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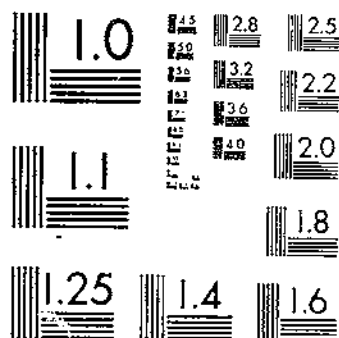
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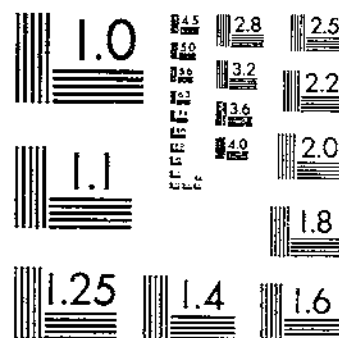
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TB 1429 (1971) USDA TECHNICAL BULLETINS NEARCTIC SAWFLIES, III, HETERARTHRIINAE ADULTS AND LARVAE
SMITH, D. R. 1 OF 2

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NEARCTIC SAWFLIES

III. Heterarthrinae: Adults and Larvae (Hymenoptera: Tenthredinidae)

By **DAVID R. SMITH**

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NEARCTIC SAWFLIES.

III. Heterarthrinae: Adults and Larvae (Hymenoptera: Tenthredinidae)

By DAVID R. SMITH, *entomologist, Systematic Entomology Laboratory,
Agricultural Research Service*

The Heterarthrinae are represented in America north of Mexico by 37 species in 12 genera and three tribes. This subfamily includes some of the most economically important sawflies, such as the birch leaf miner (*Fenusa pusilla* (Lepeletier)), the elm leaf miner (*Fenusa ulmi* Sundevall), the European alder leaf miner (*Fenusa dohrnii* (Tischbein)), the rose-slug (*Endelomyia aethiops* (Fabricius)), and the pear-slug (*Caliroa cerasi* (Linnaeus)). Members of the tribes Heterarthrini and Fenusini all are leaf miners in the larval stage and may be destructive to *Alnus*, *Betula*, *Crataegus*, *Platanus*, *Populus*, *Potentilla*, *Prunus*, *Quercus*, *Rubus*, *Salix*, *Ulmus*, and *Viola*. Members of the tribe Caliroini are external feeders in the larval stage and skeletonize the leaves of *Castanea*, *Nyssa*, *Prunus*, *Pyrus*, *Quercus*, *Rosa*, and *Salix*.

This bulletin is the first comprehensive revision of the Heterarthrinae and is intended to provide a means for identifying the Nearctic genera and species of this subfamily. Other information may be found in the literature cited, which includes most of the pertinent literature for each taxon.

The subfamily limits accepted here are those proposed by Ross (1937, 1951).¹ Specimens may be keyed to this subfamily by using Ross' 1937 key to the subfamilies of Tenthredinidae. The name "Phyllotominae" was used for this subfamily at that time. Benson (1952) treated the components of this group in a different manner. His concept of the subfamily Heterarthrinae was more limited and included only the genus *Heterarthrus*. *Caliroa* and *Endelomyia* were included in the tribe Caliroini of the Blennocampinae, and the Fenusini were also considered a tribe in the Blennocampinae.

The adults of the Heterarthrinae may be characterized as follows: Vein *M* and 1*m-cu* of forewing divergent; vein *M* meets *Sc* + *R* at or near junction of *Rs* + *M* and *Sc* + *R*; vein 2*A* and 3*A* complete for entire length, connected to 1*A* by oblique crossvein in Caliroini and Heterarthrini, or vein 2*A* and 3*A* partially atrophied, leaving anal cell petiolate and vein 2*A* and 3*A* present as stub, which may be straight, curved up, or curved up and meeting

¹ The year in italic after the author's name is the key to the reference in Literature Cited, p. 69.

1A to form small basal anal cell in the Fenusini. The wing venation of various species is shown in plates I, 1-9; II, 10-18; and III, 19-20. In general, these sawflies are small black robust species.

The sawflies of the Heterarthrinae are divided into three groups, each composed of closely related genera, and here treated as the tribes Caliroini, Heterarthrini, and Fenusini.

The Caliroini include two genera, *Endelomyia* and *Caliroa*, which are separated from the other tribes by the complete 2A and 3A vein of the forewing and the tarsal claw with a single outer tooth and large acute basal lobe.

Heterarthrus is the only genus in the Heterarthrini, which is a Palearctic group with only one introduced species found in North America. This tribe is separated from the others by the complete 2A and 3A vein of the forewing, the 10- or 11-segmented antenna, and the tarsal claw with two subequal outer teeth and a large acute basal lobe.

The Fenusini, represented in North America by nine genera, are separated from the other tribes by the petiolate anal cell of the forewing and with only the basal stub of vein 2A and 3A present. The genera in this tribe may be divided further into three groups: (1) Those genera with cell *R*₁ closed in the hindwing—*Messa*, *Metalus*, and *Setabara*; (2) those genera with cell *R*₁ open in the hindwing, with a simple tarsal claw, and with the stub of vein 2A and 3A of the forewing curved up and meeting 1A to form a small basal anal cell—*Fenusia*, *Fenella*, and *Prolatus*; (3) those genera with cell *R*₁ open in the hindwing, with a tarsal claw having a large acute basal lobe, and with the stub of vein 2A and 3A of the forewing either straight or curved up at its apex—*Profenusia*, *Bidigitus*, and *Nefusa*.

The larvae of the Heterarthrinae fall into three distinct groups:

(1) The typically sawflylike larva of *Endelomyia aethiops*, an external feeder (pl. XI, 130-136). The body is neither flattened nor sluglike (or tadpolelike) in appearance. The larva of this species may be separated from other sawfly larvae by the mandibles, which have four truncate teeth on the ventral margin and by the presence of tubercles on the thorax, on annulets 2 and 4 of abdominal segments 1 to 8, and on terga 9 and 10.

(2) The sluglike or tadpolelike larvae of *Caliroa*, all external feeders (pl. XI, 137-141). These larvae have an enlarged thorax with the body sharply narrowing at the base and toward the apex of the abdomen; the head is hypognathous; the thoracic legs are reduced in size; and a large fleshy protuberance stems anteriorly from each prothoracic leg.

(3) The small dorsoventrally flattened larvae of the Heterarthrini and Fenusini (pls. XII-XVIII), all leaf miners. The head is usually dorsoventrally flattened and prognathous; the thoracic legs are usually reduced, sometimes lacking tarsal claws; various numbers of sclerotized plates are present on the venter of the body; and the prolegs are reduced or wanting.

The larvae are not well known for the *Caliroa* species, but they are well known for most of the leaf-mining species. Many

of the leaf-mining species have been reared and the larvae have been described in the literature.

The terminology used in this revision is that of Ross (1937) and Smith (1969) for adults and that of Yuasa (1922), Lorenz and Kraus (1957), and Smith (1969) for larvae. I have examined the types of all species discussed in this bulletin except those located in Europe.

Hosts

The known host plants for the North American species of Heterarthrinae are as follows:

<i>Plant family and genus</i>	<i>Insect species</i>
Salicaceae:	
<i>Salix</i>	{ <i>Caliroa ladrata</i> MacGillivray <i>Messa wuestnei</i> (Konow)
<i>Populus</i>	{ <i>Messa hortulana</i> (Klug) <i>Messa leucostoma</i> (Rohwer) <i>Messa populifoliella</i> (Townsend)
Betulaceae:	
<i>Betula</i>	{ <i>Fenusa pusilla</i> (Lepeletier) <i>Heterarthrus nemoratus</i> (Fallén) <i>Messa nana</i> (Klug) <i>Profenusa thomsoni</i> (Konow)
<i>Alnus</i>	<i>Fenusa dohrnii</i> (Tischbein)
Fagaceae:	
<i>Quercus</i>	{ <i>Caliroa fasciata</i> (Norton) <i>Caliroa lobata</i> MacGillivray <i>Caliroa obsoleta</i> (Norton) <i>Caliroa petiolata</i> , new species <i>Caliroa quercuscoccinea</i> (Dyar) <i>Profenusa alumna</i> (MacGillivray) <i>Profenusa inspirata</i> (MacGillivray) <i>Profenusa lucifex</i> (Ross)
<i>Castanea</i>	<i>Caliroa lorata</i> MacGillivray
Ulmaceae:	
<i>Ulmus</i>	<i>Fenusa ulmi</i> Sundevall
Platanaceae:	
<i>Platanus</i>	<i>Bidigitus platani</i> (Burks)
Cornaceae:	
<i>Nyssa</i>	<i>Caliroa nyssae</i> , new species
Violaceae:	
<i>Viola</i>	<i>Nefusa ambigua</i> (Norton)
Rosaceae:	
<i>Rosa</i>	<i>Endelomyia aethiops</i> (Fabricius)
<i>Rubus</i>	{ <i>Metallus capitalis</i> (Norton) <i>Metallus rohweri</i> MacGillivray
<i>Crataegus</i>	<i>Profenusa canadensis</i> (Marlatt)
<i>Potentilla</i>	<i>Fenella nigrita</i> Westwood

<i>Prunus</i>	{ <i>Caliroa cerasi</i> (Linnaeus) <i>Caliroa liturata</i> MacGillivray <i>Profenusa canadensis</i> (Marlatt) <i>Setabara histrionica</i> (MacGillivray) (?)
<i>Pyrus</i>	<i>Caliroa cerasi</i> (Linnaeus)

The *Caliroa* species recorded on *Ceanothus*, *Cotoneaster*, and *Acer* by Smith (1967) are larvae only. They cannot be ascribed to a particular species.

Systematic Arrangement

Family TENTHREDINIDAE

Subfamily HETERARTHRIINAE

Tribe CALIROINI

Genus *Endelomyia* Ashmead

(1) *Endelomyia aethiops* (Fabricius); British Columbia, Colorado, Connecticut, Delaware, District of Columbia, Idaho, Illinois, Kansas, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Montana, New Jersey, New York, Ohio, Oregon, Pennsylvania, Utah, Virginia, Washington; Palearctic; on *Rosa*.

Genus *Caliroa* O. Costa

(2) *Caliroa cerasi* (Linnaeus); widespread in North America; also in Australia, New Zealand, South Africa, South America; Palearctic; on *Prunus*, *Pyrus*, other Rosaceae.

(3) *Caliroa distincta*, new species; British Columbia, California, Nevada, Oregon.

(4) *Caliroa fasciata* (Norton); Connecticut, Illinois, Iowa, Maine, Maryland, New Jersey, New York, Ohio, Ontario, Virginia; on *Quercus*.

(5) *Caliroa floridana*, new species; Florida.

(6) *Caliroa hyalina*, new species; Oregon.

(7) *Caliroa labrata* MacGillivray; Alberta, British Columbia, California, Nevada, Oregon; on *Salix*.

(8) *Caliroa liturata* MacGillivray; Colorado, Connecticut, Florida, Georgia, Illinois, Louisiana, Missouri, Montana, New York, Rhode Island, South Carolina, Tennessee, Virginia; on *Prunus*.

(9) *Caliroa lobata* MacGillivray; Illinois, Iowa, Maryland, Michigan, New York, Texas, Vermont, Virginia; on *Quercus*.

(10) *Caliroa lorata* MacGillivray; Alabama, Maine, Maryland, Massachusetts, New York, North Carolina, Pennsylvania, Virginia, Wisconsin; on *Castanea*.

(11) *Caliroa lunata* MacGillivray; Illinois, Michigan, Newfoundland, New Hampshire, New York, Ohio, Pennsylvania, Texas, Virginia, West Virginia.

(12) *Caliroa nyssae*, new species; Georgia, Maryland, Mississippi, Pennsylvania, Virginia; on *Nyssa*.

(13) *Caliroa obsoleta* (Norton); Connecticut, Georgia, Illinois, Iowa, Massachusetts, Michigan, Minnesota, New Jersey, New York, Ontario, Virginia, Wisconsin; on *Quercus*.

(14) *Caliroa petiolata*, new species; Maryland, Pennsylvania, Virginia; on *Quercus*.

(15) *Caliroa quercuscoccineae* (Dyar); Connecticut, Delaware, District of Columbia, Illinois, Louisiana, Maine, Maryland, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, North Carolina, Pennsylvania, Virginia, Wisconsin; on *Quercus*.

Tribe HETERARTHRIINI

Genus *Heterarthrus* Stephens

(16) *Heterarthrus nemoratus* (Fallén); Maine, Massachusetts, New Brunswick, Newfoundland, New Hampshire, New York, Nova Scotia, Ontario, Quebec; Palearctic; leaf miner of *Betula*.

Tribe FENUSINI

Genus *Metallus* Forbes

(17) *Metallus bensoni*, new species; British Columbia, New York.

(18) *Metallus capitalis* (Norton); British Columbia, Illinois, Maine, New Brunswick, Newfoundland, New Hampshire, New York, Oregon, Quebec; leaf miner of *Rubus*.

(19) *Metallus rohweri* MacGillivray; Connecticut, Delaware, Florida, Illinois, Maine, Maryland, Massachusetts, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Ontario, Pennsylvania, Rhode Island, Virginia, Wisconsin; leaf miner of *Rubus*.

Genus *Messa* Leach

(20) *Messa hortulana* (Klug); Massachusetts; Palearctic; leaf miner of *Populus*.

(21) *Messa leucostoma* (Rohwer); Alberta, California, Colorado, Iowa, Minnesota, New Brunswick, Oregon, Washington; leaf miner of *Populus*.

(22) *Messa nana* (Klug); Maine, New York; Palearctic; leaf miner of *Betula*.

(23) *Messa populifoliella* (Townsend); Arizona, Colorado, Connecticut, Michigan, New Brunswick, New Mexico, Ontario, South Dakota; leaf miner of *Populus*.

(24) *Messa wuesneii* (Konow); Alaska, British Columbia, California, Colorado, Nevada; Palearctic; leaf miner of *Salix*.

Genus *Setabara* Ross

(25) *Setabara histrionica* (MacGillivray); California, Colorado, Idaho, Nevada, Oregon, Washington; leaf miner of *Prunus* (?).

Genus *Profenusa* MacGillivray

(26) *Profenusa alumna* (MacGillivray); Illinois, Maine, Maryland, New York, Pennsylvania, Virginia; leaf miner of *Quercus*.

(27) *Profenusa canadensis* (Marlatt); Arkansas, District of Columbia, Illinois, Iowa, Kentucky, Maine, Massachusetts, Michigan, Missouri, New York, Ontario, Pennsylvania, Quebec, Texas; leaf miner of *Crataegus* and *Prunus*.

(28) *Profenusa inspirata* (MacGillivray); California, Nevada, Oregon; leaf miner of *Quercus*.

(29) *Profenusa lucifex* (Ross); Illinois, Maine, New York, Ontario; leaf miner of *Quercus*.

(30) *Profenusa thomsoni* (Konow); Connecticut, Maine, Ontario, Quebec, Vermont; Palearctic; leaf miner of *Betula*.

Genus *Bidigitus* Smith

(31) *Bidigitus platani* (Burks); California; leaf miner of *Platanus*.

Genus *Nefusa* Ross

(32) *Nefusa ambigua* (Norton); Maine, Maryland, Massachusetts, Michigan, New York, Ohio, Pennsylvania, Quebec, Tennessee, Wisconsin; leaf miner of *Viola*.

Genus *Prolatus* Smith

- (33)
- Prolatus artus*
- Smith; Oregon.

Genus *Fenusa* Leach

(34) *Fenusa dohrnii* (Tischbein); Alberta, British Columbia, Colorado, Connecticut, Illinois, Maine, Massachusetts, Michigan, New Brunswick, Newfoundland, New Hampshire, New Mexico, New York, Nova Scotia, Ontario, Oregon, Pennsylvania, Saskatchewan, Utah, Washington; Palaearctic; leaf miner of *Alnus*.

(35) *Fenusa pusilla* (Lepeletier); Connecticut, Maine, Massachusetts, New Brunswick, Newfoundland, New Hampshire, New Jersey, New York, Nova Scotia, Ontario, Oregon, Quebec, Vermont; Palaearctic; leaf miner of *Betula*.

(36) *Fenusa ulmi* Sundevall; Massachusetts, Michigan, New York, Ontario, Quebec; Palaearctic; leaf miner of *Ulmus*.

Genus *Fenella* Westwood

(37) *Fenella nigrita* Westwood; Connecticut, Maine, Michigan, Ontario; Palaearctic; leaf miner of *Potentilla*.

Keys to Heterarthrinae Genera

ADULTS

1. Forewing with vein 2A and 3A complete for its entire length, connected to 1A by oblique crossvein (pl. I, 1, 3, 8) 2
Forewing with anal cell petiolate, basal section of 2A and 3A atrophied with only basal stub present or curving up to meet 1A and forming small basal anal cell (pl. II, 10, 12, 14, 17; pl. III, 19); *Fenusini* 4
2. Antenna with 10 or more segments (pl. III, 31); tarsal claw with two subequal outer teeth and large acute basal lobe (pl. III, 23); head markedly depressed between eyes (pl. III, 30); Heterarthrini
Heterarthrus Stephens
Antenna nine-segmented (pl. IV, 40-42); tarsal claw with one outer tooth and large acute basal lobe (pl. III, 22); head convex between eyes (pl. III, 29); Caliroini 3
3. Apical four antennal segments not reduced, segments beyond second gradually decreasing in length (pl. IV, 42); basal emargination of anal cell of forewing with short basally projecting spur (pl. I, 1); anal cell of hindwing petiolate (pl. I, 2) *Endelomyia* Ashmead
Apical four antennal segments reduced in length, together only slightly longer than third segment (pl. IV, 40, 41); basal emargination of anal cell of forewing without spur (pl. I, 3); anal cell of hindwing sessile or petiolate (pl. I, 4, 5) *Caliroa* O. Costa
4. Cell R₁ of hindwing open at apex (pl. II, 15, 16, 18) 5
Cell R₁ of hindwing closed (pl. II, 11, 13) 10
5. Tarsal claw with one or two outer teeth and large acute basal lobe (pl. III, 22, 23); stub of 2A and 3A of forewing straight or curved up at apex (pl. II, 14, 17); hindwing with anal cell present or absent (pl. II, 15, 16) 6
Tarsal claw simple or with small inner tooth, basal lobe absent (pl. III, 21); stub of 2A and 3A of forewing curved up, meeting 1A to form small basal anal cell (pl. III, 19); hindwing with anal cell absent (pl. III, 20) 8
6. Tarsal claw with two subequal outer teeth (pl. III, 23) *Bidigitus* Smith
Tarsal claw with single outer tooth (pl. III, 22) 7
7. Prepectus present *Nefusa* Ross
Prepectus absent *Profenusa* MacGillivray

8. Antenna long and slender, third and fourth segments subequal in length (pl. III, 37); foretarsus $1\frac{1}{2}$ times or more longer than foretibia (pl. III, 25) *Prolatus* Smith
 Antenna stout, third segment longer than fourth segment (pl. III, 32-34); foretarsus subequal in length to foretibia (pl. III, 26) 9
9. Antenna with 10 or 11 segments (pl. III, 34); hindtarsus with fourth segment not conspicuously produced apically (pl. III, 28) *Fenella* Westwood
 Antenna nine-segmented (pl. III, 32, 33); hindtarsus with fourth segment conspicuously produced apically (pl. III, 27) *Fenusa* Leach
10. Tarsal claw with small indistinct lobe at base, appearing simple (pl. III, 24) *Setabara* Ross
 Tarsal claw with large acute basal lobe (pl. III, 22) 11
11. Second antennal segment broader than long (pl. III, 33, 39); third and fourth antennal segments usually subequal in length *Metallus* Forbes
 Second antennal segment longer than broad (pl. III, 35, 36); third antennal segment usually longer than fourth segment *Messa* Leach

LARVAE

(based on final feeding stage)

1. Sluglike or typically sawflylike in appearance; body cylindrical, not dorsoventrally flattened; head round, not dorsoventrally flattened; prolegs distinct; external feeders (pl. XI) 2
 Modified; body dorsoventrally flattened; head usually dorsoventrally flattened; prolegs reduced or absent; leaf miners (pls. XII-XVIII) 3
2. Head higher than wide; membranous process stemming anteriorly from each prothoracic leg; body largest in region of thorax, distinctly narrowing toward apex of abdomen; anal prolegs united (pl. XI, 137) *Caliroa* O. Costa
 Head round; prothoracic legs without membranous processes; body cylindrical, not sharply tapering toward apex; anal prolegs separated (pl. XI, 130-132) *Endelomyia* Ashmead
3. Prolegs absent; each coxa of thoracic legs with three small tubercles; on *Quercus*, *Betula* (pl. XIV, 179; pl. XV, 181, 184, 189, 190; pl. XVI, 200) *Profenusa* MacGillivray (pt.)
 Prolegs present, although reduced; coxae without tubercles 4
4. Prolegs present on abdominal segments 2 to 7 and 10; on *Rubus* (pl. XIII, 159-161) *Metallus* Forbes
 Prolegs present on abdominal segments 2 to 8 and 10 5
5. Each proleg surrounded by well-defined crescentlike dark area (pl. XII, 152, 153; pl. XIV, 164) 6
 Prolegs without dark areas, or present only around anal proleg 7
6. Mesosternum, metasternum, and sternum of first abdominal segment with dark plates; on *Populus*, *Betula*, *Salix* (pl. XII, 152, 153; pl. XIV, 164) *Messa* Leach
 Mesosternum, metasternum, and sternum of first abdominal segment without plates; on *Crataegus* (pl. XVI, 201, 202) *Profenusa* MacGillivray (pt.)
7. Dark crescentlike plate surrounding anal proleg; on *Betula* (pl. XII, 143) *Heterarthrus* Stephens
 Anal proleg without dark plate 8
8. Mesosternum and metasternum without dark plates; on *Platanus* (pl. XVII, 212) *Bidigitus* Smith
 Mesosternum and metasternum with light or dark plates; not on *Platanus* 9
9. First abdominal sternum without dark plate; on *Ainus* *Fenusa* Leach (pt.)
 First abdominal sternum with dark plate; not on *Ainus* 10

10. Ninth abdominal sternum with cluster of small spines; small spines about prolegs on segments 6 to 8 and at center of sterna 1 to 6; on *Ulmus* (pl. XVIII, 220-222) *Fenusa* Leach (pt.) 11
 Abdomen and prolegs smooth, without spines
11. Plates on thoracic sterna and first abdominal sternum very dark, rectangular in shape, longer than wide; on *Betula* (pl. XVIII, 232, 233) *Fenusa* Leach (pt.)
 Plates lighter, that of prosternum wider than long, those of mesosternum, metasternum, and first abdominal sternum small; on *Potentilla* (pl. XVII, 213, 214) *Fenella* Westwood

Keys to Leaf-Mining Larvae of *Betula* and *Quercus*

BETULA

1. Prolegs absent; each coxa with three small tubercles on inner anterior surface; thoracic legs short, tarsal claw absent (pl. XV, 181, 182, 184) *Profenusa thomsoni* (Konow)
 Prolegs present, reduced; coxae without small tubercles; thoracic legs longer, distinctly segmented, tarsal claw present, sometimes reduced 2
2. Anal proleg without dark ring (pl. XVIII, 232) *Fenusa pusilla* (Lepelletier)
 Anal proleg with dark ring (pl. XII, 143, 153) 3
3. Each proleg with dark ring (pl. XII, 152, 153) *Messa nana* (Klug)
 Only anal proleg with dark ring (pl. XII, 142, 143) *Heterarthrus nemoratus* (Fallén)

Hering (1937) compared the birch leaf-mining species of Europe, and Lindquist (1959) gave a key to three birch leaf-mining species of Ontario.

QUERCUS

1. Mesosternum with dark plate (pl. XIV, 179) *Profenusa inspirata* (MacGillivray)
 Mesosternum without dark plate (pl. XV, 189) 2
2. Thoracic legs each with minute tarsal claw; antenna longer with distinct apical segment (pl. XVI, 199, 200) *Profenusa lucifex* (Ross)
 Tarsal claws absent; antenna without small apical segment (pl. XV, 190, 192) *Profenusa alumna* (MacGillivray)

Tribe CALIROINI

The tribe Caliroini includes two genera, *Endelomyia* and *Caliroa*, the larvae of which are external feeders on the leaves of various trees and shrubs. The adults are recognized by the complete vein 2A and 3A of the forewing, connected to 1A by an oblique cross-vein, the nine-segmented antenna, and the tarsal claw with a single outer tooth and a large acute basal lobe. The larvae may be distinguished as outlined in the introductory discussion on larvae.

Genus ENDELOMYIA Ashmead

Endelomyia Ashmead, 1898, p. 256; Konow, 1905, p. 74 (= *Eriocampoides* Konow); MacGillivray, 1909b, p. 346; Rohwer, 1911b, p. 100 (= *Caliroa* O. Costa); Ross, 1937, p. 70 (= *Caliroa* O. Costa); Benson, 1938, p. 368; Benson, 1940, p. 214; Ross, 1951, p. 28; Benson, 1952, p. 96; Malaise, 1957, p. 18; Malaise, 1963, p. 176; Smith, 1967, p. 279.

Type-species: "*M. rosae* Harris." Original designation (see discussion below).

Description.—Second antennal segment longer than broad; third segment longer than fourth segment; segments beyond third gradually decreasing in length, apical four segments not reduced (pl. IV, 42). Clypeus truncate; malar space less than diameter of front ocellus. Prepectus absent. Tarsal claw with single outer tooth and large acute basal lobe (pl. III, 22). Forewing with vein 2A and 3A complete, connected to 1A by oblique crossvein; basal angle of vein 2A and 3A with short basally projecting spur (pl. I, 1). Hindwing with anal cell petiolate; cell *M* present, cell *Rs* absent (pl. I, 2).

A single Holarctic species is in this genus, *aethiops* (Fabricius), which is an external feeder in the larval stage on the foliage of *Rosa*.

The type-species was designated as "*M. rosae* Harris" by Ashmead (1898). This species was originally described by Harris (1841) as *Selandria rosae* and is a synonym of *aethiops*.

Description of *Endelomyia* Species*Endelomyia aethiops* (Fabricius)

Tenthredo aethiops Fabricius, 1781, p. 416; Fabricius, 1787, p. 256; Gmelin, 1790, p. 2662; Fabricius, 1793, p. 121; Fabricius, 1804, p. 39; Klug, 1814, p. 66; Klug, 1819, p. 84; Lepeletier, 1823, p. 112; Hartig, 1837, p. 268; Zetterstedt, 1838, p. 339; Ratzeburg, 1844, p. 130; Gorski, 1852, p. 191.

Allantus aethiops: Jurine, 1807, p. 56.

Hylotoma aethiops: Fallén, 1807, p. 209.

Nematus aethiops: Spinola, 1808, p. 155.

Phyllotoma aethiops: Fallén, 1829, p. 33.

Selandria aethiops: Stephens, 1835, p. 51; Westwood, 1850, p. 207; Kaltenbach, 1867, p. 92; Kaltenbach, 1874, p. 221.

Blennocampa aethiops: Costa, 1850, p. 48; Kaltenbach, 1874, p. 200.

Eriocampa aethiops: Cameron, 1876b, p. 192; Konow, 1886a, p. 109.

Eriocampoides aethiops: Konow, 1890, p. 248; Dalla Torre, 1894, p. 192; Konow, 1905, p. 74.

Caliroa aethiops: Enslin, 1914, p. 253; Middleton, 1922, p. 12; Dovnar-Zapolsky, 1929, p. 15; Johnson, 1930, p. 93; Dovnar-Zapolsky, 1931, p. 55; Balachowsky and Mesnil, 1935, p. 234; Smith, Kelley, Dean, et al., 1943, p. 384; Hardouin, 1945, p. 161; Berland, 1947, p. 270; Schuh and Mote, 1948, p. 125; Dominguez Garcia-Tejero, 1950, p. 185; Tadic, 1956, p. 18.

Endelomyia aethiops: MacGillivray, 1909b, p. 346; Yuasa, 1922, p. 58; Miles, 1935, p. 126; Benson, 1940, p. 214; Ross, 1951, p. 28; Benson, 1952, p. 96; Maxwell, 1955, p. 54; Peterson, 1956, p. 268; Malaise, 1957, p. 18; Lorenz and Kraus, 1957, p. 113; Benson, 1962, p. 391; Smith, 1967, p. 279; Benson, 1968, p. 148.

Selandria rosae Harris, 1841, p. 380; Norton, 1861, p. 223; Norton, 1867, p. 256; Scudder, 1869, p. 268; LeBaron, 1871, p. 79; Riley, 1875, p. 27; Riley, 1877, p. 19; Provancher, 1878, p. 100; Provancher, 1880, p. 127; LeBaron, 1880, p. 66; Provancher, 1883, p. 202; MacGillivray, 1909b, p. 346 (= *aethiops* Fabricius).

Eriocampa rosae: Cameron, 1882, p. 227; Dalla Torre, 1894, p. 132.

Monostegia rosae: Provancher, 1888, p. 351; Riley, 1892, p. 6; Dyar, 1895a, p. 194; Dyar, 1895b, p. 338.

Endelomyia rosae: Ashmead, 1898, p. 250; Chittenden, 1908, p. 1.

Eriocampoides rosae: Konow, 1905, p. 74; Gillette and List, 1915, p. 2.

The European synonymy for *aethiops* was given by Enslein (1914) and Benson (1952).

Female.—Average length, 4.6 mm. Black; extreme apex of each femur and all of each tibia and tarsus white to infusate; back tibia and tarsus occasionally black. Wings lightly infusate.

Sheath straight above, rounded below. Serrulae of lancet each lobelike, rounded at apex, with one anterior and one posterior subbasal tooth located near ventral margin of lancet (pl. IV, 62).

Male.—Unknown in North America. They are very rare in Europe (Benson, 1952).

Larva.—Final feeding stage (pl. XI, 130–136). Length, 13 mm. Body cylindrical, typically sawflylike, not distinctly narrowing toward apex. Yellowish green when alive; tubercles concolorous with rest of body.

Head rounded, hypognathous. Antenna conical, five-segmented. Clypeus with four setae; labrum truncate, with six setae; epipharynx with about 12 spines on each side; each mandible with ventral row of four long rectangular teeth; in addition, right mandible with one large truncate middle tooth and two sharp dorsal teeth and left mandible with one pointed middle tooth and three sharp dorsal teeth; one seta on basal angle of each mandible; maxillary palpus four-segmented, second segment with one seta, palpifer with three setae, galea conical, lacinia with 12 to 14 spines; labial palpus four-segmented.

Thoracic legs normal, five-segmented; tarsal claw present; each tibia with lateral pad; membranous process of prothoracic leg absent. Tubercles of thorax arranged as in plate XI, 130.

Prolegs on abdominal segments 2 to 8 and 10. Abdominal segments 1 to 8 each with six annulets; annulets 2 and 4 each with two small conical tubercles on each side of body; ninth segment with row of six to eight tubercles dorsally on fourth annulet; dorsum of 10th segment with eight to 10 tubercles arranged approximately in three transverse rows. Suranal and subanal areas with setae. Spiracles not winged.

The larva was described by Dyar (1895a), Yuasa (1922), Miles (1935), Peterson (1956), and Lorenz and Kraus (1957), and the internal larval anatomy was described by Maxwell (1955). The distinct mandibles and tubercle arrangement of the body will separate it from most other sawfly larvae.

Holotypes.—The location of the type of *aethiops* Fabricius is not known. Harris' type of *rosae* cannot be found.

Distribution.—Widespread in North America; Europe. The following data are limited to the State or Province and city or county of those specimens I have examined.² *British Columbia*: Agassiz; Vancouver. *Colorado*: Boulder; Ft. Collins. *Connecticut*: Lyme; Branford. *Delaware*: Newark. *District of Columbia*: Washington. *Idaho*: Lenore. *Illinois*: Algonquin; Urbana; Champaigne; Rock Island; Alto Pass; Oakwood. *Kansas*: Yates Center; Douglas Co.; Manhattan. *Kentucky*: Lexington. *Maine*: Belfast. *Massachusetts*: Wellesley. *Michigan*: Detroit; East Lansing; LaPeer Co. *Minnesota*: Olmstead Co. *Missouri*: Jackson Co.; Kansas City; Columbia. *Montana*: Bozeman. *New Jersey*: N. Brunswick. *New York*: Oswego; Ithaca; Fulton Co. *Ohio*: Sugar Grove. *Oregon*: Troutdale; Salem; Forest Grove; Langdon Lake; Corvallis; Oakville. *Pennsylvania*: Philadelphia; Montgomery Co. *Utah*: Providence. *Virginia*: Falls Church; Vienna; Arlington; Bluemont. *Washington*: Colton; Woodland.

Host.—The larva is an external feeder on the foliage of wild and cultivated roses (*Rosa* spp.).

Biology.—Numerous papers have appeared on the life history of this species. The more noteworthy are those of Harris (1841), Riley (1892), Chittenden (1908), Middleton (1922) in North America, and Miles (1935) in England.

The adults fly in May and June and oviposit in the edge of a leaf, usually in serrations. There may be from two to five eggs per leaf. Incubation is from 9 to 14 days. The young larvae feed on either side of the leaf, but the older larvae prefer the lower surface. The feeding period is from 20 to 27 days, and, on maturing, the larvae enter the soil to overwinter. There is one generation a year.

This is one of the three common sawflies that feed on the foliage of roses. The others—*Cladius isomerus* Norton and *Allantus cinctus* (L.)—are not treated in this bulletin. *C. isomerus* is univoltine and oviposits in the stems. The larva is distinctly hairy. *A. cinctus* has one or two generations a year. The larva has fewer and pointed mandibular teeth and smaller less conspicuous tubercles on the body than the larva of *aethiops*.

Discussion.—Rose-slug is the approved common name for this species. It has received much attention in the literature and was recognized as a pest of roses as early as 1841 by Harris. In Massachusetts in the 1840's it was such a pest that \$100 was offered for the most successful way to destroy it (Chittenden, 1908).

E. aethiops has sometimes been associated with the genus *Caliroa*, but the antenna and wing venation of the adult and the nonsluglike appearance of the larva separate it from species of *Caliroa*.

² Throughout this bulletin all information pertaining to distribution records is given essentially as it appeared on the insect labels.

Genus *CALIROA* O. Costa

Caliroa O. Costa, 1859, p. 59; Dalla Torre, 1894, p. 192 (= *Eriocampoides* Konow); Ashmead, 1898, p. 256; Konow, 1905, p. 74 (= *Eriocampoides* Konow); MacGillivray, 1909b, p. 347; Rohwer, 1911a, p. 119; Rohwer, 1911b, p. 100; Enslin, 1914, p. 252; Yuasa, 1922, p. 58; Ross, 1937, p. 70; Benson, 1938, p. 368; Crevecoeur and Maréchal, 1938, p. 493; Benson, 1940, p. 214; Berland, 1947, p. 269; Ross, 1951, p. 28; Benson, 1952, p. 96; Takeuchi, 1952, p. 56; Malaise, 1957, p. 18; Lorenz and Kraus, 1957, p. 111; Malaise, 1961, p. 240; Malaise, 1963, p. 176; Okutani, 1965, p. 29; Smith, 1967, p. 279.

Type-species: *Caliroa sebetia* O. Costa. Monotypic.

Eriocampoides Konow, 1890, p. 239; Dalla Torre, 1894, p. 192; Ghigi, 1904, p. 4; Konow, 1905, p. 74; MacGillivray, 1909b, p. 347 (= *Caliroa* O. Costa).

Caliroa subgenus *Eriocampoides*: Rohwer, 1911b, p. 100; Enslin, 1914, p. 252. Type-species: *Tenthredo limacina* Retzius. Designated by MacGillivray, 1909b.

Periclistoptera Ashmead, 1898, p. 255; Konow, 1905, p. 74 (= *Eriocampoides* Konow); Enslin, 1914, p. 252 (= *Caliroa* O. Costa).

Type-species: *Monostegia alba* Norton. Original designation.

Description.—Second antennal segment longer than broad; third segment longer than fourth segment; apical four segments reduced, together subequal in length to or only slightly longer than third segment (pl. IV, 40, 41). Clypeus shallowly emarginate; malar space less than diameter of front ocellus. Prepectus absent. Tarsal claw with one outer tooth and large acute basal lobe (pl. III, 22). Forewing with vein 2A and 3A present for entire length, connected to 1A by oblique crossvein; basal angle of vein 2A and 3A without basally projecting spur. Hindwing with anal cell petiolate or sessile; cells *Rs* and *M* both present, both absent, or either one or the other present (pl. I, 3–5). Hindwing of male with peripheral vein (except *cerasi*) (pl. I, 6–7).

MacGillivray (1909b) treated 15 species of *Caliroa* from North America and gave a key to species that is based on variable and ambiguous characters and is impossible to use. Ross (1951) listed 15 species, but he did not express most of the synonymy. The present revision treats 14 species, five of which are new. Benson (1952) reported four species from England and Okutani (1965) seven species from Japan. There are probably about 30 world species.

This revision is based largely on the female genitalia and hindwing venation. Males have not been associated with some species, are less commonly collected, and their recognition characters are not so obvious as those of the female, although slight differences do exist in their genitalia, venation of the hindwing, and coloration. The relative lengths of the antennal segments and coloration of the tibiae and tarsi of the females sometimes have been used in the taxonomy of *Caliroa*; however, these characters are variable, vague, and difficult to see and describe, and they are not relied upon in this revision.

On the basis of the females, two groups of *Caliroa* may be recognized: (1) Those species that have the anal cell of the hindwing petiolate and cells *Rs* and *M* usually absent and (2) those species

that have the anal cell of the hindwing sessile and cells *Rs* and *M* either both present or at least one or the other present. These venational characters are one of the major divisions in the key to species. Occasionally abnormal specimens appear, and these should be taken through both parts of the key for correct determination.

Caliroa larvae are easily distinguished from larvae of other sawflies by their sluglike or tadpolelike appearance and by the presence of a fleshy protuberance extending anteriorly from each prothoracic leg (pl. XI, 137). They are usually covered with a dark or transparent slime. The head is hypognathous and the thorax is enlarged, with the body distinctly narrowing toward the posterior.

Larvae have not been associated with enough species of *Caliroa* to permit a key for their separation. Larval material is available for study from various hosts, most of it from *Prunus* and *Quercus*. However, at least two species have been associated with *Prunus* and five species with *Quercus*, and it is impossible to determine to which species the larvae belong. Also, a study of the larval material available indicates that there are few obvious characters for species separation. The most obvious character seems to be the color of the head capsule, but this color may change from amber to black in the various instars.

Dyar (1895b) attempted to separate the larvae of some species by using size and head capsule coloration, and Yuasa (1922) gave a key to five species, largely based on the same characters. However, the keys of these authors cannot be relied upon because the taxonomy of the adults was not well known at that time. Lorenz and Kraus (1957) gave a key to the larvae of four European species, which is also based on coloration. Consequently, I have not attempted a key because of the lack of associated specimens, lack of adequate characters, and the impracticality of a key leading only, for example, to "species A" or to "species B."

Caliroa includes the common pear-slug (*C. cerasi*), which feeds on a wide variety of Rosaceae in the larval stage but seems to prefer *Prunus* and *Pyrus*. Other *Caliroa* species are associated with *Castanea*, *Nyssa*, *Prunus*, *Quercus*, and *Salix*. Some adults have been collected from *Betula*, but this host is not yet authenticated. Some larvae have been taken while feeding on *Acer*, *Ceanothus*, and *Cotoneaster*, but the species are not known.

Key to *Caliroa* Species

- | | |
|--|---------------------------|
| 1. Female | 2 |
| Male | 15 |
| 2. Pronotum and mesonotum rufous | <i>floridana</i> , n. sp. |
| Thorax entirely black | 3 |
| 3. Hindlegs entirely black | <i>cerasi</i> (Linnaeus) |
| Tibia and tarsus of hindlegs partly white | 4 |
| 4. Anal cell of hindwing with short petiole; cells <i>Rs</i> and <i>M</i> usually absent (pl. I, 5) | 5 |
| Anal cell of hindwing sessile; cells <i>Rs</i> and <i>M</i> both present or either one or the other present (pl. I, 4) | 10 |
| 5. Serrulae of lancet deep, lobelike, rounded at apex (pl. V, 63, 67) | 6 |
| Serrulae of lancet shallow or pointed at apex (pl. V, 64-66, 68) | 7 |

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6. Serrulae broad, close together (pl. V, 63); western *distincta*, n. sp.
Serrulae slender, far apart (pl. V, 67); eastern *lunata* MacGillivray
7. Serrulae slender, pointed at apex (pl. V, 64); western *hyalina*, n. sp.
Serrulae broad, usually flattened at apex (pl. V, 65-66, 68); eastern
species 8
8. Lancet with 19 to 20 serrulae (pl. V, 68) *lorata* MacGillivray
Lancet with 15 to 17 serrulae 9
9. Serrulae flattened at apex, each with two anterior and two posterior
subbasal teeth (pl. V, 65) *liturata* MacGillivray
Serrulae rounded at apex, each with three or four small anterior and
two or three large posterior subbasal teeth (pl. V, 66) *petiolata*, n. sp.
10. Serrulae each with large distinct lobelike subbasal teeth (pl. V, 69;
pl. VI, 74) 11
Serrulae each with small less conspicuous subbasal teeth (pl. VI, 72,
73; pl. VII, 75, 76) 12
11. Serrulae usually with two anterior subbasal teeth (pl. V, 69);
western *labrata* MacGillivray
Serrulae usually with one anterior subbasal tooth (pl. VI, 74);
eastern *obsoleta* (Norton)
12. Lancet with 17 to 18 serrulae 13
Lancet with 20 to 21 serrulae 14
13. Serrulae of lancet evenly rounded with subbasal teeth extending to
ventral margin of lancet (pl. VII, 76); hindwing usually with cells
Rs and *M* present (pl. I, 4) *quercuscoccineae* (Dyar)
Serrulae of lancet with anterior and posterior basal margins lacking
subbasal teeth, subbasal teeth confined to rounded apex (pl. VI,
72); hindwing usually with cell *Rs* present, cell *M* absent *nyssae*, n. sp.
14. Serrulae deep, lobelike, rounded at apex (pl. VI, 73) *lobata* MacGillivray
Serrulae small, shallow, more pointed at apex (pl. VII, 75)
..... *fasciata* (Norton)
15. Hindwing without peripheral vein (males not seen; based on Benson
(1952)) *cerasi* (Linnaeus)
Hindwing with peripheral vein (pl. I, 6, 7) 16
16. Abdomen rufous with central part of dorsum usually black
..... *lobata* MacGillivray
Abdomen entirely black 17
17. Apex of anal cell of hindwing removed some distance from margin
of wing, usually by at least half the width of anal cell at its widest
point (pl. I, 7) 18
Apex of anal cell close to or touching margin of wing (pl. I, 6) 21
18. Legs beyond coxae entirely whitish *petiolata*, n. sp.
At least hindfemur black 19
19. Wings hyaline; western *hyalina*, n. sp.
Wings infuscated; eastern species 20
20. Front and middle femora at least half white; harpe short, as broad
as long (pl. IX, 101); smaller species *liturata* MacGillivray
Front and middle femora black; harpe longer than broad (pl. IX,
98); larger species *lorata* MacGillivray
21. Wings infuscated *fasciata* (Norton) and *quercuscoccineae* (Dyar)
Wings hyaline 22
22. All femora black; western *labrata* MacGillivray
All femora with at least apical part white; eastern 23
23. Hindtibia mostly black with only extreme apex white; harpe long,
slender (pl. IX, 99) *obsoleta* (Norton)
Hindtibia with apical half white; harpe short and broad (pl. IX,
105) *nyssae*, n. sp.

Descriptions of *Caliroa* Species

Caliroa cerasi (Linnaeus)

Tenthredo cerasi Linnaeus, 1758, p. 557; Dalla Torre, 1894, p. 194 (lists

- numerous references to this species under names "*Tenthredo cerasi*, *Hylotoma cerasi*, *Phyllotoma cerasi*, and *Selandria cerasi*," all of which are questionable synonyms of *limacina* Retzius).
- Caliroa cerasi*: Rohwer, 1911a, p. 119; Webster, 1912a, p. 167; Webster, 1912b, p. 125; Wilson, 1913, p. 118; Ewing, 1917, p. 330; Britton, 1921, p. 199; Wellhouse, 1922, p. 1086; Yuasa, 1922, p. 59; Severin, 1923, p. 13; Zappe, 1926, p. 322; Obarski, 1933, p. 156; Benson, 1940, p. 214; Russo, 1943, p. 396; Hardouin, 1943, p. 160; Smith, 1943, p. 384; Schuh and Mote, 1948, p. 124; Ross, 1951, p. 28; Benson, 1952, p. 96; Maxwell, 1955, p. 55; Tadic, 1956, p. 18; Peterson, 1956, p. 268; Lorenz and Kraus, 1957, p. 112; Raizenne, 1957, p. 25; Benson, 1962, p. 391; Benson, 1968, p. 148.
- Eriocampoides cerasi*: Cook, 1914, p. 40.
- Tenthredo limacina* Retzius, 1783, p. 73.
- Eriocampa limacina*: André, 1881, p. 322; Cameron, 1882, p. 224; Froggatt, 1901, p. 1.
- Eriocampoides limacina*: Konow, 1890, p. 248; Dalla Torre, 1894, p. 194; Marlatt, 1897, p. 1; Konow, 1905, p. 74; MacGillivray, 1909b, p. 347; Tullgren, 1910, p. 294; Rohwer, 1911a, p. 121; Jørgensen, 1913, p. 266; Camacho, 1917, p. 1; Tillyard, 1921, p. 2; Izquierdo, 1921, p. 43; Porter, 1928, p. 3; Porter, 1930a, p. 370; Porter, 1930b, p. 9; Forsius, 1931, p. 14; Twinn, 1934, p. 72; Jourdan and Kungs, 1935, p. 205; Talhouk, 1941, p. 128; Kotte, 1941, p. 165; Trujillo Peluffo, 1942, p. 275.
- Caliroa limacina*: Enslin, 1914, p. 254; Enslin, 1924, p. 37; Wolff, 1924, p. 45; Forsius, 1927, p. 6; Hepp, 1929, p. 253; Dovnar-Zapolsky, 1929, p. 8; Forsius, 1929, p. 83; Dovnar-Zapolsky, 1931, p. 55; Conde, 1934, p. 180; Beffa, 1934, p. 583; Balachowsky and Mesnil, 1935, p. 234; Miles, 1935, p. 117; Grandi, 1936, p. 224; Golfari, 1937, p. 241; Poluzzi, 1939, p. 525; Benson, 1940, p. 214; Chiesa Molinari, 1942, p. 463; Berland, 1947, p. 271; Domínguez García-Tejero, 1950, p. 183; Scognamiglio, 1954, p. 96; Spitzsch, 1956, p. 314; Lukhnevich, 1960, p. 18; Dadurian, 1962, p. 81.
- Tenthredo cerasi* Peck, 1799, p. 9.
- Selandria cerasi*: Harris, 1841, p. 383; Norton, 1861, p. 222; Winchell, 1865, p. 321; Norton, 1867, p. 254; Riley, 1875, p. 27; Thomas, 1881, p. 67; Forbes, 1883, p. 98; Packard, 1890, p. 522; MacGillivray, 1909b, p. 348 (= *limacina* Retzius).
- Eriocampa cerasi*: Dalla Torre, 1894, p. 130; Dyar, 1895a, p. 195; Dyar, 1895b, p. 338.
- Eriocampoides cerasi*: Konow, 1905, p. 74.
- Caliroa laudata* MacGillivray, 1909b, p. 356, ♀; Frison, 1927, p. 238; Ross, 1951, p. 29 (= *cerasi* Linnaeus).
- Caliroa lacinata* MacGillivray, 1909b, p. 357, ♀; Frison, 1927, p. 238; Ross, 1951, p. 29 (= *cerasi* Linnaeus).

Female.—Average length, 4.8 mm. Black with front and middle tibiae brownish. Wings lightly, uniformly infuscated.

Antenna with third segment subequal in length to segments 4 plus 5; apical four segments subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with anal cell sessile; cells *Rs* and *M* usually both present, sometimes both absent or one or the other present. Lancet with about 17 serrulae, each serrula long, pointed at apex, with one anterior and three posterior subbasal teeth (pl. VI, 70).

Male.—Parthenogenetic, unknown in North America. Males are rare in Europe but apparently common in Turkey (Benson, 1968). Benson (1952) stated that they lack a peripheral vein in the hindwing.

Larva.—Final feeding stage. Length, 11 mm. May be separated from other known *Caliroa* larvae by the following combination of

characters: (1) Host: *Pyrus*, *Prunus*, or other Rosaceae; (2) dark-brown head capsule in late feeding stages; and (3) black, rather than transparent, slime covering body. The general shape of the body, mandibles, epipharynx, and maxilla are as illustrated in plate XI, 137-141.

The larva of *cerasi* has been described numerous times in the literature. Dyar (1895a, 1895b) and Yuasa (1922) attempted to separate it from other North American *Caliroa* larvae. Miles (1935), Peterson (1956), and Lorenz and Kraus (1957) all described and illustrated the larva, but Scognamiglio (1954) has given the most complete descriptive and morphological account of the larva. Maxwell (1955) described the internal larval anatomy.

Holotypes.—Malaise and Benson (1934) stated that Linnaeus' type of *cerasi* is lost. The location of Retzius' and Peck's types are not known. MacGillivray's types are at the Illinois Natural History Survey: *C. landata*, a female, is labeled "Vancouver, B.C., 19-VI-03," and *C. lacinata*, a female, is labeled "Algonquin, Ill., 6-8-94."

Distribution.—Widespread in temperate Eurasia and North America; also, Africa, Argentina, Australia, Chile, China, New Zealand, Tasmania, Uruguay. I have seen specimens from the following North American States and Provinces: British Columbia, California, Colorado, Connecticut, Delaware, District of Columbia, Georgia, Idaho, Illinois, Iowa, Maine, Massachusetts, Michigan, Minnesota, Montana, Nebraska, New Hampshire, New Jersey, New Mexico, New York, Ontario, Oregon, Pennsylvania, Quebec, Rhode Island, South Dakota, Utah, Virginia, Washington.

Hosts.—The larva is an external feeder on the foliage of many Rosaceae, preferably pear (*Pyrus*) and cherry (*Prunus*). Dyar (1895a) and Wellhouse (1922) reported that this species feeds on *Crataegus*, and labels on adult specimens indicate that *Sorbus* may be a host. Benson (1952) recorded *Amygdalus*, *Crataegus*, *Cydonia*, *Mespilus*, *Quercus*, *Rosa*, *Rubus*, *Salix*, and *Sorbus* as hosts of this species in England.

Biology.—The first reference to the life history of *cerasi* was as early as 1799 when Peck was awarded \$50 and a gold medal from the Massachusetts Agricultural Society for his printed account "Natural History of the Slug Worm." Since that time numerous papers have appeared, such as those by Harris (1841), Winchell (1865), Riley (1870), Thomas (1881), Forbes (1883), Marlatt (1897), Webster (1912a, 1912b), Wilson (1913), Ewing (1917), and Britton (1921). The insect has always received attention in reports of State entomologists. Outside of North America biological work has been carried on wherever this pest exists, such as in England (Miles, 1935), Lebanon (Talhouek, 1941), Morocco (Jourdan and Rungs, 1935), Chile (Porter, 1928, 1930a, 1930b; Izquierdo, 1921), Argentina (Jørgensen, 1913; Chiesa Molinari, 1942), Uruguay (Trujillo Peluffo, 1942), Australia (Froggatt, 1901), and New Zealand (Tillyard, 1921).

In North America two generations a year are usual, the first in May or June, the second in July or August. The eggs are inserted on the underside of the leaf near a midrib or larger vein. The

feeding period may extend to 3 weeks, after which the larva enters the ground to pupate for the next generation or to overwinter. Slight differences are found in the biology of *cerasi* and *liturata*, another species associated with *Prunus*. (See section on biology under *liturata*.)

Discussion.—*C. cerasi* is easily separated from all other *Caliroa* species by the entirely black legs. All other species, except *floridana*, which has a rufous pronotum and mesonotum, have some white markings on the hindtibia and hindbasitarsus. The lancet with the relatively slender serrulae, each with one anterior and three posterior subbasal teeth, is also distinctive for this species.

Pear-slug is the approved common name.

Caliroa distincta, new species

Female.—Length, 4.8 mm. Black; front and middle tarsi, front and middle tibiae, and extreme apex of front and middle femora brownish to white; basal one-third of hindtibia and basal one-third of hindbasitarsus white. Wings very lightly, uniformly, infuscated.

Antenna with third segment subequal in length to segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with cells *Rs* and *M* absent; anal cell with short petiole. Lancet with 16 to 17 serrulae; serrulae deep, close together, and lobelike, each rounded at apex and with three or four anterior and three or four posterior subbasal teeth located near ventral margin of lancet (pl. V, 63).

Male.—Unknown.

Larva.—Unknown.

Holotype.—Female, 7 mi. N.W. Roseburg, Oregon, Douglas Co., May 8, 1964, J. D. Vertrees, U.S.N.M. (U.S. National Museum) type No. 70212.

Paratypes.—*British Columbia*: Cultus Lake, 21-VII-1948, H. R. Foxlee (1 ♀); Salmon Arm, 10-VII-1935, A. A. Dennys (1 ♀); Robson, 9-V-1947, H. R. Foxlee (1 ♀). *California*: Sta. Cruz Mts. (2 ♀♀); nr. Stanford U., Bear Creek Gulch, March 25, 1915, Harold Morrison (1 ♀). *Nevada*: "Nev." (1 ♀). *Oregon*: "Oregon," Koebele (1 ♀). Talent, May 2, 1936, L. G. Gentner (1 ♀); Douglas Co., 4 mi. S. Canyonville, May 21, 1964, D. R. Smith (1 ♀). Deposited in the Canadian National Collection, U.S. National Museum, and at Oregon State University.

Distribution.—Pacific coastal region from British Columbia to California and Nevada.

Host.—Unknown.

Biology.—Unknown.

Discussion.—This western species is recognized by the petiolate anal cell and absence of cells *Rs* and *M* in the hindwing and the large lobelike serrulae of the lancet. The lancet is similar to that of *lobata* of eastern North America, but in *distincta* the serrulae are larger, closer together, and fewer.

Culiroa fasciata (Norton)

Selandria fasciata Norton, 1864, p. 9, ♀; Norton, 1867, p. 256; Cresson, 1928, p. 6.

Eriocampa fasciata: Dalla Torre, 1394, p. 130.

Eriocampoides fasciata: Konow, 1905, p. 74.

Culiroa fasciata: MacGillivray, 1909b, p. 362; MacGillivray, 1916, p. 80; Ross, 1951, p. 29; Maxwell, 1955, p. 55 (?).

Female.—Average length, 4.8 mm. Black; front and middle tibiae and tarsi white; basal two-thirds of hindtibia and basal two-thirds of hindbasitarsus white. Wings moderately to darkly infuscated on basal two-thirds, nearly hyaline on apical one-third.

Antenna with third segment shorter than segments 4 plus 5; apical four segments together slightly shorter than third segment. Clypeus shallowly, circularly emarginated. Hindwing with cells *Rs* and *M* both present; anal cell sessile. Lancet with 20 to 22 serrulae; each serrula shallow and broad, rounded at apex, with one or two anterior and three or four posterior subbasal teeth (pl. VII, 75).

Male.—Average length, 4.5 mm. Color similar to that of female except for extreme apex of each femur, which is white, and hindtibia, which is only one-half white. Hindwing with peripheral vein; anal cell with apex close to margin of wing (pl. I, 6). Genitalia as in plate IX, 103 and 104; harpe longer than broad, pointed at apex.

Larva.—Unknown. Maxwell (1955) described the internal anatomy of a species of *Caliroa* on *Crataegus*, which she called *fasciata*.

Holotype.—*S. fasciata* Norton, a female labeled "Mass.," is type No. 10340 at the Academy of Natural Sciences of Philadelphia.

Distribution.—Eastern North America. *Connecticut*: Union, June 24, 1932; Poquonock, June 27, 1905; E. Hartford, Aug. 25, 1950. *Illinois*: Hardin, June 5-9, 1932; Parker, June 4, 1913; Jeff, June 12, 1934. *Iowa*: Mt. Pleasant, May 1, 1933, on pin oak. *Maine*: Brunswick, Mare Pt., 1-VII-65, ex w. birch; Augusta, VIII-10, 1941; Woolwich, emgd. VI-6, 7, VII-10, 14, 16, 1958, ex red oak. *Maryland*: Plimmers Id., July 6, 1921, June 18, 1916, VIII-3-1912; Glen Echo. *New Jersey*: Ateo; Manahawkin, V-30-11. *New York*: Ardsley, Westchester Co., May 30, 1957. *Ohio*: Put-in-Bay, June 20-30, 1924. *Ontario*: Little Rapids, 3-V-1955, red oak; Nestorville, 18-IV-1955, red oak. *Virginia*: Veitch, July 7, 1914, *Quercus velutina*; Falls Church, July 23, 1913, reared VII-7-1916, *Quercus palustris*.

Host.—*Quercus* spp. Series of adults have been reared from larvae feeding on *Quercus velutina* Lam., *Q. palustris* Muenchh., and *Q. rubra* L.

Biology.—No information is available.

Discussion.—This species is most closely related to *quercuscoccineae*; however, *quercuscoccineae* has only 17 or 18 serrulae on the lancet and each serrula has several more anterior subbasal teeth. I could not separate the males of these two species. The presence of cells *Rs* and *M* and sessile anal cell of the hindwing and the rela-

tively shallow serrulae of the lancet will separate the females from those of other *Caliroa* species. The wings, which are only partly infuscate, will also help to differentiate this species. The males are more difficult to separate from those of other species. The closeness of the anal cell to the margin of the hindwing, entirely black body, and partly infuscate wings will help to separate them.

Caliroa floridana, new species

Female.—Length, 4.8 mm. Head and antenna black; labrum brownish. Thorax black with pronotum, tegula, and mesonotum rufous. Legs black with front tibia and tarsus whitish. Abdomen black. Wings uniformly, darkly infuscated.

Antenna with third segment shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with cells *Rs* and *M* both absent; anal cell with very short petiole. Lancet with 20 to 22 serrulae; each serrula relatively deep, rounded at apex, and with two or three anterior and two or three posterior subbasal teeth (pl. VI, 71).

Male.—Unknown.

Larva.—Unknown.

Holotype.—Female, Hillsboro Co., Fla., 3-24-30, C. L. Rabb, Florida Fruit Fly Trap Survey. U.S.N.M. type No. 70213.

Paratypes.—Florida: Sumter Co., 4-24-30, W. A. Bryant, Florida Fruit Fly Trap Survey (1 ♀); LaBelle, IV-21-21, J. N. Knull (1 ♀). Deposited in the U.S. National Museum.

Distribution.—Known only from Florida.

Host.—Unknown.

Biology.—Unknown.

Discussion.—The red pronotum and mesonotum and black hind-legs will separate this species from all other *Caliroa* species. The lancet is very similar to that of *fasciata* except for several more anterior subbasal teeth on the serrulae of the lancet of *floridana*. I have not seen specimens that may indicate intermediate color variations between this and other species and am therefore considering this species distinct.

Caliroa hyalina, new species

Female.—Length, 4.8 mm. Black; front and middle tibiae and tarsi, basal one-third of hindtibia, and basal one-third of hind-basitarsus white. Wings hyaline.

Antenna with third segment subequal in length to segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with cells *Rs* and *M* absent; anal cell with very short petiole. Lancet with 16 to 17 serrulae; serrulae far apart, each serrula slender, pointed at apex, with one anterior and two posterior subbasal teeth (pl. V, 64).

Male.—Length, 4.6 mm. In color and structure similar to female. Hindwing with peripheral vein; anal cell with apex removed from

margin of wing (pl. I, 7). Genitalia as in plate IX, 96; harpe only slightly longer than broad.

Larva.—Unknown.

Holotype.—Female, Salem, Oreg., VII-10-18, on cherry, E. J. Newcomer, collector, Quaintance No. 14085. U.S.N.M. type No. 70214.

Paratypes.—Oregon: Mt. Hood (1 ♀, ♂); same data as for holotype (1 ♀); "Oregon," Koebele (2 ♀♀, 1 ♂); Klamath Falls, June 6, 1956, Joe Schuh, coll. (1 ♀). Deposited in the U.S. National Museum and at Oregon State University.

Distribution.—Known only from Oregon.

Host.—Adults were collected from cherry.

Biology.—No information is available.

Discussion.—This species is similar to *cerasi*, but may be separated by the more hyaline wings, lack of cells *Rs* and *M* in the hindwing, the petiolate anal cell of the hindwing, and the widely separated serrulae of the lancet, each serrula with fewer subbasal teeth. The venation of the hindwing and lancet characters will also separate *hyalina* from other *Caliroa* species.

Caliroa labrata MacGillivray

Caliroa labrata MacGillivray, 1909b, p. 360, ♂; Frison, 1927, p. 238; Ross, 1951, p. 29.

Female.—Average length, 4.8 mm. Black; front tibia and tarsus, basal one-half of middle tibia, and basal one-third of hindtibia white. Wings uniformly, lightly infuscated.

Antenna with third segment subequal in length to or slightly shorter than segments 4 plus 5; apical four segments together longer than segment 3. Clypeus circularly emarginated. Hindwing with anal cell sessile; cells *Rs* and *M* both present. Lancet with 16 to 17 serrulae; each serrula shallow, broad, with large lobate subbasal teeth, usually two large posterior and two large anterior subbasal teeth (pl. V, 69).

Male.—Average length, 4.5 mm. Black with extreme apex of front and middle femora, all of front and middle tibiae and tarsi, and basal one-half of hindtibia white. Hindwing with peripheral vein; apex of anal cell close to margin of wing (pl. I, 6). Genitalia as in plate IX, 97; harpe longer than broad, apex and inner margin rounded.

Larva.—I have seen one small larva, probably an early instar, taken from *Salix*. The head capsule and thoracic legs are dark brown.

Holotype.—At the Illinois Natural History Survey, a male labeled "Mts. near Claremont, Calif., Baker."

Distribution.—Western North America. *Alberta*: Jumping Pd. Cr., 20 mi. W. Calgary, July 3, 1962. *British Columbia*: Remo, June 13, 1960. *California*: Mt. Shasta, Siskiyou Co., 3561', em. 9 Oct. 1965, 30 Sept. 1965, leaf slug, no cocoon, *Salix lemmonii*; 8 mi. S. Bieber, Lassen Co., VIII-3-1965. *Nevada*: Galena Cr., Campground, 7 mi. S.W. Reno, Washoe Co., 6100', 27-VI-1965, 11-

VII-1965, *Salix lasiolepis*; Douglas Co., east end Kingsbury Grade, 3 mi. S. Genoa, 4800', 10-VII-1965, em. 7, 8-VIII-1965, *Salix lasiolepis*. Oregon: Corvallis, August 8, 1962.

Host.—Adults have been bred from larvae feeding on *Salix* spp.

Biology.—No information is available.

Discussion.—The sessile anal cell and presence of cells *Rs* and *M* in the hindwing and the large lobate subbasal teeth of the serrulae of the lancet distinguish *labrata* from other *Caliroa* species. It is most closely related to *obsoleta*, but *labrata* may be separated by the more darkly infuscated wings and the serrulae, which usually have an extra anterior and posterior subbasal lobe. Also, the host of *obsoleta* is *Quercus* and that of *labrata* is *Salix*. This is the only known North American *Caliroa* species associated with *Salix*.

Caliroa liturata MacGillivray

"3S" (in Key), Dyar, 1895b, p. 338.

Caliroa obsoleta Dyar, nec Norton, 1896, p. 237.

Caliroa liturata MacGillivray, 1909b, p. 349, ♀; Frison, 1927, p. 238; Ross, 1951, p. 29.

Caliroa lineata MacGillivray, 1909b, p. 350, ♀; Frison, 1927, p. 238; Ross, 1951, p. 29. New synonymy.

Caliroa loricata MacGillivray, 1909b, p. 351, ♀; Frison, 1927, p. 239; Ross, 1951, p. 29. New synonymy.

Caliroa (*Eriocampoides*) *amygdalina* Rohwer, 1911c, p. 263, ♂, ♀; Cushman, 1911, p. 91; Ross, 1951, p. 28; Burks, 1967, p. 16. New synonymy.

Female.—Average length, 4.5 mm. Black; front and middle tibiae and tarsi, basal two-thirds of hindtibia, and basal one-half of hindbasitarsus white. Wings uniformly, lightly infuscated, sometimes slightly darker basally.

Antenna with third segment subequal in length to or only slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with cells *Rs* and *M* absent; anal cell with short petiole. Lancet with 17 to 18 serrulae; each serrula low, flattened at apex, and with two anterior and two posterior subbasal teeth, flattened apex sometimes with several teeth, and apical serrulae usually with only one anterior and one posterior subbasal tooth (pl. V, 65).

Male.—Average length, 4.3 mm. Black; front and middle tibiae and tarsi, apical half of each femur, and basal half of hindtibia and hindbasitarsus whitish. Hindwing with peripheral vein; apex of anal cell removed some distance from margin of wing (pl. I, 7). Genitalia as in plate IX, 101 and 102; harpe slightly longer than broad.

Larva.—The larva was described by Dyar (1896) under the name "*obsoleta*" and by Cushman (1911) under the name "*amygdalina*." The following may serve to distinguish the larva: (1) Feeds on *Prunus* spp. and (2) the head is pale brown, as opposed to dark brown for *cerasi*, which also feeds on *Prunus*.

Holotypes.—MacGillivray's types, all females, are at the Illinois Natural History Survey and are labeled as follows: *C. liturata*, "Florida"; *C. lineata*, "Columbia, Mo., 15 July 1905"; *C. loricata*,

"Columbia, Mo., 2 Sept. 1905." *C. amygdalina* Rohwer, a female, is U.S.N.M. type No. 13371, labeled "Hunter No. 1936, II-15, 7-24-10, bred peach, Tallulah, La., 7-13-10."

Distribution.—Widespread in eastern North America. *Colorado*: Boulder, 5500', June 9, 11, 19, 21, 1961, 6000', June 4, 1961. *Connecticut*: Lyme, VI-19-18; Windsor, VIII-20-1951. *Florida*: "Florida." *Georgia*: Austell, VIII-27-10. *Illinois*: McLean, June 25, 1940; Dubois, May 21, 1917. *Louisiana*: Baton Rouge, May 1, 1896, Sept. 9, 1922, bred from peach leaves, adult, Sept. 28; Tallulah, 8-22-10, 8-12-10, on peach, August 18, 1909, on peach. *Missouri*: Columbia, July 15, 1905, Sept. 2, 1905. *Montana*: "Montana." *New York*: Ithaca, July 4, 1918; Buffalo, 6-25-10; Keene Valley, on plum (Dyar's "3S"). *Rhode Island*: Kingston, June 20, 1905. *South Carolina*: Clemson Co., May 31, 1895. *Tennessee*: Rhea Co., VI-14-1939, peach orchard. *Virginia*: Falls Church, June 9, 1921, July 20, 1917; Suffolk, June 11, 1895; Vienna, VI-12-1915, bred from plum.

Hosts.—This species has been bred from peach and plum (*Prunus* spp.). Dyar (1896) bred it from "*Prunus serotina*" and "*P. pennsylvanica*."

Biology.—Cushman (1911) reported on the biology of this species. The first adults were found in April in Louisiana and were present until cold weather in the fall, usually after six or seven generations. Oviposition is on the upper side of the leaf close to the midrib or a larger vein. This is opposed to *cerasi*, which usually oviposits on the underside of the leaf. The *liturata* larvae feed for about 3 weeks and drop to the ground to pupate. The total life cycle takes about 20 to 30 days. Another difference between the two species is that the *liturata* larvae do not eat the exuvium whereas the *cerasi* larvae do.

Discussion.—Attention was given to this species in 1910 when it was discovered damaging peach trees in Louisiana. Rohwer (1911c), believing it was a new species, described it as *amygdalina*; however, MacGillivray (1909b) had described it as *liturata* 2 years before. The petiolate anal cell and absence of cells *Rs* and *M* in the hindwing and short lancet with the serrulae shallow and truncate at their apices will separate the females from those of other *Caliroa* species. The males are more difficult to identify, but the anal cell of the hindwing does not reach the margin of the wing, the wings are infuscated, and the front and middle femora are partly white. Generally this is a smaller species than most other *Caliroa* species.

Caliroa lobata MacGillivray

Caliroa lobata MacGillivray, 1909b, p. 355, ♀; Frison, 1927, p. 239; Ross, 1951, p. 29.

Female.—Average length, 4.8 mm. Black; extreme apex of each femur, all middle and front tibiae and tarsi, basal three-fourths of hindtibiae, and basal three-fourths of hindbasitarsus white.

Wings uniformly, moderately infuscated, sometimes lighter on apical one-third.

Antenna with third segment shorter than segments 4 plus 5; apical four segments subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with cells *Rs* and *M* both present; anal cell sessile. Lancet with 20 to 21 serrulae; each serrula deep, symmetrical, lobelike, with apex rounded and three or four anterior and three or four posterior subbasal teeth located near ventral margin of lancet (pl. VI, 73).

Male.—Average length, 4.5 mm. Antenna, head, and thorax black. Each leg entirely whitish beyond coxa except apical one-third of hindtibia and hindbasitarsus, which are black. Abdomen dark rufous with central part of each terga and hypandrium black. Hindwing with peripheral vein; apex of anal cell near margin of vein (pl. I, 6). Genitalia as in plate IX, 107.

Larva.—Unknown.

Holotype.—At the Illinois Natural History Survey, a female, labeled "Oswego, N.Y., July 25, 1895."

Distribution.—Eastern North America. *Illinois*: "N. Ill."; Muncie, IX-16; Havana, July 28, 1910. *Iowa*: County No. 16. June 19, 1918. *Maryland*: Plummers Id., Aug. 12, 1914, IX-13-1958, VIII-5-1914. *Michigan*: Marquette. *New York*: L.I.; Oswego, July 25, 1895; Ithaca, June 19, 1908. *Texas*: College Station, April 19, 1932. *Vermont*: Rutland, Aug. 1-15, 1916. *Virginia*: Falls Church, July 25, Aug. 13, 16, 22, Sept. 12, 1927, reared, *Quercus*, Aug. 28, 1912. *Quercus velutina*, VII-25-1916, *Quercus palustris*, May 20, 1918, IX-11-20, IX-19, 1917.

Host.—*Quercus* spp. Adults have been bred from larvae feeding on *Quercus palustris* Muenchh. and *Q. velutina* Lam.

Biology.—No information is available.

Discussion.—The sessile anal cell and presence of cells *Rs* and *M* of the hindwing and the large lobate serrulae of the lancet will distinguish the female of the species. The males may be separated by the rufous abdomen, which is black in all other known *Caliroa* males.

Caliroa lorata MacGillivray

Caliroa lorata MacGillivray, 1900b, p. 355, ♀; Frison, 1927, p. 239; Ross, 1951, p. 29.

Eriocampoides castaneae Rohwer, 1917, p. 152, ♀. New synonymy.

Caliroa castaneae: Ross, 1951, p. 29.

Female.—Average length, 4.8 mm. Black; front and middle tibiae and tarsi, basal one-half of hindtibia, and basal one-half of hindbasitarsus white. Wings uniformly, lightly, infuscated.

Antenna with third segment slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with cells *Rs* and *M* both absent; anal cell with short petiole. Lancet with 19 to 21 serrulae; serrulae shallow, not extending far below margin of lancet, each serrula with anterior margin more or less straight,

with one anterior subbasal tooth, posterior margin oblique, with two or three subbasal teeth (pl. V, 68).

Male.—Average length, 4.5 mm. Color similar to that of female. Hindwing with peripheral vein; apex of anal cell removed short distance from margin of wing (pl. I, 7). Genitalia similar to plate IX, 97; harpe at least twice as long as broad.

Larva.—Unknown.

Holotypes.—*C. lorata* MacGillivray, a female, is at the Illinois Natural History Survey with the data "Mt. Tom, Mass., July 16, '98." *E. castaneae* Rohwer, a female, is U.S.N.M. type No. 15486 with the data "11307a Hopk. U.S., reared, Aug. 5, '12, *Castanea dentata*, Falls Church, Va., Wm. Middleton."

Distribution.—Eastern North America. *Alabama*: Pызiton, Clay Co. *Maine*: Winslow, Kennebec Co., June 30, 1957. *Maryland*: Plummers Id., 20-VI-1912, 8-26-1960; Glen Echo; 3 mi. S.E. Beltsville, May 30, 1966. *Massachusetts*: Mt. Tom, July 16, '98. *New York*: Ithaca. *North Carolina*: "N.C." *Pennsylvania*: Wernersville, VIII-5-1913; 5 mi. W. Davidsburg, VI-16-1958; Harrisburg, VI-17. *Virginia*: Falls Church, reared Aug. 5, 1912, *Castanea dentata*, VI-19-13, *Castanea dentata*, July 16, 1913, VIII-14-1913, *Castanea pumila*; Black Pond, Fairfax Co., June 19, 1919; Glen-carlyn, V-26; Barcroft, VI-5-11; Vienna, reared, Aug. 13, 1912, *Castanea dentata*. *Wisconsin*: Gays Mills, 7-2-1930.

Host.—Adults have been bred from larvae feeding on *Castanea* spp.

Biology.—No information is available.

Discussion.—The petiolate anal cell and absence of cells *Rs* and *M* in the hindwing and the low serrulae of the lancet will distinguish the females of this species. The males may be separated by the apex of the anal cell of the hindwing, which is removed from the margin of the wing, the infuscated wings, and the black femora.

Caliroa lunata MacGillivray

Caliroa lunata MacGillivray, 1909b, p. 353, ♀; Frison, 1927, p. 239; Ross, 1951, p. 29.

Caliroa lala MacGillivray, 1909b, p. 361, ♀; Frison, 1927, p. 238; Ross, 1951, p. 29. New synonymy.

Female.—Average length, 4.5 mm. Black; front and middle tibiae and tarsi, basal one-half of hindtibia, and basal one-half of hindbasitarsus white. Wings lightly infuscated.

Antenna with third segment slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with cells *Rs* and *M* both absent; anal cell with short petiole. Lancet with 17 to 19 serrulae; serrulae far apart, each long, slender, symmetrical, with apex rounded and two or three anterior and two or three posterior subbasal teeth located near ventral margin of lancet (pl. V, 67).

Male.—Unknown.

Larva.—Unknown.

Holotypes.—MacGillivray's types are at the Illinois Natural History Survey. *C. lunata*, a female, is labeled "Ithaca, N.Y., 27 May '93," and *C. lata*, a female, is labeled "Ithaca, N.Y., 22 July '90."

Distribution.—Eastern North America. *Illinois*: Shawneetown, June 14, 1934; Kampsville, June 10, 1932; Vienna, July 10, 1935; Oakdale, 8-3-35; Riverside Woods, Cook Co., 9-3-1949. *Michigan*: "Mich." *Newfoundland*: 3 mi. S.E. St. George's, June 27, 1966. *New Hampshire*: Notchland, Carroll Co., June 12, 1967. *New York*: Ithaca, May 27, '93, July 22, '90; Babylon, L.I., VII-13-1937; New Balt., 8-11-93. *Ohio*: Columbus, 05-10-1902. *Pennsylvania*: Harrisburg, VI-22. *Texas*: Liberty, III-18-08. *Virginia*: Rosslyn. *West Virginia*: Lost River St. Pk., Hardy Co., Aug. 1-14, 1960.

Host.—Unknown.

Biology.—Unknown.

Discussion.—This species may be recognized by the absence of cells *Rs* and *M* and the petiolate anal cell of the hindwing and the long slender lobelike serrulae of the lancet. The lancet resembles that of *lobata* and *distincta*, but in *lunata* the serrulae are more slender and farther apart. Also, there are fewer serrulae in the lancet of *lunata* than in that of *lobata*.

Caliroa nyssae, new species

Female.—Length, 4.8 mm. Black; extreme apices of front and middle femora, all front and middle tibiae and tarsi, basal one-half of hindtibia, and basal two-thirds of hindbasitarsus white. Wings hyaline.

Antenna with third segment slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus circularly emarginated. Hindwing with anal cell sessile; cell *Rs* present, cell *M* absent. Lancet with 17 to 18 serrulae; each serrula low, broad, anterior and posterior margins smooth, without subbasal teeth, about five or six teeth present on apical rounded part (pl. VI, 72).

Male.—Length, 4.5 mm. In color and structure similar to female. Hindwing with peripheral vein; apex of anal cell close to margin of wing (pl. I, 6). Genitalia as in plate IX, 105 and 106; harpe slightly longer than broad.

Larva.—Unknown.

Holotype.—Female, Falls Church, Va., reared, Aug. 5, 1912, *Nyssa sylvatica*, Wm. Middleton, collector, Hopk. U.S. 11308a. U.S.N.M. type No. 70215.

Allotype.—Male, same data as for holotype. Deposited with holotype.

Paratypes.—*Georgia*: Dalton, Aug. 29, 1909 (1 ♀); Atlanta, 8-6-41, P. W. Fattig (1 ♀). *Maryland*: Glen Echo, R. M. Fouts (1 ♀). *Mississippi*: Biloxi, Sept. 29, 1908, black gum, J. Brodei (1 ♀); Biloxi, VIII-31, 1908, issued IX-14-1908, on black gum (1 ♀). *Pennsylvania*: Lakemont Park, Blair Co., 8-8-1947 (1 ♀). *Virginia*: Data as for holotype (1 ♂); Great Falls, reared May 26,

1914, *Nyssa*, Heinrich, colr., Hopk. U.S. 11398e (2 ♀ ♀); Kearney, reared, Sept. 9, 1912, *Nyssa* sp. ?, Wm. Middleton, colr., Hopk. U.S. 11317d (1 ♀); Falls Church, IX-5-17, G. M. Greene (1 ♀); Falls Church, July 24, 1920, Wm. Middleton, colr. (1 ♀). Deposited in the U.S. National Museum and at the Illinois Natural History Survey.

Distribution.—Eastern North America.

Host.—Adults have been reared from larvae feeding on *Nyssa sylvatica* Marsh.

Biology.—No information is available. Collection dates on specimens indicate this species flies in late summer, usually in August.

Discussion.—The sessile anal cell, presence of cell *Rs* and absence of cell *M* in the hindwing, hyaline wings, and lancet will separate females of this species. The hindwing venation is unique and is very consistent in this species; however, the lancet should always be checked before final determination. The closeness of the anal cell to the margin of the hindwing, the hyaline wings, the partly white femora, and short broad harpe of the genitalia will distinguish males of this species.

Caliroa obsoleta (Norton)

Selandria obsoleta Norton, 1867, p. 254; Provancher, 1878, p. 100; Provancher, 1883, p. 202; Cresson, 1928, p. 8.

Caliroa obsoleta: Kirby, 1882, p. 182; Provancher, 1888, p. 351 (?); Yuasa, 1922, p. 59; Ross, 1951, p. 29.

Eriocampoides obsoleta: Dalla Torre, 1894, p. 196; Konow, 1905, p. 74.

Selandria quercus alba Norton, 1867, p. 258, ♀; Norton, 1872, p. 85; Packard, 1890, p. 205. New synonymy.

Monostegia quercus alba: Kirby, 1882, p. 186; Dyar, 1894, p. 43.

Eriocampa quercus alba: Dalla Torre, 1894, p. 132.

Selandria quercus-alba Cresson, 1880, p. 60. Correction of *quercus alba* Norton.

Caliroa quercus-alba: Yuasa, 1922, p. 59; Ross, 1951, p. 29; Raizenne, 1957, p. 25 (?).

Eriocampoides quercus Konow, 1905, p. 74. Correction of *quercus alba* Norton.

Female.—Average length, 4.5 mm. Black; extreme apex of each femur, all front and middle tibiae and tarsi, basal two-thirds of hindtibia, and basal two-thirds of hindbasitarsus white. Wings uniformly hyaline.

Antenna with third segment slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with anal cell sessile; cells *Rs* and *M* usually both present, but either one or both may be absent. Lancet with 18 to 20 serrulae; each serrula shallow, with large lobelike subbasal teeth, one on anterior margin and two on posterior margin, all distinct and subequal in size (pl. VI, 74).

Male.—Average length, 4.3 mm. Color similar to that of female except for each femur, which is whitish. Hindwing with peripheral

vein; apex of anal cell close to margin of wing (pl. I, 6). Genitalia as in plate IX, 99; harpe longer than broad.

Larva.—Dyar (1894) described the larva and stated that the head capsule is brownish black. I have not seen the larvae, and Dyar's description does not adequately characterize the larva of this species.

Holotypes.—*S. obsoleta* Norton, a female, labeled "Mass." is type No. 10717 at the Academy of Natural Sciences of Philadelphia. I could not find the type of *quercus alba* Norton.

Distribution.—Eastern North America. *Connecticut*: Lyme, reared, VI-6-16, *Quercus alba*, July 8, 1918; Stamford, Aug. 17, 1931, reared, Aug. 4, 1931, swamp white oak; East River, 8-20-23, 1914, white oak leaf, reared Aug. 12, 1916, white oak; E. Hartford, Aug. 25, 1950; Stafford, VIII-24-1950. *Georgia*: Athens, 5-23-37. *Illinois*: Oakwood, June 2, 1927; Perry Springs, Aug. 11, 1948, on white oak; White Pines St. Pk., May 30, 1936; Fox Lake, June 10, 1936; White Pine Forest, Ogle Co., July 4, 1932; Grand Tower, June 2, 1913; Ziegler, Aug. 21, 1933; Herod, June 23, 1927. *Iowa*: Mt. Pleasant, May 20, 1930. *Massachusetts*: Southwick, VIII-29-1916; Woods Holl, on white oak (Dyar's "J"). *Michigan*: Douglas Lake, July, 1914. *Minnesota*: "Minn." *New Jersey*: Ateo. *New York*: Napeague, L.I., VII-2-1954; Bedford. *Westchester Co.*, July 6, 1907; Ithaca, Aug. 12, 1918; Ft. Montgomery, Aug. 6, 1923. *Ontario*: One Sided Lake, June 30, 1960. *Virginia*: Falls Church, reared, Aug. 28, 1912, *Quercus alba*, June 27, 1913, reared July 29, 1912, *Quercus prinus*, reared July 29, 1912, *Quercus alba*, July 31, 1916, *Quercus minor*; Glencarlyn, June 5, 1918. *Wisconsin*: Madison, 8-10-1929; Colona, June 19, 1934.

Host.—Reared from *Quercus* spp. Apparently most common on white oak (*Quercus alba* L.) but also reared from *Q. stellata* Warg. (= *Q. minor* Sarg.) and *Q. prinus* L. Dyar (1894) reared this species from white oak; the reared adults are labeled "J."

Biology.—The only information on the biology is that by Dyar (1894). The adults oviposit on the underside of the leaf "near the tip." After feeding, the larvae drop to the ground and "form a cavity in the earth, lined with a brown secretion."

Discussion.—The large distinct subbasal teeth of the lancet and the sessile anal cell of the hindwing will separate this species. Cells *Rs* and *M* of the hindwing are normally present, but some specimens, including the type of *obsoleta*, lack both cells; in other specimens either one or the other cell may be absent. The wings are usually hyaline, but some specimens from more northern localities have lightly infuscated wings. The lancet is close to that of *labrata*, but there are more subbasal teeth on the serrulae of *labrata* and its host is *Salix*.

Norton's type of *quercus alba* is apparently lost. Its synonymy with *obsoleta*, however, seems justified, since it was apparently bred from white oak, a common host for this species, and, according to Norton's (1867) original description, the wings of *quercus*

alba are hyaline and cells *Rs* and *M* are both present in the hindwing, both of which are usual characters for this species.

Caliroa petiolata, new species

Caliroa lineata of auctt., nec MacGillivray, Burks, 1958, p. 12; Burks, 1967, p. 16.

Female.—Length, 4.5 mm. Black; each front and middle tibia and tarsus, basal two-thirds of hindtibia, and basal two-thirds of hindbasitarsus white. Wings lightly infuscated on basal two-thirds, hyaline on apical one-third.

Antenna with third segment slightly shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with cells *Rs* and *M* absent; anal cell with short petiole. Lancet with 15 to 16 serrulae; each serrula shallow, not extending far below ventral margin of lancet, slightly asymmetrical with two or three anterior and four or five posterior subbasal teeth (pl. V, 66).

Male.—Length, 4.3 mm. Color similar to that of female except for each femur, which is whitish. Hindwing with peripheral vein; anal cell with apex removed some distance from margin of wing (pl. I, 7). Genitalia as in plate IX, 100; harpe about as long as broad.

Larva.—Unknown.

Holotype.—Female, Caroline Co., Va., 7-15-1941, larva on *Quercus palustris*. L. A. Hetrick. U.S.N.M. type No. 70216.

Allotype.—Male. Same data as for holotype. Deposited with holotype.

Paratypes.—*Maryland*: College Park, Aug. 9, 1919, *Quercus palustris*, E. N. Cory (3 ♀♀). *Pennsylvania*: 6 mi. S. E. Meadville, Crawford Co., VII-1-61, on oak, F. B. Negley, collector (2 ♀♀). *Virginia*: Same data as for holotype (2 ♀♀, 1 ♂); data as for holotype, V-16-1941 (2 ♀♀); data as for holotype, V-17-1941 (1 ♂). Deposited in the U.S. National Museum.

Distribution.—Eastern North America.

Host.—The type series was reared from larvae on *Quercus palustris* Muenchh.

Biology.—Unknown.

Discussion.—The petiolate anal cell and absence of cells *Rs* and *M* of the hindwing, short lancet, and shallow serrulae of the lancet will separate the females of this species. The anal cell with the apex removed from the margin of the hindwing, white femora, and genitalia will separate the males.

Caliroa quercuscoccineae (Dyar)

Monostegia quercus-coccineae Dyar, 1894, p. 42, ♀, larva; Dyar, 1895b, p. 338; Taylor, 1931, p. 459.

Caliroa quercus-coccineae: MacGillivray, 1909b, p. 359; MacGillivray, 1916, p. 80; Yuasa, 1922, p. 59; Ross, 1951, p. 29.

Female.—Average length, 4.7 mm. Black; extreme apex of each femur, all front and middle tibiae and tarsi, basal two-thirds of hindtibia, and basal two-thirds of hindbasitarsus white. Wings with basal two-thirds moderately infuscated, apical one-third hyaline.

Antenna with third segment shorter than segments 4 plus 5; apical four segments together subequal in length to third segment. Clypeus shallowly, circularly emarginated. Hindwing with cells *Rs* and *M* present; anal cell sessile. Lancet with 17 to 18 serrulae; each serrula moderately deep, rounded at apex, nearly symmetrical, and with three or four anterior and three or four posterior subbasal teeth (pl. VII, 76).

Male.—Average length, 4.5 mm. Color similar to that of female. Hindwing with peripheral vein; anal cell with apex close to margin of wing (pl. I, 6). Genitalia similar to plate IX, 103 and 104; harpe longer than broad, narrowing toward apex.

Larva.—Dyar (1894) described the larva and stated that the head capsule is "orange-yellowish." The characters given by Dyar do not permit an adequate characterization of this species.

Holotype.—Female, U.S.N.M. type No. 4127, labeled "T" and "Collection, H. G. Dyar." Dyar's "T" is from Woods Holl, Mass.

Distribution.—Eastern North America. *Connecticut*: Lyme, 7-8-18; Stonington, VII-5-32, *Quercus velutina*. *Delaware*: "Delaware," Sept. 23, 1960, on oak. *District of Columbia*: Sept. 10, 1913, coll. on pin oak. *Illinois*: Urbana, June 20, 1932; Carbondale, July 22, 1909. *Louisiana*: Shreveport, III-27-07. *Maine*: Augusta, VII-21-1944. *Maryland*: Glen Echo, 4-97. *Michigan*: "Mich." *Minnesota*: Northfield, VII-3-17. *Missouri*: Warrenton, VII-8-1963. *New Hampshire*: Hanover. *New Jersey*: Westfield, July 15, 1956. *North Carolina*: Durham, Oct. 8, 1942, *Quercus palustris*. *Pennsylvania*: North East, VI-18-16; Inglenook, VI-27-09. *Virginia*: Falls Church, reared VII-29-16, *Quercus alba*, reared, Aug. 26, 1912, *Quercus velutina*. *Wisconsin*: Trout Lake, July 21-23, 1937; Minong, Kimball Lake, Aug. 25, 1945.

Host.—*Quercus* spp. Dyar (1894) reared the type series from "*Quercus coccinea*." Other specimens examined have been reared from larvae on *Quercus velutina* Lam., *Q. palustris* Muenchh., and *Q. alba* L.

Biology.—The only information on the biology is that by Dyar (1894). The eggs are inserted parallel to the midrib of the leaf. The larvae feed gregariously, and, after maturing, drop to the ground and "form little elliptical cells in the ground for pupation."

Discussion.—The sessile anal cell and presence of cells *Rs* and *M* in the hindwing, the partially infuscated wings, and rounded serrulae of the lancet will serve to distinguish this species. It is closest to *fasciata* but may be separated by the fewer serrulae of the lancet: *fasciata* has more than 20, *quercuscoccineae* has less than 20. There are apparently no distinguishing characters between the males of the two species. If the distinguishing characters between *fasciata* and *quercuscoccineae* are found to be variable, it may be necessary to synonymize the two species.

Tribe HETERARTHRI

The single genus in the tribe Heterarthri may be separated by the complete vein 2A and 3A of the forewing, the 10- or 11-segmented antenna, and the bifid tarsal claw with an acute basal lobe. The larvae are dorsoventrally flattened, typical of the leaf-mining larvae of the Fenestriini, and may be separated in the key to larvae. Only one species is in North America, introduced from Europe.

Genus HETERARTHUS Stephens

Phyllotoma Fallén, 1829, p. 25; Cameron, 1882, p. 282; Dalla Torre, 1894, p. 197; Ashmead, 1898, p. 255; Konow, 1905, p. 72; Enslin, 1914, p. 257; Forsius, 1930, p. 103; Ross, 1937, p. 70; Weber, 1939, p. 541; Berland, 1947, p. 273. Preoccupied.

Type-species: *Phyllotoma vagans* Fallén. Designated by Rohwer, 1911b.

Heterarthrus Stephens, 1835, p. 94; Westwood, 1840, p. 54; Dalla Torre, 1894, p. 197 (= *Phyllotoma* Fallén); Ross, 1951, p. 29; Benson, 1952, p. 77; Malaise, 1961, p. 236.

Type-species: *Decatria fuscipennis* Stephens (= *Tenthredo* (*Emphytus*) *ochropoda* Klug). Original designation.

Heterarthrus Cameron, 1882, p. 282. Emendation for *Heterarthrus* Stephens.

Decatria Stephens, 1835, p. 94; Dalla Torre, 1894, p. 197 (= *Phyllotoma* Fallén).

Type-species: *Decatria fuscipennis* Stephens. Monotypic and original designation.

Druida E. Newman, 1838, p. 484; Dalla Torre, 1894, p. 197 (= *Phyllotoma* Fallén).

Type-species: *Druida parviceps* E. Newman. Monotypic.

Phlebatrophia MacGillivray, 1909b, p. 345; Forsius, 1930, p. 103 (= *Phyllotoma* Fallén).

Type-species: *Phlebatrophia mathewsoni* MacGillivray. Monotypic and original designation.

Description.—Antenna 10- to 12-segmented (pl. III, 31). Head flattened, markedly depressed between eyes from dorsal view (pl. III, 30). Malar space twice width of diameter of front ocellus; clypeus truncate; postgenal carina absent. Tarsal claw with two long subequal outer teeth and large acute basal lobe (pl. III, 23). Prepectus absent. Forewing with vein 2A and 3A complete for entire length, connected to 1A by oblique crossvein. Hindwing with radial cell open; cells *Rs* and *M* absent; anal cell present (pl. I, 8, 9).

This very distinct genus is separated from other Heterarthrinae genera by the antenna, head, wing venation, and tarsal claw. Benson (1952) placed this genus in a subfamily by itself, the Heterarthrinae, and placed the other taxa treated in this bulletin in the subfamily Blennocampinae. About 10 species are in this genus. Only one species is found in North America, an introduced form that is destructive to *Betula* spp. in northeastern United States and eastern Canada. The larva is known for this species and is treated under the species description.

Description of *Heterarthrus* Species*Heterarthrus nemoratus* (Fallén)

Hylotoma nemorata Fallén, 1808, p. 47.

Phyllotoma nemorata: Thomson, 1870, p. 268; Thomson, 1871, p. 176; André, 1880, p. 235; Cameron, 1882, p. 284; Brischke and Zaddach, 1883, p. 254; Konow, 1890, p. 248; Dalla Torre, 1894, p. 198; Konow, 1905, p. 72; Enslin, 1914, p. 258; Rohwer, 1920, p. 63; Taylor, 1929, p. 323; Dovnar-Zapolsky, 1929, p. 39; Pierson, 1929, p. 588; Pierson, Taylor, and Wilkins, 1930, p. 1; Taylor, 1931, p. 452; Glasgow, 1932, p. 693; Conde, 1934, p. 181; Twinn, 1934, p. 76; Pierson and Brower, 1936, p. 37; Goebeil, 1937, p. 1; Hering, 1937, p. 73; Balch, 1939, p. 36; Benson, 1940, p. 213; Buhr, 1941, p. 910; Wahlgren, 1944, p. 139; Reeks and Smith, 1945, p. 10; Berland, 1947, p. 274.

Heterarthrus nemoratus: Ross, 1951, p. 30; Benson, 1952, p. 77; Maxwell, 1955, p. 56; Raizenne, 1957, p. 25; Lorenz and Kraus, 1957, p. 146; Lindquist, 1959, p. 626; Benson, 1962, p. 389; Burks, 1967, p. 16.

Phyllotoma nemoralis Fallén, 1829, p. 35; Dalla Torre, 1894, p. 198 (= *nemorata* Fallén).

Phlebotrophia mathewsoni MacGillivray, 1909b, p. 345, ♀; Yuasa, 1922, p. 60; Frison, 1927, p. 256; Rohwer, 1929, p. 63 (= *nemorata* Fallén).

Female.—Average length, 4.5 mm. Antenna black; head black with clypeus, mouth parts, inner orbits, malar space, supraclypeal area, and spot above each antenna yellow. Thorax black with posterior half of pronotum and tegula yellow. Legs white with each coxa and basal half of each femur black. Abdomen black with yellow spots on lateral apical margin of each terga. Wings hyaline, infusate band below stigma, lighter on hindwing; costa of forewing yellow, stigma black.

Antenna with 10 or 11 segments (pl. III, 31). From above, head markedly depressed between eyes (pl. III, 30). Sheath straight above, rounded below, with narrow scopa at apex (pl. IV, 43, 44).

Male.—Unknown. Parthenogenetic.

Larva.—Final feeding stage (pl. XII, 142–147). Length, 8.0 mm. Dorsoventrally flattened. White with head capsule, pronotal plate, prosternal plate, small central areas of mesosternum and metasternum, and ring around anal proleg dark brown.

Head dorsoventrally flattened, prognathous. Antenna conical, four-segmented. Labrum slightly wider than long, truncate; epipharynx with about 12 long spines on each half; maxillary palpus four-segmented, first and second segments each with one seta; galea long, digitate; lacinia with two long bifurcate spines and numerous smaller spines below these; right mandible with dorsal and ventral cutting edges; left mandible similar to right mandible but dorsal edge divided into three blunt teeth; one seta on basal angle of each mandible; labial palpus three-segmented, mentum with numerous small spines.

Pronotal plate present; prosternal plate present, cut into large circular areas around each prothoracic leg; small dark plates at center of mesosternum and metasternum. Thoracic legs indistinctly three-segmented; tarsal claw minute, appearing absent. Prothoracic spiracle not winged.

Prolegs on abdominal segments 2 to 8 and 10; anal proleg surrounded by sclerotized plate. Segments each two-annulate.

Holotypes.—MacGillivray's type is at the Illinois Natural History Survey, a female, labeled "New Glasgow, Nova Scotia." Fallén's types are probably in the Zoological Museum, Lund, Sweden.

Distribution.—Northeastern United States and southeastern Canada; Europe. The following records are from specimens examined: *Maine*: Bar Harbor; Aurora; Bethel; Phillips; Mt. Desert Is. *Massachusetts*: Amherst. *New Brunswick*: Fredericton. *Newfoundland*: Grand Falls. *New Hampshire*: Mt. Washington; Shelburne; Gorham. *New York*: Keene; Mt. Marcy summit. *Nova Scotia*: New Glasgow; Truro. *Quebec*: Gaspé; Cascadepédia R.; Lake St. John. Raizenne (1957) recorded this species from the following localities in southern Ontario: Bruce, Kent, Leeds, Simcoe, Victoria, Welland, and York.

Host.—Leaf miner of *Betula* spp. Glasgow (1932) stated that the preferred hosts are white and gray birch, although yellow and black birch are attacked to some extent.

Biology.—Pierson, Taylor, and Wilkins (1930) studied this species in Maine. The adults appear in May or June, later at higher elevations, and the female oviposits in the leaf margin. The feeding period lasts about a month, during which the larvae mine throughout the leaf. The mined areas first appear as small brown patches on the edge of the leaf, and later these patches increase in size and merge together. On maturing, the larvae remain in the leaf to overwinter and pupate. There is one generation a year. Of the four birch leaf-mining sawflies, both *nemoratus* and *Messa nana* oviposit on the leaf margins; *Fenusa pusilla* and *Profenusa thomsoni* oviposit on the surface of the leaf. However, *nana* goes into the soil to overwinter and pupate, whereas *nemoratus* remains in the leaf. Pierson (1929), Glasgow (1932), Pierson and Brower (1936), and Goebel (1937) have all published notes on the biology of this species.

Discussion.—This species is easily recognized by the antenna, head, and wing venation. The larvae may be separated from other birch leaf-mining sawfly species by the presence of prolegs and the presence of a sclerotized ring only around the anal proleg.

The first record for *nemoratus* in North America was from Pictou, Nova Scotia, in 1908. By 1927 this species had reached epidemic proportions in eastern Maine, and by 1928 it was found throughout Maine to New Hampshire and Massachusetts. Glasgow (1932) first reported it from New York. Recently the populations have been at a very low ebb.

Tribe FENUSINI

The larvae of all species of the tribe Fenusini are leaf miners. The adults may be distinguished by their small size and petiolate

anal cell of the forewing. The larvae are small and dorsoventrally flattened, with a varying number of sclerotized plates on the body.

Genus METALLUS Forbes

Metallus Forbes, 1885, p. 87; Dalla Torre, 1894, p. 156 (= *Fenusia* Leach); MacGillivray, 1909a, p. 265; MacGillivray, 1916, p. 159; Benson, 1936, p. 622; Ross, 1937, p. 71; Conde, 1937, p. 108; Benson, 1940, p. 212; Benson, 1941, p. 86; Berland, 1947, p. 261; Ross, 1951, p. 30; Benson, 1952, p. 106; Takeuchi, 1952, p. 59; Lorenz and Kraus, 1957, p. 133; Smith, 1967, p. 280.

Type-species: *Metallus rubi* Forbes. Monotypic.

Entodecta Konow, 1886b, p. 184; Dalla Torre, 1894, p. 166; Ashmead, 1898, p. 253; Konow, 1904, p. 4; Konow, 1905, p. 85; Helién, 1935, p. 22; Benson, 1936, p. 622 (= *Metallus* Forbes); Ross, 1937, p. 71; Ross, 1951, p. 30 (= *Metallus* Forbes).

Type-species: *Penthredo* (*Allantus*) *pumila* Klug. Designated by MacGillivray, 1909a.

Polybates MacGillivray, 1909a, p. 264; MacGillivray, 1916, p. 158; Ross, 1937, p. 71 (= *Entodecta* Konow); Ross, 1951, p. 30 (= *Metallus* Forbes).

Type-species: *Polybates slossonae* MacGillivray. Monotypic.

Description.—Antenna with second segment broader than long; third segment slightly longer than or subequal in length to fourth segment; in males third and fourth antennal segments widened and laterally flattened, segments beyond fourth less distinctly flattened (pl. III, 38, 39). Postgenal carina absent; malar space linear; clypeus truncate. Prepectus absent. Tarsal claw with long outer tooth and large acute basal lobe (pl. III, 22). Forewing with vein 2A and 3A straight at apex. Hindwing with cell R_1 closed; anal cell present; cells R_s and M absent (pl. II, 10, 11).

The broad second antennal segment and the flattened antenna of the male will separate this genus from *Messa*, its closest relative. Also, the serrulae of the female lancet are long and lobelike in species of *Metallus* and flattened in species of *Messa*, and the penis valve of the male genitalia of *Metallus* lacks a long apical filament, which is found in males of *Messa* species.

About eight described species are in this genus, three of which are found in North America. Two of the North American species are associated with *Rubus*.

Larvae are known for two species of *Metallus*. They may be separated from those of all other genera of Fenusini by the presence of prolegs on abdominal segments 2 to 7 and 10. Other genera have no prolegs or they are present on segments 2 to 8 and sometimes 10.

Keys to *Metallus* Species

ADULTS

1. All tibiae black; mesonotum sometimes partly rufous; antenna of male laterally flattened *rohveri* MacGillivray
- Legs entirely yellowish; thorax always black; male unknown 2

2. Serrulae of lancet long, pointed at apex, with single anterior subbasal tooth near ventral margin of lancet (pl. VIII, 87) *bensoni*, n. sp.
 Serrulae short r, rounded at apex, with one anterior and one posterior subbasal tooth near ventral margin of lancet (pl. VIII, 88) *capitalis* (Norton)

LARVAE

1. Mesosternum and metasternum with dark plates; lacinia with three or four spines (pl. XIII, 154, 159) *rohweri* MacGillivray
 Mesosternum with small dark plate on anterior margin; metasternum without plate; lacinia with three spines *capitalis* (Norton)

Descriptions of *Metallus* Species*Metallus bensoni*, new species

Female.—Length, 4.5 mm. Black with all legs entirely yellowish. Wings uniformly, moderately infuscated.

Second segment of antenna broader than long; third segment slightly longer than fourth segment (pl. III, 38). Clypeus truncate; malar space less than diameter of front ocellus. Tarsal claw with one outer tooth and large acute basal lobe (pl. III, 22). Forewing with vein 2A and 3A straight at apex. Hindwing with radial cell closed; cells *Rs* and *M* absent; anal cell present. Sheath straight above, rounded below, scopa absent (pl. IV, 46). Serrulae of lancet long, each pointed at apex with one anterior subbasal tooth near ventral margin of lancet and no posterior subbasal teeth (pl. VIII, 87).

Male.—Unknown.

Larva.—Unknown.

Holotype.—Female, New York, Albany Co., nr. Rensselaerville, Huyck Preserve, 23 June 1967, Malaise trap 1, R. and J. Matthews. Deposited in the Museum of Comparative Zoology, Harvard University.

Paratypes.—*British Columbia*: Grouse Mt., July 20, 1936, H. H. Ross (1 ♀). *New York*: Same data as for holotype, 9 June 1967 (1 ♀), 21 June 1967 (1 ♀), 1 July 1967 (1 ♀), 9 July 1967, Malaise trap 4 (1 ♀), 13 July 1967 (1 ♀), 17 July 1967 (1 ♀), 23 July 1967 (1 ♀), 8–12 August 1967 (1 ♀), 9 August 1967 (1 ♀), 14 August 1967 (2 ♀♀), 14 August 1967, Malaise trap 4 (1 ♀), 17 August 1967 (1 ♀), 17 August 1967, Malaise trap 2 (1 ♀), 18 August 1967 (2 ♀♀), 19 August 1967 (1 ♀), 20–23 August 1967 (2 ♀♀), 5–7 September 1967, Malaise trap 2 (1 ♀). Deposited in the Museum of Comparative Zoology, Harvard University, U.S. National Museum, and at the Illinois Natural History Survey.

Distribution.—Known only from British Columbia and New York.

Host.—Unknown.

Biology.—The dates of capture extend throughout the summer. There may be several generations a year.

Discussion.—This species is similar to *capitalis* in coloration, but *bensoni* is slightly larger, the wings are slightly darker, and the serrulae of the lancet are longer, pointed at their apices, and

each has only one anterior subbasal tooth. The entirely yellowish legs will separate *bensoni* from *rohweri*. The British Columbia specimen is identical to those from New York.

Metalhus capitalis (Norton)

Selandria capitalis Norton, 1867, p. 247, ♀; Cresson, 1928, p. 4.

Blennocampa capitalis: Cresson, 1880, p. 59; Dalla Torre, 1894, p. 170; Konow, 1905, p. 84.

Scolioneura capitalis: Marlatt, 1895, p. 234.

Metalhus capitalis: MacGillivray, 1909a, p. 266; MacGillivray, 1916, p. 159; Ross, 1937, p. 30; Smith, 1967, p. 280.

Entodecta capitalis: Ross, 1937, p. 71.

Entodecta humilis Konow, 1908, p. 84, ♀; Ross, 1937, p. 71 (= *capitalis* Norton). Synonymy not certain.

Polybates stlossonae MacGillivray, 1909a, p. 265, ♀; MacGillivray, 1916, p. 158; Frison, 1927, p. 256; Ross, 1937, p. 71 (= *capitalis* Norton).

Polybates secundus Rohwer, 1910, p. 202, ♀; MacGillivray, 1916, p. 159; Ross, 1937, p. 71 (= *capitalis* Norton).

Female.—Average length, 4.0 mm. Black with all legs entirely yellowish. Wings uniformly, lightly infuscate.

Antenna slender, third segment slightly longer than fourth segment (pl. III, 38). Sheath straight above, rounded below, scopa absent (pl. IV, 46). Serrulae of lancet each lobelike, rounded at apex, with one anterior and one posterior subbasal tooth, each located near ventral margin of lancet (pl. VIII, 88).

Male.—Unknown.

Larva.—Very similar to that of *rohweri* with the following differences: Small plate on anterior margin of mesosternum; metasternum without plate; lacinia with three spines; palpifer with two setae; mandibles slightly different, as in plate XIII, 162 and 163. Described from larvae taken from raspberry leaves, Friday Harbor, Washington, Sept. 17, 1956.

Holotypes.—*S. capitalis* Norton, a female labeled "N.Y." is type No. 10338 at the Academy of Natural Sciences of Philadelphia. *P. stlossonae*, a female labeled "Franconia, N.H.," is at the Illinois Natural History Survey. *P. secundus* Rohwer, a female labeled "Red Head, St. John, N.B., Sept. 1, '07, A. G. Leavitt, collector," is U.S.N.M. type No. 12926. Konow's type is probably at the Deutsches Entomologisches Institut, Eberswalde, Germany.

Distribution.—Probably transcontinental across northern United States and southern Canada. *British Columbia*: Vancouver, 19-VIII-32. *Illinois*: Mineral Springs, VIII-28-16. *Maine*: Mt. Katahdin, Camp Kennedy, 3000', Aug. 1902; Mt. Katahdin, 8-31-23; Bar Harbor, emgd. V-43, miner ex raspberry. *New Brunswick*: Red Head, St. John, Sept. 1, 1907. *Newfoundland*: 20 mi. N.E. Deer Lake, June 28, 1966. *New Hampshire*: Franconia; Hampton. *New York*: Brooklyn; Niagara Falls, 9-4-11. *Oregon*: Astoria, 25-5; Astoria, May 4, 1962, raspberry; Spring Cr., Baker, 11-VIII-1952. *Quebec*: St. Hilaire; Ile Jesus, 4 mi. N. Montreal, Aug. 19, 1956.

Host.—Adults have been reared from larvae mining in the leaves of raspberry (*Rubus* sp.).

Biology.—Collection dates of adults range from May to Septem-

ber, most of them in August, indicating that there may be more than one generation a year. There is no literature on the life history of this species.

Discussion.—This is a small species that may be separated from *bensoni* by the lower and more rounded serrulae of the lancet and the presence of a posterior subbasal tooth on each serrula. The yellowish tibiae will separate *capitalis* from *rohweri*.

Metallus rohweri MacGillivray

Metallus rubi Forbes, 1885, p. 87, ♂; MacGillivray, 1909a, p. 268; MacGillivray, 1916, p. 160; Yuasa, 1922, p. 99; Frison, 1927, p. 210; Rohwer, 1927, p. 67; Daniel, 1928, p. 5; Ross, 1937, p. 72. Preoccupied.

Fenusa rubi: Cresson, 1887, p. 160; Dalla Torre, 1894, p. 157; Dyar, 1898, p. 137; Konow, 1905, p. 90.

Metallus rohweri MacGillivray, 1909a, p. 267, ♀; MacGillivray, 1916, p. 159; Frison, 1927, p. 252; Ross, 1937, p. 72 (= *rubi* Forbes); Ross, 1951, p. 30; Smith, 1967, p. 280.

Metallus bethunei MacGillivray, 1914, p. 366, ♂, ♀; MacGillivray, 1916, p. 160; Caesar, 1921, p. 33; Yuasa, 1922, p. 99 (?); Frison, 1927, p. 251; Rohwer, 1927, p. 67 (= *rubi* Forbes); Daniel, 1928, p. 5 (= *rubi* Forbes).

Scolioneura capitalis of auctt., nec Norton, Houghton, 1908, p. 212; Houghton, 1910, p. 10.

Female.—Average length, 5.2 mm. Black with labrum, each trochanter, tibia, and tarsus white; thorax sometimes rufous with metapleuron and pectus black, or with intermediates between this and those with thorax all black. Wings darkly infuscated, usually darker on basal one-half.

Antenna stout, third segment subequal in length to fourth segment (pl. III, 38). Sheath short, straight above, rounded below, subtruncate at apex; scopa absent (pl. IV, 45). Serrulae of lancet shallow, broad, rounded at apex, each with three or four small anterior subbasal teeth and no posterior subbasal teeth (pl. VIII, 89).

Male.—Average length, 5.0 mm. Color similar to black specimens of females, never with rufous thorax. Antenna thickened, laterally flattened, especially noticeable on segments 2 to 5 (pl. III, 39). Genitalia as in plate X, 108 and 109; penis valve long and slender, with long apical spine.

Larva.—Final feeding stage (pl. XIII, 154–161). Length, 9.0 mm. Body cylindrical, slightly dorsoventrally flattened. White; head capsule, plates on venter and dorsum of thorax, and crescent-shaped marks about each proleg brownish.

Head dorsoventrally flattened, prognathous, diamond shaped from above. Antenna one-segmented. Labrum slightly emarginated; epipharynx with row of about eight to 10 long spines on each half; right mandible with one ventral tooth and three rounded dorsal teeth; left mandible with one rounded ventral tooth, one large rounded dorsal tooth, and one blunt inner tooth; maxillary palpus four-segmented, one seta on second segment; palpifer with one seta; galea long, digitate; lacinia short, inconspicuous, with three or four stout spines; labial palpus small, two-segmented.

Pronotum, mesonotum, and metanotum each with lightly sclero-

tized plate, pronotal plate largest. Prosternum with dark plate covering nearly entire sternum; mesosternum and metasternum with smaller central plates. Prothoracic spiracle winged. Thoracic legs five-segmented; tarsal claw present.

Abdominal segments 2 to 9 each with two annulets; pleural lobes present. Prolegs on abdominal segment 2 to 7 and 10, dark crescent-shaped plate present about anterior margin of each proleg, those about anal prolegs largest. Abdominal spiracles not winged.

Holotypes.—At the Illinois Natural History Survey, a specimen is labeled as holotype of *M. rubi* Forbes. It is a male and is without data. Frison (1927) stated that there is a lectotype male with the data "Normal, Illinois, reared from mines in leaves of raspberries, August 12, 1884." MacGillivray's types are at the Illinois Natural History Survey: *M. rohweri*, a female, is labeled "Block Island, R.I., Aug. 28, 1891," and *M. bethunei*, a female, is labeled "Jordan Harbor, July 5, 1919."

Distribution.—Eastern North America. *Connecticut*: Lyme, Aug. 27, 1918, 5-1-18, 7-8-18, 7-11-18; Branford, 2-IX-51; Windsor. *Delaware*: Dover, 5-30-1906. *Florida*: Archibald Biological Sta., Highlands Co., 2-6-66, blotch miner, blackberry. *Illinois*: "N. Ill." *Maine*: Mt. Desert, emgd. 5-VI-1953, ex blackberry; Augusta, VIII-21-43, about dewberry. *Maryland*: J. Cabin John, 7-IX-12, 14-9-14, 28-VIII-1916; Plummers Island, Aug. 4, 1911; Marshall Hall; Bowie, V-30-44; Glen Echo. *Massachusetts*: Boston, Arnold Arboretum, July 25, 1921; Sherborn, Nantucket Island. *Michigan*: Stevensville, Berrien Co., V-29-38. *Missouri*: "C. Mo." *New Jersey*: Somerville, 1921. *New York*: Cold Spring Harbor, VIII-9-20; Gardiner's Island; Fredonia; Greenport, L.I., Sept. 6, 1951; Ithaca, Aug. 5, 1898. *North Carolina*: Chadbourn, Apr. 16, 1910, collected on dewberry. *Ohio*: Put-in-Bay. *Ontario*: St. Kits, VIII-12-1911; Jordan Harbor; Vineland, Aug. 14, 1952; Toronto, 7-10-09. *Pennsylvania*: Harrisburg, Hetzels Swamp, July 9, 1910; Enola, VI-7-08; Colmanville, iss. 14 Aug. '05, leaf miner in blackberry; Presque Is., 7-17-1947. *Rhode Island*: Block Island. *Virginia*: Falls Church, VI-17-17, June 9, 1921, June 25, 1921; Whicle, Aug. 28, 1943; Eastern Field Station, Aug. 29, 1918. *Wisconsin*: Trout Lake, Aug. 1911; Baraboo, 8-10-10.

Host.—Leaf miner of blackberry (*Rubus* spp.). Daniel (1928) stated that they may attack dewberry close to blackberry patches.

Biology.—Daniel (1928) gave the life history of this species from his studies in New York. Two generations a year occur, adults of the first generation appearing in June and those of the second generation in August. The eggs are inserted into the leaf from the upper side, usually on the surface near the midrib or a prominent vein. The egg and larval stages combined last about 6 weeks, after which the mature larva drops to the ground to pupate or overwinter in the soil. Houghton (1908, 1910) also published notes on the life history of this species in Delaware under the name "*Scolioneura capitalis*."

Discussion.—This species may be separated from the other two species of *Metallus* by the black femora, lower and broader serrulae

of the lancet, and, when present, the red thorax. Also, *rohweri* is a larger species and the wings are more darkly infuscated than in *bensoni* and *capitalis*.

Genus MESSA Leach

Messa Leach, 1817, p. 126; Westwood, 1840, p. 54; Dalla Torre, 1894, p. 156 (= *Fenusa* Leach); Enslin, 1914, p. 307; MacGillivray, 1914, p. 365; Benson, 1936, p. 625; Benson, 1941, p. 86; Ross, 1951, p. 30; Benson, 1952, p. 107; Takeuchi, 1952, p. 59; Lorenz and Kraus, 1957, p. 136; Malaise, 1964, p. 33; Smith, 1967, p. 280.

Type-species: *Tenthredo hortulana* Klug. Monotypic.

Fenusella Enslin, 1914, p. 270; Benson, 1936, p. 625; Stritt, 1936, p. 56; Benson, 1941, p. 86 (= *Messa* Leach); Berland, 1947, p. 265; Malaise, 1964, p. 33.

Type-species: *Fenusa wuestneii* Konow. Monotypic and original designation.

Melanobates MacGillivray, 1916, p. 158; Benson, 1936, p. 622 (= *Fenusella* Enslin); Ross, 1937, p. 71 (= *Scolioneura* Konow); Ross, 1951, p. 30 (= *Messa* Leach).

Type-species: *Parabates leucostomus* Rohwer. Monotypic.

Description.—Antenna nine- or 10-segmented; second segment longer than broad; third segment longer than fourth segment; antenna of males not widened or laterally flattened (pl. III, 35, 36). Postgenal carina absent; clypeus truncate; malar space linear. Tarsal claw with long outer tooth and large acute basal lobe (pl. III, 22). Forewing with vein 2A and 3A curved up at apex. Hindwing with cell R, closed; anal cell present; cells Rs and M absent (p. II, 12, 13).

This genus is separated from *Metallus* by the long second antennal segment and by the third antennal segment, which is always longer than the fourth segment. The antennae of males of *Messa* species are not enlarged as are those of *Metallus* species. Also, the genitalia of *Messa* species are relatively uniform, having serrulae of the female lancet flat and a long apical filament on the penis valve of the male genitalia. The color pattern of the species of this genus appears constant within the species.

About seven or eight species are in this genus, five of which are found in North America. All are leaf miners in the larval stage and are associated with *Betula*, *Populus*, and *Salix*.

The larvae are not well enough known to permit a key for their separation. I have seen some specimens from *Populus*, but they have not been associated. The only larva I have described and specimens of which I have examined is that of *nana*. The larvae of *Messa* may be separated from those of other genera of Fenusini by the following combination of characters: Abdominal prolegs present on segments 2 to 8 and 10; a dark crescent-shaped plate anterior to each proleg; mesosternum, metasternum, and sternum of first abdominal segment each with a dark plate. The larvae are typical of most leaf miners and are dorsoventrally flattened with the head prognathous.

Key to *Messa* Species

1. Frons with distinct circular ridge; mesonotum without fine surface sculpture; segment 8 of antenna more than twice as long as broad; forewing with infuscate band below stigma; male unknown; leaf miner of *Betula* 2
nana (Klug)
 Frons without ridge; mesonotum with fine surface sculpture on front and lateral lobes; segment 8 of antenna less than two times longer than broad; forewing uniformly subhyaline 3
2. Mesopleuron pale yellowish or orange 4
 Mesopleuron black
3. Head, pectus, and venter of abdomen mostly yellowish orange; male with coloration similar to that of female; leaf miner of *Populus* 2
populifoliella (Townsend)
 Head, pectus, and abdomen black; clypeus yellowish; male unknown; leaf miner of *Populus* 3
hortulana (Klug)
4. Clypeus and pronotum white; male and female similar; leaf miner of *Populus* 4
leucostoma (Rohwer)
 Clypeus and pronotum black; male and female similar; leaf miner of *Salix* 2
westneii (Konow)

Descriptions of *Messa* Species*Messa hortulana* (Klug)

Tenthredo (*Emphytus*) *hortulana* Klug, 1814, p. 276, ♀; Kriechbaumer, 1884, p. 208.

Messa hortulana: Leach, 1817, p. 126; Stephens, 1835, p. 40; Westwood, 1840, p. 54; Enslin, 1914, p. 308; Koornneff, 1925, p. 360; Dovnar-Zapolsky, 1929, p. 38; Hering, 1934, p. 67; Stritt, 1935, p. 187; Benson, 1941, p. 89; Benson, 1943, p. 10; Jones, 1945, p. 218; Benson, 1952, p. 108; Lorenz and Kraus, 1957, p. 137; Malaise, 1964, p. 33; Benson, 1968, p. 150.

Emphytus hortulana: Hartig, 1837, p. 258.

Phaenusa hortulana: André, 1880, p. 231.

Fenusa hortulana: Fletcher, 1881, p. 127; Cameron, 1882, p. 296; Konow, 1885, p. 297; Konow 1886b, p. 270; Konow, 1890, p. 249; Dalla Torre, 1894, p. 157; Konow, 1905, p. 90.

Fenussella hortulana: Benson, 1936, p. 625; Buhr, 1941, p. 915; Stritt, 1944, p. 25; Berland, 1947, p. 267.

Female.—Average length, 4.0 mm. Antenna black above, lighter on ventral surface; head black with clypeus, basal half of each mandible, and rest of mouth parts whitish. Thorax black with tegula and pronotum white, spot on lateral margins of prescutum and all of mesopleuron yellowish orange. Legs entirely yellowish orange with each trochanter, base of each coxa, and each tarsus infuscated. Abdomen black with white band on posterior margin of each segment. Wings hyaline.

Antenna 10-segmented, if nine-segmented then ninth segment at least $1\frac{1}{2}$ times length of eighth segment (pl. III, 35). Frons without ridge. Front and lateral lobes of mesonotum with fine surface sculpture. Sheath short, straight above, rounded below, with narrow scopa at apex (pl. IV, 51, 52). Lancet with each serrula low and flattened, with one anterior and four or five posterior subbasal teeth as in plate VII, 80.

Male.—Unknown in North America. The males are very rare in Europe (Benson, 1952).

Larva.—Unknown.

Holotype.—Probably in the Zoological Museum of Berlin.

Distribution.—In North America known only from Massachusetts; Europe. *Massachusetts*: Malden, lombardy poplar, Gip. Moth Lab. 12164J18, bred specimens, 5-2-24 (6 ♀♀), 5-3-24 (1 ♀), 5-10-24 (2 ♀♀); Wellesley (1 ♀).

Host.—Adults were bred from larvae on lombardy poplar (*Populus nigra* var. *italica* Muenchh.) in Massachusetts. Benson (1952) recorded the host as *Populus nigra* L. in England.

Biology.—There is little information on the life history of this species except notes by Buhr (1941) and Hering (1934).

Discussion.—This species is separated by the yellowish-orange mesopleuron and black pectus. *M. populifoliella* has considerably more yellow on the head and abdomen, and *leucostoma* and *westnecii* are nearly entirely black.

This is the first North American record for *hortulana*. The specimens from Massachusetts are identical to specimens from Europe and were also bred from an introduced shade tree, lombardy poplar, which is native to Europe. This is probably an introduced species.

Messa leucostoma (Rohwer)

Parabates leucostoma Rohwer, 1910, p. 202, ♀.

Scolioneura leucostoma: Ross, 1937, p. 71.

Messa leucostoma: Ross, 1951, p. 30.

Glennocampa amara MacGillivray, 1923a, p. 161, ♀; Frison, 1927, p. 238; Ross, 1951, p. 30 (= *leucostoma* Rohwer).

Female.—Average length, 4.0 mm. Antenna black, first segment and ventral surface of rest of antenna sometimes brownish. Head black with clypeus, labrum, basal half of each mandible, and rest of mouth parts whitish; supraclypeal region, paraantennal fields, and spot above each antenna sometimes brownish. Thorax black with tegula white and posterior margin of pronotum white; rest of pronotum sometimes brownish. Legs mostly black with white to infuscated areas on extreme apex of each femur and each front and middle tibia. Abdomen black with narrow to wide white margin on posterior edge of each segment. Wings hyaline.

Antenna nine-segmented; ninth segment shorter or subequal in length to eighth segment. Head without circular ridge on frons. Front and lateral lobes of mesonotum with fine surface sculpture. Sheath straight above, rounded below, with narrow scopa at apex (pl. IV, 51, 52). Lancet with each serrula low and flattened, with one anterior and three or four posterior subbasal teeth as in plate VII, 80.

Male.—Average length, 4.0 mm. In color and structure similar to female. Genitalia as in plate X, 112 and 113; harpe rounded at apex, subtruncate at base and at inner lower margin; penis valve broad, with long apical filament.

Larva.—Unknown.

Holotypes.—*P. leucostoma* Rohwer is U.S.N.M. type No. 12925, a female labeled "St. John, N.B., 18 Jul., A. G. Leavitt, collector."

B. amara MacGillivray is at the Illinois Natural History Survey, a female, labeled "Edmonton, Alta., 21-V-1917, F. S. Carr."

Distribution.—Transcontinental across southern Canada and northern United States with southern extensions into California and Colorado. *Alberta*: Edmonton, May 21, 1917. *California*: Elkhorn Ferry, Yolo Co., March 30, 1963; Winnemucca Lake, Carson Pass, July 14, 1964; Pacheco, Contra Costa Co., on cottonwood, 4-8-1958; Mint Canyon, 3-8-62; Forestville, April 21, 1938. *Colorado*: "Colo." *Iowa*: Ames, May 7, 1950. *Minnesota*: Itasca Park, May 23, 1937. *New Brunswick*: St. John, July 18. *Oregon*: Willamette River, Benton Co., May 4, 1961. *Washington*: Yakima, March 30, 1932.

Host.—Adults have been collected from cottonwood.

Biology.—Unknown.

Discussion.—This widespread species is variable in coloration except for the black mesopleuron, white margin of the pronotum, and white clypeus, which appear constant in all the specimens examined. *M. wuestneii* has the pronotum and clypeus black, and *populifoliella* and *leucostoma* have a yellowish-orange mesopleuron. The color variations, such as the brownish areas on the head, are most common in the California specimens, but they appear to be the same species.

Messa nana (Klug)

Tenthredo (*Allantus*) *nana* Klug, 1814, p. 72; Hartig, 1837, p. 266; Kriechbaumer, 1884, p. 117.

Fenusa nana: Stephens, 1835, p. 41.

Blennocampa nana: Thomson, 1870, p. 285; Thomson, 1871, p. 212; André, 1881, p. 302; Cameron, 1882, p. 254; Brischke and Zaddach, 1883, p. 278; Konow, 1886b, p. 215.

Scollioneura nana: Konow, 1890, p. 249; Dalla Torre, 1894, p. 168; Konow, 1905, p. 85; Enslin, 1914, p. 298; Hering, 1931, p. 109; Conde, 1934, p. 185; Benson, 1936, p. 625; Hering, 1937, p. 74; Benson, 1940, p. 212; Buhr, 1941, p. 911; Wahlgren, 1944, p. 145; Berland, 1947, p. 260; Wahlgren, 1951, p. 74.

Messa nana: Benson, 1941, p. 89; Benson, 1952, p. 107; Lorenz and Kraus, 1957, p. 136; Smith, 1967, p. 280.

Female.—Average length, 4.5 mm. Antenna and head black; labrum and apical segments of maxillary and labial palpi whitish. Thorax black with tegula and posterior margin of pronotum white. Legs with each coxa, trochanter, and femur black; extreme apex of each femur, tibia, and tarsus white. Abdomen black. Wings subhyaline with infuscate band on forewing below stigma; costa and basal parts of veins whitish, stigma and remainder of veins black.

Antenna nine-segmented, slender; eighth segment more than twice as long as broad (pl. III, 36). Head with circular ridge on frons, enclosing anterior ocellus at posterior edge of ridge. Mesonotum without surface sculpture. Sheath straight above, rounded below, with narrow scopa at apex (pl. IV, 49, 50). Serrulae of lancet each low and rounded, with about 10 subbasal teeth and one prominent anterior subbasal tooth (pl. IX, 95).

Male.—Unknown in North America. Benson (1952) has seen

only two males from Britain. His description of the male is as follows: "♂ mainly yellow; white are: the tegulae and the outer half of each side of the pronotum; black or piceous are: the vertical and postoccipital parts of the head, middle of pronotum, mesonotum except for sides of front lobes, mesosternum, mesepimeron, most of metathorax, and also the medial basal portions of the basal tergites, though fading out between the 4th and 6th; costa and stigma pale yellow, rest of venation brownish white. 4-4.5 mm."

Larva.—Final feeding stage (pl. XII, 148-152). Length, 9.0 mm. Slightly dorsoventrally flattened. Whitish with head capsule and thoracic and abdominal plates brownish.

Head dorsoventrally flattened, prognathous. Antenna conical, two-segmented. Labrum as wide as long, truncate; epipharynx with row of 10 to 13 spines on each half; right and left mandibles with dorsal and ventral cutting edges, without distinct teeth, left mandible with one inner tooth; maxillary palpus four-segmented, one seta on second segment; palpifer with one seta; galea long, digitate; lacinia with eight to 10 spines; labial palpus three-segmented.

Single dark plate on pronotum; mesonotum with anterior and posterior transverse narrow plates; metanotum with anterior transverse narrow plate. Prosternum, mesosternum, and metasternum with dark plates, prosternal plate largest. Thoracic legs each five-segmented; tarsal claw present; thoracic legs dark brownish.

Prolegs present on abdominal segments 2 to 8 and 10; dark ring surrounding anterior margin of each proleg; anal proleg with complete dark ring. Sternum of first abdominal segment with small central dark plate; sternum of ninth abdominal segment with two small dark spots and sometimes with another dark spot lateral to each of these. Spiracles winged. Abdominal segments each with two annulets.

The larvae described here were taken from birch in Maine. Lorenz and Kraus (1957) also described the larva.

Holotype.—Probably in the Zoological Museum of Berlin.

Distribution.—Northeastern United States; Europe. *Maine*: Scarborough, June 4, 1966, ex red oak, L. J. Lipovsky (1 ♀); Scarborough, Cumberland Co., ex birches in nursery, June 2, 1967, D. R. Smith (10 ♀♀). *New York*: Oswego Co., Oswego Tws., from sticky board trap in pear orchard, 6-8-66, R. W. Stelle (2 ♀♀); Albany Co., nr. Rensselaerville, Huyck Preserve, 8 June 1967, R. and J. Matthews (Malaise trap 3) (1 ♀).

Host.—A leaf miner of *Betula* spp.

Biology.—In Maine there is apparently one generation a year. The adults emerge early in the spring, usually the end of May or the first of June, and are found flying about the host at about the same time *Fenusa pusilla* is active. The female oviposits in the margin of the leaf, similar to *Heterarthrus nemoratus*, and the larvae mine toward the center. *F. pusilla* and *Profenusa thomsoni* both oviposit on the surface near the center of the leaf. On maturing, the *nana* larvae drop to the soil where they pupate and over-

winter. In this respect *nana* differs from *nemoratus*, which remains in the leaf.

Hering (1937), Buhr (1941), and Wahlgren (1944, 1951) published notes on the life history of this species in Europe.

Discussion.—This is the most distinct species in this genus and is recognized by its larger size, presence of a ridge on the frons, lack of surface sculpture on the mesonotum, the infusate band on the forewing, and the more rounded serrulae of the lancet. It was first found in Maine in 1966 and reported by Smith (1967) from Maine and New York. It is probably an introduced species and adds another sawfly leaf-mining pest for *Betula*, which now has four in North America.

Messa populifoliella (Townsend)

cottonwood leaf miner, Townsend, 1892a, p. 26.

Tineidae ? larva, Townsend, 1892b, p. 234.

Blennocampa populifoliella Townsend, 1893, p. 304.

Messa populifoliella: Burks, 1958, p. 13; Titus and Underwood, 1966, p. 1; Underwood and Titus, 1968, p. 407.

Scotioneura populi Marlatt, 1895, p. 235, ♂, ♀; Burks, 1958, p. 13 (= *populifoliella* Townsend).

Messa populi: Ross, 1951, p. 30.

Scotioneura luteopicta Rohwer, 1911d, p. 398, ♂; Ross, 1951, p. 30 (= *populi* Marlatt); Burks, 1958, p. 13 (= *populifoliella* Townsend).

Female.—Average length, 4.0 mm. Antenna yellow with dorsal surface beyond first segment black. Head yellow with middle fovea, lateral furrows, areas around each ocellus, and sutures of postocellar area black; clypeus white. Thorax yellow with katapimeron, mesonotum except lateral margins of anterior lobe and posterior lateral and anterior mesal margins of lateral lobes, and metanotum black; pectus yellow or black. Legs entirely yellow. Abdomen yellow with most of dorsum black, black decreasing toward posterior; sheath black. Wings subhyaline; veins black with basal parts yellow; stigma and costa light to dark brown.

Antenna nine-segmented; ninth segment of antenna shorter than or subequal in length to eighth segment. Anterior and lateral lobes of mesonotum with fine surface sculpture, sometimes difficult to see. Frons without circular ridge. Sheath straight above, rounded below, with narrow scopa at apex (pl. IV, 51, 52). Each serrula of lancet low and flattened, with one anterior and three or four posterior subbasal teeth (pl. VII, 80).

Male.—Average length, 4.0 mm. In color and structure similar to female. Hypandrium narrowed posteriorly, tapering to blunt point. Genitalia as in plate X, 110 and 111; harpe rounded, oblong; penis valve with long apical filament; parapenis wider than those of *westonii* and *leucostoma*.

Larva.—Underwood and Titus (1968) described the larva. The later feeding stages have a large pronotal plate, a small transverse mesonotal plate, a large prosternal plate, smaller mesosternal and metasternal plates, a small plate on the sternum of the first abdominal segment, crescent-shaped dark plates at anterior of each proleg, and a large dark plate about the anal proleg. From the

description I am unable to clearly differentiate the larva from other known *Messa* larvae, and I have not seen specimens.

Holotypes.—*S. populi* Marlatt is U.S.N.M. type No. 4032, a female labeled "51" and "Townsend, 1891. New Mexico." *S. luteopicta* Rohwer is U.S.N.M. type No. 14011, a female labeled "Brookings, S.D." Townsend did not select a type. He (1892b) described the larva, but believed it to be a "Tineid?." Later Townsend obtained adults and described them as a manuscript species of Dr. Riley, *Blennocampa populifoliella*. Marlatt (1895) described *populi* from the same locality where Townsend obtained specimens and probably from the same series Townsend examined. Therefore, I have designated a lectotype for Townsend's species from a series collected by Townsend: U.S.N.M. type No. 70217, a female labeled "Las Cruces, N.M."

Distribution.—Central and eastern North America, west to Arizona. Arizona: "Ariz." Colorado: Deric, June 1, 1901, leaf miner on cottonwood. H. G. Dyar. Connecticut: Windsor, 4-1951, James B. Kring. Michigan: Ottawa Co., May 23, 1937, Dreisbach. New Mexico: "N. Mex."; Las Cruces, Apr. 21, 1897, C. J. Ckll. South Dakota: Brookings, June 20, 1909, H. C. Severin.

Also in Canada from New Brunswick and from eastern Ontario to the Manitoba border (Underwood and Titus, 1968).

Host.—Leaf miner of *Populus* spp. *Populus fremonti* Wats. (Townsend, 1892a), *P. cugenei* Simon-Louis, *P. nigra* var. *italica* Muenchh., *P. tremuloides* Michx., and *P. balsamifera* L. (Underwood and Titus, 1968).

Biology.—Underwood and Titus (1968) gave the life history of this species in New Brunswick. The adults appear during the last 2 weeks of May, and the females oviposit on the margin of the leaf, usually near the tip. The larvae feed for 14 to 20 days, making blotch mines throughout the leaf. On maturing, they drop to the ground and make cells in the soil where they overwinter and pupate. There is one generation a year.

Discussion.—The color pattern makes this species distinctive. The yellow markings of the head, thorax, and abdomen will separate it from other *Messa* species. I have seen only a few specimens from widely scattered localities.

Messa wuestneii (Konow)

Fenusa wuestneii Konow, 1894, p. 91, ♂, ♀; Konow, 1905, p. 90.

Fenusaella wuestneii: Enslin, 1914, p. 305; Malaise, 1920, p. 104; Malaise, 1931, p. 59; Condo, 1937, p. 108; Buhr, 1941, p. 923; Malaise, 1964, p. 33.

Messa wuestneii: Benson, 1941, p. 89; Benson, 1952, p. 108; Lorenz and Kraus, 1957, p. 137; Benson, 1959, p. 90; Benson, 1962, p. 391; Burks, 1967, p. 16.

Fenusa alaskana Kincaid, 1900, p. 345, ♂; Konow, 1905, p. 90 (*alascana*); Benson, 1959, p. 90 (= *wuestneii* Konow).

Messa alaskana: Ross, 1951, p. 30.

Female.—Average length, 3.7 mm. Antenna and head black; ventral surface of antenna and labrum sometimes brownish. Thorax black with tegula white; posterior angles of pronotum sometimes with touch of white. Legs black with extreme base of

each femur, front tibia, and apices of middle and hindtibiae whitish; each tarsus infuscated. Abdomen black, sometimes with narrow white margin on posterior edge of each segment. Wings lightly, uniformly infuscated.

Antenna nine-segmented; ninth segment shorter than or subequal in length to eighth segment. Circular ridge on frons absent. Front and lateral lobes of mesonotum with fine surface sculpture. Sheath short, straight above, rounded below, with narrow scopa at apex (pl. IV, 51, 52). Each serrula of lancet low and flattened, with one anterior and three or four posterior subbasal teeth (pl. VII, 81).

Male.—Average length, 3.7 mm. In color and structure similar to female. Genitalia as in plate X, 114 and 115; harpe oblong, rounded at apex; parapenis narrow; penis valve with long apical filament.

Larva.—Malaise (1920), Buhr (1941), and Lorenz and Kraus (1957) described the larva of this species. I have not seen specimens.

Holotypes.—*F. alaskana* Kincaid is U.S.N.M. type No. 5281, a male labeled "Kukak Bay, Alaska, July 4, '99, Harriman Expedition '99, T. Kincaid, collector." Konow's type is probably at the Deutsches Entomologisches Institut, Eberswalde, Germany.

Distribution.—Western North America from Alaska to California and Colorado; Europe. *Alaska*: Kukak Bay, July 4, '99; Anaktuvuk Pass, on willow, 7-14-68. *British Columbia*: Vancouver, April 21, 1931. *California*: San Francisco, March 3, 1927, March 12, 1932, on *Salix lasiolepis*; Carmel Bay, Placer Co., June 27, 1965, *Salix lemmonii*; 1 mi. W. Hobart Mills, Nevada Co., May 13, 1966, *Salix lemmonii*, *S. geveiana*; Lassen Co., McCoy Flat Res., 31 mi. N.W. Susanville, June 15, 1966, *Salix lemmonii* *bebbi*, complex; Willows. *Colorado*: "Colo."; Green Mt. Falls, June 14, 1938. *Nevada*: Mt. Rose Pass, 11 mi. S.W. Reno, Washoe Co., July 10, 1965, *Salix lemmonii*; same data, June 27, 1965; same data, July 18, 1965; same data, July 7, 1965.

Host.—Leaf miner of *Salix* spp.

Biology.—Malaise (1931) and Buhr (1941) described the life history of this species in Europe; there is no North American literature on its life history.

Discussion.—This small species may be separated from other *Messa* species by the almost entirely black coloration. It is a Holarctic species and was recorded from North America by Benson (1959).

Genus SETABARA Ross

Parabates MacGillivray, 1909a, p. 262; Benson, 1936, p. 625 (= *Fenusella* Enslin); Ross, 1937, p. 70 (= *Scolioneura* Konow). Preoccupied. Type-species: *Parabates histrionicus* MacGillivray. Original designation. *Setabara* Ross, 1951, p. 31 (new name for *Parabates* MacGillivray); Smith, 1967, p. 281.

Description.—Antenna stocky; second segment longer than broad; third segment longer than fourth segment; segments beyond third subequal in length. Clypeus truncate; malar space linear; postgenal carina absent. Prepectus absent. Tarsal claw simple with blunt inconspicuous basal lobe (pl. III, 24). Forewing with stub of vein 2A and 3A curved up at apex. Hindwing with cells *Rs* and *M* absent; anal cell present; cell *R*₁ closed (similar to pl. II, 13).

The closed radial cell of the hindwing and inconspicuous basal lobe of the tarsal claw will distinguish this genus from other North American genera. The single species of this genus is known only from western United States and is probably associated with *Prunus*.

Description of *Setabara* Species

Setabara histrionica (MacGillivray)

Parabates histrionicus MacGillivray, 1909a, p. 262, ♀; Frison, 1927, p. 255.

Scolioneura histrionica: Ross, 1937, p. 71.

Setabara histrionica: Ross, 1951, p. 31; Smith, 1967, p. 281.

Female.—Average length, 4.0 mm. Black with labrum brownish and extreme apex of each femur, extreme base of middle and back tibiae, and front tibia whitish. Wings lightly infuscated.

Front and lateral lobes of mesonotum with fine surface sculpture. Sheath short, straight above, rounded below, with small scopa at apex (pl. IV, 60, 61). Lancet with each serrula low, broad, truncate at apex, without distinct anterior or posterior subbasal teeth (pl. VII, 83).

Male.—Average length, 4.0 mm. In color and structure similar to female. Genitalia as in plate X, 116 and 117; harpe long, inner apical margin flat; penis valve rectangular, with short apicolateral spine.

Larva.—Unknown.

Holotype.—U.S.N.M. type No. 12177, a female labeled "Colo."

Distribution.—Western North America. *California*: Hambone, Shasta N.F., 5-8-34. *Prunus* sp. *Colorado*: "Colo." *Idaho*: Lenore, 1000', May 19, 1937. *Nevada*: "Nev." *Oregon*: Talent, Apr. 19, 1960, on *Prunus*; Talent, April 11, 1935; Klamath Falls, 5-11-64, *Prunus subcordata*: Boyer, May 15, 1937. *Washington*: Almota, 4-17.

Host.—Adults have been collected from *Prunus* sp.

Biology.—Unknown.

Discussion.—This is not a well-known species, apparently closely related to some *Messa* species but differing by the small basal lobe of the tarsal claw and lack of a long filament on the penis valve of the male genitalia.

Genus *PROFENUSA* MacGillivray

Profenusa MacGillivray, 1914, p. 364; MacGillivray, 1916, p. 156; Ross, 1937, p. 72; Benson, 1941, p. 86; Ross, 1951, p. 30; Benson, 1952, p. 108;

Lorenz and Kraus, 1957, p. 137; Malaise, 1964, p. 33; Smith, 1966, p. 719; Smith, 1967, p. 280.

Type-species: *Profenusa collaris* MacGillivray. Monotypic.

Gunnea Malaise, 1964, p. 33. New synonymy.

Type-species: *Tenthredo pygmaea* Klug. Original designation.

Description.—Second antennal segment longer than broad; third segment longer than fourth segment. Clypeus truncate; postgenal carina absent; malar space less than diameter of front ocellus. Prepectus absent. Tarsal claw with one long outer tooth and large acute basal lobe (pl. III, 22). Forewing with stub of vein 2A and 3A straight at apex. Hindwing with cell R_1 open; anal cell present or absent, if present then cell is longer than its petiole (pl. II, 14–16).

The open radial cell of the hindwing, the straight 2A and 3A vein of the forewing, the single outer tooth and basal lobe of the tarsal claw, and the absence of a prepectus will distinguish this genus.

About eight species are in this genus, five of which are found in North America. The North American species are associated with *Betula*, *Crataegus*, and *Quercus*.

Malaise (1964) established the genus *Gunnea* and separated it from *Profenusa* only on the basis of the presence of an anal cell in the hindwing. This is a variable character in *Profenusa* and cannot be valid for separation of species that are so closely related in habits and larval and other adult morphological characters.

Larvae are known for all five species of *Profenusa*. All species, except *canadensis*, are very distinct and conform to a similar pattern. The larvae of *lucifer*, *inspirata*, *thomsoni*, and *alumna* are distinctly dorsoventrally flattened, lack prolegs, have very reduced thoracic legs, lack tarsal claws (except very minute tarsal claws in *lucifer*), have three small spines or tubercles on the coxa of each thoracic leg, and have a minutely spiniform integument. The larva of *canadensis* has prolegs, well-developed thoracic legs with tarsal claws, lacks the spines on the coxae, and has a smooth integument. The larva of *canadensis* may be confused with those of *Messa* or *Metallus*, but *canadensis* may be separated by the presence of prolegs on abdominal segments 2 to 8 and 10 and the lack of dark plates on the mesosternum, metasternum, and sternum of the first thoracic segment. The larva of *canadensis* is as in plate XVI, 201. The larvae of the other four species of *Profenusa* are similar in general habitus, as in plate XV, 181.

Keys to *Profenusa* Species

ADULTS

- | | |
|---|---|
| 1. Female | 2 |
| Male | 6 |
| 2. Thorax, either part of mesonotum, upper part of mesepisternum, or prothorax, rufous; clypeus usually white | 3 |
| Thorax black; clypeus black | 4 |

3. Mesonotum, except scutellum, rufous; serrulae of lancet lobelike (pl. VIII, 90); leaf miner of *Crataegus* *canadensis* (Marlatt)
Mesonotum black; serrulae of lancet pointed at apex (pl. VIII, 94);
leaf miner of *Quercus* *lucifex* (Ross)
4. Hindtibia black; California and Oregon; leaf miner of *Quercus* *inspirata* (MacGillivray)
Hindtibia white; eastern species 5
5. Hindwing without anal cell; serrulae of lancet with eight or nine
small posterior and equal number of anterior subbasal teeth (pl.
VIII, 91); sheath rounded below (pl. IV, 57); leaf miner of
Betula *thomsoni* (Konow)
Hindwing with anal cell; serrulae of lancet with two or three anterior
subbasal teeth and five or six posterior subbasal teeth (pl. VIII,
92); sheath subtruncate at apex (pl. IV, 56); leaf miner of
Quercus *alumna* (MacGillivray)
6. Abdomen, mesopleuron, and pectus orange yellow *canadensis* (Marlatt)
Entirely black 7
7. Western species, California and Oregon *inspirata* (MacGillivray)
Eastern species; rare *alumna* (MacGillivray)

LARVAE

1. Prolegs present; tarsal claw distinct; sternal plates, except for that
on prosternum, absent; labrum wider than long, emarginated; coxae
without spines; leaf miner of *Crataegus* (pl. XVI, 201-206) *canadensis* (Marlatt)
- Prolegs absent; tarsal claw absent or very minute; mesosternal and
metasternal plates sometimes present; labrum longer than wide,
truncate; each coxa with three small spines or tubercles 2
2. Mesosternum and metasternum each with central dark plate; thoracic
legs two-segmented; leaf miner of *Betula* (pl. XV, 181-814) *thomsoni* (Konow)
Metasternum without plate; mesosternum with or without plate;
thoracic legs with more than two segments; leaf miners of *Quer-*
cus 3
3. Thoracic legs each with minute tarsal claw (pl. XVI, 200) *lucifex* (Ross)
Tarsal claw absent 4
4. Mesosternal plate present; thoracic legs four-segmented; western
species, California and Oregon (pl. XIV, 178, 179) *inspirata* (MacGillivray)
Mesosternal plate absent; thoracic legs three-segmented; eastern
species (pl. XV, 189, 190) *alumna* (MacGillivray)

Descriptions of *Profenusa* Species*Profenusa alumna* (MacGillivray)

Messa alumna MacGillivray, 1923b, p. 23, ♀; Frison, 1927, p. 251; Benson, 1959, p. 91 (= *thomsoni* Konow [!]).

Fenusa alumna: Ross, 1936, p. 265.

Profenusa alumna: Ross, 1951, p. 30.

Fenusa curta of auctt., nec Norton, Dyar, 1895b, p. 343; Dyar, 1898, p. 137 (?).

Messa amica MacGillivray, 1923b, p. 23, ♀, Frison, 1927, p. 251; Ross, 1936, p. 265 (= *alumna* MacGillivray).

Messa appota MacGillivray, 1923b, p. 24, ♂; Frison, 1927, p. 251; Ross, 1936, p. 265 (= *alumna* MacGillivray).

Profenusa mainensis Smith, 1966, p. 720, ♀, larva. New synonymy.

Female.—Average length, 4.0 mm. Black with each tibia and tarsus whitish. Wings infuscated, slightly darker toward base.

Hindwing with anal cell present. Sheath straight above and be-

low, subtruncate at apex (pl. IV, 56), not as rounded as that of *thomsoni* (pl. IV, 57). Serrulae of lancet low, far apart, each serrula with two or three anterior and five or six posterior subbasal teeth; clumps of lateral spines located centrally on segments 3 to 11 (pl. VIII, 92).

Male.—Average length, 4.0 mm. In color and structure similar to female. Genitalia as in plate X, 120 and 121; penis valve oblong, without lobes, with two small spines near apex, one directed dorsally, the other ventrally.

Larva.—Final feeding stage (pl. XV, 189–196). Length, 7.5 mm. Body dorsoventrally flattened; integument covered with minute rounded spines. White to light brown with pronotal plate, prosternal plate, head capsule, thoracic legs, and spiracles dark brown; usually black spot on each side of head. In lateral view similar to *thomsoni* (pl. XV, 181).

Head dorsoventrally flattened; prognathous. Antenna with one segment; ocularium small; eyespot conspicuous, located posterior to antenna. Labrum longer than wide, truncate; epipharynx with row of eight or nine spines on each half and row of shorter spines anterior to these; maxillary palpus four-segmented, one seta on second segment; galea long, digitate, subequal in length to maxillary palpus; lacinia with five stout spines; each mandible similar, right mandible with several irregular ventral and dorsal teeth, left mandible with several irregular ventral teeth, rounded dorsal cutting edge, and one inner tooth; each mandible with one seta on outer basal angle; labial palpus two-segmented.

Thoracic legs small, directed laterally, three-segmented with apical segment minute; tarsal claw absent; each coxa with three small tubercles. Prothoracic spiracle winged. Pronotal and prosternal plates present.

Prolegs absent. Abdominal spiracles winged, located dorsal to pleural lobes.

Smith (1966) described the larva of this species, and those references to *curta* by Dyar (1895b, 1898) probably pertain to the larva of this species.

Holotypes.—MacGillivray's types are at the Illinois Natural History Survey: *M. alumna*, a female, is labeled "N. Ill."; *M. amica*, a female, is labeled "N. Evans, N.Y., 8-2-08, M. C. V. Coll."; *M. appota*, a male, is labeled "Buffalo, N.Y., 6-27-09, M.C.V. Coll." *P. mainensis* Smith is U.S.N.M. type No. 67982, a female labeled "Canton, Maine, May 30 1964, ovipositing on red oak leaves, G. LaBonte."

Distribution.—Northeastern United States. *Illinois*: "N. Ill."; Algonquin. *Maine*: Many adults from the following localities collected during the last of May and in June: Augusta, Gilead, Canton, South Paris, Peru, Strong. *Maryland*: Plummers Island, 23-7-16. *New York*: N. Evans, 8-2-08; Buffalo, 6-27-09. *Pennsylvania*: Dupont, Aug. 14-16, 1944. *Virginia*: Falls Church, Aug. 12, 1912, *Quercus*, July 15, 1912.

Host.—Most of the damage in Maine is on red oak (*Quercus rubra* L.). It may also attack *Q. macrocarpa* Michx., *Q. alba* L., *Q.*

velutina Lam., and *Q. ilicifolia* Wagh. Dyar (1895b) found the larva on *Q. macrocarpa*.

Biology.—This species has done considerable damage to oaks in Maine where the leaf-mining larvae cause severe browning and blotching of the leaves. The adults fly in spring and early summer, from the end of May to the first of July, and oviposit in the upper surface of the leaf. When the larvae mature, they drop to the ground to overwinter and pupate in the soil. Larvae have been observed on the foliage until mid-August. This species is apparently parthenogenetic with very rare males. Among the long series from Maine, males have never been seen; however, males have been taken in other parts of its range—in Illinois, New York, and Virginia.

Discussion.—The general habitus of this species closely resembles that of *thomsoni*, but the presence of the anal cell in the hindwing, the more truncate sheath, and small serrulae of the lancet will separate *alumna*. The larvae are separated from those of other *Profenusa* species by the absence of mesosternal and metasternal plates, absence of prolegs, and absence of tarsal claws.

The close similarity of *alumna* to *thomsoni* led to the synonymy of these two species by Benson (1959) and subsequent description of a new species, *mainensis*, by Smith (1966). The examination of the type of *alumna* proved that this synonymy was a mistake and that *alumna* is actually the oak leaf miner, probably native to North America, whereas *thomsoni* is undoubtedly an introduced species. The references to *alumna* by Burks (1958), Lindquist (1959), Watson (1959), or any other literature treating *alumna* as a birch leaf miner do not pertain to *alumna* (MacGillivray) but actually to *thomsoni* (Konow).

Profenusa canadensis (Marlatt)

Scolioneura canadensis Marlatt, 1895, p. 235, ♀.

Metallus canadensis: MacGillivray, 1916, p. 160.

Profenusa canadensis: Ross, 1937, p. 72; Hamilton, 1943, p. 59; Hamilton, 1950, p. 694; Ross, 1951, p. 30; Peterson, 1956, p. 270; Malaise, 1964, p. 28; Martineau, 1965, p. 46; Smith, 1966, p. 719.

Profenusa collaris MacGillivray, 1914, p. 364, ♂, ♀; Parrott and Fulton, 1915a, p. 551; Parrott and Fulton, 1915b, p. 519; MacGillivray, 1916, p. 157; Frison, 1927, p. 258; Ross, 1937, p. 72 (= *canadensis* Marlatt).

Female.—Average length, 4.0 mm. Antenna black, sometimes with ventral surface whitish; head black, clypeus and mouth parts white. Thorax black with mesonotum, except scutellum, rufous; mesopleuron and pectus rufous or black; prothorax usually rufous; tegula and posterior margin of pronotum white. Legs white to yellowish orange, usually with hindcoxa and hindfemur darker or black. Abdomen black; each segment with narrow white band on posterior edge. Wings hyaline.

Hindwing with anal cell present. Sheath short, rounded at apex (pl. IV, 53). Each serrula of lancet deep, lobelike, rounded at apex, without subbasal teeth (pl. VIII, 90).

Male.—Average length, 4.0 mm. Antenna black, sometimes with ventral surface whitish; head black, clypeus and mouth parts white.

Thorax yellowish orange with mesonotum and metanotum black. Legs entirely yellowish orange. Abdomen entirely yellowish orange, sometimes with black or infuscate areas on basal terga or black longitudinal line on dorsum. Structure as for female. Genitalia as in plate X, 118 and 119; penis valve with long ventral lobe.

Larva.—Final feeding stage (pl. XVI, 201–206). Length, 7.5 mm. Cylindrical, slightly dorsoventrally flattened. White; head capsule, spiracles, thoracic legs, prosternal plate, and crescent-shaped marks about each proleg light brown.

Head dorsoventrally flattened, nearly hypognathous. Antenna conical, indistinctly three-segmented. Eyespot posterior to antenna. Labrum wider than long, emarginated; epipharynx with row of seven to nine long spines on each half; right mandible with two ventral teeth and two dorsal teeth; left mandible with three ventral teeth and two dorsal teeth; each mandible with one seta on outer basal angle; maxillary palpus four-segmented, one seta on second segment; galea digitate, subequal in length to palpus; lacinia with seven to nine long spines; labial palpus three-segmented, relatively long and distinct compared to that of other *Profenusa* species.

Thoracic legs five-segmented, directed laterally; tarsal claw present. Pronotal and mesonotal plates light colored; prosternal plate light colored; mesosternal and metasternal plates absent. Prothoracic spiracle not winged. Coxa of each thoracic leg without small spines or tubercles.

Prolegs present on abdominal segments 2 to 8 and 10, rudimentary on segments 1 and 9. Spiracles of abdomen not winged. Pleural lobes present. Abdominal segments 1 to 8 each with three annulets. Light crescent-shaped plates present at anterior of each proleg.

The larva has been described by Parrott and Fulton (1915b), Hamilton (1950), and Peterson (1956).

Holotypes.—*S. canadensis*, a female labeled "Can.," is type No. 10222 at the Academy of Natural Sciences of Philadelphia. It also bears a label "Type No. 4031 USNM." There is a specimen with the same data in the U.S. National Museum collection; however, it cannot be the type, since Marlatt (1895) stated that the type was in the collection of the American Entomological Society. *P. collaris* MacGillivray, a female labeled "cherry, 5/4/11, Geneva, N. Y.," is at the Illinois Natural History Survey.

Distribution.—Widespread in eastern North America. *Arkansas*: Bentonville, 4–14–19. *Crataegus*. *District of Columbia*: Apr. 3, 1945, on *Crataegus*. *Illinois*: Muncie, V–1–27, May 4, 1936; White Heath, May 1, 1915, May 5, 1940, April 30, 1916; Monticello, May 4, 1947; St. Joseph, May 3, 1914; Oakwood, May 4, 1936. *Iowa*: Shenandoah, 4–21–46. *Kentucky*: Lexington, Apr. 17, 1919, hawthorn. *Maine*: Augusta, emgd. 23–VI–56, ex *Crataegus*; Brownville Junction, June 9, 1967. *Massachusetts*: Boston, May 10, 1909; Forest Hills, V–3–12. *Michigan*: East Lansing, May 17, 1963. *Missouri*: Columbia. *New York*: Geneva, 5–20–15; Greendale, V–11–39, soil under cherry tree; Oswego, 6–3–66; Ithaca; Nassau, May 27, 1917. *Ontario*: Manotick, 20–V–66, *Crataegus* sp. *Penn-*

sylvania: Harrisburg, V-11-20, on foliage of *Crataegus* sp.; Chestnut Hill, 5-4-25. *Quebec*: Ste. Foy. *Texas*: Longview, III-26-08.

Hosts.—Leaf miner of *Crataegus* spp. and *Prunus* sp. This species is apparently most destructive to hawthorn. Parrott and Fulton (1915a, 1915b) recorded a population on cultivated cherry, the English Morello variety, but other varieties of cherry were not subject to attack.

Biology.—Parrott and Fulton (1915b) and Hamilton (1950) published the life history of this species. The adults emerge early in the spring, usually during April and May. The females oviposit near the margin of the leaf, but not on the margin nor near the center. The larva mines toward the center of the leaf leaving blotch mines. On maturing, the larvae drop to the ground and form earthen cells in which they overwinter and pupate the following spring. There is one generation a year.

Discussion.—The rufous mesonotum of the female and yellow-orange coloration of the male will separate this species from other *Profenusa* species. The genitalia of both sexes are also distinct. This species is of occasional economic importance, especially in ornamental plantings of *Crataegus*.

Profenusa inspirata (MacGillivray)

Parabates inspiratus MacGillivray, 1909a, p. 264, ♀.

Fenusa inspirata: Ross, 1936, p. 265.

Profenusa inspirata: Ross, 1951, p. 30; Smith, 1966, p. 719.

Female.—Average length, 4.0 mm. Black with each front and middle tibia and tarsus and hindtarsus whitish. Wings uniformly, lightly infuscated.

Hindwing with anal cell present. Sheath straight above, rounded below (pl. IV, 57). Each serrula of lancet pointed, finely serrate, with greater number of posterior than anterior subbasal teeth; lateral spines on segments lacking (pl. VIII, 93).

Male.—Average length, 4.0 mm. In color and structure similar to female. Genitalia as in plate X, 122 and 123; penis valve oblong, without lobes; two short spines present near apex, one directed dorsally, the other ventrally.

Larva.—Final feeding stage (pl. XIV, 174-180). Length, 7.5 mm. Dorsoventrally flattened; integument covered with minute rounded spines. White to light brown with head capsule, pronotal plate, prosternal plate, mesosternal plate, thoracic legs, spiracles, and spots surrounding abdominal spiracles dark brown. In lateral view similar to larva of *thomsoni* (pl. XV, 181).

Head dorsoventrally flattened, from above similar to that of *alumna* (pl. XV, 192). Antenna apparently with small second segment; eyespot located posterior to antenna; antennaria small. Labrum longer than wide; epipharynx with row of eight or nine spines on each half with row of smaller spines anterior to these; right and left mandible similar, each with three ventral teeth and rounded dorsal cutting edge; maxillary palpus four-segmented,

one seta on second segment; galea long, digitate, subequal in length to maxillary palpus; lacinia with four stout spines; labial palpus two-segmented.

Thoracic legs reduced, directed laterally, apparently four-segmented with apical segment minute; tarsal claw absent; each coxa with three rounded tubercles. Large pronotal and prosternal and small mesosternal plates present. Prothoracic spiracle winged.

Abdominal prolegs absent. Annulation indistinct. Abdominal spiracles winged. Small darkened spots surrounding each spiracle.

The larvae are described from specimens taken from valley oak, Merced, Calif., on July 27, 1959.

Holotype.—U.S.N.M. type No. 12176, a female labeled "Nev."

Distribution.—Pacific coastal region of North America. *California*: 4 mi. W. Quincy, Plumas Co., VI-19-49; Quincy, July 1, 1958; Yosemite, 3880'-4000', 6-12-28; Hatchet Mtn., Shasta Co., 7-14-33, adults on *Alnus* sp. *Nevada*: "Nev." *Oregon*: Corvallis, May 10, 1931; Touvelle St. Pk., 8 mi. N. Medford, May 21, 1960; Jackson Co., Buckhorn Mineral Springs, 11 mi. E.S.E. Ashland, 2800', May 19, 1960; Jackson Co., 1 mi. E. Brownsboro, May 18, 1962; Wasco Co., 3 mi. E. Mosier, May 23, 1959; Talent, May 20, 1959, on *Quercus garryana*; Medford, V-5-53; Klamath Co., 10 mi. S.W. Keno, May 23, 1962, on Garry oak; Jackson Co., 1 mi. N. Sams Valley, May 24, 1964, on oak leaves.

Host.—Leaf miner of *Quercus* spp. Adults have been taken from *Q. garryana* Dougl. and *Alnus* sp., and larvae were taken from valley oak (*Q. lobata* Née).

Biology.—No information is available.

Discussion.—This is the only known western species of *Profenusa*. It is similar to *thomsoni* and *alumna*, but it may be distinguished by the dark hindtibia and characters of the male and female genitalia.

Profenusa lucifer (Ross)

Fenusa lucifer Ross, 1936, p. 266, ♀.

Profenusa lucifer: Ross, 1951, p. 31; Lindquist and Jackson, 1965, p. 1; Smith, 1966, p. 719.

Female.—Average length, 4.0 mm. Head and antenna black; clypeus and mouth parts white to yellow orange. Thorax black with pronotum, tegula, and upper half or less of mesepisternum rufous to yellow orange. Legs entirely yellow orange. Abdomen black. Wings lightly, uniformly infuscated.

Hindwing with anal cell open, vein 2A and 3A partially atrophied. Sheath straight above, rounded below (pl. IV, 57). Lancet with each serrula pointed, central serrulae each with about 10 fine anterior and 10 fine posterior subbasal teeth (pl. VIII, 94).

Male.—Unknown.

Larva.—Final feeding stage (pl. XVI, 197-200). Very similar to larva of *alumna* except for following differences: Antenna slightly longer with small second segment; spots on each side of

head larger and darker; tarsal claw present, very small, and located on anterior side of tarsus; thoracic legs four-segmented; mesosternum sometimes with narrow dark plate on posterior edge.

The prepupa may be distinguished from that of *alumna* by the presence of a tarsal claw.

Holotype.—At the Illinois Natural History Survey, a female labeled "Fox Lake, Ill., June 30, 1935, DeLong and Ross."

Distribution.—Northeastern United States and southeastern Canada. *Illinois*: Fox Lake, June 30, 1935. *Maine*: Augusta, emerged April 18, 1966, from larva on white oak; Augusta, July 9, 1965, emgd. April 8, 11, 1966, bred ex white oak; Berwick, June 1, 1966, sweeping under red oak; Portland, Baxter Park, June 11, 1967. *New York*: Orient L.I., June 16, 1947; Riverhead, L.I., August 24, 1934. *Ontario*: Forest districts of Kenora and Fort Frances (Lindquist and Jackson, 1965).

Host.—Leaf miner of *Quercus* spp. Most common on white oak (*Quercus alba* L.) and also on red oak (*Q. rubra* L.) in Maine. Lindquist and Jackson (1965) reared this species from bur oak (*Q. macrocarpa* Michx.) in western Ontario.

Biology.—The note by Lindquist and Jackson (1965) is the only information available on the life history of this species. In western Ontario the larvae complete their feeding in late July or early August and drop to the ground to overwinter in the soil. The larvae make irregular blotch mines in the leaves. In Maine the adults appear in June.

Discussion.—This species received little attention from the time of the description in 1936 until 1965, when it was discovered damaging oaks in Ontario and Maine. It may be distinguished from other *Profenusa* species by the rufous pronotum and partly rufous mesepisternum. Some specimens have the upper half of the mesepisternum rufous, other specimens only the dorsal margin.

Profenusa thomsoni (Konow)

Fenusa thomsoni Konow, 1886b, p. 270, ♀; Konow, 1890, p. 249; Konow, 1905, p. 90.

Fenusella thomsoni: Enslin, 1914, p. 306; Dovnar-Zapolsky, 1931, p. 56; Conde, 1934, p. 186; Hering, 1937, p. 75; Buhr, 1941, p. 912; Wahlgren, 1951, p. 75.

Profenusa thomsoni: Benson, 1941, p. 88; Benson, 1943, p. 11; Benson, 1952, p. 108; Lorenz and Kraus, 1957, p. 137; Benson, 1959, p. 91; Forbes, Underwood, Cuming, and Eidt, 1960, p. 29; Martin, 1960, p. 376; Piercnek, 1962, p. 285; Benson, 1962, p. 392; Smith, 1966, p. 719; Burks, 1967, p. 16; Benson, 1968, p. 149.

Profenusa alumna of auctt., nec MacGillivray, Burks, 1958, p. 13; Lindquist, 1959, p. 620; Watson, 1959, p. 618.

Female.—Average length, 4.0 mm. Black with each tibia and tarsus whitish. Wings infuscated, darker on basal half.

Hindwing with anal cell absent. Sheath straight above, rounded below (pl. IV, 57). Serrulae of lancet wide, close together, central serrulae each with six or seven anterior and six or seven posterior subbasal teeth; apical serrulae each with four or five anterior and six or seven posterior subbasal teeth; group of lateral spines present on segments 4 to 9 (pl. VIII, 91).

Male.—Unknown. Parthenogenetic.

Larva.—Final feeding stage (pl. XV, 181–188). Length, 7.0 mm. Body dorsoventrally flattened; integument covered with minute spines, venter of 10th abdominal segment smooth. White to light brown with head capsule, pronotal, prosternal, mesosternal, and metasternal plates, thoracic legs, and spiracles dark brown.

Head dorsoventrally flattened, prognathous. Antenna one-segmented; antennaria small; eyespot posterior to antenna. Labrum longer than wide, truncate; epipharynx with row of seven to nine spines on each half; left and right mandibles similar except for inner tooth of left mandible, ventral margin of each mandible with four or five fine teeth, dorsal margin without teeth; one seta on outer basal angle of each mandible; maxillary palpus four-segmented, second segment with one seta; galea long, digitate, subequal in length to maxillary palpus; lacinia with five or six stout spines; labial palpus two-segmented.

Thorax with large dark pronotal and prosternal plates and small mesosternal and metasternal plates. Prothoracic spiracle winged. Thoracic legs two-segmented, tarsal claw absent; each coxa with three short spines.

Abdominal prolegs absent. Abdominal spiracles winged, located dorsal to pleural lobes. Segments indistinctly three-annulate.

Watson (1959) described the larva of this species in detail, and Lindquist (1959) gave characters to separate it from other birch leaf-mining sawfly larvae.

Holotype.—Probably at the Deutsches Entomologisches Institut, Eberswalde, Germany.

Distribution.—Northeastern United States and southeastern Canada; Europe. *Connecticut*: Hartland, July 25, 1930; Hamden, July 5, 1926. *Maine*: Canton, 21–VII–64, white birch; Gilead, July 7, 1965, white birch; Brunswick, many dates from June 23 to July 16, 1965. *Ontario*: Sault Ste. Marie, 4–VII–55, white birch. *Quebec*: Routhierville, July 2, 1966. *Vermont*: Stratford, IV–19–1962.

Host.—Leaf miner of *Betula* spp. Martin (1960) recorded *B. papyrifera* Marsh., *B. alleghaniensis* Britt. (= *B. lutea* L.), and *B. populifolia* Marsh.

Biology.—Martin (1960) presented the life history of this species. In Ontario the adults emerge from the middle of July to the first of August. The females oviposit near the center of the leaf, usually near a vein, with very few eggs placed near the margin of the leaf. The larvae form typical blotch mines while feeding. On maturing, the larvae drop to the ground and overwinter in the soil. In Maine the adults begin emerging during the last part of June.

Discussion.—This species is separated from *alumna* by the absence of an anal cell in the hindwing, more rounded sheath, and larger serrulae of the lancet. The larvae have mesosternal and metasternal plates, both absent in *alumna* larvae. This is one of the four sawfly leaf miners of *Betula* known in North America.

As explained under *alumna*, the synonymy of *alumna* with

thomsoni by Benson (1959) was a mistake, and caution should be used when referring to distributional and taxonomic data in those publications that report "*Profenusa alumna* (MacGillivray)" as a leaf miner of *Betula*. The distributional data by Watson (1959), for example, are not entirely correct. *P. thomsoni* is probably an introduced species.

Genus *BIDIGITUS* Smith

Bidigitus Smith, 1967, p. 280.

Type-species: *Profenusa platani* Burks. Original designation.

Description.—Antenna with second segment longer than broad; third segment longer than fourth segment; segments beyond third gradually decreasing in length. Clypeus truncate; malar space less than half diameter of front ocellus; postgenal carina absent. Prepectus absent. Tarsal claw with two long subequal outer teeth and large acute basal lobe (pl. III, 23). Forewing with stub of vein 2A and 3A faint, curved up at apex; vein 1m-cu strongly directed downward meeting Cu, closer to vein Cu_a than to crossvein cu-a. Hindwing with cell R₁ open at apex; anal cell present, petiole much longer than cell; cells R_s and M absent (pl. II, 17, 18).

This genus is close to *Profenusa*, but it is separated by the bifid tarsal claw and wing venation. The single species in this genus is known only from California and is associated with *Platanus*.

Description of *Bidigitus* Species

Bidigitus platani (Burks)

Profenusa platanae Burks, 1957, p. 207, ♂, ♀, larva; Brown and Eads, 1965, pp. 14, 22-32.

Profenusa platani: Smith, 1966, p. 719; Burks, 1967, p. 16.

Bidigitus platani: Smith, 1967, p. 280.

Female.—Average length, 4.0 mm. Black with tegula, extreme apex of each femur, each front and middle tibia, basal two-thirds of hindtibia, and each tarsus whitish. Wings uniformly, lightly infuscated.

Sheath long and narrow, pointed at apex (pl. IV, 47). Serrulae of lancet far apart, each low, with two anterior and three or four posterior subbasal teeth (pl. VII, 85).

Male.—Average length, 4.0 mm. In color and structure similar to female. Hypandrium truncate. Genitalia as in plate X, 128 and 129; harpe long and narrow; parapenis rounded, about as wide as long; penis valve subrectangular with apical and dorsoapical lobes.

Larva.—Final feeding stage (pl. XVII, 207-212). Length, 9.0 mm. Slightly dorsoventrally flattened. White; head capsule and legs light brownish. In dorsal view slightly widened at thorax and narrowing toward apex of abdomen.

Head dorsoventrally flattened, prognathous. Antenna two-segmented, second segment small; antennaria large; eyespot posterior to antenna. Labrum wider than long, emarginated; epipharynx with row of nine to 10 spines on each half; left mandible with large

apical tooth, two small ventral teeth, and three larger dorsal teeth; right mandible similar to left mandible but with two dorsal teeth; each mandible with one seta on outer basal angle; maxillary palpus four-segmented, one seta on second segment; galea long, digitate, subequal in length to palpus; lacinia long, with about seven spines of unequal length all directed mesally; labial palpus three-segmented.

Thoracic legs five-segmented, directed laterally, relatively long and segments distinct; tarsal claw present. Prosternum with large smooth plate of similar color as rest of body, smaller plates located centrally on mesosternum, metasternum, and pronotum.

Prolegs present on abdominal segment 2 to 8 and 10; rudimentary on ninth segment. Abdominal segments 1 to 7 each two-annulate, first annulet one-third size of second annulet. Conspicuous pleural lobes present.

Burks (1957) and Brown and Eads (1965) also described the larva.

Holotype.—U.S.N.M. type No. 63460, a female labeled "Santa Barbara, Calif., May 20, 1956, reared from *Platanus racemosa*, Clark O. Eads."

Distribution.—Known only from California. *California*: The only adult record is that of the type locality. Larvae have been taken from the following: Anaheim, Apr. 20, 1962, on *Platanus*; Lakeport, V-16-1952, ex plane tree (leaf blisters); Claremont, April 24, 1961, *Platanus racemosa*. Brown and Eads (1965) stated that this species is "very common throughout southern California, as well as the rest of California."

Host.—Leaf miner of the California plane tree (*Platanus racemosa* Nutt.).

Biology.—Brown and Eads (1965) described the life history of this species. The adults appear in February and oviposit in the upper surface of the leaf. The larvae feed for about 30 days making blotch mines in the leaves. Up to 95 larvae have been found in a single leaf. On maturing, the larvae drop to the soil and form small cells lined with a tough papery material in which they pupate or overwinter. There are from three to five generations a year, and 7 to 11 weeks are required to complete a life cycle.

Discussion.—The damage caused by this species has been known for a long time in California, but it was believed to be caused by a lepidopterous blotch miner. In 1956 the damage was first recognized as being caused by a sawfly, and the sawfly was described as new in 1957 by Burks. The tarsal claw and wing venation will easily distinguish this species from those of related genera.

Genus NEFUSA Ross

Nefusa Ross, 1951, p. 31; Benson, 1959, p. 92; Smith, 1967, p. 281.
Type-species: *Messa anita* MacGillivray. Original designation.

Description.—Antenna with second segment longer than broad; third segment longer than fourth segment; segments beyond third subequal in length. Clypeus truncate; malar space linear; postgenal

carina absent. Prepectus present, narrow, set off by suture. Tarsal claw with one outer tooth and large acute basal lobe (pl. III, 22). Forewing with stub of vein 2A and 3A straight at apex. Hindwing with cells *Rs* and *M* absent; anal cell present; cell *R*₁ open (similar to pl. II, 14, 15).

The presence of a prepectus will separate this genus from all other genera of North American *Fenusini*. The single species known for this genus is a leaf miner of *Viola* in eastern North America.

Description of *Nefusa* Species

Nefusa ambigua (Norton), new combination

Fenusia ambigua Norton, 1867, p. 225, ♂; Dalla Torre, 1894, p. 156; Konow, 1905, p. 90.

Messa ambigua: MacGillivray, 1916, p. 157.

Messa anita MacGillivray, 1923b, p. 23, ♀; Frison, 1927, p. 251. New synonymy.

Fenusia anita: Ross, 1936, p. 265.

Nefusa anita: Ross, 1951, p. 31; Burks, 1967, p. 17; Smith, 1967, p. 281.

Nefusa sp. ?, Shaw, 1940, p. 951.

Female.—Average length, 4.0 mm. Antenna and head black with first and second antennal segments, labrum, and mouth parts yellowish. Thorax black with tegula and pronotum white to yellowish. Legs entirely yellowish. Abdomen mostly black on dorsum, yellowish on venter. Wings very lightly infuscated.

Sheath straight above, rounded below, scopa absent (pl. IV, 48). Lancet with each serrula pointed, with one prominent anterior and four or five fine posterior subbasal teeth (pl. VII, 86).

Male.—Average length, 4.0 mm. In color and structure similar to female. Genitalia as in plate X, 126 and 127; penis valve long and slender, subrectangular; harpe truncate at apex; parapenis large, rectangular.

Larva.—Shaw (1940) briefly described the larva, but it cannot be characterized by this description. I have not seen specimens.

Holotypes.—*M. anita* MacGillivray, a female labeled "Wis.," is at the Illinois Natural History Survey. Norton's type of *ambigua* cannot be located. In his original description Norton (1867) stated "Penn. 1 ♂. (Smith. Inst.);" however, I could not locate such a specimen in the U.S. National Museum. Norton's original description fits the interpretation of this species, and three specimens of this species at the Academy of Natural Sciences of Philadelphia bear a determination label "*Fenusia ambigua*," apparently written by Norton.

Distribution.—Eastern North America. *Maine*: Augusta, emgd. VII-27, 12-1943, *Viola*; Portland, Baxter Park, June 11, 1967. *Maryland*: Bowie, V-29-1945; Glen Echo; Cabin John, VIII-21-1917. *Massachusetts*: Salem, reared, June 27, 1924, violet; Amherst, VIII-40. *Michigan*: Bay Co., June 2, 1940; Livingston Co., June 5-6, 1943. *New York*: Ithaca, Aug. 5, 1918. *Ohio*: Hocking Co., 5-25-30. *Pennsylvania*: State College, 7-3-47, violet leaf miner; Mt. Holly Springs, VII-4-1918. *Quebec*: Montreal, 3-VI-

06. *Tennessee*: Gatlinburg, GSMNP, 5500', July 18, 1947. *Wisconsin*: "Wis."

Host.—Leaf miner of *Viola* sp. Shaw (1940) reared it from "*Viola papilionacea*."

Biology.—The only information on the life history of this species is a note by Shaw (1940) on a *Fenusa*? attacking violet in Massachusetts. Adults were observed from the last of July to the middle of August. They deposit their eggs singly in the upper surface of the leaf. The larvae feed for 22 to 28 days, then go into the soil where they overwinter.

Discussion.—This species is very distinct and is recognized by the presence of a prepectus and the light coloration of the first two antennal segments, labrum, pronotum, legs, and venter of the abdomen.

Genus PROLATUS Smith

Prolatus Smith, 1967, p. 282.

Type-species: *Prolatus artus* Smith. Original designation.

Description.—Antenna with second segment about as long as broad; third segment subequal in length to or only slightly longer than fourth segment (pl. III, 37). Clypeus truncate; malar space linear; postgenal carina absent. Tarsal claw simple, long and slender (pl. III, 21). Front tarsus long, $1\frac{1}{2}$ times or more length of front tibia; middle tarsus $1\frac{1}{2}$ times length of middle tibia; hindtarsus shorter than hindtibia (pl. III, 25). Prepectus absent. Forewing with vein 2A and 3A curving up and meeting 1A to form small basal anal cell. Hindwing with cell *R*₁ open; anal cell absent; cells *R*₅ and *M* absent (similar to pl. III, 20).

This genus is distinguished by the simple tarsal claw, the unusually long front and middle tarsi, and the subequal third and fourth antennal segments. The tarsal claw and wing venation most closely resemble those of *Fenusa*.

The single species of this genus is known only from Oregon and the host is not known.

Description of *Prolatus* Species

Prolatus artus Smith

Prolatus artus Smith, 1967, p. 283, ♀.

Female.—Length, 3.8 mm. Black with clypeus, labrum, each mandible, tegula, upper posterior margins of pronotum, extreme apex of each femur, and extreme base of each tibia light brown to whitish. Wings uniformly, lightly infuscated.

Head and body, except anterior and lateral lobes of mesonotum, densely covered with fine white hairs. Sheath long and slender, rounded below and at apex (pl. IV, 55). Each serrula of lancet broadly and flatly rounded with eight or 10 subbasal teeth and single lateral tooth at anterior of each serrula (pl. VII, 84).

Male.—See Discussion.

Larva.—Unknown.

Holotype.—U.S.N.M. type No. 69159, a female labeled "Oregon, Josephine Co., 10 mi. N.W. Pinehurst, May 5, 1962, David R. Smith."

Distribution.—Oregon: Pinehurst, May 5, 1962; Corvallis, Scott's Hill, moss and ground litter, March 10, 1960 (♂, see Discussion).

Host.—Unknown.

Biology.—Unknown.

Discussion.—A character not included in the description is the presence of a radial crossvein in the hindwing. This is sometimes a variable character in sawflies, and extra veins may appear at random in any species. More specimens will be needed to ascertain its value. A male from near Corvallis, Oreg., fits the description given here, but this specimen is of doubtful association because of the lack of a radial crossvein in the hindwing. It does fit the generic description.

Genus FENUSA Leach

Fenusa Leach, 1817, p. 126; Westwood, 1840, p. 54; Cameron, 1882, p. 290; Dalla Torre, 1894, p. 156; Ashmead, 1898, p. 250; Konow, 1905, p. 89; MacGillivray, 1914, p. 365; Enslin, 1914, p. 301; MacGillivray, 1916, p. 157; Benson, 1936, p. 623; Ross, 1936, p. 263; Ross, 1937, p. 72; Benson, 1941, p. 87; Berland, 1947, p. 263; Ross, 1951, p. 31; Benson, 1952, p. 108; Takeuchi, 1952, p. 59; Zirngiebl, 1955, p. 93; Lorenz and Kraus, 1957, p. 138; Malaise, 1961, p. 37; Smith, 1967, p. 282.

Type-species: *Tenthredo* (*Emphytus*) *pumila* Klug. Monotypic.

Kaliosysphinga Tischbein, 1846, p. 79; Konow, 1886b, p. 269; Dalla Torre, 1894, p. 158; Ashmead, 1898, p. 250; Konow, 1905, p. 89 (*Kaliosysphinga*); Enslin, 1914, p. 301 (= *Fenusa* Leach); Benson, 1936, p. 623; Zirngiebl, 1955, p. 93.

Type-species: *Kaliosysphinga* *dohrnii* Tischbein. Monotypic.

Aphadnirus O. Costa, 1859, p. 40; Dalla Torre, 1894, p. 158 (= *Kaliosysphinga* Tischbein); Benson, 1936, p. 623 (= *Fenusa* Leach).

Type-species: *Aphadnirus* *tantillus* O. Costa. Monotypic.

Kaliofenusa Viereck, 1910, p. 591; MacGillivray, 1916, p. 157; Benson, 1936, p. 623 (= *Fenusa* Leach).

Type-species: *Fenusa* *ulmi* Sundevall. Monotypic.

Description.—Antenna with second segment as long as broad; third segment longer than fourth segment; segments beyond third slightly decreasing in length (pl. III, 32, 33). Clypeus truncate; malar space less than diameter of front ocellus; postgenal carina absent. Prepectus absent. Tarsal claw simple. Front and middle tarsi subequal in length to their respective tibiae. Forewing with vein 2A and 3A curved up, meeting 1A to form small basal anal cell. Hindwing with cell R_1 open; anal cell absent; cells R_s and M absent (pl. III, 19, 20).

The simple tarsal claw, basal anal cell of the forewing, open radial cell of the hindwing, and short tarsi will distinguish species of this genus. Three species are in this genus, all of which are Holarctic. They are leaf miners of *Alnus*, *Betula*, and *Ulmus*.

Larvae are known for all three species of *Fenusa*. As a group they are difficult to distinguish from those of *Bidigitus* and *Fenella*,

but the following combination of characters will help to differentiate them: Reduced prolegs present on abdominal segments 2 to 8 and 10; dark crescent-shaped marks about prolegs absent; mesosternum and metasternum with light or dark plates; sternum of first abdominal segment with dark plate (except in *dohrnii*). The generic key (p. 7) to larvae and hosts will help to separate the larvae from those of other Fenusini.

Keys to *Fenusa* Species

ADULTS

1. Lateral lobes of mesonotum with fine surface sculpture; abdominal tergites dull with alutaceous surface sculpture; vein 2r of forewing joins Rs before 3r-m; male rare; leaf miner of *Ulmus ulmi* Sundevall
Lateral lobes of mesonotum and abdominal tergites smooth, without surface sculpture; vein 2r of forewing joins Rs beyond 3r-m (pl. III, 19) 2
2. Antenna longer than thorax with third segment only 1½ times as long as fourth segment and segments 4 and 5 at least more than twice as long as broad (pl. III, 32); hindtibia usually black; male unknown; leaf miner of *Alnus dohrnii* (Tischbein)
- Antenna shorter than thorax with third segment twice as long as fourth segment and segments 4 and 5 less than twice as long as broad (pl. III, 33); hindtibia usually white; males common; leaf miner of *Betula pusilla* (Lepeletier)

LARVAE

1. Large central dark-brown plates on prosternum, mesosternum, metasternum, and sternum of first abdominal segment (pl. XVIII, 232, 233); leaf miner of *Betula pusilla* (Lepeletier) 2
2. Small sclerotized plates on mesosternum and metasternum, plate on sternum of first abdominal segment present or absent
- Small plate present on sternum of first abdominal segment; distinct short spines on venter of ninth abdominal segment and about prolegs of eighth abdominal segment (pl. XVIII, 220-222); leaf miner of *Ulmus ulmi* Sundevall
- Plate on sternum of first abdominal segment absent; venter of apical abdominal segments without spines; leaf miner of *Alnus dohrnii* (Tischbein)

Descriptions of *Fenusa* Species

Fenusa dohrnii (Tischbein)

- Kaliosysphinga dohrnii* Tischbein, 1846, p. 80; André, 1880, p. 238; Konow, 1886b, p. 269; Konow, 1890, p. 249; Dalla Torre, 1894, p. 158; Konow, 1905, p. 89; Slingerland, 1905, p. 58.
- Fenusa dohrnii*: Enslein, 1914, p. 302; MacGillivray, 1916, p. 157; Yuasa, 1922, p. 97; Seidel, 1926, p. 239; Obarski, 1933, p. 157; Conde, 1934, p. 186; Ross, 1936, p. 263; Crevecoeur and Maréchal, 1938, p. 496; Benson, 1940, p. 213; Benson, 1941, p. 90; Buhr, 1941, p. 909; Wahlgren, 1944, p. 146; Berland, 1947, p. 264; Hering, 1951, pp. 220, 314; Ross, 1951, p. 32; Wahlgren, 1951, p. 75; Benson, 1952, p. 109; Takeuchi, 1952, p. 60; Maxwell, 1955, p. 59; Raizenne, 1957, p. 25; Lorenz and Kraus, 1957, p. 140; Rafes, 1958, p. 40; Benson, 1962, p. 392; Smith, 1967, p. 282; Benson, 1968, p. 150.
- Fenusella dohrnii*: Dovnar-Zapolsky, 1929, p. 38.
- Fenusa curtus* Norton, 1862, p. 199, ♀; Norton, 1867, p. 225; Prevancher, 1888, p. 347 (?); Dalla Torre, 1894, p. 156; Konow, 1905, p. 90; Cresson, 1928, p. 5; Taylor, 1931, p. 451; Ross, 1936, p. 263 (= *dohrnii* Tischbein).

Phaenusa melanopoda Cameron, 1876a, p. 6.

Fenusa melanopoda: Cameron, 1882, p. 292; Fletcher, 1891, p. 252.

Fenusa varipes of nuctt., nec Lepeletier, Dyar, 1893, p. 247; Harrington, 1893, p. 69; Dyar, 1898, p. 137.

The complete European synonymy is not given here. Benson (1952) gave *melanopoda* Cameron and *westwoodi* Cameron as synonyms of this species.

Female.—Average length, 4.0 mm. Black with front and middle tibiae whitish; hindtibia and all tarsi black to whitish, variable. Wings moderately, uniformly infuscated.

Antenna more slender and longer than that of *pusilla*; longer than thorax with third segment $1\frac{1}{2}$ times as long as fourth segment and segments 4 and 5 at least more than twice as long as broad (pl. III, 32). Surface sculpture on mesonotum and abdomen absent. Vein 2r of forewing joins Rs apical to 3r-m. Sheath short and rounded (pl. IV, 59). Lancet with each serrula low, flat, with one anterior and about three posterior subbasal teeth (pl. VII, 78).

Male.—Unknown. Parthenogenetic.

Larva.—Final feeding stage (pl. XVIII, 228, 229). Length, 7.0 mm. Similar to the larva of *pusilla* with the following differences: Body evenly covered with minute darkened spines; sternum of first abdominal segment without dark plate; pronotal and sternal plates of thorax lightly sclerotized; mandibles with fewer teeth.

The larva differs from that of *ulmi* by the lack of a plate on the sternum of the first abdominal segment, lack of a concentration of small spines on the venter of the ninth abdominal segment and about the prolegs, and by having two spines on the lacinia.

Dyar (1893) described six larval stages of this species, and Slingerland (1905) described the larva but could not distinguish it from *ulmi*. Lorenz and Kraus (1957) also described the larva.

Holotypes.—*F. curtus* Norton, a female labeled "Penna.," is type No. 10317 at the Academy of Natural Sciences of Philadelphia. Tischbein's type may be at the Zoological Museum, Hamburg, Germany.

Distribution.—Transcontinental across North America; Europe. Japan; South Africa. The following records are merely a list of localities taken from the specimens I have examined. *Alberta*: Edmonton; Wabano. *British Columbia*: Fernie. *Colorado*: Eldora; Crystola; Granby; Rocky Mountain Nat'l. Park; Green Mtn. Falls; Cameron Pass; Ward; Empire; Boulder Canyon; Poudre River Canyon. *Connecticut*: Lyme; Wallingford; Stamford. *Illinois*: Chicago. *Maine*: North Bridgeton; Orono. *Massachusetts*: N. Adams. *Michigan*: Ann Arbor. *New Brunswick*: Nerepis. *Newfoundland*: Cook's Brook; Spruce Brook; Brichy Lk. Bog; Baie Verte Cp.; Terra Nova Nat'l. Park; Aspen Brook Cp.; Catamaran Cp.; Crabbs River Camp; Cormack; Codroy Pond; Corner Brook; Deer Lake; Big Falls. *New Hampshire*: Franconia. *New Mexico*: Taos. *New York*: Ithaca; Brooklyn. *Nova Scotia*: Antigonish. *Ontario*: Ottawa; Weston; Swansea. *Oregon*: Hood River; Wallowa Co.; Wallowa Mtns. *Pennsylvania*: North East. *Saskatchewan*: Waskesia. *Utah*: Hana; Unita Mtns. *Washington*: Nehcotte.

Host.—Leaf miner of *Alnus* spp. Dyar (1893) bred this species

from "*Alnus rugosa (serrulata)*" in Massachusetts, and Slingerland (1905) recorded this species from European alder (*Alnus glutinosa* (L.) Gaertn.).

Biology.—Slingerland (1905) gave the most complete account of the biology of this species from his observations in New York. The adults are active about the middle of May and oviposit in the surface of the leaf, usually in the central part between the larger veins. The larvae feed for about 3 weeks, mining through the leaf, then drop to the ground where they pupate or overwinter in a papery cocoon in the soil. All stages have been reported active through September, and there are probably two or three generations a year. The damage is recognized by the "blisterlike" appearance of the leaves. Up to 12 larvae may feed in a single leaf and their mines coalesce to form the "blisters."

Discussion.—This species is most likely to be confused with *pusilla* but may be separated by the more slender and longer antenna and darker back tibia. The lack of surface sculpture on the mesonotum and flat serrulae of the lancet will separate *dohrnii* from *ulmi*.

Although Norton described this species in 1862 under the name "*curtus*," it first received attention in North America when it was found damaging European alder at the Experimental Farm in Ottawa by Fletcher (1891). Harrington (1893) also found this species in Ottawa. Dyar (1893) discovered this species in Massachusetts, and Slingerland (1905) first recorded it from Newark and Ithaca, N.Y.

The European alder leaf miner is the approved common name for this species.

Fenusa pusilla (Lepelletier)

Tenthredo pumila Klug, 1814, p. 277; Kriechbaumer, 1884, p. 209. Preoccupied.

Fenusa pumila: Leach, 1817, p. 126; Stephens, 1835, p. 41; Westwood, 1840, p. 54; Thomson, 1870, p. 272; Thomson, 1871, p. 186; Cameron, 1882, p. 293; Enslin, 1914, p. 303; Britton, 1925, p. 340; Britton, 1926, p. 329; Dovnar-Zapolsky, 1929, p. 39; Friend, 1931, p. 171; Glasgow, 1932, p. 693; Malaise, 1932, p. 27; Friend, 1933, p. 291; Obarski, 1933, p. 157; Twinn, 1934, p. 76; Marriner, 1936, p. 42; Hering, 1937, p. 75; Balch, 1939, p. 37; Brown, 1940, p. 16; Benson, 1940, p. 213; Buhr, 1941, p. 912; Wahlgren, 1944, p. 147; Berland, 1947, p. 261; Hering, 1951, p. 314.

Emphytus pumila: Hartig, 1837, p. 259.

Phaenusa pumila: Cameron, 1876a, p. 7; André, 1880, p. 231.

Kaliosysphinga pumila: Konow, 1885, p. 297; Konow, 1886b, p. 269; Konow, 1890, p. 249; Dalla Torre, 1894, p. 158; Konow, 1905, p. 89; Zirnigle, 1955, p. 93.

Dolerus pusillus Lepelletier, 1823, p. 120; Blanchard, 1840, p. 241.

Phaenusa pusilla: André, 1880, p. 229.

Fenusa pusilla: Ross, 1936, p. 265; Benson, 1940, p. 213; Ross, 1951, p. 31; Wahlgren, 1951, p. 75; Benson, 1952, p. 109; Maxwell, 1955, p. 59; Peterson, 1956, p. 270; Ghent, 1956, p. 17; Raizenne, 1957, p. 25; Lorenz and Kraus, 1957, p. 140; Schuder, 1958, p. 150; Lindquist, 1959, p. 626; Benson, 1962, p. 392; Cheng and LeRoux, 1965, p. 175; Smith, 1967, p. 282; Burks, 1967, p. 16.

Female.—Average length, 3.7 mm. Black with extreme apex of

each femur, each tibia, and tarsus whitish. Wings lightly infuscated, darker on basal half.

Antenna stocky, shorter than thorax; third segment twice as long as fourth segment; segments 4 and 5 less than twice as long as broad (pl. III, 33). Mesonotum and abdomen without surface sculpture. Vein 2r of forewing joins Rs apical to 3r-m (pl. III, 19). Sheath short and rounded (pl. IV, 59). Lancet with each serrula low and flattened, with one anterior and five or six posterior sub-basal teeth (pl. VII, 79).

Male.—Average length, 3.5 mm. In color and structure similar to female. Genitalia as in plate X, 124 and 125.

Larva.—Final feeding stage (pl. XVIII, 230-235). Length, 5.5 mm. Slightly dorsoventrally flattened. White; head capsule light brown; plates of thoracic sterna and sternum of first abdominal segment dark brown.

Head dorsoventrally flattened, round from above, prognathous. Antenna one-segmented. Labrum slightly emarginated with two setae on dorsal surface; epipharynx with row of four or five stout spines on each half; maxillary palpus four-segmented, first, second, and third segments each with one small seta; galea conical, subequal in length to maxillary palpus; lacinia with two stout spines; palpifer with four setae; right mandible with four ventral and two dorsal teeth; left mandible with four ventral and three dorsal teeth; each mandible with one seta on outer basal angle; labial palpus three-segmented; mentum with four setae.

Thorax with dark prosternal, mesosternal, and metasternal plates. Thoracic legs five-segmented, short and directed laterally; tarsal claw small but present.

Sternum of first abdominal segment with dark plate. Prolegs on abdominal segments 2 to 8. Abdominal segments 1 to 8 each with two annulets. Small spines on venter of ninth segment and about prolegs absent.

The larva has been described by Friend (1933), Peterson (1956), Lorenz and Kraus (1957), and Lindquist (1959).

Holotypes.—Klug's type is probably in the Zoological Museum of Berlin. The location of Lepeletier's type is not known; it may be in the Museum of Natural History, Paris.

Distribution.—Northeastern and northwestern United States, southeastern Canada; Europe. The following records are from those specimens I have examined; in States where this species is widespread, specific localities are not given. *Connecticut*: Widespread. *Maine*: Widespread. *Massachusetts*: Widespread. *New Brunswick*: Widespread. *Newfoundland*: Insular, widespread. *New Hampshire*: Widespread. *New Jersey*: Widespread. *New York*: Widespread. *Nova Scotia*: Widespread. *Ontario*: St. George; Islington. *Oregon*: Gresham. *Quebec*: Widespread in southern part of Province. *Vermont*: Widespread. This species has also been recorded in the U.S. Agr. Res. Serv. Coop. Econ. Insect Rpt. for 1967 (17 (34): 800) from the following States, but I have not seen specimens: Delaware, Indiana, Iowa, Maryland, Michigan, Minnesota, Ohio, Pennsylvania, Rhode Island, Washington, West Virginia, and Wisconsin.

Host.—Leaf miner of *Betula* spp.

Biology.—Friend (1933) published the most complete biological treatment of this species in North America. The adults fly early in the spring, usually in May, and are very common everywhere around birches. There are several generations a year, and the adults may be collected from May to August. Oviposition is on the surface of the leaf, not on the margins as is that of *Heterarthrus nemoratus* and *Messa nana*. On maturing, the larvae drop to the soil to pupate or overwinter. The birch forests of the Northeastern States may turn entirely brown as a result of the damage by the mining larvae.

Discussion.—This species may be confused with *dohrnii* but is separated by the shorter antenna and white back tibia. The lack of surface sculpture on the mesonotum and low flat serrulae of the lancet will separate it from *ulmi*.

This species was first discovered in North America by Britton (1925) in Connecticut. It has since become widespread in northeastern United States, eastern Canada, and more recently has been introduced into Oregon and Washington. Friend (1933) reported on its history and included a good bibliography.

The approved common name for this species is the birch leaf miner.

Fenusa ulmi Sundevall

Fenusa ulmi Sundevall, 1844, p. 240; Healy, 1869, p. 297; Kaltenbach, 1874, p. 539; Cameron, 1882, p. 295; Enslin, 1914, p. 302; Dovnar-Zapolsky, 1929, p. 38; Conde, 1934, p. 185; Stritt, 1935, p. 187; Grandi, 1936, p. 246; Skala, 1936, p. 56; Ross, 1936, p. 265; Crevecoeur and Maréchal, 1938, p. 497; Benson, 1940, p. 213; Benson, 1941, p. 89; Buhr, 1941, p. 925; Wahlgren, 1944, p. 147; Berland, 1947, p. 264; Wahlgren, 1951, p. 75; Ross, 1951, p. 31; Benson, 1952, p. 109; Maxwell, 1955, p. 58; Zirngiebl, 1955, p. 93; Raizenne, 1957, p. 25; Lorenz and Kraus, 1957, p. 140; Benson, 1962, p. 392; Smith, 1967, p. 282.

Phaenusa ulmi: Cameron, 1876a, p. 9; André, 1880, p. 230.

Kaliosysphinga ulmi: Konow, 1886b, p. 269; Konow, 1890, p. 249; Dalla Torre, 1894, p. 159; Slingerland, 1905, p. 49; Konow, 1905, p. 89; Herrick, 1913, p. 491.

Kaliofenusa ulmi: Viereck, 1910, p. 591; MacGillivray, 1916, p. 157; Yuasa, 1922, p. 97; Twinn, 1934, p. 77.

"an elm leafminer," Felt, 1898a, p. 21; Felt, 1898b, p. 237.

Messa alsia MacGillivray, 1923b, p. 22, ♀; Frison, 1927, p. 251; Ross, 1936, p. 265 (= *ulmi* Sundevall).

Female.—Average length, 4.0 mm. Entirely black with front tibia whitish and middle tibia and hindtibia brownish. Wings uniformly, lightly infuscated.

Antenna stocky; third segment $1\frac{1}{2}$ times length of fourth segment; segments 4 and 5 less than twice as long as broad (pl. III, 33). Lateral lobes of mesonotum with fine surface sculpture; abdominal tergites dull with alutaceous surface sculpture. Vein 2r of forewing meets Rs basal to 3r-m. Sheath short, rounded (pl. IV, 58). Lancet with each serrula long, lobelike, rounded at apex, without subbasal teeth (pl. VII, 77).

Male.—Unknown in North America. Rare in Europe (Benson, 1952).

Larva.—Final feeding stage (pl. XVIII, 220-227). Length, 7.8 mm. Slightly dorsoventrally flattened. White; head capsule, notal and sternal plates of thorax, and sternal plates of first three abdominal segments light brown. Dorsum and venter of body with fine microscopic setae, larger and more abundant around prolegs of abdominal segments 7 and 8 and on ventral swellings of abdominal segment 9.

Head dorsoventrally flattened; prognathous. Labrum slightly emarginated, two setae on dorsal surface; epipharynx with six stout spines on each half; right mandible with three ventral and two dorsal teeth; left mandible with three ventral and three dorsal teeth; one seta on outer basal angle of each mandible; maxillary palpus four-segmented; galea conical, subequal in length to maxillary palpus; lacinia with three stout spines; three setae on palpifer; labial palpus three-segmented, conspicuous; mentum with four setae.

Pronotal plate present; large prosternal plate and small mesosternal and metasternal plates present. Mesonotum and metanotum with dorsal swellings lacking microscopic setae. Thoracic legs five-segmented, small; tarsal claw minute, hooklike, appearing absent but visible under high magnification.

Venter of abdominal segments 1 to 4 with small light central plates. Prolegs present on segments 2 to 8, each with numerous microscopic spines about them; swellings on venter of segment 9 with concentration of small spines.

Healy (1869a), Slingerland (1905), Yuasa (1922), and Lorenz and Kraus (1957) also described the larva of *ulmi*. Maxwell (1955) described the internal larval anatomy.

Holotypes.—*M. alsia* MacGillivray, a female labeled "Ithaca, N.Y., 16 May 97," is at the Illinois Natural History Survey. The location of Sundevall's type is not known.

Distribution.—Northeastern United States and southeastern Canada. The following records are from those specimens that I have examined. *Massachusetts*: Danvers, V-15-26, *Ulmus*. *Michigan*: East Lansing, May 15, 17, 1963. *New York*: Ithaca, June 6, 1904, V-22-1926, V-17-1963, June 2, 1904; Van Natta's Dam, Ithaca, May 23, 1937; Inlet Valley, Ithaca, V-3-1913; New Rochelle, May 9, 1925; Geneva, May 17, 1954, V-18-15; Delmar, May 15, 1906; Albany, April 5, 1903. *Ontario*: Weston, May 29, 1934. *Quebec*: St. Hilaire, 24-V-22.

Host.—Leaf miner of elm (*Ulmus* spp.). Felt (1898a) recorded it from American elm. However, Slingerland (1905) recorded it from English and Scotch elms in New York and stated that the American elms were immune from attack even where the different host species were growing in close proximity.

Biology.—Slingerland (1905) reported on the biology of this species. The adults fly from the middle of May to the first of June. The eggs are usually inserted near the midrib of the leaf, sometimes as many as 25 per leaf. The larvae feed for about 3 weeks, and, as they develop, the mines may coalesce to give a blisterlike appearance to the leaf. About mid-July the larvae drop to the

ground and form thin papery cocoons in the soil where they overwinter. There is one generation a year.

Discussion.—The surface sculpture of the mesonotum and abdomen, the position of vein 2r in the forewing, and the lobelike serrulae of the lancet will separate this species from other *Fenusa* species.

This is probably an introduced species that was brought to America with the imported elms. The first record for North America is that by Felt (1898a), who recorded it from New York as being a pest of elms. Slingerland (1905) first found this species in New York in 1899.

The approved common name for this species is the elm leaf miner.

Genus FENELLA Westwood

Fenella Westwood, 1840, p. 54; Cameron, 1882, p. 288; Konow, 1886b, p. 271; Dalla Torre, 1894, p. 155; Ashmead, 1898, p. 250; Konow, 1905, p. 90; Enslin, 1914, p. 308; Benson, 1936, p. 623; Benson, 1941, p. 87; Berland, 1947, p. 267; Benson, 1952, p. 109; Benson, 1953, p. 136; Lorenz and Kraus, 1957, p. 138; Smith, 1967, p. 281.

Type-species: *Fenella nigrita* Westwood. Monotypic.

Description.—Antenna with 11 or 12 segments; second segment longer than broad; third segment longer than fourth segment; segments beyond third subequal in length (pl. III, 34). Clypeus truncate; malar space less than diameter of front ocellus; postgenal carina absent. Tarsal claw simple, basal lobe absent (pl. III, 21); fourth segment of back tarsus not conspicuously produced apically (pl. III, 28). Forewing with vein 2A and 3A curved up and joining 1A forming small basal anal cell. Hindwing with radial cell open; anal cell absent; cells *Rs* and *M* absent (similar to pl. III, 19, 20).

Fenella is close to *Fenusa*, but it may be separated by the longer antenna and the less apically produced fourth segment of the back tarsus. Also, members of this genus are associated with herbs, whereas members of *Fenusa* are associated with trees.

This is a small genus of about six species, only one of which has been found in North America. Benson (1953) treated five species in a revision of this genus.

Description of *Fenella* Species

Fenella nigrita Westwood

Fenella nigrita Westwood, 1840, p. 54; Thomson, 1870, p. 270; Thomson, 1871, p. 180; Cameron, 1876a, p. 15; André, 1880, p. 233; Cameron, 1882, p. 288; Brischke and Zaddach, 1883, p. 257; Konow, 1886b, p. 271; Konow, 1887, p. 276; Konow, 1890, p. 249; Dalla Torre, 1894, p. 155; Ghigi, 1904, p. 16; Enslin, 1914, p. 308; Dovnar-Zapolsky, 1929, p. 39; Dovnar-Zapolsky, 1931, p. 55; Conde, 1934, p. 186; Stritt, 1935, p. 187; Grandi, 1936, p. 250; Kvicala, 1938, p. 151; Benson, 1940, p. 213; Benson, 1941, p. 89; Buhr, 1941, p. 908; Wahlgren, 1944, p. 148; Berland, 1947, p. 268; Wahlgren, 1951, p. 76; Benson, 1952, p. 109; Benson, 1953, p. 136; Lorenz and Kraus, 1957, p. 140; Ermolenko, 1961, p. 94; Smith, 1967, p. 281.

Female.—Average length, 3.0 mm. Black with labrum, extreme apex of each femur, each tibia, and each tarsus brownish. Wings uniformly, moderately infuscated.

Sheath short, rounded, without scopa at apex (pl. IV, 54). Basal serrulae of lancet pointed, with no anterior and seven or eight fine posterior subbasal teeth; apical serrulae flattened, each with seven or eight fine teeth on apical flattened margin (pl. VII, 82).

Male.—Unknown. Parthenogenetic.

Larva.—Final feeding stage (pl. XVII, 213–219). Length, 6.0 mm. Dorsoventrally flattened. White; head capsule, pronotal plate, large prosternal plate, and small mesosternal and metasternal plates light brown; dorsum of 10th abdominal segment very light brown.

Head dorsoventrally flattened, prognathous; oblong in dorsal view. Antenna conical, indistinctly three-segmented. Labrum slightly emarginated with two setae on dorsum; epipharynx with row of five short spines on each half; each mandible with three teeth; one seta on outer basal angle of each mandible; maxillary palpus four-segmented, palpifer with two setae; galea long, subequal in length to maxillary palpus; lacinia with two long stout spines; labial palpus three-segmented, long and distinct; mentum with four setae.

Pronotal plate present; large prosternal and small mesosternal and metasternal plates present. Thoracic legs five-segmented, short, directed laterally; tarsal claw present.

Prolegs on abdominal segments 2 to 8, indistinct on 10. Abdominal segments 1 to 8 indistinctly two-annulate. Small plate on sternum of first abdominal segment. Dorsum of 10th abdominal segment slightly darkened, with numerous setae.

Lorenz and Kraus (1957) described the larva of this species.

Holotype.—Westwood's types are in the Hope Museum, Oxford, England.

Distribution.—Northeastern United States and southeastern Canada; Europe. *Connecticut*: Canaan, 15–VIII–65, A. Stone. *Maine*: Penobscot Co., 3 mi. N. Passadumkeag, May 20, 1966, D. R. Smith. *Michigan*: E. Lansing, May 17, 1963, F. E. Giles, May 18, 1962, G. Eickwort. *Ontario*: Ottawa, ex *Potentilla*, July 20, 1964, W. R. Richards.

Host.—Leaf miner of *Potentilla* sp. In Britain it is found on *Agrimonia eupatoria* L. and *Potentilla reptans* L. (Benson, 1952).

Biology.—There is no North American literature on the life history of this species. In Europe Wahlgren (1944, 1951) and Lorenz and Kraus (1957) published some life-history notes.

Discussion.—This small species was first collected in North America at Ottawa, Ontario. Since then several specimens have been found from other localities. It is identical to the European specimens of *nigrita* and may be an introduced species.

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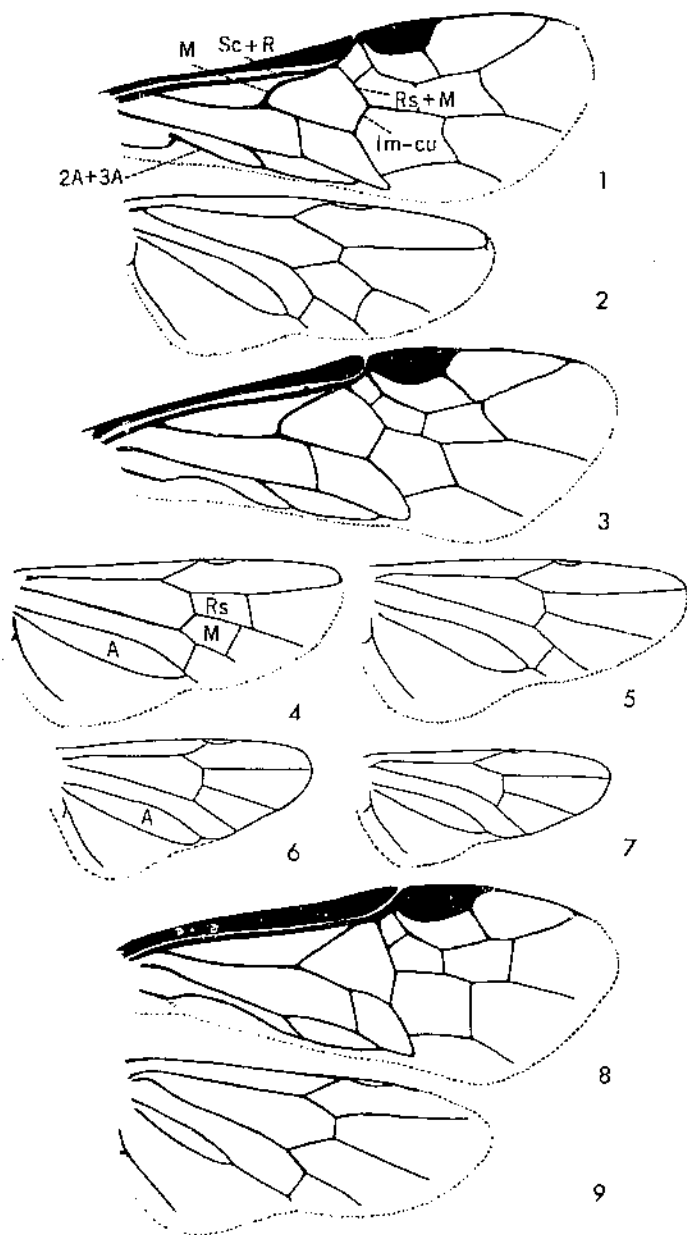
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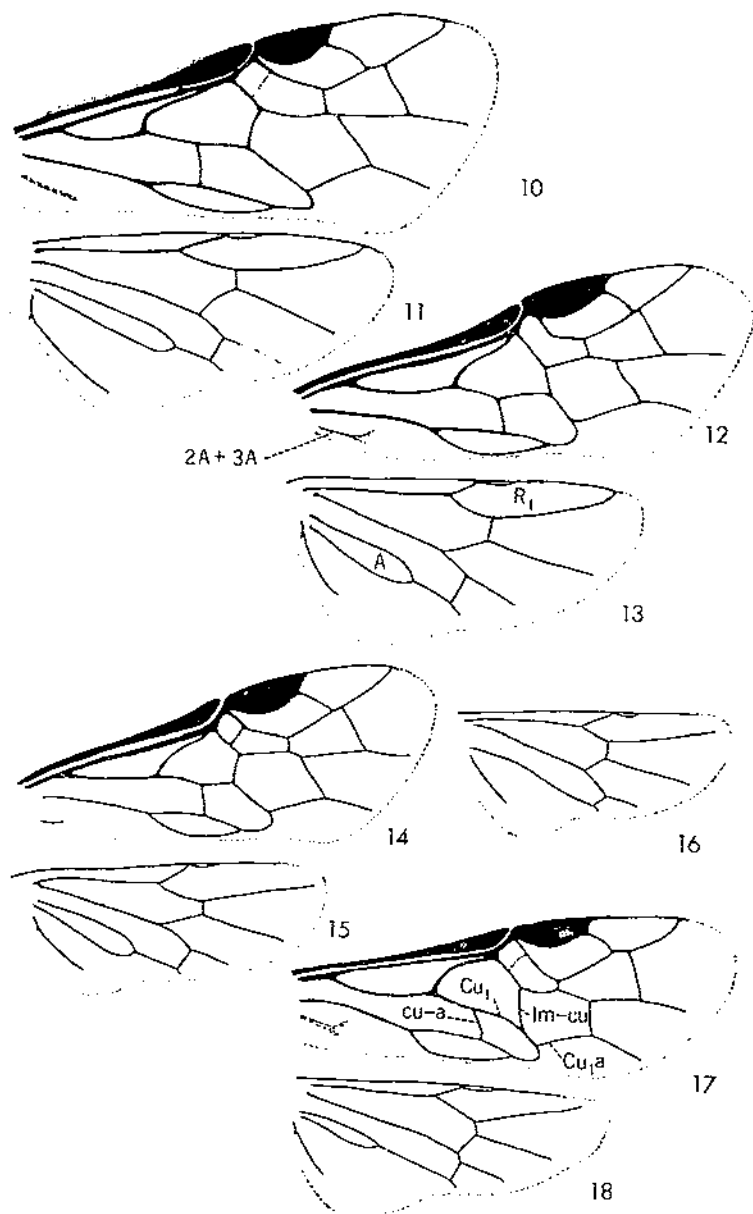
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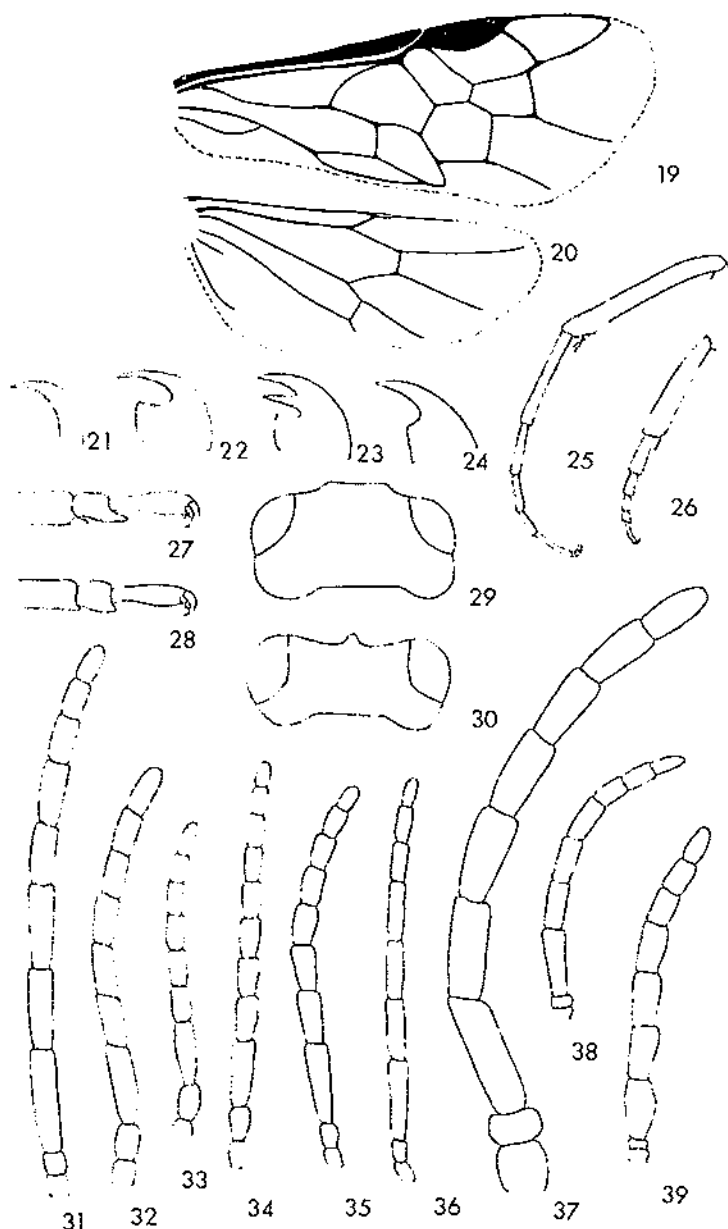
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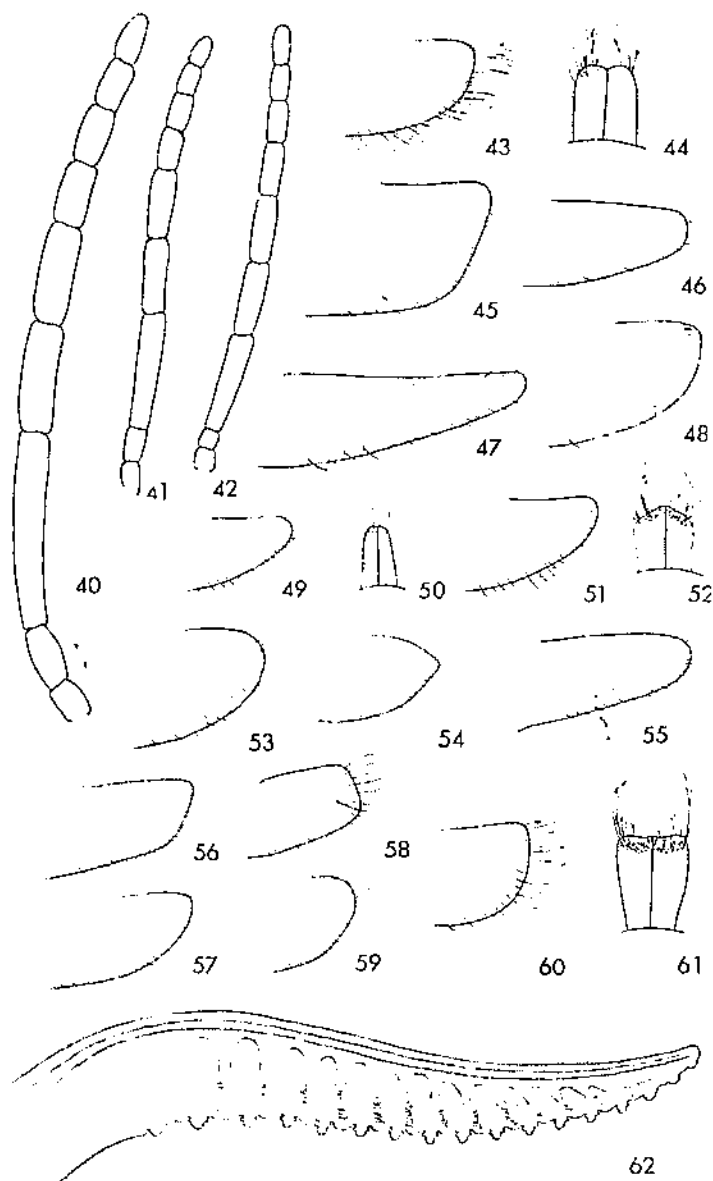
Forewing (1) and hindwing (2) of *Endelomyia aethiops*; forewing (3) and hindwing (4) of *Caliroa cerasi*; hindwing of *C. lorata* female (5), *C. fasciata* male (6), and *C. lorata* male (7); forewing (8) and hindwing (9) of *Heterarthrus nemoratus*. [A = anal cell; 2A + 3A = second and third anal vein; M = media, medial cell; 1m-cu = first mediocubital crossvein; Rs = radial sector, radial sector cell; Rs + M = radial sector and media; Sc + R = subcosta and radius.]



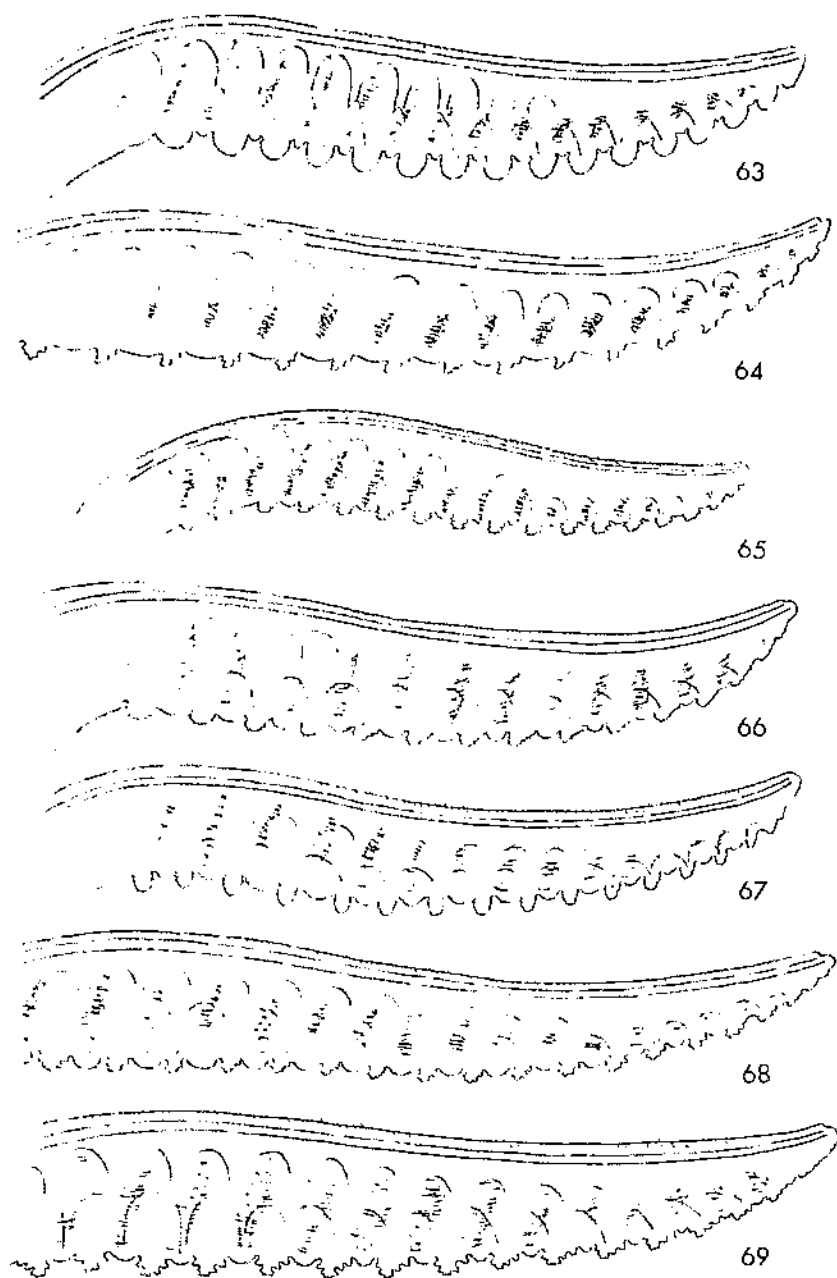
Forewing (10) and hindwing (11) of *Metallus rohweri*; forewing (12) and hindwing (13) of *Alessa leucostoma*; forewing (14) and hindwing (15) of *Profenusa canadensis*; hindwing of *P. thomsoni* (16); forewing (17) and hindwing (18) of *Bidigitus platani*. [**A** = anal cell; **2A + 3A** = second and third anal vein; **Cu₁** = cubital vein; **Cu_{1a}** = cubital anal vein; **cu-a** = cubital anal crossvein; **Im-cu** = first medio-cubital crossvein; **R₁** = radial cell.]



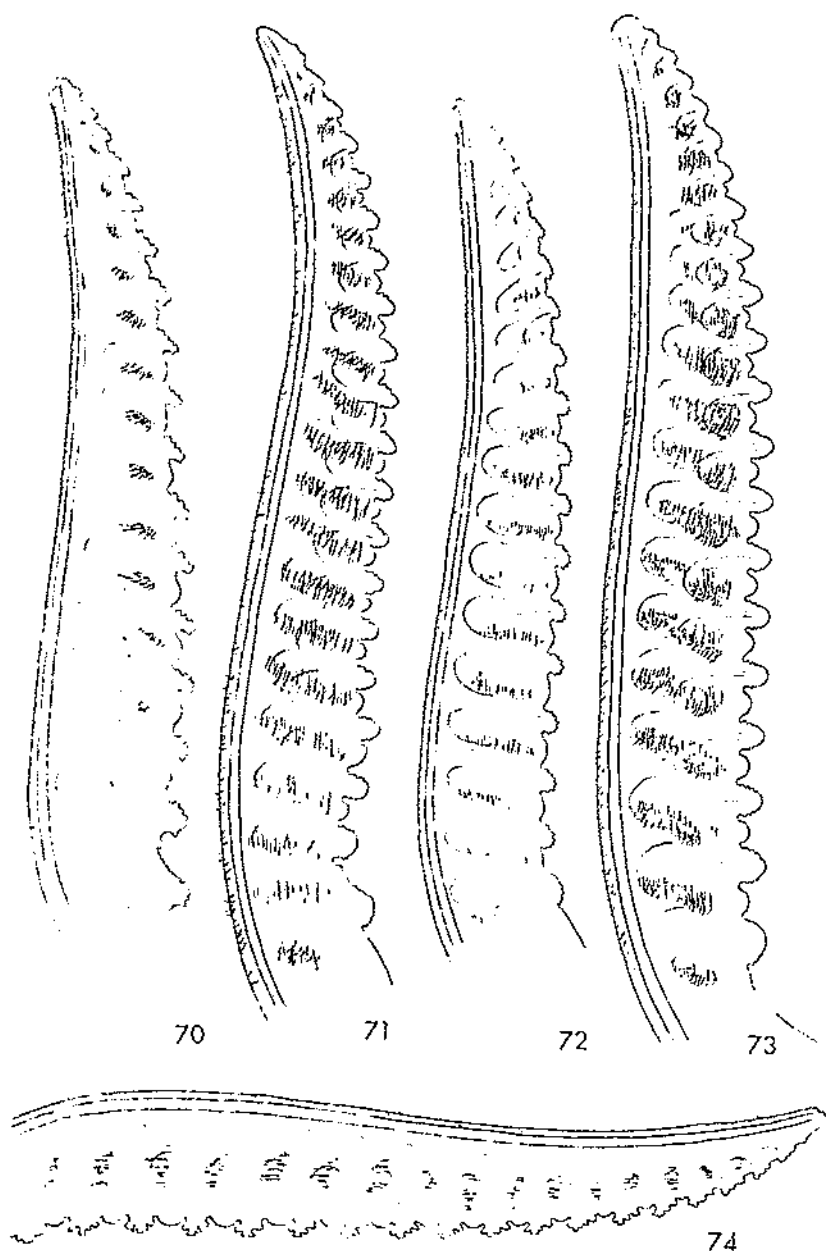
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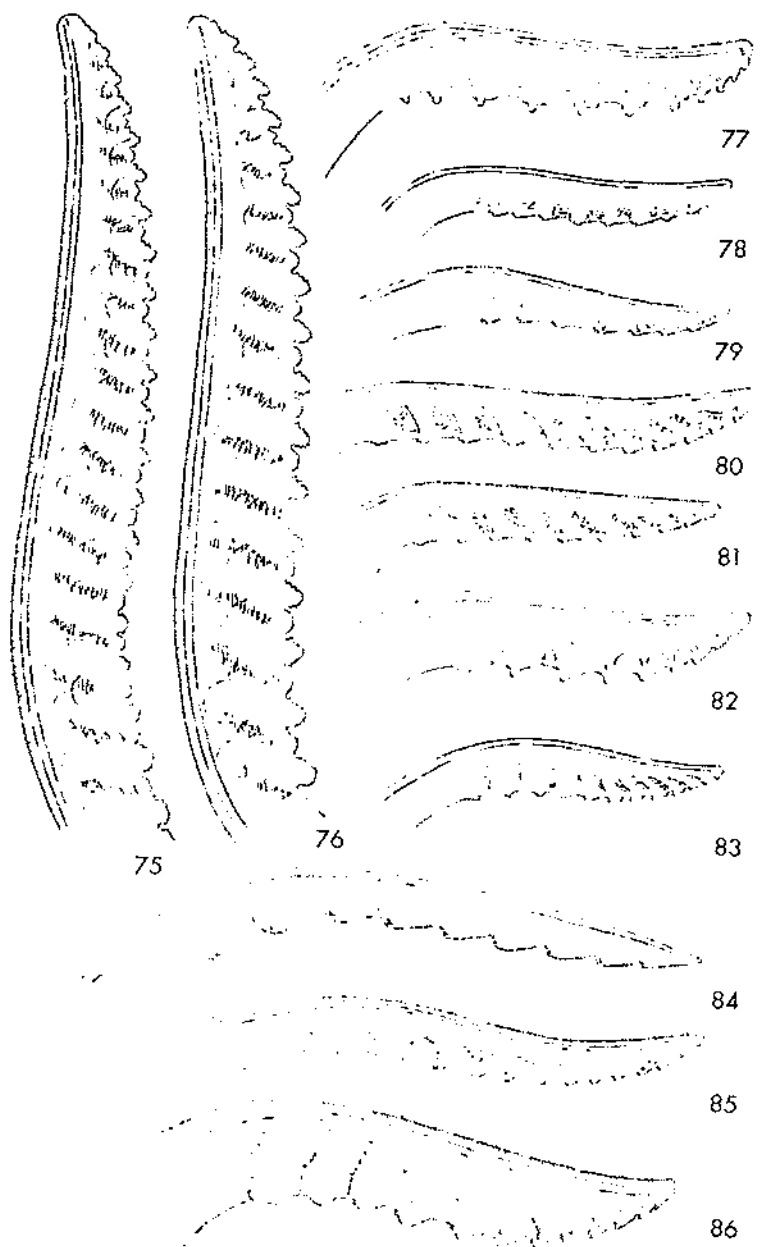
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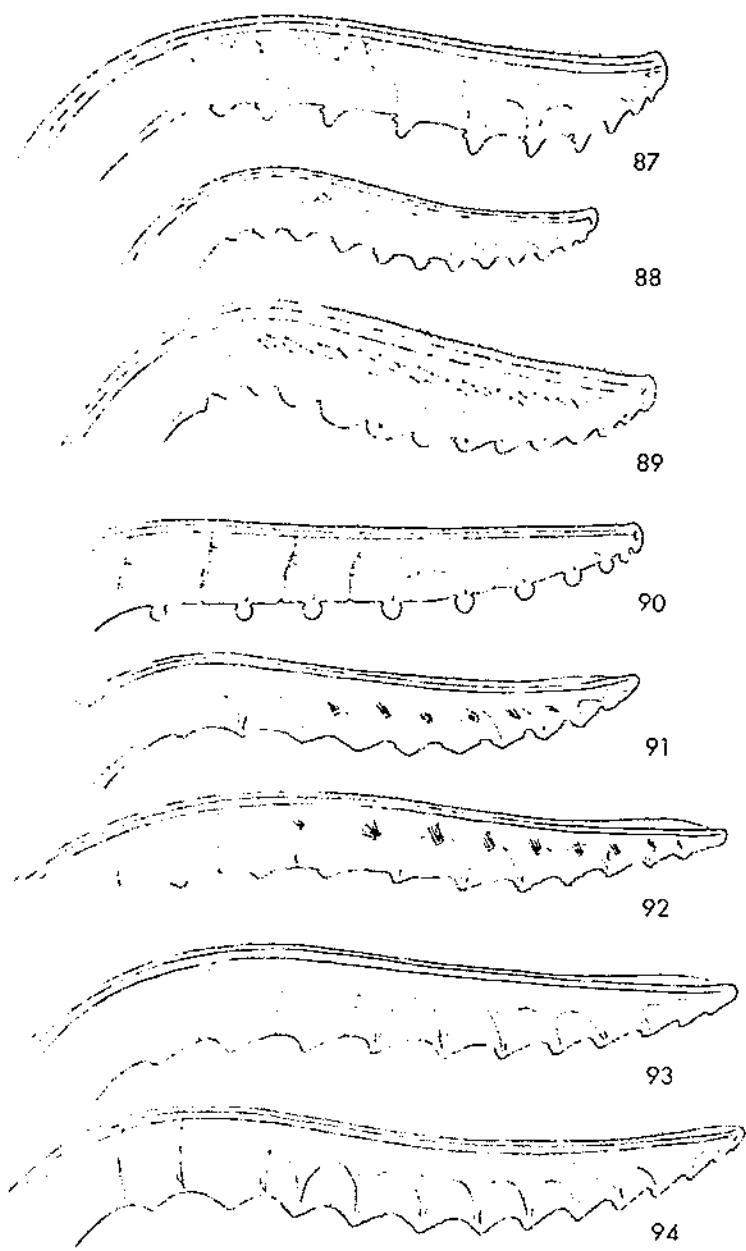
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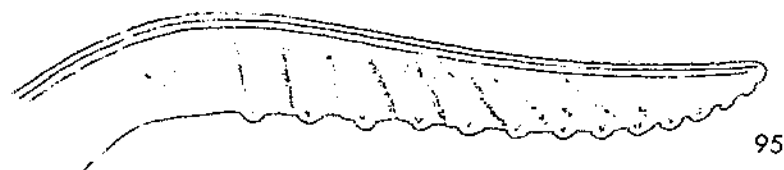
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Female lancets of *Metallus bensoni* (87), *M. capitalis* (88), *M. rohveri* (89), *Profenusa canadensis* (90), *P. thomsoni* (91), *P. alumna* (92), *P. inspirata* (93), and *P. lucifex* (94).



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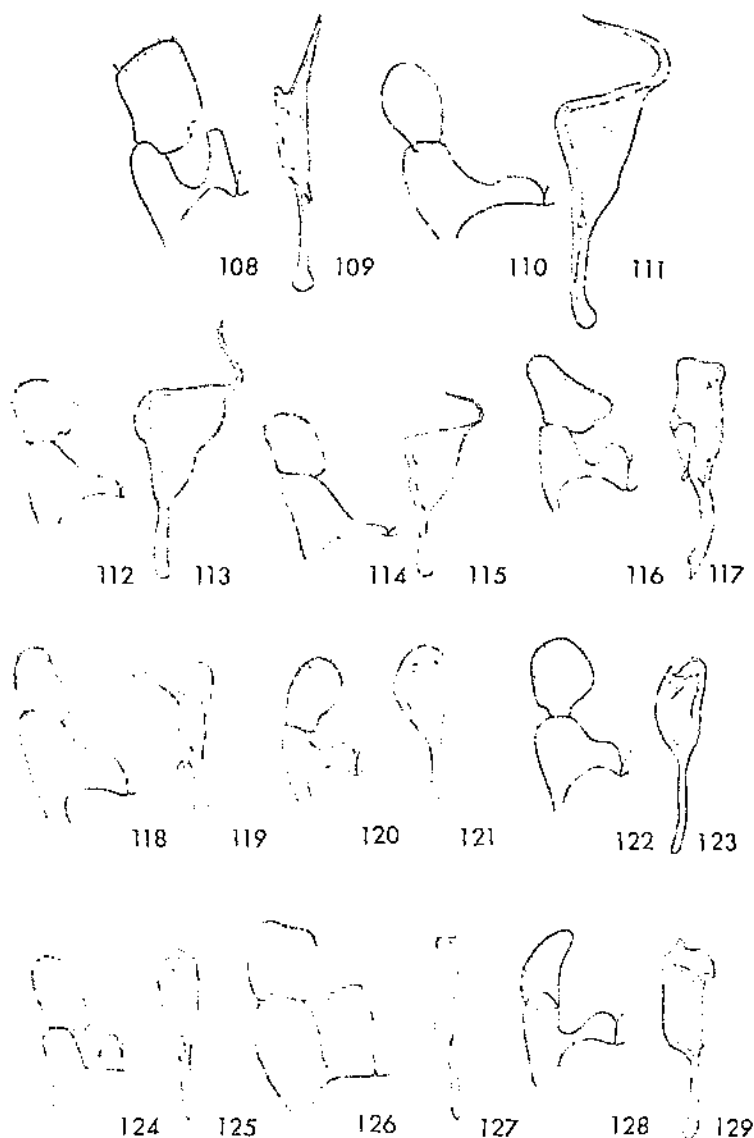


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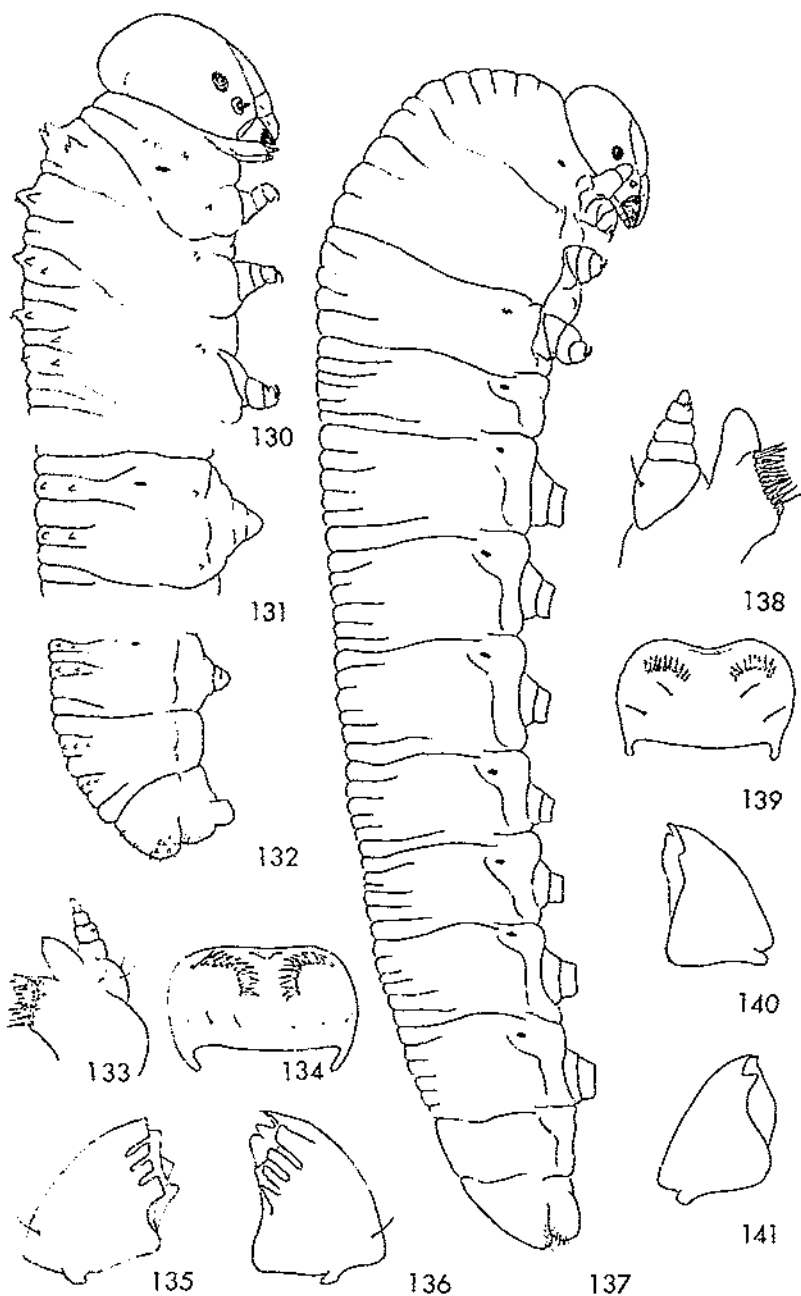


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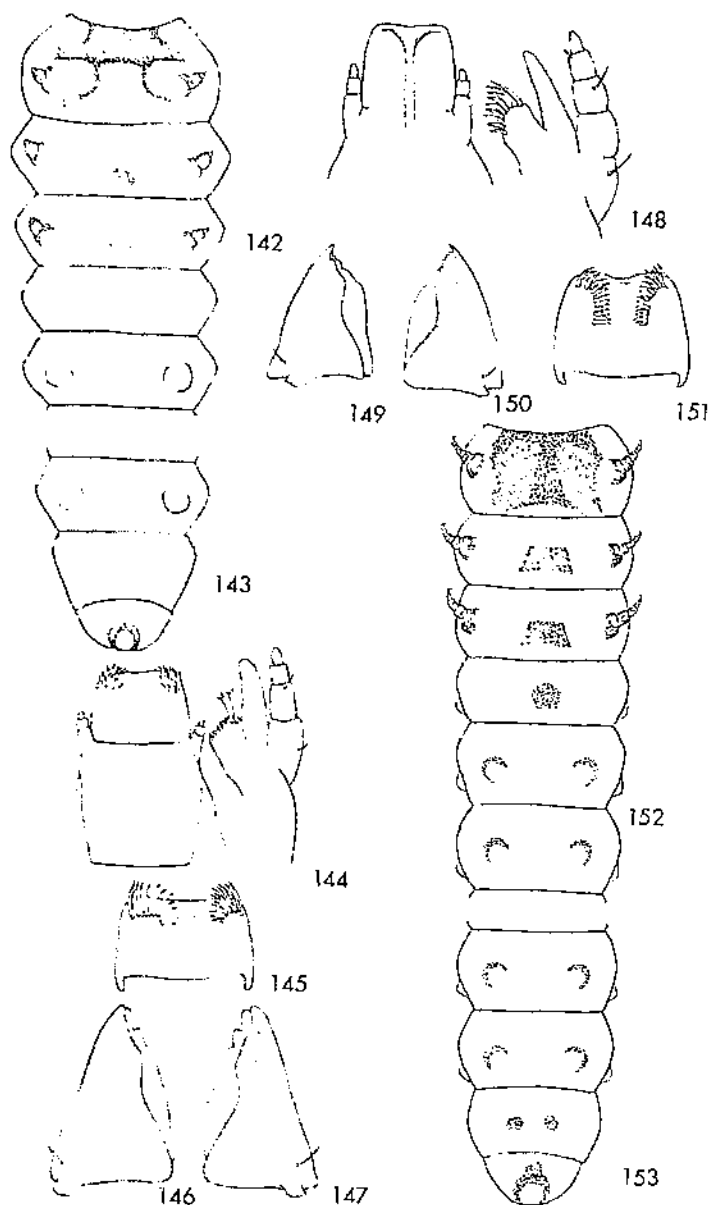


Endelomyia aethiops larva: Head and thorax (130); third abdominal segment (131); eighth, ninth, and tenth abdominal segments (132); maxilla (133); epipharynx (134); right (135) and left (136) mandibles, ventral. *Caliroa cerasi* larva: Lateral (137); maxilla (138); epipharynx (139); left (140) and right (141) mandibles, ventral.

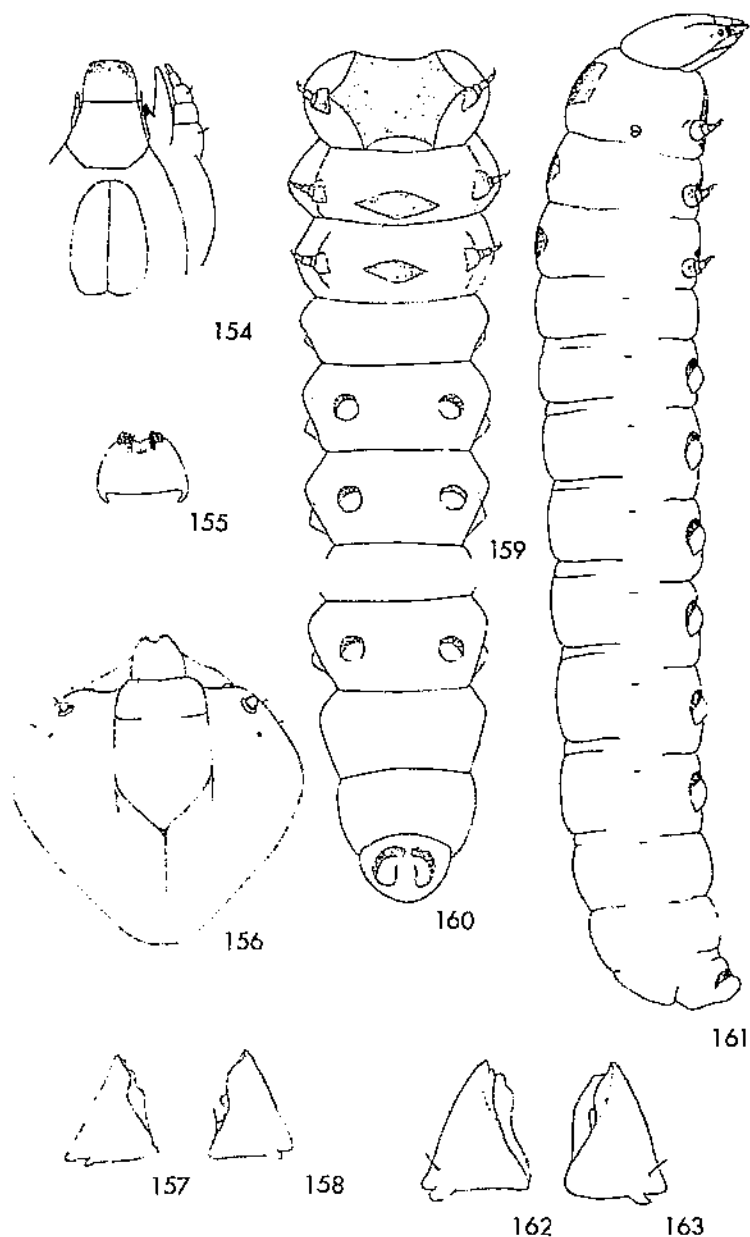
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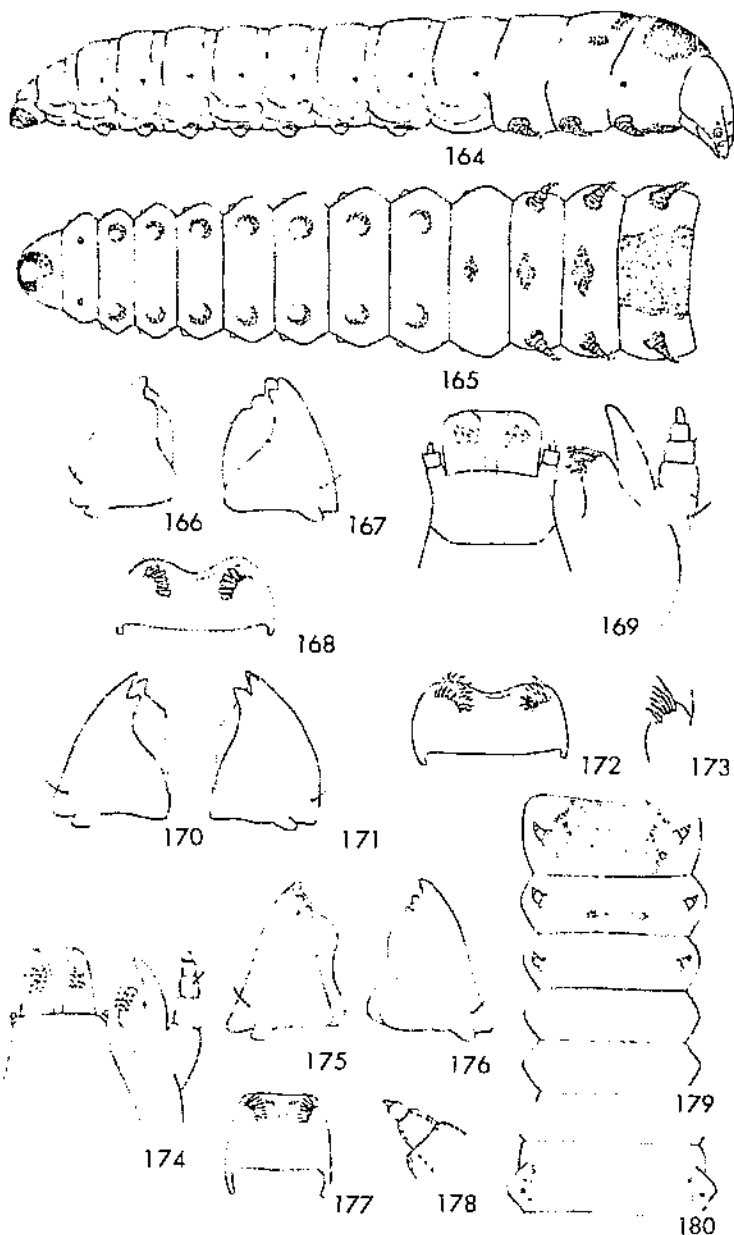
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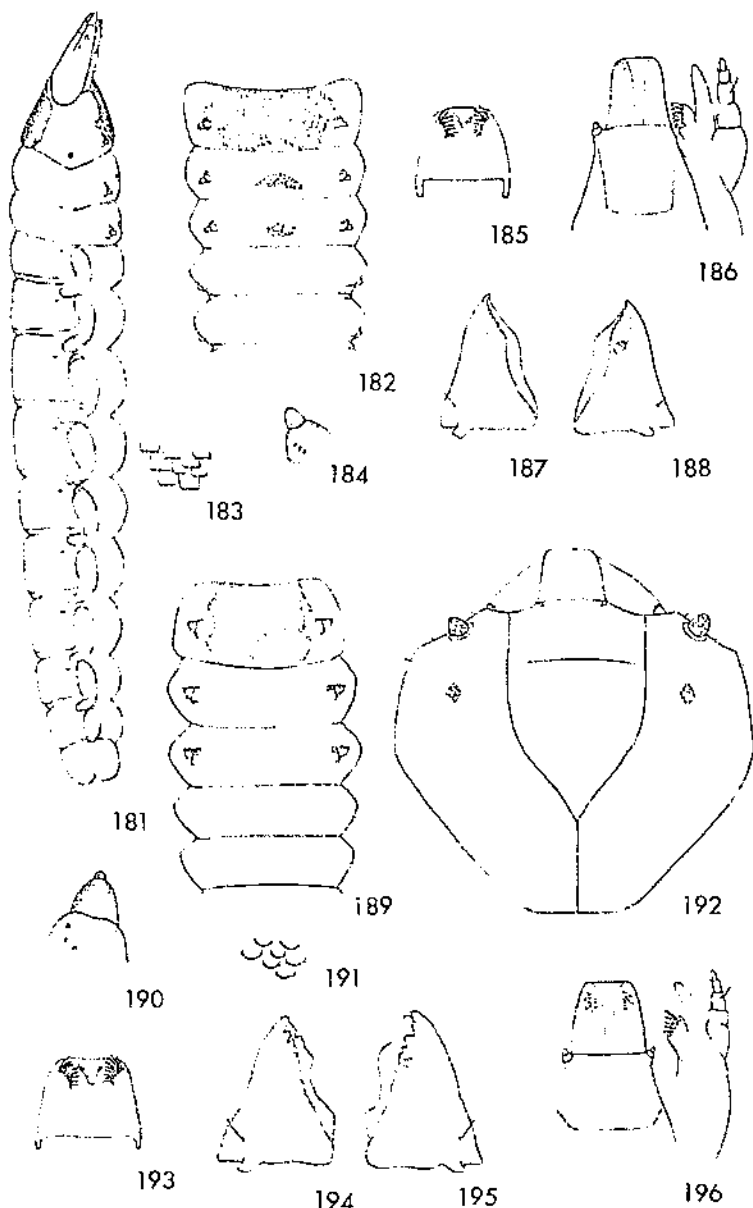
Heterarthrus nemoratus larva: Thorax and first two abdominal segments, ventral (142); eighth, ninth, and 10th abdominal segments, ventral (143); labium and maxilla, ventral (144); epipharynx (145); right (146) and left (147) mandibles, ventral. *Messa nana* larva: Labium and maxilla, ventral (148); right (149) and left (150) mandibles, ventral; epipharynx (151); thorax and first three abdominal segments, ventral (152); abdominal segments 7 to 10, ventral (153).



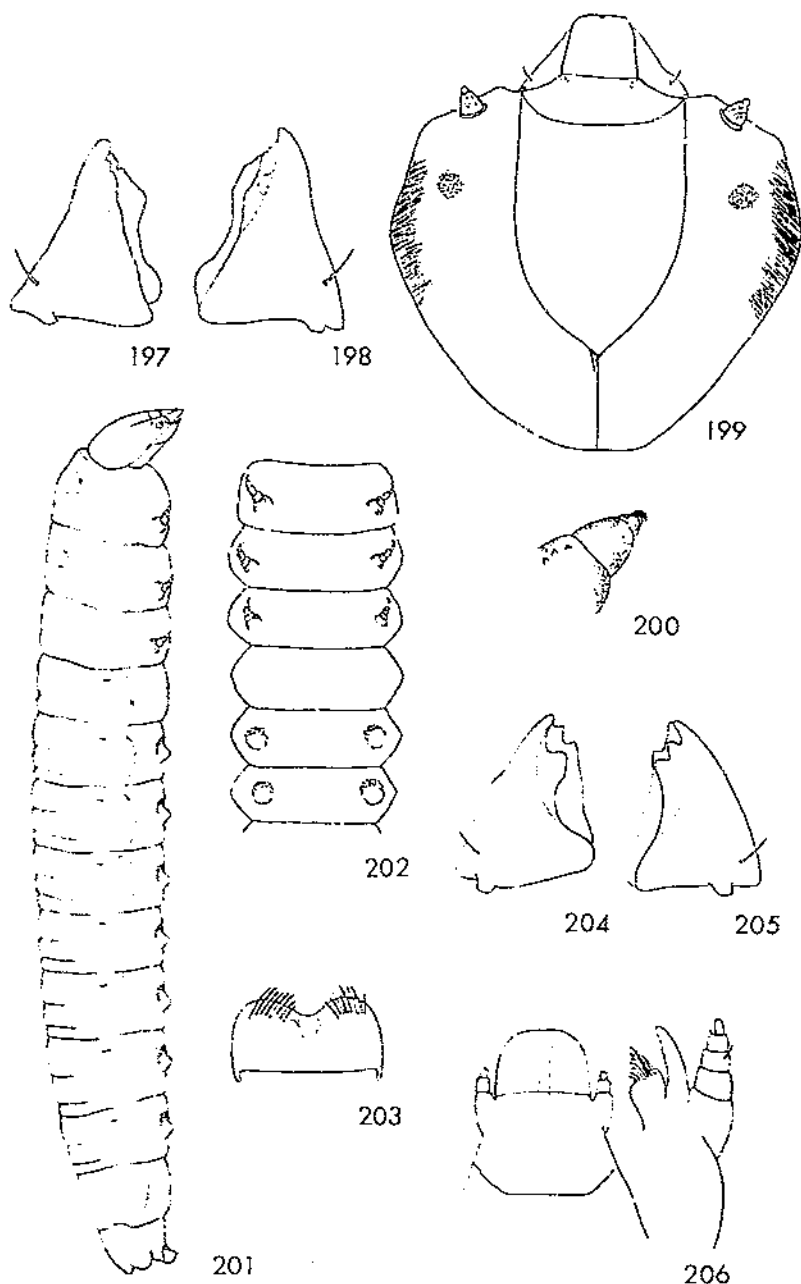
Metallus rohweri larva: Labium and maxilla, ventral (154); epipharynx (155); head, dorsal (156); right (157) and left (158) mandibles, ventral; thorax and first three abdominal segments, ventral (159); abdominal segments 7 to 10, ventral (160); entire larva, lateral (161). *Metallus capitalis* larva: Right (162) and left (163) mandibles, ventral.



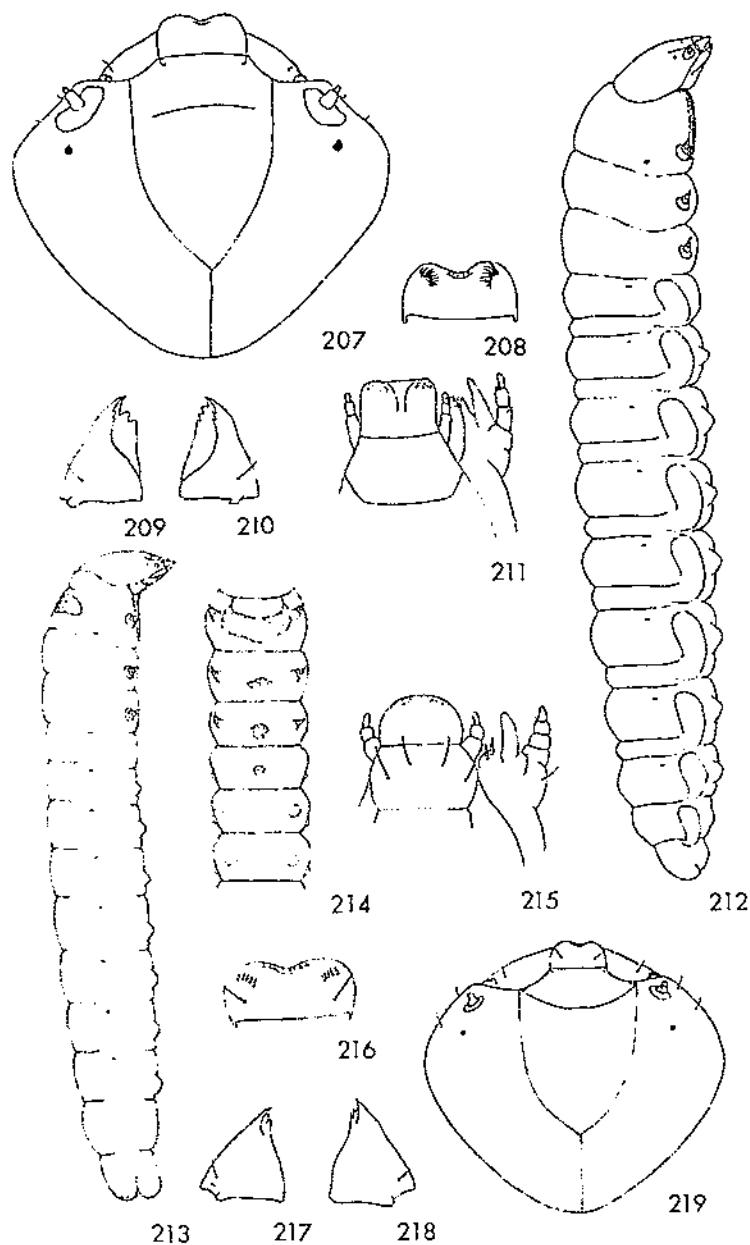
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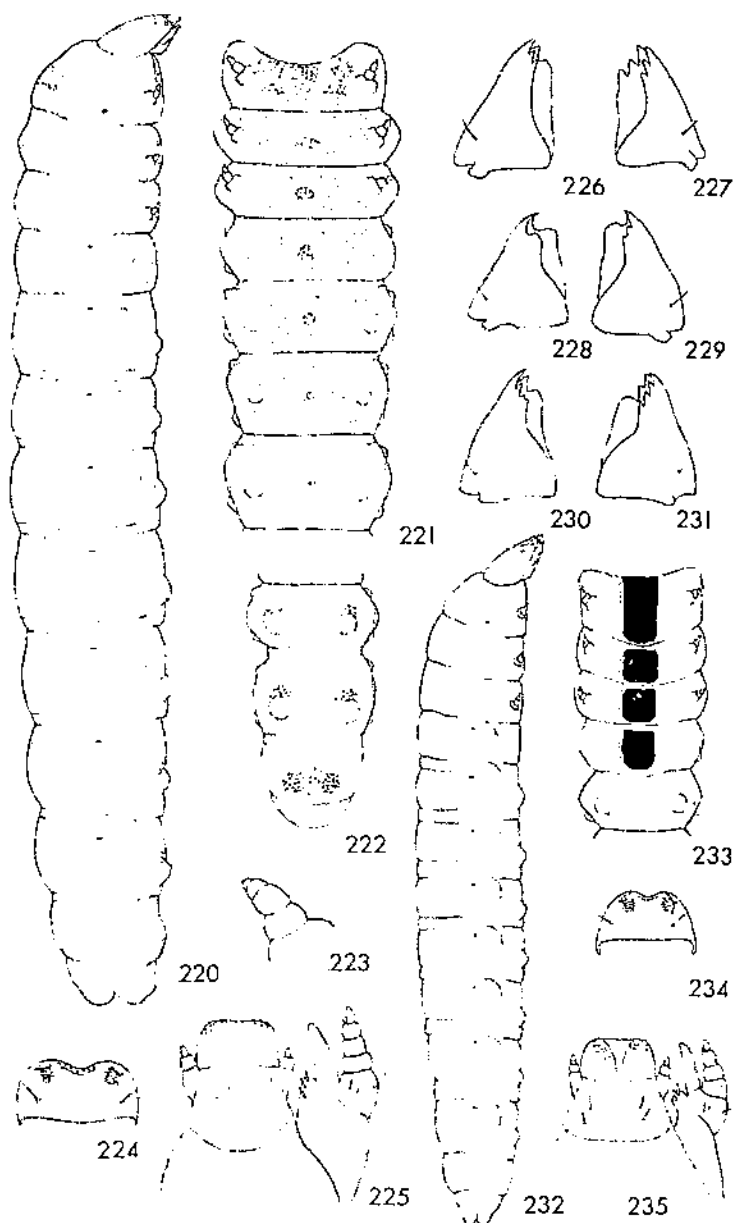
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