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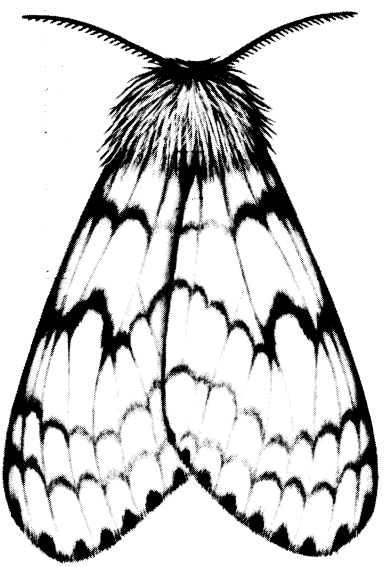
Gypsy Moth Handbook

Selected Parasites and Hyperparasites of the Gypsy Moth, with Keys to Adults and Immatures



In 1974 the U.S. Department of Agriculture initiated the Combined Forest Pest Research and Development Program, an interagency effort that concentrated on the Douglas-fir tussock moth in the West, on the southern pine beetle in the South, and on the gypsy moth in the Northeast. The work reported in this publication was funded in whole or in part by the program. This manual is one in a series on the gypsy moth.

Contents

Selected Parasites and Hyperparasites of the Gypsy Moth,[1] with Keys to Adults and Immatures

by
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Preface

In recent years there has been renewed interest in biological control of destructive forest insects, including the gypsy moth. Studies of gypsy moth parasites have been hampered by lack of keys to parasitic wasps and, until recently, to parasitic flies. This handbook includes keys to adults, puparia, and cocoons of selected gypsy moth parasites found in, imported to, or likely to be imported to North America. The keys are supplemented by illustrations and by a technical glossary. Also included are tables summarizing important biological data on all parasites treated in the keys. Additional notes are made concerning why certain species were not included, as well as synonyms used in the North American literature.

[1] Lepidoptera: Lymantriidae. *Lymantria dispar* (L.) is preferred to the often used name *Porthetria dispar* (Ferguson 1978*a*).

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Introduction

Parasite importation for the biological control of *Lymantria dispar* (L.) began in 1905 and continued through 1914. Further importations were made from 1922 to 1933, and from 1963 to the present. More than 40 species have been introduced; 9 are currently established in the Northeastern United States. The gypsy moth importation and release programs have been reviewed by Howard and Fiske (1911), Burgess and Crossman (1929), Dowden (1962), Hoy (1976), Clausen (1978), and Reardon (1978).

Lymantria dispar is distributed in the western Palearctic region from southern Sweden and Russia south of 58° N latitude to North Africa, Syria, and northern Iran; and in the eastern Palearctic region from Siberia south of 55° N latitude to Japan, China, northern India, and northern Afghanistan (Anon. 1953). In the Nearctic region, *L. dispar* is distributed at present in New England except northern New Hampshire, northern Maine, and northeastern Vermont; in southeastern Quebec; in New Jersey; in eastern and central New York and Pennsylvania; in northeastern and northcentral Maryland; and in southcentral Michigan (Baker 1972, Bryce 1978). The typical *L. dispar* of the western Palearctic and Nearctic regions is replaced by *Lymantria dispar japonica* (Motschulsky) in Japan (Ferguson 1978*b*). *Lymantria obfuscata* (Walker) is distributed in India (Sabrosky and Reardon 1976).

The parasites in this handbook include flies and wasps known to parasitize the gypsy moth and include native, established, and exotic species recently released and other selected exotic species.

In this handbook are keys to families and species of adults and immatures that are designed to aid in the identification of parasites recovered from *L. dispar.* They cannot be satisfactorily used to identify suspected gypsy moth parasites whose hosts are unknown.

Selected hyperparasites are included in the keys if they are likely to be recovered from field-collected gypsy moth caterpillars and pupae. Hyperparasites that attack primary parasites after they leave the gypsy moth are not included. Hyperparasites are identified in the keys but are not discussed further in the handbook. Schewyrew (1912) has been followed in regard to the two species of *Theronia* and *Monodontomerus aereus* Walker as hyperparasites.

The key to immature stages is limited to those forms that are external to the host. Some closely related species could not be separated because of morphological similarities. Despite these limitations, the immature key should be useful when adults are in poor condition, fail to emerge, or when immediate identifications are required.

The keys are intended to be useful to workers with some training in insect morphology and taxonomy. Illustrations and a glossary are provided to illustrate and explain technical terms; both should enable the reader to use the keys without references to other publications. In the use of morphological terminology, recent authors have been followed in the taxonomy of particular groups included here: Tachinidae from Sabrosky and Reardon (1976); and Hymenoptera from Townes (1969) and Joseph et al. (1973).

Information on biology, distribution, and relative importance is presented in tabular form for all parasites included in the keys. Biological data are based on personal observation and on world literature. The biology and relative importance of the parasites may vary with location, host density, and other variables. This information is not intended to be complete but to serve as a guide for further reference.

There are numerous parasites that have been recorded from the gypsy moth besides those treated in the keys and tables. Thompson (1946) lists 186 species of wasps and flies reared from the gypsy moth. Other sources of parasite records are Shenefelt (1972), Telenga (1955), Morley and Rait-Smith (1933), Muesebeck et al. (1951), Krombein (1958), and Krombein and Burks (1967). Not all catalogers have critically reviewed host and distributional records; some data, therefore, are inaccurate (Nixon 1974). The criteria mentioned earlier eliminate most of these species from consideration, although it may superficially appear that some species not included do meet the criteria mentioned earlier. Reasons for not including certain species are given in a separate section, which also includes comments on synonyms of species treated here that were used in North American literature. Only wasp synonyms are discussed in this section, because synonyms of gypsy moth fly parasites are well covered by Sabrosky and Reardon (1976).

Keys to Adults of Selected Parasites and Hyperparasites of the Gypsy Moth

Key to Families

1. With one pair of wings; hind wings reduced to halteres. Diptera (flies) 2
— With two pair of wings, or so tiny as to be difficult to determine the number of wings. Hymenoptera (wasps) 3
2. Postscutellum strongly convexly developed ..... Tachinidae
— Postscutellum not strongly convexly developed ..... Other Diptera[4]
3. Front wings with both longitudinal and cross veins enclosing at least a few cells (figs. 34 and 43) 4
— Front wings with venation reduced to an apparent single longitudinal vein having a short branching vein near the end, and without closed cells (figs. 53 and 54) 5
4. Two recurrent veins in front wing (fig. 34) ..... Ichneumonidae
— One recurrent vein in front wing (figs. 43 and 44) ..... Braconidae
5. Body length[5] usually at least 4 mm long; hind femora swollen and dentate on lower margin (fig. 52) ..... Chalcididae
— Smaller, usually less than 4 mm long; hind femora normal size or possibly with a single tooth on lower margin 6
6. Pronotum in side view triangular and extending to the tegula (fig. 61) ..... Scelionidae
— Pronotum in side view quadrate and not reaching the tegula (fig. 62) 7
7. Hind coxa considerably larger than front coxa; mesopleura with a distinct groove for the reception of the femora (fig. 55); body length over 2 mm ..... Torymidae
— Hind coxa little if any larger than front coxa; mesopleura usually large and convex, at least without a distinct groove (fig. 56); body length between 1 and 2 mm 8
8. The submarginal vein long and extending to the base of the stigmal vein, without a marginal vein (fig. 57); the mesonotum without notauli and evenly convex (fig. 58) ..... Encyrtidae
— The submarginal vein shorter, with a marginal vein (fig. 53); mesonotum with notauli and either convex (fig. 59) or flattened or slightly concave with a median triangular elevation anteriorly (fig. 60) ..... Eupelmidae

[4] To separate scavengers see Sabrosky and Reardon (1976).
[5] Body length is measured from the anterior part of the head exclusive of the antennae to the apex of the abdomen exclusive of the ovipositor.

Key to Tachinidae

1. Two sternopleural bristles (fig. 20)[6] 2
— 3 or 4 sternopleural bristles (figs. 17, 18, and 19) 4
2. Intermediate abdominal segments without median discal bristles; cheeks unusually narrow (fig. 6); legs predominantly yellow, only tarsi black ..... *Carcelia amplexa* (Coquillett)
— Intermediate abdominal segments with median discal bristles (fig. 4); cheeks not as narrow (figs. 7, 8, and 9) 3
3. Mesonotum, viewed from behind, with 4 narrow black stripes (fig. 2); each humerus with 3 strong bristles arranged in a triangle (fig. 15) ..... *Eusisyropa virilis* (Aldrich and Webber)
— Mesonotum, viewed from behind, with 3 stripes, the median a fusion of usual pair of submedian stripes, and twice breadth of a lateral stripe (fig. 3); each humerus with 5 bristles (fig. 16) ..... *Nemorilla pyste* (Walker)
4. Intermediate abdominal segments, each with pair of strong and erect median discal bristles; abdomen of female with spined ventral keel (fig. 26) 5
— Intermediate abdominal segments without median discal bristles; abdomen of female without spined ventral keel 6
5. Eyes appearing bare, their hairs minute and sparse (fig. 10); 3 pairs of posterior dorsocentral bristles ..... *Blondelia nigripes* (Fallén)
— Eyes densely long haired; 4 pairs of posterior dorsocentral bristles ..... *Compsilura concinnata* (Meigen)
6. Four sternopleural bristles (fig. 18) 7
— Three sternopleural bristles 10
7. Facial ridges bristled on lower $^1/_2$ to $^3/_4$; wing with 2–3 bristles on node at base of R_{4+5} on upperside of wing; underside of fourth abdominal segment of male of normal appearance, the hairs well spaced 8
— Facial ridges almost bare, only a few weak bristles and hairs above vibrissae; wing with only one bristle on node at base of R_{4+5}; underside of fourth abdominal segment of male with a pair of well-defined, dense fascicles of hairs (figs. 24 and 25) 9
8. Paired median marginal bristles present on abdominal segments 1+2 and 3 (fig. 4), the pair on 1+2 normally weak ..... *Lespesia frenchii* (Williston)
— Median marginals absent on abdominal segments 1+2 and 3 .....

[6] Rarely a weak, hairlike, third sternopleural bristle in *Eusisyropa virilis*. If in doubt, *E. virilis* has 3 strong humeral bristles arranged in a definite triangle (fig. 15).

..... *Lespesia aletiae* (Riley)

9. Hair patches, on underside of fourth abdominal segment, in males large, each obviously more than half as long as segment; the area between patch and anterior margin of segment bare of hairs (fig. 24) ..... *Palexorista inconspicua* (Meigen)

— Hair patches in males small, each 1/2 length of segment (fig. 25); with at most a row of ordinary hairs between patch and anterior margin of segment, or with only scattered hairs, or none at all .... *Palexorista disparis* Sabrosky

10. Prealar bristle long and strong, obviously longer than adjacent intra-alar bristle and as long as posterior notopleural (fig. 13); 1 pair of reclinate orbital bristles present; eyes bare; abdomen with median marginal bristles on segments 1+2 and 3, those on 3 especially strong ..... *Blepharipa pratensis* (Meigen)

— Prealar bristle relatively short, usually clearly less than adjacent intra-alar bristle and posterior notopleural bristle (fig. 14); 2 pairs of reclinate orbital bristles present (fig. 4) 11

11. Eyes distinctly haired (figs. 11 and 12) 12

— Eyes appearing bare, hairs minute and sparse (Fig. 10) 14

12. Back of head with a partial row of black hairs behind postocular cilia ..... *Parasetigena silvestris* (Robineau-Desvoidy)

— Back of head with only whitish hairs behind postocular cilia 13

13. Facial ridges with strong, well-spaced bristles on lower 2/3 to 3/4; second antennal segment bright reddish yellow in both sexes .... *Spoggosia claripennis* (Macquart)

— Facial ridges not as strongly bristled, bristles weaker, closer together, and decumbent, on lower half or less; second antennal segment black except narrowly at apex ..... *Exorista segregata* (Rondani)

14. Two median lateral bristles present on each side of scutellum (fig. 21) ..... *Tachinomyia* spp.

— Only 1 median lateral bristle on each side of scutellum (fig. 22) ...15

15. Dorsum of abdomen almost entirely gray tomentose, without conspicuous shining black crossbands, and with a more or less distinct median white line, or partial line ..... *Exorista rossica* Mesnil

— Dorsum of abdomen with broad, shining black crossbands posteriorly on segments 3–5, and usually with distinct black median line or narrow stripe, often less evident in females 16

16. Males[7] with median forceps (fused cerci) characteristically elongate, narrow, compressed (fig. 28); parafrontals anteriorly, especially in males, with fine, pale hairs, appearing almost bare under low magnification; cheek in both sexes relatively narrow, as seen in profile only 1/5 height of eye ..... *Exorista japonica* (Townsend)

— Males with median forceps (fused cerci) broadened and flattened, distally suddenly narrowed to acute apex (fig. 29); parafrontals, especially in males, with longer black hairs that are much more distinct; cheek in both sexes usually wider, about 1/4 height of eye ..... *Exorista larvarum* (L.)

---------- *Exorista mella* (Walker)[8]

[7] Females of the 3 following species are difficult to separate.

[8] The relationship of palearctic *E. larvarum*, extensively introduced into North America, and the native *E. mella* has not been satisfactorily studied.

Key to Ichneumonidae[9]

1. Areolet large, with one of its sides usually as long as or longer than upper abscissa of postnervulus (fig. 30); first tergite with a large glymma, its spiracle near or a little behind the middle; male clasper ending in a narrow rod about half the length of first segment of the hind tarsus. Hyperparasite ..... Mesochorinae[10]
— Areolet usually smaller and narrower (fig. 31), all of its sides plainly shorter than upper abscissa of postnervulus; otherwise not entirely agreeing with above 2
2. First abdominal segment somewhat petiolate, usually at least twice as long as widest part, and at least twice as wide at apex as near base viewed from above, spiracle situated behind the midlength of the tergite (fig. 32) 3
— First abdominal segment quadrate, length less than twice the width, apex but little wider than base viewed from above (fig. 33); spiracle situated near or before the midlength of the tergite (fig. 34) 6
3. Second abdominal tergite with a gastrocoelus ..... *Lymantrichneumon disparis* (Poda)
— Second abdominal tergite without a gastrocoelus 4
4. Cross section of first abdominal segment near its basal third depressed oval in shape; suture separating first abdominal sternite from its tergite above the midheight on the petiolar part of segment (fig. 35); propodeum viewed from above narrowed toward apex, dorsal surface without distinct carinae except at base; inner margin of eyes strongly indented near base of antennae (fig. 36) ..... *Casinaria* spp.
— Cross section of first abdominal segment near its basal third quadrate or triangular in shape; suture separating first abdominal sternite from its tergite below the midheight on the petiolar part of segment (fig. 39); propodeum viewed from above quadrate in overall shape, not appreciably narrowed toward apex; median longitudinal carinae extending beyond basal area; inner margin of eyes not strongly indented 5
5. Petiole of first abdominal segment with a conspicuous lateral pit or glymma (fig. 37); abdominal tergites entirely black; nervulus of front wing forming a wider angle of at least 70° with the discoideus (fig. 38) ..... *Hyposoter tricoloripes* (Viereck)
— Petiole without a conspicuous lateral pit (fig. 39); second abdominal

[9] Sections of this key were adapted from an unpublished key by Robert Carlson.
[10] For a recent taxonomic study of this subfamily see Dasch (1971).

tergite with apex brown; nervulus strongly sloping to make an angle of about 55° with the discoideus (fig. 31). . . . . *Phobocampe disparis* (Viereck)

6. Thorax and abdomen mostly yellow or light brown; mesopleural suture with a weak angulation near the middle (fig. 34); tarsal claws enlarged, each with an enlarged bristle with a spatulate tip (fig. 40) . . . . . *Theronia* spp. 7

— Thorax and abdomen mostly black; mesopleural suture straight; tarsal claws not enlarged and not with a spatulate bristle 8

7. Head mostly black, conspicuously darker than most of thorax; hind femur without a ventral ridge. Hyperparasite . . *Theronia hilaris* (Say)

— Head yellowish, concolorous with most of thorax; hind femur with a ventral ridge (fig. 34). Hyperparasite . . . . . *Theronia atalantae fulvescens* (Cresson)

8. Apices of abdominal tergites whitish; base of most hind tarsal segments white, contrasting with dark apices; inner margin of eye strongly concave slightly above level of insertion of antennae (fig. 41) . . . . . *Itoplectis conquisitor* (Say)

— Apices of abdominal tergites dark; hind tarsal segments entirely dark; inner margin of eye usually only weakly concave (more strongly concave in males of *C. turionellae* and *C. disparis*) (fig. 42) . . . . . *Coccygomimus* spp. 9

9. Hind tibia with a whitish area medially; dark basally and apically .10

— Hind tibia entirely black, fuscous, or reddish yellow 11

10. Hind coxa and disc of scutellum reddish . . . . . *Coccygomimus turionellae moraguesi* (Schmiedeknecht)

— Hind coxa and disc of scutellum black . . . . . *Coccygomimus turionellae turionellae* (Linnaeus)

11. Hind coxa reddish yellow . . . . . *Coccygomimus pedalis* (Cresson)

— Hind coxa black 12

12. Hind tibia reddish yellow . . . . . *Coccygomimus instigator* (Fabricius)

— Hind tibia fuscous or black . . . . . *Coccygomimus disparis* (Viereck)

Key to Braconidae

1. Front wing with 2 cubital cells (second intercubital vein absent) (fig. 43); body usually not over 3 mm long ..... *Apanteles* spp. 4
— Front wing with 3 cubital cells (second intercubital vein present although sometimes indistinct) (fig. 44); body usually at least 4 mm long 2
2. First abdominal tergum widened at apex, at least 3 times as wide as apex as at base (fig. 45); clypeus with apical margin transverse and touching upper edge of mandibles *Meteorus pulchricornis* (Wesmael)
— First abdominal tergum with apex less than twice as wide as base (fig. 46); clypeus semicircularly arched at apical margin, forming a circular opening with mandibles (fig. 47) ..... *Rogas* spp. 3
3. Body mostly medium to light brown .... *Rogas indiscretus* Reardon
— Body mostly dark brown to dull black, dorsal surfaces black except disc of second abdominal segment and sometimes apex of first abdominal segment and parts of mesonotum and scutellum brown .... *Rogas lymantriae* Watanabe
4. Apex of first abdominal tergum narrower than base (fig. 48); propodeum mostly smooth and shining, irregularly punctate but not rugose. 5
— Apex of first abdominal tergum as wide or wider than base (fig. 49); propodeum rugose 6
5. First abdominal tergum evenly tapered at apex (fig. 48) .... *Apanteles porthetriae* Muesebeck
— First abdominal tergum abruptly narrowed at apex (fig. 50) .... *Apanteles liparidis* (Bouché)
6. Second abdominal tergum about $^{1}/_{10}$ longer than third tergum; third tergum usually coarsely punctate to apex; basal antennal segments of female bright yellow ..... *Apanteles ocneriae* Ivanov
— Second abdominal tergum subequal to $^{1}/_{10}$ shorter than third tergum; third tergum usually distinctly smoother and less punctate on apical half; basal antennal segments of female black .... *Apanteles melanoscelus* (Ratzeburg)

Key to Chalcididae[11] (genus Brachymeria)

1. Complete frontal (preorbital) carinae present in both sexes[12] (fig. 51); females without a median (inner ventral) tooth on hind coxae; apical half of scutellum with a vaguely defined, median, longitudinal depression; space between lateral ocellus and compound eye shagreened (covered with a closely set roughness). Hyperparasite ..... *B. compsilurae* (Crawford)

— Frontal (preorbital) carinae absent in females (or vaguely indicated and short in males); if present in females then hind coxa with a median (inner ventral) tooth 2

2. Hind coxae of female with a median (inner ventral) tooth (fig. 52) .. 3

— Hind coxae without an inner tooth or protuberance both in male and female 4

3. Hind tibia yellow with a blackish ventral carina from base to tip; interspaces between the punctures on the thorax smooth ..... *B. intermedia* (Nees)

— Hind tibia mostly yellowish with the base and ventral portion blackish; interspaces between the puncture on the thorax finely reticulate ..... *B. lasus* (Walker)

4. Scutellum emarginate; preorbital and postorbital carinae distinct; hind tibia yellowish at base, apex and dorsal portion, and ventral middle portion black. Hyperparasite ..... *B. fiskei* (Crawford)

— Scutellum weakly emarginate or entire or rounded; preorbital carina faint or absent; postorbital carina present; hind tibia mainly yellow with the base alone black ..... *B. euploeae* (Westwood)

[11] Taken, in part, from Joseph et al. (1973) although we have followed the opinion of Boucek (1973) in treating *B. euploeae* and *B. lasus* as distinct species.

[12] *B. fiskei* also has preorbital carinae present in both sexes (see couplet 4).

Key to Encyrtidae, Eupelmidae, Scelionidae, and Torymidae

1. Pronotum in profile more or less triangular and extending to the tegulae (fig. 61); trochanter 1-jointed 2
   ..... *Anastatus disparis* Ruschka
— Pronotum in profile more or less squarish and not extending back to the tegulae (fig. 62); trochanter 2-jointed 3
2.[13] Abdomen aside with blunt lateral edge; frons smooth and polished; females with 11-segmented antennae ..... *Telenomus* spp.[14]
— Abdomen aside with sharp lateral edge; frons roughly sculptured; females with 12-segmented antennae ..... *Gryon* spp.[15]
3. Mesopleura large, entire; flat, without femoral groove in the female and usually in the male (fig. 56); spur of middle tibia usually very large and stout 4
— Mesopleura rarely large, with an oblique femoral groove or impression (fig. 55); spur of middle tibia normal, not enlarged 5
4. Submarginal vein long and extending to the base of stigmal vein; without a marginal vein (fig. 57); 11-segmented antennae .....
   ..... *Ooencyrtus kuvanae* (Howard)
— Submarginal vein shorter and with a marginal vein (fig. 53); 12- or 13-segmented antennae ..... *Anastatus kashmirensis*[16] Mathur
   ..... *Anastatus disparis* Ruschka
5. Hind coxae more or less triangular in cross-section, sharply ridged above; hind femora slightly swollen with a single ventral tooth. Hyperparasite ..... *Monodontomerus aereus* Walker
— Hind coxae cylindrical, long; hind femora greatly swollen and with many teeth beneath ..... *Brachymeria* spp. (see key to Chalcididae)

[13] Taken, in part, from Masner (1958).

[14] The male of *Telenomus lymantriae* Kozlov is unknown and the female has first abdominal segment and legs, including coxae, yellow; body black.

[15] Two species of *Gryon, howardi* Mokrzecki and Ogloblin and *lymantriae* Masner, have been infrequently recovered from the gypsy moth, and their exact relationship has not been satisfactorily studied. The genus *Gryon* is included here to avoid confusion with *Telenomus*.

[16] The females are similar morphologically, while the males are distinct: In *A. kashmirensis*, the hind tibial basal area is tan and the apical areas dusky, and in *A. disparis*, the hind tibia is dark except at the extreme base. Final determination pending examination of topotypical material of *kashmirensis-disparis-japonicus* (Gordh 1976).

Key to Selected Immatures

The species and groups treated in this key are limited to those in the resting stage that are more or less visible. In some genera and tribes, characteristics could not be found to separate species, as was the situation for *Rogas* spp. and the Exoristini. *Parasetigena silvestris* (R.-D.) is the only common gypsy moth parasite in the Exoristini. Differences in biology should help separate *P. silvestris* from any *Exorista* spp. and *Spoggosia claripennis* that may be reared from gypsy moth, because the latter two have at least two generations a year, whereas *P. silvestris* has only one. The only species of *Carcelia* treated in this key is *amplexa* (Coquillett), because it is the only one reared from gypsy moth that is known to be in the Nearctic region. The tachinid section of the key was modified from Sabrosky and Reardon (1976).

1. Pupa covered at least partially with silken strands (i.e. cocoon), color white, yellow, light brown, gray or black; or within mummified skin of host caterpillar; wasp cocoons 2
— Pupa covered with skin of last stage of the larva, without silken strands, color reddish brown to black; fly puparia 9
2. Cocoon within mummified skin of host caterpillar ..... *Rogas* spp.
— Cocoon external to host although host remains may adhere to it ... 3
3. Cocoons 4–5 mm long; thickly covered with silken strands; color white or pale yellow ..... *Apanteles* spp. 4
— Cocoons usually at least 5 mm long; covering parchmentlike, with only a few silken strands, or at least sections of darker parchment-like covering visible beneath silken strands; at least partly brown, gray, or black 6
4. Cocoons occurring in groups (a cluster of at least 4 or 5) .... *Apanteles ocneriae* Ivanov and *Apanteles liparidis* (Bouché)
— Cocoons occurring singly 5
5. Cocoons pale yellow ..... *Apanteles melanoscelus* (Ratzeburg)
— Cocoons pure white ..... *Apanteles porthetriae* Muesebeck
6. Cocoon a uniform brown color; free from host, and suspended from substrate at end of a silken strand; 2 mm in diameter and 5–6 mm long; ends acutely rounded (fig. 73) *Meteorus pulchricornis* Wesmael
— Cocoon with mottling, banding or both; if color nearly uniform then it is dark gray; free or adhering to host; usually at least 3 mm in diameter; ends bluntly rounded 7
7. Cocoon tightly adhering to ventral side of caterpillar remains (fig. 74) ..... *Hyposoter tricoloripes* (Viereck)
— Cocoon free from host 8
8. Cocoon length at least twice width; with irregular dark bands or mottling that contrasts with white or yellow coloration elsewhere ... . *Casinaria* spp.
— Cocoon stouter, length only about $1^1/_2$ times diameter; with one broad, gray median band (sometimes indistinct) and dark gray apices (fig. 75) ..... *Phobocampe disparis* (Viereck)
9. Puparium densely beset with spinules, or fine spinelike hairs, which form a furlike covering; spiracular plates strongly projecting, height one half or more the diameter of plates; the surface of spiracular plates very uneven with the slits at the apex of 3 ridges (fig. 64) ..... *Palexorista* spp. 10
— Puparium chiefly bare, any spinules confined to definite rows or narrow segmental bands; spiracular plates usually flush with surface or at least if projecting with the surface relatively smooth 11

10. Spiracular slits straight or only slightly curved; the distance between plates about $^2/_3$ the diameter of plates; no fold or integument surrounding the area of spiracular plates ..... *Palexorista inconspicua* (Meigen)
— Spiracular slits wavy; the distance between plates about equal to diameter of plates; 1 or 2 folds of integument surrounding the area of spiracular plates ..... *Palexorista disparis* Sabrosky
11. Spiracular slits strongly sinuous, with distinct loops (fig. 65) 12
— Spiracular slits straight or only gently curved (fig. 66) or wavy or zigzag (fig. 67), but not widely looped 14
12. Subspiracular protuberance large, prominent, and with triangular, ridgelike extension dorsally between spiracular plates (fig. 65) ..... *Blepharipa pratensis* (Meigen)
— Subspiracular protuberance, if present, without triangular extension between plates ..... *Lespesia* spp. 13
13. Subspiracular protuberance moderately strong (fig. 68) ..... *Lespesia aletiae* (Riley)
— Subspiracular protuberance small and weak (fig. 69) ..... *Lespesia frenchii* (Williston)
14. Spiracular slits distinctly wavy or zigzag in outline (figs. 67 and 70) 15
— Slits straight or gently curved (fig. 66) 16
15. Strong subspiracular protuberance present (fig. 67) ..... *Carcelia amplexa* (Coquillett)
— Protuberance absent (fig. 70) *Eusisyropa virilis* (Aldrich and Webber)
16. Posterior end of puparium narrowed, subconical, the spiracular plates distinctly projecting and slightly divergent (fig. 71) ..... *Nemorilla pyste* (Walker)
— Posterior end of puparium not subconical, the spiracular plates little if any elevated above surrounding surface (figs. 63 and 66) 17
17. Posterior end of puparium in profile somewhat depressed above apex and more or less conspicuously bulging between anus and subspiracular protuberance (fig. 63); spiracular plates well above apex of puparium, on the depressed and slanting surface ..... Tribe Exoristini (*Exorista* spp., *Parasetigena, Spoggosia, Tachinomyia*)
— Posterior end of puparium in profile broadly and evenly rounded, the spiracular plates almost vertical to long axis of puparium (fig. 66) 18
18. Usually with deep groove between spiracular plates, plates comparatively small, with small subspiracular protuberance close to them and usually projecting beyond them (fig. 72) ..... *Blondelia nigripes* (Fallén)

— Space between plates flat or finely wrinkled, not with deep groove; plates comparatively larger, and subspiracular protuberance less projecting and not as close to plates, the 3 appearing less crowded together (fig. 66) ..... *Compsilura concinnata* (Meigen)

Tables of Biological Information for Selected Parasites of the Gypsy Moth

Table 1.—Species Known to Be Established in or Native to North America

Parasite	Stage attacked	Host preference	Voltinism	Over-wintering stage
Braconidae				
Apanteles melanoscelus (Ratzeburg)	larva	oligophagous	bivoltine	immature in cocoon
Ichneumonidae				
Coccygomimus pedalis (Cresson)	pupa	polyphagous	multivoltine	prepupa (?) in host
Itoplectis conquisitor (Say)	pupa	polyphagous	multivoltine	prepupa (?) in host
Phobocampe disparis (Viereck)	larva	oligophagous	univoltine	adult in cocoon
Encyrtidae				
Ooencyrtus kuvanae (Howard)	egg	oligophagous	multivoltine	female adult in litter
Eupelmidae				
Anastatus disparis Ruschka	egg	oligophagous	univoltine (occasionally bivoltine)	immature in host
Chalcididae				
Brachymeria intermedia (Nees)	pupa	polyphagous	multivoltine	female adult in litter
Tachinidae				
Blepharipa pratensis (Meigen)	larva	oligophagous	univoltine	pupa in litter
Carcelia amplexa (Coquillett)	larva	polyphagous	uni-bivoltine	pupa in litter
Compsilura concinnata (Meigen)	larva	polyphagous	multivoltine	immature in host

Distribution and Relative importance	References
western Palearctic and Northeastern United States, parasitism commonly 0–22%	Crossman 1922, Burgess and Crossman 1929, Ticehurst et al. 1978
Nearctic, parasitism occasional	Townes and Townes 1960
Nearctic, parasitism occasional	Townes and Townes 1960
western Palearctic and Northeastern United States, parasitism commonly 0–30%	Burgess and Crossman 1929, Ticehurst et al. 1978, Muesebeck and Parker 1933
Palearctic and Northeastern United States, parasitism commonly 10–50%	Burgess and Crossman 1929, Dowden 1961, Crossman 1925
Palearctic and some areas in Northeastern United States, parasitism commonly 0–40%	Burgess and Crossman 1929, Parker 1933, Crossman 1925
Neotropic, Palearctic, and Northeastern United States, parasitism commonly 0–67%	Joseph, Narendran and Joy 1973, Dowden 1935, Ticehurst et al. 1978, Burks 1960a, Krombein and Burks 1967
Palearctic and Northeastern United States, parasitism commonly 0–54%	Sabrosky and Reardon 1976, Ticehurst et al. 1978
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Palearctic and Nearctic, parasitism commonly 0–54%	Sabrosky and Reardon 1976, Ticehurst et al. 1978

Parasite	Stage attacked	Host preference	Voltinism	Over-wintering stage
Eusisyropa virilis (Aldrich and Webber)	larva	polyphagous	bivoltine	immature in host
Exorista larvarum (L.)	larva	polyphagous	multivoltine	immature in host
Exorista mella (Walker)	larva	polyphagous	multivoltine	immature in host
Lespesia aletiae (Riley)	larva	polyphagous	multivoltine	immature in host
Lespesia frenchii (Williston)	larva	polyphagous	multivoltine	immature in host
Nemorilla pyste (Walker)	larva	polyphagous	multivoltine	immature in host
Tachinidae				
Parasetigena silvestris (Robineau-Desvoidy)	larva	oligophagous	univoltine	pupa in litter
Spoggosia claripennis (Macquart)	larva	polyphagous	multivoltine	pupa in litter
Tachinomyia spp.	larva	polyphagous	univoltine	pupa in litter

Distribution and Relative importance	References
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Palearctic, parasitism common; United States, parasitism rare	Sabrosky and Reardon 1976
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Palearctic and Northeastern United States, parasitism commonly 0–68%	Sabrosky and Reardon 1976, Ticehurst et al. 1978
Nearctic, parasitism occasional	Sabrosky and Reardon 1976
Nearctic, parasitism occasional	Sabrosky and Reardon 1976

Table 2.—Species Not Known to Be Established in North America

Parasite	Stage attacked	Host preference	Voltinism	Over-wintering stage
Braconidae				
Apanteles liparidis (Bouché)	larva	polyphagous	multivoltine	immature in host
Apanteles porthetriae Muesebeck	larva	oligophagous	multivoltine	immature in host
Apanteles ocneriae Ivanov	larva	monophagous	univoltine(?)	immature in cocoon(?)
Meteorus pulchricornis Wesmael	larva	polyphagous	multivoltine	
Rogas indiscretus Reardon	larva	oligophagous	bivoltine(?)	immature in mummified host
Rogas lymantriae Watanabe	larva	monophagous	bivoltine(?)	immature in mummified host(?)
Ichneumonidae				
Casinaria spp.	larva	polyphagous	multivoltine	prepupa (?) in cocoon
Coccygomimus disparis (Viereck)	pupa	polyphagous	multivoltine	prepupa(?) in host
Coccygomimus instigator Fab.	pupa	polyphagous	multivoltine	prepupa(?) in host
Coccygomimus turionellae turionellae (L.)	pupa	polyphagous	multivoltine	prepupa(?) in host

Distribution and Relative importance	References
Palearctic, parasitism common	Burgess and Crossman 1929
western Palearctic, parasitism common	Burgess and Crossman 1929, Muesebeck 1928
western Palearctic, parasitism occasional	Telenga 1955, Vasić 1973
western Palearctic, parasitism occasional	Burgess and Crossman 1929
eastern Palearctic (India), parasitism occasional	Reardon et al. 1973
eastern Palearctic (Japan), parasitism occasional	
Palearctic, parasitism occasional	Townes, Momoi and Townes 1965, Fuester 1978
eastern Palearctic, parasitism occasional	Townes, Momoi and Townes 1965
Palearctic, parasitism occasional	Townes, Momoi and Townes 1965
Palearctic, oriental parasitism occasional; Nearctic (Canada)	Townes, Momoi and Townes 1965, Walkley 1958, Oehlke 1967

Parasite	Stage attacked	Host preference	Voltinism	Over-wintering stage
Coccygomimus turionellae moraguesi (Schmiede-knecht)	pupa	polyphagous	multivoltine	prepupa(?) in host
Hyposoter tricoloripes (Viereck)	larva	polyphagous	multivoltine	prepupa(?) in cocoon
Lymantrichneu-mon disparis (Poda)				female adult in decaying logs, stumps, etc.
Eupelmidae				
Anastatus kashmirensis Mathur	egg	polyphagous	multivoltine	larva in host
Chalcididae				
Brachymeria lasus (Walker)	pupa	polyphagous	multivoltine	
Brachymeria euploeae (Westwood)	pupa	polyphagous	multivoltine	
Scelionidae				
Telenomus spp.	egg	polyphagous	multivoltine	
Gryon spp.	egg	polyphagous	multivoltine	
Tachinidae				
Blondelia nigripes (Fallen)	larva	polyphagous	multivoltine	immature in host
Exorista japonica (Townsend)	larva	polyphagous	multivoltine	immature in host

Distribution and Relative importance	References
western Palearctic (Morocco)	Oehlke 1967
western Palearctic, parasitism occasional	Fuester 1978
Palearctic, parasitism occasional	Howard and Fiske 1911
eastern Palearctic (India), parasitism occasional	
Oriental and eastern Palearctic	Joseph et al. 1973
eastern Palearctic (India)	Joseph et al. 1973
Palearctic, parasitism occasional	Kozlov 1967
Palearctic, parasitism occasional	Masner 1958
Palearctic, parasitism occasional	Sabrosky and Reardon 1976
eastern Palearctic, parasitism occasional	Sabrosky and Reardon 1976

Parasite	Stage attacked	Host preference	Voltinism	Over-wintering stage
Exorista rossica Mesnil	larva	polyphagous	multivoltine	immature in host
Exorista segregata Rondani	larva	polyphagous	multivoltine	immature in host
Palexorista disparis Sabrosky	larva	polyphagous	multivoltine	immature in host
Palexorista inconspicua (Meigen)	larva	polyphagous	multivoltine	immature in host

Distribution and Relative importance	References
Palearctic, parasitism common	Sabrosky and Reardon 1976
western Palearctic, parasitism common	Sabrosky and Reardon 1976
eastern Palearctic (northern India), parasitism common	Sabrosky and Reardon 1976
Palearctic, parasitism occasional	Sabrosky and Reardon 1976

Notes on Species and Names Not Included in Keys and Tables

Anastatus bifasciatus Fonscolmbe of Howard and Fiske (1911), Crossman (1925), Muesebeck and Dohanian (1927); misidentification of *Anastatus disparis* Ruschka. See Burks (1967) and Peck (1963).

Anastatus japonicus Ashmead. Specialists are uncertain if this eastern Palearctic species is the same as *A. disparis* Ruschka. If they are the same species, *japonicus* is the preferred name because it has priority (Gordh 1976).

Apanteles fulvipes (Haliday) of Howard and Fiske (1911); misidentification of *A. liparidis* (Bouché). See Burgess and Crossman (1929).

Apanteles inclusus Ratzeburg. This widely distributed Palearctic species is a parasite of *Euproctis chrysorrhoea* (L.) (browntail moth), *Lymantria monacha* (L.) (nun moth), and *Euproctis similis* (Fuessly) (goldtail moth). Records of it from *Lymantria dispar* (L.) (Shenefelt 1972) were not confirmed.

Apanteles lacteicolor Viereck. This western Palearctic species was introduced early and became established on the browntail moth in New England (Burgess and Crossman 1929). Muesebeck (1918) found that parasitism by the first generation adults upon small gypsy moth caterpillars could be considerable when in the vicinity of a browntail infestation. However, the choice of gypsy moth seems to be one only of necessity to find an alternate host to complete the summer generation. The wasp is still limited in distribution to the relatively small area of New England colonized by the browntail moth. For workers collecting in that area the adult can readily be separated from other *Apanteles* reared from gypsy moth caterpillars by the presence of the areola on the propodeum (Muesebeck 1920).

Apanteles ruidus Wilkinson. Cotypes in the United States National Museum were reared in India from *Pyrausta machaeralis*. Shenefelt (1972) includes no species of *Lymantria* in the host list. The laboratory colony at the Connecticut Agriculture Experiment Station, New Haven, Connecticut, called "*Apanteles ruidus*" originating in India is not *ruidus* of Wilkinson (1928) according to Muesebeck (Weseloh 1978). The taxonomic status of the New Haven colony (and other colonies obtained from the same population) is uncertain, but is close to *A. melanoscelus* (Ratzeburg).

Apanteles solitarius (Ratzeburg) of Howard and Fiske (1911), Parker (1935), and Dowden (1962); synonym of *A. melanoscelus* (Ratzeburg). See Nixon (1974).

Apanteles vitripennis (Curtis) of Crossman and Webber (1924), Burgess (1926); misidentification of *A. porthetriae* Muesebeck (Muesebeck 1978).

Brachymeria euploeae (Westwood). At present, colonies of a

Brachymeria from India are being maintained at Middletown, Pa., and New Haven, Conn. The species was originally identified as *B. euploeae* (Westwood). However, individuals key to *B. lasus* in Joseph, Narendran, and Joy (1973). Lab studies indicate that it readily parasitizes *Exorista japonica* puparia as well as *L. dispar* pupae when given a choice of the two, whereas *B. lasus,* in colony at Middletown and originating in Japan, prefers *L. dispar* pupae, although it will parasitize *E. japonica* in the absence of *L. dispar* (Fusco 1978). Therefore, the taxonomic status of this *Brachymeria* population from India, although close to *lasus,* is still uncertain.

Brachymeria obscurata (Walker) of Burgess and Crossman (1929), Hoy (1976), and Thompson (1954); synonym of *B. lasus* (Walker). See Joseph, Narendran, and Joy (1973).

Campoplex validus (Cresson) of Krombein and Burks (1967); transferred to *Sinophorus* by Townes (1969).

Chalcis flavipes Panzer of Crawford (1910), Howard and Fiske (1911), Crossman and Webber (1924); misidentification of *Brachymeria intermedia* (Nees). See Marlatt (1928) and Burks (1960*b*).
Chalcis obscurata Walker of Howard and Fiske (1911), and Crossman and Webber (1924); synonym of *Brachymeria lasus* (Walker). See Joseph, Narendran, and Joy (1973).

Coccygomimus tenuicornis (Cresson). Riley and Howard (1894) report occasional parasitism of the gypsy moth. However, this was probably a misidentification of *C. pedalis* (Cresson) or *Itoplectis conquisitor* (Say) (Carlson 1978).
Ephialtes (Itoplectis) conquisitor (Say) of Cushman (1920*b*); transferred to *Itoplectis* by Townes (1940).

Ephialtes pedalis (Cresson) of Cushman (1920*b*); transferred to *Coccygomimus* by Townes (1945).

Ephialtes temnopleuris Cushman (1920*b*); synonym of *Itoplectis conquisitor* (Say). See Townes (1940).

Ephialtes tenuicornis (Cresson) of Cushman (1920*b*); transferred to *Coccygomimus* by Townes and Townes (1960).

Eulimneria valida (Cresson) of Thompson (1946); transferred to *Sinophorus* by Townes, Townes, and Gupta (1961).

Glyptapanteles fulvipes (Haliday) of Howard (1905); misidentification of *Apanteles liparidis* (Bouché). See Burgess and Crossman (1929).

Hyposoter disparis Viereck (1911) of Burgess and Crossman (1929), and Muesebeck and Parker (1933); transferred to *Phobocampe* by Townes (1945). The name *H. disparis* is synonymized by Carlson (1979).

Ichneumon disparis Poda of Howard and Fiske (1911), and Thompson (1946); transferred to *Lymantrichneumon* by Heinrich (1968).

Limnerium disparis Viereck of Howard and Fiske (1911); transferred to *Phobocampe* by Townes (1945).

Meteorus japonicus Ashmead of Burgess and Crossman (1929); and Hoy (1976); synonym of *M. pulchricornis.* See Muesebeck (1978).

Meteorus versicolor Wesmael. This species from the western Palearctic region was introduced early and became established on the browntail moth (Burgess and Crossman 1929). Gypsy moth caterpillars are only occasionally attacked by this species (Muesebeck 1918).

Ooencyrtus kuwanai (Howard) of Muesebeck et al. (1951), and Krombein and Burks (1967). Incorrect emendation of *O. kuvanae.* See Coulson (1978).

Pimpla conquisitor (Say) of Howard and Fiske (1911); transferred to *Itoplectis* by Johnson and Hammar (1912).

Pimpla disparis Viereck (1911) of Howard and Fiske (1911); transferred to *Coccygomimus* by Townes and Townes (1960).

Pimpla examinator Fab. of Howard and Fiske (1911) and Dowden (1962); synonym of *Coccygomimus turionellae* (L.). See Townes, Momoi, and Townes (1965).

Pimpla instigator (Fab.) of Morley and Rait-Smith (1933), Thompson (1946), and Dowden (1962); transferred to *Coccygomimus* by Townes and Townes (1960).

Pimpla pedalis Cresson of Fernald (1896), Howard and Fiske (1911), and Townes (1940); transferred to *Coccygomimus* by Townes (1945).

Pimpla porthetriae Viereck (1911) and of Howard and Fiske (1911); synonym of *Coccygomimus disparis* (Viereck). See Townes, Momoi, and Townes (1965).

Pimpla tenuicornis Cresson of Fernald (1896); transferred to *Coccygomimus* by Townes (1960).

Protichneumon disparis (Poda) of Morley and Rait-Smith (1933); transferred to *Lymantrichneumon* by Heinrich (1968).

Schedius kuvanae Howard (1910) and of Howard and Fiske (1911), Crossman (1925), Muesebeck and Dohanian (1927), Burgess and Crossman (1929); transferred to *Ooencyrtus* by Marlatt (1929).

Sinophorus validus (Cresson). This species has been reared from gypsy moth, but only rarely (Carlson 1973).

Theronia fulvescens (Cresson) of Howard and Fiske (1911), Cushman (1920*a*), Brimley (1938); status changed to *Theronia atalantae*

fulvescens (Cresson) by Viereck (1917).

Theronia melanocephala (Brulle) of Fernald (1896), Viereck (1917), Cushman (1920*a*), Cushman (1928), Brimley (1938); synonym of *Theronia hilaris* (Say). See Cushman and Gahan (1921) and Townes (1940).

This glossary provides an explanation of technical terms used in the keys. Both singular and plural (pl.) forms of a word are given if the plural is unlike English plurals ending in -s. Synonymous terms are denoted by (=).

abdomen.—The posterior, or third section of the insect body. In the parasitic wasps the section is narrowly joined to the posterior of the thorax. In hymenoptera the apparent first section is the morphological second segment, the morphological first segment having been transferred to the thorax as the propodeum. In some species the abdomen is abruptly enlarged so that the narrow "waist" is not apparent. Abdominal segments are numbered from front to rear with the apparent first segment designated number one. In the tachinids the abdomen is apparently composed of four segments. The apparent first is a composite with the second and referred to here as segment 1+2, the following ones as 3, 4, and 5. Segments 3 and 4 (apparent 2 and 3) are referred to as the intermediate segments.

abscissa.—A section of wing vein from one interruption to the next.

antenna, pl. *antennae*.—Paired appendages on the head above the face. In the tachinids they are three segmented, with the apical segment longer than the basal two. In the wasps they are many segmented, sometimes elbowed, and usually attached about the midheight of the head, but sometimes are attached

only a short distance above the mouth.

apical.—At the end, tip, or outermost part.

areolet.—A small cell (second cubital cell) near the center of the front wing of some ichneumonid wasps (fig. 30).

carina, pl. *carinae.*—A ridge or keel (fig. 51).

cercus, pl. *cerci* (anal forceps).—The median lobes of the male genitalia (figs. 28 and 29).

cheek (=*gena*).—Side of head below the eye (fig. 7).

clasper.—The lateral, outside piece of the male genitalia.

clypeus.—A sclerite on the lower part of the anterior of the head between the face and the labrum, usually separated from the face by a groove.

cocoon.—A papery or silken structure enclosing the pupa.

coxa. pl. *coxae.*—The first (basal) leg segment.

Cubital cells.—The cells of the front wing of wasps lying between the radius and cubitus. There are typically three with the first lying behind the stigma and the third at the apex of the wing. They are separated by the first and second intercubital cross veins (fig. 44).

cubitus.—The third longitudinal vein in the apical half of the front wing which in the wasps typically has its base near the base of the stigma and its apex a little posterior to the apex of the wing. The basal abscissa is often absent (fig. 43).

discal bristles.—The bristles on the central area of the dorsum of abdominal segments (fig. 4).

decumbent.—Referring to bristles that are bent over or angled so as to form about a 45° angle or less with the surface to which they are attached.

discoideus.—In the front wing of wasps the vein running as the apparent continuation of the medius and curving to near the posterior margin of the wing (fig. 31).

dorsum.—The back or top side of an insect.

emarginate.—Notched.

eye.—The large compound eye on each side of the head composed of many individual elements (fig. 4).

face.—Anterior of the head between the eyes and between the base of the antennae and the clypeus (fig. 41).

femoral groove.—A dorso-ventral concavity on the mesopleuron where the mesofemur normally rests when appressed against the thorax (fig. 55).

femur, pl. *femora.*—The third leg segment, the more basal of the two longest leg segments (fig. 52). In many species the second segment is very small, making the femur the apparent second segment.

first intercubitus.—The first (and sometimes only) cross vein connecting the radius and cubitus (fig. 44).

first recurrent vein.—In the front wing of wasps the cross vein connecting the cubitus with the discoideus (fig. 44).

gastrocoelus.—A concave impression on each side near the base of the second tergite of wasps.

glymma.—A groove or pit on some wasps in the side of the first tergite, between its spiracle and base (fig. 37).

head.—The first main body section, having mouth parts, antennae, and eyes.

humerus, pl. *humeri.*—The shoulder or convex anterior corner area of the mesonotum (fig. 5).

intra-alar bristles.—A row of bristles on each side of mesonotum lateral to a dorsocentral row (fig. 4).

keel.—Spined ridge on underside of abdomen, formed by the compressed ventral parts of segments; shaped like the keel of a ship (fig. 26).

mandible.—One of the paired mouth-part structures in wasps. They are hinged to the lower part of the head a short distance below the eyes (fig. 41).

marginal bristles.—The bristles on the hind margins of segments, usually as a pair of median marginals on abdominal segments 1+2 and 3 (fig. 4).

marginal vein.—In the front wings of some wasps a longitudinal vein running along the anterior edge from the apex of the submarginal vein to the base of the stigmal vein (fig. 54).

medius.—A longitudinal vein in the basal part of the front wing about midway between the front and hind margins (fig. 31).

mesonotum.—The dorsal part of the relatively large middle section of the thorax, and partially bordered laterally by the base of the front wings in tachinids and most wasps.

mesopleural suture.—A vertical or somewhat oblique groove near and more or less parallel to the posterior edge of the mesopleurum. It runs from the base of the middle coxa to the base of the front wing (fig. 34).

mesopleuron.—The relatively large middle section of the side of the thorax.

metanotum.—The dorsal area of the last thoracic segment. In wasps narrow and indistinct and lying between the postscutellum and the much larger propodeum.

nervulus.—The cross vein which connects the discoideus and submedius in the front wing of wasps (fig. 38).

notaulus, pl. *notauli.*—One of a pair of grooves of the mesonotum of some wasps separating the median area from the lateral areas (fig. 59).

ocellus, pl. *ocelli.*—The small simple eye located at the top of the head. There are typically three with the center more anterior than the lateral two (fig. 41).

parafrontal.—The area of the head above the base of the antennae between the median stripe and the eye (fig. 5).

pectinate.—Referring to a structure having a row of close set spines, like the teeth of a comb.

petiole.—In wasps the anterior part of the first abdominal segment extending back to the spiracle (fig. 37).

posterior dorsocentral bristles.—Two rows of bristles on the posterior area of the mesonotum. They are the second row of bristles lateral to the median line (fig. 4).

postnervulus.—In the front wing of wasps the cross vein which connects the posterior end of the first recurrent vein to the posterior longitudinal vein (brachius) (fig. 30).

postocular cilia.—Slender even hairs in a row immediately behind each eye, usually with tips curved forward over the eye (fig. 4).

postscutellum.—A transverse area immediately behind or beneath the scutellum; in tachinids, conspicuously convex and bulging (fig. 5).

prealar bristle.—The anterior postsutural bristle of the row at the edge of the mesonotum immediately above the wing base (figs. 4, 13, and 14).

propodeum.—The apparent last dorsal section of the thorax in wasps (fig. 32). It is the morphological first

segment of the abdomen which has transferred to the thorax. It extends anterodorsally almost to the postscutellum, with the metanotum being narrow and indistinct.

pupa.—The inactive ("resting") stage in those insects (such as true flies and wasps) that transform from a larva to an adult of different appearance.

radius.—The second longitudinal vein in the apical half of the wing. Its base typically joins the stigma and its apex terminates at the wing margin anterior to the apex of the wing (fig. 43).

reclinate orbital bristles.—Bristles inclined backward which are located between the anterior ocellus and the eye (fig. 4).

sclerite.—A hardened body wall plate bounded by sutures or membranous areas.

scutellum.—A median, subtriangular or shield-shaped area projecting at the rear of the main area of the mesonotum (fig. 5).

second intercubitus.—The more posterior cross vein connecting the radius and cubitus, if the cubital cell is interrupted by two veins (fig. 44); absent in some wasp groups (*Apanteles* spp.).

second recurrent vein.—In the front wing of ichneumonids the cross vein connecting the cubitus to the subdiscoideus (fig. 34).

spatulate.—Narrowed basally and broad and flattened apically.

spiracle.—An external opening of the trachial system. In adult tachinidae there is one on each side of the propleura, and on the metapleura. In adult parasitic wasps there is one at the lateral edges of the propodeum and the first seven abdominal segments (fig. 32).

spiracular plates (=*stigmatal plates*).—In mature larvae and puparia of Diptera, the hardened and usually black plates at the posterior bearing the spiracular slits, usually flush with surface of puparium or only slightly elevated, sometimes strongly projecting (fig. 65).

spiracular slits.—Narrow slitlike spiracles occurring on the spiracular plates. They occur in sets of three in most tachinids (fig. 73).

sternite.—Hardened body wall plate on the ventral side of the body especially of an abdominal segment.

sternopleural bristles.—The bristles on the sternopleuron, or central area of side of thorax, above the coxa of middle leg (fig. 17).

stigma.—A thickening of the wing membrane near the middle of the front margin of the front wing. It is usually darker than the membrane (fig. 30).

stigmal vein.—The short vein extending posteriorly from the front margin in the front wings of some wasps (fig. 57).

subdiscoideus.—A longitudinal vein which runs from the postnervulus to the lower apex of the front wing of wasps (fig. 31).

submarginal vein.—A longitudinal vein paralleling the front margin at the base of the front wing in some wasps (fig. 57).

subspiracular protuberance.—A swelling or projection below the spiracular plates in puparia of some species (fig. 65).

suture.—An external linelike groove in the body wall.

tarsal claws.—A pair of small hooks at the apex of the last segment on the legs (fig. 40).

tarsus, pl. *tarsi.*—The apical segments of the leg, usually five in number but sometimes less in smaller wasps (fig. 34).

tergite.—The dorsal (upper) hardened plate of each abdominal segment of wasps.

thorax.—The middle of the three main body segments to which are attached the wings and legs. It is comprised of the prothorax, mesothorax and metathorax.

tibia.—The fourth leg segment. Typically the posterior of the two longest leg segments, having one or two spurs at the apex and narrower than the femur (fig. 34).

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Figures

Figures 1–29.—Tachinidae.

1. General wing of a tachinid.
2. General color pattern on thorax of a tachinid (dorsal view).
3. General color pattern on thorax of genus *Nemorilla* (dorsal view).
4. Diagrammatic dorsal view of a tachinid.
5. Diagrammatic lateral view of a tachinid.
6–9. Side view of heads of *Carcelia* (6), *Eusisyropa* (7), *Nemorilla* (8), and *Palexorista* (9).
10–12. Semidiagrammatic figures of compound eyes with hairs.
13–14. Semidiagrammatic figures of side view of thorax to show strong and weak pre-alar bristles (PRAL).
15–16. Semidiagrammatic figures of humeral bristles.
17–20. Semidiagrammatic figures of sternopleural bristles.
21–22. Semidiagrammatic figures of marginal scutellar bristles.
23–25. Semidiagrammatic figures of underside of abdominal segment 4 of *Blepharipa* (23), *Palexorista inconspicua* (24), and *P. disparis* (25).
26. Semidiagrammatic figure of side view of abdomen of females of *Compsilura* and *Blondelia*.
27. Semidiagrammatic figure of base of hind legs of typical *Carcelia*.
28–29. Semidiagrammatic figure of median forceps (fused cerci) of males of *Exorista japonica* (28) and *E. larvarum* (29).

ACR = Acrostical bristles
AP = Apical cell
ANT = Antenna
AR = Arista
AS = Apicoscutellar bristle
B = Barette
DC = Dorsocentral bristles
DI = Discal cell
DS = Discoscutellar bristle
FR = Frontal bristles
FS = Frontal stripe
H = Humerus*
HA = Halter
HB = Humeral bristles
HPL = Hypopleuron*
IAL = Intra-alar bristles
IV = Inner vertical bristle
LS = Lateral scutellar bristles
M = Media vein
m = Medial crossvein
MD = Median discal bristle
MM = Median marginal bristle
MSNT = Mesonotum
MSNTS = Mesonotal suture
MSPL = Mesopleuron*
MSS = Mesothoracic spiracle
MTPL = Metapleuron
MTS = Metathoracic spiracle
NP = Notopleuron*
NPB = Notopleural bristles
OC = Ocellar bristle
OV = Outer vertical bristle
PAC = Postalar callus
PAL = Postalar bristles
PFA = Parafacial area
PFR = Parafrontal area
PO = Proclinate orbital bristles
POC = Postocular cilia
PPL = Propleuron*
PRAL = Prealar bristle
PSC = Postscutellum
PTPL = Pteropleuron*
PV = Postvertical bristle
R = Radius vein

r-m = Radio-medial crossvein
RO = Reclinate orbital bristles
SAL = Supra-alar bristles
SC = Scutellum
STB = Stigmatic bristles
STPL = Sternopleuron*
V = Vibrissa
W = Wing
WB = Wing base
*Bristle names correspond to segment names

Figure 1.—

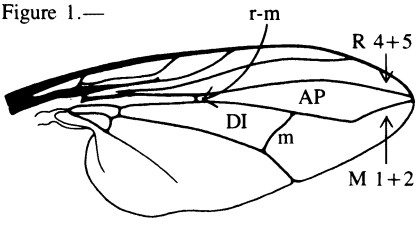


Figure 2.—General Tachinid

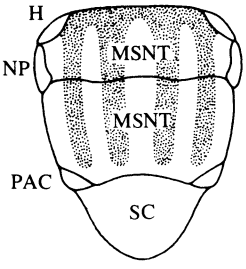
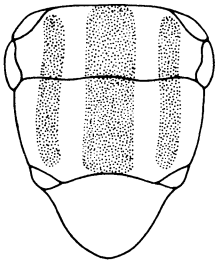


Figure 3.—Nemorilla



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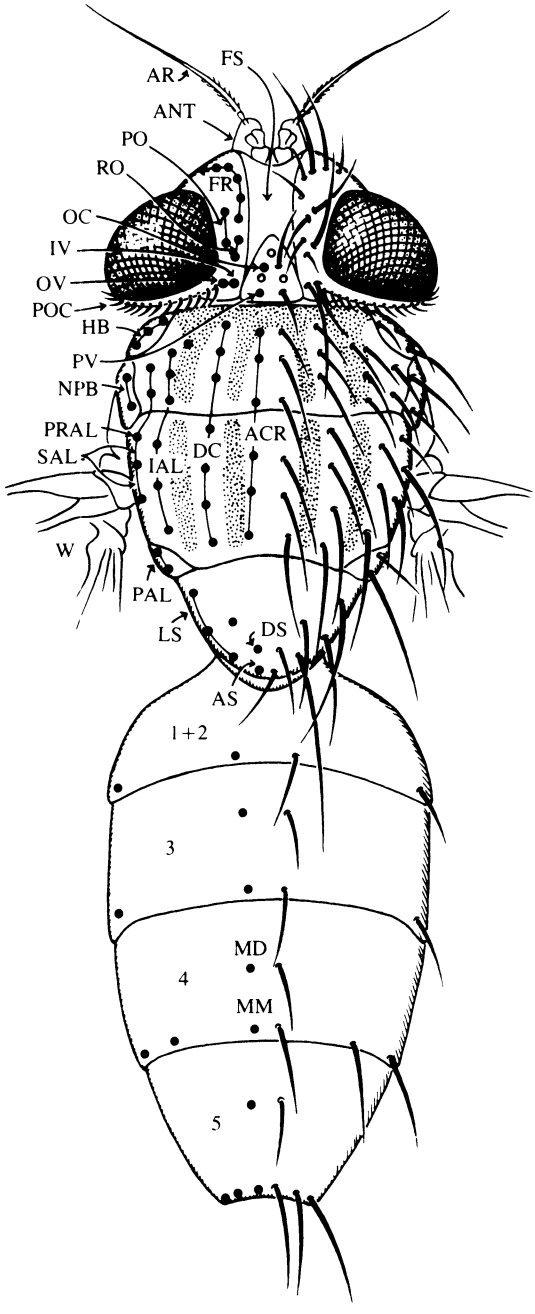

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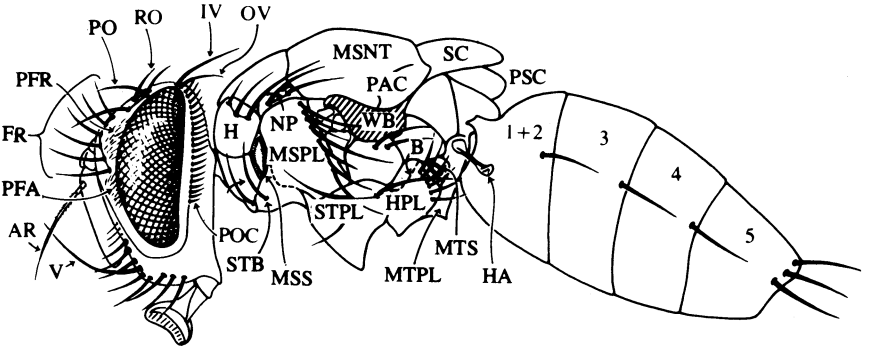

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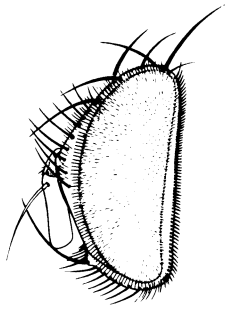

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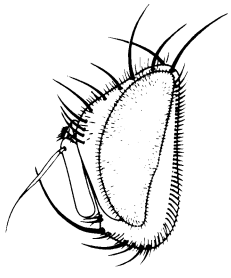

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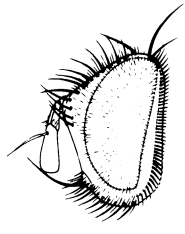

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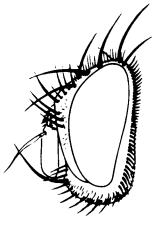

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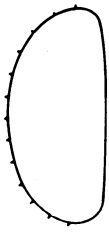

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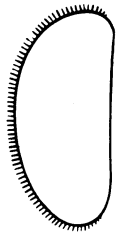

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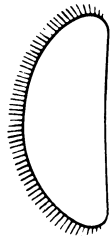

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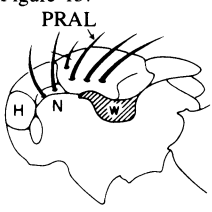

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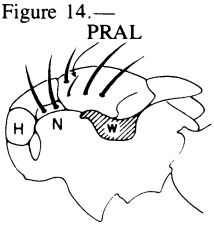

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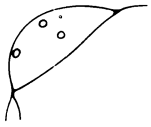

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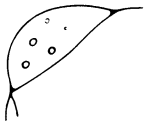

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Figure 18.—

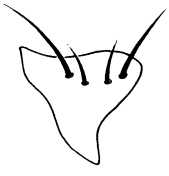
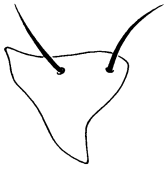


Figure 19.—

Figure 20.—



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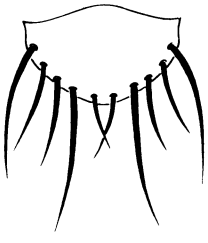

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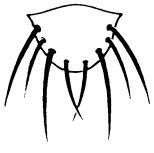

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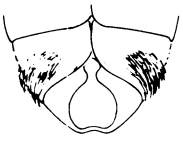

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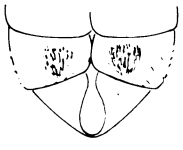

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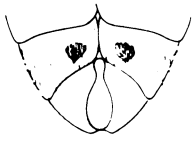


Figure 26.—

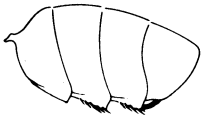


Figure 27.—

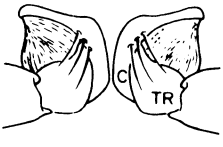


Figure 28.—

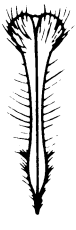
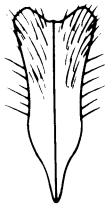


Figure 29.—



Figures 30–42.—Ichneumonidae

30. *Mesochorus* sp., front wing.
31. *Phobocampe disparis* (Viereck), front wing.
32. *Hyposoter tricoloripes* (Viereck), propodeum and first two abdominal segments (dorsal view).
33. *Coccygomimus disparis* (Viereck), propodeum and first two abdominal segments (dorsal view).
34. *Theronia atalantae fulvescens* (Cresson) (lateral view).
35. *Casinaria* sp., first abdominal segment (lateral view).
36. *Casinaria* sp., head (facial view).
37. *Hyposoter tricoloripes* (Viereck), first abdominal segment (lateral view).
38. *Hyposoter tricoloripes* (Viereck), front wing.
39. *Phobocampe disparis* (Viereck), first abdominal segment (lateral view).
40. *Theronia atalantae fulvescens* (Cresson), last tarsal segment.
41. *Itoplectis conquisitor* (Say), head (facial view).
42. *Coccygomimus pedalis* (Cresson), head (facial view).

AB—Abdomen
AB1—First abdominal segment
AB2—Second abdominal segment
ARE—Areolet
AS—Antennal sockets
AT1—First antennal segment
CB—Claw bristle
CL—Claw
CX3—Hind coxa
D—Discoideus
E—Eye
F3—Hind femora
FA—Face
GL—Glymma
HD—Head
LPN—Lower abscissa of postnervulus
M—Medius
MD—Mandibles
MS—Mesopleural suture
N—Nervulus
O—Ocellus
P—Petiole
PR—Propodeum
RV1—First recurrent vein
RV2—Second recurrent vein
SD—Subdiscoideus
SP—Spiracle
ST—Sternite
TA—Tarsus
TE—Tergite
TH—Thorax
UPN—Upper abscissa of postnervulus

Figure 30.—

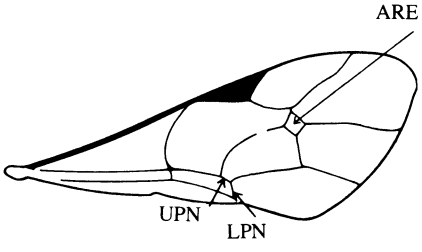


Figure 31.—

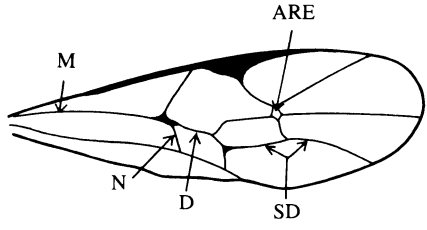


Figure 32.—

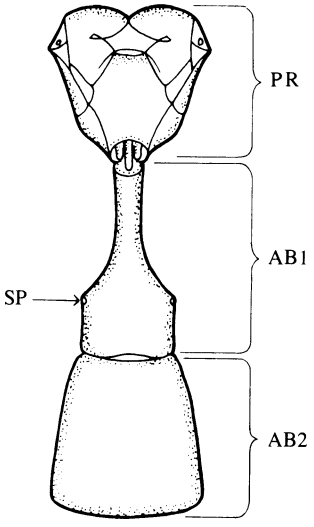


Figure 33.—

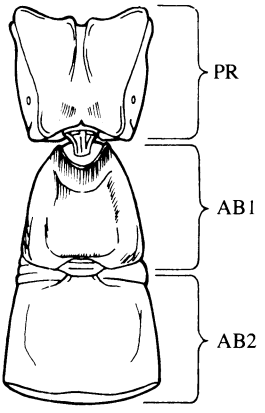


Figure 34.—

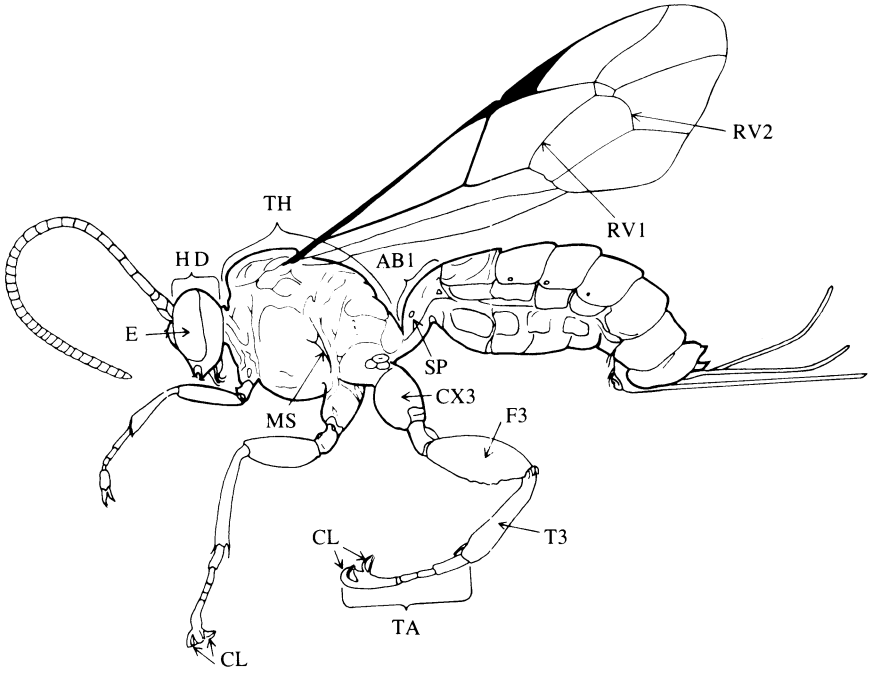


Figure 35.—

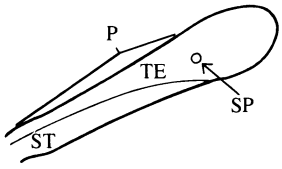


Figure 36.—

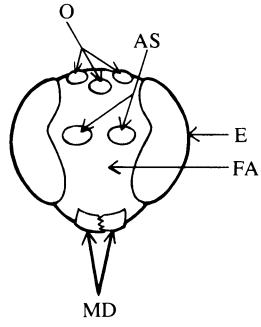


Figure 37.—

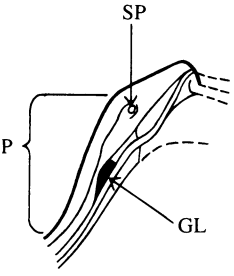


Figure 38.—

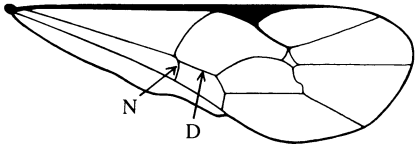


Figure 39.—

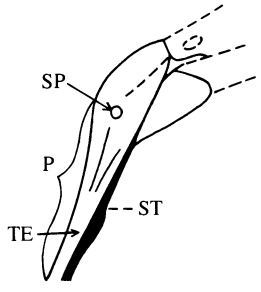


Figure 40.—

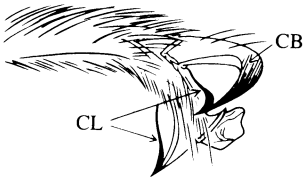


Figure 41.—

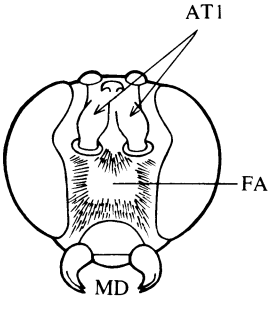
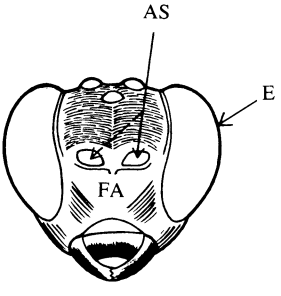


Figure 42.—



Figures 43–50.—Braconidae

43. *Apanteles melanoscelus* (Ratzeburg), front wing
44. *Meteorus pulchricornis* (Wesmael), front wing
45. *M. pulchricornis* (Wesmael), propodeum and first abdominal segment (dorsal view)
46. *Rogas indiscretus* Reardon, propodeum and first abdominal segment (dorsal view).
47. *R. indiscretus* Reardon, head (facial view).
48. *Apanteles porthetriae* Muesebeck, anterior of abdomen (dorsal view).
49. *A. melanoscelus* (Ratzeburg), abdomen (dorsal view).
50. *A. liparidis* (Bouché), anterior of abdomen (dorsal view).

AB1—First abdominal tergite
AB2—Second abdominal tergite
AB3—Third abdominal tergite
AT1—First antennal segment
C1—First cubital cell
C2—Second cubital cell
C3—Third cubital cell
CL—Clypeus
CU—Cubitus
E—Eye
FA—Face
IC1—First intercubitus
IC2—Second intercubitus
MD—Mandible
PR—Propodeum
R—Radius
RV1—First recurrent vein
ST—Stigma

Figure 43.—

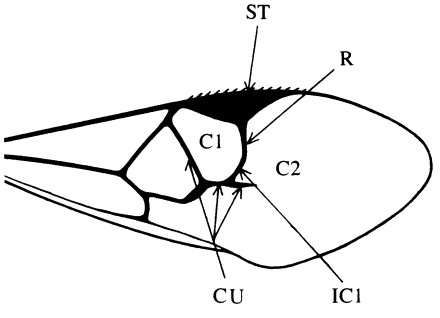


Figure 44.—

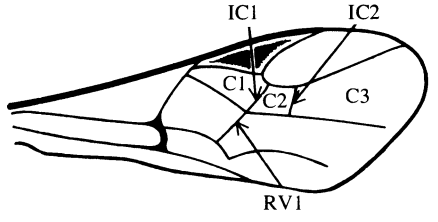


Figure 45.—

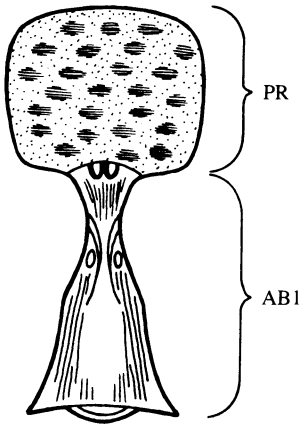


Figure 46.—

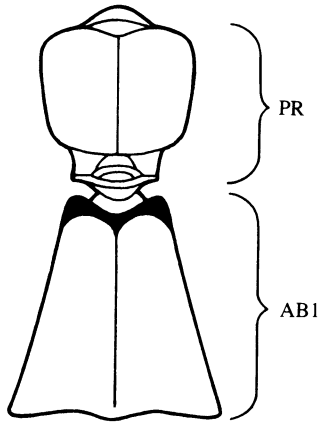


Figure 47.—

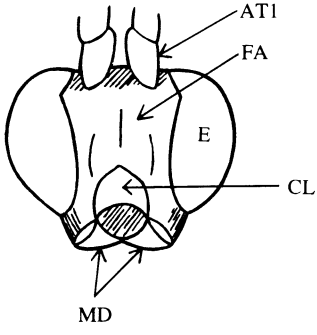


Figure 48.—

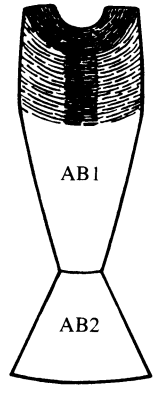


Figure 49.—

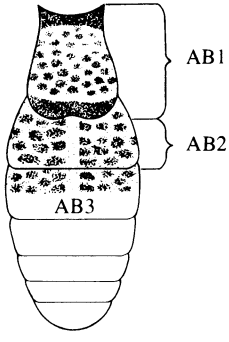
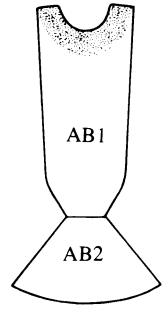


Figure 50.—



Figures 51–62.—Chalcididae, Encyrtidae, Eupelmidae, Scelionidae, and Torymidae.

51. *Brachymyeria* sp., head (lateral view).
52. *Brachymeria* sp., hind leg.
53 *Anastatus disparis* Ruschka, front wing.
54. *Telenomus* sp., front wing.
55. *Monodontomerus* sp. (lateral view without legs).
56. *Ooencyrtus kuvanae* (Howard) (lateral view without antennae and legs).
57. *O. kuvanae* (Howard), front wing.
58. *O. kuvanae* (Howard), thorax (dorsal view).
59. *Anastatus disparis* Ruschka, male, thorax (dorsal view).
60. *A. disparis* Ruschka, female, thorax (dorsal view).
61. Scelionidae, thorax without appendages (lateral view).
62. Chalcidoidea, thorax (lateral view) (diagrammatic).

AX—Axilla
CT—Coxal tooth
CX1—Front coxa
CX2—Middle coxa
CX3—Hind coxa
E—Eye
F3—Hind femora
FC—Frontal carina
FG—Femoral groove
GM—Genotemporal margin
MN—Mesonotum
MP—Mesopleuron
MV—Marginal vein
NE—Notauli
PC—Postorbital carina
PR—Pronotum
SC—Scutellum
SM—Submarginal vein
SV—Stigmal vein
T3—Hind tibia
TE—Tegula

Figure 51.—

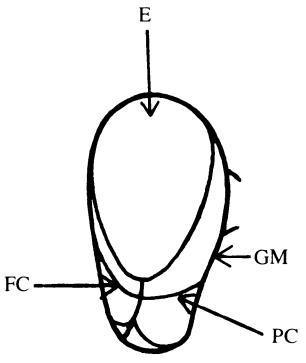


Figure 52.—

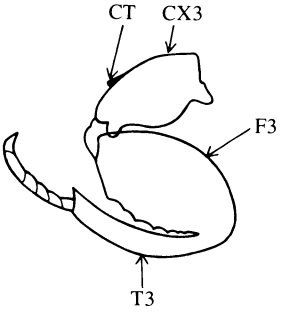


Figure 53.—

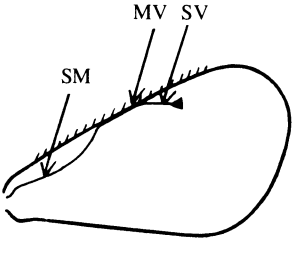


Figure 54.—

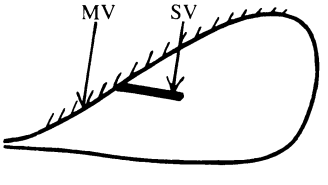


Figure 55.—

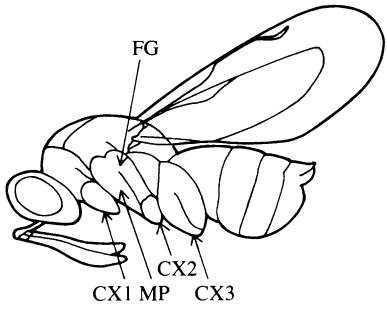


Figure 56.—

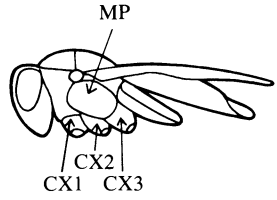


Figure 57.—

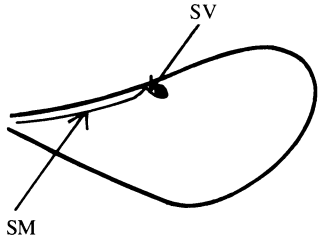


Figure 58.—

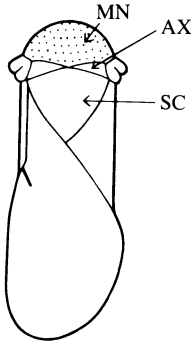


Figure 59.—

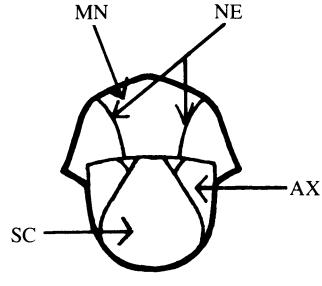


Figure 60.—

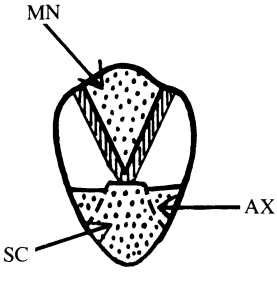


Figure 61.—

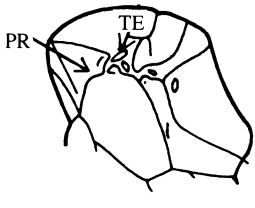
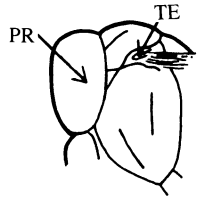


Figure 62.—



Figures 63–72.—Puparia of Tachinidae (on left, posterior end; on right, spiracular plates, subspiracular protuberance, and distance from anus).

63. *Parasetigena silvestris*
64. *Palexorista inconspicua*
65. *Blepharipa pratensis*
66. *Compsilura concinnata*
67. *Carcelia amplexa*
68. *Lespesia aletiae*
69. *Lespesia frenchii*
70. *Eusisyropa virilis*
71. *Nemorilla pyste*
72. *Blondelia nigripes*

SP—Spiracular plate
SS—Spiracular slit
SSP—Subspiracular protuberance
A—Anus

Figure 63.—

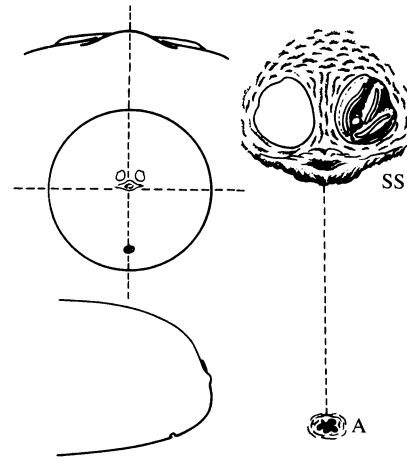


Figure 64.—

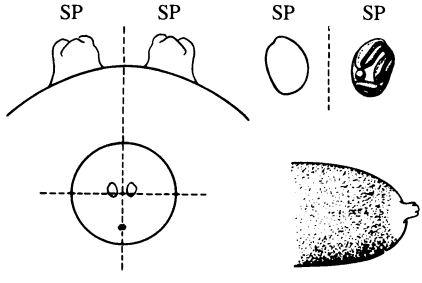


Figure 65.—

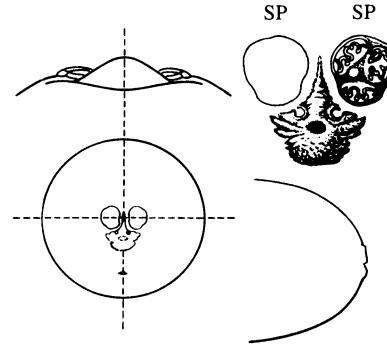


Figure 66.—

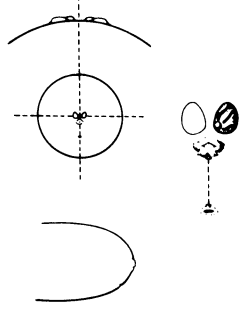


Figure 67.—

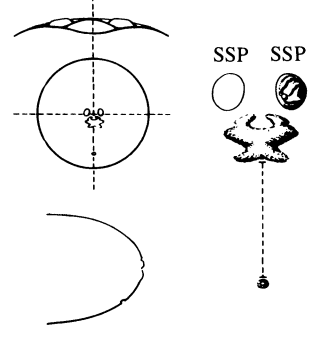


Figure 68.—

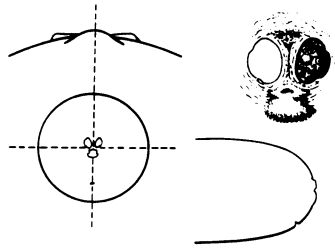


Figure 69.—

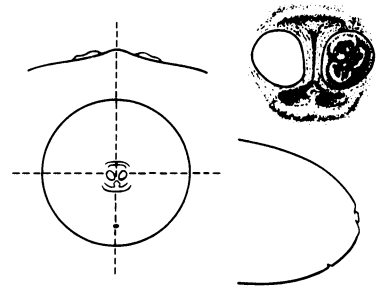


Figure 70.—

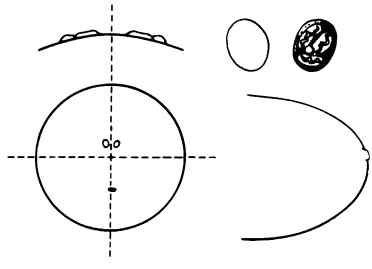


Figure 71.—

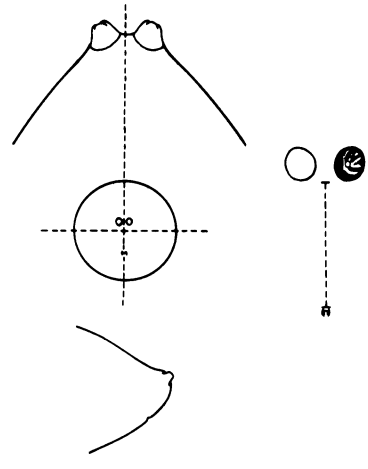
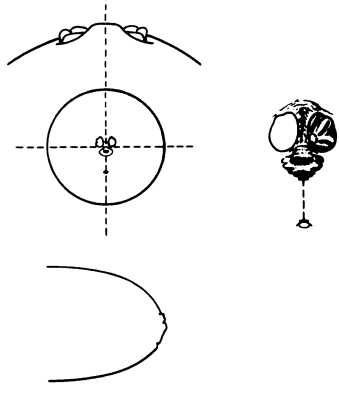


Figure 72.—



Figures 73–75.—Cocoons of Ichneumonidae

73. *Meteorus pulchricornis* Wesmael
74. *Hyposoter tricoloripes* (Viereck)
75. *Phobocampe disparis* (Viereck)

Figure 73.—

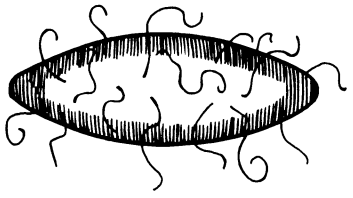


Figure 74.—

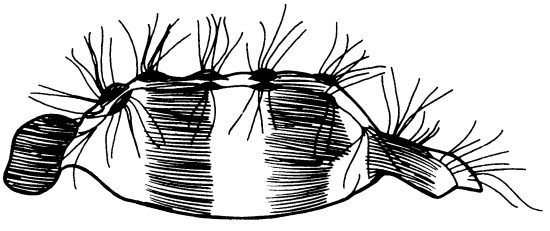
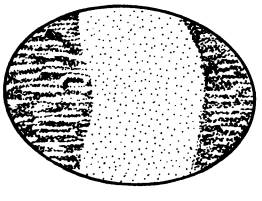


Figure 75.—



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