavus* above.

146. *Agiommatus attaci* Ferrière
Hosts: *Attacus atlas*
Distribution: West Malaysia to western Java
Biology: Eggs of the host moth are attacked.

References: Ferrière (1930b), Thompson (1944), Boucek (1988: 458), Peigler (1989: 94)
Remarks: Since this species was not included in the monograph of Boucek, I am not certain if it has been reassigned to a different genus since the original description.

Specific record: *ex Attacus atlas*: Lake Toba, near Brastagi, Sumatera Utara, Sumatra, Indonesia, 8 October 1986, U. Paukstadt (DMNH).

147. *Agiommatus* sp.
Hosts: *Antheraea* spp.
Distribution: Australasia
Biology: Eggs of the host are attacked.
References: Boucek (1988: 458)
Remarks: If the host records come from the Papuan region, they may be erroneous, and actually refer to *Syntherata* or *Opodiphthera,* species of which are often misclassified as *Antheraea*.

148. *Agiommatus* sp.
Hosts: *Antherina suraka*
Distribution: Madagascar
Biology: Griveaud stated that the eggs of the host are strongly infested by this parasitoid and *Mesocomys*.
References: Griveaud (1962: 51), Boucek (1988: 458)
Remarks: Although the type species of the genus was described from Sumatra, the parasitoid reported by Griveaud (1962) may in fact be a true *Agiommatus*. In his monograph, Boucek (1988) described many new genera in the Pteromalini, but indicated that this genus does range in Madagascar.

Family Chalcididae

These are on average the largest chalcids. The family has been spelled Chalcidae in much literature. Adults typically have enlarged hind femora which make recognition easy. Boucek (1988) downgraded the subfamily Brachymeriinae to the tribe Brachymeriini, within the Chalcidinae.

149. *Ceratosmicra albifrons* (Walsh)
Hosts: Hyperparasitoid in *Hyposoter fugitivus* in *Anisota senatoria,* many Lepidoptera including Microlepidoptera and Noctuidae, also several parasitic Hymenoptera
Distribution: Québec and Maine to Florida; British Columbia to Mexico
Biology: The wasp is probably a facultative hyperparasitoid. It is not known if *C. albifrons* would oviposit into a healthy larva of *Anisota*, or must find a larva that is mummified containing a cocoon of the primary parasitoid *H. fugitivus*. The parasitism appears to be similar to that observed for *Ceratosmicra meteori* in the southeastern United States.
References: Burks (1979: 867), Riotte & Peigler (1981), Delvare (1992: 221-222)
Remarks: Specific record: *ex Anisota senatoria:* Patuxent Wildlife Refuge, Maryland, 8 October 1951, R. T. Mitchell (DMNH). This specimen given to me by Mitchell has a dried cocoon of *Hyposoter fugitivus* (in a mummified larva of *Anisota senatoria*) pinned below it with an exit hole in the side.

This species was classified under the genus *Conura* by Delvare (1992). He considered *Spilochalcis, Conura,* and *Ceratosmicra* to be three subgenera of *Conura*, pointing out his reasons for considering each of the three groups to be monophyletic.

Therefore, such an arrangement is subjective. I, also subjectively, choose to retain the three groups as full genera. Subgeneric usage has been accepted much more extensively in the classification of Hymenoptera, than in that of Lepidoptera. Several authors have listed this species previously under the generic name *Spilochalcis*.

150. *Ceratosmicra meteori* Burks
Hosts: Hyperparasitoid in *Hyposoter fugitivus* in *Dryocampa rubicunda, Anisota fuscosa, Anisota peigleri, Anisota senatoria*
Distribution: Massachusetts to Washington State, down into Mexico
Biology: Apparently this species is usually or always a hyperparasitoid of Braconidae and small Ichneumonidae. It is the most abundant of all hyperparasitoids attacking *H. fugitivus* in Virginia according to Coffelt & Schultz.
References: Burks (1979: 868), De Santis (1979: 54), Riotte & Peigler (1981), Delvare (1992: 219), Coffelt & Schultz (1993b)
Remarks: This species was listed by Delvare in the genus *Conura* and subgenus *Ceratosmicra*. See remarks above pertaining to generic classification in this group.

Specific records: All hyperparasitoids in *Hyposoter fugitivus: ex Dryocampa rubicunda*, Greenville, South Carolina, June 1980, R. S. Peigler (LACM); *ex Anisota fuscosa*, Brazos and Walker counties, Texas, 1976, R. S. Peigler (USNM); *ex Anisota peigleri*, Henderson Co., North Carolina, September 1974, David Montross (USNM); Clemson, South Carolina, 10 September 1976, R. Peigler (USNM); Seneca, South Carolina, 30 September 1975, R. S. Peigler (USNM); *ex Anisota senatoria*, Patuxent Wildlife Refuge, near Laurel, Maryland, R. T. Mitchell; Stubblefield Lake, Walker Co., Texas, October 1979, G. W. Brooks (DMNH); collected with net: Walsenburg, Huerfano Co., Colorado, 28 June 1976, H. E. Evans (CSU).

151. *Conura maria* (Riley) (Figure 5)
Hosts: *Samia cynthia, Rothschildia cincta, Rothschildia forbesi, Callosamia angulifera, Callosamia promethea, Hyalophora cecropia, Antheraea polyphemus, Agapema anona, Hemileuca oliviae, Hylesia, Thyridopteryx ephemeraeformis* (Haworth) (Psychidae)
Distribution: North America, Central America, Trinidad, probably northern South America
Biology: Emergence patterns of adults were tabulated in Packard (1914) and Peigler (1985a). Frank stated that the percent parasitization of *Samia cynthia* in Philadelphia was as high as 85%. This chalcid and other closely related ones are koinobionts. This species is a larval-pupal parasitoid.
References: Packard (1914: 247, 268), Collins & Weast (1961), Peck (1963: 938), De Santis (1979: 48), Burks (*in* Krombein et al. 1979: 866), Peigler (1977, 1985a), Frank (1986), Fritz et al. (1986), d'Araújo e Silva et al. (1968), Young (1985), Weast (1989: 6), Delvare (1992: 253), Tuskes et al. (1996)
Remarks: Although I retain the three subgenera as full genera in this group, this species, long known in most literature under *Spilochalcis mariae*, actually belongs to the subgenus *Conura* as defined by Delvare. The original spelling of the specific epithet is to be preserved, *maria* instead of *mariae*, as noted by Delvare.

It is interesting to note that there are few host records for the genus *Hyalophora*. Hosts with hanging cocoons appear to be especially attacked. Although most species of *Hemileuca* form their pupae at ground level, that of *H. oliviae* is in a weak cocoon among weeds, well above ground level.

Young (1985) reported "*Spilochalcis* sp." attacking "*Rothschildia* sp." at a site 5 km N of Bagaces, Guanacaste, Costa Rica in 1984. The parasitoid was probably *C. maria*

or a closely allied species. The host was almost certainly *R. lebeau*. It is also likely that the report of a "black and yellow chalcidine wasp" attacking caterpillars of *Hylesia* on the Osa Peninsula, Costa Rica, by Hogue (1972) is this species.

The parasitoid reported from *Agapema anona* from Pima Co., Arizona, by Tuskes et al. under the name "*Spilochalcis* n. sp." is undoubtedly the same as those I received from Chris Conlan from the same host and region. Conlan's material agrees with that of *C. maria* from the eastern United States, and is conspecific in my opinion.

Specific records: *ex Callosamia angulifera*, Taylors, Greenville Co., South Carolina, spring 1966, R. S. Peigler (DMNH, LACM); *ex Rothschildia* (probably *cincta*), Jocotepec, Jalisco, Mexico, June 1979, R. L. Halbert (DMNH, LACM); *ex Rothschildia forbesi*, Hidalgo Co., Texas, February 1980 (indoors), J. E. Eger & C. W. Agnew (LACM); Brownsville, Texas, 27 February 1916, R. A. Vickery (UCM); *ex Antheraea polyphemus*, Baton Rouge, East Baton Rouge Parish, Louisiana, 14 February 1976 (indoors), J. E. Eger (DMNH, LACM); *ex Thyridopteryx ephemeraeformis*, College Station, Brazos Co., Texas, 31 August 1979, T. J. Kring (LACM); Mountain Grove, Missouri, 7 April 1914, N. P. Homes (UCM); *ex Agapema anona*: Guadalupe Canyon, Cochise Co., Arizona, September 1995, C. Conlan, about 25 emerged from one host (DMNH, CUAC); one adult collected on leaf of sweetgum, Stubblefield Lake, Walker Co., Texas, 1980, R. S. Peigler; *ex Hyalophora cecropia*: Pittsburgh, Pennsylvania, 15 January 1930 [indoors] (CSU).

152. *Conura mendozaensis* (Cameron)
Hosts: *Rothschildia arethusa*
Distribution: known from the original locality of Mendoza, Argentina
Biology: The larva is the site of oviposition, the host then matures, spins a cocoon and pupates, and the adult parasitoids emerge from the cocoon of the host. The parasitoid is gregarious.
References: Delvare (1992: 253)
Remarks: According to Delvare, the lectotype female in the BMNH is all that remains of the original type material. In addition, Delvare examined a series reared from the only known host, also from Argentina.

153. *Spilochalcis* sp.
Hosts: *Rothschildia* sp., *Eacles imperialis magnifica*
Distribution: Brazil
Biology: The authors cited it as a hyperparasitoid under *Eacles*.
References: d'Araújo e Silva et al. (1968: 260-261, 270)
Remarks: The record for *Rothschildia* likely refers to *Conura mendozaensis*. The record for *Eacles* is probably for a species of *Conura* also, perhaps even *C. mendozaensis*.

154. *Phasgonophora bauhiniae* Girard
Hosts: *Epiphora bauhiniae*
Distribution: Africa
References: Packard (1914: 268); Burks (*in* Krombein et al. 1979: 869), Boucek (1988: 62-63)
Remarks: The current generic placement of this species is undoubtedly incorrect (J. LaSalle, personal communication). True *Phasgonophora* species parasitize larvae of wood-boring beetles. A future revision of the sub-Saharan Chalcididae will certainly result in reassignment of *P. bauhiniae* to another genus.

Peck (1963: 938) cited *Phasgonophora sulcata* Westwood as a parasitoid of *Antheraea*

polyphemus. This record is surely an error so I do not give it a full listing in this catalog. This parasitoid parasitizes only beetles of the family Buprestidae as far as known (Burks *in* Krombein et al. 1979: 869).

The citation by Schultze (1913: 16) of "Schlupfwespen" emerging from cocoons of *Epiphora bauhiniae* may refer to this parasitoid.

155. *Brachymeria intermedia* (Nees)
Hosts: *Hemileuca oliviae*, numerous other hosts in Lepidoptera and Diptera
Distribution: native to Europe and North Africa, introduced to United States, ranging from Maine to Maryland
Biology: Probably attacks the pupae of hosts as an idiobiont.
References: Burks (*in* Krombein et al. 1979: 872), Sullivan (1987: 3); Boucek (1988: 68)
Remarks: Under the text of the range caterpillar (*Hemileuca oliviae*), Sullivan reported that releases of chalcid and ichneumon wasps were begun in 1977 in the vicinity of Branson, Las Animas Co., Colorado, resulting in a reduced infestation of the pest. Releases of 6,250 *Brachymeria intermedia* were made in 1986 in hopes of establishing the parasitoid in the field permanently for control of the range caterpillar.

Specific record: Fort Collins, Colorado, lab colony, January 1979 (CSU).

156. *Brachymeria ovata* (Say)
Hosts: *Hemileuca oliviae, Hyposoter fugitivus* in *Anisota senatoria* and *Anisota peigleri*; see Biology below
Distribution: All of continental United States into Mexico, most islands of the Caribbean, Venezuela, Colombia, Paraguay, Uruguay
Biology: According to Burks, this parasitoid attacks pupae of over 100 species of moths and butterflies which have a pupal size of more than 15 mm and are exposed in the open. It is a solitary idiobiont. Burks stated that it is always a primary parasitoid of Lepidoptera. However, Coffelt & Schultz observed it to be a hyperparasitoid in Virginia, as did I in South Carolina.
References: Ainslie (1910), Packard (1914: 268), Peck (1963: 938), Stehr & Cook (1968: 298), Watts & Everett (1976), Burks (1960; *in* Krombein et al 1979: 872-873), De Santis (1979: 59), Fritz et al. (1986), Boucek (1988: 68-69), Coffelt & Schultz (1993b)
Remarks: This wasp is referred to in the older literature under the name *Chalcis ovata*. The wasp is coal black with white markings. Boucek stated that this coloration is useful to recognize this genus.

Specific record: Three specimens were reared as hyperparasitoids of *Hyposoter fugitivus* in *Anisota peigleri*, Greenville, South Carolina, July 1992, ex-larvae on *Quercus palustris*, R. S. Peigler (DMNH, BMNH); Palisade, Colorado, lab colony, 1979 (CSU); Corona, Riverside Co., California, 10 June 1939 (CSU); Urbana, Illinois, June 1934, E. M. Heiss (CSU).

157. *Brachymeria* sp.
Hosts: *Maltagorea fusicolor*
Distribution: Madagascar
Biology: According to Griveaud, the larvae of the host are attacked. However, Boucek indicated that species of this large, widely distributed genus are parasitoids of pupae.
References: Griveaud (1962: 26), Boucek (1988: 68-69)
Remarks: Griveaud cited the host as *Tagoropsis subocellata* form *madagascariensis*.

158. *Brachymeria* sp.
Hosts: *Epiphora* sp.
Distribution: sub-Saharan Africa
Biology: There are 22 specimens that were reared from one host cocoon in the BMNH. The host cocoon is present, and has an exit hole chewed in the side. It is clearly of the genus *Epiphora*.
References: previously unpublished
Remarks: The series of 22 specimens bears the following data: Mt. Mzonje, Nyassaland, 24 December 1913, S. A. Neave (BMNH). The locality may also be spelled Mazonle. The former Nyassaland is now the country of Malawi. John LaSalle (personal communication) said that Lepidoptera having large conspicuous cocoons are commonly attacked by species of *Brachymeria* in many regions of the world. There is a possibility that this series represents the taxon cited above under the name *Phasgonophora bauhiniae*.

159. *Brachymeria* sp. or spp.
Hosts: *Samia walkeri, Samia canningii, Cricula trifenestrata kransi*
Distribution: Guangdong Province, China; Assam, India; Sulawesi, Indonesia
Biology: The larvae of the host are probably attacked and then the wasps emerge from the cocoons of the host. In the case of the one reared from *Cricula*, they were solitary parasitoids.
References: Hill & Cheung (1978: 73), Naumann (1995)
Remarks: The parasitoids reared from *Cricula* by Naumann were illustrated by him in color. They were from hosts from Tondano, Sulawesi Utara, collected August 1994.

Hill & Cheung wrote "many of the pupae [of *Samia walkeri*] observed locally are parasitized by large black chalcid wasps." Robert Mayo (pers. comm.) reported to me chalcids from cocoons of *Samia canningii* from Assam in 1993. Unfortunately, no specimens were retained.

160. *Hockeria crassa* Boucek
Hosts: *Imbrasia cytherea*
Distribution: southern Africa
Biology: Reared from pupa of host.
References: Geertsema (1975)
Remarks: The record is based on material reared by H. Geertsema in 1968 in Cape Province. An unidentified species of *Hockeria* was also reared by Geertsema from the pupa of *Imbrasia belina*, which he indicated was apparently not *H. crassa* or *H. nudaureliae*.

161. *Hockeria nudaureliae* Boucek
Hosts: *Imbrasia cytherea*
Distribution: southern Africa
Biology: Reared from pupa of host.
References: Geertsema (1975)
Remarks: The record is based on specimens reared by H. Geertsema in 1968 in Cape Province. The specific name comes from the generic name *Nudaurelia*, a synonym of *Imbrasia*.

162. *Kriechbaumerella* sp.
Hosts: *Bunaea alcinoe*
Distribution: western Africa
Biology: Reared from the larva of the host.
References: Akanbi (1973)
Remarks: The rearing was in Ibadan, Nigeria. Akanbi cited the genus of parasitoid as *Eucepsis*, which is a synonym of *Kriechbaumerella* according to G. Prinsloo (personal communication to R. Oberprieler).

Family Eupelmidae

163. *Eupelmus cyaniceps* (Ashmead)
Hosts: Hyperparasitoid in *Hyposoter fugitivus* in *Anisota senatoria*, and numerous other hosts in Lepidoptera, Coleoptera, and Hymenoptera
Distribution: California to Florida to Ontario
Biology: Recorded as a hyperparasitoid by Coffelt & Schultz.
References: Coffelt & Schultz (1993b), Burks (*in* Krombein et al. 1979: 882)

164. *Eupelmus urozonus* (Dalman)
Hosts: *Imbrasia belina*
Distribution: southern Africa
Biology: The eggs of hosts are attacked.
References: van den Berg (1971)

165. *Eupelmus* sp.
Hosts: *Antheraea pernyi, Antheraea yamamai*
Distribution: Europe, presumably Balearic Islands of Spain (see remarks below)
Biology: Parasitoid of the eggs of the host.
References: Arzone (1971b), Sonthonnax (1899: 72)
Remarks: Arzone cited this genus of egg parasitoid attacking *A. pernyi* in Europe. The first host is native to China, but has been introduced to the Balearics where it remains established. The second host is native to Japan but introduced into southeastern Europe more than a century ago.

Genus *Anastatus*

These tiny wasps resemble ants, and probably mimic them as they crawl on leaves and stems searching for hosts. They are all primary idiobiont parasitoids of eggs of insects. The key by Burks (1967) is only for females, and is not sufficient for me to make determinations with great confidence, so anyone revising this genus in the future should re-examine my material to verify the identifications. The host range is wide enough that alternate hosts besides Saturniidae obviously exist. For those developing from overwintering eggs (*Hemileuca*), it is clear that the eggs are routinely attacked in the autumn. In cases where only males are reared, it is likely that unmated females parasitized the host eggs. (Males of most Hymenoptera are haploid, developing from unfertilized eggs.) Males of *Anastatus* are mostly black or metallic blue-black.

Kapraly (1990) stated that three other species of *Anastatus* besides *A. pearsalli* were reared from eggs of *C. promethea* in Ohio, but that (pers. comm., 1995) no voucher specimens were deposited in The Ohio State University insect collection and he discarded all parasitoids after the study.

166. *Anastatus albitarsis* (Ashmead)
Hosts: *Antheraea yamamai, Saturnia japonica, Saturnia pyretorum*
Distribution: Japan, Taiwan, China
Biology: Attacks eggs of the host.
References: Voelschow (1902: 56), Sakamoto (1990: 150-154), Boucek (1988: 550), Arzone (1971b), Thompson (1944: 204)
Remarks: Sakamoto published a photograph of the adult parasitoid. It measures 4-5 mm long. According to Boucek, the name *Pseudanastatus* is a synonym of *Anastatus*; Sakamoto used the former name. This is probably the parasitoid that Voelschow reared in Germany from eggs he imported from Japan.

167. *Anastatus bifasciatus* Fourcroy
Hosts: *Samia cynthia, Malacosoma neustria* L. (Lasiocampidae), *Dendrolimus pini* L. (Lasiocampidae), *Dendrolimus spectabilis* Butler, *Gonometa fasciata* (Lasiocampidae), three species of *Thaumetopoea* (Notodontidae), and Hemiptera (Coreidae and Pentatomidae)
Distribution: Europe, including Italy, Ukraine, Spain, Crete; Asia including Korea; Africa, including Uganda
Biology: Parasitizes the eggs of the host.
References: Arzone (1971b)
Remarks: This parasitoid attacks eggs of *Samia cynthia* in Italy. The saturniid host species is native to China, but introduced populations occur in northern Italy. According to Arzone, she collected a cluster of 12 eggs of *Samia cynthia* from which 4 caterpillars had hatched, but later 3 males and 4 females of the parasitoid emerged, one per egg. The preimaginal stages of the parasitoid take about two months to develop. Arzone described how the wasps chew out of the host eggs. It is possible that the host in northern Italy is *Samia walkeri* instead of *S. cynthia*; I have not yet resolved that taxonomic problem.

168. *Anastatus colemani* Crawford
Hosts: *Attacus atlas*
Distribution: Malaysia, elsewhere in tropical Asia
References: Ferrière (1930b), Thompson (1944), Boucek (1988: 550-552), Peigler (1989), Arzone (1971b)
Remarks: I am not certain that this species is correctly placed under *Anastatus*. It is not listed in the monograph by Boucek, although he cited numerous species for the Indo-Australian region.

169. *Anastatus furnissi* Burks
Hosts: *Callosamia promethea, Coloradia pandora, Hylesia lineata, Hemileuca*
Distribution: Recorded from Oregon, upper South Carolina, and Guanacaste Province, Costa Rica.
Biology: A primary ovarian parasitoid.
References: Burks (1967) Burks (*in* Krombein et al. 1979: 887), Peigler (1985a), Janzen (1984)
Remarks: The record of "*Pseudohazis*" given in the original description by Burks (1967) from Oregon refers to one of the following three species of *Hemileuca: hera, eglanterina,* or *nuttalli*. It is almost certain that all of these species serve as hosts in Oregon, even if still not recorded as such. See also possible record from Georgia below under *A. reduvii*.

Specific records: *ex Callosamia promethea*: Greenville, Greenville Co., South Carolina, July 1984, R. S. Peigler [host is not native to locality; eggs obtained from a captive female were attached to a tree of *Quercus nigra* for a few days and then brought indoors] (USNM).

170. *Anastatus hirtus* (Ashmead)
Hosts: *Anisota senatoria, Thyanta custator* (Fabr.) (Hemiptera: Pentatomidae)
Distribution: New York to Florida
Biology: Attacks the eggs of the host. An average of almost 12% of the egg masses were attacked in coastal Virginia.
References: Coffelt & Schultz (1992), Burks (*in* Krombein et al. 1979: 887)

171. *Anastatus pearsalli* Ashmead
Hosts: *Callosamia promethea, Antheraea polyphemus, Paonias astylus* (Drury) (Sphingidae), eggs of various Pentatomidae (Heteroptera), and cocoons of *Apanteles* (Braconidae) [possibly *Cotesia*]
Distribution: Massachusetts to North Carolina, westward to Wisconsin and Arkansas
Biology: Attacks the eggs of the host as a primary parasitoid. The non-saturniid hosts were cited by Burks.
References: Burks (1967: 429), Burks (*in* Krombein et al. 1979: 887), Kapraly (1990)
Remarks: In the study by Kapraly, parasitism by *A. pearsalli* ranged from 51% to 74%. Egg parastism was highest on *Sassafras albidum*, intermediate on *Fraxinus americana*, and lowest on *Prunus serotina*.

172. *Anastatus reduvii* (Howard)
Hosts: *Eupackardia calleta, Antheraea polyphemus, Agapema platensis, Anisota consularis, Anisota pellucida, Anisota discolor, Anisota fuscosa, Anisota senatoria*, other insects in orders Orthoptera, Neuroptera, and Heteroptera, and other Lepidoptera including Arctiidae
Distribution: Maryland to Florida, west to Kansas and Texas, West Indies, Central America, northern South America
Biology: I have reared this species from eggs of *Anisota* and *E. calleta*. The parasitoid from the latter host was several times larger than those from *Anisota*, although the coloration and markings were the same. Eggs of *E. calleta* are much larger than those of *Anisota*.
References: Burks (1967), Burks (*in* Krombein 1979: 888), De Santis (1979: 177), Riotte & Peigler (1981: 121), Peigler (1985a), Peigler & Kendall (1993)
Remarks: Specific records: *ex Eupackardia calleta*: Beeville, Bee Co., Texas, emerged 2 March 1977, R. S. Peigler (USNM); *ex Agapema platensis*: Kickapoo Cavern State Natural Area, Kinney Co., Texas, emerged 26 January 1989, R. O. Kendall (DMNH); *ex Anisota fuscosa, A. senatoria, A. discolor*: Stubblefield Lake, Walker Co., Texas, September 1976, R. S. Peigler (DMNH, USNM); *ex Anisota consularis*: Pulaski, Bulloch Co., Georgia, August 1990, R. S. Peigler (DMNH, CUAC); White Springs, Florida, August 1975, R. S. Peigler & J. Wm. McCord (USNM); Statesboro, Georgia, July 1975, Peigler & McCord (USNM); *ex Anisota pellucida*: White Springs, Florida, July 1975, Peigler & McCord (USNM).

Some of the specimens from Georgia listed above keyed to *A. furnissi*, but I think they are probably *A. reduvii*.

173. *Anastatus semiflavidus* Gahan
Hosts: *Hemileuca nevadensis, Hemileuca oliviae, Hemileuca electra, Hemileuca neumoegeni, Eupackardia calleta*
Distribution: Kansas and Texas to California
Biology: Fritz et al. verified that this parasitoid can remain dormant in the larval stage in a host egg for up to two years. Host eggs are attacked in the fall. Adult parasitoids are not active below 15°C according to studies by Mendel et al. in New Mexico. The latter authors provided a detailed account of the biology of this parasitoid.
References: Comstock & Dammers (1939), Peck (1963: 938), Burks (1967), Watts & Everett (1976), Burks (*in* Krombein et al. 1979: 888), Riotte & Peigler (1981: 121), Fritz et al. (1986), Mendel et al. (1987), Duncan (1991).
Remarks: This is an important parasitoid of the range caterpillar (*H. oliviae*), which reaches pest status in New Mexico because of overgrazing by cattle in grasslands on plateaus at high elevations.

All five specimens reported by Duncan (1991) appear to be this species, but the series includes both sexes.

Specific records: *ex Hemileuca nevadensis*: Roggen, sand dunes, Weld Co., Colorado, 28 June 1990, M. J. Weissmann (CUAC, DMNH); *ex Hemileuca neumoegeni*: 8 km west of Blue Diamond Road, Highway 160, Clark Co., Nevada, May 1988, M. J. Smith (CUAC, DMNH); *ex Hemileuca electra*: near Cataviña, Baja California Norte, Mexico, 15 January—5 February 1995, K. L. Wolfe (CUAC, DMNH); *ex Eupackardia calleta*: Ajo, Pima Co., Arizona, 24 January 1991, J. B. Duncan (DMNH).

174. *Anastatus* sp.
Hosts: *Imbrasia belina, Imbrasia cytherea*
Distribution: southern Africa
Biology: Parasitoid of eggs of the host species.
References: van den Berg (1971, 1974), Geertsema (1975)

175. *Anastatus* sp. (Figure 7)
Hosts: *Saturnia walterorum, Agapema anona, Hemileuca nevadensis, Hemileuca burnsi*
Distribution: Southern California and southern Arizona
Biology: Attacks the egg of the host. The eggs of *Saturnia walterorum* normally hatch within 10 days, but those containing these parasitoids did not yield adult wasps until August, suggesting that alternate hosts must be used since the host flies only in early spring (February and March). The parasitoids reared from an egg mass of *Agapema anona* emerged in March, shortly after being collected; the larvae of *A. anona* on the same tree of *Condalia globosa* (and probably from the same egg mass that produced the parasitoids) were nearly mature.
Remarks: This is probably one (or more) of the other species listed above, but since only males were obtained from these rearings, it was not possible to identify them to species level. The wasps are solidly metallic blue-black. The specimens from the first host listed are larger because its eggs are larger. It is not certain that the parasitoids from the four rearings represent one species.

Specific records: *ex Saturnia walterorum*: 8 km west of Escondido, 250 m, San Diego Co., California, emerged 8-13 August 1994, K. L. Wolfe (DMNH); *ex Agapema anona*: Ajo, Pima Co., Arizona, emerged March 1994, R. S. Peigler (DMNH); *ex Hemileuca nevadensis*: Chino, Los Angeles Co., California, host eggs collected January 1978, D. C. Hawks (DMNH); *ex Hemileuca burnsi*: Littlerock, Los Angeles Co., California, emerged February 1989, K. L. Wolfe (DMNH).

176. *Anastatus* sp.
Hosts: *Samia cynthia, Samia ricini, Dendrolimus* spp. (Lasiocampidae)
Distribution: China
Biology: Parasitoids of eggs of the moths.
References: United Nations (1980: 73)
Remarks: The United Nations report on sericulture in China stated that eggs of *Samia* were being used for mass rearing of *Anastatus* and *Trichogramma* for biological control of *Dendrolimus sibiricus* and *D. punctatus*, which are forest pests in China. *Samia* stocks were also being used to culture the pathogens *Bacillus thuringiensis* and *Beauveria* to combat the same pests. I believe that mass applications of these pathogens and parasitoids adversely affect populations of native Lepidoptera, including Saturniidae, the same sort of ecological damage we see in North America by similar attempts to control the gypsy moth (*Lymantria dispar* (Linnaeus), Lymantriidae).

177. *Anastatus* sp.
Hosts: *Attacus mcmulleni*
Distribution: Andaman Islands, India, in the Bay of Bengal
Biology: Solitary ovarian parasitoids.
References: Veenakumari et al. (1995: 172)
Remarks: This species is probably not *A. colemani*, because it was identified by A. Polaszek (International Institute of Entomology, London) who presumably had material of *A. colemani* available for comparison. It may be an undescribed species. Dammerman (1929) also reported an unidentified species of *Anastatus* attacking *Attacus atlas*; it may be this species or *A. colemani*.

178. *Mesocomys menzeli* (Ferrière)
Hosts: *Attacus atlas, Samia ricini, Antheraea* sp.
Distribution: southeastern Asia; Sumatra, and as far east as Java
Biology: The female oviposits into eggs of large Saturniidae and probably also other Bombycoidea which are laid in clusters. Probably only one parasitoid egg is deposited per host egg. Menzel stated that there may be up to 80% parasitism of eggs.
References: Menzel (1925), van Hall (1926), Ferrière 1930b, Thompson (1944), Arzone (1971b), Boucek (1988: 553-554), Peigler (1989)
Remarks: Reported by Menzel and van Hall as *Anastatus* sp. and by Ferrière, Thompson, Arzone, and Peigler as *Anastatus menzeli*. Boucek reassigned this species to *Mesocomys*. Ferrière referred to "variety *obscurus*", which may be a dark form of this species or a separate species.

179. *Mesocomys pulchriceps* Cameron
Hosts: *Imbrasia cytherea, Imbrasia tyrrhea, Imbrasia belina, Pseudobunaea irius, Gynanisa maja, Aurivillius aratus, Bunaea*
alcinoe, Cirina forda, Heniocha dyops, Urota sinope, Usta terpsichore, Argema mimosae, Epiphora mythimnia
Distribution: southern Africa
Biology: Primary parasitoid of eggs of the host moth. This parasitoid probably attacks eggs of several species of Saturniidae, as Boucek indicated that wasps of this genus favor eggs of large Bombycoidea. Most of the host records above result from laboratory rearings of the parasitoid by van den Berg, who offered eggs of the various moths to attack. There is no doubt they would attack all of these hosts in nature.
References: Webb (1964), Arzone (1971b), van den Berg (1971, 1974), Geertsema (1975), Boucek (1988: 553-554)

Remarks: Van den Berg cited the first host under the name *Nudaurelia cytherea clarki* Geertsema.

180. *Mesocomys vuilleti* Crawford
Hosts: *Bunaea aslauga, Cirina forda*
Distribution: Madagascar, Sudan
Biology: Eggs of the hosts are parasitized.
References: Griveaud (1962: 46, 51), Arzone (1971b), Boucek (1988: 553-554)
Remarks: Griveaud wrote "Les élevages effectués ont donné un Chalcidien parasite: *Mesocomys vuilleti* Crawford." Some authors have cited the host as *Cirina butyrospermi*, a synonym of *C. forda*. R. Oberprieler (pers. comm.) suspects that the name *vuilleti* could be a synonym of *pulchriceps*.

181. *Mesocomys pauliani* Ferrière
Hosts: *Antherina suraka*
Distribution: Madagascar
Biology: Eggs of the host are attacked.
References: Griveaud (1962: 51), Arzone (1971b)
Remarks: Griveaud stated that eggs of the host are strongly infested by this parasitoid (which he cited only as *Mesocomys* sp.) and a species of *Agiommatus*.

182. *Arachnophaga* sp.?
Hosts: *Hemileuca nevadensis*
Distribution: Los Angeles County, California
Biology: Parasitoids of eggs.
References: Burks (*in* Krombein et al. 1979: 884-885)
Remarks: Specific record: *ex Hemileuca nevadensis*: Chino, Los Angeles Co., Arizona, host eggs collected January 1978, D. C. Hawks. These specimens were sent by me to USNM and the following reply came from M. E. Schauff: "Specimens have critical parts missing. More precise determination depends on characters found in other sex." He identified them as "probably *Arachnophaga*."

183. Eupelmidae, genus undetermined
Hosts: *Citheronia laocoon*
Distribution: southern Brazil
Biology: Parasitoid of eggs.
References: Dias (1978)

Family Encyrtidae

184. *Ooencyrtus cirinae* Prinsloo
Hosts: *Cirina forda*
Distribution: known only from the vicinity of Pretoria, Transvaal, South Africa
Biology: Parasitoid of eggs of the host. Wasps emerged in October.
References: Prinsloo (1987: 21), Askew (1971: 139)
Remarks: The original rearing was made by R. Oberprieler.

185. *Ooencyrtus kuvanae* Howard
Hosts: *Saturnia pyretorum, Hemileuca oliviae*, other Lepidoptera and Hymenoptera
Distribution: Taiwan, introduced to North America, where it occurs in New England and New Mexico at least
Biology: Parasitoid of eggs, or in the case of *Apanteles* perhaps of the exposed cocoons.

References: Peck (1963: 938), Arzone (1971b), Gordh (*in* Krombein et al. 1979: 953-954)
Remarks: This parasitoid has sometimes been classified in the genus *Schedius*. It has been spelled in some literature as *kuwanae*.

186. *Ooencyrtus phoebi* Huang & Noyes
Hosts: *Attacus atlas*
Distribution: Java, and probably elsewhere in tropical Asia
Biology: Egg parasitoids.
References: Ferrière (1931: 285), Trjapitzin (1965: 324), Arzone (1971b), Peigler (1989: 94), Huang & Noyes (1994)
Remarks: This species was listed by the first four authors above as *Ooencyrtus major* Ferrière.

187. *Ooencyrtus* sp.
Hosts: *Anisota senatoria*
Distribution: coastal Virginia
Biology: Attacks the eggs of the host. Only a mean egg mass parasitism of 0.09% was recorded.
References: Coffelt & Schultz (1992), Askew (1971: 139)

188. *Epiencyrtus thyreodontis*? (Ashmead)
Hosts: *Automeris zozine*?, *Thyreodon atricolor* (Olivier) (Ichneumonidae)
Distribution: eastern United States, from at least Massachusetts to upper South Carolina
Biology: This tiny wasp was observed on the integument of a mature larva of the host cited above, but was removed before it could oviposit. The host, native to Chiapas, Mexico, was being reared under a cloth bag on a small tree of *Quercus nigra*. It is not known if it could have successfully parasitized the host. If so, *Automeris io* would serve as a normal host in the locality.
References: G. Gordh (*in* Krombein et al. 1979: 963)
Remarks: Specific record: on *Automeris zozine*: Greenville, South Carolina, 24 June 1977, R. S. Peigler (DMNH). The parasitoid was identified by J. LaSalle (BMNH) with a question mark on the species name.

189. Encyrtidae, genus undetermined
Hosts: *Citheronia laocoon*
Distribution: southern Brazil
Biology: Parasitoid of eggs.
References: Dias (1978)

Family Eulophidae

LaSalle (1994) provided a monumental reclassification of the Tetrastichinae, a large group that includes several genera below beginning with *Tetrastichus*. He pointed out that the subfamily is one of the largest and most widespread of all parasitic Hymenoptera, and that "species can be solitary or gregarious, internal or external parasitoids, primary or secondary parasitoids, predatory, or phytophagous" (LaSalle 1994: 115).

190. *Eulophus* sp.
Hosts: *Hemileuca nevadensis*
Distribution: upper South Carolina
Biology: Attacks the mature larva of the host, the parasitoid larvae leave the host and form naked pupae on the leaf. There were 14 eulophids in this lot.
References: unpublished
Remarks: This series of sibling wasps was reared from a mass of cocoons that emerged from a mature larva of the host (not native to the area), reared on Lombardy poplar. The parasitoid was identified by J. LaSalle (BMNH).

Specific record: *ex Hemileuca nevadensis*: Greenville, South Carolina, July 1973, R. S. Peigler (DMNH).

191. *Dimmockia incongrua* (Ashmead)
Hosts: Hyperparasitic in *Hyalophora cecropia*, parasitic in other insects including Tachinidae and Braconidae
Distribution: eastern North America
Biology: This is almost always a secondary parasitoid.
References: Peck (1963: 938), Burks (*in* Krombein et al. 1979: 976)
Remarks: Although Peck cited the saturniid above as a host, Burks did not, evidently because he knew that the rearing on which the record was based resulted from hyperparasitism.

192. *Euplectrus comstockii* Howard
Hosts: *Rothschildia lebeau*, other Lepidoptera including mostly Noctuidae
Distribution: El Salvador, Puerto Rico, Trinidad; widespread in North America from Arizona to Florida to South Dakota to Connecticut; also in South America
Biology: Burks wrote "This is one of the very few chalcidoid genera that spin cocoons; these usually are placed under the emaciated body of the host larva."
References: De Santis (1979: 254), Burks (*in* Krombein et al. 1979: 977)
Remarks: The saturniid host was cited by De Santis as *Rothschildia aroma*.

193. *Euplectrus nigroclypeatus* Ferrière
Hosts: *Antherina suraka*
Distribution: Madagascar
Biology: According to Boucek, the species in this genus are primary gregarious ectoparasites of lepidopterous larvae. When mature, they then spin a loose cocoon beside the dead host and pupate below the cocoon. This method of pupation is an unusual and perhaps unique characteristic for the Chalcidoidea.
References: Griveaud (1962: 51), Boucek (1988: 633)
Remarks: Griveaud misspelled the generic name as *Euplectus*.

194. *Cirrospilus inimicus* Gahan
Hosts: Hyperparasitic in *Gambrus extrematis* (Ichneumonidae) in *Hyalophora cecropia*
Distribution: Illinois, southward
References: Peck (1963: 938), De Santis (1979), Burks (*in* Krombein et al. 1979: 983-984)
Remarks: Although Peck cited this as a parasitoid of *H. cecropia*, Burks did not, because he knew it was a hyperparasitoid.

195. *Tetrastichus* spp.
Hosts: *Hemileuca oliviae, Callosamia promethea*
Distribution: Ohio and New Mexico (probably two species)
Biology: Eggs are attacked. No details were given by the authors.
References: Burks (1943), Fritz et al. (1986), Kapraly (1990)
Remarks: These records probably refer to two species of *Aprostocetus*. The one from New Mexico may in fact be *A. pandora*; that from Ohio perhaps is the one cited below as "*Aprostocetus* sp. near *pandora*".

196. *Tetrastichus* sp.
Hosts: *Arsenura xanthopus*
Distribution: state of São Paulo, Brazil
Biology: One wasp emerges from each host egg. Parasitism can approach 100%. The egg is layed within 80 to 120 seconds after the ovipositor of the female wasp is inserted into a host egg. This parasitoid was considered to be valuable by Lordello & Mariconi as a control agent of the moth which is a frequent defoliator of *Luehea* trees.
References: Lordello & Mariconi (1953), d'Araújo e Silva et al. (1968: 262)
Remarks: This parasitoid is probably a species of *Aprostocetus*, as many of the species in that genus were formerly considered to be in the genus *Tetrastichus*. The report of a species of *Tetrastichus* as a hyperparasitoid in the tachinid *Zygofrontina* by d'Araújo e Silva et al. in Brazil is possibly an error.

197. *Tetrastichus* sp.
Hosts: *Attacus atlas*
Distribution: Java, Indonesia
Biology: Eggs of the host moth are attacked.
References: Ferrière (1931: 291), Thompson (1944), Boucek (1988: 693-694), Peigler (1989: 94), LaSalle (1994: 198-199)
Remarks: Whatever species was being referred to by Ferrière in the original report, it probably was not a true *Tetrastichus* based on the host preferences cited by Boucek, who indicated that eggs of Lepidoptera are not hosts.

198. *Aprostocetus pandora* Burks
Hosts: *Coloradia pandora*
Distribution: western United States
Biology: Patterson reared 128 wasps from 17 eggs of *Coloradia pandora*, with as few as 3 coming out of one egg and as many as 11 from another egg, with 7.5 being the average.
References: Patterson (1929), Burks (1943; *in* Krombein et al. 1979: 999), Peck (1963: 938), LaSalle (1994: 148)
Remarks: This parasitoid was cited as *Tetrastichus* sp. by Patterson and Peck. The name should not be confused with *Brachymeria pandora* (Crawford) a South American species of the Chalcididae that attacks Hesperiidae (De Santis 1979: 60).

199. *Aprostocetus* sp. near *pandora*
Hosts: *Anisota senatoria, Anisota peigleri*
Distribution: eastern United States including Connecticut, Virginia, South Carolina, and Texas
Biology: This is a primary parasitoid of eggs of the hosts.
References: Hitchcock (1961a), Riotte & Peigler (1981) Coffelt & Schultz (1992)
Remarks: This parasitoid was cited as *Tetrastichus* sp. by Hitchcock and Riotte & Peigler. Coffelt & Schultz reported this parasitoid to be a new species. J. LaSalle

(BMNH) gave me some of the specimens from Coffelt & Schultz, and identified my Texas material as being the same. The females are blackish, the males light brown.

Specific records: *ex Anisota senatoria*: Norfolk, Virginia, 6 August 1987, M. Coffelt (DMNH, USNM, BMNH); *ex Anisota* sp.: Stubblefield Lake, Walker Co., Texas, 11 September 1976, R. S. Peigler (DMNH); *ex Anisota peigleri*: Greenville, South Carolina, August 1978, R. S. Peigler (USNM).

200. *Horismenus bisulcus* Ashmead
Hosts: *Automeris* sp.
Distribution: Brazil
Biology: This is stated to be a hyperparasitoid of *Apanteles*.
References: d'Araújo e Silva et al. (1968: 263)
Remarks: I am unable to verify this name in De Santis (1979) who apparently did not list it anywhere under *Horismenus*.

201. *Horismenus cockerelli* Blanchard
Hosts: Hyperparasitoid in *Apanteles* in *Eacles imperialis magnifica*
Distribution: Brazil
Biology: Stated to be a hyperparasitoid of *Apanteles* (Braconidae) by the authors cited below.
References: d'Araújo e Silva et al. (1968: 260-261), De Santis (1979: 271)
Remarks: The braconid host is probably not a true *Apanteles*, but another microgastrine.

202. *Horismenus floridanus* (Ashmead)
Hosts: *Apanteles, Cotesia* (Braconidae) attacking *Anisota* and other Lepidoptera
Distribution: New Jersey to California to Florida
Biology: These tiny black wasps emerge from cocoons of microgastrine braconids. The comment by Riotte & Peigler that exposed cocoons are not attacked, but that eggs of the eulophid are laid in the lepidopterous host needs to be verified with more carefully controlled rearing conditions.
References: Burks (*in* Krombein et al. 1979: 1014), Riotte & Peigler (1981: 121)
Remarks: Specific record: *ex Cotesia anisotae* in *Anisota* spp.: Stubblefield Lake, Walker Co., Texas, 15 October 1976, R. S. Peigler (DMNH, USNM). Material from the rearing was determined by G. Gordh.

203. *Horismenus* sp. near *lixivorous* (Crawford)
Hosts: Hyperparasitoid in *Hyposoter fugitivus* in *Anisota senatoria*
Distribution: coastal Virginia
Biology: A hyperparasitoid attacking mummified larvae of *Anisota senatoria* containing cocoons of *Hyposoter fugitivus*.
References: Coffelt & Schultz (1993b)
Remarks: According to the above authors who reared two specimens, it does not match any other known *Horismenus* in the USNM as communicated to them by M. E. Schauff.

204. *Pediobius tarsalis* (Ashmead)
Hosts: Hyperparasitoid in Ichneumonidae and Tachinidae in Lepidoptera, including *Hyalophora cecropia*
Distribution: New Hampshire to North Carolina, west to Washington and California
Biology: Always a secondary parasitoid.
References: Peck (1963: 938), Burks (*in* Krombein et al. 1979: 1018)

205. *Pediobius* sp.
Hosts: *Imbrasia cytherea, Imbrasia belina*
Distribution: South Africa
Biology: Parasitoid of eggs.
References: van den Berg (1971, 1974), Geertsema (1975)
Remarks: The pine emperor (*Imbrasia cytherea*) is considered a pest of pines in South Africa. Van den Berg reported that host under the name *Nudaurelia cytherea clarki* Geertsema.

206. Eulophidae, genus undetermined
Hosts: *Citheronia laocoon*
Distribution: southern Brazil
Biology: Parasitoid of eggs.
References: Dias (1978)

Family Trichogrammatidae

These are among the tiniest Hymenoptera, most measuring much less than 1 mm in length. They are all egg parasitoids, and a few are mass-reared for biocontrol programs. Host range is based more on habitat instead of taxonomy of the host.

207. *Trichogramma australicum* Girault
Hosts: *Antheraea yamamai*
Distribution: Japan, Indo-Australian region
Biology: A primary parasitoid of eggs of the host.
References: Burks (1979: 1037), Sakamoto (1990: 150-153)
Remarks: Boucek (1988) did not treat this family. Burks wrote that the species of *Trichogramma* do not select their host eggs based on taxonomy of the host, but rather by environmental conditions. For example, one species of *Trichogramma* may oviposit into eggs of most insects in a moist coniferous forest, while another may attack many species of hosts in a grassland prairie.

208. *Trichogramma dendrolimi* Matsumura
Hosts: *Samia cynthia, Samia ricini, Saturnia japonica, Antheraea yamamai*, *Dendrolimus* spp. (Lasiocampidae)
Distribution: China, Japan
Biology: Parasitoids of eggs.
References: United Nations (1980: 73), Thompson (1944: 204), Sakamoto (1990: 150-153)
Remarks: Eggs of *Samia* are being used in China to mass rear this parasitoid to be used as a biological control agent against forest pests in the genus *Dendrolimus*. See also *Anastatus* sp. above. In Japan, where *Antheraea yamamai* is mass reared for production of tensan silk, the trichogrammatid is considered a pest when it attacks eggs of this moth.

209. *Trichogramma minutum* (Riley)
Hosts: *Anisota senatoria, Dryocampa rubicunda, Coloradia pandora*, and many other insects
Distribution: North America, including southern Canada down to central United States, but not in the Southwest and Deep South
Biology: Patterson reared this parasitoid from 5 eggs of *Coloradia pandora*. He

obtained 20 to 37 wasps from each host egg, the average being 29.5, and a total of 147 wasps. Burks stated that eggs of almost any arboreal insect will be parasitized.
References: Allen (1976), Patterson (1929), Hitchcock (1961a), Peck (1963: 938), Burks (*in* Krombein et al. 1979: 1039), Coffelt & Schultz (1992)

210. *Trichogramma pretiosa* (Riley)
Hosts: *Anisota senatoria*
Distribution: same as for *T. minutum* above
Biology: Host eggs deposited on lower vegetation in rural areas will be attacked.
References: Hitchcock (1961a), Coffelt & Schultz (1992), Burks (*in* Krombein et al. 1979: 1039)

211. Chalcidoidea, family and genus undetermined
"*Cynips*" *bombycida* Rondani
Hosts: *Saturnia pyri*
Distribution: Europe
References: Packard (1914: 268)
Remarks: Packard apparently cited the generic name in quotes, as do I, because he knew that Cynipidae are Hymenoptera that make galls, i.e. are plant feeders instead of parasitoids, in general. It is not possible at this time to track this name until the type specimen can be located, unless it is lost.

Superfamily Prototrupoidea

212. Family Diapriidae, genus and species undetermined
Hosts: A hyperparasitoid of the tachinid *Carcelia evolans* reared from *Imbrasia cytherea*
Distribution: South Africa
Biology: Emerged from the puparium of the tachinid. The diapriid may be attack the tachinid larva within the caterpillar of the moth; more likely, it oviposits into the puparium of the tachinid after the latter has left the primary host, since diapriids specialize in parasitizing Diptera. It is thus not likely to be a facultative hyperparasitoid.
References: van den Berg (1974), Muesebeck (1979: 1127), Boucek (1988: 30).
Remarks: Van den Berg cited the saturniid primary host as *Nudaurelia cytherea clarki* Geertsema.

Family Scelionidae

213. *Telenomus almanzori* Marelli
Hosts: *Hylesia nigricans*
Distribution: Argentina
References: d'Araújo e Silva et al. (1968: 267)

214. *Telenomus attaci* Nixon
Hosts: *Attacus atlas*
Distribution: Malaysia and Thailand
Biology: Egg parasitoid.
References: Arzone (1971b)

215. *Telenomus graptae* Howard
Hosts: *Antheraea polyphemus*, butterflies in Nymphalidae, Lycaenidae, and Hesperiidae
Distribution: Québec to Arizona

Biology: This is an idiobiont parasitoid of eggs. The wasps are usually less than 1 mm long.
References: Collins & Weast (1961), C. F. W. Muesebeck (*in* Krombein et al. 1979: 1168)
Remarks: Since all known hosts listed by Muesebeck are butterflies, the record for *Antheraea polyphemus* should be verified. It may have been based on a misidentification of another species in the genus *Telenomus*.

216. *Telenomus hyelosiae* (Brèthes)
Hosts: *Hylesia nigricans*
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 267), De Santis (1967, 1980)
Remarks: This insect was listed under the name *Neonecremnus hylesiae* by d'Araújo e Silva et al., who attempted to correct the original spelling of the specific name, which is based on the host genus.

217. *Telenomus poeta* Girault
Hosts: *Saturnia japonica*
Distribution: Japan
References: Thompson (1944: 204)

218. *Telenomus* sp.
Hosts: *Callosamia promethea*
Distribution: North America
Biology: Parasitoid of eggs.
References: Kapraly (1990)
Remarks: Kapraly (1990) indicated that a single species of *Telenomus* was reared from eggs of *C. promethea* in Ohio, but that (personal communication, 1995) no voucher specimens were kept. This record may belong under *T. graptae* above.

219. *Telenomus* sp.
Hosts: *Coloradia pandora*
Distribution: northern Arizona
Biology: Parasitism ranged from 4% to 56%. Parasitized eggs are black and easily distinguished from unparasitized ones. Some eggs in an egg mass are not attacked, alongside of ones that are.
References: Schmid & Bennett (1988)

220. *Telenomus* sp.
Hosts: *Hylesia* (probably *nigricans*)
Distribution: Parana State, Brazil
References: Janzen (1984)
Remarks: The observations cited by Janzen were made by J. A. Winder in Brazil, who cited the host under the synonym *Hylesia fulviventris*.

Superfamily Trigonalyoidea
Family Trigonalyidae

These wasps resemble small yellowjackets and are koinobiont hyperparasitoids of Tachinidae and Ichneumonidae. Carlson (1979) said that eggs are laid singly on leaves, to be injested by caterpillars. The report by Hirai & Ishii (1995) gives

additional details typical of their parasitization. In most literature the family name has been spelled Trigonalidae, but Trigonalyidae is apparently correct.

221. *Lycogaster pullata pullata* Shuckard
Hosts: Hyperparasitoid in *Enicospilus americanus* in *Antheraea polyphemus*
Distribution: Vermont to Georgia across to North Dakota
Biology: Hyperparasitoid. Eggs are deposited on leaves and eaten by a caterpillar. Then the hyperparasitoid larvae find larvae of the primary parasitoid within the caterpillar (primary host).
References: Packard (1914: 268), Carlson (1979: 1198)
Remarks: Cockerell (*in* Packard) wrote that this wasp was bred in Berlin by an entomologist named Bischoff from an imported cocoon of *A. polyphemus*, but that it was apparently a hyperparasitoid in a cocoon of *Enicospilus americanus*. Cockerell used the name *Erymotylus macrurus* for the latter.

222. *Lycogaster pullata nevadensis* Cresson
Hosts: Hyperparasitoid of tachinid in *Agapema dentifasciata*
Distribution: Oregon, South Dakota, Colorado, New Mexico, Nevada, northeastern Mexico
Biology: One specimen was reared from a cocoon of *Agapema*, undoubtedly as a hyperparasitoid of a tachinid.
References: Peigler & Kendall (1993), Askew (1971: 128), Carlson (1979: 1198)
Remarks: Specific record: *ex Agapema dentifasciata*: 58 km ENE of Matehuala, Nuevo León, emerged 9 January 1981, R. O. Kendall (TAMU). The specimen was determined by A. S. Menke (USDA). This rearing gives a range extension for the parasitoid to the southeast beyond that cited by Carlson.

223. *Poeciligonalos costalis* (Cresson)
Hosts: Hyperparasitoid in tachinids in *Automeris io, Anisota senatoria, Anisota virginiensis,* and *Anisota discolor*
Distribution: Massachusetts to Florida to Ohio to Texas
Biology: Hyperparasitoid.
References: Carlson (1979: 1198), Riotte & Peigler (1981: 120), Tuskes et al. (1996)
Remarks: Specific records: *ex Anisota senatoria:* Stubblefield Lake, Walker Co., Texas, 1977, R. S. Peigler; *ex Anisota discolor*: Stubblefield Lake, Texas, 27 April 1977, R. S. Peigler (USNM). This rearing gives a range extension for the parasitoid to the southwest beyond that cited by Carlson.

DIPTERA

Family Tachinidae

These flies are usually black or gray, often with conspicuous stripes and prominent bristles. Many resemble large house flies and calliphorid flies. Most Tachinidae (pronounced tak-EYE-ni-dee) are endoparasitoids of larvae of insects, especially Lepidoptera. An archaic synonym is Larvaevoridae. The German name for the group is *Raupenfliegen* meaning "caterpillar flies." They are, as far as I know, all koinobionts, and virtually none are hyperparasitoids. Some are gregarious, others solitary. There are various mechanisms of oviposition to get the egg onto or into a suitable host. Some females inject one or more eggs into a host, with a slender ovipositor telescoped within the abdomen. Others deposit eggs onto hosts, to which these adhere very firmly. It is not unusual to see the oval, flattened white or gray eggs on

a caterpillar. Many kinds of tachinids spread large numbers of eggs indiscriminantly on leaves so that some will be consumed by appropriate hosts. Such eggs are called microtype (Salkeld 1980) and must be resistent to crushing in the mandibles of the caterpillar. Eclosion is triggered by enzymes in the digestive system of the host. A remarkable variation is known in the genus *Belvosia*, as described below under that genus.

Herting (1960) gave a detailed and well-illustrated account of the internal development of larvae of tachinids in their hosts. In most species the mature maggots exit the host, drop to the ground, and pupate in the soil. It is easier for a maggot than an adult fly to chew a tiny hole and squeeze through a cocoon or pupa, the fragile adult lacking chewing mouthparts. A trail of mucous which dries to a glossy, transparent streak may reveal which cocoon or cocoons in the rearing cage yielded the maggots. The mature maggot will contract, turn reddish brown, forming a puparium (plural: puparia), and pupate within the puparium, which shows segmentation since it is really the last larval skin, darkened and reshaped. Entomologists must protect puparia from desiccation or flies will die before emerging. Care should be also taken to avoid excessive moisture and lack of ventilation, which leads to mold and can also be fatal. Adult flies are often collected at flowers and in malaise traps. A good discussion of biology of Tachinidae was given by Wood (1987: 1197-1200).

The taxonomy of the family is in disarray, because many unrelated groups look alike. The group is traditionally difficult and many misidentifications exist in literature where host records are reported. Many species have been reassigned to other genera, and many genera synonymized in recent years. Existing classifications, especially at the tribal level, include some groupings that are not natural. Newer studies based on valid synapomorphies are finally advancing our knowledge of tachinid classification. I have updated the nomenclature whenever possible. For this catalog I arranged the genera phylogenetically as far as possible using literature available to me, retaining subfamilies but omitting tribes, because of considerable disagreement among even recent authors. It would not have been possible to compile the Tachinidae section of the present catalog without access to the taxonomic catalog by Dr. Benno Herting of Germany and the host-parasitoid catalog by Dr. Paul Arnaud of the California Academy of Sciences, San Francisco. Arnaud's catalog is a monumental work that is valuable because many tachinids are important factors in biological control of other insects that are pests in forests and agroecosystems.

Subfamily Phasiinae

The tachinids in this subfamily differ considerably in appearance from all others listed below. The Phasiinae often have dark brown wings, flat orange abdomens, and dense brushes of hairs on the legs. Most of these attack adult bugs of the hemipteran families Coreidae and Pentatomidae.

224. *Cylindromyia binotata* (Bigot)
Hosts: *Actias luna, Euschistus* spp. (Hemiptera: Pentatomidae)
Distribution: North America
Biology: According to Arnaud, the pupa of *A. luna* and the adults of the Hemiptera were attacked. I have often observed the white eggs of various Phasiinae attached to adult bugs (Pentatomidae and Coreidae). It therefore seems possible that the rugose, brown pupa of a moth could be attacked, since it resembles the exoskeleton

of a brown stink bug. However, how would the bug enter the cocoon of the moth to oviposit on the pupa? Moreover, almost all phasiines parasitize only Hemiptera.
References: Cole (1969: 530), Arnaud (1978: 172), Pujade & Sarto (1986: 169)
Remarks: Pujade & Sarto gave a color illustration of a species in this genus, showing that it differs greatly in appearance from all other tachinids listed below.

Subfamily Tachininae

225. *Ceromya luteicornis* (Curran)
Hosts: *Bunaea alcinoe, Imbrasia belina, Imbrasia cytherea, Imbrasia epimethea*
Distribution: South Africa
References: Cuthbertson & Munro (1941, as *Actia*), Akanbi (1973), van den Berg (1974), Crosskey (1984: 307)
Remarks: Crosskey listed this genus as attacking Saturniidae, Sphingidae, Lymantriidae, and Noctuidae.

226. *Tachina* sp.
Hosts: *Antheraea yamamai*
Distribution: Japan
References: Sakamoto (1990: 150), Herting (1984: 84)
Remarks: Sakamoto listed "*Echinomyia* sp." as a parasitoid of *A. yamamai*. According to Herting, that generic name is a synonym of *Tachina*. I do not know which species this record belongs to, because Herting listed numerous Palaearctic species in the genus.

227. *Linnaemyia comta* (Fallén)
Hosts: *Saturnia pavonia*
Distribution: Transcaucasus; Scotland to far eastern Russia
References: Thompson (1944: 535), Herting (1984: 96-97)
Remarks: The name is sometimes misspelled as *L. compta*.

228. *Eurithia consobrina* (Meigen)
Hosts: *Saturnia pavonia*
Distribution: Ireland and Scotland to Transcaucasus to northern Kazakhstan; northern China (Gansu); far eastern Russia (Kunashir Islands and Sakhalin)
References: Thompson (1944: 535), Herting (1984: 104-105)
Remarks: The name of the parasitoid was cited by Thompson as *Ernestia consobrina*.

Subfamily Goniinae

229. *Compsilura concinnata* (Meigen)
Hosts: *Hemileuca lucina, Hemileuca maia, Hemileuca oliviae, Automeris io, Anisota senatoria, Anisota virginiensis, Dryocampa rubicunda, Cirina forda, Imbrasia cytherea, Callosamia promethea, Hyalophora cecropia, Actias luna, Actias isabellae, Saturnia pavonia, Antheraea polyphemus, Bombyx mori* (L.) (Bombycidae), many sawflies (Hymenoptera: Symphyta), many Lepidoptera in Lasiocampidae, Lymantriidae, Arctiidae, Noctuidae, Notodontidae, Sphingidae, Geometridae, Hesperiidae, Nymphalidae, Pieridae, Papilionidae, other families, and some Microlepidoptera
Distribution: Europe; introduced to eastern North America to control gypsy moth (*Lymantria dispar* (L.)), and now recorded from California and British Columbia; southern Africa; Australia; Asia

Biology: The ovipositing female fly larviposits, i.e., deposits live larvae into the host sawfly or caterpillar. Solitary host larvae are more vulnerable to attack than ones in aggregations.
References: Schaffner & Griswold (1934), Herting (1960: 55-57, 151; 1984), Cole (1969: 563-564), Taylor (1961), van den Berg (1974), Crosskey (1976: 302; 1984), Allen (1976), Arnaud (1978: 149-168), Cantrell (1986), Szujecki (1987), Stamp & Bowers (1990), Tuskes et al. (1996)
Remarks: Interactions between Lepidoptera that feed on blueberry and their parasitoids were discussed by Szujecki. These associations included *Saturnia pavonia* and *Compsilura concinnata*.

230. *Oswaldia aurifrons* (Townsend)
Hosts: *Anisota senatoria, Nematus ventralis* Say (Hymenoptera: Tenthredinidae)
Distribution: eastern North America to Utah
References: Cole (1969: 565), Arnaud (1978: 406)
Remarks: Records in literature prior to Arnaud appear under the name *Dexodes aurifrons*. Cole treated *Dexodes* as a subgenus of *Oswaldia*.

231. *Pilimyia*, or an allied genus
Hosts: *Opodiphthera helena*
Distribution: eastern Australia
References: Cantrell (1986)
Remarks: Cantrell cited the host under the name *Antheraea helena*.

Genus *Exorista*

The biology of a species in this genus was described by Kugler (1961). The eggs are deposited by female flies onto the integument of the host larvae. Generally, late stage larvae are attacked. Upon eclosion, the tachinid larva immediately penetrates the host integument. It feeds on fat-bodies and hemolymph at the point of internal attachment, then at maturity attacks vital organs of the host. It leaves the host to pupate in the soil.

232. *Exorista japonica* (Townsend)
Hosts: *Antheraea yamamai*
Distribution: Japan, Taiwan, and mainland China.
References: Sakamoto (1990: 150 as *Eutachina japonica*), Herting (1984: 5)

233. *Exorista larvarum* (Linnaeus)
Hosts: *Saturnia pyri*
Distribution: Europe
References: Thompson (1944: 535), Herting (1984: 5)
Remarks: This record is probably based on a misidentification of the parasitoid.

234. *Exorista mella* (Walker)
Hosts: *Hemileuca grotei, Hemileuca oliviae, Callosamia promethea,* one sawfly (Hymenoptera: Tenthredinidae), and numerous Lepidoptera in Lasiocampidae, Arctiidae, Lymantriidae, Notodontidae, Noctuidae, Nymphalidae, Danaidae, and a few others.
Distribution: North America
Biology: Larvae of the parasitoid emerge from mature host larvae. Judging from the

long host list given by Arnaud, it would appear that hairy or spiny caterpillars are preferred. There are many such hosts listed in Arctiidae, Lymantriidae, and Lasiocampidae, but very few with smooth integuments like *Danaus plexippus* (L.) and *Callosamia promethea*. The latter hosts should be verified.
References: Ainslie (1910), Packard (1914: 269), Schaffner & Griswold (1934), Watts & Everett (1976), Arnaud (1978), Kendall & Peigler (1981)
Remarks: According to Watts & Everett, a synonym is *E. larvarum*.

235. *Exorista* sp. near *mella*
Hosts: *Hemileuca oliviae, Hemileuca burnsi*
Distribution: California, New Mexico
Biology: Maggots emerge from mature host larvae and pupate in the ground.
Remarks: These two records may represent one or two species. They were identified by N. E. Woodley. There were eight specimens reared from California, and one from New Mexico. A puparium is pinned with each specimen.

Specific records: *ex Hemileuca burnsi*: Phelan, San Bernardino Co., California, June 1986, D. C. Hawks (DMNH, USNM); *ex Hemileuca oliviae*: 18 km W of Grenville, Union Co., New Mexico, September 1987, R. S. Peigler (USNM).

236. *Exorista rustica* (Fallén)
Hosts: *Saturnia pyri*, sawflies (Hymenoptera), other Lepidoptera including Lasiocampidae
Distribution: Ireland, England, Scandinavia, Transcaucasus, Israel, Siberia, Mongolia
References: Rougeot (1971: 92, as *Tachina festivata*), Herting (1960: 39; 1984: 9-11)
Remarks: Herting (1960) pointed out that this very common tachinid may indeed use Lepidoptera as hosts occasionally, although sawflies are the normal hosts. In my opinion, there has been so much taxonomic confusion for this fly (two pages of synonymies in Herting 1984) that the record for *Saturnia pyri* is likely based on a misidentification.

237. *Exorista sorbillans* (Wiedemann) (Figure 9)
Hosts: *Saturnia caecigena, Saturnia spini, Saturnia pavonia, Saturnia pyri, Antheraea yamamai, Antheraea assamensis, Antheraea paphia, Samia cynthia, Samia ricini, Attacus atlas, Attacus caesar, Attacus lorquinii, Imbrasia tyrrhea, Holocerina smilax*
Distribution: Mediterranean (Europe and northern Africa), eastward to Japan, tropical and temperate Asia, tropical Africa
Biology: Good details were given by Bannerjee. Aspects of the egg were given by Manjunatha & Puttaraju. Watanabe & Mitsuhashi succeeded in rearing the larvae on artificial diet.
References: Cuthbertson & Munro (1941), Thompson (1944: 535-536), Lederer (1952: 144), Crosskey (1976: 303; 1984), Manjunatha & Puttaraju (1993), Bannerjee (1993), Chowdhury (1962: 24; 1981, 1982), Peigler (1989: 93-94), Herting (1960, 1984), Sarkar (1988: 31-32), Thangavelu et al. (1988: 76-82, fig. 36), Rougeot (1971: 107, 116), Gupta (1987: 985-986), Sakamoto (1990: 150), Watanabe & Mitsuhashi (1995)
Remarks: Gupta reported that this tachinid had been reared as a hyperparasitoid of the ichneumonid *Lissosculpta javanica* (Cameron) (Ichneumoninae: Gyrodontini). The primary host was probably the lasiocampid moth *Dendrolimus punctatus*. I do not list this species under the Ichneumonidae as it has not been reared as a parasitoid of Saturniidae.

The record of *Samia cynthia* cited by Crosskey is apparently from West Malaysia, therefore probably refers to one of the more tropical species of *Samia* occurring on the mainland. Crosskey (pers. comm. in 1996) indicated the name *sorbillans* refers to a complex of species, and that at least 12 species are still arranged under this name in the BMNH collection.

Although Herting (1984: 6) listed virtually no synonyms, it is clear that several are being used in the sericulture literature. The main one is *Tricholyga bombycis* (Lederer, Chowdhury, Sarkar, etc.), also spelled *Thrycolyga* (Cuthbertson & Munro). Indian authors call this species the "uzi fly," a name also applied to *Blepharipa zebina* and *B. sericariae* (see below). Probably reports of these three species and others are widely confused, especially in tropical Asia. The word uzi is apparently of Japanese origin. It would be a worthwhile project for an entomologist in Asia to make a comprehensive taxonomic study of the tachinids that damage the domestic and wild silk crops of Japan, China, India, Thailand, etc. to resolve the nomenclatural confusion. Such work would be useful in developing effective control programs.

238. *Exorista* sp.
Hosts: *Hemileuca magnifica*
Distribution: southwestern United States
References: Stone et al. (1988)

Genus *Chetogena*

This genus is commonly reared from saturniids in North America, especially from Hemileucinae in the West. The genus needs taxonomic revision, and it has not been possible for experts to assign species names to most of the material we have reared in recent years. The generic names *Spoggosia* and *Euphorocera* are now considered to be synonyms (Herting 1984: 13; Woodley 1987: 1221), so most records in the literature under those names belong under *Chetogena*. Herting spelled the name *Chaetogena*. Eggs are laid on the head or integument of the caterpillars, often easily seen. Some biological observations on a species in this genus were given by Terkanian (1993).

239. *Chetogena claripennis* (Macquart)
Hosts: *Hemileuca oliviae, Hemileuca maia, Hemileuca lucina, Hemileuca artemis, Hemileuca electra, Hemileuca nevadensis, Automeris io, Callosamia promethea, Hyalophora cecropia, Anisota senatoria, Dryocampa rubicunda*
Distribution: Throughout almost all of the continental United States, into Mexico and Canada
References: Ainslie (1910), Packard (1914: 269), Watts & Everett (1976), Allen (1976), Arnaud (1978: 219-229), Schaffner & Griswold (1934)
Remarks: This parasitoid is in most literature under the name *Euphorocera claripennis*, and in Schaffner & Griswold as *Phorocera claripennis*.

240. *Chetogena floridensis* (Townsend)
Hosts: *Dryocampa rubicunda*, several other families of moths and butterflies
Distribution: United States: Colorado to Maryland, and all through Southeast
References: Arnaud (1978: 231-233)

241. *Chetogena* sp. near *floridensis* (Townsend)
Hosts: *Agapema galbina*
Distribution: southern Texas

References: Buck & Keister (1956), Peigler & Kendall (1993)
Remarks: The authors above cited this parasitoid under the generic name *Euphorocera*.

242. *Chetogena obliquata* (Fallén)
Hosts: *Saturnia pyri*
Distribution: Sweden to Israel to Tajikistan
References: Thompson (1944: 535), Herting (1984: 14)
Remarks: Thompson cited the species as *Phorocera echinura*.

243. *Chetogena* spp.
Hosts: *Hemileuca oliviae, Hemileuca magnifica, Hemileuca juno, Hemileuca eglanterina, Hemileuca grotei, Hemileuca slosseri, Automeris io*
Distribution: western North America
Biology: Eggs are seen on the heads or integuments of mature larvae. Mature host larvae die without pupating, and maggots emerge from them, pupating in a rearing container, or in nature, dropping to the ground and pupating in soil.
References: Coolidge (1908), Fritz et al. (1986), Kendall & Peigler (1981), Stone et al. (1988), Peigler (1985a), Peigler & Stone (1989)
Remarks: As mentioned above, records cited in earlier literature (including recent) under the generic names *Spoggosia* and *Euphorocera* refer to this genus. Wood (1987) synonymized these names under *Chetogena*. Virtually all species of the Hemileucinae of the western United States will produce flies in this genus if mature larvae are collected in the field. Among the series cited below reared from *H. grotei* and *H. magnifica*, more than one species appears to be in each lot.

Specific records: *ex Automeris io*: Aurora, Colorado, 3 March 1982 [indoors], S. E. Stone (USNM); *ex Hemileuca grotei*: Inks Lake State Park, Burnet Co., Texas, 15 May 1979, R. S. Peigler (DMNH); *ex Hemileuca magnifica*: Jaroso, Costilla Co., Colorado, September 1985, S. E. Stone (USNM, DMNH); *ex Hemileuca eglanterina*: Orient Mine, 16 km SE of Villa Grove, Saguache Co., Colorado, 17 July 1991, M. J. Weissmann (DMNH); *ex Hemileuca juno*: east side of Tucson, Pima Co., Arizona, 24 May 1986, D. Hyatt (DMNH).

Genus *Belvosia*

This genus is important in the New World as significant parasitoids of Saturniidae. They are large flies and are specialists on large hosts like Sphingidae, large Noctuidae, Arctiidae, and Saturniidae. The genus needs revision, and N. E. Woodley is currently working on that project, making particular use of copious material being reared by D. H. Janzen in Costa Rica. Woodley's revision will not be published for at least a few more years, so I am not delaying publication of this catalog in anticipation of it. For the moment, we must rely on older taxonomic works like that of Aldrich (1928), and host records as found in Arnaud (1978) and d'Araújo e Silva et al. (1968). Some of the parasitoid names and host records listed below are undoubtedly in error. Synonyms of *Belvosia* include *Triachora, Willistonia,* and *Belvosiopsis*.

The eggs are microtype (Salkeld 1980) and the method of oviposition is remarkable. The female locates a suitable host caterpillar and then deposits an egg or eggs on the leaf just in front of where it is eating. This efficient method differs from microtype eggs of other tachinids in which a lot of eggs are wasted by never being injested by a suitable host. Some species like *B. bifasciata* have a fairly broad host range, attacking hosts in three or more subfamilies of Saturniidae and also Sphingidae. Other species appear to be very specific to a single genus of host.

244. *Belvosia argentifrons* Aldrich
Hosts: *Citheronia regalis*
Distribution: Florida
References: Aldrich (1928), Arnaud (1978: 88), Peigler (1985a)
Remarks: Specific record: *ex Citheronia regalis*: Gainesville, Florida, 17 February 1983, C. Bennett (USNM). Specimens of the aforementioned record were sent to me by Steven Passoa and identifed by N. E. Woodley.

245. *Belvosia bella* G. T.
Hosts: *Hylesia lineata*
Distribution: Guanacaste Province, Costa Rica
Biology: The adult flies emerge from the cocoons of the host.
References: Janzen (1984)

246. *Belvosia bicincta* (Robineau-Desvoidy)
Hosts: *Eacles imperialis magnifica*, large Noctuidae
Distribution: Brazil; Costa Rica; Jamaica
Biology: Crocomo & Parra reared this parasitoid from the above host in the state of São Paulo. They found generally two to four flies per host. Of 370 host pupae, they found that 16 had this parasitoid, for a 4.32 percent parasitization.
References: Aldrich (1928), d'Araújo e Silva et al. (1968: 261), Crocomo & Parra (1979), Arnaud (1978: 88)

247. *Belvosia bifasciata* (Fabricius) (Front Cover illustration)
Hosts: *Callosamia securifera, Antheraea polyphemus, Hemileuca maia, Hemileuca lucina, Hemileuca slosseri, Hemileuca peigleri, Hemileuca nevadensis, Hemileuca juno, Citheronia regalis, Eacles imperialis, Anisota discolor, Anisota assimilis, Anisota senatoria, Dryocampa rubicunda,* and a few Sphingidae
Distribution: Across much of United States from Atlantic States (Connecticut to Florida), New Mexico, Arizona, and California. According to Cole, restricted to the temperate zone.
Biology: Packard stated that the specimen he illustrated emerged from a pupa of *H. nevadensis* that was two years old. In small hosts such as *Hemileuca* and *Anisota*, one parasitoid develops, whereas in large hosts such as *Eacles*, several parasitoids emerge. Perhaps ovipositing females are able to distinguish the number of eggs to "feed" the host based on its size. Parasitoids pupate within the pupa of the host, the adult flies emerging from the anterior end of the host pupa, sometimes leaving their puparia partially exserted.
References: Packard (1914: pl. 103), Aldrich (1928), Schaffner & Griswold (1934), Comstock & Dammers (1939), Cole (1969: 577), Allen (1976), Arnaud (1978: 88-90), Riotte & Peigler (1981), Wangberg (1983), Peigler (1985a), Peigler & Stone (1989), Tuskes et al. (1996)
Remarks: Specific records: *ex Eacles imperialis*: Stubblefield Lake, Walker Co., Texas, May 1980, R. S. Peigler (DMNH); *ex Anisota discolor*: Stubblefield Lake, Texas, emerged indoors 2 December 1977, R. S. Peigler (DMNH); netted on oaks: Stubblefield Lake, Texas, 3 October 1993, R. S. Peigler (DMNH); on flowers of *Euonymus japonica*: Greenville, South Carolina, 9 August 1987, R. S. Peigler (DMNH); *ex Hemileuca maia*: Louisiana State University campus, Baton Rouge, Louisiana, August 1980, J. E. Eger (USNM); *ex Hemileuca juno*: Wickenburg, Arizona, 26 September 1938 (Comstock & Dammers 1939); *ex Dryocampa rubicunda*: Chafee, New York, April 1935, J. G. Françlemont (CUIC).

248. *Belvosia chelsai* (Blanchard)
Hosts: *Eacles imperialis opaca*
Distribution: Argentina
References: Margheritis & Rizzo (1965: 149).

249. *Belvosia ciliata* Aldrich
Hosts: *Copaxa*, possibly *lavendera*, *Leucanella leucane*, Hesperiidae
Distribution: North America (Missouri), Central America (Mexico, Panama), South America (Brazil)
References: Aldrich (1928), Arnaud (1978: 90-91)
Remarks: Tuskes et al. (1996) cited *Hyalophora cecropia* erroneously as a host for this parasitoid. The confusion was apparently in reference to *Lespesia ciliata* as cited by Arnaud (1978: 665).

250. *Belvosia esuriens* (Fabricius)
Hosts: *Automeris janus*
Distribution: Trinidad
References: Aldrich (1928: 42-43), Thompson (1944: 89)
Remarks: The parasitoid was cited under the name *Willistonia esuriens* by Thompson.

251. *Belvosia formosa* Aldrich
Hosts: *Rothschildia orizaba, Automeris* sp.
Distribution: Mexico, West Indies, Costa Rica, Brazil
References: Aldrich (1928), Arnaud (1978: 91)

252. *Belvosia leucopyga* van der Wulp
Hosts: *Rothschildia jacobaeae, Hylesia* (probably *nigricans*)
Distribution: South America (Brazil and Venezuela), Central America (Yucatán, Mexico)
References: Aldrich (1928), d'Araújo e Silva et al. (1968: 272), Janzen (1984)
Remarks: A synonym is *Belvosiopsis brasiliensis*, according to Aldrich. The rearing from *Hylesia* cited by Janzen was done by J. A. Winder in the state of Parana, Brazil, who used the synonym *Hylesia fulviventris*.

253. *Belvosia nigrifrons* Aldrich (Figure 8)
Hosts: *Rothschildia orizaba, Rothschildia lebeau, Rothschildia cincta guerreronis, Rothschildia erycina, Eupackardia calleta*
Distribution: Mexico, El Salvador, Honduras, Costa Rica
References: Aldrich (1928), Thompson (1944), Quezada (1967)
Remarks: Specific records: *ex Rothschildia erycina*: 15 km S of OTS Station, Selva Verde Reserve, Heredia, Costa Rica, 10 April 1990, M. M. Collins (DMNH); *ex Rothschildia cincta guerreronis*: near La Mira, Michoacán, Mexico, 5 July 1994, K. L. Wolfe & S. Smoot (DMNH); Tiquilipán, Michoacán, July 1986, K. Wolfe & S. Smoot (DMNH).

Thompson (1944: 532) cited *Belvosia analis* Macquart as attacking *Rothschildia jorulla* [which only occurs in Mexico. I consider the most likely host for a species of *Rothschildia* in El Salvador to be *R. lebeau.*], but Aldrich (1928: 45) pointed out that this name cannot be identified because it is based on a type-specimen that is lost. Considering the locality and the host, it is surely a record for *B. nigrifrons*.

254. *Belvosia recticornis* (Macquart)
Hosts: *Hylesia alinda, Hylesia umbrata, Hylesia* spp.
Distribution: Mexico, Panama, Ecuador
References: Aldrich (1928), Arnaud (1978: 91-92)
Remarks: *Hylesia darlingi* (a name used by both Aldrich and Arnaud) is a junior synonym of *H. umbrata* (C. Lemaire, pers. comm.).

255. *Belvosia townsendi* Aldrich
Hosts: *Eacles imperialis, Eacles oslari, Citheronia regalis*
Distribution: New York, Pennsylvania, New Jersey, Virginia, Ohio, Indiana, North Carolina, South Carolina, Georgia, Kansas, Texas, Arizona
Biology: Material from the rearing from Austin, Texas, cited below was given to me by T. Friedlander; there were two parasitoids in this host. There were 3 or 4 or more parasitoids per host in the rearings from Arizona.
References: Aldrich (1928), Schaffner & Griswold (1934), Arnaud (1978: 92), Peigler (1985a)
Remarks: Specific records: *ex Eacles imperialis nobilis*: Austin, Texas, July 1976, H. Pianka (USNM); *ex Eacles oslari*: Sonoita Creek, Santa Cruz Co., Arizona, 1972, K. Hansen (USNM).

256. *Belvosia weyenberghiana* van der Wulp
Hosts: *Rothschildia jacobaeae, Rothschildia* sp.
Distribution: South America (Argentina, Brazil)
References: Aldrich (1928), d'Araújo e Silva et al. (1968: 270), Margheritis & Rizzo (1965: 156)

257. *Belvosia* spp.
Hosts: *Hylesia nanus, Hemileuca magnifica, Hemileuca stonei*
Distribution: southern Brazil; Arizona
References: d'Araújo e Silva et al. (1968: 269)
Biology: One parasitoid per host.
Remarks: Specific records: *ex Hemileuca magnifica*: Apache Co., Arizona, August 1987, P. Savage (DMNH); *ex Hemileuca stonei*: Molino Basin, Santa Catalina Mts., Pima Co., Arizona, September 1987, S. E. Stone (CSU, DMNH).
The first host was cited as *Micrattacus nanus* from Brazil.

Genus *Leschenaultia*

This genus appears to be closely related to *Belvosia*, although Cole, Arnaud, and others place it in a separate tribe. The flies are large, and resemble those of the previous genus, but are a bit more flattened. The eggs are microtype (Salkeld 1980), so are probably deposited on foliage of the hostplants of the hosts. A synonym is *Blepharipeza*.

258. *Leschenaultia adusta* (Loew)
Hosts: *Coloradia pandora, Malacosoma* (Lasiocampidae), several Arctiidae
Distribution: North America, Atlantic States to California
Biology: Apparently prefers larvae that are hairy or spiny. Patterson stated that host larvae are parasitized but fail to pupate. The maggots emerge from the pre-pupae of the hosts and form their puparia alongside in the soil cavities. He stated that as many as 41 puparia were collected in an area of ground about 1 m square where 76 pupae of *C. pandora* were found.

References: Patterson (1929: 17), Cole (1969: 577), Arnaud (1978: 293-294)
Remarks: This parasitoid is cited in most literature under the name *Blepharipeza adusta*.

259. *Leschenaultia fulvipes* (Bigot)
Hosts: *Hemileuca lucina, Hemileuca grotei, Hemileuca maia, Malacosoma* (Lasiocampidae)
Distribution: New England to Texas
References: Schaffner & Griswold (1934, as *Blepharipeza fulvipes*), Cole (1969: 577), Arnaud (1978), Kendall & Peigler (1981)

260. *Leschenaultia* sp. near *fulvipes* (Bigot)
Hosts: *Hemileuca slosseri*
Distribution: Texas
References: Peigler & Stone (1989)

261. *Leschenaultia* spp.
Hosts: *Hemileuca oliviae, Hemileuca slosseri, Hylesia* sp., *Automeris* sp.
Distribution: North America, South America
Biology: Fritz et al. stated that the parasitoid oviposited on ends of spines near the host's head.
References: Fritz et al. (1986), Peigler (1985a), Peigler & Stone (1989)
Remarks: Specific records: *ex Hylesia* on *Pinus*: La Unión, Departamento de Olacho, Honduras, October 1981, J. Mankins, sent to Peigler by S. Passoa (USNM); *ex Automeris sp.:* Mexico City, Mexico, 10 June 1979, R. L. Halbert (DMNH). The latter record probably refers to *A. cecrops* since I have observed that host to be common in the suburban habitat of Mexico City. J. E. Slosser reported to me the records of "*Leschenaultia* sp. near *fulvipes*, and possibly another species of *Leschenaultia*" from reports of parasitoids he had submitted for identification.

262. *Masicera pavoniae* (Robineau-Desvoidy)
Hosts: *Saturnia pavonia, Saturnia pyri, Saturnia spini, Acherontia atropos* (L.) (Sphingidae), *Eligmodonta ziczac* (L.) (Notodontidae)
Distribution: France, Germany, and Poland to Turkey and Syria, but not on British Isles
Biology: The host larvae are attacked, and the adult flies emerge after overwintering in the pupae or cocoons of the hosts. There can be a single parasitoid in a small host, or as many as 20 in a large host like *S. pyri*. There was only a single fly reared from the specific record cited below, and its puparium was in the host cocoon alongside of the host pupa. It overwintered within, but I do not know whether the maggot exited the pupa in the fall or the spring.
References: Herting (1960: 98; 1984), Packard (1914: 269), Thompson (1944), Cole (1969: 584), Rougeot (1971: 92 as *Tachina marginalis* and *Masicera pratensis*), Peigler (1985a)
Remarks: Herting used the name *pratensis* in his 1960 catalog, but synonymized this name under *pavoniae* in his 1984 catalog. The true *pratensis* is a species of the closely related genus *Blepharipa* (Herting 1984: 76). Any records in literature under the names *pratensis* and *marginalis* cited as parasitoids of Saturniidae should be referred to *pavoniae*. Claude Lemaire sent me the following specimen, identified by C. Sabrosky.

Specific record: *ex Saturnia pavonia*: Gordes, Dept. of Vaucluse, France, 14 May 1979, C. Lemaire (USNM).

263. *Masicera silvatica* (Fallén)
Hosts: *Actias isabellae, Saturnia pavonia, Saturnia spini, Macrothylacia rubi* (L.) (Lasiocampidae)
Distribution: Sweden to Spain
References: Packard (1914: 269), Thompson (1944), Ylla (1992), Gómez & Fernández (1976: 73), Herting (1960: 97; 1984: 77), Rougeot (1971: 80, 107).
Remarks: There has been some confusion by earlier authors of this species with *Exorista sorbillans*. The latter would be a logical parasitoid for *A. isabellae* and *Saturnia*, so the records of *M. silvatica* need to be verified in these hosts. However, the record of *M. rubi* is valid, and therefore it is likely that the three saturniids are also hosts.

264. *Baumhaueria goniaeformis* (Meigen)
Hosts: *Saturnia pyri*
Distribution: Europe to Israel to Transcaucasus
References: Thompson (1944: 535), Herting (1984: 79)

265. *Pimelimyia natalensis* Curran
Hosts: *Cirina forda, Bombycomorpha bifascia* Walker (Lasiocampidae)
Distribution: Africa
Biology: The larva is attacked, the mature parasitoid larvae emerge from the pupa of the host, drop to the ground, form puparia in soil, and emerge a few weeks later.
References: Taylor (1961), Crosskey (1984)
Remarks: Richard Harland-Rowe sent me specimens of *Pimelimyia semitestacea* (Villeneuve) that he reared from *Gonometa rufobrunnea* Aurivillius (Lasiocampidae): Francistown, Botswana, emerged October 1991 and January 1992 (DMNH). The maggots emerged from the host cocoons and pupated a few weeks prior to the emergence of the adult flies. I extrapolated these data to make comments on the biology of *P. natalensis* above. The *P. semitestacea* is a large fly with chestnut eyes, black and gray striped thorax, tan scutellum, and tan patches on the abdominal tergites. Taylor cited it under the name *Sturmia semitestacea*, and as having been reared from *Gonometa postica* Walker.

266. *Sturmia* sp.
Hosts: *Automeris* sp.
Distribution: Brazil
Biology: If a true *Sturmia*, oviposition is on foliage of foodplants of host caterpillars. Hosts injest eggs, tachinid larvae mature when the host pupates, then maggots leave the host to pupate in soil. These notes are based on the report of Hirai & Ishii on *Sturmia bella*.
References: d'Araújo e Silva et al. (1968: 263), Hirai & Ishii (1995)
Remarks: This vague record may not represent a true *Sturmia*.

267. *Blepharipa sericariae* Rondani
Hosts: *Antheraea yamamai, Bombyx mori*
Distribution: Japan
Biology: The best treatment of the biology is a well-illustrated account by Bolle.
References: Bolle (1898), Sakamoto (1990: 150), Herting (1984: 75-76)
Remarks: Sakamoto placed this fly in the genus *Sturmia*, but under that genus Herting cited only *S. bella* from the Palaearctic region. The name *sericariae* refers to the fact that species of *Bombyx* (=*Sericaria*) serve as hosts. Bolle called this pest the

"Ujifliege" and *Ugimyia sericaria*. The Japanese name "uzi" is also applied by Indian authors to *Exorista sorbillans* (see above) and *Blepharipa zebina* (see below). All of these tachinids kill millions of caterpillars, thus diminishing yields of cocoon crops in domestic and wild silk industries.

268. *Blepharipa tibialis* (Chao)
Hosts: *Antheraea pernyi, Malacosoma neustria* (L.) (Lasiocampidae),
Distribution: northern China, including provinces of Liaoning and Heilongjiang
References: Qu et al. (1990), Herting (1984: 76)

269. *Blepharipa wainwrighti* (Baronov)
Hosts: *Archaeoattacus edwardsii, Attacus atlas*
Distribution: southeastern Asia
References: Crosskey (1976: 303), Peigler (1989: 93-94)

270. *Blepharipa zebina* (Walker)
Hosts: *Archaeoattacus edwardsii, Antheraea paphia*, Sphingidae, and other large Lepidoptera
Distribution: far eastern Russia, Japan (Kyushu and Hokkaido), Himalayas of India.
Biology: The female lays up to 250 eggs. About 30 to 40 are deposited on the body of a caterpillar. Eclosion is within 3 days. Mature maggots emerge within 10 to 12 days. Pupation is in the ground where they overwinter, and emergence is in the spring. Adult flies mate while in flight.
References: Jolly et al. (1974, 1975), Herting (1984: 76), Singh et al. (1993)
Remarks: In some of the sericulture literature coming out of India this species has been confused with *Exorista sorbillans* (see above). It is, along with that species, apparently a significant pest of tasar and other wild silk crops, although I find no reports of *Samia ricini* and *Antheraea assamensis* as hosts, the sources in Assam of eri and muga silks, respectively. *Exorista sorbillans, B. zebina,* and *B. sericariae* are all called "the uzi fly" in the sericulture industry.

271. *Drino atropivora* (Robineau-Desvoidy)
Hosts: *Imbrasia tyrrhea*
Distribution: Africa
References: Cuthbertson & Munro (1941), Crosskey (1984)
Remarks: This parasitoid has been listed under the generic names *Sturmia* (by Robineau-Desvoidy and Cuthbertson & Munro) and *Zygobothria* (Crosskey). The latter is a synomym of *Drino* in the opinion of Herting (1984: 52).

272. *Drino incompta* (van der Wulp)
Hosts: *Eacles imperialis, Hemileuca maia,* and several Sphingidae
Distribution: eastern United States
References: Packard (1914: 269), Arnaud (1978: 190-191)
Remarks: Most records are in literature under the name *Sturmia inquinata*.

273. *Drino inconspicua* (Meigen)
Hosts: *Actias isabellae, Gynanisa maja, Holocerina smilax*, other Lepidoptera including Arctiidae, Sphingidae, Lasiocampidae, Lymantriidae, and Notodontidae, and many species of *Diprion* (Hymenoptera: Diprionidae)
Distribution: Europe, including Sweden, across to central Siberia, but not in Britain; northeastern North America; Africa

Biology: Females lay about 100 eggs, deposited onto larvae of the hosts. About 5 to 10 minutes after hatching, larvae bore into the hosts. In Europe, virtually all of the hosts are sawflies and caterpillars that feed on pines (*Pinus*) and other conifers. The first instar parasitoid larvae overwinter in the hosts, which in some cases are larvae themselves (i.e., *Dendrolimus pini*).
References: Cleu (1925), Ceballos & Ajengo (1943: 62), Testout (1947), Herting (1960: 80), Gómez & Fernández (1976: 73), Ylla (1992: 391), Rougeot (1971: 80), Arnaud (1978: 191-193), Cuthbertson & Munro (1941), Cole (1969: 580), Crosskey (1984)
Remarks: For *Actias isabellae*, most European authors cited this parasitoid under the name *Argyrophylax inconspicua*. Another synonym according to Ceballos & Ajengo is *A. bimaculata* Hartig. Most American authors cited it as *Sturmia inconspicua*. The hosts cited by Arnaud in North America correspond closely to those of Europe, except for the addition of non-conifer-feeding Lasiocampidae in the genus *Malacosoma*. The parasitoid has been classified as *Carcelia* by some authors, in the genus *Palexorista* by Crosskey, and in *Sturmia* by Cuthbertson & Munro! I am grateful to R. Oberprieler for his insight in helping me clarify the tangled taxonomy of this parasitoid. He and I assume that all five generic combinations with *inconspicua* refer to a single widely ranging tachinid.

274. *Drino lota* (Meigen)
Hosts: *Aglia tau,* Sphingidae, and a few other Lepidoptera
Distribution: Scotland to southern Sweden
Biology: Up to 12 eggs are laid on the top of a larva, the latter instars preferred. The tachinid larvae bore into the host when they hatch. They mature and emerge from the host, dropping to the ground to pupate in soil. They overwinter in their puparia. The larva of *Aglia tau* could be considered "sphingiform" so the fact that it and certain sphingids serve as hosts is logical.
References: Herting (1960: 79; 1984), Cole (1969: 578)

275. *Patelloa fuscimacula* (Aldrich & Webber)
Hosts: *Antheraea polyphemus, Orgyia vetusta* Boisduval (Lymantriidae)
Distribution: California and British Columbia
Biology: If this species is truly congeneric with the three species of *Patelloa* studied by Salkeld, we may assume it has microtype eggs laid on leaves of hostplants.
References: Essig (1926), Collins & Weast (1961), Arnaud (1978: 415), Cole (1969: 584), Salkeld (1980)
Remarks: The lymantriid host was cited as *Hemerocampa vetusta*. The parasitoid is cited in virtually all literature as *Phorocera fuscimacula*.

276. *Phryxe pecosensis* (Townsend)
Hosts: *Hemileuca maia, Hemileuca lucina*, sawflies (Hymenoptera: Tenthredinidae), several families of Lepidoptera
Distribution: Québec to British Columbia south to California and New Mexico
Biology: Females "deposit maggots in choria [eggshells] on hosts." The eggs are whitish, small to medium macrotype.
References: Cole (1969: 584), Arnaud (1978: 433-436), Herting (1984: 45)
Remarks: There is confusion of the relationship of this genus. Various authors have placed it in or near *Drino, Zenillia, Exorista,* and *Lydella*. The record cited by Thompson (1944: 294) of the Palaearctic *Phryxe vulgaris* (Fallén) attacking *Hemileuca* surely represents a misidentification and probably belongs here.

277. *Pales blepharipus* (Brauer & Bergenstamm)
Hosts: *Lobobunaea angasana*
Distribution: Africa
References: Cuthbertson & Munro (1941)
Remarks: The parasitoid was cited under the generic name *Ctenophorocera* by Cuthbertson & Munro.

278. *Pales pavida* (Meigen)
Hosts: *Samia cynthia*, many Lepidoptera from several families including Nymphalidae, Noctuidae, Sphingidae, Bombycidae, Lasiocampidae, Arctiidae, Geometridae, Lymantriidae, Notodontidae, Pyralidae, and Tortricidae. (see Herting's catalog also)
Distribution: Scotland to Japan; Transcaucasus
Biology: The microtype eggs are laid on the leaves of the hostplant, and are thus injested by the host caterpillars. Parasitoid larvae hatch in the alimentary canal and migrate to the silk glands living apneustically until the first molt. They then go to the integument (no particular region as in some parasitoids) and establish a respiratory hole. Some host larvae spin little or no silk; otherwise, the host cocoons are thin and usually lack a peduncle. The host pre-pupa does not pupate. One to 9 parasitoid larvae emerge from the pre-pupa and form their puparia in the host cocoon. Adult flies emerge about two weeks later via the pre-formed exit of the host cocoon. Larvae of this tachinid are attacked by *Eupteromalus arzoneae* (Pteromalidae).
References: Arzone (1970, 1971a), Herting (1984: 68)
Remarks: Arzone published a very detailed and well illustrated article on the biology of this tachinid in the host *Samia cynthia*, established along the western banks of Lake Maggiore in northwestern Italy. The host may actually be *Samia walkeri*, as I have not yet resolved the taxonomic question of which species (or both) occurs in Italy as introduced populations from China.

279. *Pales pumicata* (Meigen)
Hosts: *Samia cynthia*
Distribution: Europe
References: Arzone (1970), Herting (1984: 67-68)
Remarks: This tachinid has sometimes been classified in the genus *Phorocera*.

280. *Pales setigena* (Curran)
Hosts: *Lobobunaea angasana*
Distribution: Africa
References: Cuthbertson & Munro (1941), Crosskey (1984)
Remarks: The first authors cited this tachinid under the generic name *Phorocera*.

281. *Pales* sp.
Hosts: *Saturnia pavonia*
Distribution: Europe
References: Rougeot (1971: 107), Herting (1984: 15-16)
Remarks: This record is probably referable to *P. pumicata* above or to some other species of Tachinidae recorded from *S. pavonia*.

Genus *Winthemia*

This is an important genus of tachinids that parasitizes many Lepidoptera, including Saturniidae, in many regions of the world. Eggs are laid on the integument of the host, and then maggots hatch and bore into the host. The African species which Taylor (1961) cited below were listed under the genus *Sericophoromyia*. Lester Kohalmi (pers. comm. in 1993) has reared an unidentifed species of this genus from both *Hyalophora cecropia* and *H. columbia columbia* in Kenora, Ontario.

282. *Winthemia amplipilosa* (Curran)
Hosts: *Imbrasia cytherea, Urota sinope*
Distribution: Africa
References: Taylor (1961), Crosskey (1984)

283. *Winthemia cecropia* (Riley)
Hosts: *Actias luna, Antheraea polyphemus, Hyalophora cecropia*
Distribution: North America, probably only in the East
References: Arnaud (1978: 506-507)
Remarks: A synonym is *Winthemia platysamiae.*

284. *Winthemia citheroniae* Sabrosky
Hosts: *Citheronia regalis, Eacles imperialis*
Distribution: Florida
References: Arnaud (1978: 507)

285. *Winthemia conformis* (Curran)
Hosts: *Imbrasia belina, Imbrasia wahlbergii, Pseudobunaea irius*
Distribution: Africa
References: Cuthbertson & Munro (1941), Crosskey (1984)

286. *Winthemia cruentata* (Rondani)
Hosts: *Saturnia pyri*
Distribution: Japan and Mongolia to Transcaucasus to Italy and Sweden
References: Thompson (1944), Herting (1984: 38)

287. *Winthemia datanae* (Townsend)
Hosts: *Anisota senatoria, Anisota virginiensis, Dryocampa rubicunda, Hyalophora cecropia,* several moths in Notodontidae, Arctiidae, Noctuidae, Sphingidae, Lasiocampidae, and Lymantriidae
Distribution: eastern North America
References: Schaffner & Griswold (1934), Hitchcock (1961b), Arnaud (1978: 507-510), Peigler (1985a)
Remarks: This parasitoid was cited by Schaffner & Griswold from *Anisota senatoria* and *Dryocampa rubicunda* as "variety B". Their record from *Samia cynthia* as "*Winthemia (?) datanae*" is surely an error, so I do not list it in the above list of hosts. Hitchcock also listed a parasitoid called "*Winthemia* sp. near *datanae*" as attacking *Anisota senatoria.*

Donald Henne (pers. comm.) has reared this parasitoid from *Anisota virginiensis* in Manitoba, near the southeastern edge of Lake Winnipeg.

288. *Winthemia lateralis* (Macquart)
Hosts: *Opodiphthera eucalypti*, several other Lepidoptera in Noctuidae, Notodontidae, Pieridae, Nymphalidae, and Geometridae
Distribution: Australia
References: Cantrell (1986)

289. *Winthemia leucanae* (Kirkpatrick)
Hosts: *Hyalophora cecropia*, other Lepidoptera in Noctuidae, Sphingidae, and Pyralidae
Distribution: North America
References: Arnaud (1978: 512-514)
Remarks: Arnaud included *H. cecropia* as a host under both normal *W. leucanae* and the form "lacking red at tip."

290. *Winthemia militaris* (Walsh)
Hosts: *Hyalophora cecropia*, other insects including butterflies (Hesperiidae), moths (Noctuidae), and grasshoppers (Acrididae)
Distribution: eastern North America
References: Arnaud (1978: 514-515)

291. *Winthemia quadrata* (Wiedemann)
Hosts: *Bunaea alcinoe, Imbrasia cytherea, Imbrasia tyrrhea, Urota sinope*
Distribution: Africa
References: Cuthbertson & Munro (1941), Crosskey (1984)

292. *Winthemia quadripustulata* (Fabricius)
Hosts: *Anisota senatoria, Antheraea polyphemus, Hyalophora cecropia, Callosamia promethea, Saturnia pavonia, Saturnia spini*, many other Lepidoptera including Noctuidae, Sphingidae, Geometridae, Arctiidae, and even Curculionidae (Coleoptera) and Diprionidae (Hymenoptera)
Distribution: North America; Scotland to Transcaucasus to Mongolia
References: Thompson (1944), Collins & Weast (1961), Arnaud (1978: 517-523), Herting (1984: 38), Peigler & Vinson (1988)
Remarks: The record under *Saturnia pyri* cited by Thompson as "*Winthemia quadripustulata cruentata*" belongs under *W. cruentata* according to synonymies by Herting (1984).

293. *Winthemia tricolor* (van der Wulp)
Hosts: *Arsenura xanthopus, Arsenura armida, Samia cynthia*
Distribution: Central America, South America
Biology: According to Lordello & Mariconi cited below, the female fly lays 1 to 33 eggs on mature caterpillars, especially near the prolegs. The prolegs are favored because the host will thrash to resist the fly, but the prolegs remain fixed and are thus easily approached. They found that it is impossible to remove the eggs without destroying them, because they are so firmly attached. Before the host larva pupates, the parasitoid larvae crawl over the surface of the pre-pupa and try to enter the body, usually at intersegmental membranes. Some parasitoid larvae die because they are pushed off on the larval skin when it pupates. Eight days later 1 to 10 maggots emerge from the host. These pupate and produce adult flies in 15 days.
References: Lordello & Mariconi (1953), d'Araújo e Silva et al. (1968: 262), Arnaud (1978: 528)

Remarks: I do not know the source of the record for *Samia cynthia* cited by Arnaud. It may have been based on a laboratory rearing in Panama where the record for *Arsenura armida* (as *A. erythrinae*) was made.

294. *Winthemia variegata* (Meigen)
Hosts: *Saturnia pavonia*
Distribution: England to Germany to Russia
References: Thompson (1944: 535), Herting (1984: 38-39)
Remarks: Thompson cited this fly under the name *Winthemia quadripustulata nigrithorax*.

295. *Winthemia* spp.
Hosts: *Hemileuca maia, Hemileuca lucina, Opodiphthera astrophela*
Distribution: New England, California, Australia
References: Cantrell (1986), Collins & Weast (1961: 94), Cole (1969: 579), Peigler (1985), Schaffner & Griswold (1934)
Remarks: Specific record: *ex Hyalophora euryalus*: 32 km east of Nevada City, 1525 m, Nevada Co., California, collected 27 August 1995 ovipositing onto mature host larva, on dorsum of abdominal segment near posterior end, M. M. Collins (DMNH).

296. *Huebneria affinis* (Fallén)
Hosts: *Saturnia pavonia, Saturnia pyri*, various Arctiidae, Noctuidae, Lasiocampidae, Lymantriidae, and other Lepidoptera
Distribution: England, Scandinavia, central Europe, Transcaucasus, southern Siberia, Mongolia
Biology: Judging from the host list, large hairy or spiny caterpillars are preferred.
References: Thompson (1944: 535), Rougeot (1971: 92: as *H. affinis* Meig.), Herting (1960: 83; 1984: 40, 55)
Remarks: Thompson cited this parasitoid as *Aplomya* [*Aplomyia*] *affinis,* and Herting classified it under the genus *Huebneria*, although he considered *Aplomyia* also to be a valid genus.

297. *Carcelia bimaculata* (Hartig)
Hosts: *Imbrasia cytherea*
Distribution: Africa
Biology: Attacks the larva of the host.
References: Geertsema (1975), Cole (1969: 580), Crosskey (1984)
Remarks: This species was placed by Crosskey in the genus *Palexorista,* but Cole (1969) and Herting (1984) indicated that the latter is a synonym of *Carcelia*. Crosskey cited the names *Carcelia* and *Palexorista* separately.

298. *Carcelia evolans* (Wiedemann)
Hosts: *Bunaea alcinoe, Epiphora* sp., *Gynanisa maja, Heniocha apollonia, Holocerina smilax, Imbrasia belina, Imbrasia wahlbergii, Imbrasia tyrrhea, Imbrasia cytherea*
Distribution: Africa
References: Taylor (1961), van den Berg (1974), Cuthbertson & Munro (1941), Crosskey (1984)

299. *Carcelia formosa* (Aldrich & Webber)
Hosts: *Automeris io*, several Noctuidae
Distribution: eastern United States to Colorado

References: Schaffner & Griswold (1934), Arnaud (1978: 116), Peigler (1985a)
Remarks: Some records for this parasitoid in older literature are under the name *Zenillia formosa*.

Specific record: *ex Automeris io*: Aurora, Arapahoe Co., Colorado, April 1982, S. E. Stone (USNM, LACM).

300. *Carcelia modicella* (van der Wulp)
Hosts: *Cricula trifenestrata javana*
Distribution: Java (Indonesia)
References: Dupont & Scheepmaker (1936: 180)
Remarks: The authors cited this parasitoid under the name *Parexorista modicella*. The rearing was reported to them by K. W. Dammerman.

301. *Carcelia lucorum* (Meigen)
Hosts: *Saturnia pyri*, Lasiocampidae, Arctiidae, Noctuidae, and other Lepidoptera
Distribution: England, Finland, Italy, Israel, western Russia to Tajikistan, Altai, and Mongolia onward to Japan
References: Herting (1960: 84-85; 1984: 57)

302. *Carcelia malacosomae* Sellers
Hosts: *Hemileuca lucina, Hemileuca maia,* Notodontidae, Arctiidae, Lasiocampidae (*Malacosoma* spp.), sawfly (Hymenoptera: Tenthredinidae)
Distribution: eastern United States to Colorado and British Columbia
References: Arnaud (1978: 119-120), Cole (1969: 580)
Remarks: According to Cole, a synonym is *Exorista cheloniae*.

303. *Senometopia excisa* (Fallén)
Hosts: *Saturnia pyri*
Distribution: Japan to southern England, widespread in Europe and Asia
References: Thompson (1944), Herting (1984: 59)
Remarks: The record was cited by Thompson under the name *Carcelia excisa*.

304. *Epicampocera succincta* (Meigen)
Hosts: *Saturnia pavonia*
Distribution: Europe to Japan including down into Transcaucasus
References: Thompson (1944: 535), Herting (1984: 44)

305. *Sisyropa eudryae* (Townsend)
Hosts: *Automeris io*, Noctuidae, Nymphalidae, Arctiidae
Distribution: Ontario and Vermont to North Carolina
Biology: Apparently large hairy or spiny caterpillars are preferred, judging from the host list.
References: Cole (1969: 581), Arnaud (1978: 461-462)

306. *Eusisyropa virilis* (Aldrich & Webber)
Hosts: *Callosamia promethea, Hyalophora cecropia,* and numerous other Lepidoptera in Danaidae, Pieridae, Nymphalidae, Hesperiidae, Lymantriidae, Noctuidae, Arctiidae, Geometridae, Psychidae, Sphingidae, Notodontidae, and a few other families
Distribution: North America
Biology: The eggs are deposited on leaves of the hostplants of hosts.

References: Schaffner & Griswold (1934), Thompson (1944: 106, 533), Cole (1969: 580), Arnaud (1978: 244-247), Salkeld (1980)
Remarks: A synonym is *Zenillia virilis*. Monty Wood (CNC) (pers. comm.) told me that "*Exorista*" *blandita* has been reared as a parasitoid of *Automeris io*, but according to Arnaud (1978: 251) the name *Exorista blanda* can refer to either *Eusisyropa virilis, Eusisyropa blanda,* or *Anaporia pristis*. Records cited by Arnaud (1978: 542, 553-554) under "*Zenillia* sp." for the following hosts probably belong here: *Anisota senatoria, Anisota virginiensis, Eacles imperialis, Actias luna, Antheraea polyphemus, Hemileuca, Automeris io, Hyalophora cecropia, Callosamia promethea*. I do not list any hosts under *Zenillia* in this catalog.

307. *Hyphantrophaga hyphantriae* (Townsend)
Hosts: *Anisota senatoria*, Lasiocampidae, Noctuidae, Pyralidae, Geometridae, Megalopygidae, Nymphalidae, Sphingidae, and Arctiidae
Distribution: Recorded throughout most of the United States
References: Arnaud (1978: 287-288)
Remarks: Some of the records in literature cite this fly under the name *Zenillia ceratomiae*.

308. *Eumasicera sternalis* (Coquillett)
Hosts: *Dryocampa rubicunda, Anisota senatoria, Anisota virginiensis, Anisota consularis*
Distribution: eastern North America, New England to Missouri to the coastal plain of Georgia, possibly to Oregon
Biology: Judging from the host records listed in Arnaud, this species is a specialist on ceratocampines, but not if Cole's record for Oregon is based on a correct identification. The eggs are deposited on foliage of hostplants so that host larvae will injest them.
References: Allen (1976), Peigler (1985a), Cole (1969: 581), Arnaud (1978: 217), Salkeld (1980), Riotte & Peigler (1981: 120)
Remarks: Specific records: *ex Anisota consularis*: Statesboro, Georgia, 24 September 1977, R. S. Peigler (USNM, DMNH); *ex Anisota virginiensis*: Pine Grove, Schuylkill Co., Pennsylvania, 16 April 1977, Wm. H. Houtz (USNM, DMNH).

309. *Eumasicera* spp.
Hosts: *Hyalophora euryalus, Anisota pellucida*
Distribution: North America
Biology: Eggs are laid on host larvae. Adult flies emerge from pupae of hosts.
Remarks: Specific records: *ex Hyalophora euryalus*: Nevada City, 975 m, Nevada Co., California, June 1995, M. M. Collins (DMNH); *ex Anisota pellucida*: Interstate Highway 10 at Apalachicola River, Gadsden Co., Florida, July 1992, R. S. Peigler (DMNH).
Specimens from the above two records were identified by R. D. Hall using key to genera in Wood (1987).

310. *Argyrophylax* sp.
Hosts: *Hemileuca maia*
Distribution: North America
References: Arnaud (1978: 86)

311. *Pacidianus persimilis* Reinhard
Hosts: *Dryocampa rubicunda*
Distribution: Ontario

References: Arnaud (1978: 407)
Remarks: No other hosts are recorded for this fly.

312. *Pacidianus* sp.
Hosts: *Anisota pellucida*
Distribution: Florida
References: Arnaud (1978: 407)
Remarks: The record came from Florida, so the host which was quoted as *Anisota virginiensis* was probably *A. pellucida*, formerly considered a subspecies of *A. virginiensis*.

Genus *Lespesia*

Most of the Saturniidae of the eastern half of North America are parasitized by one or more species of this American genus. Synonyms of this generic name cited in much of the literature are *Frontina* and *Achaetoneura*. A detailed revision was published by Beneway (1963). Sabrosky (1980) provided an improved key to the species, and clarified some of the taxonomic problems that Beneway did not resolve. The membranous eggs are deposited on the body of the host. In general, the host then pupates, and the mature maggots emerge from the host pupa in the fall or spring.

313. *Lespesia aletiae* (Riley)
Hosts: *Hemileuca maia, Anisota senatoria*, numerous other Lepidoptera in several families, plus one species of Chrysomelidae (Coleoptera)
Distribution: Ontario to southern Florida to California
Biology: a larval-pupal parasitoid
References: Thompson (1944: 294), Beneway (1963: 636-638), Cole (1969: 583), Arnaud (1978: 301-307), Coffelt & Schultz (1993b)
Remarks: In 1978 I noted the following fly in the collection at Louisiana State University, identified by C. Sabrosky: Baton Rouge, Louisiana, May 1976, M. L. Burks, reared from *Hemileuca maia*.

314. *Lespesia anisotae* (Webber)
Hosts: *Anisota pellucida, Anisota peigleri, Anisota senatoria, Anisota virginiensis, Dryocampa rubicunda*
Distribution: eastern North America
Biology: This parasitoid is very commonly reared from host larvae collected in the eastern United States, but I have not collected it in eastern Texas despite the abundance of hosts in that region. It is a larval-pupal parasitoid. Mature maggots exit the host pupae in the autumn and adults emerge in spring or summer.
References: Schaffner & Griswold (1934), Arnaud (1978, 1990), Allen (1976), Riotte & Peigler (1981), Coffelt & Schultz (1993b), Sabrosky (1980)
Remarks: Arnaud (1990) gave a detailed account of the identity of this species and how it came to be designated as the type-species of *Lespesia*. This parasitoid has been confused with *Lespesia datanarum* (Townsend), and tachinid taxonomists confused the two until Sabrosky (1980) solved the problem. The larvae of *Anisota* and *Datana* (Notodontidae) both live in masses on trees, and both are particularly common in the eastern United States. Apparently the two species of *Lespesia* are closely related, yet specialize on different genera of hosts.

Specific records: *ex Anisota pellucida*: Martin, Florida, 1974, R. S. Peigler; Ludowici and Statesboro, Georgia, 1974, 1975, R. S. Peigler (USNM); *ex Anisota peigleri*:

Westminster, Clemson, and Greenville, South Carolina, 1976, 1980, 1982, 1985, 1991, R. S. Peigler (USNM, DMNH); *ex Anisota virginiensis*: Pine Grove, Schuylkill Co., Pennsylvania, 1977, Wm. H. Houtz (USNM).

315. *Lespesia archippivora* (Riley)
Hosts: *Hemileuca oliviae*, many other Lepidoptera
Distribution: widespread in North America
References: Watts & Everett (1976), Cole (1969: 583)

316. *Lespesia* sp., *archippivora* complex
Hosts: *Hyalophora cecropia*
Distribution: North America
Biology: As many as 90 flies have been reared from a single host of *H. cecropia*. In another case, 147 maggots emerged from one pupa of the same host species, but not all of them survived to reach adulthood.
References: Beneway (1963: 639-642), Cole (1969: 583)

317. *Lespesia callosamiae* Beneway
Hosts: *Callosamia securifera, Callosamia promethea*
Distribution: eastern United States, possibly also eastern Canada
Biology: Maggots emerge in spring from host pupa, exit the cocoon through the preformed emergence valve, drop to ground, pupate in soil, emerge shortly thereafter. There are usually 2 to 6 parasitoids per host.
References: Voelschow (1902: 75, 79), Beneway (1963: 642-643), Arnaud (1978), Peigler (1977), Sabrosky (1980)
Remarks: Specific records: *ex Callosamia securifera*: Berkeley Co., South Carolina, April 1974, May 1975, and April 1976, R. S. Peigler (USNM, DMNH); Brunswick Co., North Carolina, 12-15 May 1975, R. S. Peigler (USNM, DMNH).

If the specimens from Eugene, Oregon, cited by Beneway (1963: 643) were correctly identified and labeled with the correct locality, the species has alternate hosts, since *Callosamia* occurs only in eastern North America.

318. *Lespesia dimmocki* (Webber)
Hosts: *Automeris io, Simyra henrici* (Grote) (Noctuidae)
Distribution: Manitoba to Massachusetts south to Maryland
References: Beneway (1963: 650-651), Arnaud (1978: 321)

319. *Lespesia frenchii* (Williston)
Hosts: *Dryocampa rubicunda, Anisota senatoria, Anisota virginiensis, Syssphinx bicolor, Citheronia regalis, Eacles imperialis, Actias luna, Antheraea polyphemus, Automeris io, Callosamia promethea, Hyalophora cecropia, Hyalophora columbia, Hyalophora euryalus, Samia cynthia,* numerous other Lepidoptera including Lasiocampidae, Noctuidae, Lymantriidae, Sphingidae, Notodontidae, and butterflies
Distribution: North America, from coast to coast; possibly introduced into Europe
References: Packard (1914: 268), Schaffner & Griswold (1934), Collins & Weast (1961), Beneway (1963: 657-659), Fiske & Thompson (1909), Cole (1969: 583)
Remarks: There are many records in American literature for this species attacking various Saturniidae. These were usually cited as *Frontina frenchii* or *Achaetoneura frenchii*. Herting (1960) listed *L. frenchii* as introduced into Europe "mit importieren Raupen von *Philosamia* [*Samia*] *cynthia*?" from North America. However, in his later

catalog (Herting 1984), he did not include this species among the Palaearctic fauna, instead citing *Lespesia anisotae*. It is known that the latter species was once introduced into France (Sabrosky 1990), but due to lack of hosts (*Anisota* spp.) for this very host-speciific parasitoid, it probably could not have become established in Europe. By contrast, *L. frenchii* could use numerous European Lepidoptera as hosts.

320. *Lespesia sabroskyi* Beneway
Hosts: *Antheraea polyphemus, Hyalophora euryalus, Automeris io*
Distribution: British Columbia to Québec, California to Florida.
Biology: The mature maggots chew a tiny hole in the host cocoon and squeeze through, drop to the ground, pupate in the soil, and emerge the following spring or summer. Cocoons of *Antheraea* are sealed, lacking a pre-formed exit valve. There are usually about 20 parasitoids per host. Interestingly, species of *Lespesia* that attack hosts having exit valves in their cocoons, pupate within the host cocoon. It would be interesting to see if maggots of *L. sabroskyi* would pupate in the cocoon of hosts like *H. euryalus*.
References: Beneway (1963: 666-668), Sabrosky (1980), Peigler (1985a)
Remarks: Specific records: *ex Antheraea polyphemus*: Wheat Ridge, Jefferson Co., Colorado, 5 July 1991, James A. Scott (DMNH); Littleton, Arapahoe Co., Colorado, 10 July 1990, S. Kazmeroff (DMNH, CUAC); Littleton, Jefferson Co., Colorado, June 1993, R. S. Peigler (DMNH); Glassy Mountain, Greenville Co., South Carolina, May 1979, T. C. Boozer (USNM); Ocala National Forest, Marion Co., Florida, 10 May 1983, S. Passoa (USNM).

There are several series of *Lespesia* in the UCB collection reared from *Antheraea polyphemus* and *Hyalophora euryalus* (J. A. Powell, pers. comm.). These are probably all *L. sabroskyi*.

321. *Lespesia samiae* (Webber)
Hosts: *Hyalophora cecropia, Hyalophora columbia gloveri, Hyalophora columbia columbia, Hyalophora euryalus, Agapema anona, Agapema dyari*, possibly *Malacosoma* (Lasiocampidae)
Distribution: North America
References: Sabrosky (1980), Peigler (1985a), Arnaud (1978: 318-319, as *L. ciliata*), Peigler & Kendall (1993)
Remarks: Specific records: *ex Hyalophora cecropia*: Aurora, Arapahoe Co., Colorado, indoors March 1982, S. Stone (USNM); *ex Agapema anona*: Tucson, Pima Co., Arizona, 4 December 1988, D. Mullins (DMNH); Cochise Co., Arizona, November 1984, S. E. Stone (DMNH); Sierra Vista, Cochise Co., Arizona, December 1992, R. D. Weast (DMNH); *ex Agapema dyari*: 2 km E of Hueco Inn, Hudspeth Co., Texas, 1-3 November 1994, J. Reiser (DMNH); *ex Hyalophora columbia columbia*: Kenora, Ontario, 1984, [note: *H. cecropia* at the same locality were not attacked], Lester Kohalmi (pers. comm.).

The adult flies are very difficult to identify, but this species can apparently be separated from *Lespesia* sp. near *texana* (see below) by the structure of the spiracles of the puparium. This is fortunate because the flies often die in puparia from desiccation before emerging, and thus an identification can sometimes still be made by comparison to puparia of flies associated with properly identified adults. In *L. samiae*, the puparium has spiracles in a deep pit with a rugose rim, whereas they are flush with the surface in *L.* sp. near *texana*.

The records listed by Arnaud (1978) under *L. ciliata* belong here, as pointed out by Sabrosky (1980), but I do not know if Arnaud's records for *Malacosoma* also belong here.

322. *Lespesia* sp. near, but not *texana* (Webber)
Hosts: *Rothschildia lebeau, Rothschildia cincta, Rothschildia* sp., *Agapema homogena, Agapema anona, Agapema galbina*
Distribution: southwestern United States into Central America
Biology: The maggots pupate within the cocoons of the hosts. The adult flies emerge from the host cocoons, or sometimes in *Rothschildia* die within because they are unable to escape. In the cocoon from Jalisco from 1978, numerous (more than 20) flies emerged. In the cocoon from Baja California Sur from 1995, only one puparium (which did not emerge but was identified by spiracles of puparium) was in the host cocoon, along with the shriveled host larva which did not pupate.
References: Quezada (1967), Sabrosky (1980), Peigler (1985a), Peigler & Kendall (1993)
Remarks: Specific records: *ex Rothschildia cincta*: 5 km W of Loreto, Baja California Sur, Mexico, November 1995, C. Conlan (DMNH); *ex Rothschildia* sp.: Atenquique, Jalisco, Mexico, 16 August 1978, J. C. Schaffner & D. Plitt (TAMU, DMNH, USNM); *ex Agapema homogena*: General Hitchcock Picnic Area, Santa Catalina Mts., Pima Co., Arizona, emerged 13-16 June 1984 from larvae collected in September 1983, J. Palting (USNM); *ex Agapema galbina*: Brownsville, Texas, 23 October 1967 (DMNH); *ex Agapema anona*: Meseta de la Zarca, 1900 m, Durango, Mexico, March 1992, W. Sear, J. Boone & R. Peigler (DMNH).

More than one species may be involved. These one or two species were distinguished structurally from the true *L. texana* by Sabrosky (1980), but there appear to be no host records for the true *L. texana* (Beneway 1963: 673).

323. *Lespesia* sp. or spp.
Hosts: *Dryocampa rubicunda, Anisota senatoria, Citheronia regalis, Antheraea polyphemus, Hemileuca maia*
Distribution: North America
References: Arnaud (1978: 335, 339)
Remarks: Arnaud listed the above host records from older literature, mostly from *Lespesia anonyma*, which is not a valid taxon. All of these records belong under other species of *Lespesia* or other tachinids.

324. *Lespesia lanei* Guimarães
Hosts: *Rothschildia* sp.
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 270), N. Woodley (pers. comm.)

325. *Euexorista futilis* (Osten Sacken)
Hosts: *Antheraea polyphemus*, several other medium and large Lepidoptera in Noctuidae, Nymphalidae, Lasiocampidae, Arctiidae, Geometridae, and Hesperiidae
Distribution: North America
Biology: Microtype eggs are laid on foliage. Some hosts are tree feeders, others herb feeders.
References: Cole (1969: 582-583), Salkeld (1980), Arnaud (1978: 213-216)

326. *Gnadochaeta* sp.
Hosts: *Anisota peigleri*
Distribution: upper South Carolina
Biology: One specimen was reared from a host pupa that was collected as a larva on *Quercus palustris*. It is apparently a solitary parasitoid, and it overwintered in the host pupa.
References: Wood (1987)
Remarks: Specific record: *ex Anisota peigleri*: Greenville, South Carolina, emerged 12 May 1993 from host pupa collected as a larva in August 1992, R. S. Peigler (DMNH). The specimen from this rearing was tentatively identified by R. D. Hall using the key to genera by Wood (1987). This fly is very tiny compared to others that I have reared from Saturniidae; it is about 3 mm long.

327. *Leptostylum* sp.
Hosts: *Automeris liberia*
Distribution: Peru
Biology: Thirty-three puparia were reared from a single host larva.
References: Jacobson (1991)
Remarks: Voucher specimens of this rearing are in the CUIC and USNM.

328. *Conactiodoria aleurites* Townsend
Hosts: *Citheronia laocoon*
Distribution: southern Brazil
Biology: According to Dias, based on material he reared in the state of São Paulo, larvae of the tachinid emerged from fifth instar larvae of the host in February and April. From one host, 21 maggots emerged, of which 12 formed perfect puparia (11 flies emerged), 5 made small puparia and never emerged, and 4 died without successfully forming puparia.
References: Dias (1978: 192)

329. *Lydellina villeneuvei* Townsend
Hosts: *Imbrasia belina*
Distribution: Africa
References: Cuthbertson & Munro (1941)
Remarks: The parasitoid was cited as *Lydellina caffra*.

330. *Lydellina* sp.
Hosts: Saturniidae, several other Lepidoptera in Notodontidae, Pyralidae, and Lasiocampidae
Distribution: Africa
References: Crosskey (1984)

331. *Trixomorpha indica*
Hosts: *Antheraea paphia*
Distribution: India
References: Crosskey (1976: 302)

332. *Zygofrontina* sp.
Hosts: *Rothschildia* sp.
Distribution: Brazil

References: d'Araújo e Silva et al. (1968: 270)
Remarks: The tachinid is cited by the above authors as being hyperparasitized by the perilampid *Perilampus paraguayensis* and the torymid *Perissocentrus*. They spelled the name as both *Zygofrontina* and *Zigofrontina*.

333. *Promasipoda pinguioides* Tt.
Hosts: *Arsenura armida*
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 262)

334. *Plagiotachina* sp.
Hosts: *Automeris* sp.
Distribution: Brazil
References: d'Araújo e Silva et al. (1968: 263)

335. *Tapajohoughia* sp.
Hosts: *Lonomia* sp.
Distribution: state of Rio de Janeiro, Brazil
References: d'Araújo e Silva et al. (1968: 268)

336. *Pandaromyia versatilis* Villeneuve
Hosts: *Maltagorea fusicolor*
Distribution: Madagascar
References: Griveaud (1961: 26)
Remarks: The host was cited by Griveaud as *Tagoropsis subocellata* form *madagascariensis*.

337. Tachinidae, genera unidentified
Hosts: *Hylesia, Saturnia cephalariae, Epiphora bauhiniae, Samia walkeri, Coloradia pandora, Antheraea yamamai*
Distribution: Respectively for hosts cited above: Costa Rica; Turkey; Africa; Hong Kong; northern Arizona; Slovenia
References: Respectively for hosts cited above: Hogue (1972), Romanoff (1885: 18), Schultze (1913: 16), Hill & Cheung (1978: 73), Schmid & Bennett (1988), Zivojinovic & Vasic (1963)
Remarks: Romanoff wrote "Ces chenilles sont pour-suivies par une grande espèce d'*Ichneumon* et une grande *Tachina*." Schultze referred to "Raupenfliegen." Hill & Cheung wrote "large fat bristly flies belonging to the family Tachinidae." The latter authors referred to unidentified tachinids reared from *A. yamamai*, a Japanese moth introduced in the 1860s to Austria and since spread down into Italy and the Balkans.

338. Tachinidae, genera unidentified
Hosts: *Bunaea alcinoe, Epiphora bauhiniae, Ludia delegorguei, Imbrasia wahlbergii, Usta terpsichore*
Distribution: South Africa and Namibia
References: R. Oberprieler (unpubl.)

Family Sarcophagidae

339. *Sarcophaga formosana* Senior-White
Hosts: *Samia* sp.
Distribution: West Malaysia
References: Thompson (1944: 453), Arzone (1970)

340. *Sarcophaga lambens* Wiedemann
Hosts: *Arsenura xanthopus, Citheronia regalis,* other Lepidoptera including Noctuidae and Cossidae, Hemiptera including Coreidae and Pentatomidae, Orthoptera including Acrididae
Distribution: North America, South America, Central America, Greater Antilles
Biology: Lordello & Mariconi wrote that ten flies emerged from one pupa of *Arsenura xanthopus*. They also gave an exhaustive list of other hosts recorded for this fly.
References: Thompson (1944), Lordello & Mariconi (1953)

341. *Sarcophaga* sp.
Hosts: *Hemileuca maia*
Distribution: Louisiana
Biology: Attacks the larva of the host.
Remarks: In 1978 I noted the following fly in the collection at Louisiana State University identifed by R. J. Gagne (USDA-ARS), labelled as having been reared from a larva of *Hemileuca maia*:
Baton Rouge, Louisiana, 17 April 1976, M. L. Burks. The fly had a checkered thorax and striped abdomen. The host moth is abundant on the university campus.

342. *Sarcophaga* sp.
Hosts: *Bunaea alcinoe*
Distribution: western Africa
Biology: The larva is attacked.
References: Akanbi (1973)
Remarks: The rearing was done at Ibadan, Nigeria.

Family Ceratopogonidae

343. *Forcipomyia* sp.

Small biting flies have been recorded as attacking Saturniidae, but these dipterans are not parasitoids. Biting midges of the genus *Forcipomyia* were listed by d'Araújo e Silva et al. (1968: 270) as attacking *Rothschildia* in Brazil. Some ceratopogonids suck hemolymph from other insects (Scott 1986: 70). I do not know if the Brazilian record was for caterpillars or adult moths.

Family Culicidae

344. Genus unidentified

Mosquitoes (Culicidae) were observed by Ulrich and Laela Paukstadt in Java to suck hemolymph from wings of *Attacus atlas* (see Peigler 1989: 95). As with Ceratopogonidae, these are not parasitoids. They are ectoparasites.

Family Anthomyiidae

345. *Phaonia signata* Meigen
Hosts: *Actias isabellae*
Distribution: Europe
Biology: Flies in this family have larvae of varied habits, but are not endoparasitoids. Some feed on plants, others on dung, and others are predaceous. It is likely that the record is based on a case where flies emerged from a dead pupa or larva of *A. isabellae* and were assumed to be parasitic. See comments below under Phoridae.
References: Gil (1924), Testout (1947), Rougeot (1971: 80), Gómez & Fernández (1976: 73), Ylla (1992: 391)

Remarks: This record has been perpetuated repeatedly by European authors. It should be verified.

Family Phoridae

346. *Megaselia scalaris* (Loew)

Peterson (1987) reviewed the North American Phoridae. Adult phorids are small active flies, that run with quick, jerky movements. The larvae live in many materials including seed pods, and infect wounds of higher animals. Larvae of most species feed on dead and decaying plant or animal matter. Many kinds live in caves, rodent burrows, and ant nests; others parasitize molluscs. The records below are probably all for the genus *Megaselia*. See Disney (1990).

These flies are likely to be encountered occasionally by anyone who routinely rears Lepidoptera. They are not true parasitoids, but live in pupae that have already died, and thus when they emerge as adults, are mistaken for parasitoids. Therefore, I include them in this catalog. The ubiquitous *M. scalaris*, a gracile, light brown colored fly, is probably the species to which all or most of the records below refer, according to Brian V. Brown (personal communication) of the Natural History Museum of Los Angeles County. All were reared from moth pupae.

Specific records: *ex Attacus lorquinii*, Philippines, emerged in 1978 from cocoons in Germany (Peigler 1989: 93); *ex Eacles imperialis*, College Station, Brazos Co., Texas, November 1979, T. J. Kring; *ex Hemileuca maia*, College Station, Texas, 15 July 1979, R. S. Peigler; *ex Antheraea montezuma*, 8 km west of Escondido, San Diego Co., California, 16 September 1990, K. L. Wolfe; *ex Attacus atlas*, Taipei, Taiwan, July 1980, Ying Min Wu (all DMNH); *ex Hemileuca grotei*, San Antonio, Bexar Co., Texas, R. O. Kendall (TAMU) (Kendall and Peigler 1981).

R. Oberprieler (personal communication) has reared these flies occasionally in South Africa from dead pupae of various Saturniidae.

LEPIDOPTERA

Although the vast majority of larvae of Lepidoptera are phytophagous, a surprising number are predaceous or parasitic. This topic was reviewed in detail by Pierce (1995). Two moths are recorded as parasitizing Saturniidae as follows.

Family Pyralidae

347. *Phycita dentilinella*

Hosts: *Cricula trifenestrata*, *Parasa lepida* (Cramer) (Limacodidae), other Lepidoptera, and probably other insects

Distribution: southern and eastern India

Biology: With the saturniid and limacodid hosts, the moth apparently oviposits onto the caterpillar just before it spins its cocoon. The parasitic larvae then feed on mature host larvae and continue feeding on the host pupa within its cocoon if the host lives long enough to pupate.

References: Ayyar (1929), Clausen (1940), Pierce (1995)

348. *Sthenobaea parasiticus* (Jordan)

Hosts: *Automeris* spp., *Dirphia* sp.

Distribution: northern Brazil and French Guiana

Biology: The blackish adult moths of the parasitoid were taken at light. Other moths were reared from spiny larvae of one species of *Dirphia* and several species of

Automeris by A. M. Moss at Pará. Eggs are apparently laid on the host. The shiny black parasitic larvae spin webs among the spines between spiracles on opposite sides of the same segment, forming a tunnel. They are agile and feed on the scoli of the host. After host larvae die, the parasitic larvae will sometimes bore into it. When mature they leave the host and form a black cocoon in the ground covered with sand or soil. Adults have emerged in March and November.
References: Jordan (1926), Pierce (1995)
Remarks: I agree with Pierce that the generic name *Sthenobaea* should be used, since it has priority over *Sthenauge*, if they are indeed synonyms, based on comments by Jordan himself. The generic name *Dirphia* has been used as a repository genus for many species of Hemileucinae that are now classified in several genera; the host was probably not a true *Dirphia*. Also, several Hemileucinae formerly included in *Automeris* are now considered to belong to other genera.

Family Noctuidae

349. *Scotia* sp.

This is **not** a parasitoid of Saturniidae. The generic name belongs in the Noctuidae (Lepidoptera), proposed by J. Hübner [1821]. Rougeot (1971: 107) cited "*Scotia* sp." as a parasitoid of *Saturnia pavonia*, stating that it is in Diptera. He probably confused the name of a host that shares a parasitoid with *S. pavonia*, thinking it was another record. Perhaps he was attempting to extract data from literature in a language foreign to him. I hope this "record" will not be further perpetuated in literature by authors who consult Rougeot's parasitoid lists. I did not find the name *Scotia* in any catalogs of Diptera, including Herting's (1984) on Palaearctic Tachinidae.

COLEOPTERA

350. *Lema flavipes*

Rougeot (1971: 92) cited the beetle *Lema flavipes* as parasitizing *Saturnia pyri*, but this record is apparently an error, since the genus *Lema* belongs to the family Chrysomelidae, which are leaf-feeding beetles. Adults and larvae of these beetles are phytophagous. The Rhipiphoridae are a family of beetles that is parasitic, but all attack only wasps and bees (Hymenoptera) as far as known.

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