United States
Department of
Agriculture

Agricultural
Research
Service

and

United States
Department of
Health and
Human Services

Public Health
Service

Food and Drug
Administration

Agriculture
Handbook No. 655

Insect and Mite Pests in Food

An Illustrated Key

Volume 2

Plate 2. Some **moths** (Lepidoptera) associated with the food industry (body lengths for each species are shown in millimeters in parentheses): A, **webbing clothes moth,** *Tineola bisselliella* (5-7.5) (Tineidae); B, **brown house moth,** *Hofmannophila pseudospretella* (7.5-10) (Oecophoridae); C, **lesser wax moth,** *Achroia grisella* (♂7-9; ♀9.5-12) (Pyralidae); D, *Monopis crocicapitella* (5-7) (Tineidae); E, **Angoumois grain moth,** *Sitotroga cerealella* (6-9) (Gelechiidae); F, G, **Indianmeal moth,** *Plodia interpunctella* (6-8.5) (Pyralidae); H, **rice moth,** *Corcyra cephalonica*(♂7.5-9; ♀8.5-11) (Pyralidae); I, **Mediterranean flour moth,** *Anagasta kuehniella* (9-11) (Pyralidae); J, **tobacco moth,** *Ephestia elutella* (7-9) (Pyralidae); K, **European grain moth,** *Nemapogon granella* (5-7) (Tineidae); L, **stored nut moth,** *Paralipsa gularis* (♂8.5-12; ♀8.5-13.5) (Pyralidae); M, **greater wax moth,** *Galleria mellonella* (♂9.5-11.5; ♀13-16) (Pyralidael); N, **whiteshouldered house moth,** *Endrosis sarcitrella* (7-9.5) (Oecophoridae); O, **meal moth,** *Pyralis farinalis* (♂7.5-11.5; ♀13-15) (Pyralidae).


A
B
C
D
E
F
G
H
I
J
K
L
M
N
O
Cushman '76

United States Department of Agriculture

Agricultural Research Service

and

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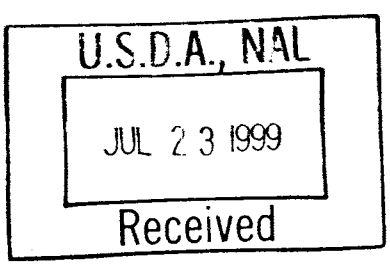
J. Richard Gorham
Editor



For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402

Issued February 1991

CONTENTS

Volume 1

Volume 2

Part 2

18

CLASSES AND ORDERS:

ARTHROPODS AND INSECTS (ARTHROPODA, INSECTA)

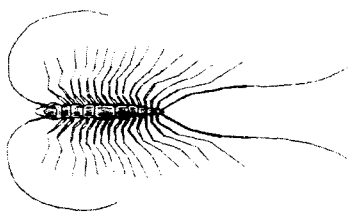
George T. Okumura

Okumura Biological Institute
6669 Fourteenth Street
Sacramento CA 95831

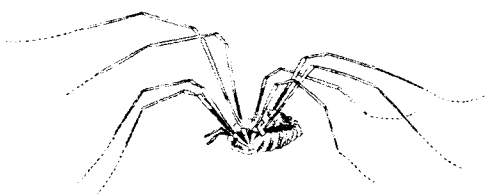
KEY TO ADULTS

Drawings by C.S. Papp unless otherwise noted.[1]

1 With more than 10 pairs of legs; body usually elongate (1A)---------- 2
With less than 10 pairs of legs; body usually not elongate (1B)---------- 3

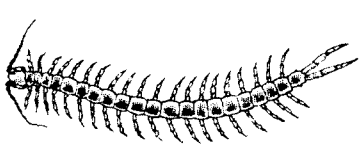


1A *Scutigera forceps*



1B harvestman

2 Most body segments with 1 pair of legs (2A)----------**centipedes,** Chilopoda
Most body segments with 2 pairs of legs (2B)----------**millipedes,** Diplopoda

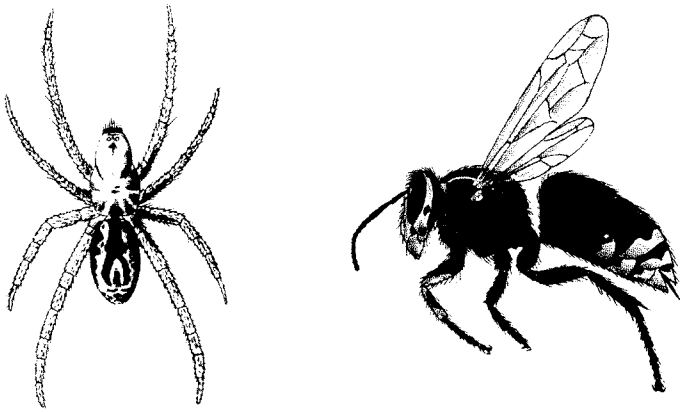


2A centipede

2B millipede

[1]Drawings 1B, 4A, 4B, 8B, 10A, 14B, 15A, 21A, 21B, 24A, 29A, 29B, and 30B from *The Common Insects of North America* by Lester A. Swan and Charles S. Papp. Reprinted by permission of Harper & Row, Publishers, Inc.; copyright 1972 by Lester A. Swan and Charles S. Papp.

3 With 4 or more pairs of legs, 1 or 2 body regions, and either 2 pairs of antennae or none; wings absent (3A) ---------- 4
With 3 pairs of thoracic legs, 3 major body regions, and 1 pair of antennae; often with 1 or 2 pairs of wings (3B). Insecta (**insects**) ---------- 5

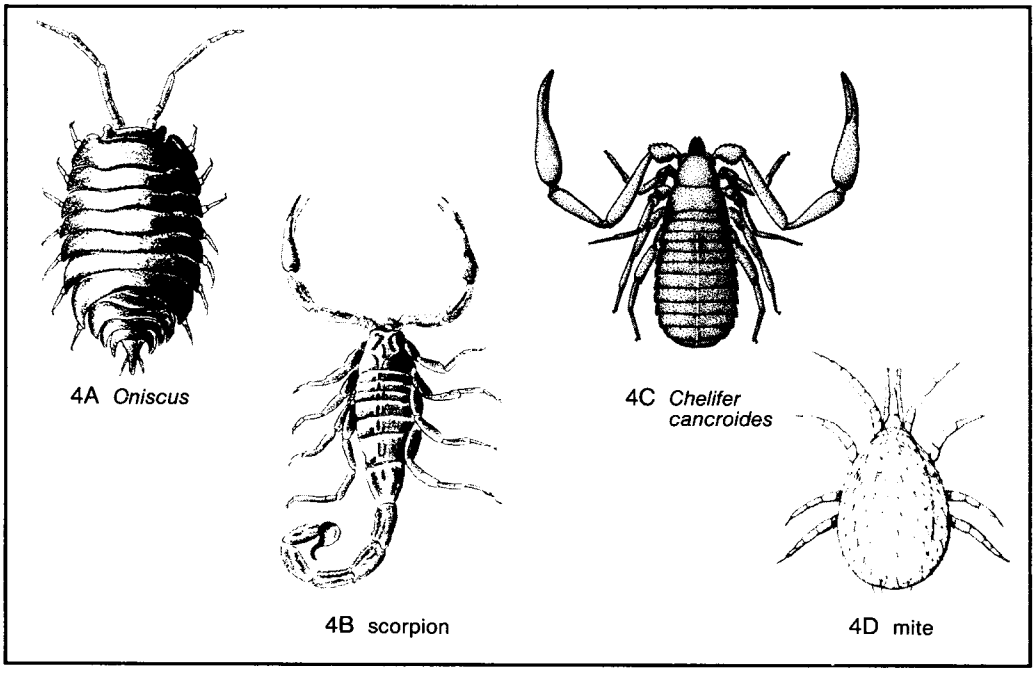


3A spider

3B *Vespula maculata*

4 With 5 or more pairs of legs and 2 pairs of antennae (one pair may be difficult to see) (4A) ----------crustaceans, Crustacea
With 4 pairs of legs; antennae absent (4B-D) ---------- **arachnids**, Arachnida
FOR KEY TO MITES, SEE CHAPTER 1

Drawing 4C by C. Feller



4A *Oniscus*

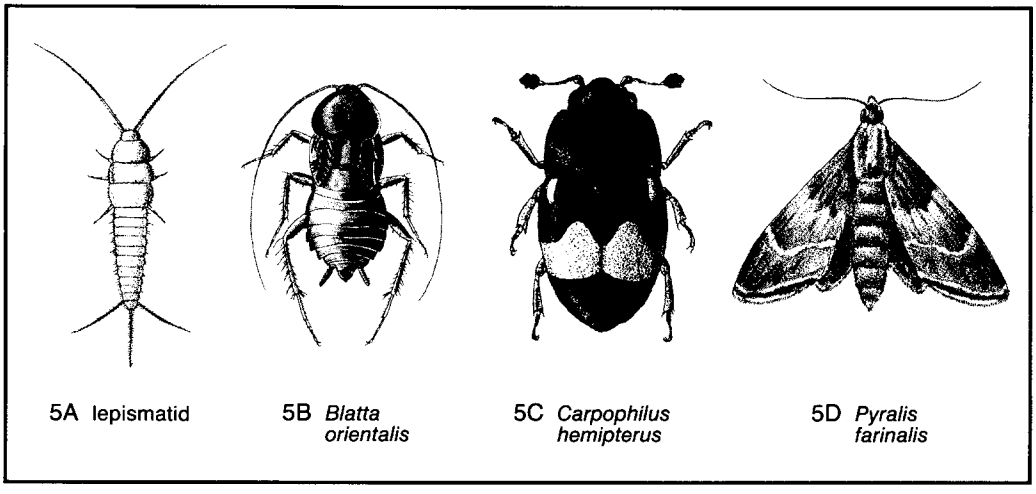
4B scorpion

4C *Chelifer cancroides*

4D mite

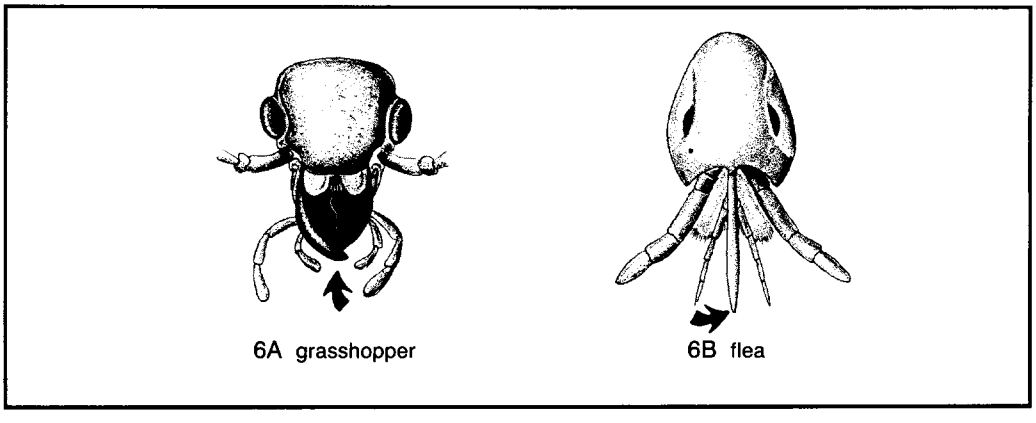
Insecta

5 Wings absent (5A) or rudimentary (5B)---------- 6
Wings present (5C, 5D) (but may be nonfunctional)---------- 21



5A lepismatid | 5B *Blatta orientalis* | 5C *Carpophilus hemipterus* | 5D *Pyralis farinalis*

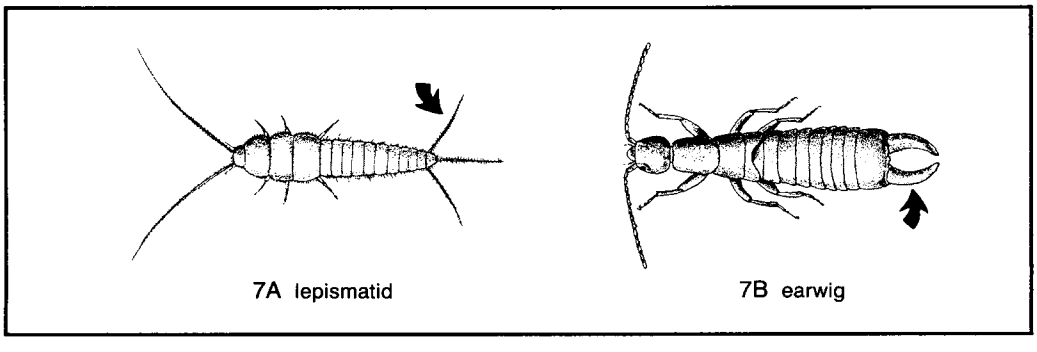
6 With jaws (chewing mouthparts) (6A)---------- 7
With a long beak or stylets (sucking mouthparts) (6B)---------- 15



6A grasshopper | 6B flea

7 With 3 long filaments at tip of abdomen (7A)----------silverfish, Thysanura
FOR KEY TO SILVERFISH, SEE CHAPTER 21

Without 3 caudal filaments (7B)---------- 8

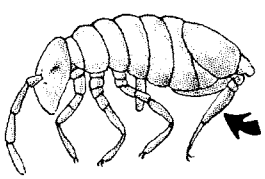


7A lepismatid | 7B earwig

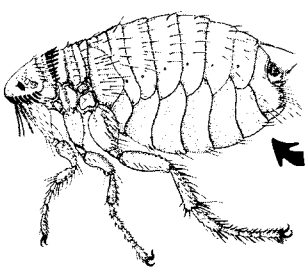
8 Abdomen with no more than 6 segments; springlike appendage usually present on posteroventral surface of abdomen (8A) ----------**springtails,** Collembola
FOR KEY TO SPRINGTAILS, SEE CHAPTER 20

Abdomen with more than 6 segments; springlike appendage absent (8B)---------- 9

Segmentation is usually readily apparent (see 11A-D) in the abdomens of the Hymenoptera included in this Handbook, but it is often very difficult to see all of the segments that may be present. Therefore, when the abdomen consists of a propodeum, petiole, and gaster (as in 11A-D), the reader may assume that more than 6 segments are present.



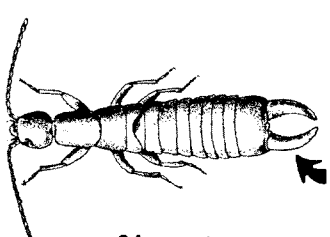
8A springtail



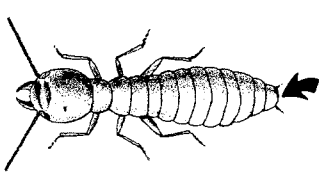
8B *Ctenocephalides felis*

9 Forcepslike appendage present at tip of abdomen (9A)------**earwigs,** Dermaptera (in part)

Forcepslike appendage absent (9B) ---------- 10



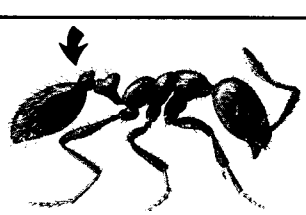
9A earwig



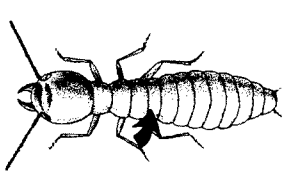
9B termite (worker)

10 Abdomen strongly constricted at base (10A). Hymenoptera (ants, parasitic wasps) (in part) ---------- 11

Abdomen not strongly constricted at base (10B) ---------- 12



10A *Monomorium minimum*

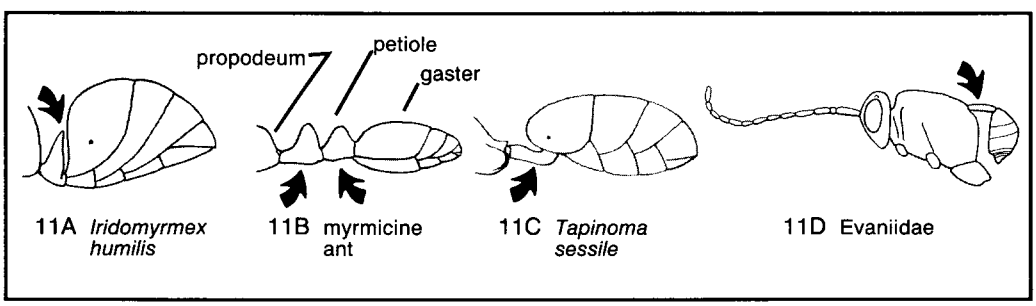


10B termite (worker)

11 One (11A) or two (11B) petiolar nodes present----------**ants,** Formicidae
FOR KEY TO ANTS, SEE CHAPTER 17

Caution: The petiolar node is vestigial in the workers of *Tapinoma sessile* (11C) and *T. melanocephalum.*
Drawings 11A-C by A.D. Cushman; 11D by G. Gordh and P. Mote.

Petiolar node absent (11D) ----------parasitic wasps
FOR KEY TO PARASITIC WASPS, SEE CHAPTER 26



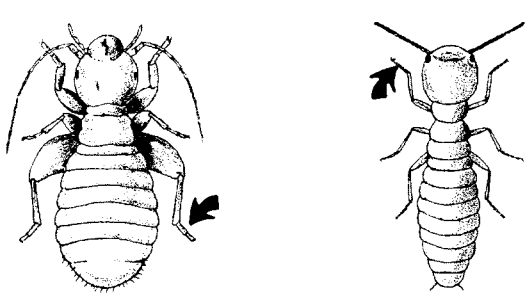
11A *Iridomyrmex humilis* 11B myrmicine ant 11C *Tapinoma sessile* 11D Evaniidae

12 Antenna with fewer than 8 segments (12A)----------**chewing lice,** Mallophaga
Antenna with more than 8 segments (12B)---------- 13

12A chewing louse 12B grasshopper

13 Tarsus with 1 to 3 segments (13A)----------**psocids,** Psocoptera
FOR KEY TO PSOCIDS, SEE CHAPTER 22

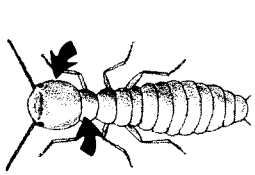
Tarsus with 4 or 5 segments (13B)---------- 14



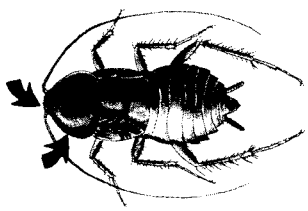
13A psocid 13B termite (worker)

14 Width of pronotum less than length of head (14A)----------**termites,** Isoptera

Width of pronotum greater than length of head (14B) (pronotum covers head of some species) ----------**crickets, cockroaches,** etc., Orthoptera *s.l.* (in part)
FOR KEY TO COCKROACHES, SEE CHAPTER 2



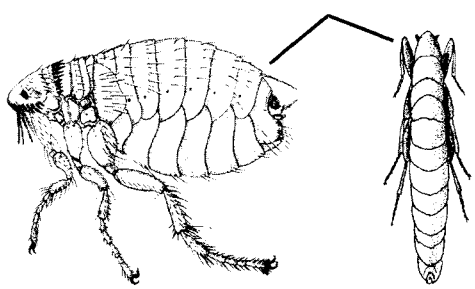
14A termite (worker)



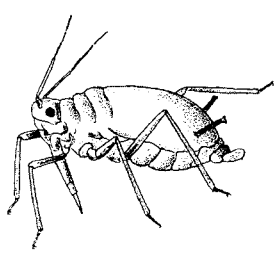
14B *Blatta orientalis*

15 Body extremely compressed (flattened from side to side) (15A)--------**fleas,** Siphonaptera

Body not compressed (may be depressed—flattened dorsoventrally—or roughly cylindrical) (15B) ---------- 16



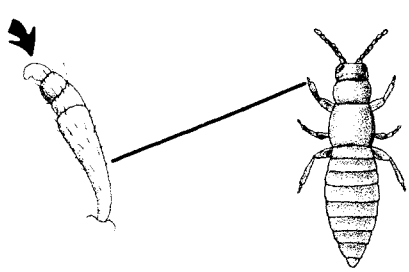
15A *Ctenocephalides felis*



15B aphid

16 Tarsus terminating in a protrusible bladder (16A) ----------**thrips,** Thysanoptera (in part)
FOR KEY TO THRIPS, SEE CHAPTER 23

Tarsus terminating in 1 or 2 claws (16B)---------- 17

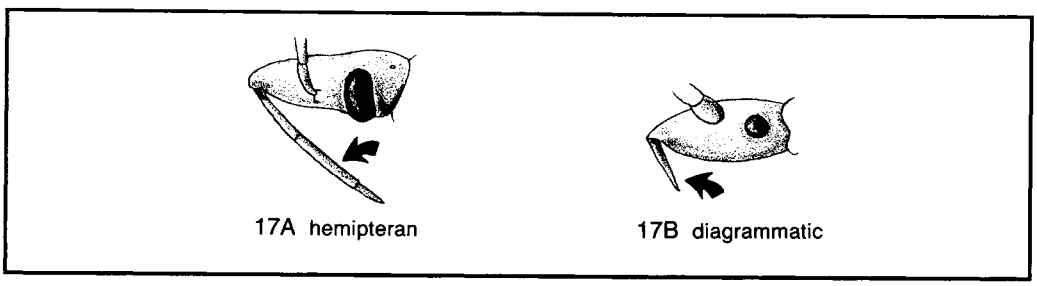


16A thrips

16B diagrammatic

17 Beak jointed (17A) ---------- 18
Beak not jointed (17B) ---------- 20

If the mouthparts appear to be retracted into the head (thus difficult to observe) and the tarsi have only one segment, go to couplet 20.



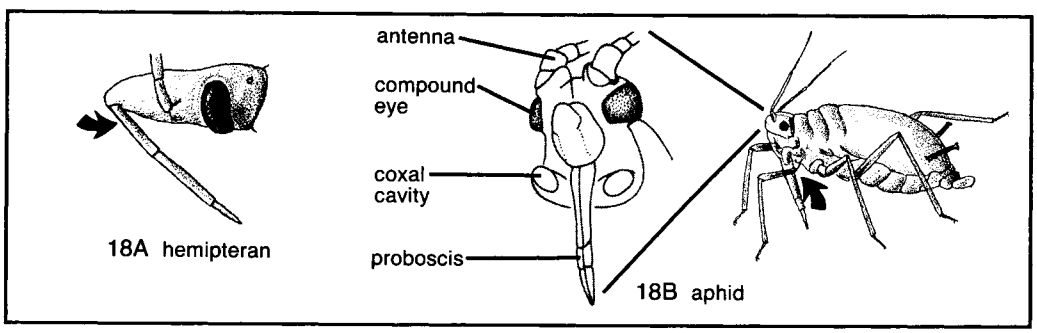
17A hemipteran

17B diagrammatic

18 Beak arising from front of head (18A) ---------- **true bugs,** Hemiptera (Heteroptera) (in part)

Beak arising from posteroventral part of head (18B). Hemiptera (Homoptera) (homopterans) (in part) ---------- 19

Drawing 18B-detail (head of *Myzus persicae*) by C. Feller.



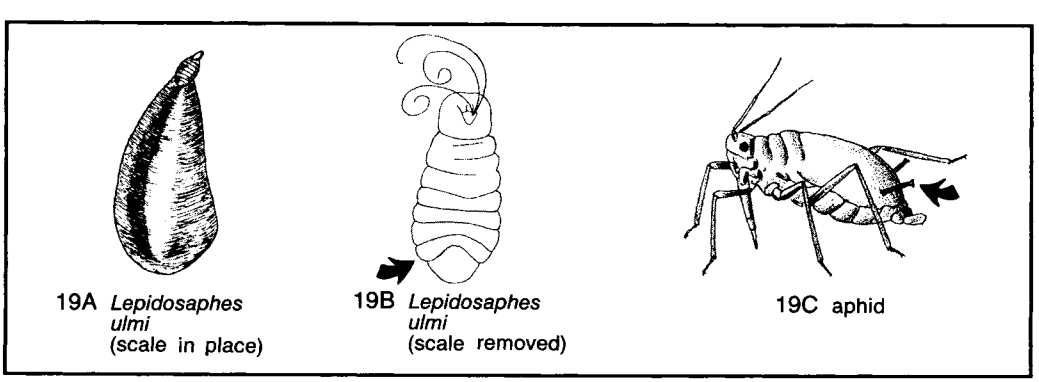
18A hemipteran

18B aphid

19 Body of female covered by scalelike structure (19A); cornicles absent (19B) ----------females, **scale insects,** Coccoidea
FOR KEY TO SCALES, SEE CHAPTER 25

Drawings 19A&B from *Microscopic-Analytical Methods in Food and Drug Control*, 1960.

Scalelike cover absent; cornicles present (19C) ----------**aphids,** Aphididae
FOR KEY TO APHIDS, SEE CHAPTER 24



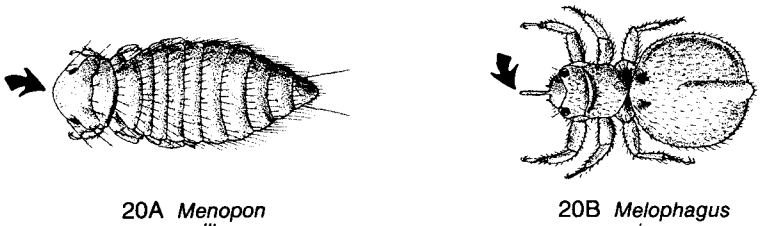
19A *Lepidosaphes ulmi* (scale in place)

19B *Lepidosaphes ulmi* (scale removed)

19C aphid

20 Mouthparts retracted into head (not protruding from front of head) (20A)
----------**sucking lice,** Anoplura

Mouthparts not retracted into head (20B). Diptera (flies) (in part)
----------**sheep ked,** *Melophagus ovinus*



20A *Menopon gallinae*

20B *Melophagus ovinus*

21 With 1 pair of wings (21A)---------- 22
With 2 pairs of wings (21B)---------- 23

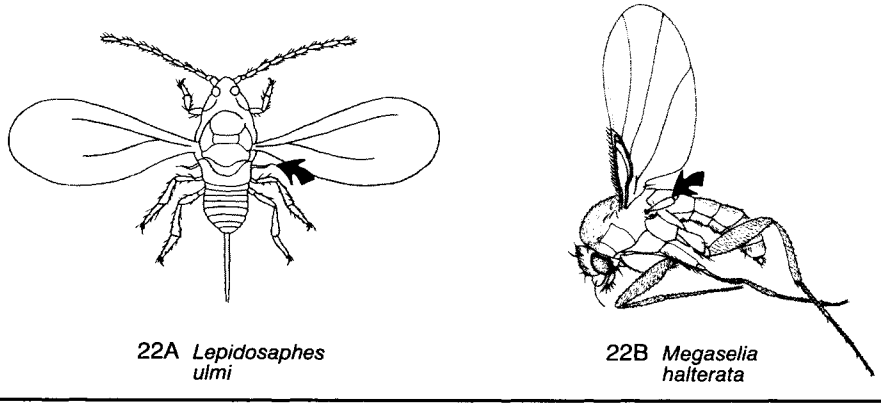
21A *Sarcophaga sarraceniae*

21B *Ostrinia nubilalis*

22 Vestigial hind wings (hamulohalterae) lanceolate (22A); mouthparts absent
----------males, **scale insects,** Coccoidea

Drawing 22A from *Microscopic-Analytical Methods in Food and Drug Control,* 1960; 22B by C. Feller.

Vestigial hind wings (halteres) capitate (22B); mouthparts present
----------**flies,** Diptera (in part)



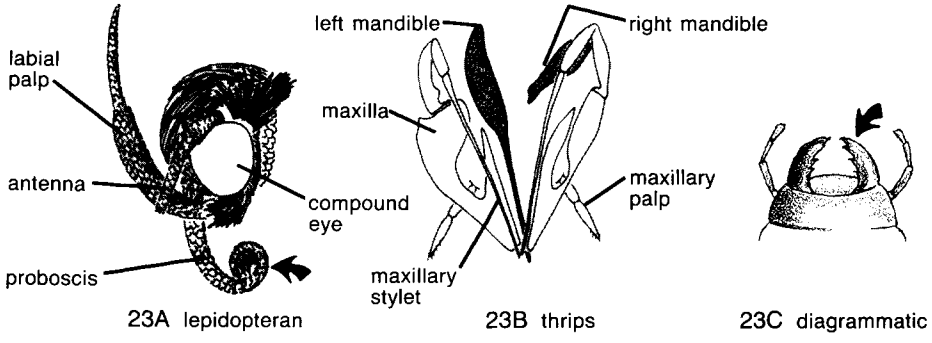
22A *Lepidosaphes ulmi*

22B *Megaselia halterata*

23 With sucking mouthparts (23A)---------- 24

The mouthparts of thrips (23B) are minute, complex, and difficult to see, but the absence of prominent, chewing-type mandibles is readily apparent, at least.
Drawings 23A&B by C. Feller.

With chewing mouthparts (23C)---------- 27

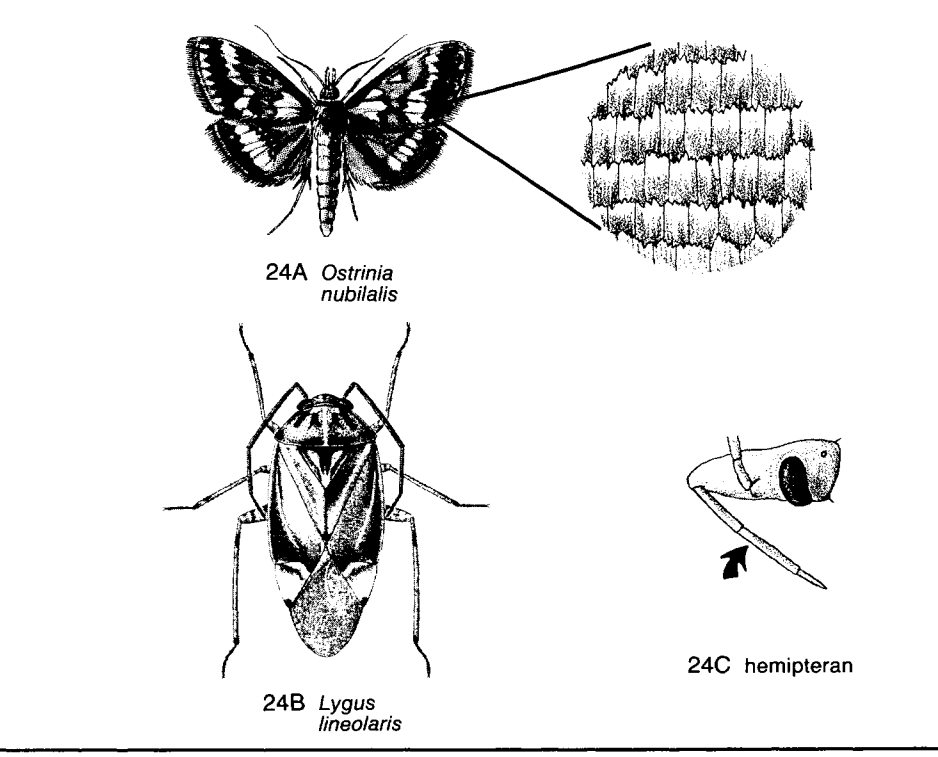


23A lepidopteran 23B thrips 23C diagrammatic

24 Wing densely covered with scales (24A); head with a coiled proboscis (see 23A)
----------**moths,** Lepidoptera
FOR KEY TO MOTHS, SEE CHAPTER 14

Wing not scaled (24B); proboscis not coiled (24C) ---------- 25

Drawing 24B by C. Feller.



24A *Ostrinia nubilalis*

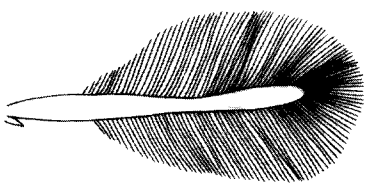
24B *Lygus lineolaris*

24C hemipteran

25 Wing with long fringe hairs (25A)----------**thrips,** Thysanoptera (in part)
FOR KEY TO THRIPS, SEE CHAPTER 23

Drawing 25A by C. Feller.

Long fringe hairs absent from wing (25B)---------- 26

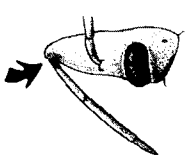


25A *Haplothrips graminis*

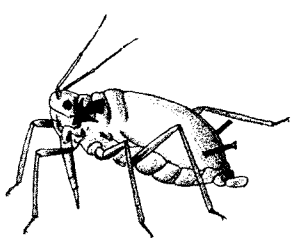
25B aphid

26 Beak arising from front of head (26A)---------**true bugs,** Hemiptera (Heteroptera) (in part)

Beak arising from posteroventral part of head (26B)
----------**leafhoppers, aphids,** etc., Hemiptera (Homoptera) (in part)
FOR KEY TO APHIDS, SEE CHAPTER 24



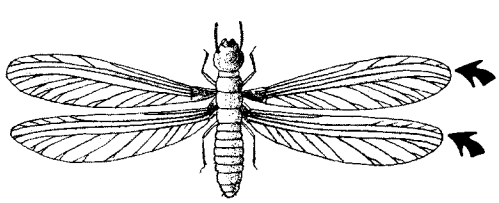
26A hemipteran



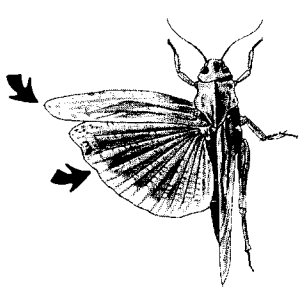
26B aphid

27 Front and hind wings membranous and similar in texture (may or may not be similar in size) (27A)---------- 28

Front and hind wings dissimilar in texture, the forewing leathery, horny, or paperlike, the hind wing membranous (27B) ---------- 29



27A termite (reproductive)

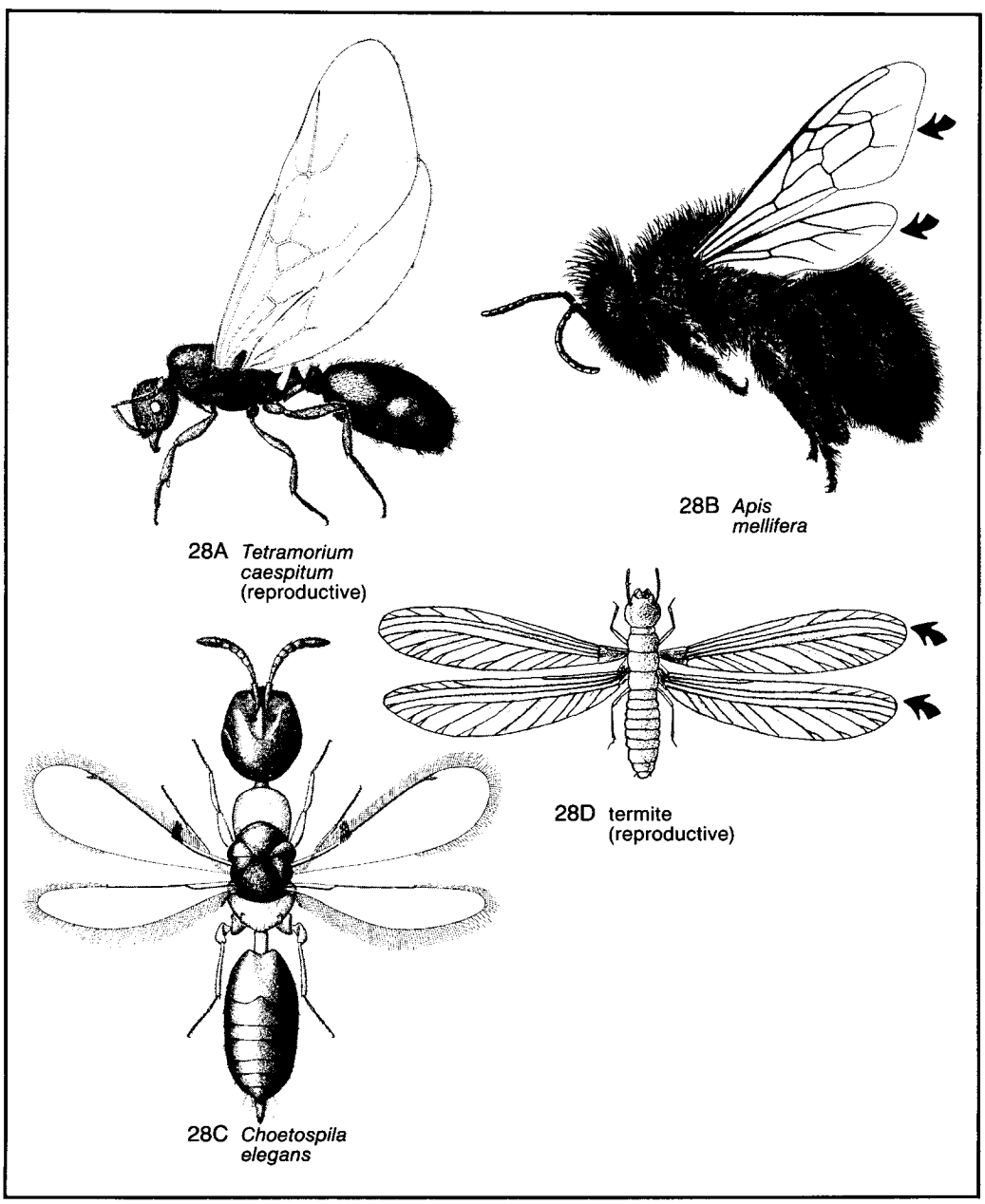


27B *Dissosteria carolina*

28 Hind wing much smaller than front wing (28A, 28B)
----------**ants, bees, wasps,** Hymenoptera (in part)
FOR KEY TO ANTS, SEE CHAPTER 17
FOR KEY TO PARASITIC WASPS, SEE CHAPTER 26

Hind wing usually shorter than front wing, but if front and hind wings are essentially similar in length (as in 28C), then the venation is greatly reduced. See also 3B, 10A, 11A-D.
Drawings 28A-C by C. Feller.

Front and hind wings similar in size (28D) ----------**termites,** Isoptera (in part)



28A *Tetramorium caespitum* (reproductive)

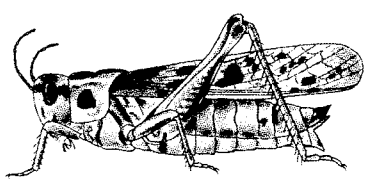
28B *Apis mellifera*

28C *Choetospila elegans*

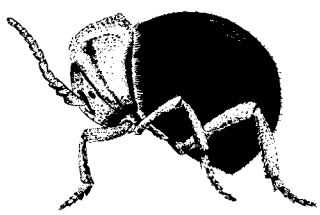
28D termite (reproductive)

29 Front wing leathery or paperlike, with distinct veins (29A)
---------- grasshoppers, cockroaches, etc., Orthoptera *s.l.* (in part)
FOR KEY TO COCKROACHES, SEE CHAPTER 2

Front wing horny or leathery, without distinct veins (but may be ridged) (29B)------ 30



29A *Camnula pellucida*



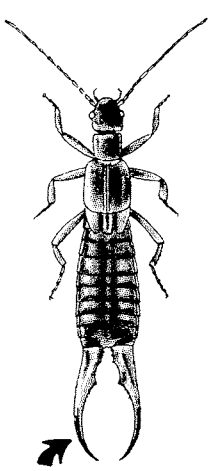
29B *Mezium americanum*

30 With forcepslike appendage at tip of abdomen ----------**earwigs,** Dermaptera (in part)

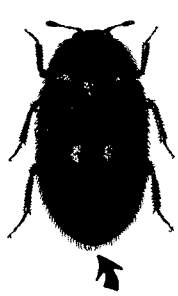
Wings always very much shorter than abdomen.

Without forcepslike appendage (30B)----------**beetles,** Coleoptera
FOR KEY TO BEETLES, SEE CHAPTER 3

If wings are abbreviated (as in Staphylinidae), then forceps are absent; wings commonly cover abdomen (30B) or nearly so (see 5C).



30A earwig



30B *Attagenus pellio*

Notes and Sketches

19 ORDERS OF LARVAL ENDOPTERYGOTA (INSECTA)[2]

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Identification of the larvae of the holometabolus insects is often more difficult than identification of the adults. Furthermore, when only incomplete or fragmentary specimens are available, the task is even more difficult and requires at the very least a considerable knowledge of insect morphology. Often, a knowledge of the life history of an insect lends credence to an identification based on an analytical key. Also, the overall habitus of a larva often identifies it as readily as one person recognizes another. Illustrations, keys, and descriptions in the existing literature, some of which is cited here (*1-16*), are often helpful aids to identification.

Certain morphological characters are a dead giveaway as to the identity of a larva, for example, the hastisetae of some dermestids or the three tarsal "claws" of blister beetle triungulins (Meloidae). Before advanced microscopic work was possible, these last structures were accepted as true claws (ungues) and from this feature the term "triungulin" was coined. Other larvae that resembled meloid triungulins, even though they had no claws or clawlike structures [for example, Strepsiptera and Rhipiphoridae (Coleoptera)], were also called triungulins (more properly, triungulinoids).

Larvae of the Holometabola are often divided into five or six types based on general body form. Thus, some are termed campodeiform (fig. 19.1A) because the form is basically that found in the genus *Campodea* (Campodeidae, order Diplura—formerly in Thysanura). Larvae of Meloidae (fig. 19.5) are good examples of the campodeiform habitus. Elateriform larvae (fig. 19.1B) resemble wireworms (Elateridae)—elongate, cylindrical, usually heavily sclerotized, with head capsule frequently somewhat flattened. Vermiform larvae (fig. 19.1C), as the name implies, are wormlike—elongate, often annulate, lacking legs, and usually having no distinct head. Flea larvae (Siphonaptera), even though they have a distinct head, and maggots (Diptera) are vermiform. Scarabaeiform larvae (fig. 19.1D) are C-shaped, usually stout-bodied (grublike), and resemble the white grubs of the beetle family Scarabaeidae. Eruciform larvae (fig. 19.1E; the term comes from the Latin stem *eruca* meaning caterpillar) are typical caterpillars with a distinct head, thoracic legs, and prolegs with crochets on some of the abdominal segments.

These terms for the various larval body types are also used to describe the successive larval stages of insects that undergo hypermetamorphosis (heteromorphosis). This is a remarkable process in which the larva assumes a different form at each succeeding molt. Hypermetamorphosis occurs primarily in parasitic insects of the orders Strepsiptera, Coleoptera (Meloidae, Rhipiphoridae), Diptera (Acroceridae, Bombyliidae, Nemestrinidae), Neuroptera (Mantispidae), and Hymenoptera (hypermetamorphosis in the last group is rather different from the kind summarized in the next few paragraphs).

Most hypermetamorphic insects start out as mobile, campodeiform larvae that actively seek out their hosts. Then they change into parasites at the first molt and often enter a scarabaeiform stage, a grublike form with legs, antennae, and other appendages greatly reduced. This is often followed by a coarctate stage somewhat like the dipteran puparium in being legless and covered by the heavily sclerotized cuticle of the larva. This stage is highly resistant to desiccation and other adverse environmental conditions. In the Meloidae there emerges from the coarctate form yet another larval stage that is brief and nonfeeding; this is followed by true pupation and eventual emergence of the adult.

Strepsipteran, rhipiphorid, and meloid triungulins are included here because they may become accidentally entrapped in honey or because they are associated with pollen or flowers that may be used as or used in human food. How they might come to be there may be deduced from their life histories. Strepsipteran triungulins apparently ride the host bee to its nest from whatever flowers it happens to visit. Meloid triungulins (except those that attack grasshopper eggs) and rhipiphorid triungulins hatch from eggs deposited on or near flower blossoms. When a bee visits the flower, the triungulins attach themselves to the bee and ride back to the nest where they dispose of the host's egg and any other competition, molt into a different stage and subsist on pollen and honey. Honeybees (*Apis mellifera*) are merely accidental, dead-end hosts. The life cycles of triungulins can be successfully completed only if the larvae find the right species of various flower-visiting, solitary or semisocial bees (Andrenidae, Anthophorinae, Colletinae, Halictidae, and Hylaeinae).

[2]Excluding Neuroptera *sens. lat.*, Mecoptera, and Trichoptera.

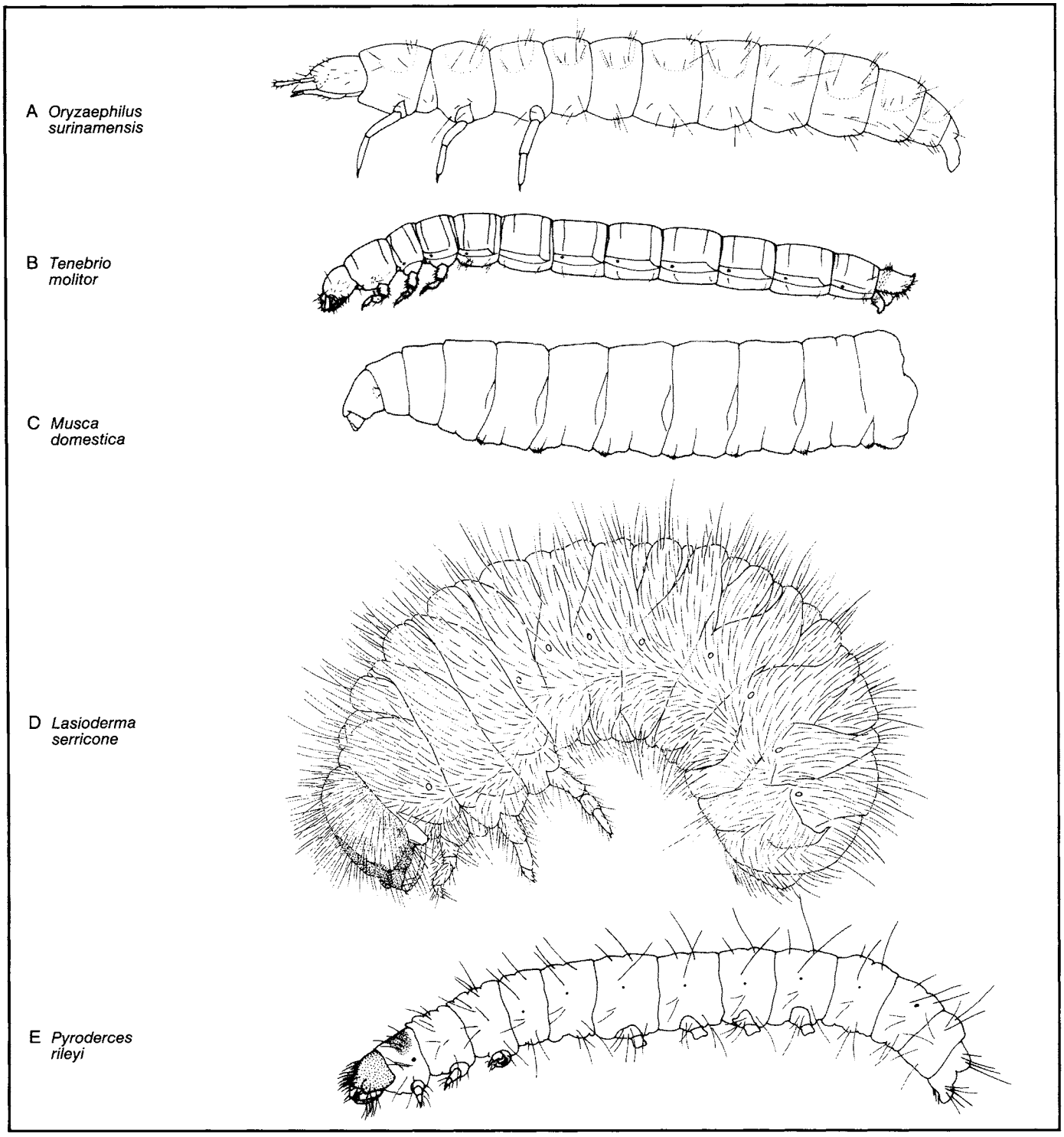


Figure 19.1. Types of insect larvae. A, campodeiform; B, elateriform; C, vermiform; D, scarabaeiform; E, eruciform. (Drawings by C. Feller.)

This is, of course, a most precarious way to make a living. Larval mortality in these groups is, therefore, exceedingly high. These insects have developed an effective way to overcome high mortality: The production of enormous numbers of eggs and larvae per female. For example, over 3,000 larvae have been recorded from a single female strepsipteran.

Any source of flower heads or pollen for use in studies such as on allergies, food fads, and flavorings could readily be contaminated by these larvae. The probability of finding them in food, however, remains extremely low.

The following key to selected orders of immature insects also includes certain infraordinal taxa (*Fannia, Eristalis,* Stratiomyidae, Rhipiphoridae, Meloidae) because the different members of a given order are so highly variable that it is impossible to bring them all out at the same point in the key. Only the first stage larvae (triungulins) of Strepsiptera, Meloidae, and Rhipiphoridae are included in this key. The characters of the other taxa treated here refer to the last larval instar. A further caution should be mentioned here, namely, that this is not a comprehensive key to the insect orders. It is distinctly biased toward those insects that are pests of stored food, are parasites of stored-food pests, or are in some other way associated with food.

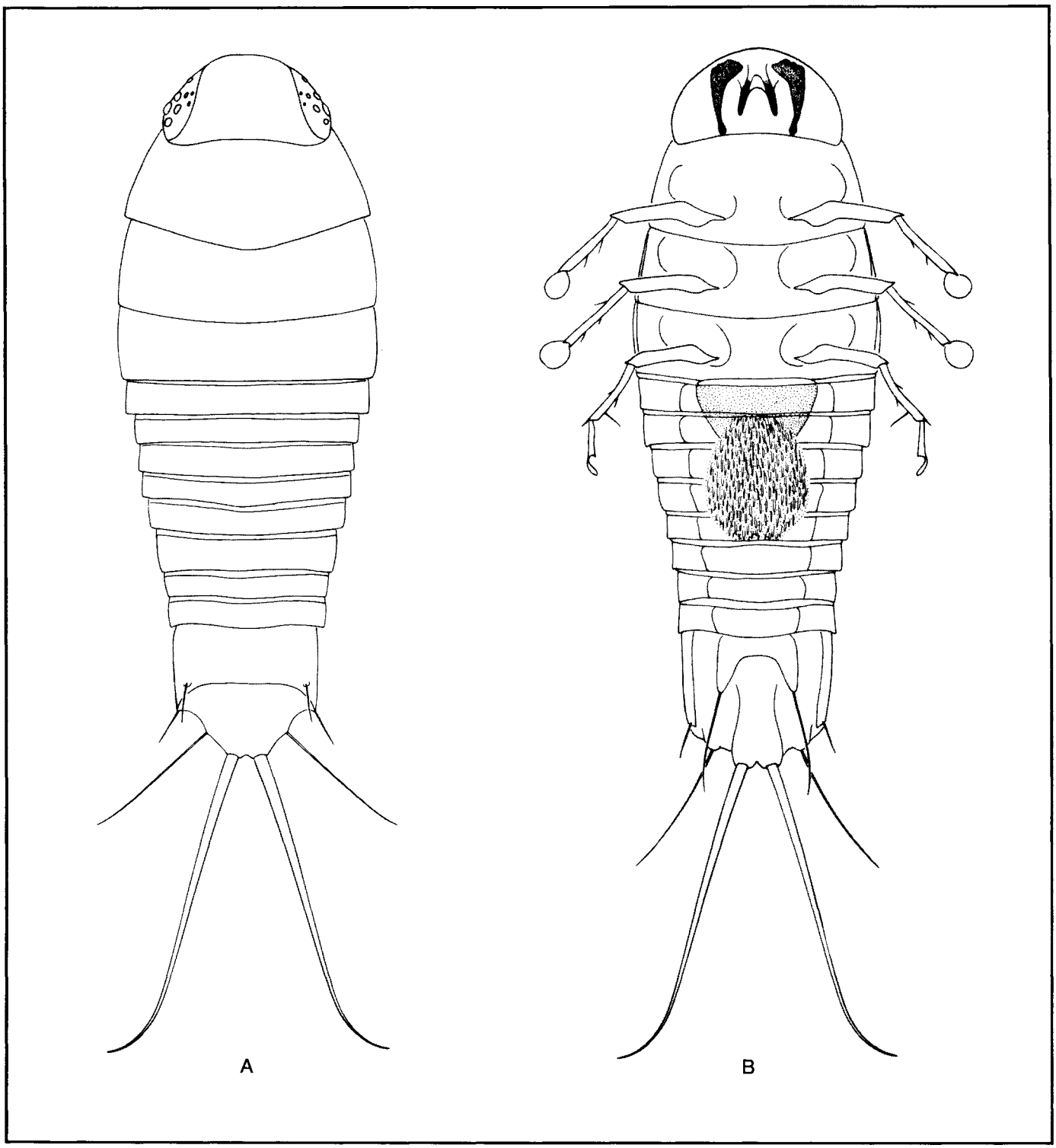


Figure 19.2. *Xenos peckii* Kirby (Stylopidae, Strepsiptera), triungulin: A, dorsal view; B, ventral view. (Drawings by C. Feller.)

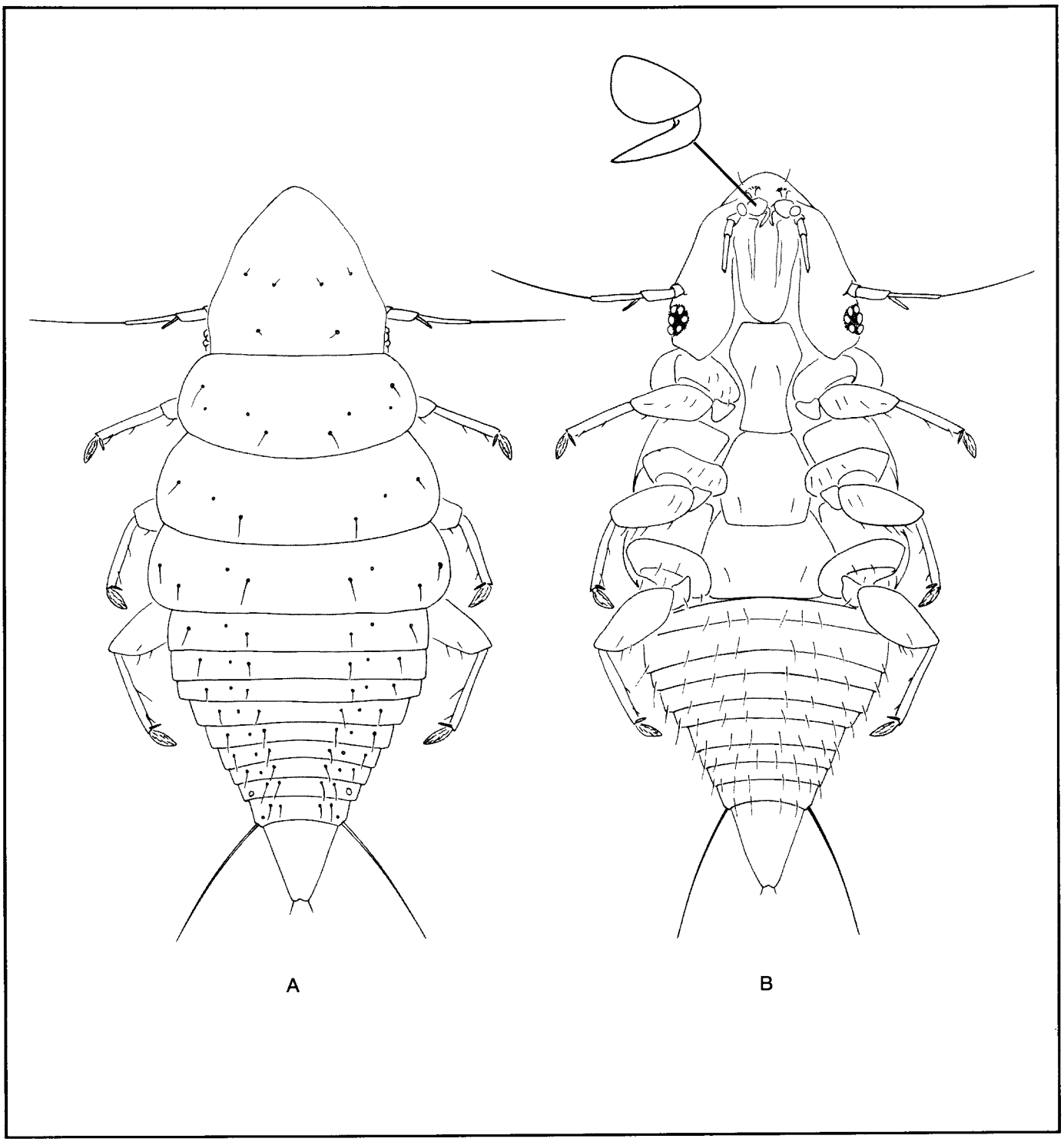


Figure 19.3. Triungulin larva of a wedge-shaped beetle (Rhipiphoridae): A, dorsal view; B, ventral view, with detail of right mandible. (Drawings by C. Feller.)

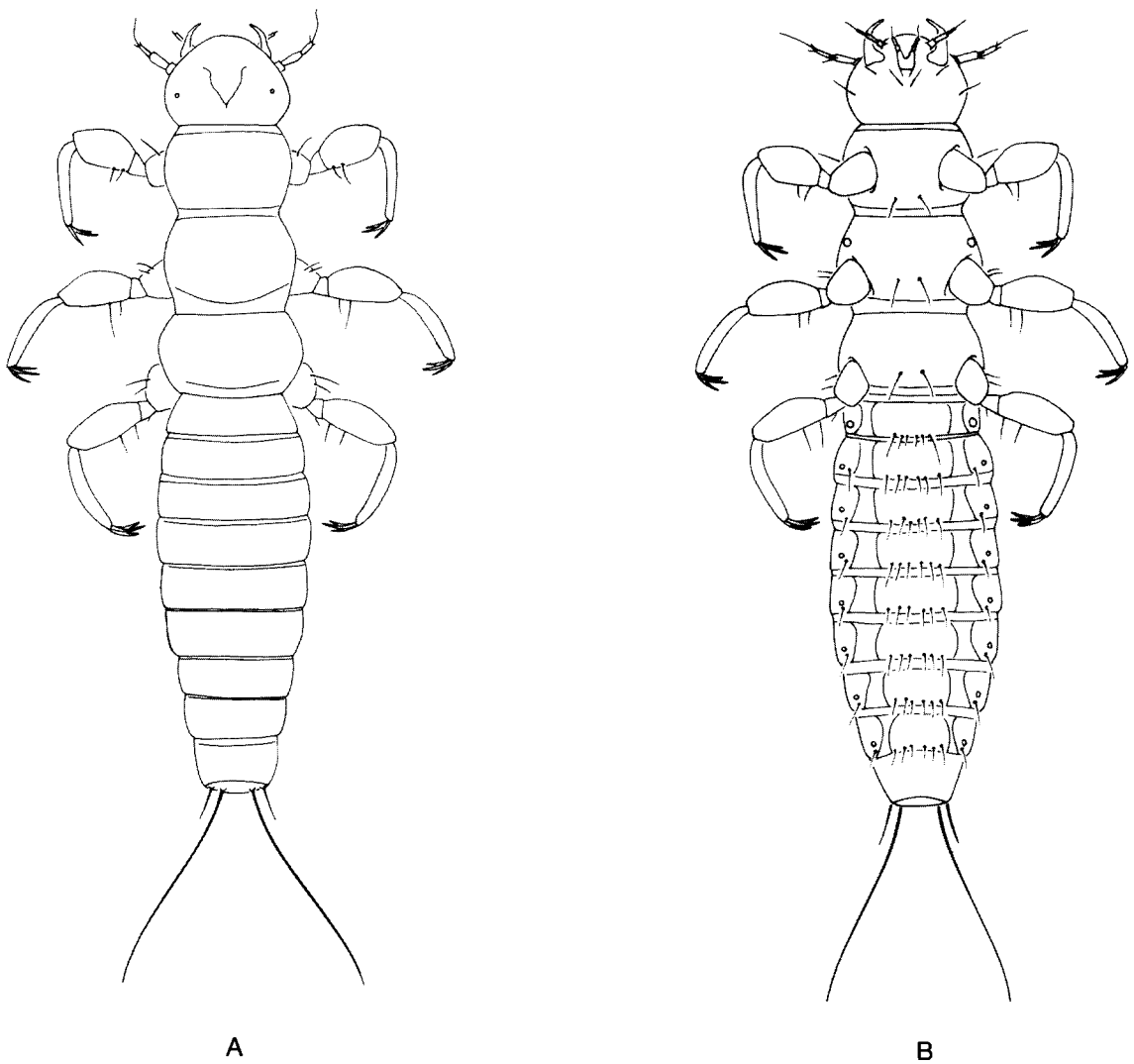


Figure 19.4. Triungulin larva of *Meloe* sp. (Meloinae, Meloidae): A, dorsal view; B, ventral view. (Drawings by C. Feller.)

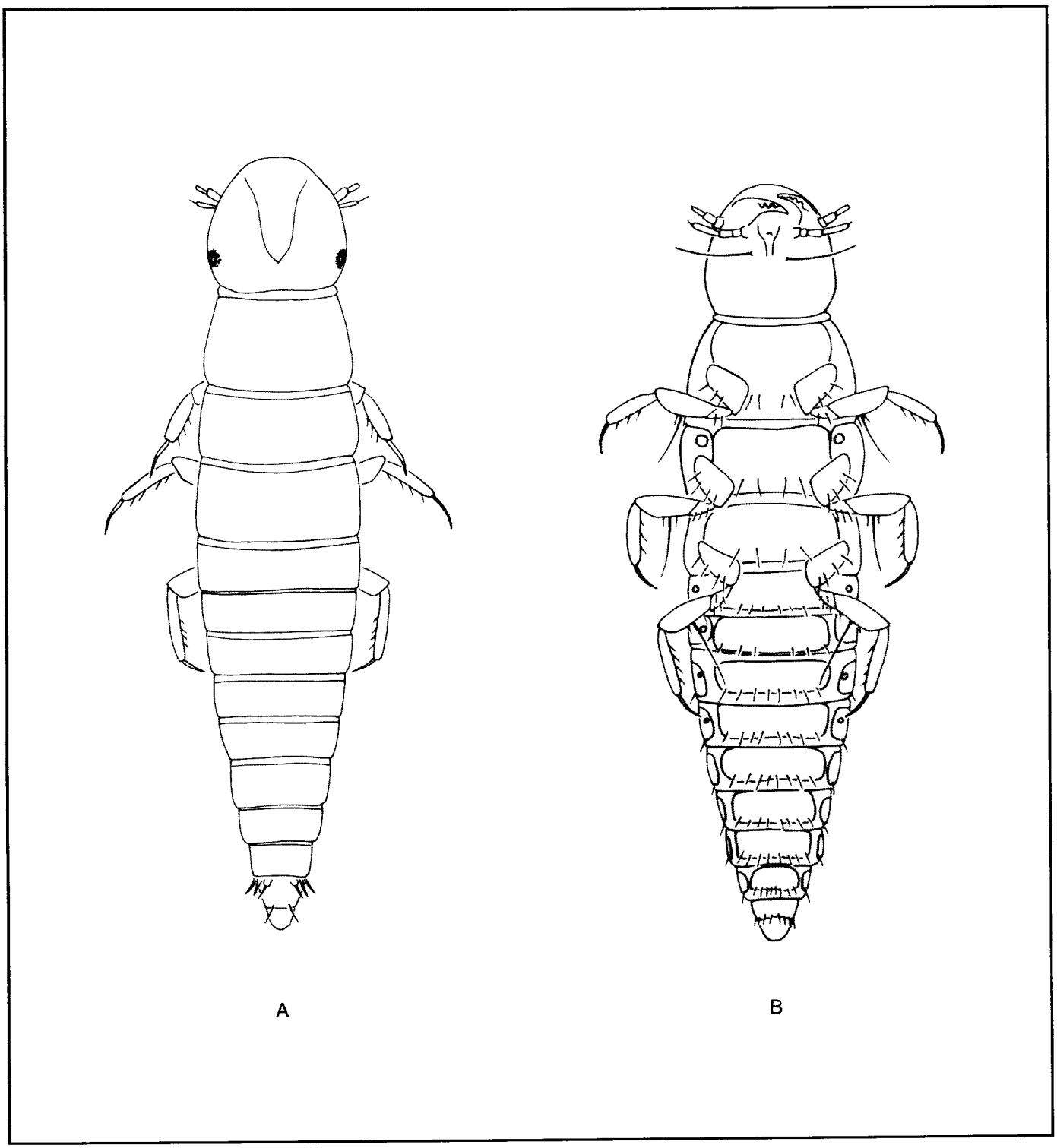


Figure 19.5. Nemognathine triungulin (Nemognathinae, Meloidae): A, dorsal view; B, ventral view. (Drawings by C. Feller.)

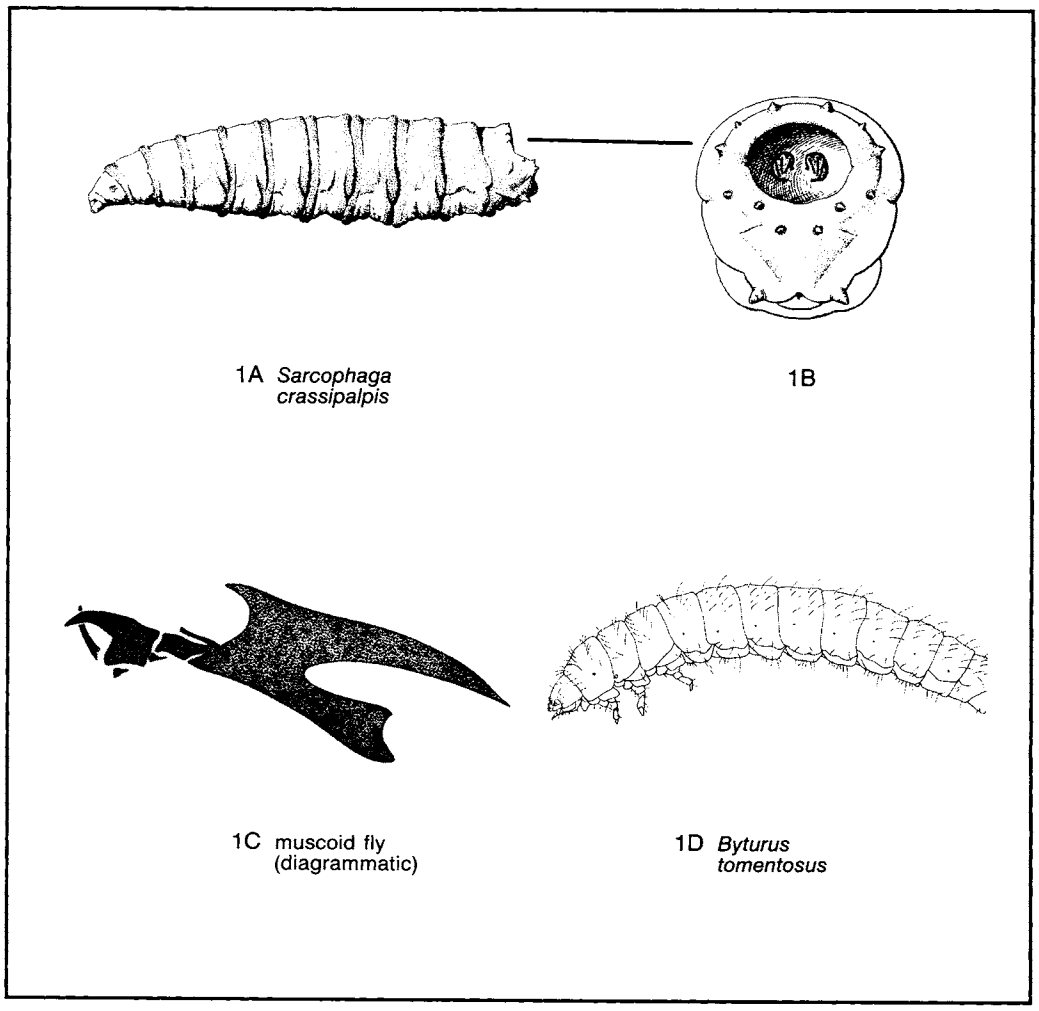
KEY
Drawings by C. Feller unless otherwise noted.

1 Typical maggots (1A); body tapering to a subacute head; posterior end somewhat truncate with 2 spiracles on posterior aspect (1B); mouthparts consisting of mouth hooks and internal pharyngeal sclerites (1C)----------**flies,** Diptera (in part)
SEE CHAPTER 16

Body circular in cross section (1B); prolegs absent; head capsule unsclerotized (1A) or only weakly sclerotized.
Drawings 1A&B by A.D. Cushman.

Not typical maggots (1D); body not tapered anteriorly; posterior end not truncated; spiracles not present on posterior aspect of posterior end; mouthparts not consisting of mouth hooks and internal pharyngeal sclerites---------- 2

Body round, oval, or flattened in cross section; mouthparts may be absent or vestigial; prolegs may be present or absent.



1A *Sarcophaga crassipalpis*

1B

1C muscoid fly (diagrammatic)

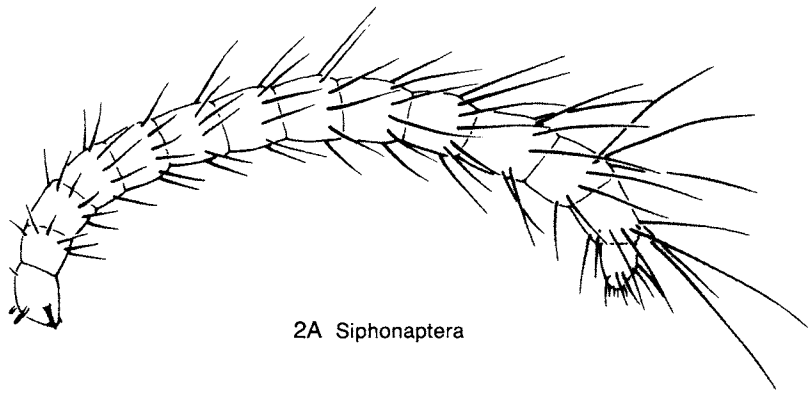
1D *Byturus tomentosus*

2 Each thoracic and abdominal segment with several long setae (2A); abdominal apex with a pair of short, subanal processes----------**fleas,** Siphonaptera

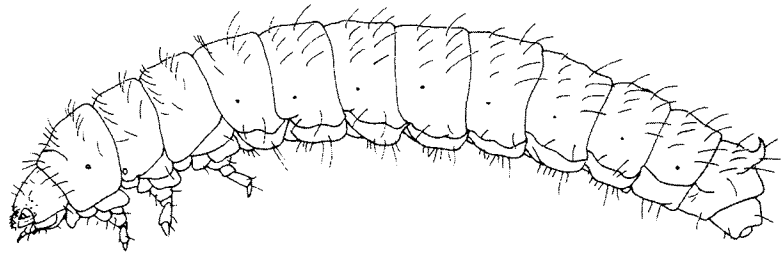
Body vermiform, very slender and elongate, usually less than 10 mm in length; antennae and mouthparts visible; legs and prolegs absent.

Long setae absent from some or all thoracic and abdominal segments (2B); abdominal apex without a pair of short, subanal processes---------- 3

Body may or may not be vermiform, but if so, then it is not as slender as in 2A; length usually more than 10 mm; legs and prolegs usually present; if prolegs are absent, then body form is not vermiform.



2A Siphonaptera



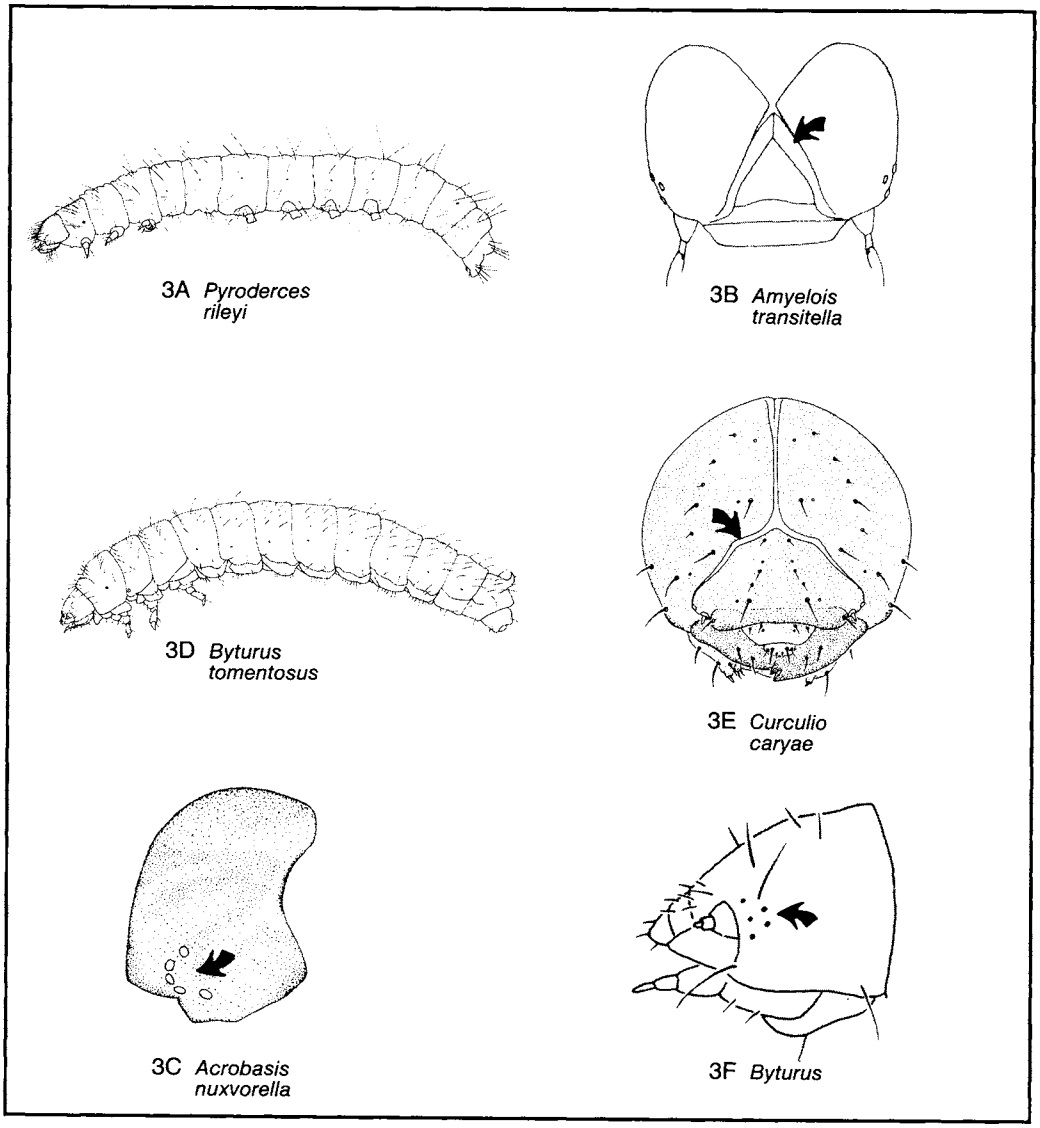
2B *Byturus tomentosus*

3 Larva eruciform (3A); adfrontal areas present (3B); prolegs and/or crochets on abdominal segments V and VI (3A); apical abdominal segments not comprising an elongate, contractile tube (3A)----------**moths,** Lepidoptera
SEE CHAPTER 15

Simple eyes (ocelli or stemmata) present, often arranged in a semi circle (3C); typical mouthparts present and visible; prolegs or crochets may also be present on abdominal segments III, IV, and XI.

Larva not eruciform (3D); adfrontal areas absent (3E); prolegs and/or crochets absent from abdominal segments V and VI, or if present on V and VI, then apical abdominal segments comprising a slender, elongate, contractile tube (see 6A)- 4

Simple eyes, if present, usually not arranged in a semicircle (3F); mouthparts variable.



3A *Pyroderces rileyi*

3B *Amyelois transitella*

3D *Byturus tomentosus*

3E *Curculio caryae*

3C *Acrobasis nuxvorella*

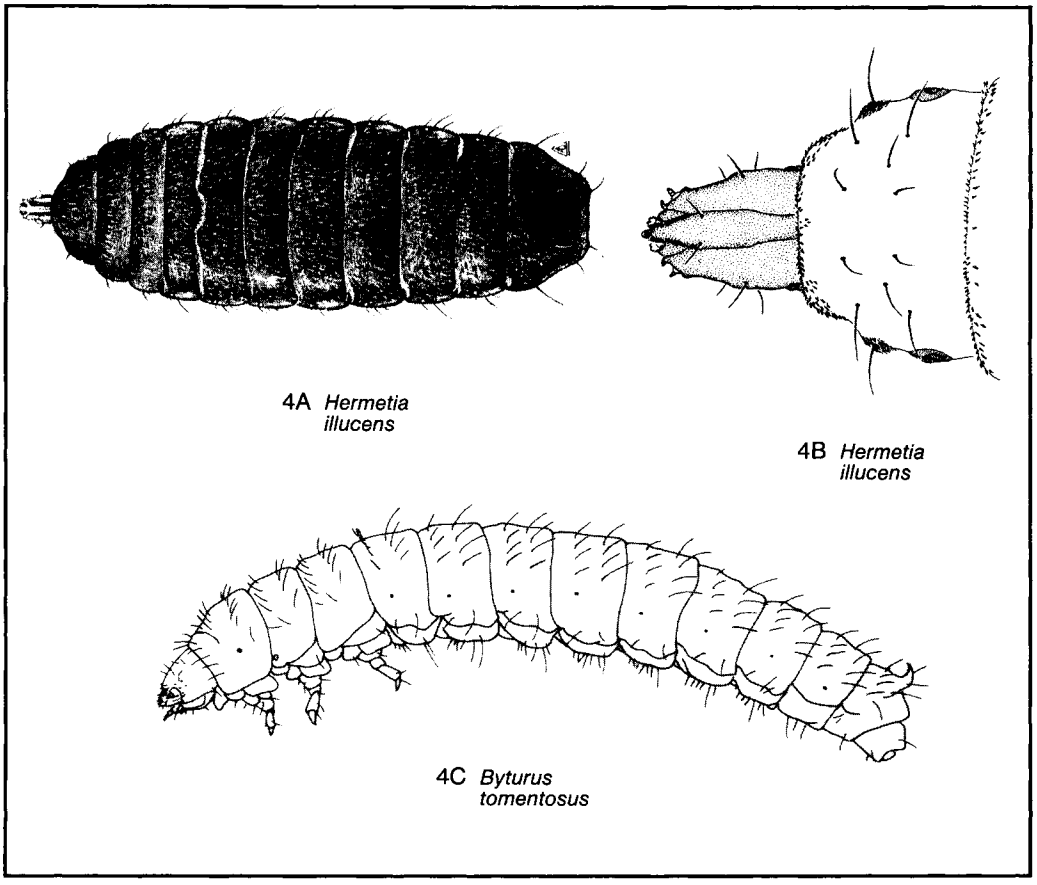
3F *Byturus*

4 Body surface rough, shagreened (4A). Diptera (**flies**) (in part)
----------**soldier flies,** Stratiomyidae

Head capsule heavily sclerotized (4B); body depressed and elongate, without dorsal and lateral spinelike processes and without elongate and contractile posterior abdominal segments (4A); mandibles inconspicuous (vestigial or absent), but mouthparts in general not reduced to fleshy remnants; thoracic legs absent. CAUTION: Other fly larvae (all much smaller than *Hermetia illucens*) with definite head capsules (but without a rough, shagreened body surface)—Scatopsidae, Psychodidae, Sciaridae, Scenopinidae—should be taken out at this point and referred to Chapter 16.

Body surface not rough or shagreened (4C)---------- 5

Head capsule may or may not be sclerotized (if sclerotized, then thoracic legs usually present); body not depressed; or body depressed but not elongate (as in *Murmidius ovalis*); or body elongate with dorsal and lateral spinelike processes (see 5A); or body elongate without dorsal and lateral spinelike processes but with posterior abdominal segments elongate and contractile (see 6A); thoracic legs present or absent (if absent, then mandibles either conspicuous or mouthparts in general reduced to fleshy remnants).



4A *Hermetia illucens*

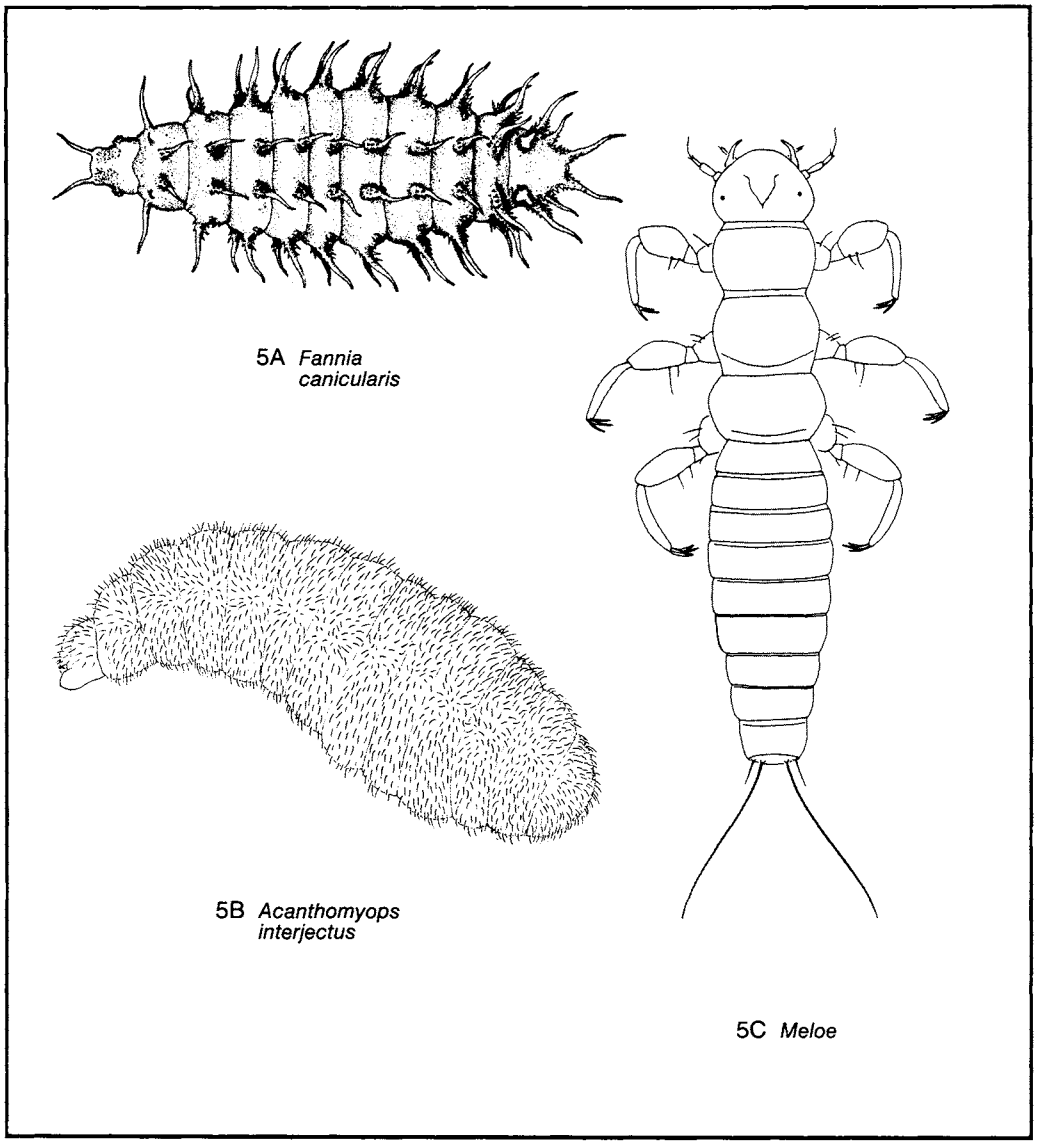
4B *Hermetia illucens*

4C *Byturus tomentosus*

5 Body moderately depressed (not saclike, minute, or campodeiform; not round in cross section), bearing spiny or fleshy processes or tubercles dorsally and laterally (5A); apical abdominal segments not elongate and contractile. Diptera (**flies**) (in part) ----*Fannia*
SEE CHAPTER 16

Head capsule minute, weakly developed. CAUTION: Some species of Phoridae also have dorsal and lateral lobes; see Chapter 16.
Drawing 5A from 9.

Body round in cross section (posterior abdominal segments may be elongate and contractile) (see 6A); or body saclike (5B); or body minute and campodeiform (5C)---- 6



5A *Fannia canicularis*

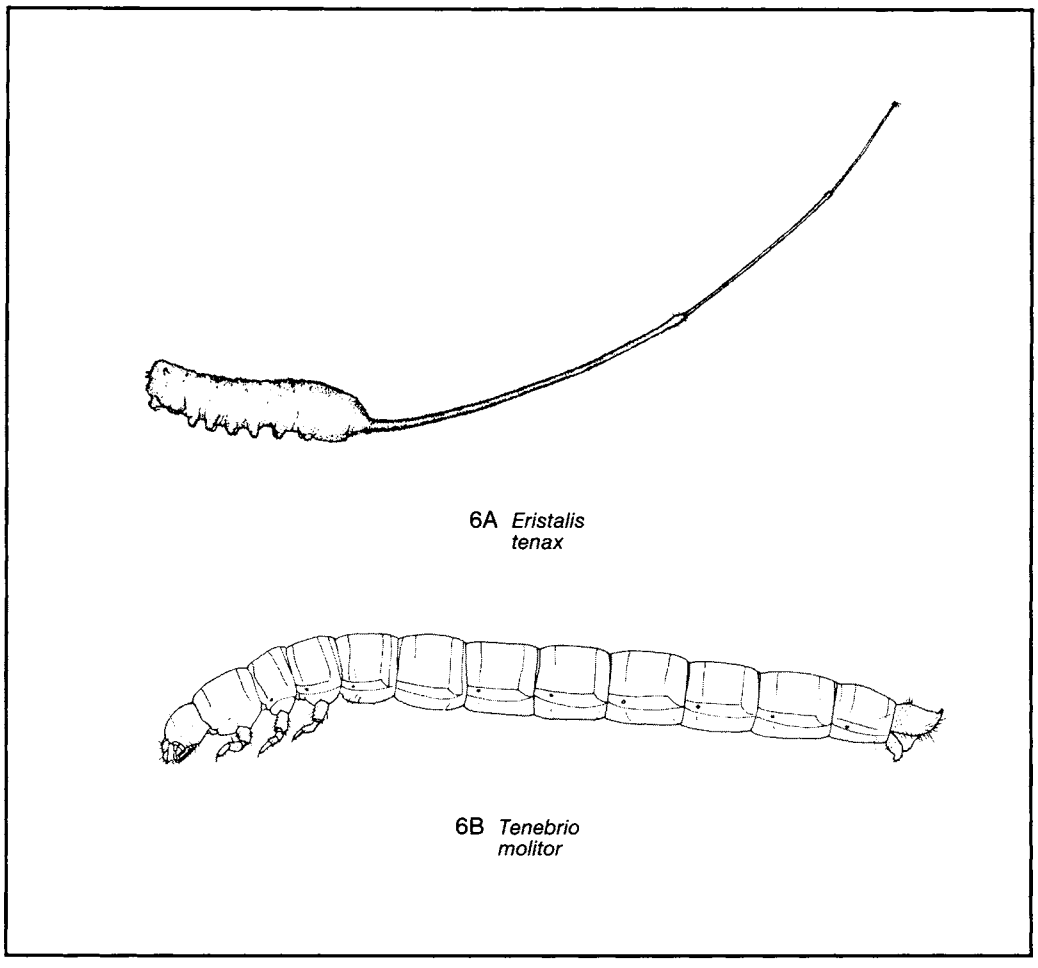
5B *Acanthomyops interjectus*

5C *Meloe*

6 Posterior end of abdomen extended into a slender, 3-segmented, elongate, contractile breathing tube (6A). Diptera (**flies**) (in part). Syrphidae (**flower flies**)----------*Eristalis*
SEE CHAPTER 16

CAUTION: Some fly larvae in the families Drosophilidae, Psychodidae, and Sepsidae have tubelike, posterior abdominal extensions; see Chapter 16.

Posterior end of abdomen not tubelike (6B)---------- 7



6A *Eristalis tenax*

6B *Tenebrio molitor*

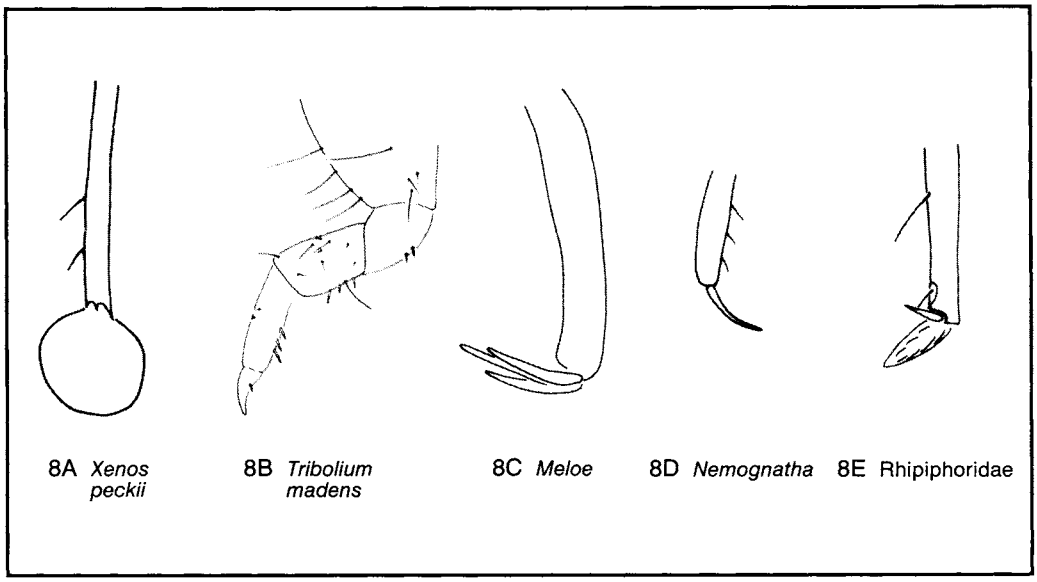
7 Thoracic legs present (as in 6B)---------- 8
Thoracic legs absent (as in 12A) or vestigial (as in 12C)---------- 12

8 Tarsi I and II consisting of short or long bristles or of pulvilliform pads (8A) ----------twisted-wing parasites, Strepsiptera

Minute campodeiform larvae (fig. 19.2)—larval body straight, not hypognathous (length usually less than 1 mm, often less than 0.5 mm); antennae and mouthparts vestigial or absent (fig. 19.2B); trochanters absent (fig. 19.2B) (trochanters are absent in all stages that exhibit legs); one pair of very long caudal setae present (fig. 19.2).

Tarsi either appearing typically coleopteran in form (8B) or consisting only of clawlike structures (8C, 8D, 8E)---------- 9

Larger larvae (length greater than 1 mm) of variable form (figs. 19.2-19.5)—campodeiform, scarabeiform, elateriform; mouthparts usually well developed and evident; trochanters usually present; long caudal setae present (fig. 19.4) or absent (fig. 19.5).



8A *Xenos peckii* 8B *Tribolium madens* 8C *Meloe* 8D *Nemognatha* 8E Rhipiphoridae

9 Tarsus distinct, with 1 or 2 claws evident (see 8B)----------**beetles,** Coleoptera (in part) SEE CHAPTER 4

Body form variable; caudal tufts of setae sometimes present. See also 3E&F, 4C, 12C.

Tarsus highly modified (see 8C-E). Coleoptera (**beetles**) (in part)---------- 10

Larva a campodeiform triungulin (larval body straight, not hypognathous); antennae and mouthparts well developed; caudal tufts absent; 1 or 2 pairs of caudal setae present; body length greater than 0.5 mm, ranging up to 3.5 mm.

10 With 3 or more pairs of ocelli (fig. 19.3B); labial palp absent (fig. 19.3B) ----------wedge-shaped beetles, Rhipiphoridae

Gula extremely short (almost absent); tarsus with pulvillus and minute claw (claw much shorter than pulvillus) (see 8E).

With 1 or 2 pairs of ocelli (fig. 19.4A); labial palp present (fig. 19.4B). Meloidae (**blister beetles**) ---------- 11

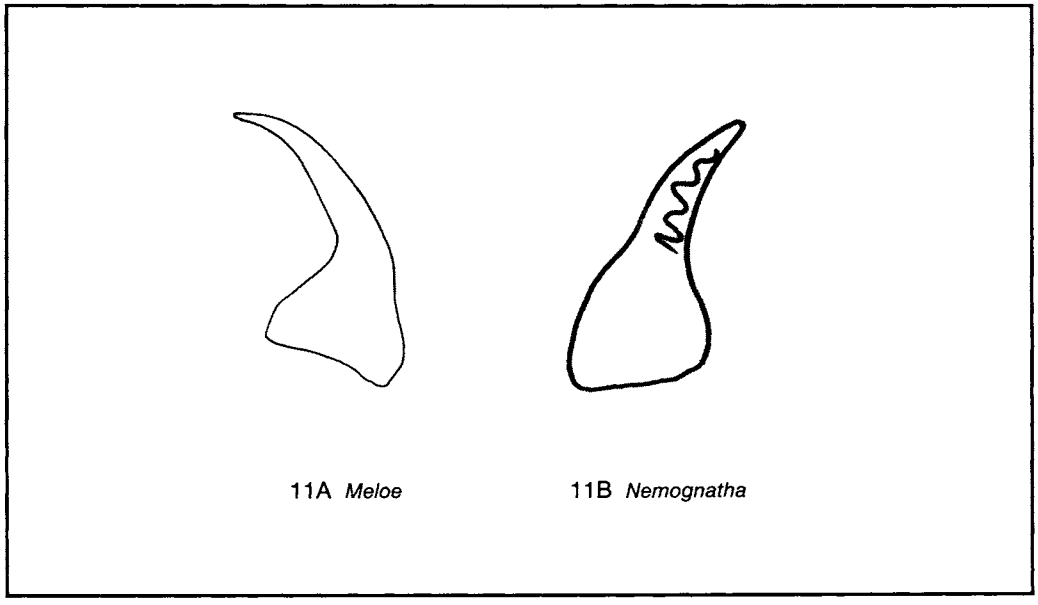
Gula well developed; labial palp 2-segmented; tarsus composed either of a single claw (see 8D) or of a strong claw bracketed by 2 strong setae, giving a 3-clawed appearance (see 8C).

11 Mandible entire (11A) or with toothlike emarginations. Meloinae (meloine blister beetles); fig. 19.4 ----------*Meloe*

With 1 pair of ocelli (fig. 19.4A). See also 8C.

Mandible with 2 or more prominent, toothlike ridges (11B); fig. 19.5 ----------nemognathine blister beetles, Nemognathinae

With 1 or 2 pairs of ocelli (fig. 19.5A). See also 8D.

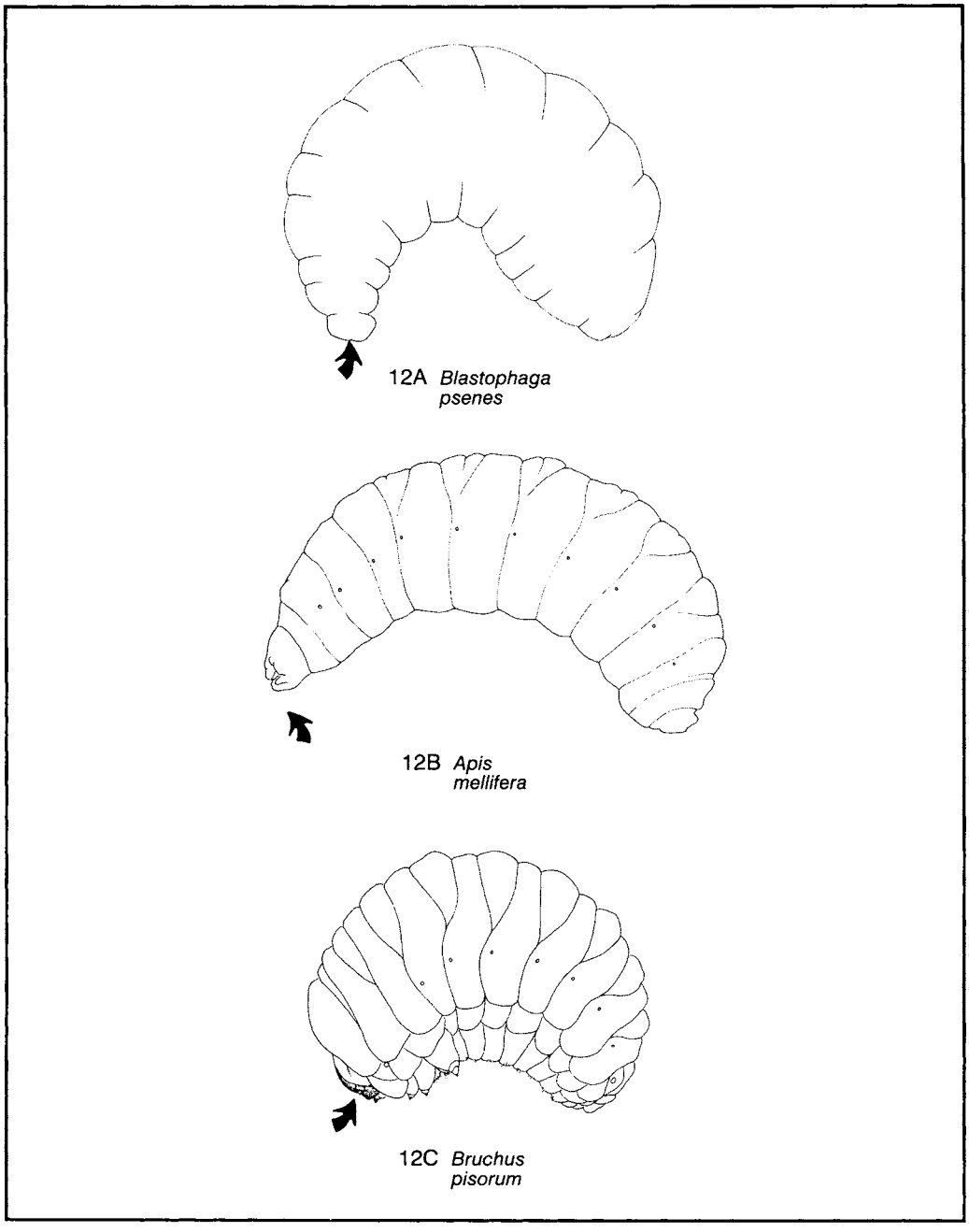


11A *Meloe* 11B *Nemognatha*

12 Head capsule unsclerotized or only weakly sclerotized (12A, 12B); mouthparts reduced to fleshy remnants or weakly sclerotized mandibles
----------**ants, bees, wasps,** Hymenoptera

See also 5B.

Head capsule well sclerotized, with distinct mouthparts (12C)
----------**beetles,** Coleoptera (in part)
SEE CHAPTER 4



12A *Blastophaga psenes*

12B *Apis mellifera*

12C *Bruchus pisorum*

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20 SPRINGTAILS (COLLEMBOLA)

Harold George Scott

4 Pats Place
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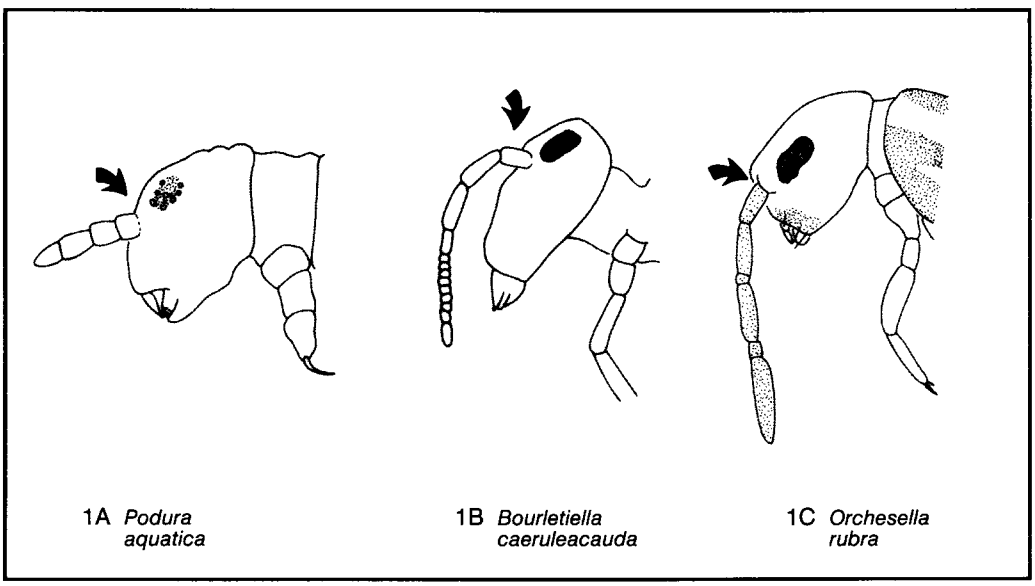
KEY

Drawings by C.J. Stojanovich and C. Feller unless otherwise noted.

1 Antenna inserted at, just before (1A), or distinctly behind (1B) middle of head ----- 2
Antenna inserted well forward on anterior half of head (1C)---------- 3

This key is based on *8* and *14*. See couplet illustration 11A for selected anatomical details.



1A *Podura aquatica*

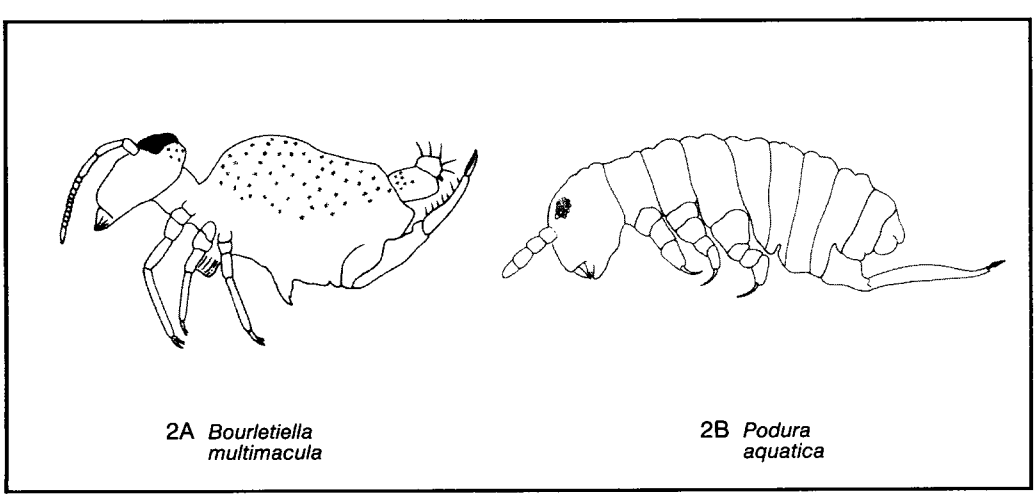
1B *Bourletiella caeruleacauda*

1C *Orchesella rubra*

2 Body globular (2A)----------Suborder Symphypleona

Species of this suborder have not been reported from stored foods.

Body elongate (2B). Suborder Metaxypleona---------- 4



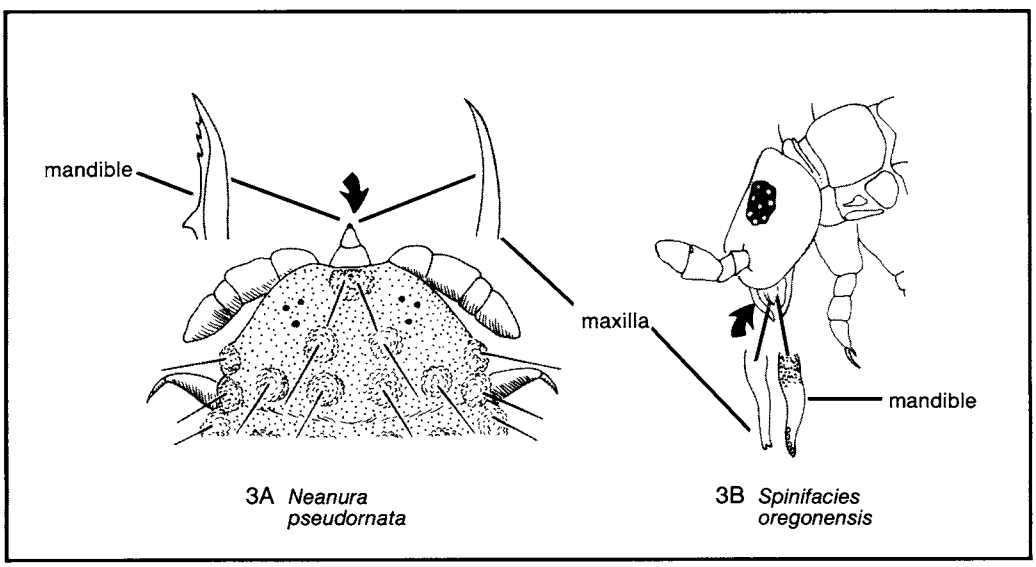
2A *Bourletiella multimacula*

2B *Podura aquatica*

3 Mouthparts conelike (3A)---------- Suborder Neoarthropleona

Species of this suborder have not been reported from stored foods.

Mouthparts not conelike (3B). Suborder Arthropleona ---------- 5



3A *Neanura pseudornata*

3B *Spinifacies oregonensis*

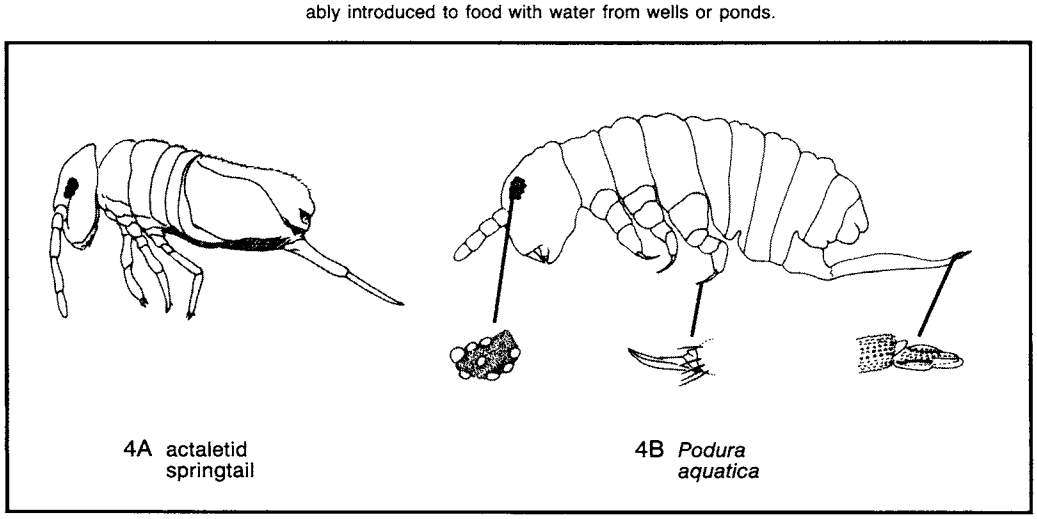
Suborder Metaxypleona

4 Abdomen with 4 or 5 apparent segments (4A)---------- actaletid springtails, Actaletidae

Species of this family have not been reported from stored foods.

Abdomen with 6 apparent segments (4B). Poduridae (podurid springtails) ---------- *Podura aquatica*

Distribution: cosmopolitan on freshwater surfaces; probably introduced to food with water from wells or ponds.



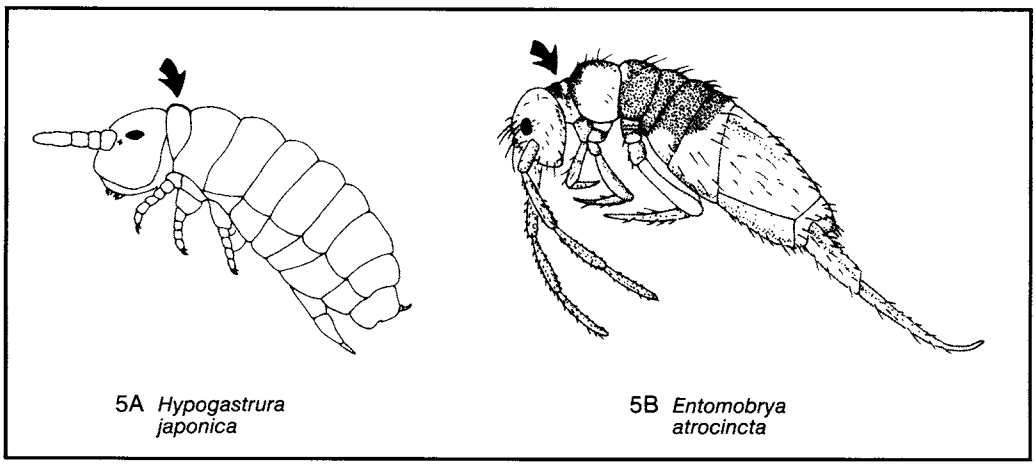
4A actaletid springtail

4B *Podura aquatica*

Suborder Arthropleona

5 Pronotum well developed (5A). Superfamily Hypogastruroidea (hypogastruroid springtails)---------- 6

Pronotum reduced (5B). Superfamily Entomobryoidea (entomobryoid springtails)-------- 10



5A *Hypogastrura japonica*

5B *Entomobrya atrocincta*

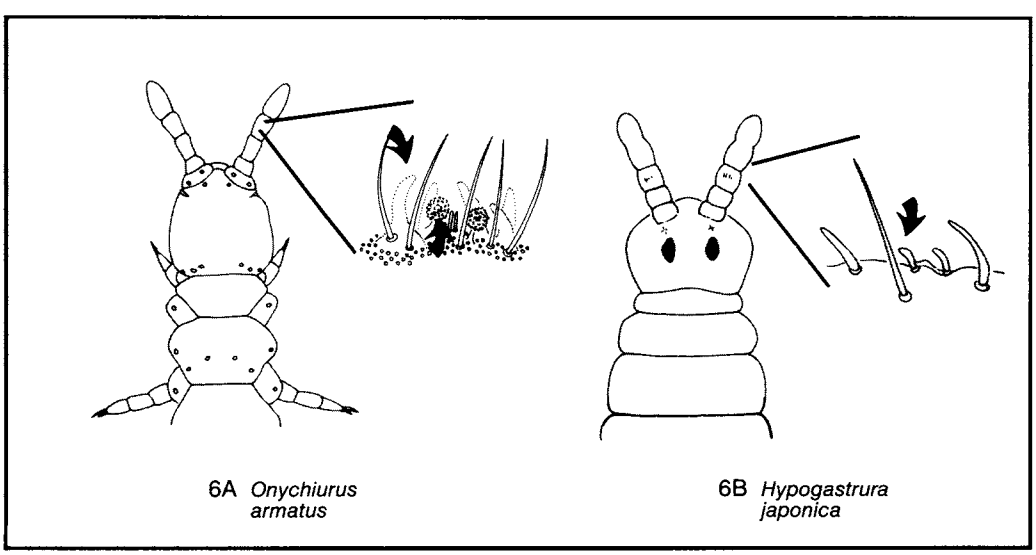
6 Sense organ on antennal segment III with rods and cones (6A). Onychiuridae (onychiurid springtails) ---------- 7

Eyes absent (6A).

Detail of sense organ redrawn by C. Feller from *EB07* (see chapter 28).

Sense organ on antennal segment III with rods only (6B). Hypogastruridae (hypogastrurid springtails) ---------- 8

Eyes usually present (6B).



6A *Onychiurus armatus*

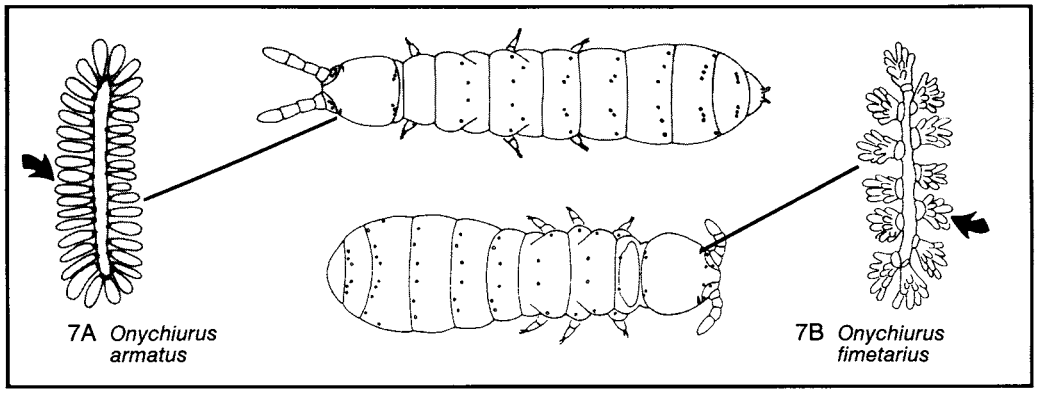
6B *Hypogastrura japonica*

7 Postantennal organ with simple vesicles (7A)----------*Onychiurus armatus*

Distribution: cosmopolitan; reported from indoor flower pots (*6*) and as a common domestic species (*18*). See also 6A.

Postantennal organ with compound vesicles (7B)----------*Onychiurus fimetarius*

Distribution: cosmopolitan; reported from indoor flower boxes (*6*) and as a common domestic species (*18*).



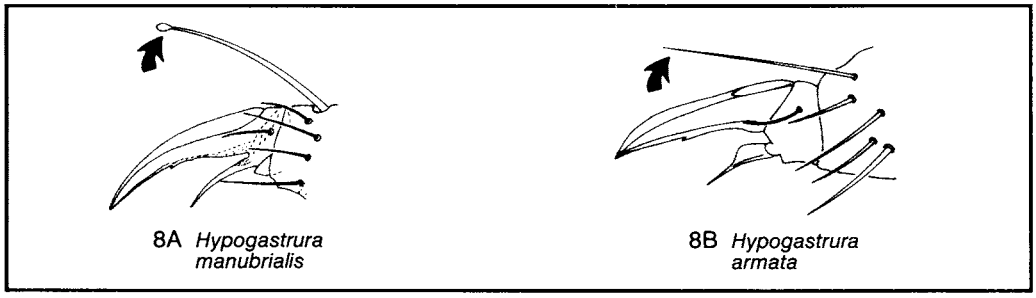
7A *Onychiurus armatus*

7B *Onychiurus fimetarius*

8 Tarsal tenent hair capitate (8A)----------*Hypogastrura manubrialis*

Distribution: probably cosmopolitan; reported as a common domestic species (*18*).

Tarsal tenent hair not capitate (8B)---------- 9



8A *Hypogastrura manubrialis*

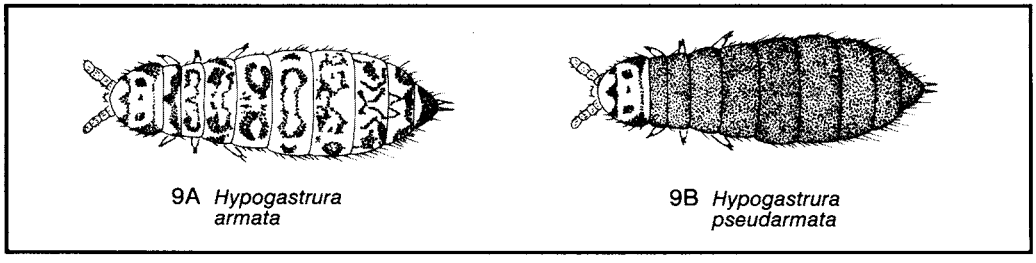
8B *Hypogastrura armata*

9 Body marbled (9A)----------*Hypogastrura armata*

Distribution: cosmopolitan; reported invading houses (*5*); associated with domestic water supplies (*6, 11*).

Body not marbled (9B)---------- *Hypogastrura pseudarmata*

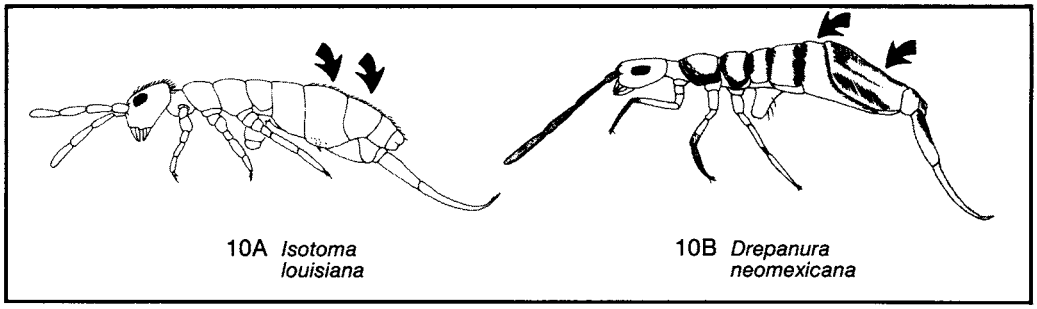
Distribution: Nearctic; reported swarming on and in houses (*6*).



9A *Hypogastrura armata*

9B *Hypogastrura pseudarmata*

10 Abdominal segment IV less than twice as long as abdominal segment III (10A), or terminal abdominal segments fused ---------- 11
Abdominal segment IV at least twice as long as abdominal segment III (10B); terminal segments not fused. Entomobryidae (entomobryid springtails) ---------- 12



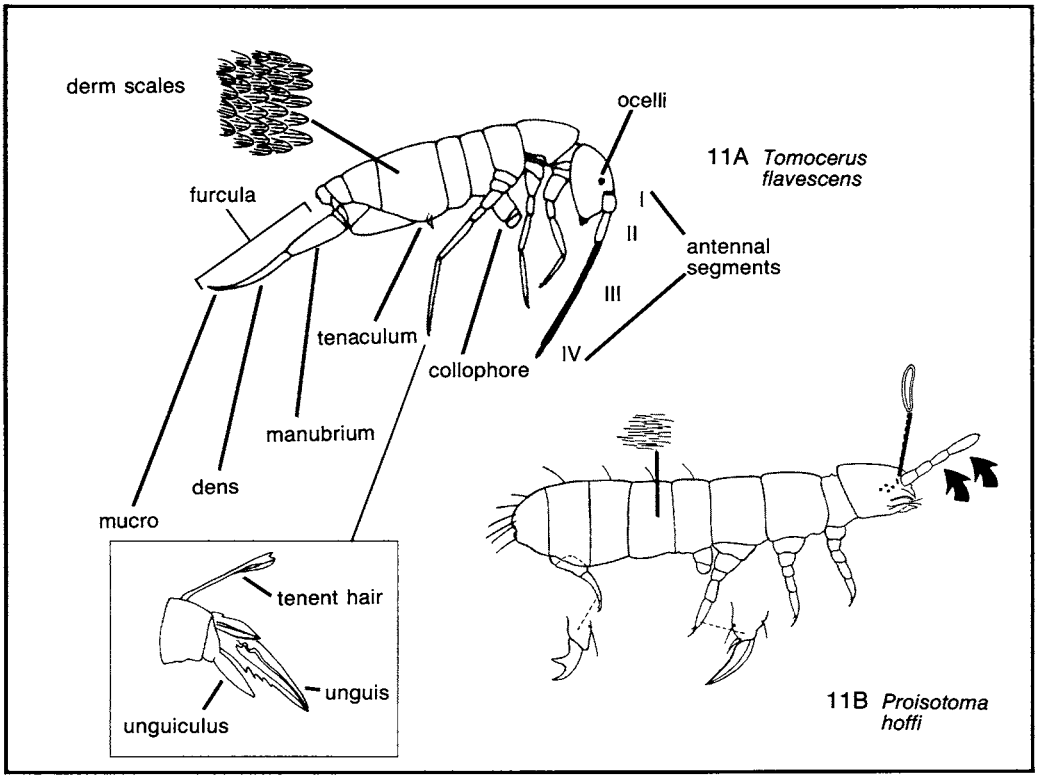
10A *Isotoma louisiana*

10B *Drepanura neomexicana*

11 Antennal segments III and IV subsegmented (11A). Tomoceridae (tomocerid springtails) ---------- *Tomocerus*

Distribution: cosmopolitan; common in houses. See *16* for a key to the Nearctic species.

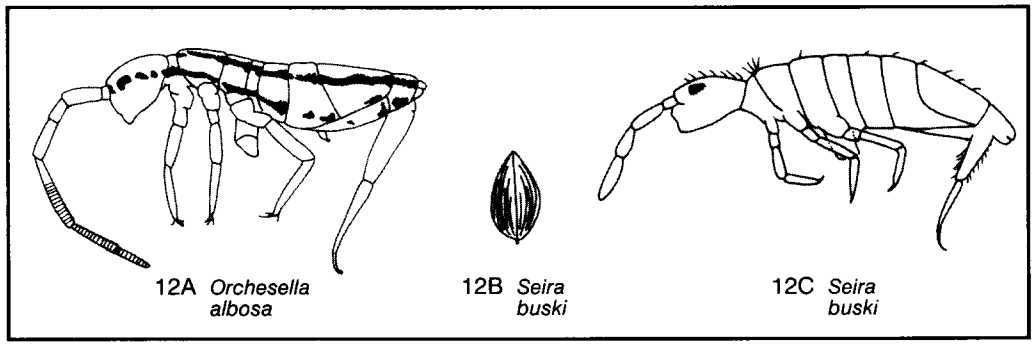
Antennal segments III and IV not subsegmented (11B). Isotomidae (isotomid springtails) ---------- 22



11A *Tomocerus flavescens*

11B *Proisotoma hoffi*

12 Body scales absent (12A) ---------- 13
Body scales (12B) (see also derm scales of 11A) present (12C) ---------- 18



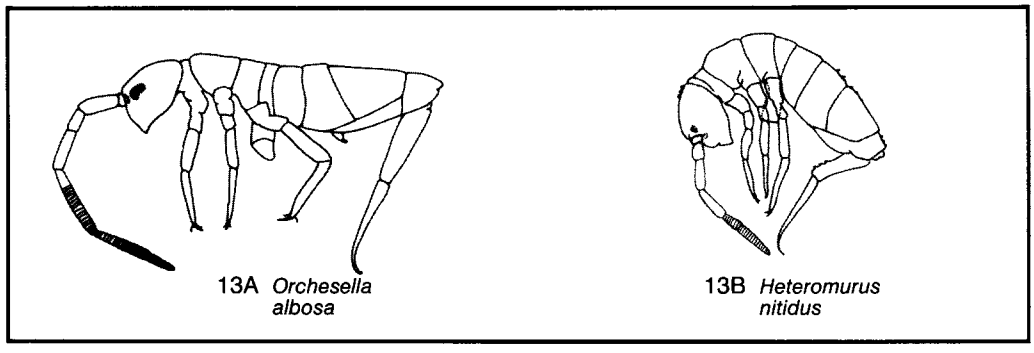
12A *Orchesella albosa* 12B *Seira buski* 12C *Seira buski*

13 Antenna with 6 segments (13A) ---------- *Orchesella albosa*

Distribution: Holarctic. Reported infesting people in Texas; some moldy household item (perhaps bedding) was probably involved (*18*).

Antenna with 4 or 5 segments (13B) ---------- 14

Antennal details of 13A&B by C. Feller.

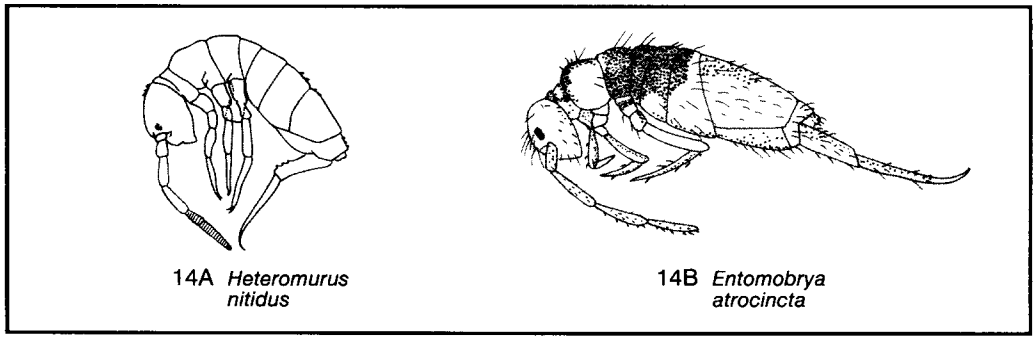


13A *Orchesella albosa* 13B *Heteromurus nitidus*

14 Antenna with 5 segments (14A) ---------- *Heteromurus*

Distribution: cosmopolitan; common in houses.

Antenna with 4 segments (14B). Genus *Entomobrya* ---------- 15

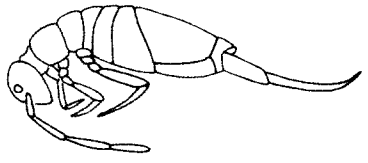


14A *Heteromurus nitidus* 14B *Entomobrya atrocincta*

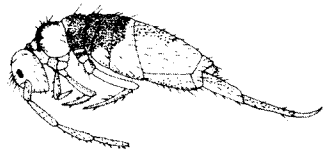
15 Body without stripes (15A)----------*Entomobrya griseoolivata*

Distribution: cosmopolitan; reported as a common domestic species (*18*) and as infesting human hair (Richard W. Fay, 1958, personal communication).

Body with stripes (15B)---------- 16



15A *Entomobrya griseoolivata*



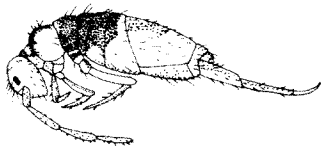
15B *Entomobrya atrocincta*

16 Some body segments striped (16A)----------*Entomobrya atrocincta*

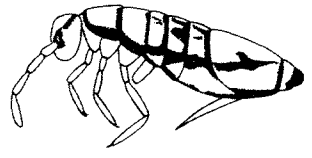
Distribution: cosmopolitan; reported from indoor flower pots containing *Poinsettia pulcherrima* (*13*) and as infesting powdered milk (*17*).

All body segments striped (16B)---------- 17

16B redrawn by C. Feller from *EB07* (see chapter 28).



16A *Entomobrya atrocincta*



16B *Entomobrya nivalis*

17 Head with a dorsal spot (17A)----------*Entomobrya nivalis*

Distribution: cosmopolitan; a common domestic species (*18*); reported infesting the sack house of a flour mill (*9, 11*) and as causing dermatitis in man (*3*). See also 16B.

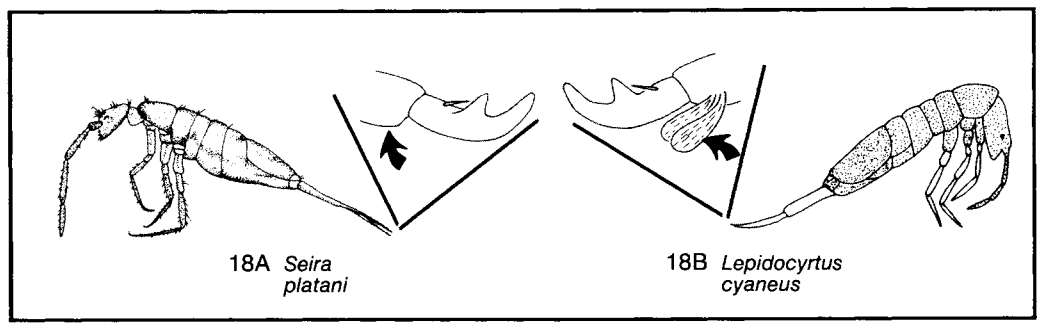
Head without a dorsal spot (17B)----------*Entomobrya purpurascens*

Distribution: Holarctic; associated with human dwellings (*1*).

17A *Entomobrya nivalis*

17B *Entomobrya purpurascens*

18 Dens without ventral scales (18A)---------- 19
Dens with ventral scales (18B) ---------- 21



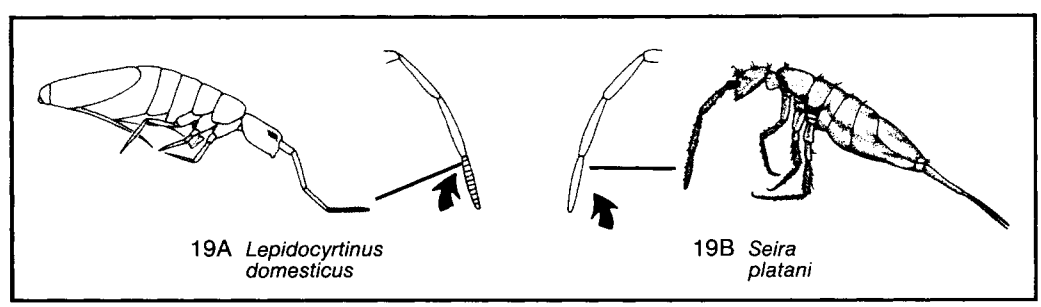
18A *Seira platani*

18B *Lepidocyrtus cyaneus*

19 Segment IV of antenna annulate (19A)----------*Lepidocyrtinus domesticus*

Distribution: cosmopolitan; associated with houses (*4*).

Segment IV of antenna not annulate (19B). Genus *Seira* ---------- 20



19A *Lepidocyrtinus domesticus*

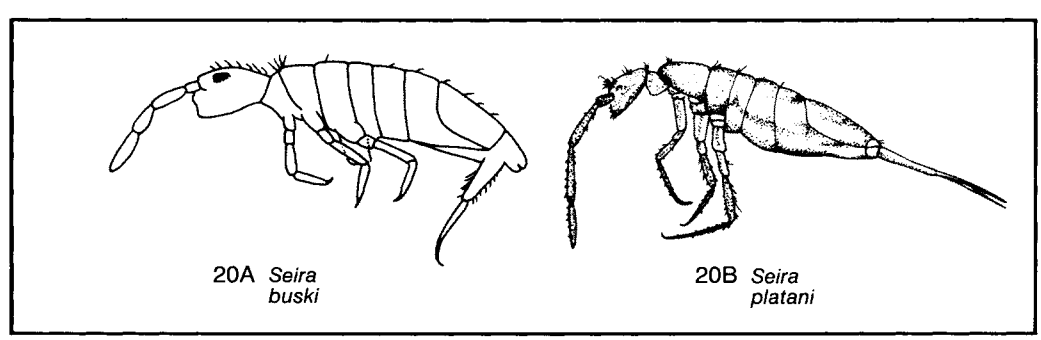
19B *Seira platani*

20 Body entirely blue (20A)----------*Seira buski*

Distribution: Holarctic; associated with houses (*7, 18*); reported as an accidental parasite of man (*2*).

Body marked with blue (20B)----------*Seira platani*

Distribution: cosmopolitan; associated with houses (*7*) and stored food (*17*); reported infesting insulation in a refrigeration plant (*10*) and as infesting human hair (Richard W. Fay, 1958, personal communication).



20A *Seira buski*

20B *Seira platani*

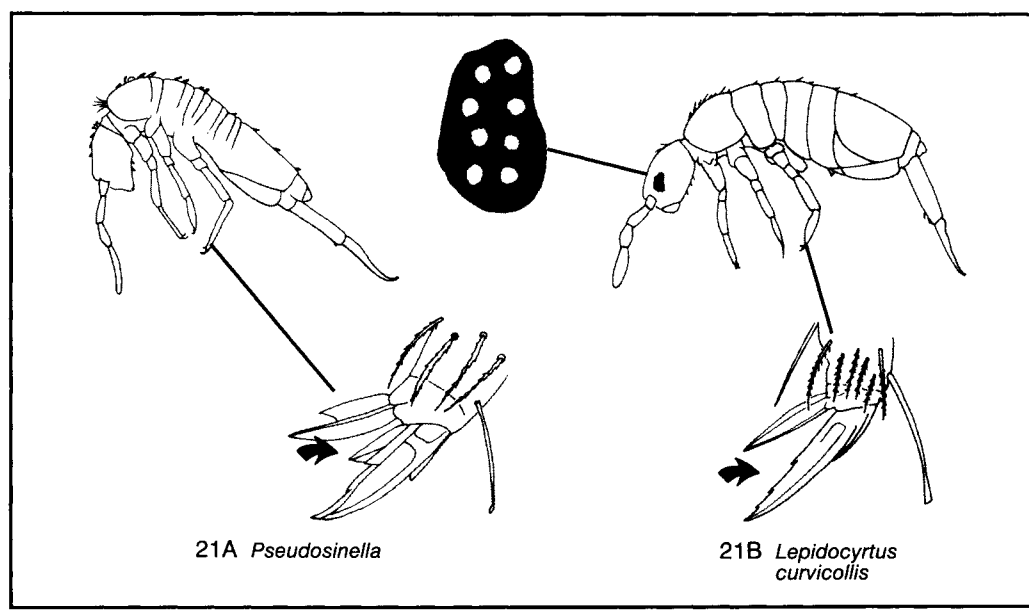
21 Basal teeth of unguis winglike (21A)---------- *Pseudosinella*

Usually fewer than 8 ocelli; many species are white and blind. Distribution: cosmopolitan; associated with houses (*5*).

Detail of tarsus (21A) redrawn by C. Feller from *EB01* (see chapter 28).

Basal teeth of unguis not winglike (21B)---------- *Lepidocyrtus curvicollis*

Eye with 8 ocelli. Distribution: cosmopolitan; associated with cellars (*4*) and houses (*18*).

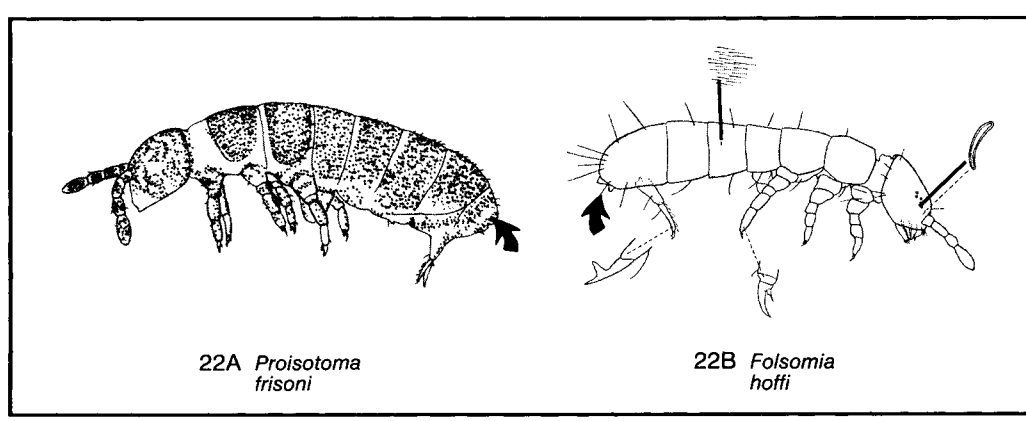


21A *Pseudosinella* 21B *Lepidocyrtus curvicollis*

22 Anus terminal (22A)---------- *Proisotoma frisoni*

Distribution: Nearctic; a common domestic species (*18*); reported from potted *Ficus elasticus* (*12*).

Anus ventral (22B)---------- 23



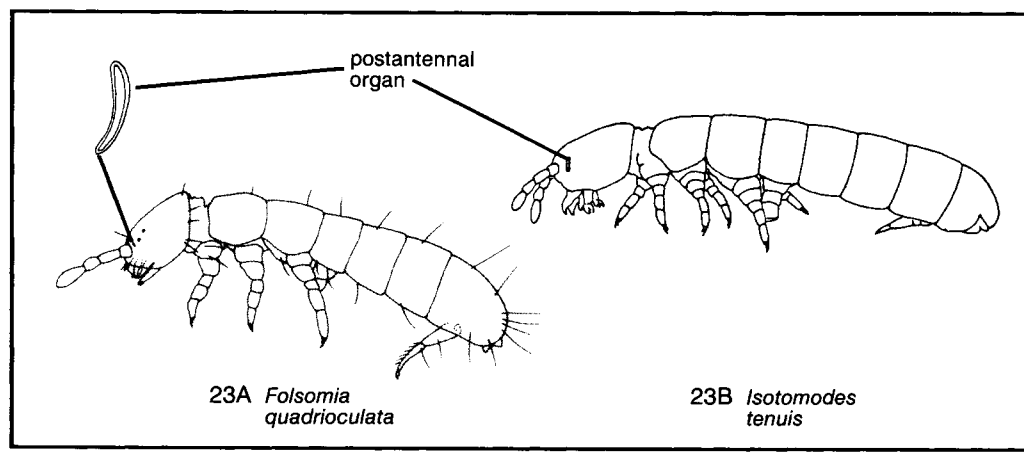
22A *Proisotoma frisoni* 22B *Folsomia hoffi*

23 Ocelli present (23A)----------*Folsomia quadrioculata*

Distribution: Holarctic; a common domestic species (*18*); reported from indoor flower pots (*6*). Some *Folsomia* have an incomplete suture between abdominal segments IV and V.

Ocelli absent (23B)---------- *Isotomodes tenuis*

Distribution: Nearctic; a common domestic species (*18*); reported from indoor flower pots (*15*).



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Notes and Sketches

21 SILVERFISH (THYSANURA)

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New York NY 10024

*Deceased

Synanthropic species are found in two of the three families of Thysanura. *Nicoletia phytophila* (Nicoletiidae) occurs in greenhouses, under flowerpots and in soil, and may cause damage to cultivated plants. All other synanthropic species belong to the Lepismatidae (*1*). They are found in human habitations and in warehouses where they feed on starchy substances, such as paper, cardboard, and books, on various stored grains and their products (e.g., flour, oats, peanuts), and on certain fabrics. The most commonly encountered species are *Acrotelsa collaris, Ctenolepisma longicaudata, Thermobia domestica,* and *Lepisma saccharina.* The first is restricted to the tropics; the others occur most frequently in areas of temperate climate. The remaining species contained in the key are also, but less commonly, found associated with man. Since synanthropic Thysanura are dispersed by man, the original range of most species is not known. Because the actual range of most species is so large and so incompletely known, their recorded distribution is not indicated here.

Most characters used in the key are easily understood. Of special interest are the larger setae (macrochaetae), which are either glabrous (3A) or minutely spinulose (3C). On the thoracic nota and abdominal sternites and tergites, the macrochaetae are either single (4A) or arranged in one or several transverse series, the so-called bristlecombs (4B). The number and distribution of the bristlecombs furnishes generic and specific characters. The macrochaetae are caducous (easily dislodged); in preserved specimens frequently only the respective sockets can be seen. Care is thus required for a correct observation of the macrochaetal pattern.

KEY

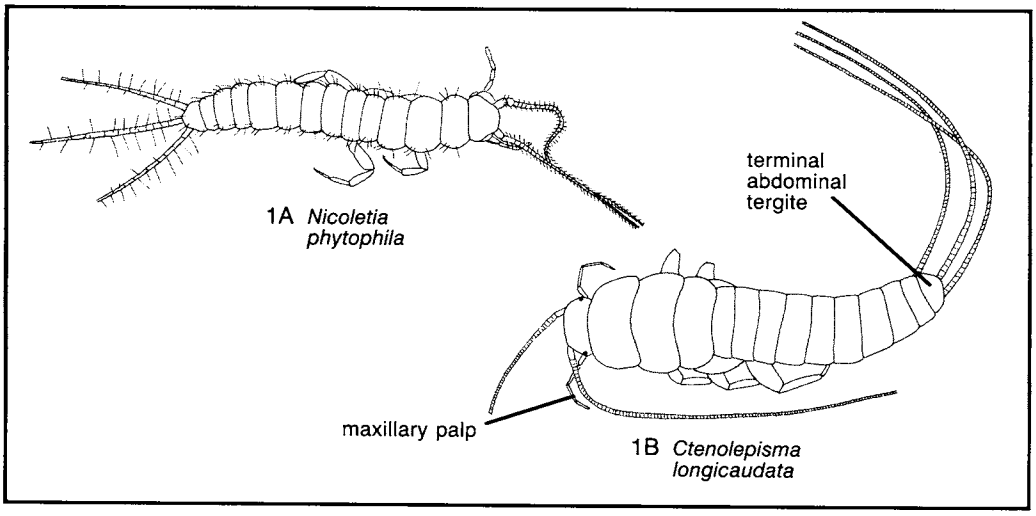
Drawings by P. Wygodzinsky.

1 Eyes absent (1A); scales absent in species mentioned here. Nicoletiidae (nicoletiid silverfish) ----------*Nicoletia phytophila*

Reference: *2.*

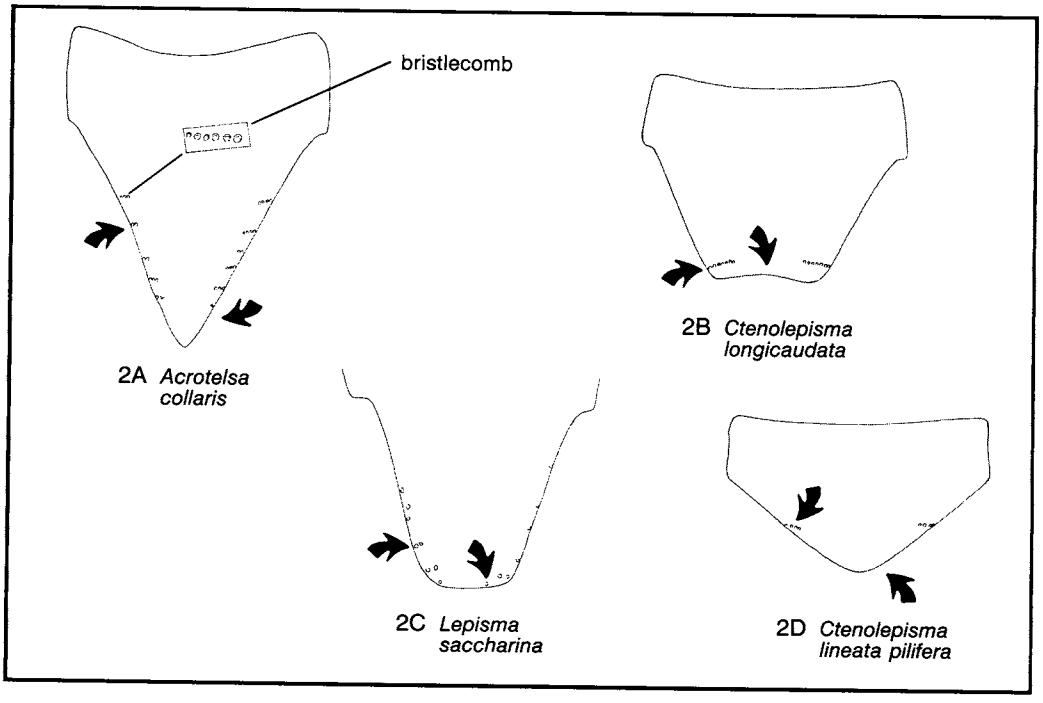
Eyes present (1B); scales present. Lepismatidae (**firebrats and silverfish**) --------- 2

Reference: *1.*



2 Last abdominal tergite distinctly pointed, with several bristlecombs on each side (2A) ---------- *Acrotelsa collaris*

Last abdominal tergite not distinctly pointed, usually with only 1 subapical bristlecomb on each side (but rarely with 1 or 2 supernumerary ones) (2B, 2C, 2D) ---------- 3



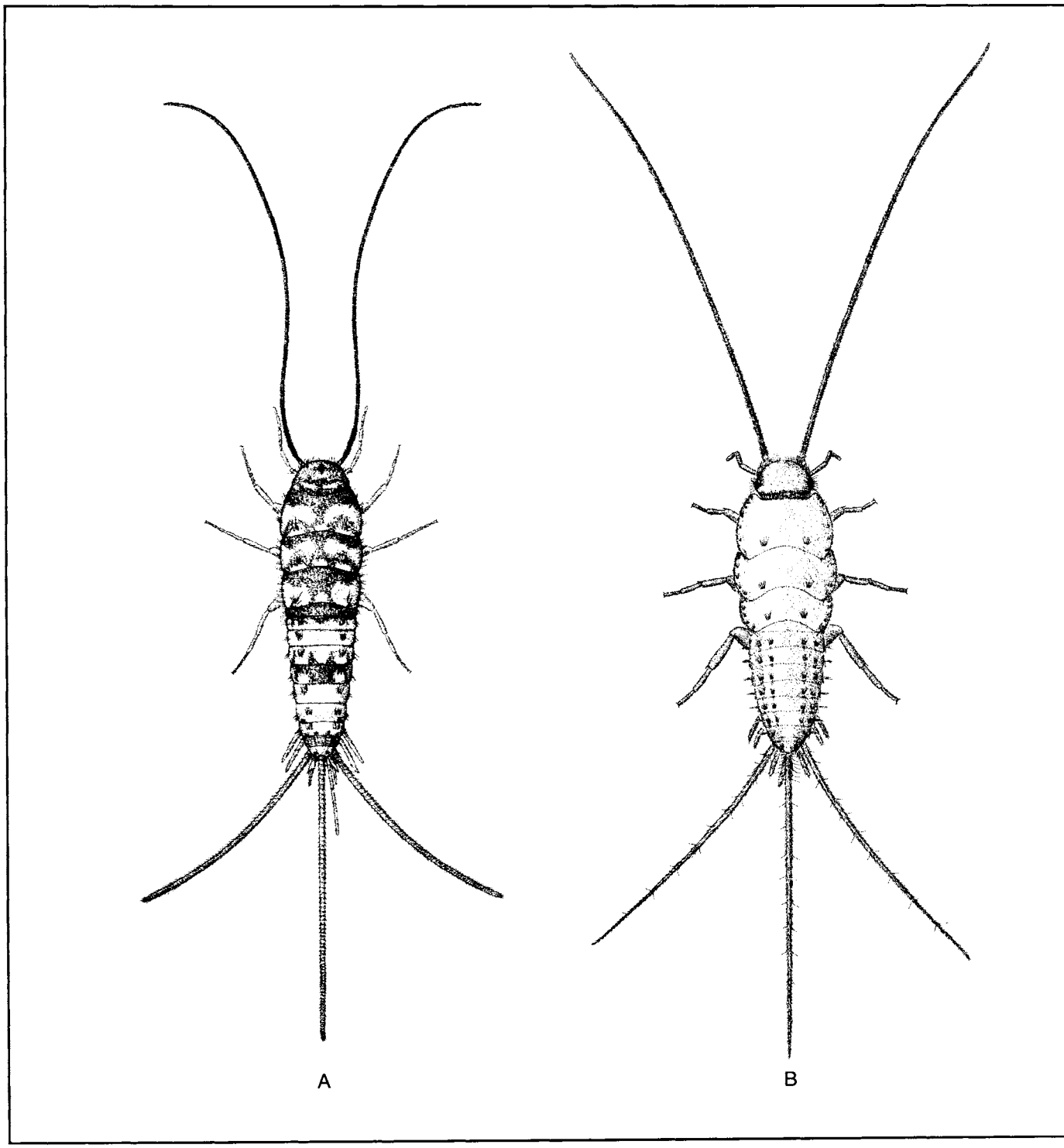
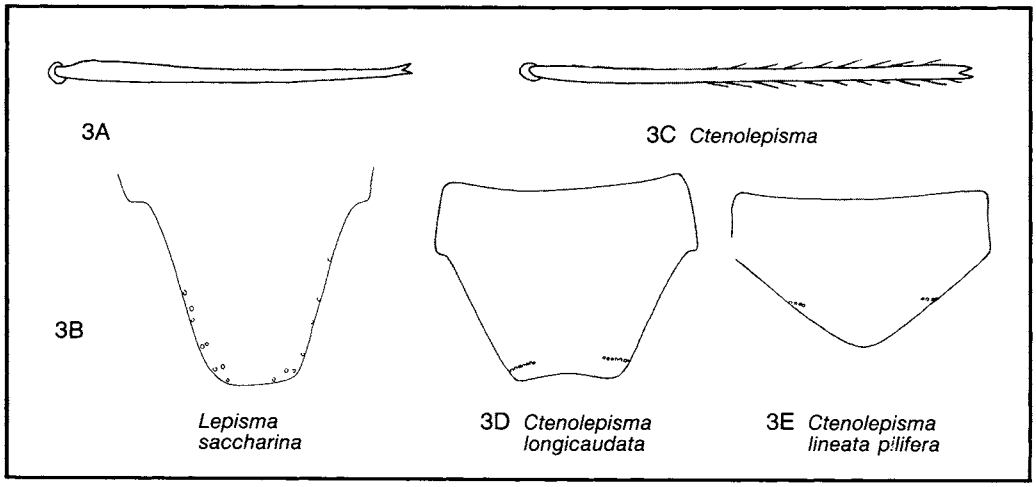


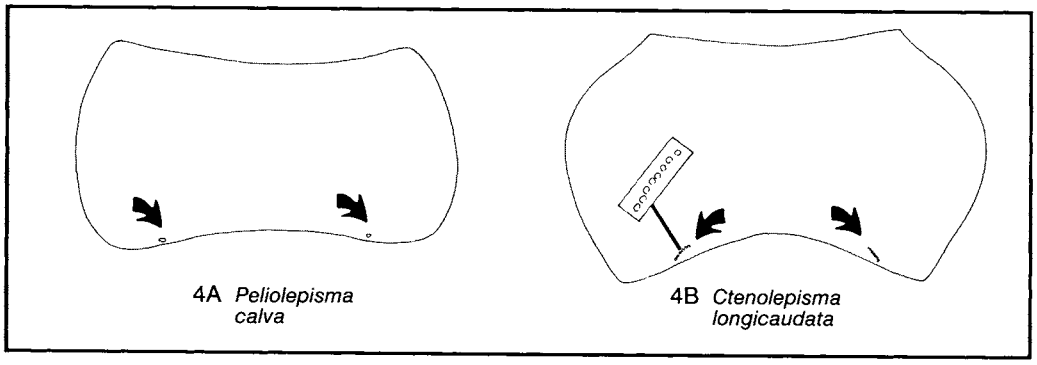
Figure 21.1. Silverfish (Lepismatidae). A, **firebrat,** *Thermobia domestica;* B, fourlined silverfish, *Ctenolepisma lineata pilifera.* (Drawings by C. Feller.)

3 Macrochaetae smooth, often bifid apically (3A); last abdominal tergite elongate, with posterior margin truncate or feebly rounded (3B)
----------common silverfish, *Lepisma saccharina*

Macrochaetae spinulose under high magnification (3C); last abdominal tergite short and broad, with posterior margin straight, emarginate (3D) or bluntly pointed (3E) 4

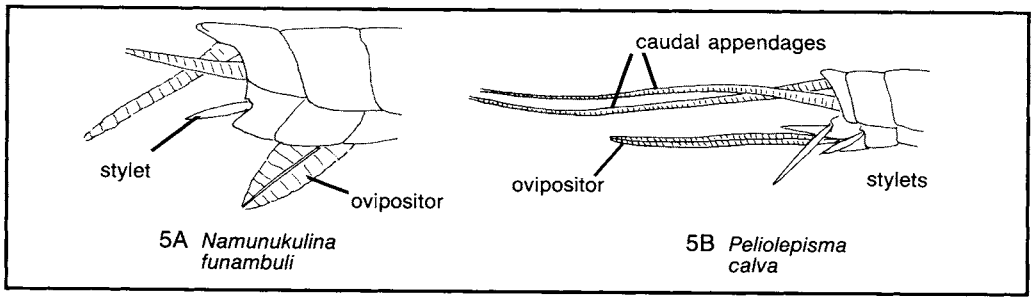


4 Hind margins of thoracic nota with 1 + 1 single macrochaetae (4A)---------- 5
Hind margins of thoracic nota with 1 + 1 bristlecombs consisting each of at least 2 macrochaetae (4B)---------- 6



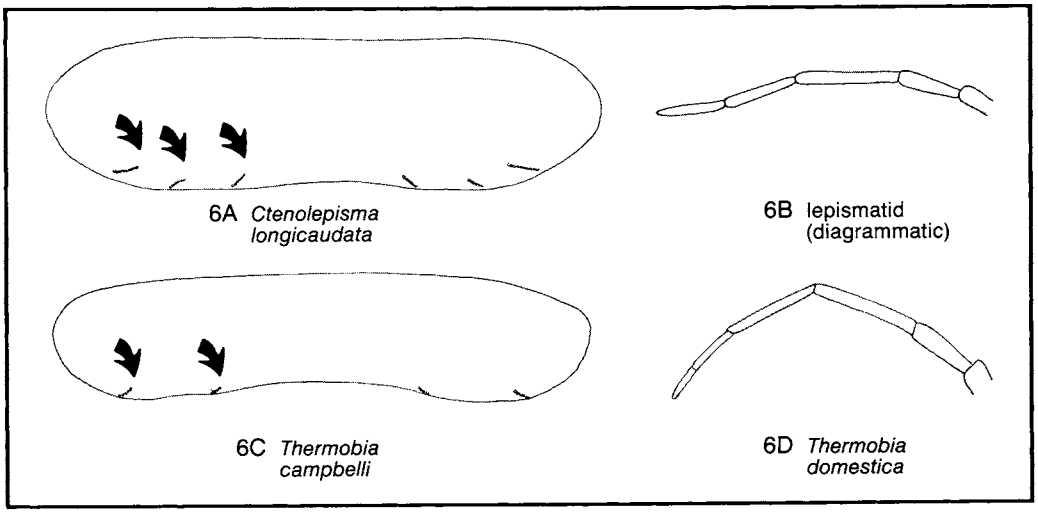
5 Abdominal stylets in 1 pair only; caudal appendages shorter than abdomen; ovipositor subconical, not extending beyond tip of abdomen (5A)----------*Namunukulina funambuli*

Abdominal stylets in 2 pairs; caudal appendages as long as or longer than abdomen; ovipositor elongated, rod-shaped, projecting beyond apex of abdomen (5B)
---------- *Peliolepisma calva*



6 Several abdominal tergites with 3 + 3 bristlecombs (6A); maxillary palp invariably with 5 segments (6B)---------- 7

Abdominal tergites with no more than 2 + 2 bristlecombs (6C); maxillary palps with 5 (6B) or 6 (6D) apparent segments---------- 9



6A *Ctenolepisma longicaudata*

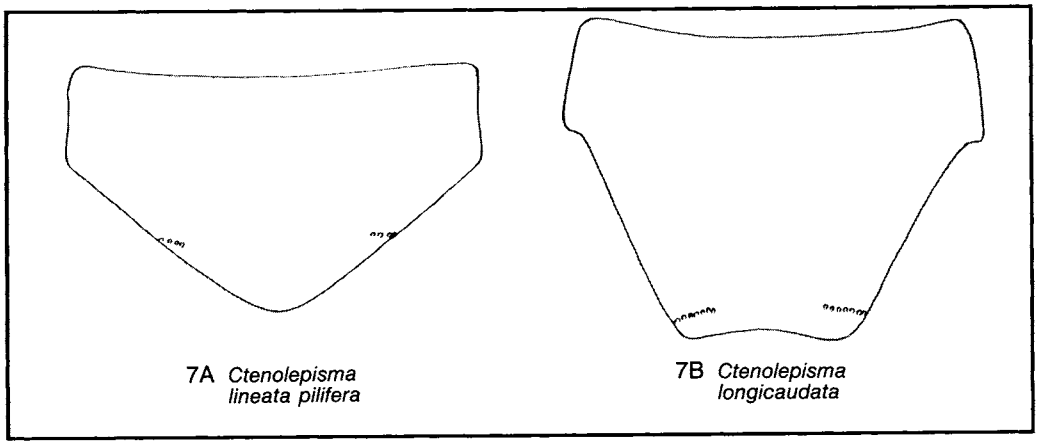
6B lepismatid (diagrammatic)

6C *Thermobia campbelli*

6D *Thermobia domestica*

7 Abdominal tergite X subtriangular (7A); fig. 21.1B ---------- fourlined silverfish, *Ctenolepisma lineata pilifera*

Abdominal tergite X with posterior margin straight or faintly emarginate (7B) ------- 8

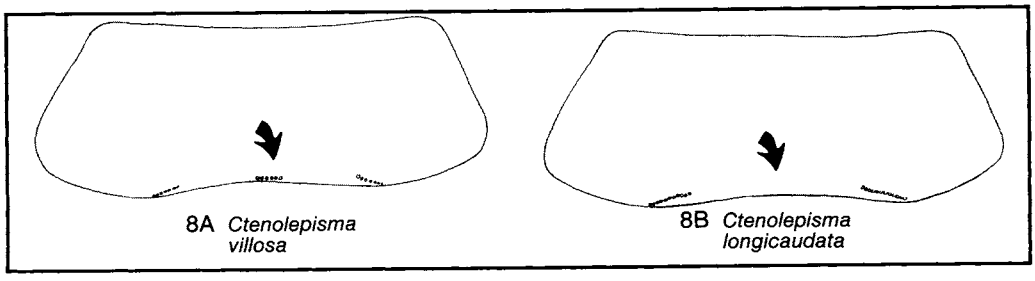


7A *Ctenolepisma lineata pilifera*

7B *Ctenolepisma longicaudata*

8 Median bristlecombs present on abdominal sternites II to VI (8A) -----*Ctenolepisma villosa*

Median bristlecombs absent from abdominal sternites (8B) ----------gray silverfish, *Ctenolepisma longicaudata*

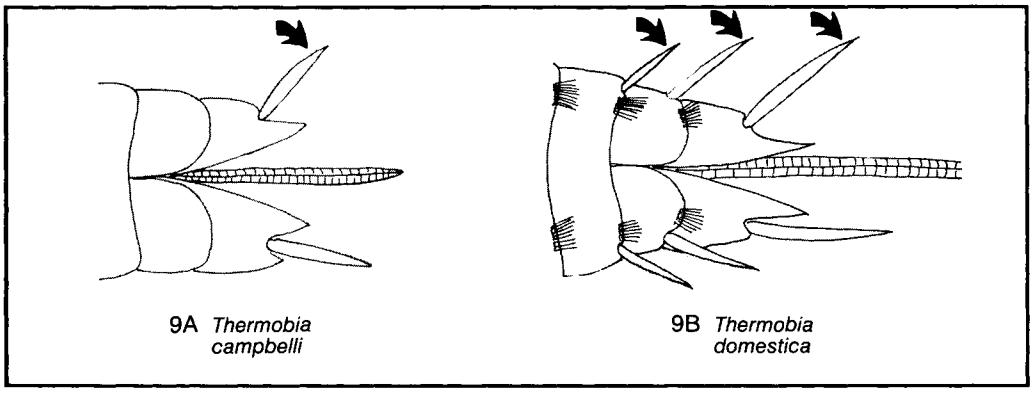


8A *Ctenolepisma villosa*

8B *Ctenolepisma longicaudata*

9 Abdominal stylets present in 1 pair only (9A); intact specimens uniformly gray dorsally----------*Thermobia campbelli*

Abdominal stylets present in 2 or 3 pairs (9B)---------- 10

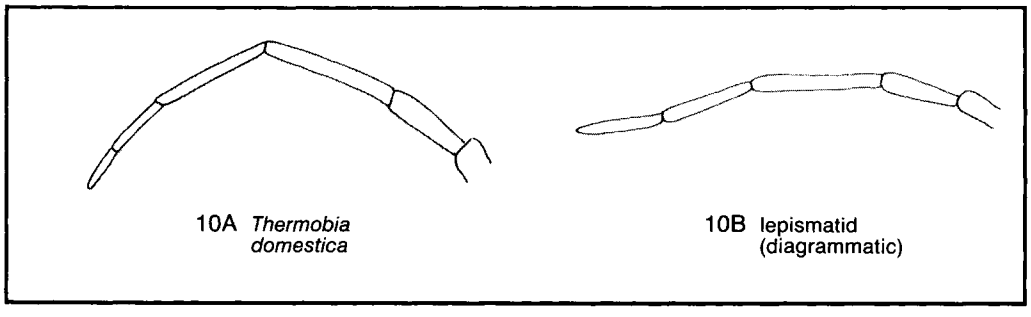


9A *Thermobia campbelli*

9B *Thermobia domestica*

10 Maxillary palp with 6 apparent segments (10A); scales of dorsum forming complex pattern in intact specimens; fig. 21.1A---------- **firebrat,** *Thermobia domestica*

Maxillary palp with 5 segments (10B); pattern of dorsum unknown ----------*Thermobia aegyptiaca*



10A *Thermobia domestica*

10B lepismatid (diagrammatic)

References Cited

1 Wygodzinsky, P.
1972. A review of the silverfish (Lepismatidae, Thysanura) of the United States and the Caribbean area. American Museum Novitates 2481:1-26.

2 Wygodzinsky, P.
1980. A survey of the Nicoletiinae of Europe (Nicoletiidae, Thysanura, Insecta). American Museum Novitates 2695:1-24.

Notes and Sketches

22 PSOCIDS (PSOCOPTERA)

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The Order Psocoptera (*16, 20, 25-28*) contains many forms which seem adaptable to living in human habitations. The fifty species included in this key undoubtedly do not represent all of the species that are found in stored foods, but, to my knowledge, they represent all such species mentioned in the literature through 1982. Few surveys have been made of psocids in domestic situations; additional surveys will probably yield other species.

Certain generic and specific names which have appeared in the psocidological literature are either not used in this key or are used in a different sense, namely: *Atropos* Leach, a synonym of *Trogium* Illiger; *Ectopsocus pumilis* (Banks), a name erroneously applied by Chapman (*8*) to *Ectopsocopsis cryptomeriae* (Enderlein) and used in that sense by all North American authors until 1965 (*4*); *Hemipsocus roseus* (Hagen), unidentifiable; *Liposcelis divinatorius* (Müller), unidentifiable; *Liposcelis granicola* Broadhead, synonym of *L. bostrychophilus* Badonnel; *Liposcelis simulans* race A Broadhead, synonym of *L. kidderi* Hagen; *Liposcelis subfuscus* Broadhead, synonym of *L. corrodens* Heymons; *Psocatropos lachlani* Ribaga, unidentifiable; *Psocatropos slossonae* Banks, probably a synonym of *P. microps* (Enderlein); *Tapinella africana* Badonnel, synonym of *Nanopsocus oceanicus* Pearman; *Troctes* Burmeister, synonym of *Liposcelis* Motschulsky.

The following comments on structures mentioned in the key may be of value to the nonspecialist. The antennae of psocids are filiform, generally nearly as long as to longer than the body. The mouthparts are of the chewing type, with laciniae in the form of elongate rods. The lacinial tips often provide useful characters (see couplet 16 in the key). Venation of the forewing (see couplets 4, 5, 18, 47) is often used in determinations. In female psocids abdominal sternum VIII (subgenital plate), somewhat enlarged and variously modified (see couplets 49, 51, 53), underlies the genital chamber. To the sides of this plate, and sometimes partially covered by it, lie the gonapophyses, the ovipositor valvulae (see couplets 44, 49), typically three on each side, but sometimes reduced to one. Abdominal sternum IX (hypandrium) of the male is comparable to the subgenital plate. The hypandrium has characters useful for separating some species (see couplets 7, 13). The XI abdominal segment is reduced to the epiproct (a single lobe above the anus) and to the paraprocts (lobes on each side of the anus). These structures may provide characters of specific value (see couplets 7, 48).

Because of the small size of psocids, it is often necessary for the taxonomist to prepare slides of cleared and stained parts before attempting an identification. Even counts of antennal segments can be difficult on whole specimens. Starting with material preserved in 80% ethanol, one can obtain suitable results with the following procedures.

1. Cut off head and posterior third of abdomen and place them in a tube containing 10% aqueous KOH solution.
2. Place the tube in a water bath and allow it to sit at room temperature until the parts sink to the bottom.
3. While waiting for the parts to sink, remove wings and legs from one side, pass them through absolute ethanol, then through euparal essence in a spot plate, and mount in euparal.
4. Bring the parts in KOH slowly to a boil on a hot plate and allow to cool to room temperature.
5. Pass the parts through one or two baths of distilled water in a spot plate, then through 80% ethanol.
6. If staining is desirable, place the parts in a saturated 95% ethanol solution of acid fuchsin for 0.5 to one hour in a spot plate, covering the well to prevent evaporation.
7. Pass the parts through one to two baths of absolute ethanol.
8. Pass each part separately through euparal essence, and place in a drop of euparal on a slide.
9. For the terminal abdominal segments, cut with a microknife by pressure against the slide to each side of the subgenital plate or hypandrium, and set this structure apart from the remainder of the parts; cut to each side of the valvulae and set this piece apart; separate the phallosome from the hypandrium and set these two pieces apart from the rest. The remaining parts are the clunium (fused terga VIII-X or IX-X), epiproct, and paraprocts.
10. With fine needles, tease paraprocts apart ventral to the anus.
11. Arrange the parts and add cover slip.
12. Dissect the head as follows. With fine needles remove the antennae and set them apart; loosen the maxillary cardines (= basal sclerites; singular, cardo) from head wall; break through mandibular attachments on one side; push off mouthparts as a group, or cut first through membrane at base of labrum; remove head capsule from the preparation and store separately; tease off labrum and mandibles.
13. Arrange the parts on the slide and add cover slip.

With very small specimens, such as *Liposcelis,* one can dispense with the dissections. It suffices to cut fine holes in the lateral abdominal cuticle to facilitate clearing, and to carry out the clearing, staining, and mounting procedures outlined above.

KEY

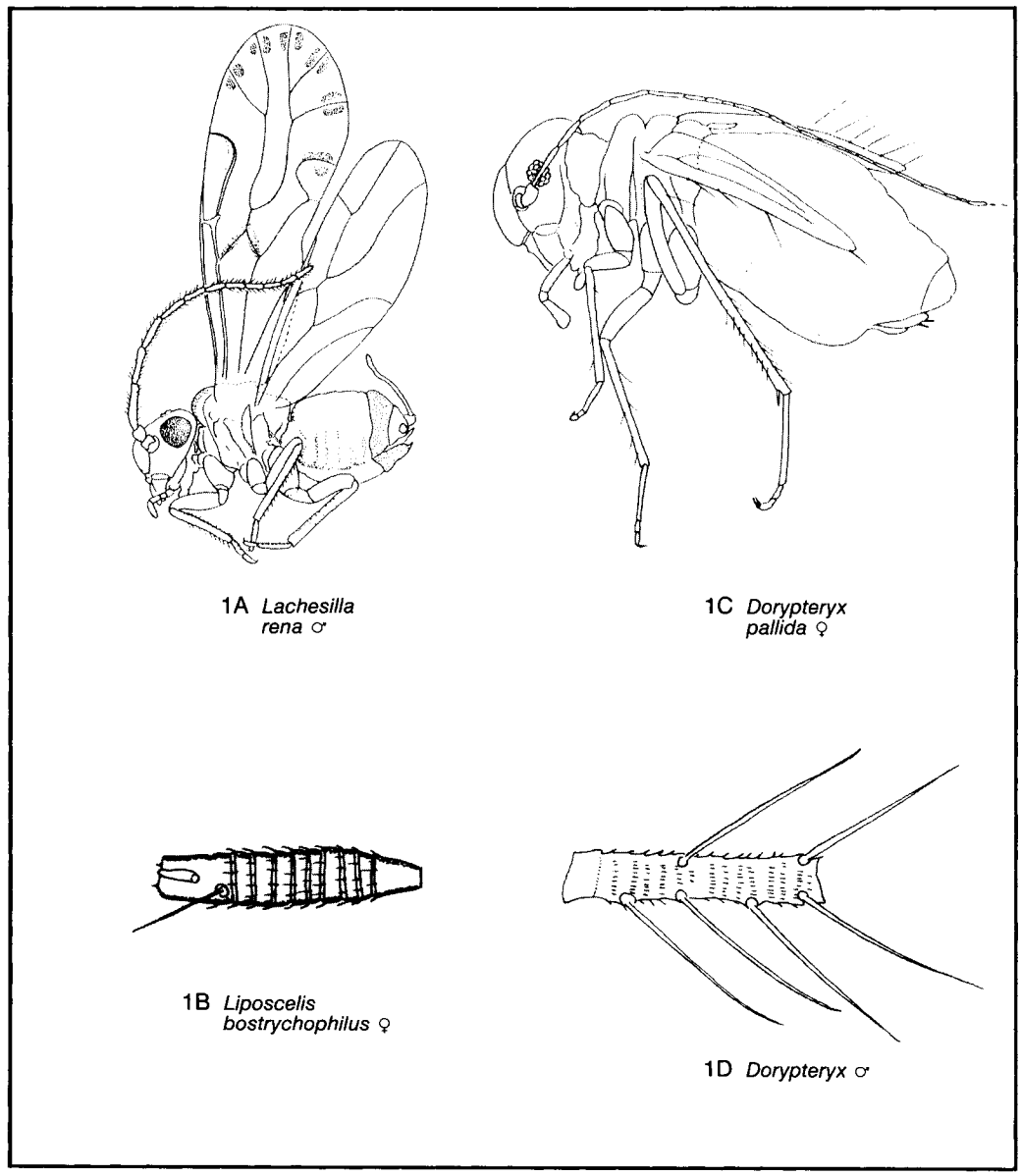
Drawings by E.L. Mockford unless otherwise noted.

1 Antenna with 13 to 15 segments (1A); if 15 segments present, some or all flagellar segments secondarily annulated (1B)---------- 2

Tarsi 2- (1A) or 3-segmented.

Antenna with more than 20 segments (1C); segments never secondarily annulated, but often with whorls of microtrichia (1D). Suborder Trogiomorpha---------- 3

Tarsi 3-segmented (1C).



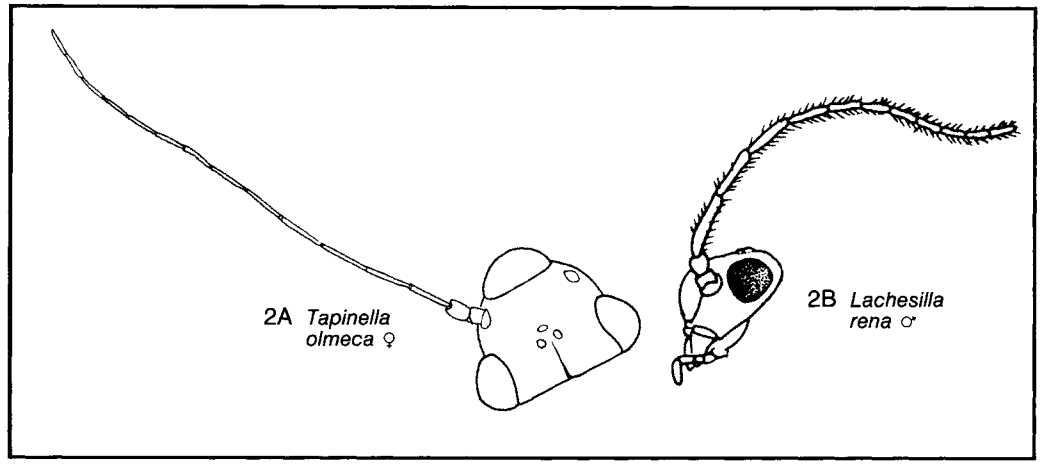
1A *Lachesilla rena* ♂

1C *Dorypteryx pallida* ♀

1B *Liposcelis bostrychophilus* ♀

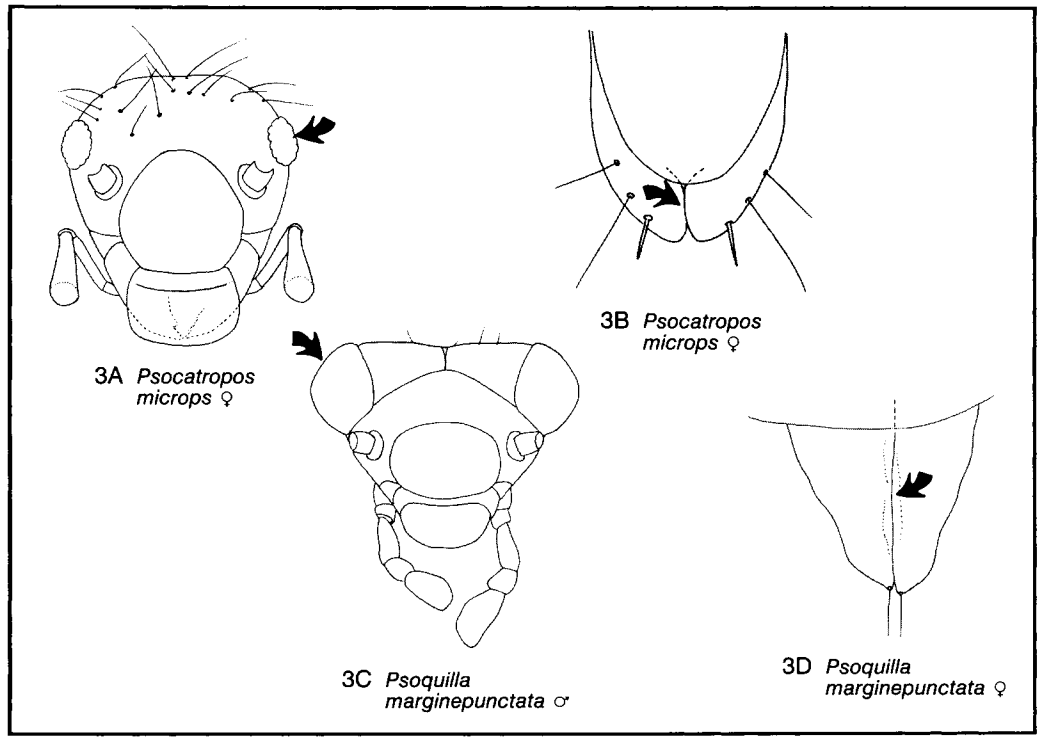
1D *Dorypteryx* ♂

2 Antenna 15-segmented (2A), with secondary annulations (apparent only under high magnification). Suborder Troctomorpha---------- 18
Antenna 13-segmented (2B), lacking secondary annulations. Suborder Psocomorpha 43



Suborder Trogiomorpha

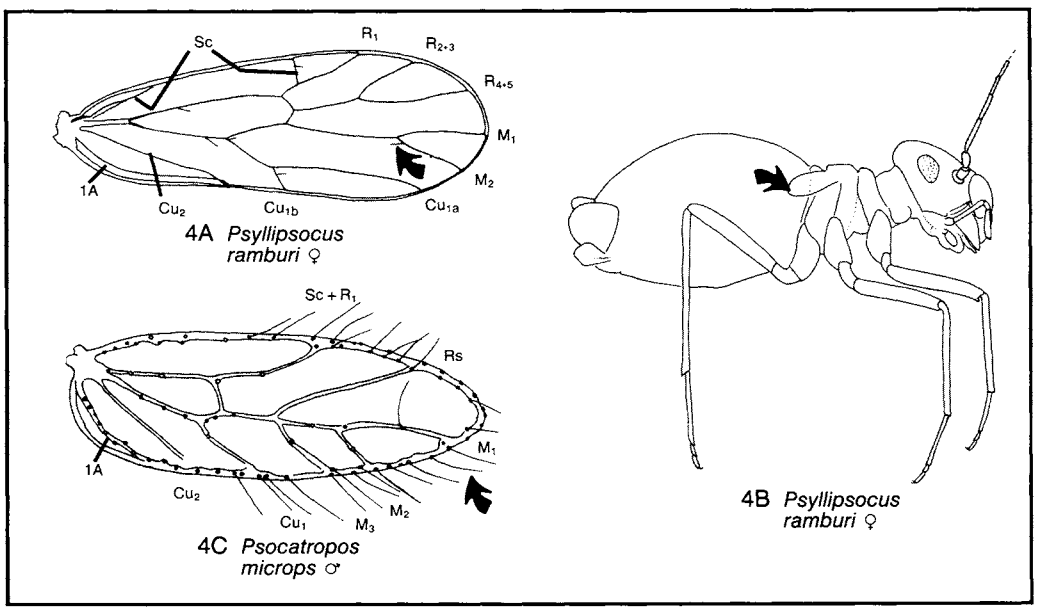
3 Head in anterior view relatively narrow, with compound eyes subdorsal (3A); ovipositor valvulae of opposite sides separated by a space or touching only at their apices (3B). Group Psocatropetae. Psyllipsocidae---------- 4
Head in anterior view relatively broad, with compound eyes contiguous with dorsal surface (3C); ovipositor valvulae of opposite sides joined along midline (3D). Group Atropetae ---------- 8



4 Forewing bearing only short setae (4A), or individuals micropterous (4B) ---------- *Psyllipsocus ramburi*

Cosmopolitan; in caves and houses. References: *1, 9-12, 27.*

Forewing beset with long setae (4C) ---------- 5



4A *Psyllipsocus ramburi* ♀

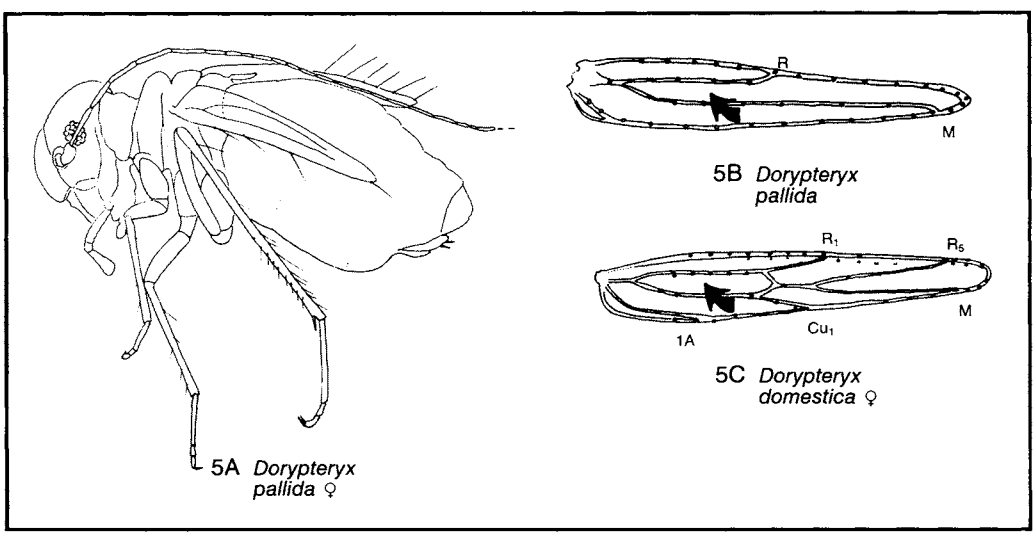
4B *Psyllipsocus ramburi* ♀

4C *Psocatropos microps* ♂

5 Forewing with only 2 longitudinal veins, both branching from a single basal vein; no closed cells (5A, 5B) ---------- *Dorypteryx pallida*

Known from domestic situations in Philadelphia, and in central and southern Europe, and from a cave in Egypt. References: *9-11.*

Forewing with more complex venation including at least 1 closed cell (5C) --------- 6



5A *Dorypteryx pallida* ♀

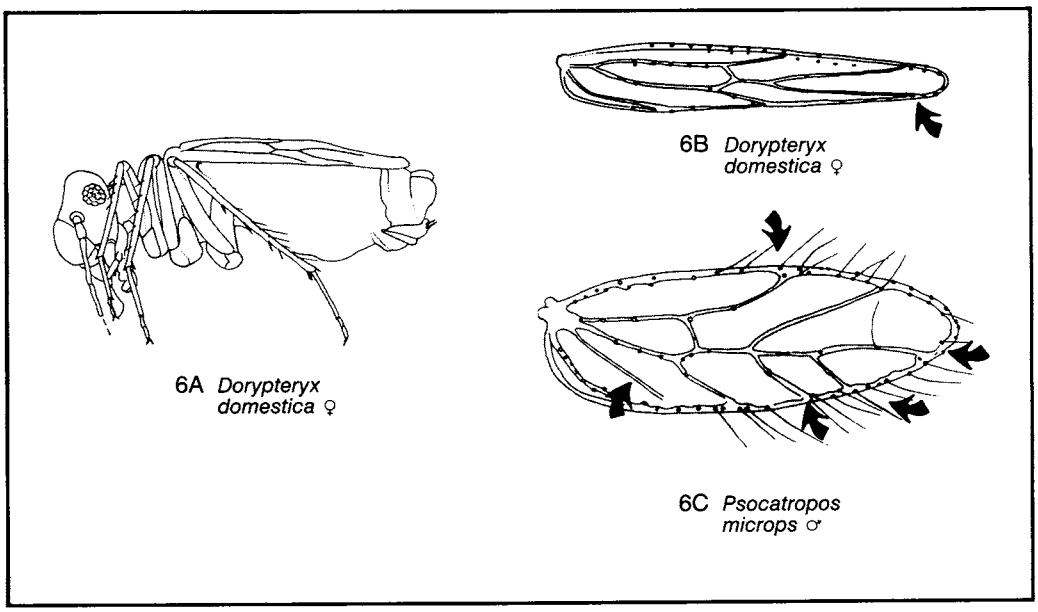
5B *Dorypteryx pallida*

5C *Dorypteryx domestica* ♀

6 Forewing with M simple and Sc and Cu_2 absent (6A, 6B) ----------*Dorypteryx domestica*

Known from buildings in Southern Rhodesia and central Europe. References: *11, 24.*

Forewing with M at least once-branched, and Sc and Cu_2 present (6C). Genus *Psocatropos* ---------- 7

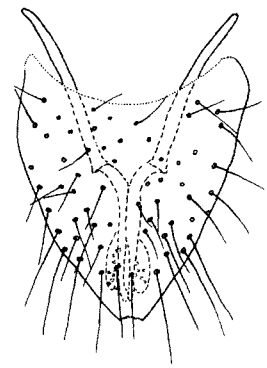


7 Forewing generally reaching or surpassing tip of abdomen; hypandrium longer than its basal width (7A); male paraproct lacking a sclerotized ridge on its distal margin (7B) ----------*Psocatropos pilipennis*

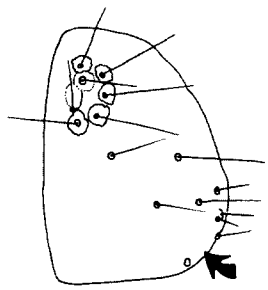
Known from houses in India, Madagascar, and the Seychelles. Reference: *3.*

Forewing generally not reaching (or just barely reaching) tip of abdomen (7C); hypandrium shorter than its basal width (7D); male paraproct pointed ventrally, with a sclerotized ridge on its distal margin (7E) ----------*Psocatropos microps*

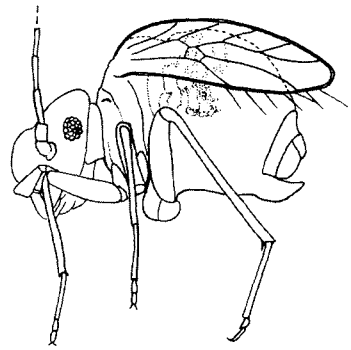
Known from houses, stored food, and outdoor situations throughout the tropics. See also 3A, 3B, 4C. References: *3, 5, 13.*



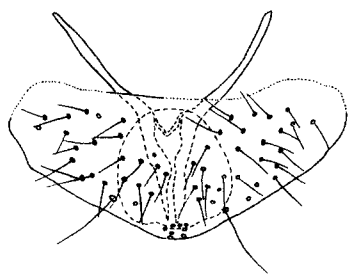
7A *Psocatropos pilipennis*



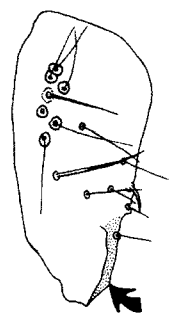
7B *Psocatropos pilipennis*



7C *Psocatropos microps* ♂



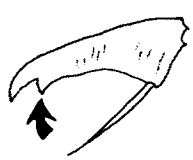
7D *Psocatropos microps*



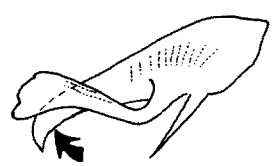
7E *Psocatropos microps*

8 Pretarsal claws each with a preapical denticle (8A); body and wings covered with scales (see 9A, 9B). Lepidopsocidae---------- 9

Pretarsal claws without preapical denticle (8B); body and wings lacking scales (see 10A, 10B)---------- 10



8A *Echmepteryx hageni* ♀



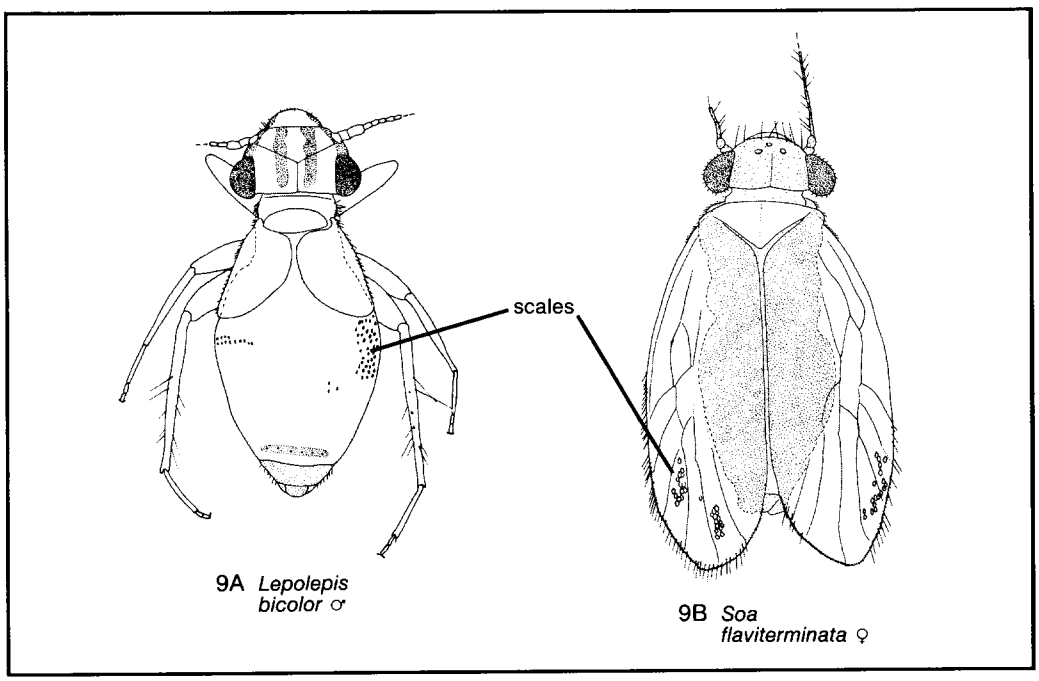
8B *Psoquilla marginepunctata* ♀

9 Forewings reaching to about posterior margin of abdominal segment I (9A); head marked with 4 longitudinal brown stripes on a creamy yellow background (9A) ----------*Lepolepis bicolor*

Collected from West African peanuts in a British port, and also from India (circumstances not noted). Reference: *7.*

Forewing surpassing posterior margin of abdomen (9B); head a uniform medium brown ---------- *Soa flaviterminata*

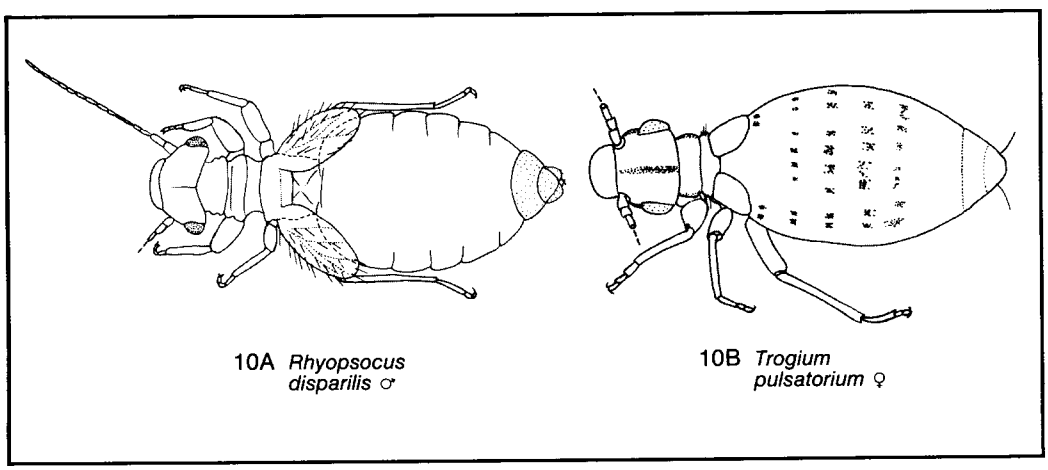
Circumtropical, but recorded from stored foods only in West Africa. References: *5, 9, 15.*



9A *Lepolepis bicolor* ♂

9B *Soa flaviterminata* ♀

10 Forewings well-developed or reduced, but always with veins (10A). Psoquillidae-- 11
Forewings reduced to tiny scales or knobs, never with veins (10B). Trogiidae------ 14



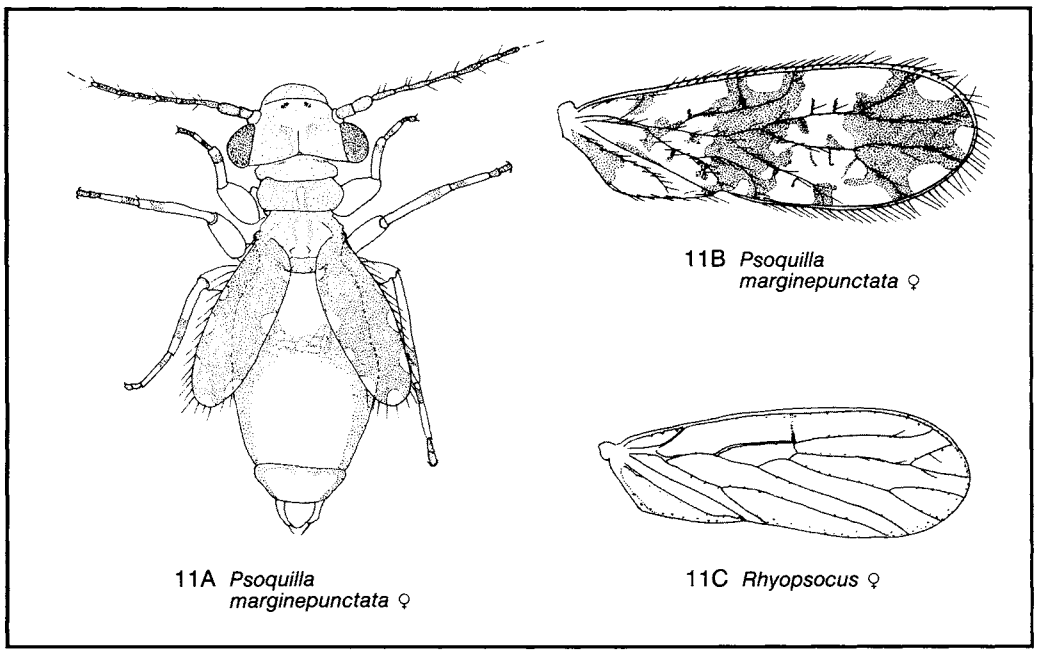
10A *Rhyopsocus disparilis* ♂

10B *Trogium pulsatorium* ♀

11 Forewings marked with a conspicuous pattern of dark and clear areas (11A, 11B) ---------- *Psoquilla marginepunctata*

Circumtropical; introduced into central Europe and southern United States; known mostly from outdoor situations in the tropics, but from stored food in West Africa and from domestic situations outside the tropics. See also 3C, 3D, 8B. References: *1, 5, 9, 19.*

Forewings uniform in color, pale brown to nearly colorless (11C). Genus *Rhyopsocus* 12



11A *Psoquilla marginepunctata* ♀

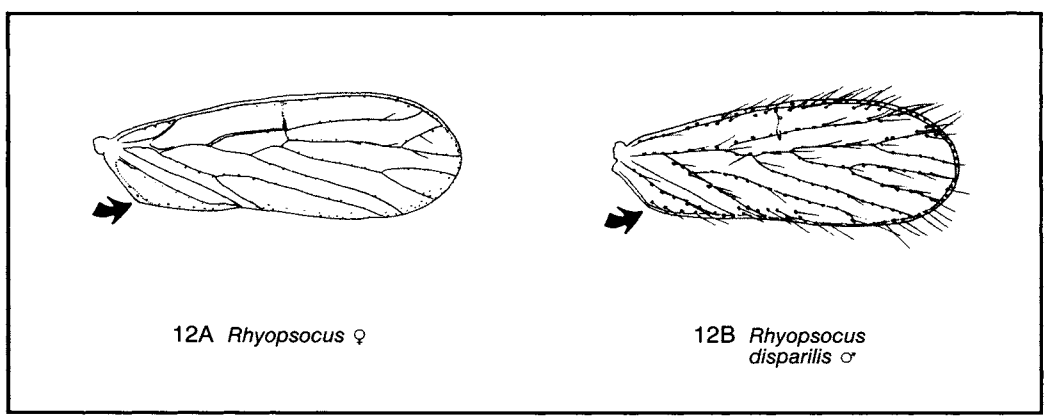
11B *Psoquilla marginepunctata* ♀

11C *Rhyopsocus* ♀

12 Anal lobe of forewing with angular posterior margin (12A) ---------- *Rhyopsocus peregrinus*

Found in a store at Manchester, England. Reference: *17.*

Anal lobe of forewing with rounded posterior margin (12B) ---------- 13



12A *Rhyopsocus* ♀

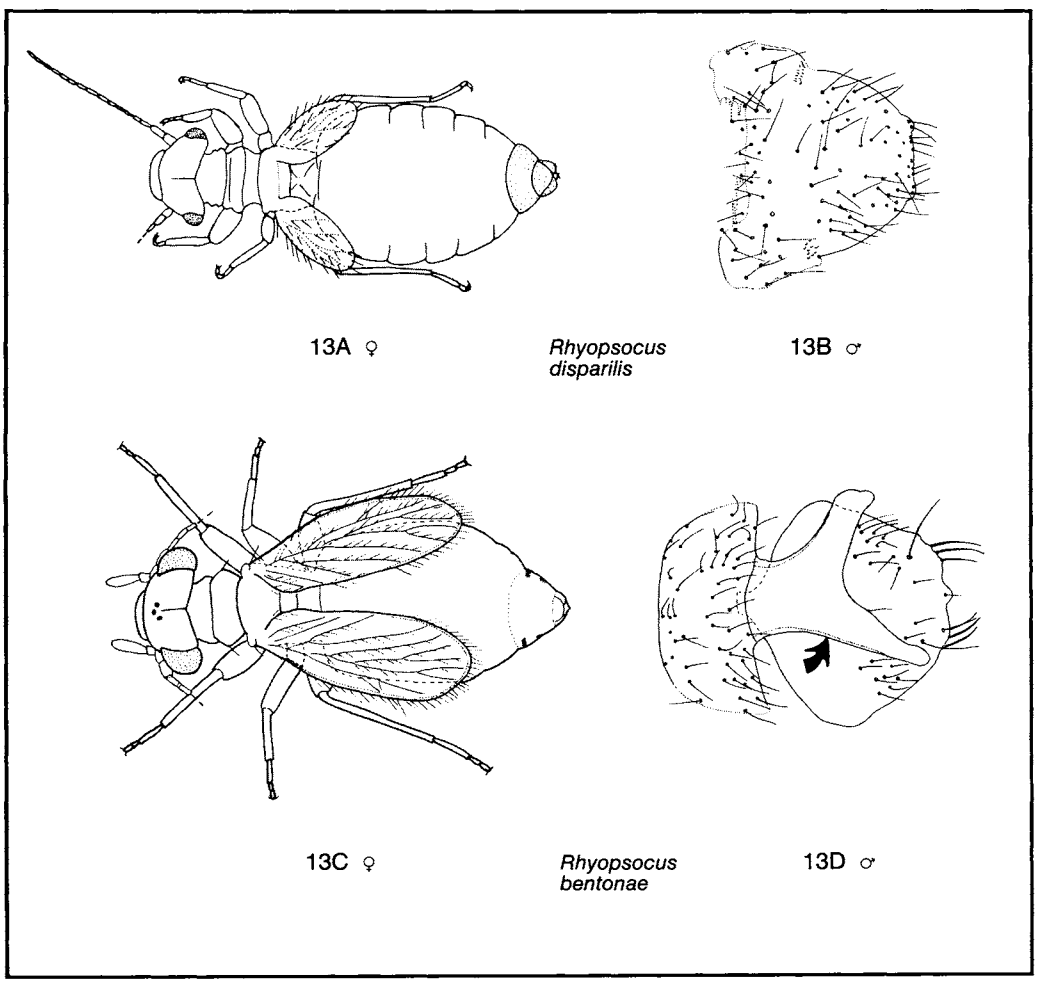
12B *Rhyopsocus disparilis* ♂

13 Body color a pale, creamy-yellow; wings variable in length, reaching as far as the basal fourth of the abdomen in the shortest-winged form (13A) to about tip of abdomen in longest-winged form; hypandrium not partially covered by preceding sternum (13B) ----------*Rhyopsocus disparilis*

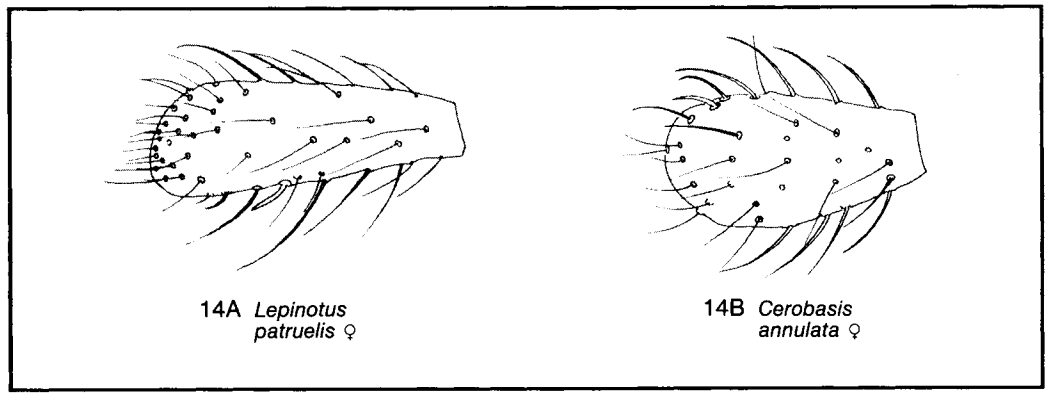
Taken in England and at New York on West African cacao, at United States ports on rice from the Philippines and Japan, on beans from the West Indies, and on pigeon peas from Guyana. References: *4, 5, 19.*

Head and thorax a tawny brown; wings variable in length, extending from about midlength of abdomen (13C) to beyond tip of abdomen; hypandrium partially covered by fishtail-shaped lobe of preceding sternum (13D) -------*Rhyopsocus bentonae*

Found in houses in southeastern United States. Reference: *31.*



14 Segment IV of maxillary palp relatively elongate and slender (14A); abdomen uniform in color (see 15B)---------- 15
Segment IV of maxillary palp relatively short and broad (14B); abdomen spotted or mottled (see 17A, 17B)---------- 17



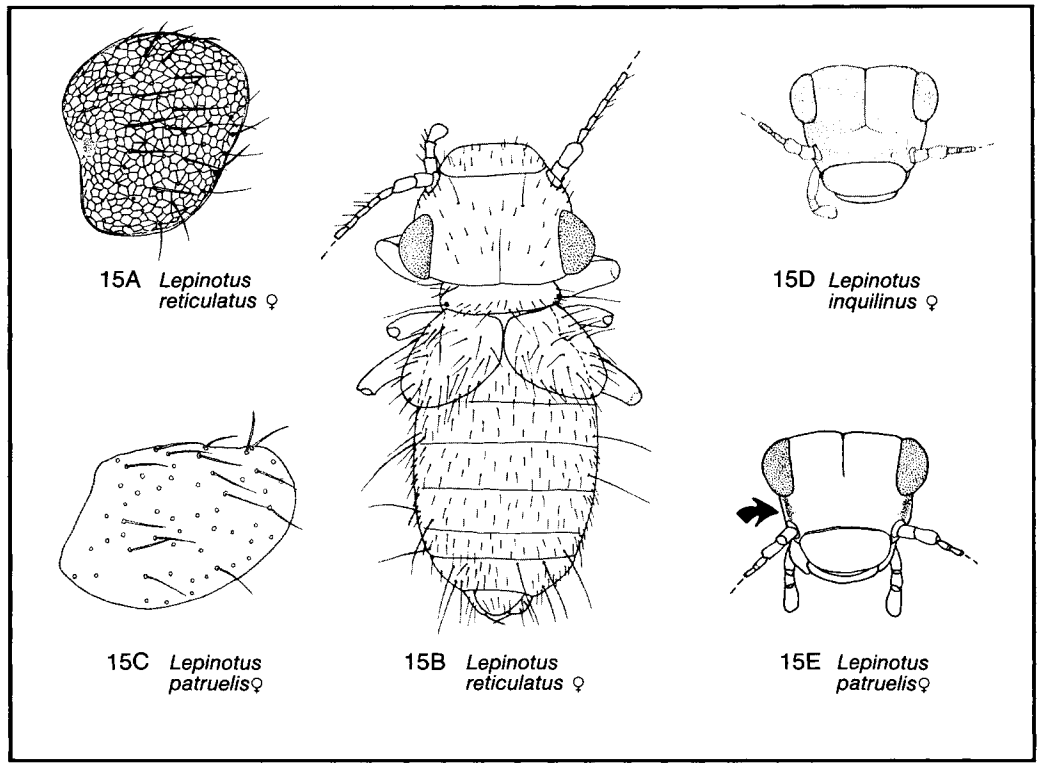
14A *Lepinotus patruelis* ♀

14B *Cerobasis annulata* ♀

15 Slide-mounted wing with a reticulate pattern (15A); head a uniform yellowish brown (15B)----------**reticulatewinged trogiid,** *Lepinotus reticulatus*

Cosmopolitan; usually in outdoor situations but common in stored grain in the United States. References: *4, 5, 9-11, 21.*

Slide-mounted wing lacking reticulate pattern (15C); head dark brown (15D) or with a dark brown band from compound eye to antennal base (15E)---------- 16



15A *Lepinotus reticulatus* ♀

15D *Lepinotus inquilinus* ♀

15C *Lepinotus patruelis*♀

15B *Lepinotus reticulatus* ♀

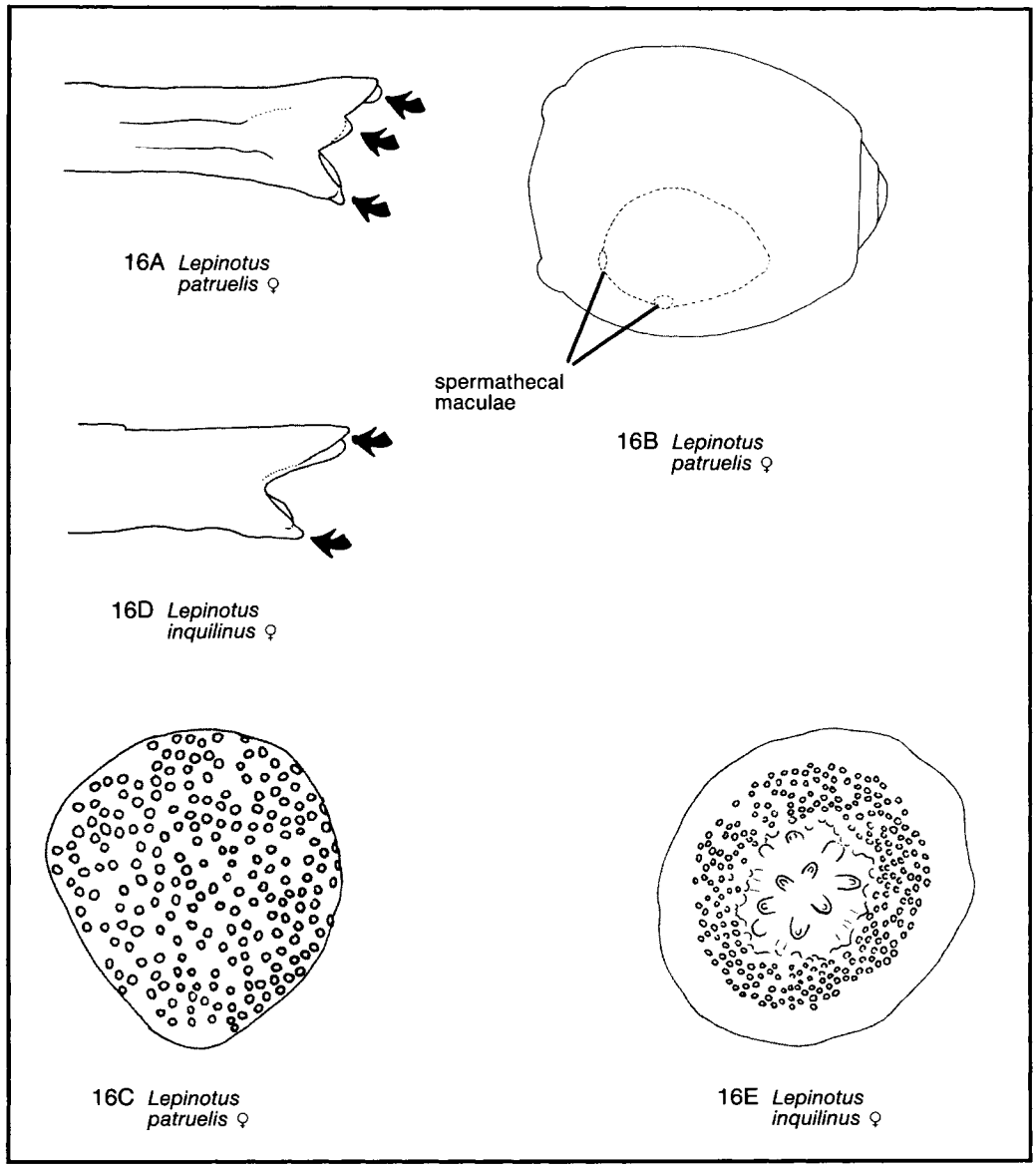
15E *Lepinotus patruelis*♀

16 Lacinial tip distinctly tridentate (16A); spermathecal maculae (16B) each with uniform, minute papillae (16C)----------*Lepinotus patruelis*

Common in houses in central Europe; often seen at United States ports on dried plant materials from central Europe. See also 14A, 15C, 15E. References: *1, 9, 11, 18.*

Lacinial tip bidentate, any medial protuberance being at most a low mound (16D); spermathecal maculae (16B) each with large central spinelike papillae and smaller peripheral granular papillae (16E) ----------*Lepinotus inquilinus*

Relatively common in houses in Europe, North America, Africa, and Madagascar. See also 15D. References: *1, 9, 10, 27.*



16A *Lepinotus patruelis* ♀

16B *Lepinotus patruelis* ♀

16D *Lepinotus inquilinus* ♀

16C *Lepinotus patruelis* ♀

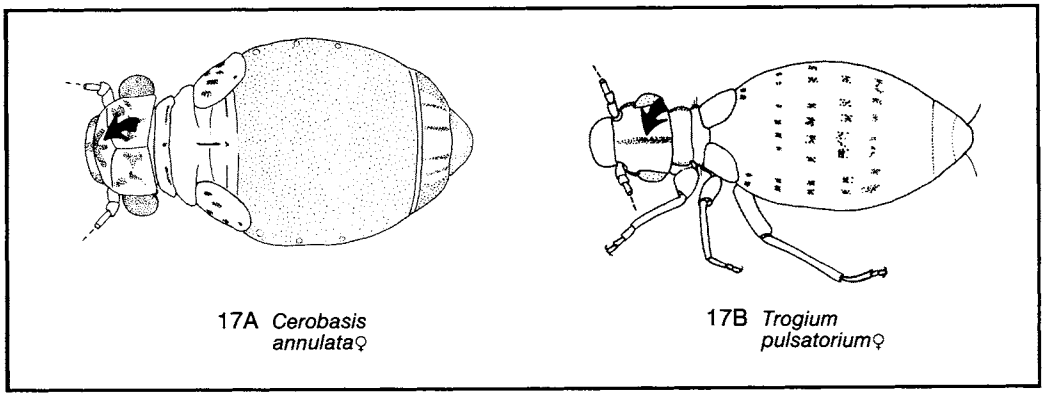
16E *Lepinotus inquilinus* ♀

17 Frons with a brown, anchor-shaped mark; wings brown-spotted (17A)
---------- *Cerobasis annulata*

Occurs in houses in Europe and North America. See also 14B. References: *9, 10.*

Frons marked with a dark longitudinal line; wings uniform in color (17B)
---------- **larger pale trogiid,** *Trogium pulsatorium*

Common in houses in Europe and North America. References: *9, 10, 12, 27.*



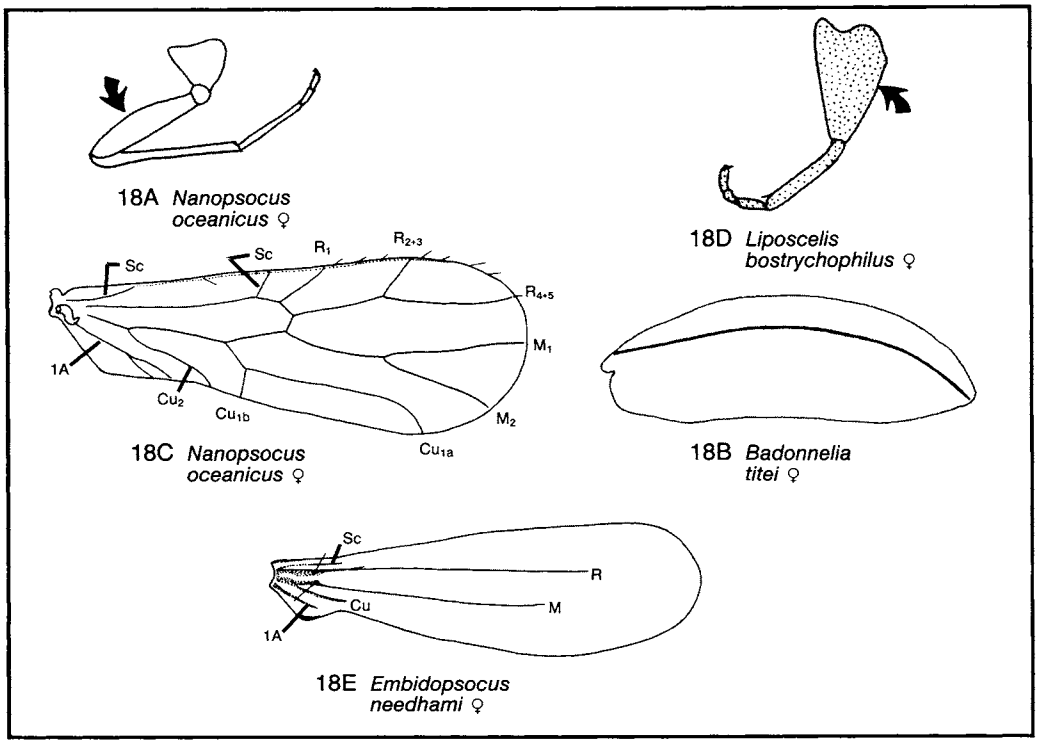
17A *Cerobasis annulata*♀

17B *Trogium pulsatorium*♀

Suborder Troctomorpha

18 Body not depressed; femur III not dilated (18A); forewings, if present, either elytriform, with reduced venation (18B), or with venation essentially complete (18C)---------- 19

Body depressed; femur III dilated (18D); wings, if present, with venation greatly reduced (18E). Liposcelidae ---------- 20



18A *Nanopsocus oceanicus* ♀

18D *Liposcelis bostrychophilus* ♀

18C *Nanopsocus oceanicus* ♀

18B *Badonnelia titei* ♀

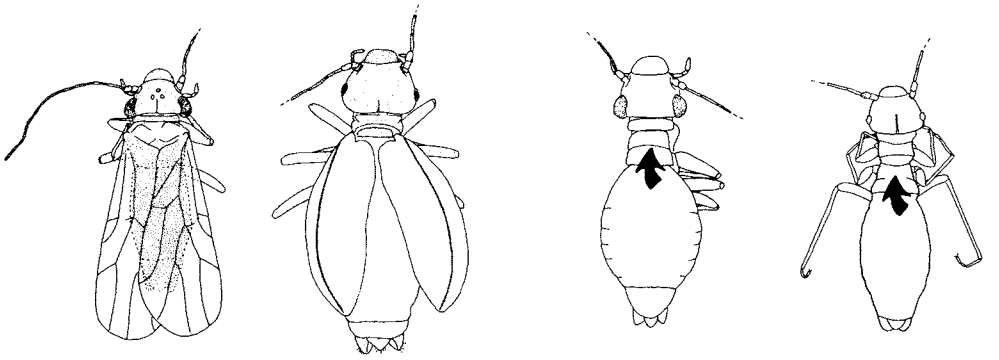
18E *Embidopsocus needhami* ♀

19 Wings, if present, flat, with many veins (19A); apterous forms with mesothorax and metathorax separated by an obvious suture (19B). Pachytroctidae ----------*Nanopsocus oceanicus*

Occurs in houses in southeastern United States and Japan (also in dried mushrooms in Japan); also known from West Africa and New Hebrides. See also 18C. Reference: *4* (= *Tapinella africana* and *T. pallida*).

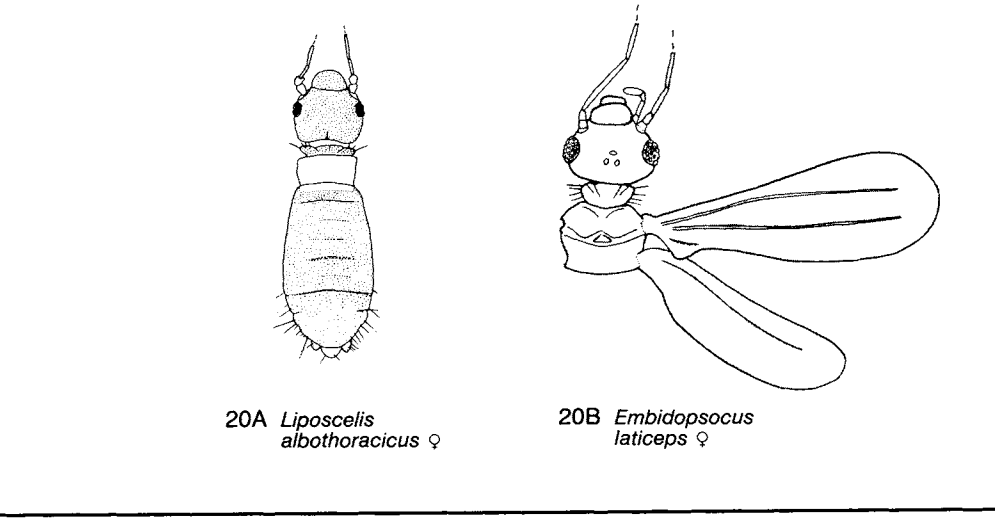
Wings, if present, convex, elytriform, with few veins (19C); apterous forms with mesothorax and metathorax fused (19D). Sphaeropsocidae ----------*Badonnelia titei*

Known from domestic situations, including stored food, in central Europe and England. References: *9, 11, 22, 23.*



19A *Nanopsocus oceanicus* ♀ 19C *Badonnelia titei* ♀ 19B *Nanopsocus oceanicus* ♀ 19D *Badonnelia titei* ♂

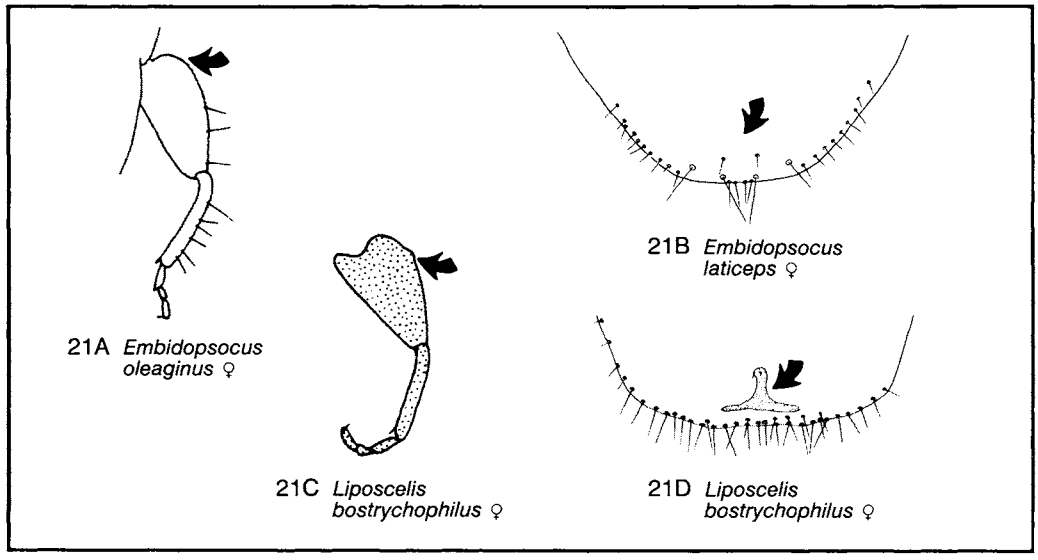
20 Wings and ocelli absent (20A)---------- 21
Wings and ocelli present (20B)---------- 22



20A *Liposcelis albothoracicus* ♀ 20B *Embidopsocus laticeps* ♀

21 Femur III moderately broad, without a lateral process (21A); subgenital plate without a T-shaped sclerite (21B) ---------- 22
Femur III very broad, with a small lateral process (21C); subgenital plate with a T-shaped sclerite (21D). Genus *Liposcelis* ---------- 25

Males of *Liposcelis* are determined at present largely by association with females. For some species, males are unknown or nonexistent. The sexes may be distinguished as follows: females larger than males; subgenital plate with T-shaped sclerite (21D); the phallosome (an elongate, partially-enclosed frame above the hypandrium) occupying about half the length of abdomen. Reference: *6*.



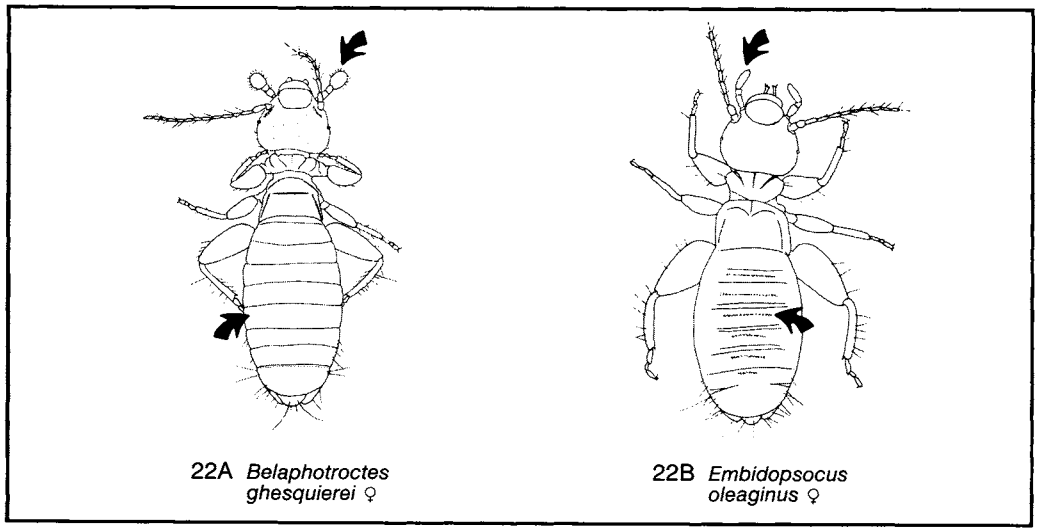
21A *Embidopsocus oleaginus* ♀

21B *Embidopsocus laticeps* ♀

21C *Liposcelis bostrychophilus* ♀

21D *Liposcelis bostrychophilus* ♀

22 Terminal segment of maxillary palp at least slightly dilated (22A); abdominal terga III-VIII each lacking a slender, heavily sclerotized transverse strip (22A). Genus *Belaphotroctes* ---------- 23
Terminal segment of maxillary palp not dilated (22B); abdominal terga III-VIII each with a slender, heavily sclerotized transverse strip (22B). Genus *Embidopsocus* 24



22A *Belaphotroctes ghesquierei* ♀

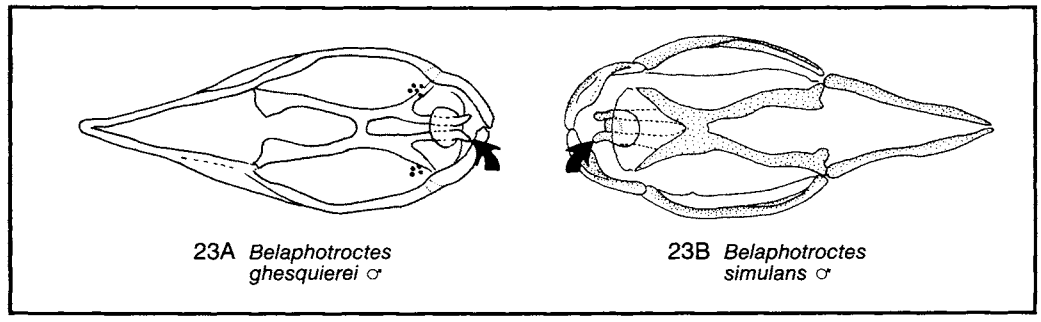
22B *Embidopsocus oleaginus* ♀

23 Endophallic central prongs with pointed tips (23A)----------*Belaphotroctes ghesquierei*

Known from Brazil, Florida, and West Africa, primarily from outdoor situations, but from stored food in West Africa. See also 22A. References: *3-5*.

Endophallic central prongs with blunt tips (23B)----------*Belaphotroctes simulans*

Found in stored food in West Africa.
Drawing adapted from *5* by C. Feller.



23A *Belaphotroctes ghesquierei* ♂

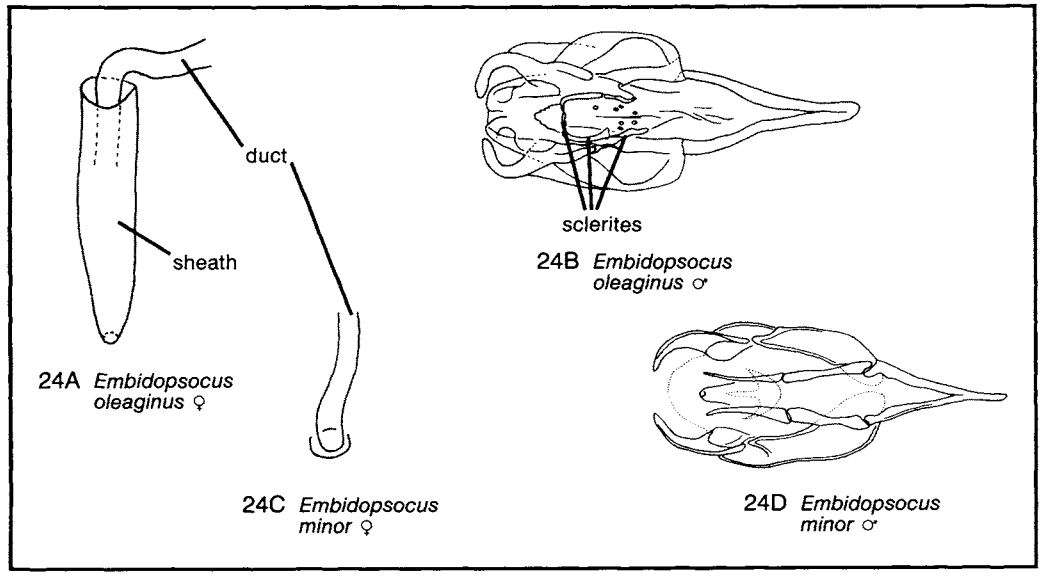
23B *Belaphotroctes simulans* ♂

24 Spermathecal duct with sheath around spermapore end (24A); endophallus with arch of small sclerites (24B)----------*Embidopsocus oleaginus*

Associated with stored foods in West Africa, Sri Lanka, and several western Pacific localities (Philippines, Taiwan, Okinawa). See also 21A, 22B. References: *1, 5*.

Spermathecal duct without sheath (24C); endophallus without arch of sclerites (24D)
---------- *Embidopsocus minor*

Taken from West African cacao in a British warehouse, and from stored foods in West Africa. References: *5, 19*.
Drawings adapted from *5* by C. Feller.



24A *Embidopsocus oleaginus* ♀

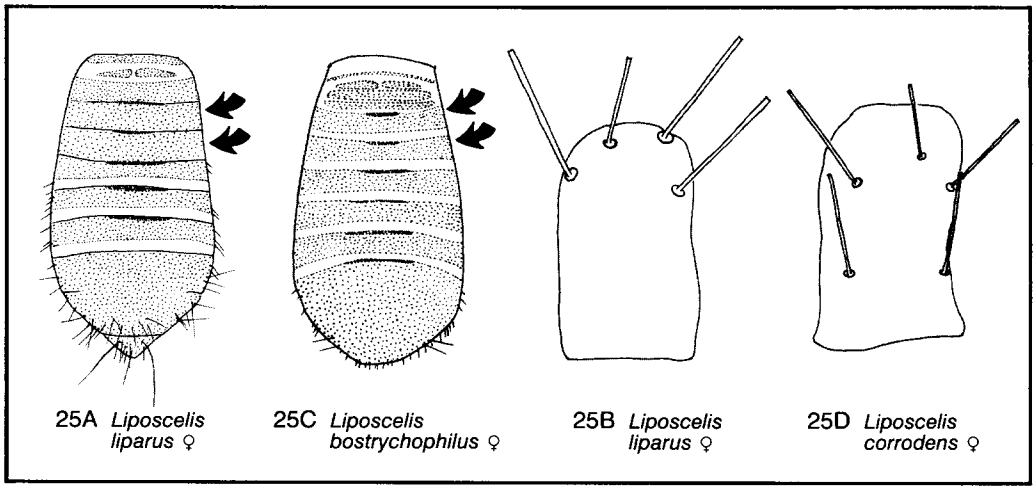
24B *Embidopsocus oleaginus* ♂

24C *Embidopsocus minor* ♀

24D *Embidopsocus minor* ♂

25 Abdominal terga III and IV uniform in color, not presenting, at least in their central portions, a posterior membranous band with sculpture different from their anterior parts (25A); all prosternal setae anterior (25B). Section I ---------- 26

Abdominal terga annulate, with distinct intersegmental membranes in posterior parts of terga III to VII showing different sculpture and paler color than the more sclerotized anterior parts of these segments (25C); prosternal setae either restricted to anterior half (25B) or distributed in both halves (25D). Section II ---------- 34

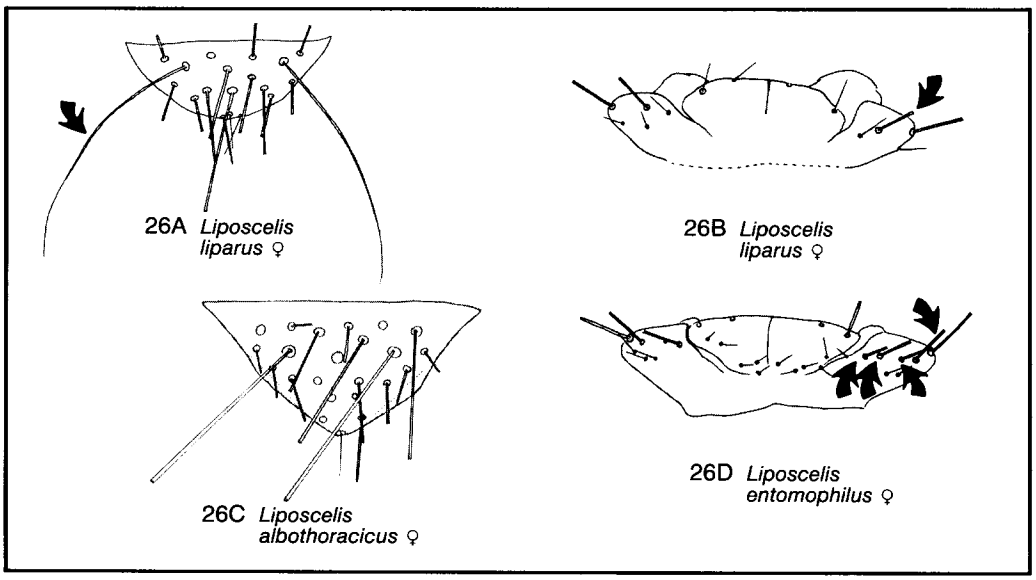


25A *Liposcelis liparus* ♀ 25C *Liposcelis bostrychophilus* ♀ 25B *Liposcelis liparus* ♀ 25D *Liposcelis corrodens* ♀

26 Epiproct with a pair of long, slender, acuminate setae (26A); lateral pronotal lobe with a long, strong humeral seta and a single long supplementary bristle (26B) ---------- *Liposcelis liparus*

In buildings in England; common in outdoor situations in western United States and South Africa. See also 25A, 25B. References: *6, 9, 11.*

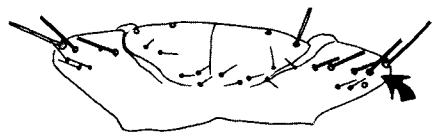
Epiproct without acuminate setae (26C); pronotal lobe with 2 or more supplementary setae (26D), or supplementary setae absent ---------- 27



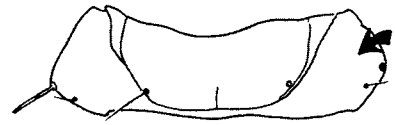
26A *Liposcelis liparus* ♀ 26B *Liposcelis liparus* ♀ 26C *Liposcelis albothoracicus* ♀ 26D *Liposcelis entomophilus* ♀

27 Lateral lobe of pronotum with a transverse row of 2 to 5 strong setae in addition to humeral seta (27A)---------- 28

Lateral lobe of pronotum with humeral seta and scattered small setae, but without a transverse row of strong setae (27B) ---------- 30



27A *Liposcelis entomophilus* ♀



27B *Liposcelis kidderi* ♀

28 Body without a striking pattern, uniform in color except apical half of abdomen somewhat darker than basal half----------*Liposcelis transvaalensis*

Recorded from stored foods in West Africa. Reference: *5.*

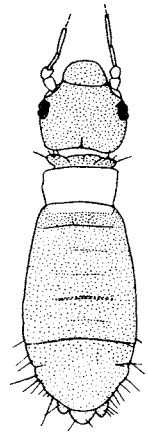
Body marked with a striking pattern of contrasting colors ---------- 29

29 Mesothorax, metathorax, and abdominal segment I white; other portions of body brown (29A) ----------*Liposcelis albothoracicus*

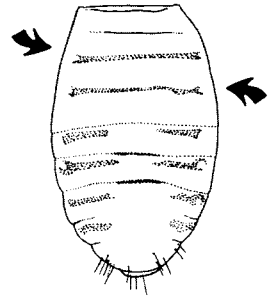
Collected from Turkish millet seed in a ship at Liverpool, England, and from an outdoor locality in southern India. See also 26C. Reference: *7.*

Body generally a creamy yellow, with lateral reddish-brown bands on abdominal terga III to VIII, continuous across terga III and IV (29B)----------*Liposcelis entomophilus*

Cosmopolitan; common in stored grain. See also 27A. References: *2, 9, 13.*



29A *Liposcelis albothoracicus* ♀

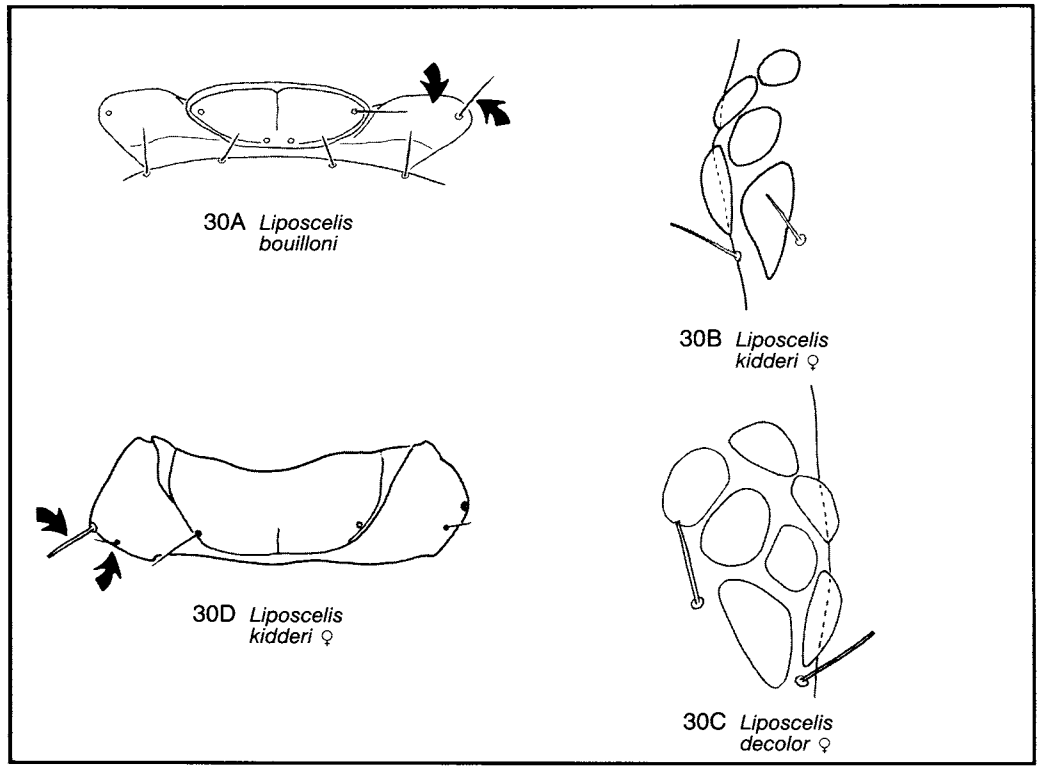


29B *Liposcelis entomophilus* ♀

30 Compound eye of both sexes with 4 facets; lateral lobe of pronotum with only humeral seta, no smaller setae (30A) ----------*Liposcelis bouilloni*

From stored coffee in West Africa, and from outdoor situations in Brazil.
Drawing adapted from 5 by C. Feller.

Compound eye of female with 5 (30B) to 7 facets (30C), of male, 4 to 5 facets; lateral lobe of pronotum with humeral seta plus 1 or more smaller setae (30D)---------- 31



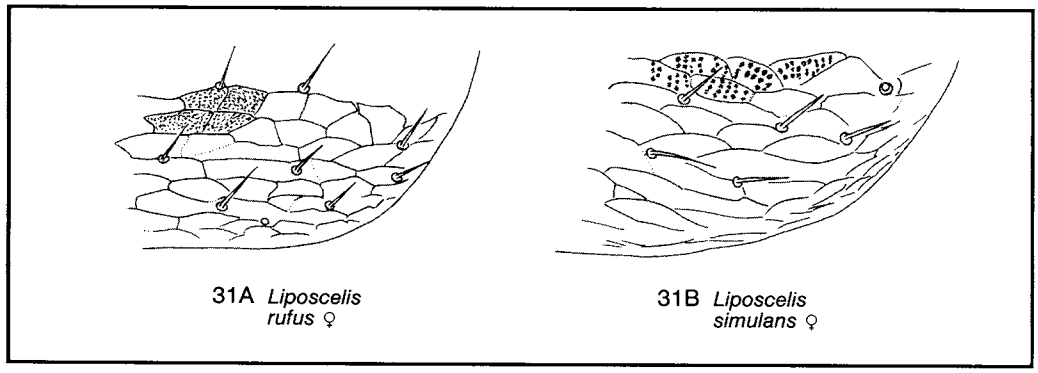
30A *Liposcelis bouilloni*

30B *Liposcelis kidderi* ♀

30D *Liposcelis kidderi* ♀

30C *Liposcelis decolor* ♀

31 Vertex sculptured with finely granulate areoles (31A; details shown only in selected areoles) ---------- 32
Vertex sculptured with areoles bearing small tubercles forming anteroposteriorly-oriented wavy lines (31B) ---------- 33



31A *Liposcelis rufus* ♀

31B *Liposcelis simulans* ♀

32 Compound eye of female with 5 (see 30B) to 6 facets, of male, 4 to 5 facets; body color medium brown----------*Liposcelis kidderi*

Occurs in houses in Europe and North America. See 30B, 30D. References: *6, 9, 11.*

Compound eye of female with 6 to 7 (usually 7) facets, of male, 5 facets; body color reddish-brown----------*Liposcelis rufus*

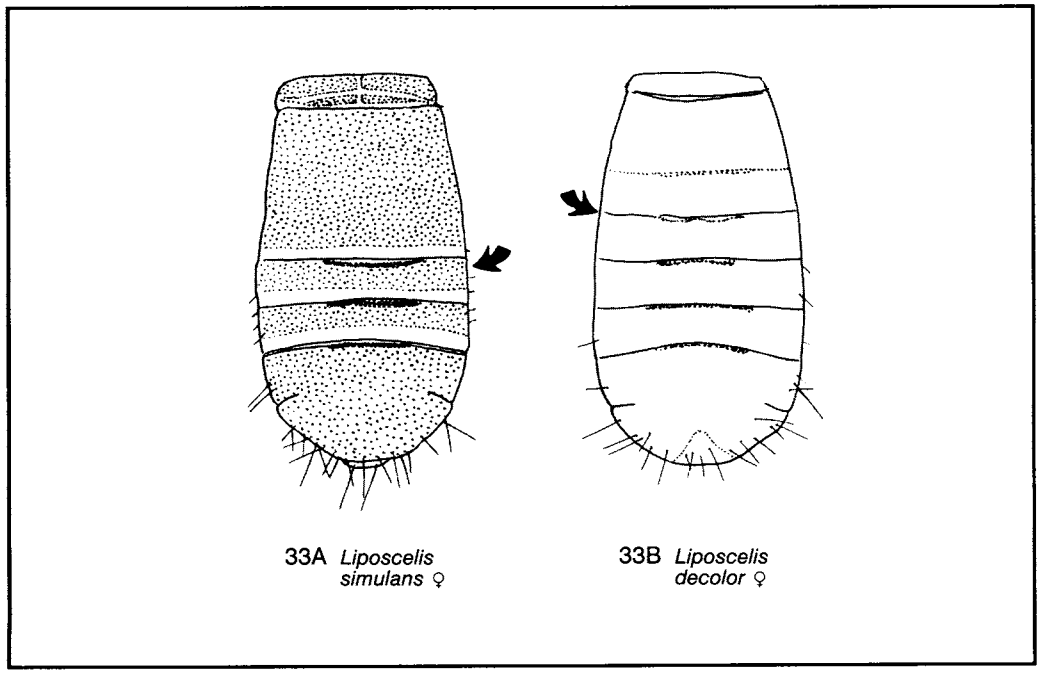
Recorded from a building in Ohio, from an outdoor locality in California, and from England (situation unknown). See 31A. References: *4, 6.*

33 Anterior margins of abdominal terga VI-VIII with prominent dark, transverse, sclerotized strips (33A); body color medium brown----------*Liposcelis simulans*

Known from houses and bird nests in central Europe, England, and the United States; frequently found in stored grain. See 31B. References: *6, 9, 11.*

Anterior margins of abdominal terga V-VIII with prominent dark, transverse, sclerotized strips (33B); body color ochre yellow----------*Liposcelis decolor*

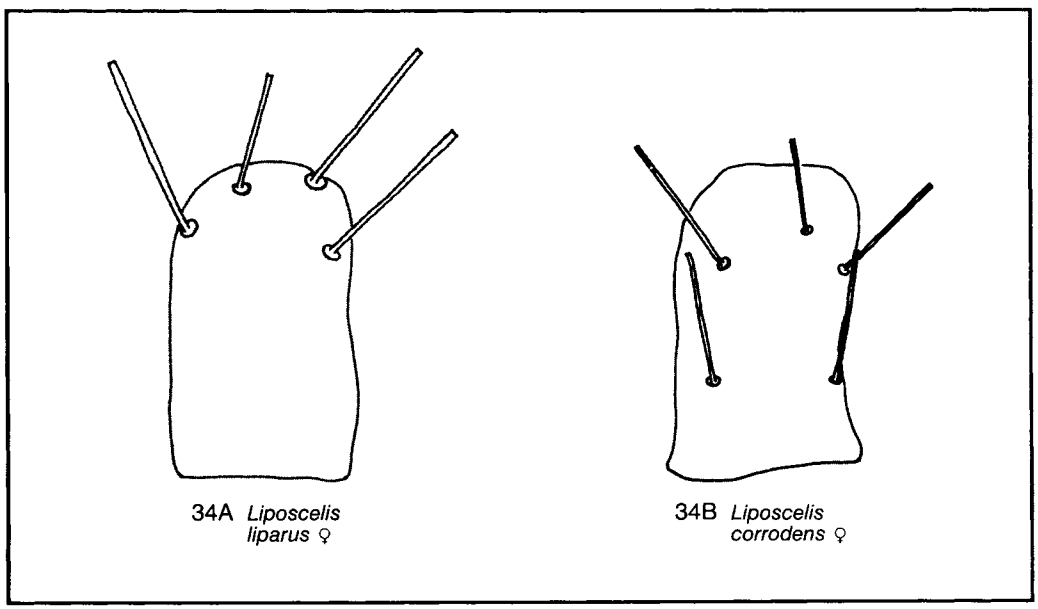
Probably cosmopolitan; occurs in houses and in stored agricultural products in Europe and, less commonly, in the United States. See also 30C. References: *2, 4, 6, 11 (= L. terricolis).*



33A *Liposcelis simulans* ♀

33B *Liposcelis decolor* ♀

34 Prosternal setae all in anterior half of prosternum (34A)---------- 35
Prosternal setae distributed in both anterior and posterior half of prosternum (34B) 40



34A *Liposcelis liparus* ♀

34B *Liposcelis corrodens* ♀

35 Compound eye of female with 7 facets ---------- 36
Compound eye of female with fewer than 7 facets---------- 38

36 Lateral lobe of pronotum with transverse row of 4 to 6 long bristles in addition to shorter setae (as in 27A) ----------*Liposcelis pubescens*

Collected from a granary and other buildings in England; also known from central Europe, Argentina, Tristan da Cunha, and New Zealand. References: *6, 9.*

Lateral lobe of pronotum with 1 long bristle (humeral seta) and several shorter setae (as in 27B) ---------- 37

37 Body length of female less than 1 mm; body color a pale reddish-brown ---------- *Liposcelis exiguus varians*

Reported once from stored peanuts in Zaire. References: *4, 5.*

Body length of female 1.2 to 1.4 mm; body color a pale chamois-brown ---------- *Liposcelis mendax*

Occurs in houses in Europe and in stored foods in Zaire. References: *5, 6, 9.*

38 Compound eye of female with 5 facets ---------- *Liposcelis mendax*

See also couplet 37.

Compound eye of female with fewer than 5 facets ---------- 39

39 Compound eye of female with 4 facets ---------- *Liposcelis obscurus*

Collected from wheat caked in the hold of a ship in Bristol, England. References: *9, 15.*

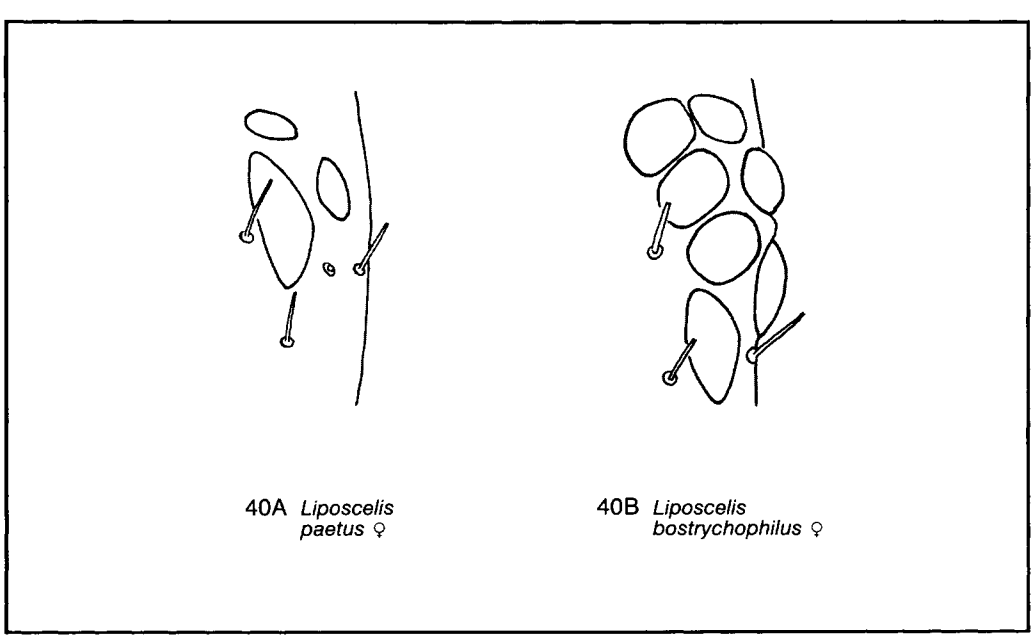
Compound eye of female with 2 facets ---------- *Liposcelis paetulus*

From a building in England. References: *5, 6, 9.*

40 Compound eye of female with 3 facets (40A) ---------- *Liposcelis paetus*

Cosmopolitan; common in stored grain. References: *5, 6, 9, 21.*

Compound eye of female with 5 to 7 facets (40B) ---------- 41



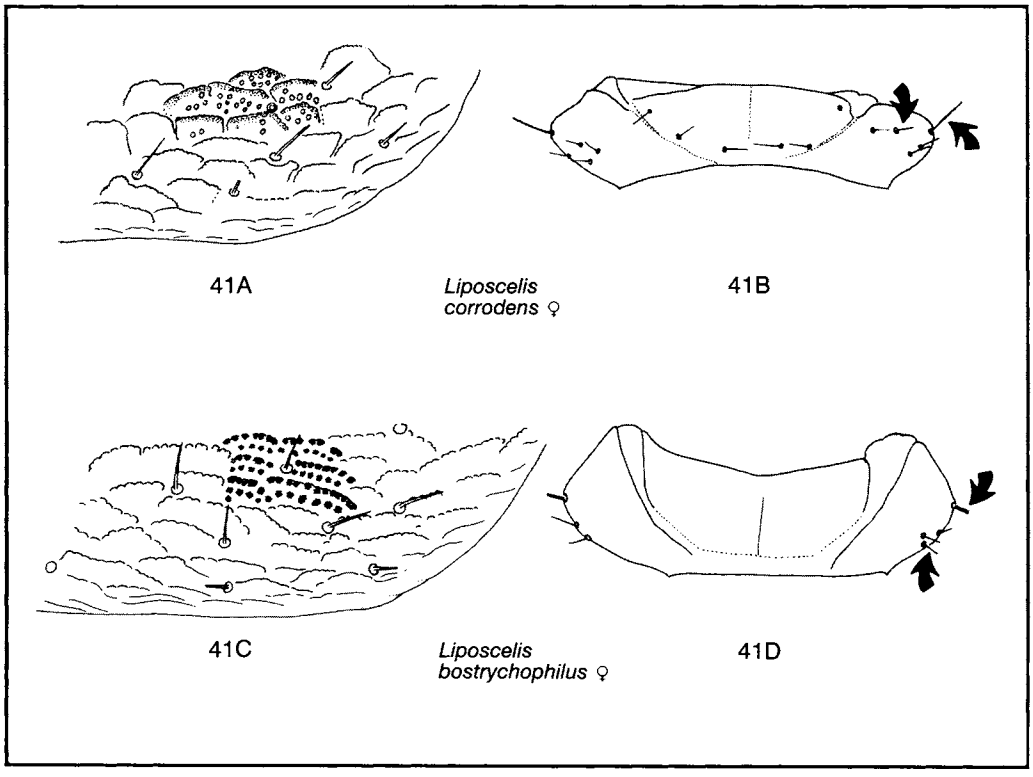
40A *Liposcelis paetus* ♀

40B *Liposcelis bostrychophilus* ♀

41 Sculpture of vertex and abdominal terga consisting of areoles that are separated by depressed lines and are tuberculate except near their borders (41A; details shown only in selected areoles); lateral lobe of pronotum with humeral seta about 3 times longer than other setae (41B) ----------*Liposcelis corrodens*

Known from Europe, North America, Japan, and Chile; occurs frequently in stored foods. See also 25D. References: *9*.

Sculpture of vertex and abdominal terga consisting of densely tuberculate areoles that are separated by bare spaces and (or) by lines of relatively more pronounced tubecles (41C); humeral seta no more than twice as long as other setae on pronotal lobe (41D) ---------- 42

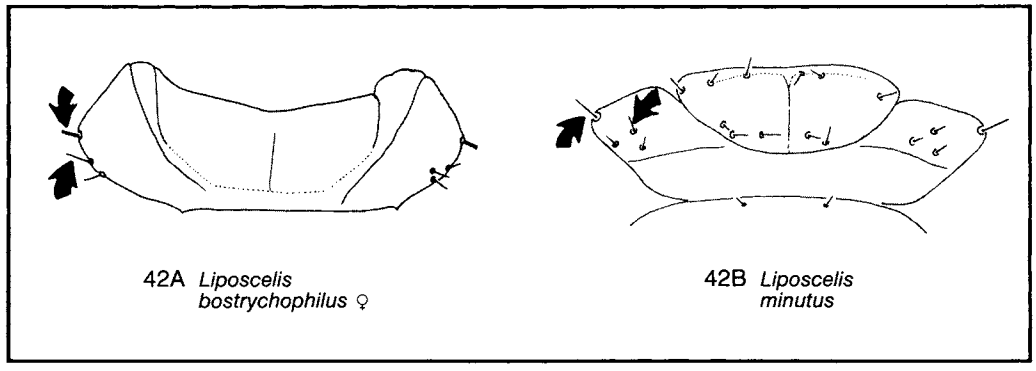


42 Humeral seta about same length as other setae on lateral lobe of pronotum (42A); compound eye of female usually with 7 facets ---------- *Liposcelis bostrychophilus*

Cosmopolitan; common in stored grain. See also 1B, 21C, 21D, 40B, 41C. References: *2, 4-6, 9, 13.*

Humeral seta about twice length of other setae on lateral lobe of pronotum (42B); compound eye of female usually with 5 facets ---------- *Liposcelis minutus*

Found in stored food in Zaire.
Drawing adapted from *5* by C. Feller.



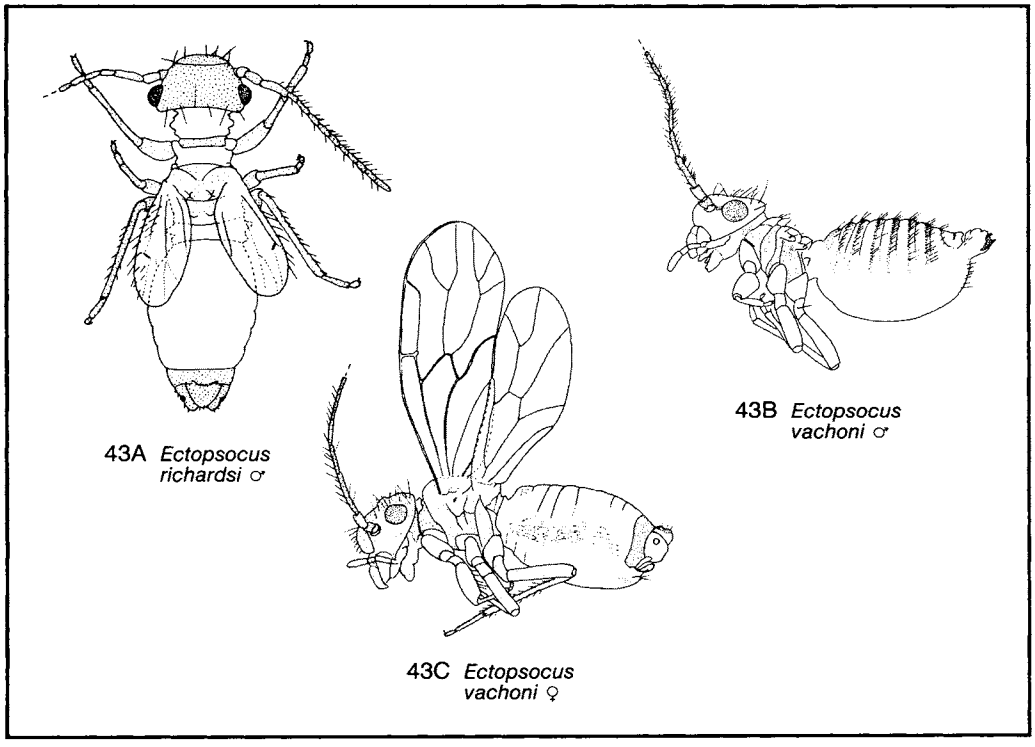
42A *Liposcelis bostrychophilus* ♀

42B *Liposcelis minutus*

Suborder Psocomorpha

43 Individuals brachypterous (43A) (wings not extending beyond midpoint of abdomen) or micropterous (43B) ---------- 44

Individuals macropterous (43C) (wings reaching or extending beyond apex of abdomen) ---------- 45



43A *Ectopsocus richardsi* ♂

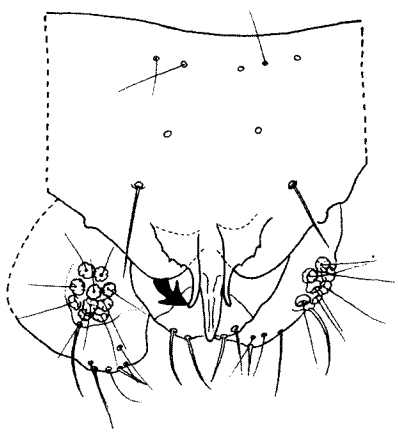
43B *Ectopsocus vachoni* ♂

43C *Ectopsocus vachoni* ♀

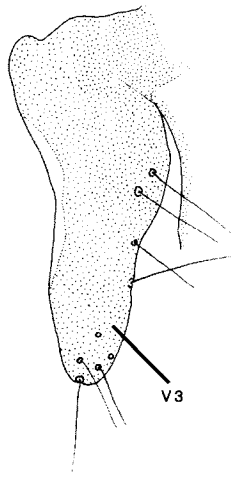
44 Clunium of male with posterodorsal margin bearing a pair of pointed processes (44A); gonapophysis of female a single valvula (44B). Lachesillidae (in part)
----------**cosmopolitan grain psocid,** *Lachesilla pedicularia*

Distributed throughout Europe and North America, primarily in outdoor situations but also common in houses and occasional in stored grain. See also 47A. References: *1, 9, 10, 30.*

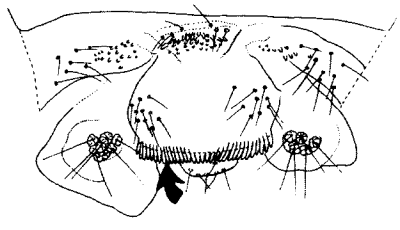
Clunium of male with a transverse comb of small teeth on posterodorsal margin (44C); gonapophysis of female composed of 3 valvulae (44D). Ectopsocidae (in part)---------- 50



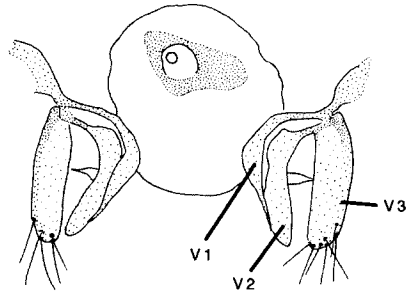
44A *Lachesilla pedicularia* ♂



44B *Lachesilla pedicularia* ♀



44C *Ectopsocus briggsi* ♂

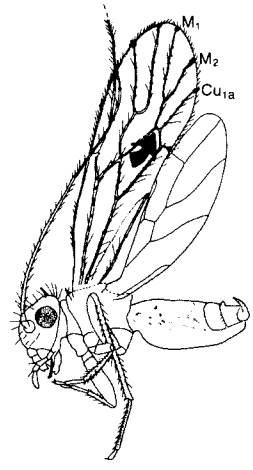


44D *Ectopsocus pumilis* ♀

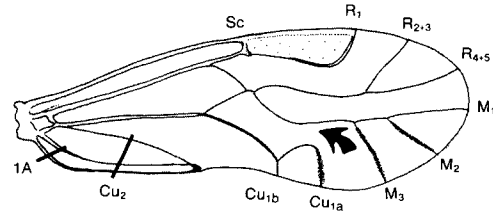
45 Cu_{1a} and M of forewing joined by crossvein; M of forewing 2-branched (45A). Hemipsocidae ---------- *Hemipsocus africanus*

Collected from Mexican pineapples and papayas at United States ports. Reference: *4.*

Cu_{1a} of forewing either absent or not joined to M; M 3-branched (45B) ---------- 46



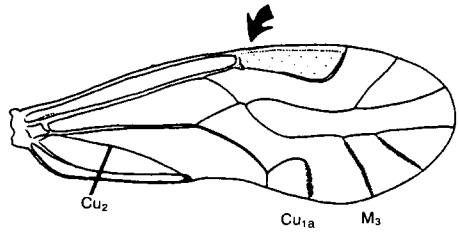
45A *Hemipsocus africanus* ♂



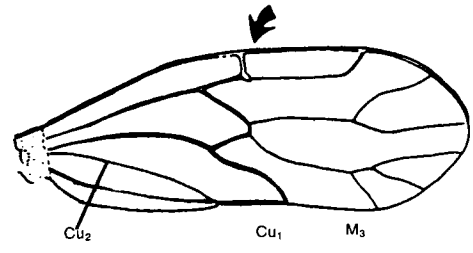
45B *Lachesilla pedicularia* ♀

46 Cu_{1a} present in forewing; pterostigma with basal constriction (46A). Lachesillidae (in part) ---------- 47

Cu_{1a} absent in forewing; pterostigma about as wide at its base as at its middle (46B). Ectopsocidae (in part) ---------- 49



46A *Lachesilla pedicularia* ♀

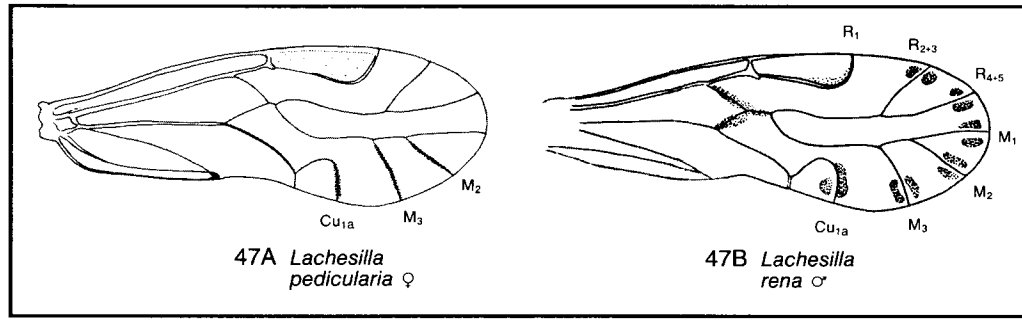


46B *Ectopsocus vachoni* ♀

47 Forewing completely clear, without spots, but with Cu_{1a}, M_2, and M_3 narrowly brown-bordered (47A)----------**cosmopolitan grain psocid,** *Lachesilla pedicularia*

See couplet 44.

Forewing with a cloudy brown spot around distal end of each radial and medial vein and around Cu_{1a} (47B)---------- 48



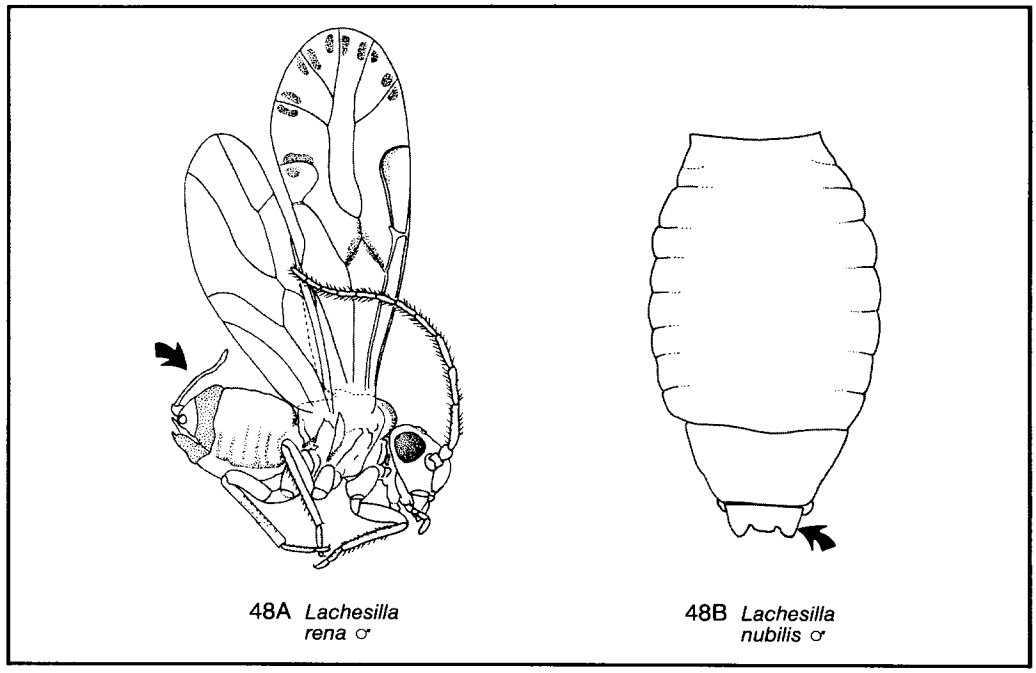
47A *Lachesilla pedicularia* ♀ 47B *Lachesilla rena* ♂

48 Forewing 1.5 to 1.7 mm in length; epiproct of male with an elongate, slender, medial process directed anteriorily on dorsal surface of abdomen (48A) ---------- *Lachesilla rena*

Found once on peas in pods in storage; common on dried soybean plants in fields of western Mexico. Reference: *30.*

Forewing 2.1 to 2.5 mm in length; epiproct with 2 short lateral processes but no medial process (48B) ----------*Lachesilla nubilis*

Widespread in North America, mostly in outdoor situations but also from stored grain. Reference: *30.*

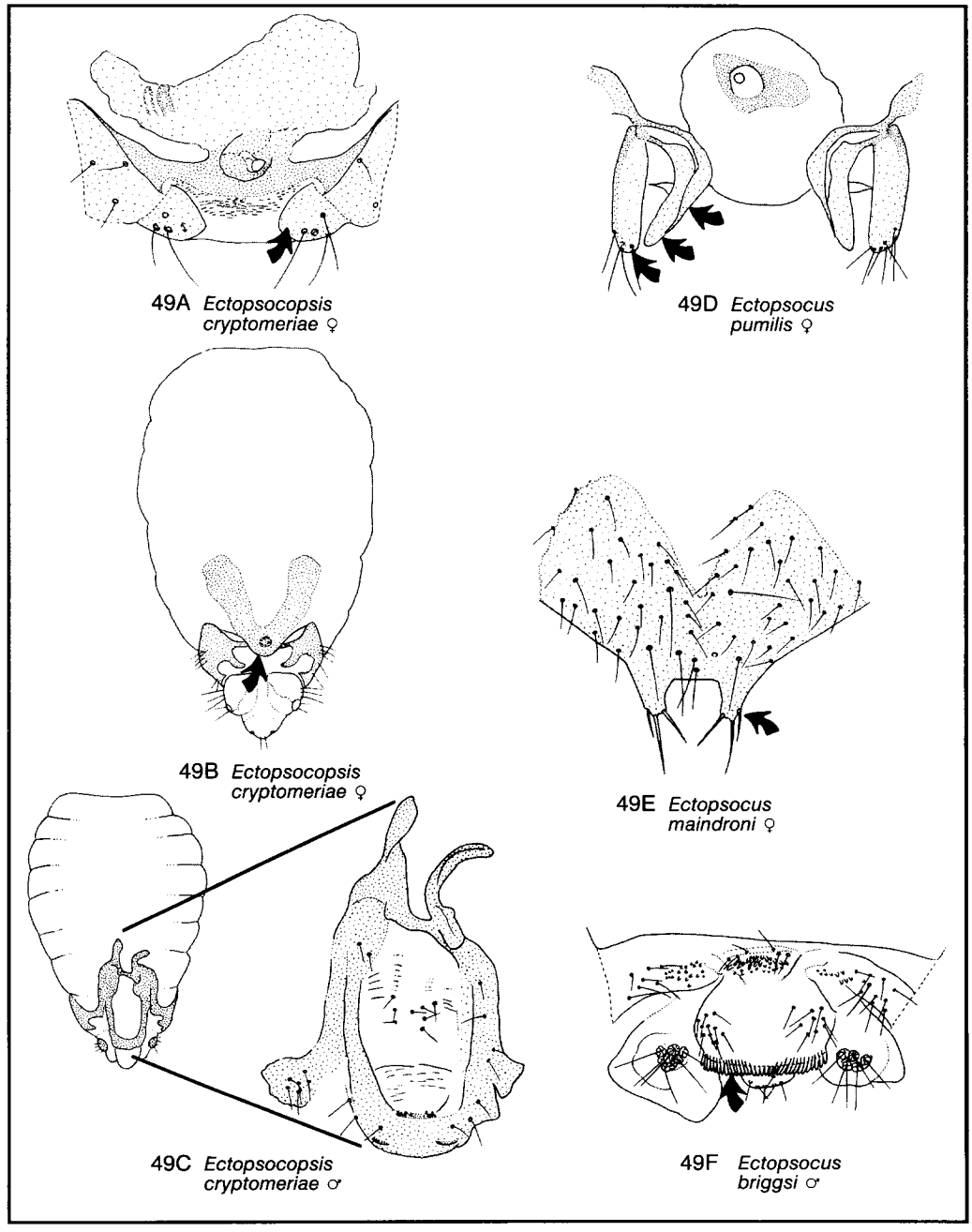


48A *Lachesilla rena* ♂ 48B *Lachesilla nubilis* ♂

49 Gonapophyses of female reduced to a rudimentary third valvula (49A); subgenital plate prolonged posteriorly by a medial process (49B); clunium of male with dorsal apophyses forming a complex clasping organ (49C) ---------*Ectopsocopsis cryptomeriae*

Nearly cosmopolitan; common in stored foods.
Reference: *13*.

Gonapophyses complete with 3 valvulae (49D); subgenital plate usually bilobed medially (49E); clunium of male carrying dorsally only a transverse comb (49F). Genus *Ectopsocus* ---------- 50



49A *Ectopsocopsis cryptomeriae* ♀

49D *Ectopsocus pumilis* ♀

49B *Ectopsocopsis cryptomeriae* ♀

49E *Ectopsocus maindroni* ♀

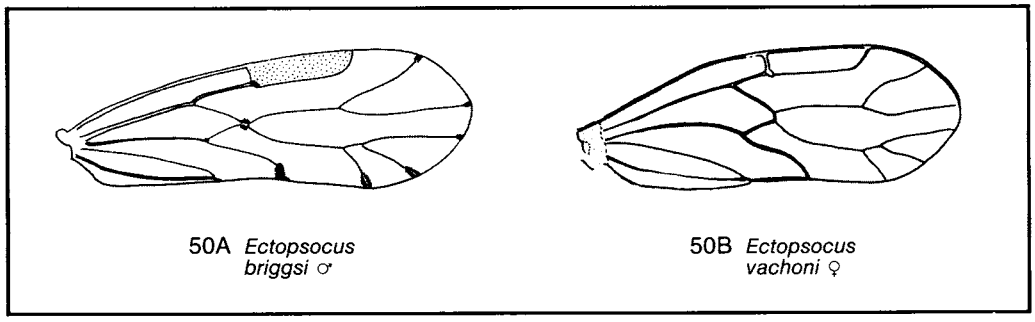
49C *Ectopsocopsis cryptomeriae* ♂

49F *Ectopsocus briggsi* ♂

50 Individuals macropterous; forewings with faint pattern of spots, 1 on end of each longitudinal vein and 1 at junction of Rs and M (50A)----------*Ectopsocus briggsi*

Present on most continents; occasionally found in houses along the Pacific coast of the United States; occasionally collected from imported herbs, citrus, and other fruits at United States ports. See also 44C. References: *9, 27.*

Individuals macropterous or short-winged; no spotted pattern on forewings of macropterous individuals (50B) ---------- 51



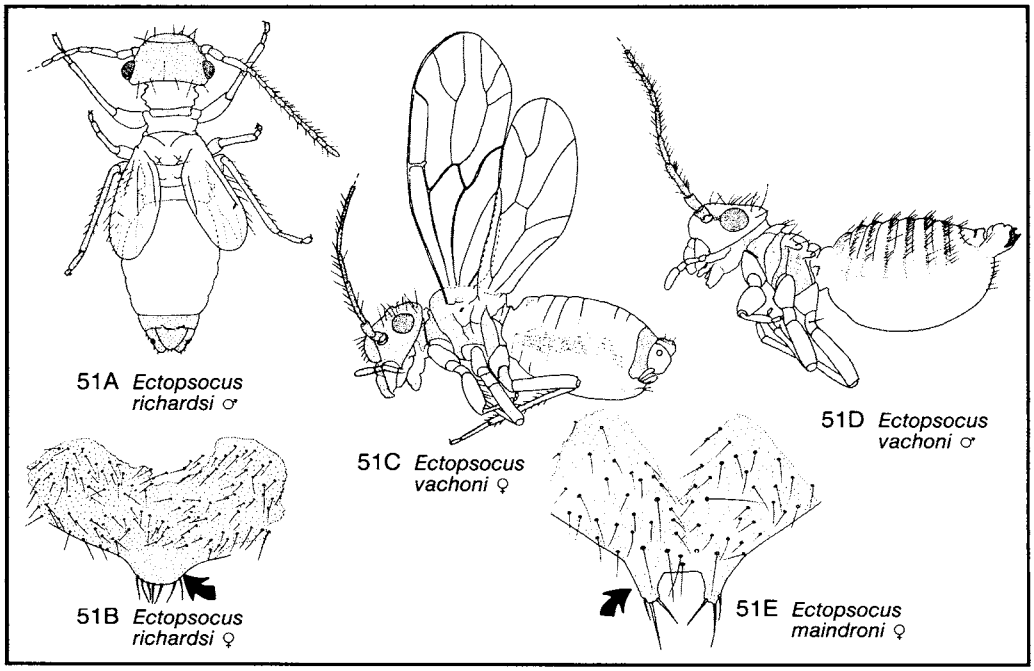
50A *Ectopsocus briggsi* ♂

50B *Ectopsocus vachoni* ♀

51 Head color a medium brown, contrasting with a paler body; adults brachypterous (51A); subgenital plate with a single, rounded, posteromedian lobe (51B) ----------*Ectopsocus richardsi*

Widespread in world trade, usually in stored grain and other dry foods. References: *5, 14, 17, 21, 29.*

Body color approximately uniform throughout; adults macropterous (51C) or micropterous (51D); subgential plate bilobed posterorly (51E)---------- 52



51A *Ectopsocus richardsi* ♂

51B *Ectopsocus richardsi* ♀

51C *Ectopsocus vachoni* ♀

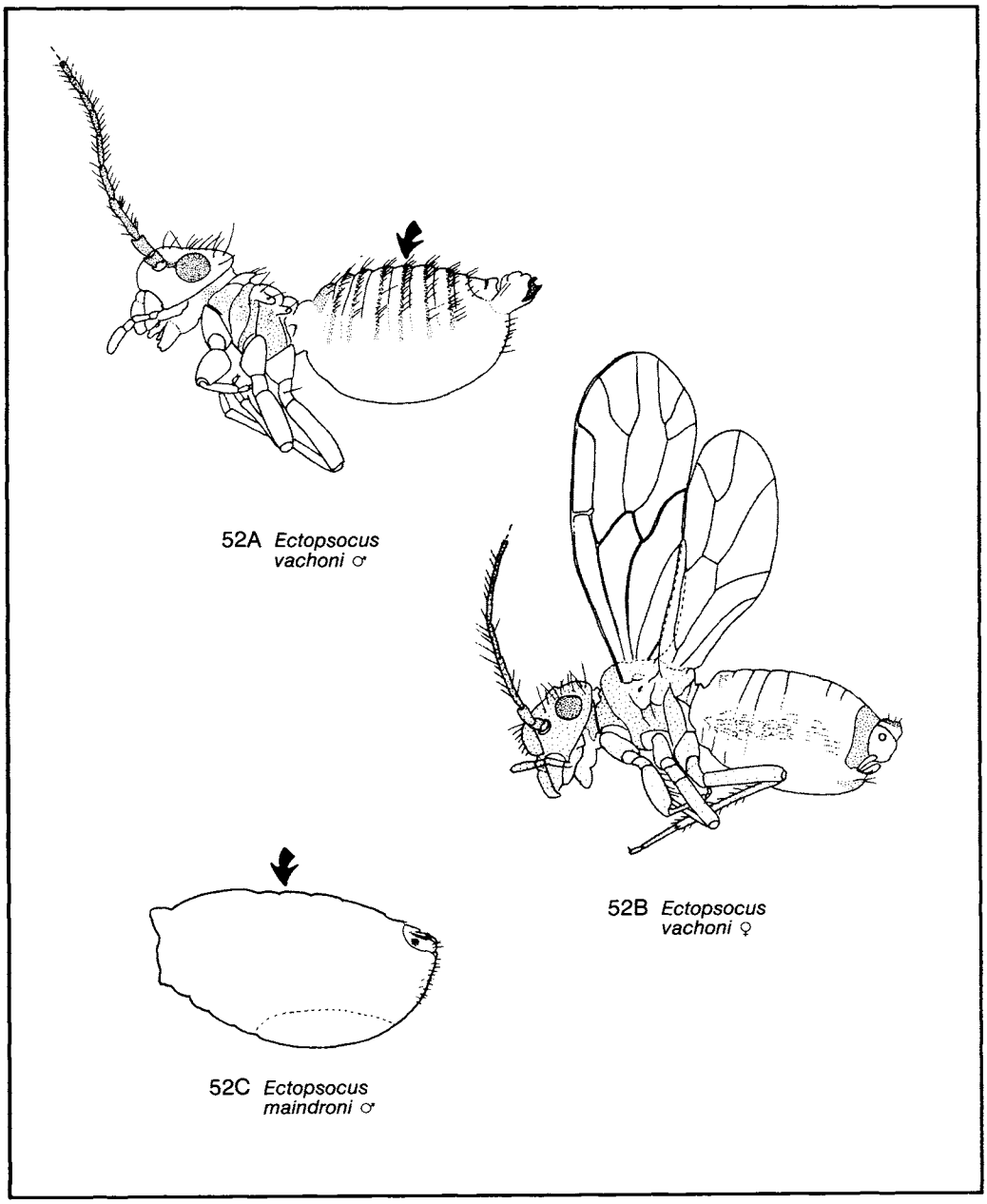
51D *Ectopsocus vachoni* ♂

51E *Ectopsocus maindroni* ♀

52 Males micropterous (52A); females micropterous or macropterous (52B); body color a medium reddish-brown; abdomen with reddish-brown annulations on a paler background (52A)----------*Ectopsocus vachoni*

Widely distributed in the subtropics; collected once from Mexican mixed vegetables on ice at Nogales AZ. References: *14.* (= *E. dimorphus*).

Adults macropterous (similar to 52B); body color a creamy yellow to pale tawny; abdomen not annulated (52C)---------- 53



52A *Ectopsocus vachoni* ♂

52B *Ectopsocus vachoni* ♀

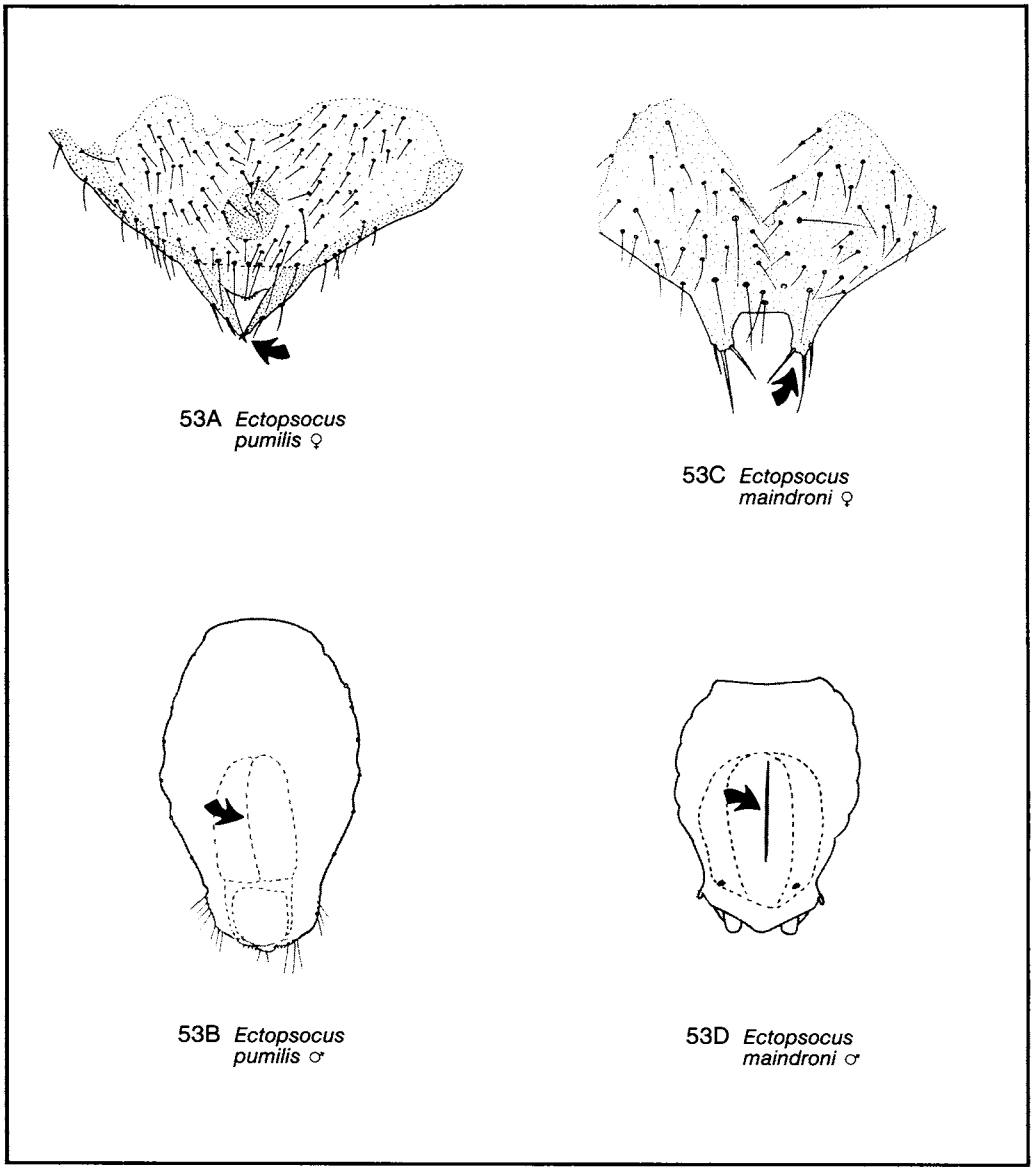
52C *Ectopsocus maindroni* ♂

53 Lobes of subgenital plate apically pointed (53A); abdominal venter of male without a posteromedial suture (53B)----------*Ectopsocus pumilis*

Occurs in houses in Florida, the West Indies, and Hong Kong. See also 44D. Reference: *4.*

Lobes of subgenital plate apically truncated (53C); abdominal venter of male with a posteromedial suture (53D)----------*Ectopsocus maindroni*

Probably circumtropical; often found around stored foods. See also 52C. Reference: *5.*



53A *Ectopsocus pumilis* ♀

53C *Ectopsocus maindroni* ♀

53B *Ectopsocus pumilis* ♂

53D *Ectopsocus maindroni* ♂

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23 THRIPS (THYSANOPTERA)

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KEY TO MACROPTEROUS FEMALES OF COMMON SPECIES

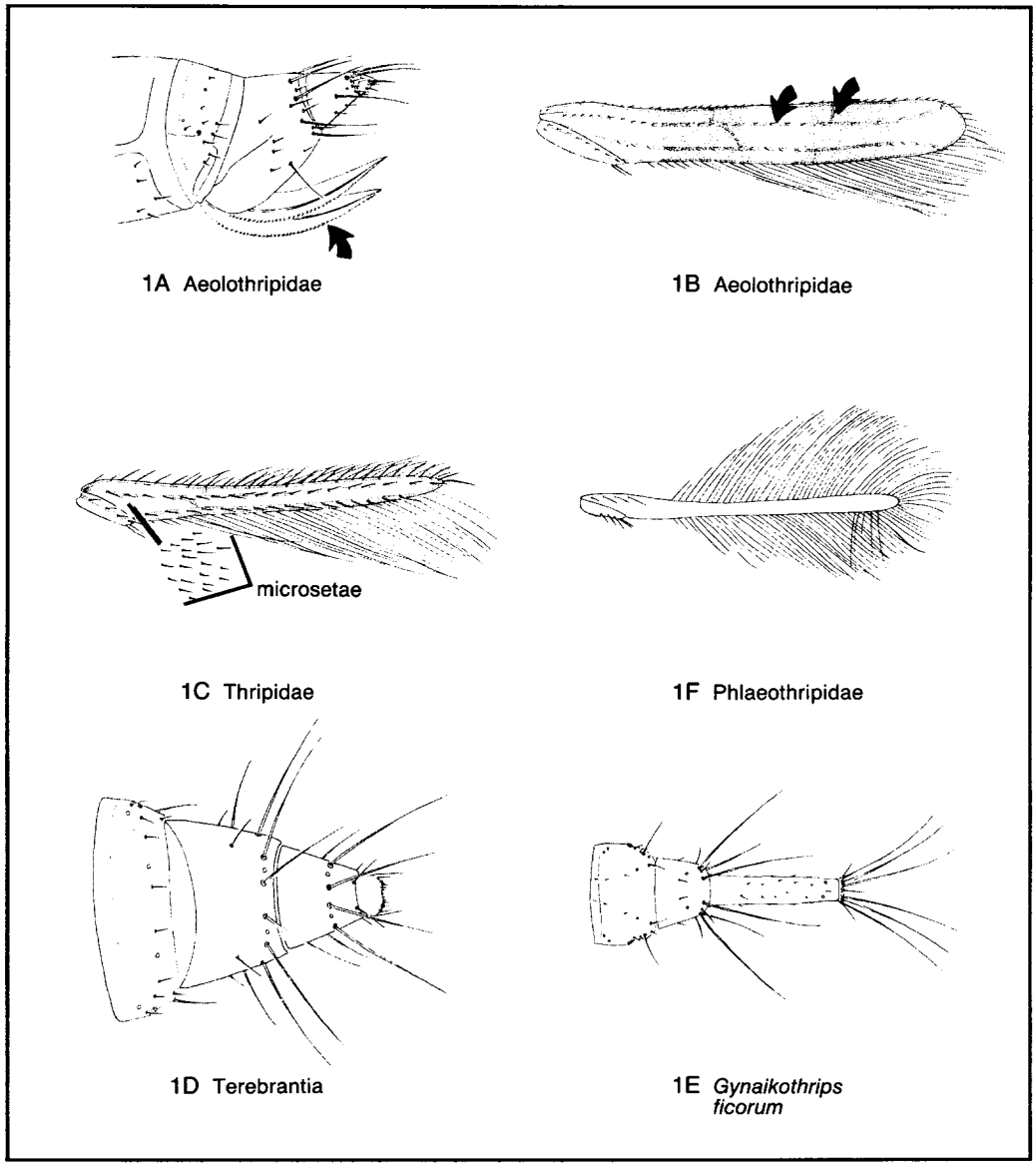
Drawings by C.S. Papp unless otherwise noted.

1 With sawlike ovipositor (1A); forewing with longitudinal veins and sometimes cross veins (1B); wings covered with microsetae (1C). Suborder Terebrantia---------- 2

Last abdominal segment usually conical (1D), rarely tubular.

Without sawlike ovipositor (1E); forewing without longitudinal veins (1F); wings without microsetae. Suborder Tubulifera. Phlaeothripidae---------- 18

Last abdominal segment usually tubular (1E).
Drawing 1E by T. Kono.



1A Aeolothripidae

1B Aeolothripidae

1C Thripidae

1F Phlaeothripidae

1D Terebrantia

1E *Gynaikothrips ficorum*

The assistance of Tokuwo Kono and Steve Nakahara in the preparation of this chapter is gratefully acknowledged.

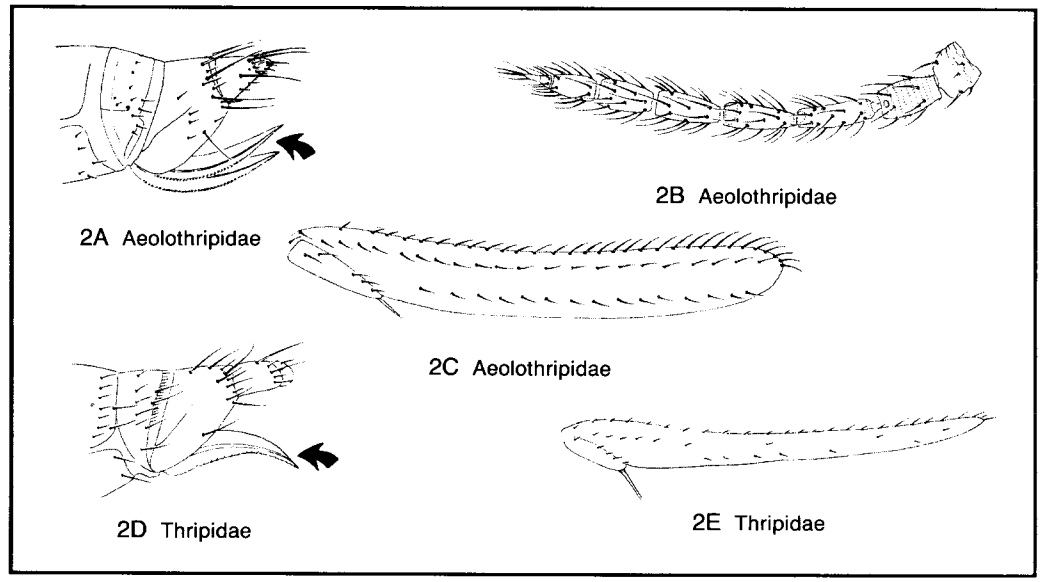
Terebrantia

2 Ovipositor upturned (2A). Aeolothripidae. Genus *Rhipidothrips*---------- 3

Antenna 9-segmented (2B); wings broad, rounded at tip (2C). The lens-shaped sensoria (2B) on antennal segments III and IV separate this genus from most other members of the family.

Ovipositor downturned (2D). Thripidae ---------- 4

Antenna 6- to 9-segmented; wings usually narrow, pointed at tip (2E). CAUTION: Heterothripidae also keys out at this point, but species of this family are unlikely associates of fruits and vegetables.

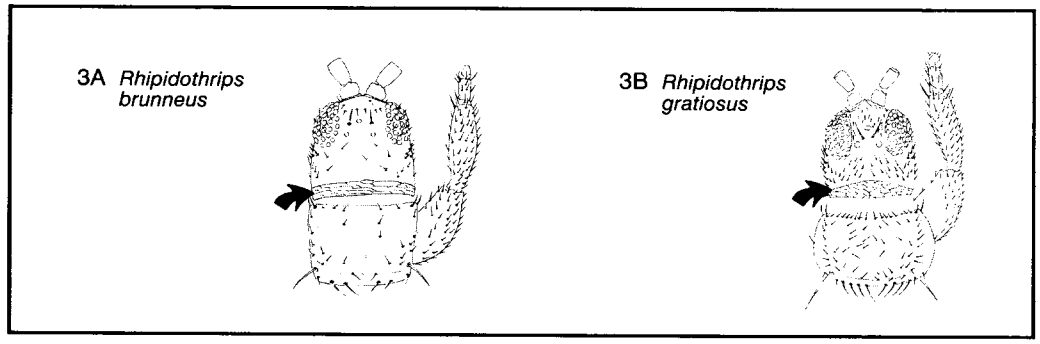


3 Antennal segment II brown; pronotum brown; head with a collar of transverse striations at the posterior margin (3A)----------*Rhipidothrips brunneus*

Distribution: England, Finland, Netherlands, USA (California, Oregon), USSR. Hosts: Grasses.

Antennal segment II yellow; pronotum white, with a small, brown, median blotch in the posterior half; dorsum of head with a collar of polygonal reticulations at the posterior margin (3B)----------*Rhipidothrips gratiosus*

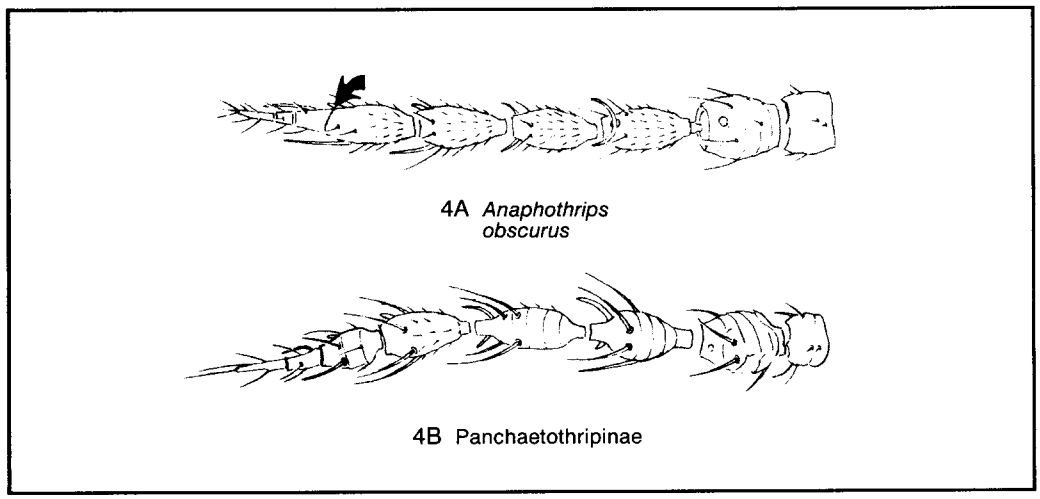
Distribution: Europe, USA (California). Hosts: Oats, grasses.



4 Antenna appearing 9-segmented (due to cleavage of segment IV) (4A)
---------- **grass thrips,** *Anaphothrips obscurus*

Body color mainly yellow, with brown markings on base of head, thoracic dorsum, and abdominal tergites. Distribution: Australia, Europe, North America. Hosts: Cereals, grasses, and various other plants.

Antenna 7- or 8-segmented (4B)---------- 5



4A *Anaphothrips obscurus*

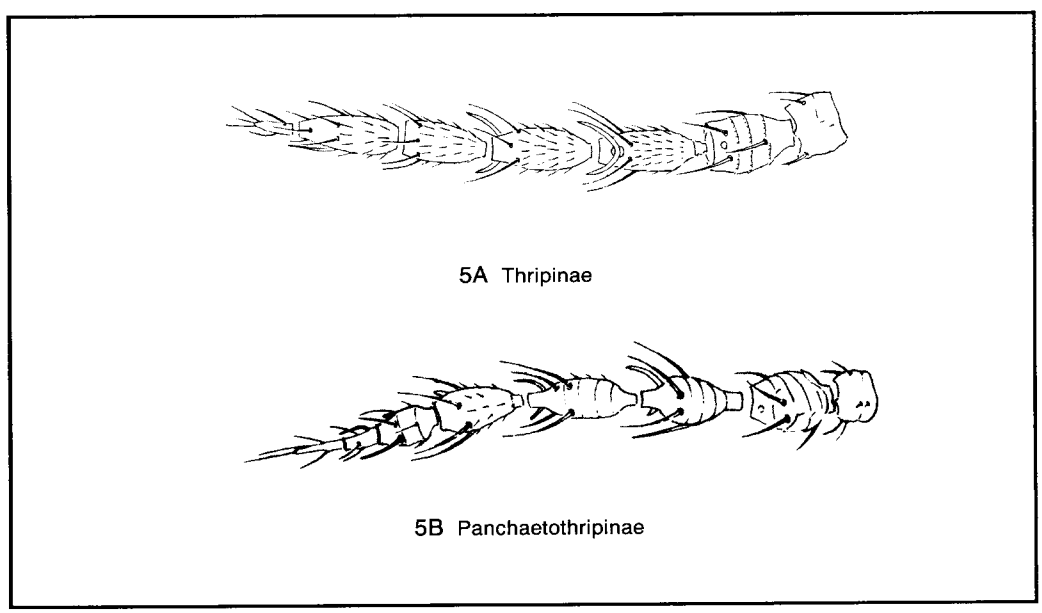
4B Panchaetothripinae

5 Antenna 7-segmented (5A). Genus *Thrips* (in part) ---------- 6

Pronotum with 2 pairs of long posteroangular setae.

Antenna 8-segmented (5B) ---------- 7

Pronotum with or without long posteroangular setae.



5A Thripinae

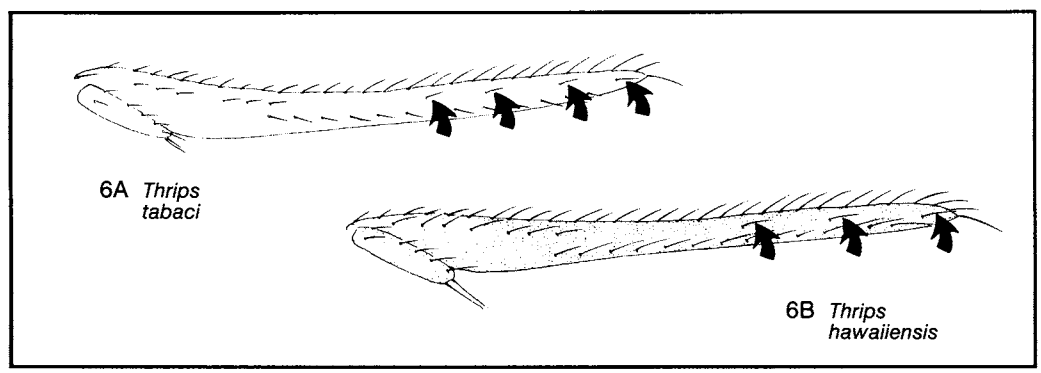
5B Panchaetothripinae

6 Forewing clear; anterior vein with 4 to 6 distal setae (6A); ocellar pigment gray; accessory setae absent from abdominal sternites---------- **onion thrips,** *Thrips tabaci*

Distribution: Cosmopolitan. Hosts: Onions, flowers of many kinds of wild and cultivated plants.

Forewing grayish-brown, clear at base; anterior vein with 3 distal setae (6B); ocellar pigment red; accessory setae present on abdominal sternites II to VII ---------- **Hawaiian flower thrips,** *Thrips hawaiiensis*

Distribution: Australia, Oriental Region, many Pacific islands, USA (District of Columbia, Florida, Georgia, Hawaii, South Carolina, Texas). Hosts: Flowers of numerous cultivated and wild plants.



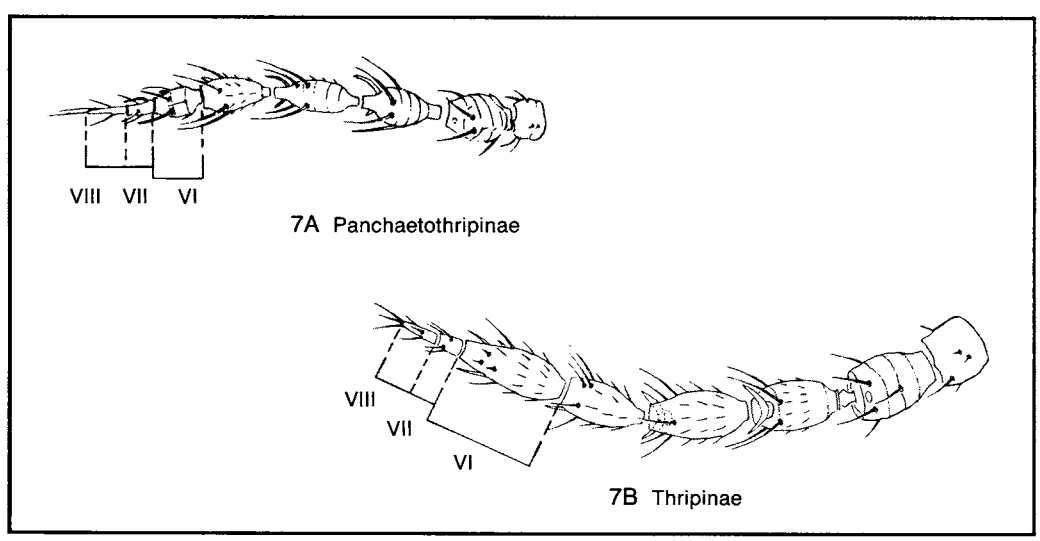
6A *Thrips tabaci*

6B *Thrips hawaiiensis*

7 Antennal segment VI shorter than combined length of segments VII and VIII (7A); head conspicuously reticulated. Panchaetothripinae ---------- 8

Antennal segments III and IV strongly vasiform (7A).

Antennal segments III and IV usually not strongly vasiform (7B).



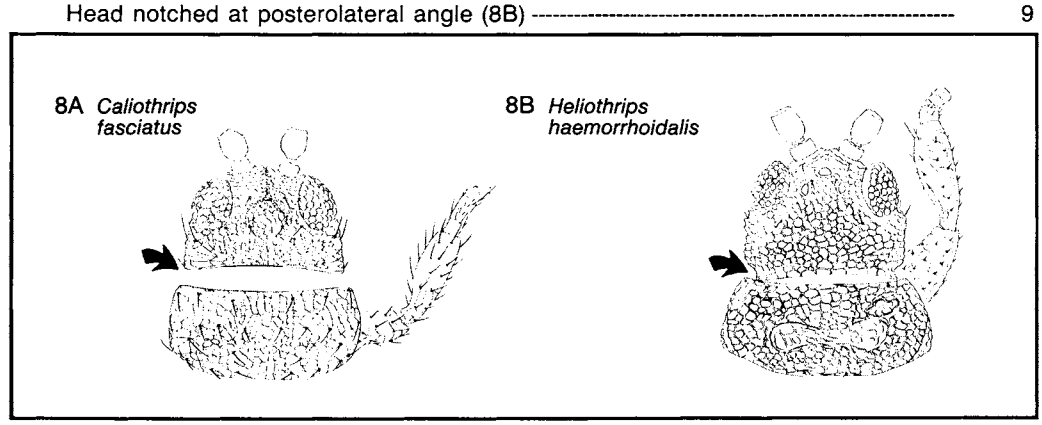
7A Panchaetothripinae

7B Thripinae

8 Head not notched at posterolateral angle (8A)---------- **bean thrips,** *Caliothrips fasciatus*

Forewing banded; sides of abdominal tergites reticulated. Distribution: Mexico, USA (New York, Western States in general, including Hawaii). Hosts: Beans, lettuce, oranges; foliage of various garden vegetables; numerous nonfood plants. CAUTION: Some other species of *Caliothrips* may also key out at this point.

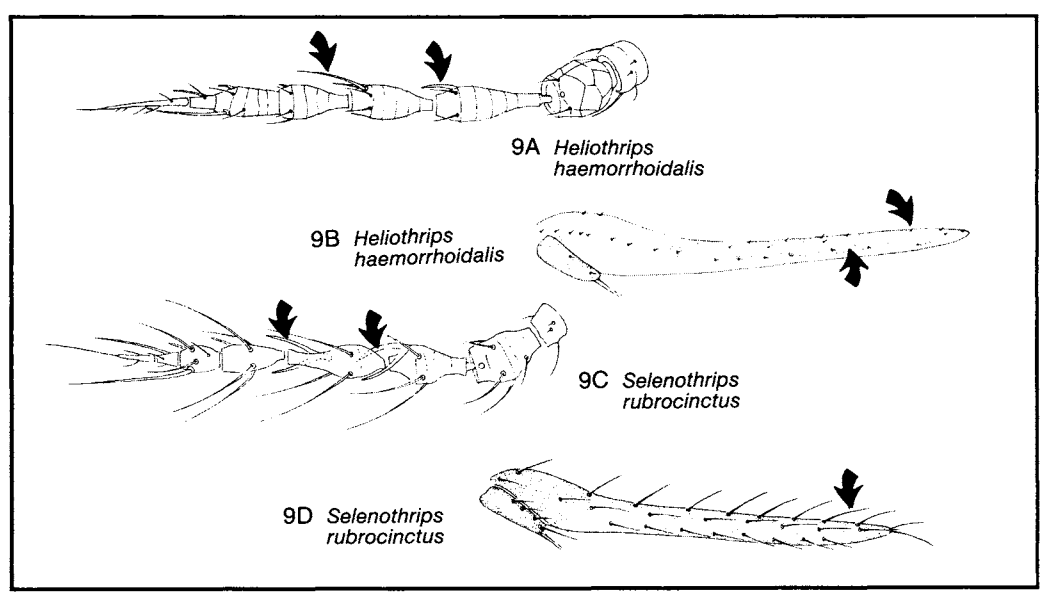
Head notched at posterolateral angle (8B) ---------- 9



9 Antennal segments III and IV with simple sensory trichomes (9A); wing veins with short, inconspicuous setae; forewing clear except for brown posterior vein (9B) ---------- **greenhouse thrips,** *Heliothrips haemorrhoidalis*

Distribution: Africa, Australia, Neotropical Region, Pacific islands, USA; greenhouses in temperate regions. Hosts: Mangoes; numerous nonfood plants. See also 8B.

Antennal segments III and IV with forked sensory trichomes (9C); wing veins with long, conspicuous setae; forewing uniformly brown (9D) or brown with transverse white bands ---------- 10

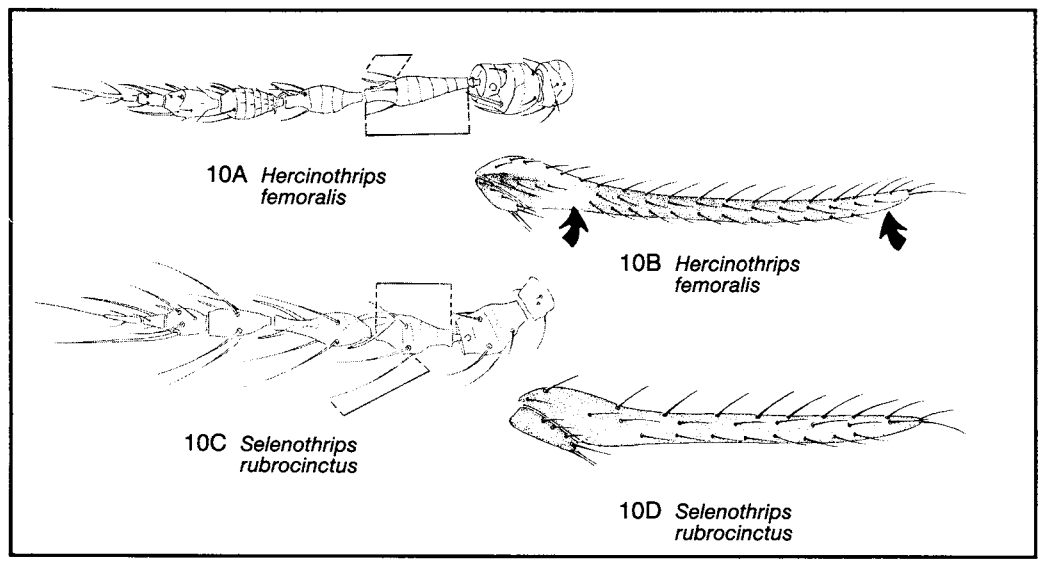


10 Setae on antennal segments III, IV, and V much shorter than their respective segments (10A); forewing with white and dark brown bands (10B)
---------- **banded greenhouse thrips,** *Hercinothrips femoralis*

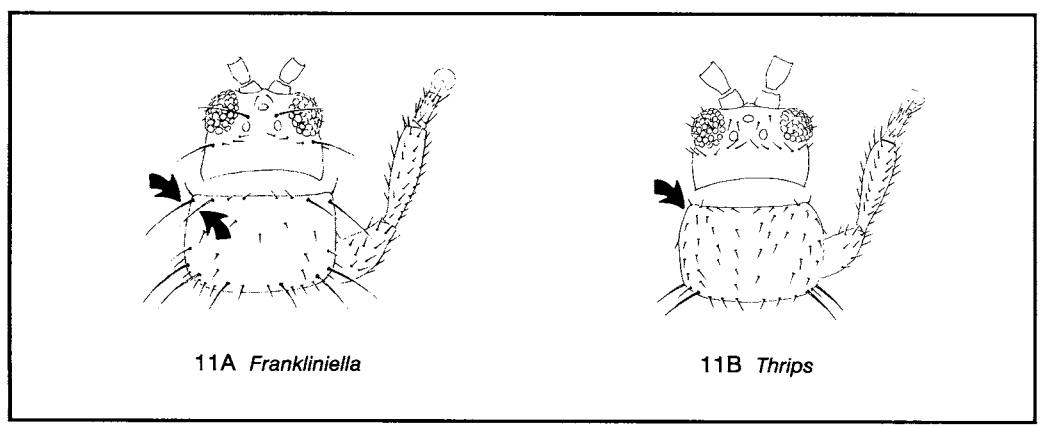
Distribution: Tropical and subtropical regions; USA (California, District of Columbia, Florida, Hawaii, Idaho, Illinois, Massachusetts, Missouri); greenhouses in temperate regions. Hosts: Sugarbeets; numerous wild and cultivated plants.

Setae on antennal segments III, IV, and V much longer than their respective segments (10C); forewing uniformly dark brown (10D)
---------- **redbanded thrips,** *Selenothrips rubrocinctus*

Distribution: Wide occurrence in tropical regions including parts of Africa, Central America, India, Philippines, South America, USA (Florida). Hosts: Mangoes; various fruit trees.



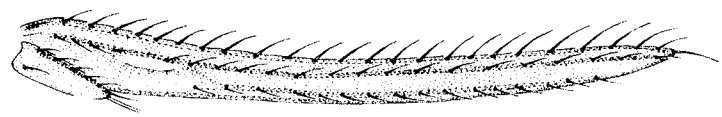
11 Pronotum with 1 pair of long anteroangular and 1 pair of anteromarginal setae (11A); forewing with complete row of setae on anterior vein (see 12A). Genus *Frankliniella* 12
Pronotum without long anteromarginal or anteroangular setae (11B); forewing with a few irregularly-spaced setae on distal half of anterior vein (see 12B)---------- 13



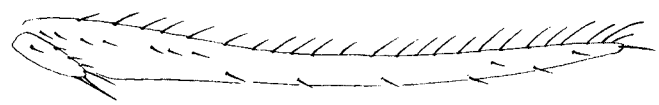
12 Forewing uniformly dark brown (12A)---------- *Frankliniella minuta*

Body dark brown; antenna completely brown, but occasionally with segment III a paler brown; pronotum with alternating short and long posteromarginal setae (see 13B). Distribution: Guatemala, Mexico, Panama, Peru, USA (Colorado, Hawaii, North Dakota, Texas, Wyoming, and several other Western States). Hosts: Flowers of numerous plants.

Forewing clear (as in 12B)----------other species of *Frankliniella*



12A *Frankliniella minuta*

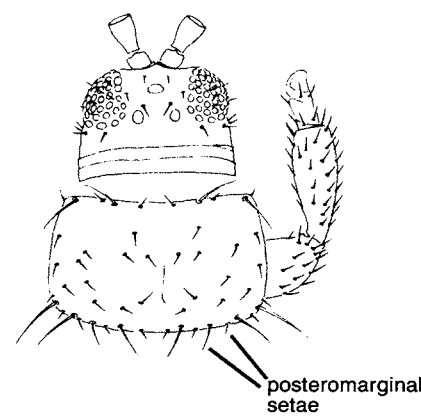


12B *Scirtothrips*

13 Anterior margin of pronotum conspicuously narrower than posterior margin (13A). Genus *Chirothrips*---------- 14

Anterior margin of pronotum equal to or slightly shorter than the posterior margin (as in 13B) ---------- 15

13A *Chirothrips*



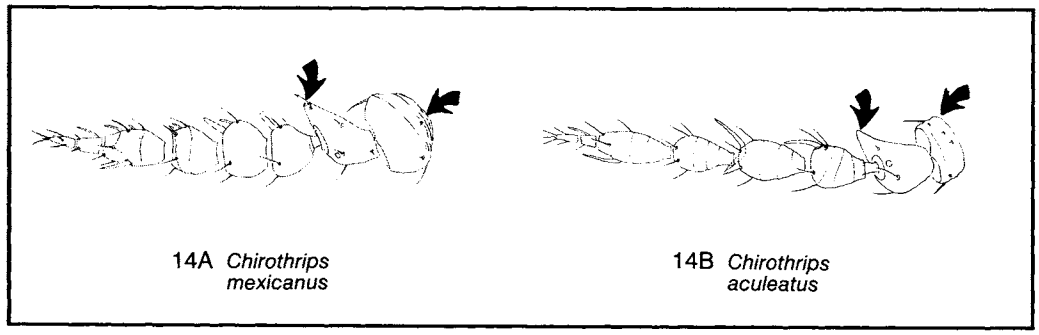
13B *Frankliniella minuta*

14 Antennal segment I large and conspicuously swollen; segment II with a short, stout seta at tip of apical projection; segment IV with a simple sensory trichome (14A); tibia I produced anteriorly on lateral apical margin----------*Chirothrips mexicanus*

Distribution: Caribbean islands, Central and South America, Mexico, Philippines, South Africa, USA (Arizona, California, Florida, Georgia, Hawaii, Louisiana, Oklahoma, Tennessee, Texas). Hosts: Various grasses and other plants.

Antennal segment I not large and conspicuously swollen; segment II without a seta at tip of apical projection; segment IV with a forked sensory trichome (14B); tibia I not produced on lateral apical margin----------*Chirothrips aculeatus*

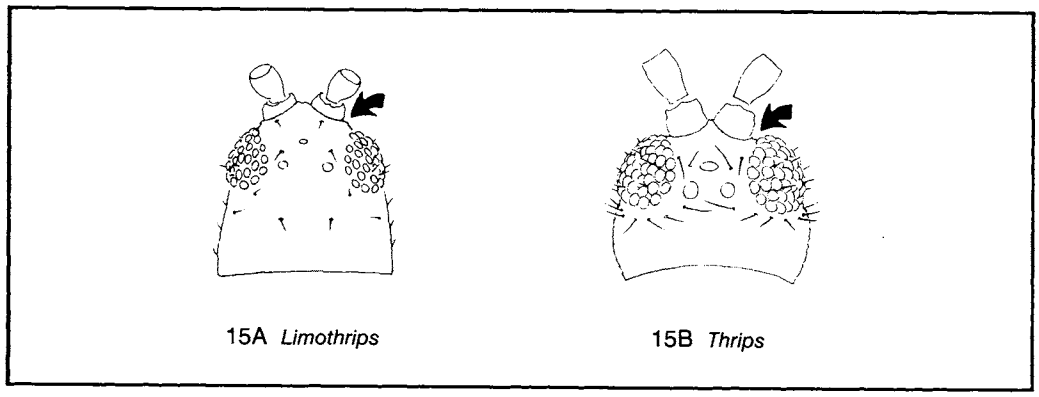
Distribution: Central and southern Europe, England, USA (Pacific Coast). Hosts: Grasses.



14A *Chirothrips mexicanus*

14B *Chirothrips aculeatus*

15 Head produced in front of eyes (15A); abdominal tergite X bearing a pair of stout, spinelike setae. Genus *Limothrips*---------- 16
Head not produced in front of eyes (15B); abdominal tergite X without spinelike setae 17



15A *Limothrips*

15B *Thrips*

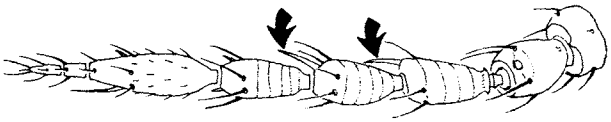
16 Antennal segment II with apical projection; antennal segments III and IV with forked sensory trichomes (16A)----------*Limothrips angulicornis*

Distribution: Australia, Chile, central and southern Europe, USA (California). Hosts: Grasses and various other plants.

Antennal segment II barrel-shaped; antennal segments III and IV with simple sensory trichomes (16B)----------**grain thrips,** *Limothrips cerealium*

Distribution: Europe, USA, and many other regions of the world. Hosts: Grasses, including oats and other cereals.

16A *Limothrips angulicornis*



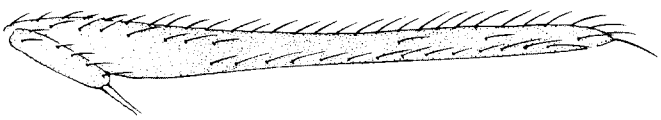
16B *Limothrips cerealium*

17 Forewing grayish-brown, clear at base, with setae in a complete row on posterior vein (17A); abdomen brown, without microsetae; abdominal sternites II to VII with accessory setae; head and thorax yellowish-orange to orange-brown. Genus *Thrips* (in part)---------- **Hawaiian flower thrips,** *Thrips hawaiiensis*

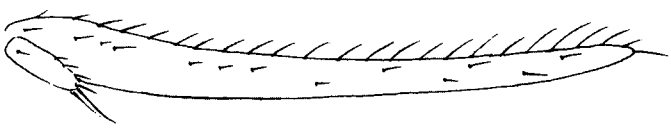
See couplet 6.

Forewing clear, with orange veins and with 3 irregulary-spaced setae on posterior vein (17B); abdomen with numerous microsetae; abdominal sternites II to VII without accessory setae; body yellowish-brown---------- **citrus thrips,** *Scirtothrips citri*

Distribution: USA (Arizona, California). Hosts: Fruits and foliage of orange trees; various nonfood plants. CAUTION: *Sericothrips* also has numerous abdominal microsetae, but there is a complete row of setae on the anterior vein of the forewing. Members of the genus *Sericothrips* are widely distributed in most parts of the world; they feed on grasses, legumes, and many other plants including cucumbers.



17A *Thrips hawaiiensis*



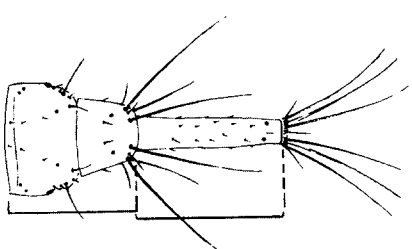
17B *Scirtothrips citri*

Tubulifera

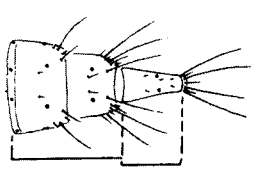
18 Antennal segments III to VIII yellow, with VII and VIII shaded brown; forewing parallel-sided; terminal abdominal segment much longer than combined length of preceding 2 segments (18A)---------- **Cuban laurel thrips,** *Gynaikothrips ficorum*

Distribution: Many tropical countries; occasionally introduced to colder regions. Hosts: Feeds and causes leaf galls on *Ficus* spp.; also found occasionally on some other plants.

Antenna brown with segment III and basal parts of IV and V yellow, or III to VI yellow with apices of V and VI brown; forewing narrowed medially; terminal abdominal segment much shorter than combined length of preceding 2 segments (18B). Genus *Haplothrips*---------- 19



18A *Gynaikothrips ficorum*



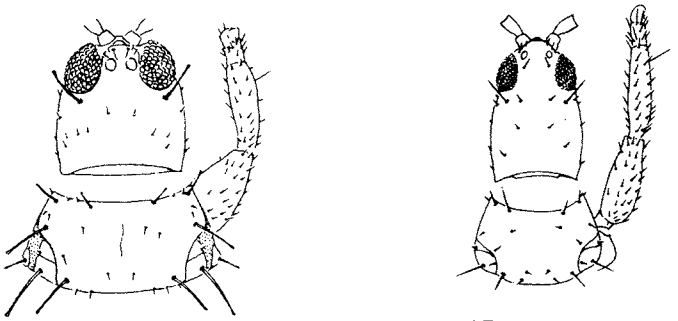
18B *Haplothrips*

19 Head about as long as wide; pronotum with well-developed major lateral setae (19A); internal pigmentation red; antennal segments III and IV and basal parts of V and VI yellow---------- **black flower thrips,** *Haplothrips gowdeyi*

Distribution: Africa, Caribbean islands, Central and South America, India, Israel, Mexico, Pacific islands, USA (California, Florida, Georgia, Hawaii, Texas). Hosts: Flowers of numerous cultivated and wild plants.

Head much longer than wide; pronotum with minute major lateral setae (19B); internal pigmentation purple; antennal segments III and basal parts of IV and V yellow ---------- **black hunter thrips,** *Haplothrips mali*

Distribution: Canada, Mexico, USA. Feeding habits: Predaceous on eggs and immature stages of other insects.



19A *Haplothrips gowdeyi*

19B *Haplothrips mali*

24 APHIDS (APHIDIDAE, HOMOPTERA)

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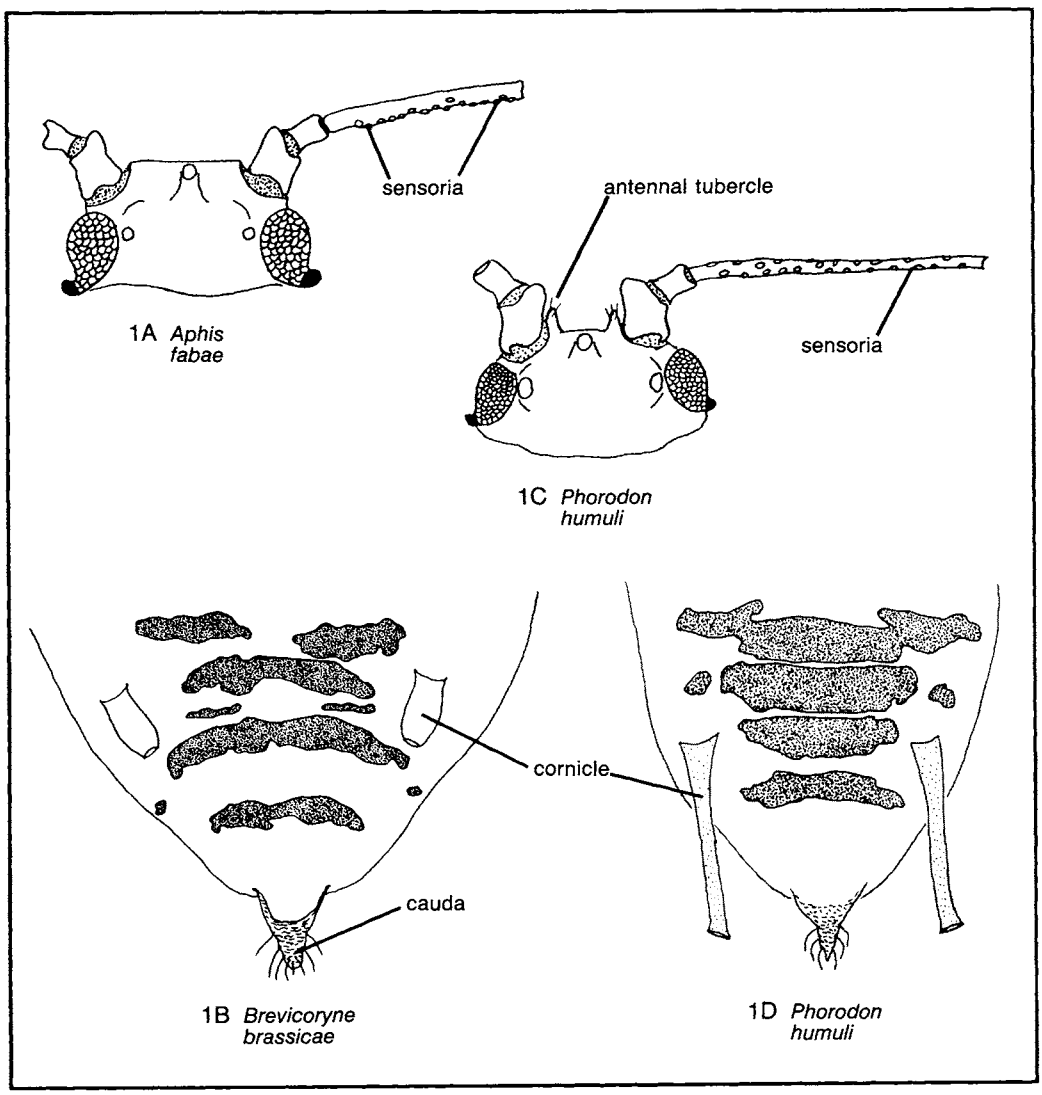
KEY

Drawings by M.B. Stoetzel.

1 Head without prominent antennal tubercles (1A); cornicle never longer than 3 times length of hind tarsus (1B)---------- 2

Head with prominent antennal tubercles (1C); cornicle 3 times or more longer than length of hind tarsus (1D)---------- 3

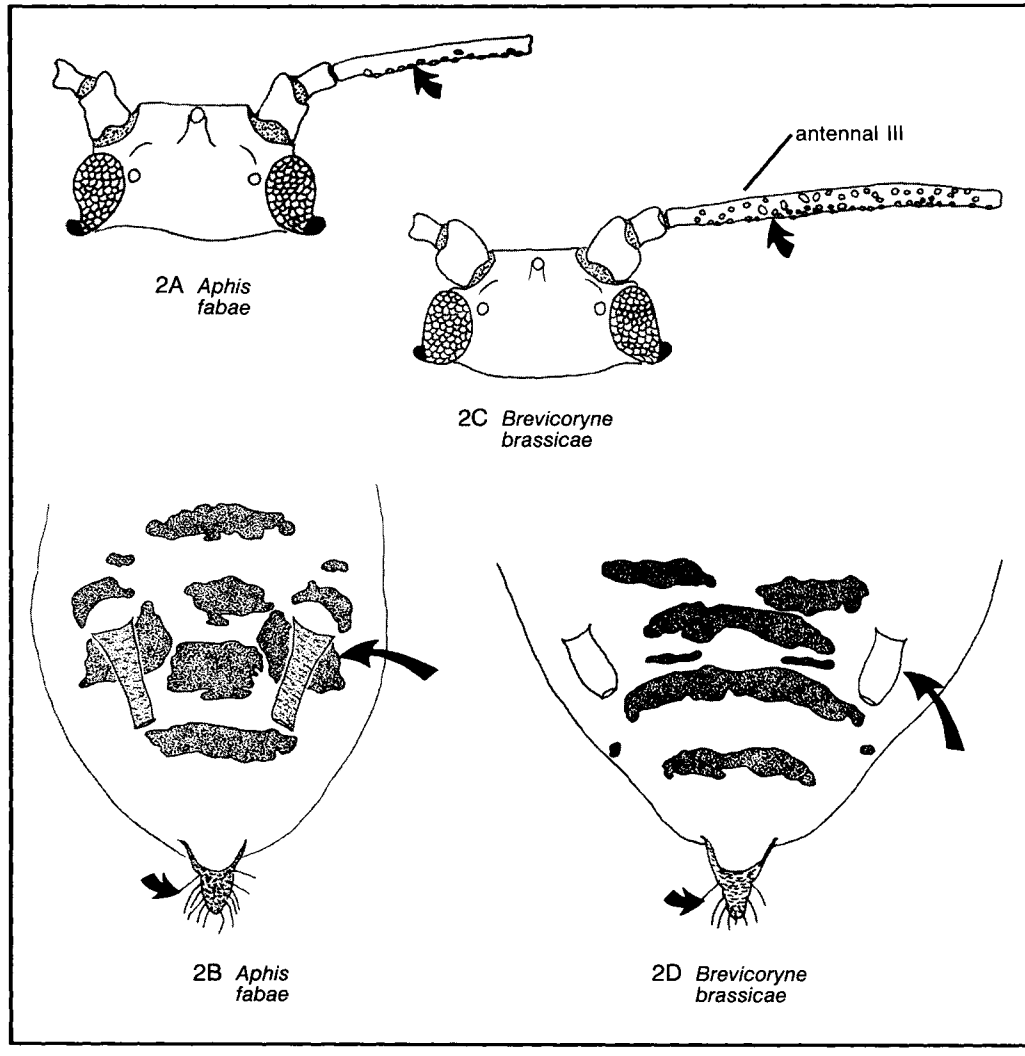


2 Alata with 12 to 18 sensoria on antennal III (2A); cornicle cylindrical, longer than cauda; cauda bushy with 12 to 14 hairs; abdomen of alata with 4 rows of dark spots and a dark area behind base of each cornicle (2B)----------**bean aphid,** *Aphis fabae*

Distribution: Holarctic, Ethiopian. Hosts: Leaves and stems of *Euonymus* and *Viburnum* as winter hosts, and on various plants (beans, beets, carrots, corn, lettuce, rhubarb, squash) as summer hosts. References: *1, 2, 4-6.*

Alata with 43 to 67 sensoria on antennal III (2C); cornicle swollen, not longer than cauda; cauda tapering, with 6 hairs; abdomen of alata with broken, dusky dashes but no dark area behind base of each cornicle (2D)
----------**cabbage aphid,** *Brevicoryne brassicae*

Distribution: Worldwide. Hosts: Broccoli, brussels sprouts, cabbage, carrots, cauliflower, celery, kale, mustard, radishes. References: *1-7.*

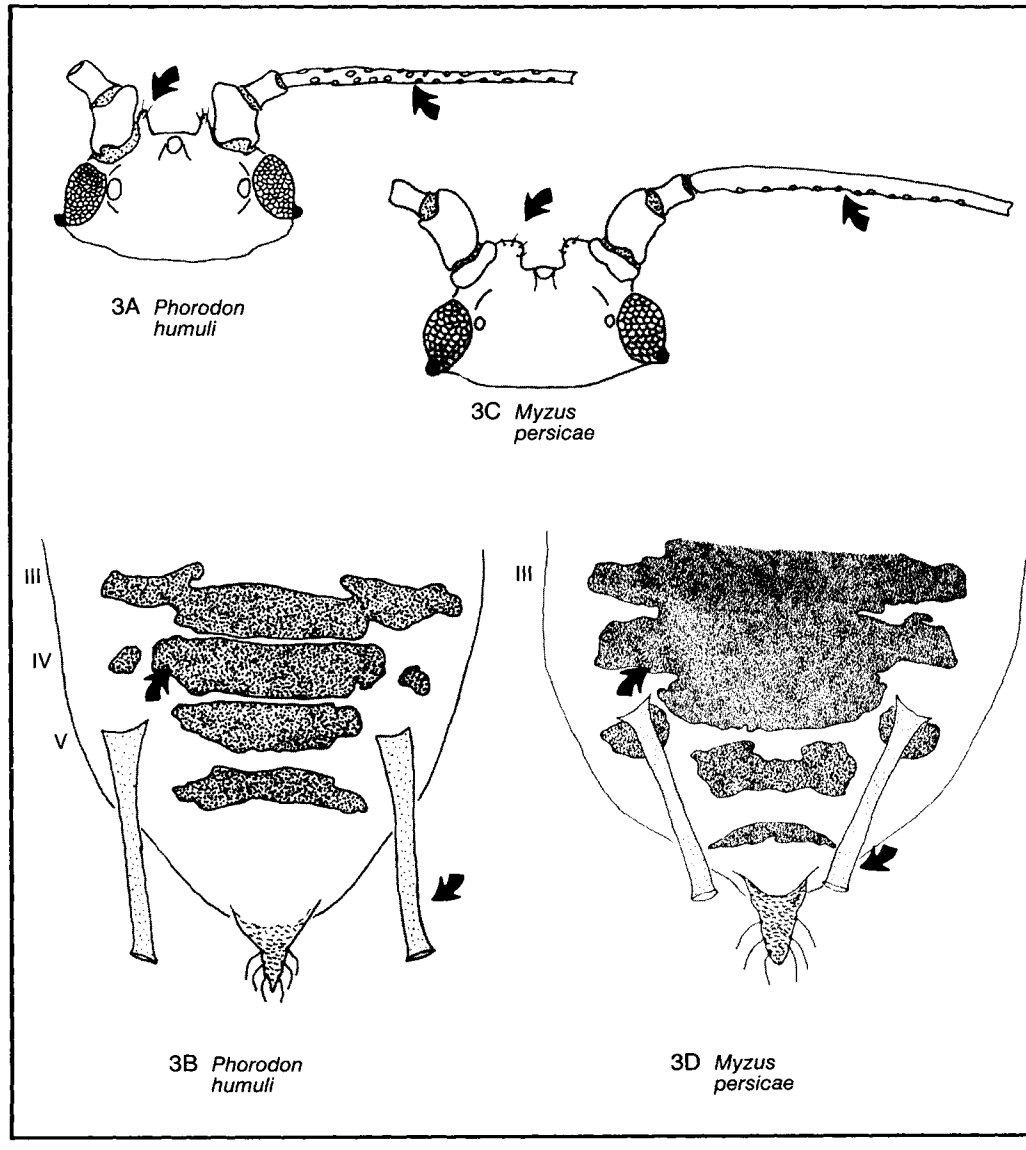


3 Alata with 23 to 27 sensoria widely distributed on antennal III; inner angle of antennal tubercle with elongate process (3A); cornicle cylindrical on distal half; abdomen of alata with dorsal bands, nearly coalescing, on III, IV and V; no dark area behind base of each cornicle (3B)----------**hop aphid,** *Phorodon humuli*

Distribution: Holarctic. Hosts: Plum leaves in winter and hop leaves in summer. References: *1, 6.*

Alata with 6 to 17 sensoria in a line on antennal III; inner angle of antennal tubercle rounded (3C); cornicle slightly dilated on distal half; abdomen of alata with dorsal patch extending from III to level of cornicle (3D)
----------**green peach aphid,** *Myzus persicae*

Distribution: Worldwide. Hosts: Polyphagous. References: *1-7.*



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Notes and Sketches

25 SCALE INSECTS (COCCOIDEA, HOMOPTERA)

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Scale insects are unique among the Insecta in that the adult females are wingless, neotenic (sexually mature nymphs), and often produce some sort of waxy covering. Adult males (fig. 25.1) superficially resemble small wasps or flies but are unique in having one pair of well-developed wings and a smaller second pair of wings (hamulohalterae). The males lack functional mouthparts and are often short-lived.

The first instar is usually called the crawler because it is generally the only active crawling stage. Immature instars may be recognized as such by their lack of a vulva or aedeagus. In most scale insects the remaining instars, excluding adult males, are sessile, even though some have legs and are capable of moving on the host. Male scales undergo an anomalous kind of complete metamorphosis that involves one or two "pupal" stages before the adult form is reached.

Several characters may be used to distinguish the Coccoidea from other homopterous insects: a single tarsal claw on each leg; a one-segmented tarsus (usually); wingless females; and adult males with one pair of wings and one pair of hamulohalterae.

In the United States there are 15 families of Coccoidea. Aclerdidae (aclerdids), Cerococcidae (cerococcids), Conchaspididae (conchaspidids), Dactylopiidae (cochineal insects), Kermesidae (gall-like scales), Tachardiidae (lac scales), Lecanodiaspididae (false pit scales), and Phoenicococcidae (phoenicococcids) are not included here because they are rarely collected and are unlikely food contaminants. Of the remaining seven relatively commonly collected families, three contain species that might be found in foods.

Foods that commonly have scale insects are citrus, tropical fruits, deciduous-tree fruits, and grapes. The three families often associated with food may be recognized by the following field characters.

Pseudococcidae (**mealybugs**): The body is usually covered with a mealy, white secretion, and the margin of the body, particularly the posterior margin, normally has at least one pair of waxy filaments (fig. 25.2).

Diaspididae (**armored scales**): A solid waxy cover is produced that is separate from the body. The waxy cover may be round, oval, or elongate and incorporates the shed skins of the crawler and second instar (fig. 25.3).

Coccidae (**soft scales**): The body is usually without wax on the upper surface or the wax is transparent. Some species produce a thick, chewing-gumlike wax or a filamentous wax, but in soft scales the wax is attached to the body surface and there are no marginal filaments except those associated with the spiracles (fig. 25.4).

The classification system of scale insects is based primarily on adult females. The following key is restricted to species that occur in the United States and can be used only with adult females mounted on microscope slides and examined with a compound microscope. A handout on scale insect mounting techniques may be obtained by writing to me at the address given above.

Figures 25.5 and 25.7-25.29 are of bilaterally divided adult females (left = dorsal; right = ventral). Figure 25.4 shows the dorsal surface only; figure 25.6, the ventral surface only. Figures 25.7, 25.8, 25.13 and 25.14 do not show dermal morphology in detail. Figures 25.24 and 25.25 lack the multitude of dermal structures apparent on slide-mounted specimens; only diagnostic features are presented in these figures.

KEY

Drawings (figs. 25.4-25.29) by P.J. Hollyoak.

1 Abdominal spiracles present (fig. 25.5)---------- 2
Abdominal spiracles absent (fig. 25.9)---------- 3

2 Anal orifice surrounded by a sclerotized ring on exterior surface of body; anal ring bearing setae and pores (fig. 25.5)----------**ensign scales,** Ortheziidae

Anal orifice without sclerotization on exterior body surface; occasionally with internal tube leading to orifice sclerotized and having pores but not setae (fig. 25.6) ----------**margarodid scales,** Margarodidae

3 Posterior abdominal segments forming a pygidium (fig. 25.9). Diaspididae (**armored scales**)---------- 4
Posterior abdominal segments not forming a pygidium (fig. 25.20)---------- 16

4 Body elongate; body length at least twice greatest width (fig. 25.8)---------- 5
Body round or oval; body length less than twice greatest width (fig. 25.12)---------- 9

5 Median lobes appearing as a single lobe (fig. 25.8). Genus *Pinnaspis*---------- 6
Median lobes separate, appearing as 2 lobes (fig. 25.9)---------- 7

6 Scale cover white; preanal scars present (fig. 25.7) ----------lesser snow scale, *Pinnaspis strachani*

Distribution: Worldwide. Hosts: Polyphagous.

Scale cover brown; preanal scars absent (fig. 25.8)-------**fern scale,** *Pinnaspis aspidistrae*

Distribution: Worldwide. Hosts: Polyphagous; especially ferns, *Citrus, Aspidistra.*

7 With 3 pairs of lobes (fig. 25.9)----------**citrus snow scale,** *Unaspis citri*

Perivulvar pores present or absent. Distribution: Africa, Asia, Australia, Bermuda, Oceania, USA (Florida, Louisiana). Hosts: *Citrus, Severina.*

With 2 pairs of lobes (fig. 25.11). Genus *Lepidosaphes*---------- 8

Perivulvar pores present.

8 Thorax and anterior abdominal segments sclerotized; some abdominal segments with marginal spurs (fig. 25.10)----------**Glover scale,** *Lepidosaphes gloveri*

Distribution: Worldwide. Hosts: Especially *Citrus.*

Thorax and anterior abdominal segments not sclerotized; abdominal marginal spurs absent (fig. 25.11)----------**purple scale,** *Lepidosaphes beckii*

Distribution: Worldwide. Hosts: Especially *Citrus.*

9 Perivulvar pores absent (fig. 25.12)---------- 10
Perivulvar pores present (fig. 25.15)---------- 12

10 Body without prosomal lobes; pygidial lobes converging apically (fig. 25.12) ----------**San Jose scale,** *Quadraspidiotus perniciosus*

Distribution: Africa, Asia, Australia, Cuba, Europe, Mexico, New Zealand, South America, USA (widely distributed). Hosts: Polyphagous, especially *Malus, Prunus,* and most Rosaceae.

Body with large prosomal lobes; pygidial lobes parallel (fig. 25.13). Genus *Aonidiella* 11

11 Scale yellowish on host; without well-developed scleroses anterior to prevulvar apophysis (fig. 25.13)----------**yellow scale,** *Aonidiella citrina*

Distribution: Africa (Guinea, Zaire), Asia (including area around the Black Sea), Australia, Mexico, Oceania (Bonin Islands, New Guinea), South America (Argentina, Chile), USA (California, Florida, Texas). Hosts: Especially *Citrus*.

Scale reddish on host; with well-developed scleroses anterior to prevulvar apophysis (fig. 25.14)----------**California red scale,** *Aonidiella aurantii*

Distribution: USA (Alabama, California, Florida, Georgia, Texas); widespread throughout warm parts of the world. Hosts: Especially *Citrus*.

12 Spiracular pores near anterior spiracles (fig. 25.15)---------- 13
Spiracular pores absent (fig. 25.17)---------- 14

13 Second lobes each with 2 lobules; medial lobes fused at base; with more than 50 perivulvar pores (fig. 25.15)----------**white peach scale,** *Pseudaulacaspis pentagona*
----------white prunicola, *Pseudaulacaspis prunicola*

Distribution: Worldwide: Hosts: Polyphagous; white prunicola, especially *Prunus*.

Second lobes simple, with 1 lobule; median lobes separate at base; with less than 50 perivulvar pores (fig. 25.16)----------**chaff scale,** *Parlatoria pergandii*

Distribution: Worldwide. Hosts: Especially *Citrus*.

14 Prepygidial abdomen with isolated cluster of submarginal, dorsal ducts on each side (fig. 25.17)----------**Florida red scale,** *Chrysomphalus aonidum*

Distribution: Throughout warm areas of the world. Hosts: Polyphagous, especially *Citrus*.

Prepygidial abdomen with submarginal, dorsal ducts scattered along posterolateral margin (fig. 25.18)---------- 15

15 Dorsal tubular ducts less than 5 times as long as wide; median lobes approximately parallel (fig. 25.18)----------**oleander scale,** *Aspidiotus nerii*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: Polyphagous.

Dorsal tubular ducts more than 5 times as long as wide; median lobes apically convergent (fig. 25.19)----------**latania scale,** *Hemiberlesia lataniae*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: Polyphagous.

16 8-shaped pores somewhere on body (normally in a band near body margin) (fig. 25.20)
----------**pit scales,** Asterolecaniidae

8-shaped pores absent (fig. 25.21)---------- 17

17 Anal region with 2 anal plates forming an operculum (fig. 25.21). Coccidae (**soft scales**)---------- 18
Anal region without plates (fig. 25.23)---------- 19

18 Ventral tubular ducts in a band around body margin (absent from area between legs); inner filament of tubular ducts swollen (fig. 25.21)-----**hemispherical scale,** *Saissetia coffeae*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: Polyphagous.

Ventral tubular ducts in area between middle pair of legs (rare or absent near body margin); inner filament of tubular ducts not swollen (fig. 25.22)
----------**brown soft scale,** *Coccus hesperidum*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: Polyphagous. See also fig. 25.4.

19 Body without ostioles, cerarii, and circulus; tubular ducts invaginated; in life, without mealy secretion except on venter; without marginal filaments (fig. 25.23)
----------**eriococcid scales,** Eriococcidae

Body with ostioles, cerarii, circulus, and noninvaginated tubular ducts (fig. 25.24); in life, covered with mealy, white secretion and bearing several marginal filaments (fig. 25.2). Pseudococcidae (**mealybugs**)---------- 20

20 With 18 pairs of cerarii; ventral anal-lobe area with a narrow, sclerotized bar (fig. 25.24)
----------**citrus mealybug,** *Planococcus citri*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: Polyphagous, especially *Citrus.*

With less than 18 pairs of cerarii; without narrow, sclerotized bar on anal lobe (fig. 25.25)---------- 21

21 Oral-rim tubular ducts present (fig. 25.25). Genus *Pseudococcus* ---------- 22
Oral-rim tubular ducts absent (fig. 25.27)---------- 23

22 Many dorsal cerarii with 2 or more associated oral-rim tubular ducts; multiocular pores restricted to posterior 2 or 3 abdominal segments (fig. 25.25)
----------**longtailed mealybug,** *Pseudococcus longispinus*

Distribution: Widespread; occurring out-of-doors in warm areas. Hosts: On many tropical plants. See also fig. 25.2.

Dorsal cerarii with at most 1 associated oral-rim tubular duct; multilocular pores on at least posterior 5 or 6 abdominal segments (fig. 25.26)
----------**grape mealybug,** *Pseudococcus maritimus*

Distribution: USA. Hosts: Especially grapes and deciduous fruit trees.

23 Dorsomedial areas with conical setae about same size as conical cerarian setae (fig. 25.27)----------**coconut mealybug,** *Nipaecoccus nipae*

Distribution: Most warm areas of the world. Hosts: Many hosts, especially palms.

Dorsomedial areas with slender setae unlike conical cerarian setae (fig. 25.28). Genus *Dysmicoccus*---------- 24

24 Setae on dorsomedial area of abdominal segments VIII and IX noticeably longer than setae on rest of dorsum (fig. 25.28)---------**pineapple mealybug,** *Dysmicoccus brevipes*

Distribution: Primarily the New World, but also reported from Africa, Asia, and Oceania. Hosts: Polyphagous, especially pineapple.

Setae on dorsomedial area of posterior abdominal segments about same length as those on rest of dorsum (fig. 25.29)
----------**gray pineapple mealybug,** *Dysmicoccus neobrevipes*

Distribution: Mexico, Oceania. Hosts: Polyphagous.

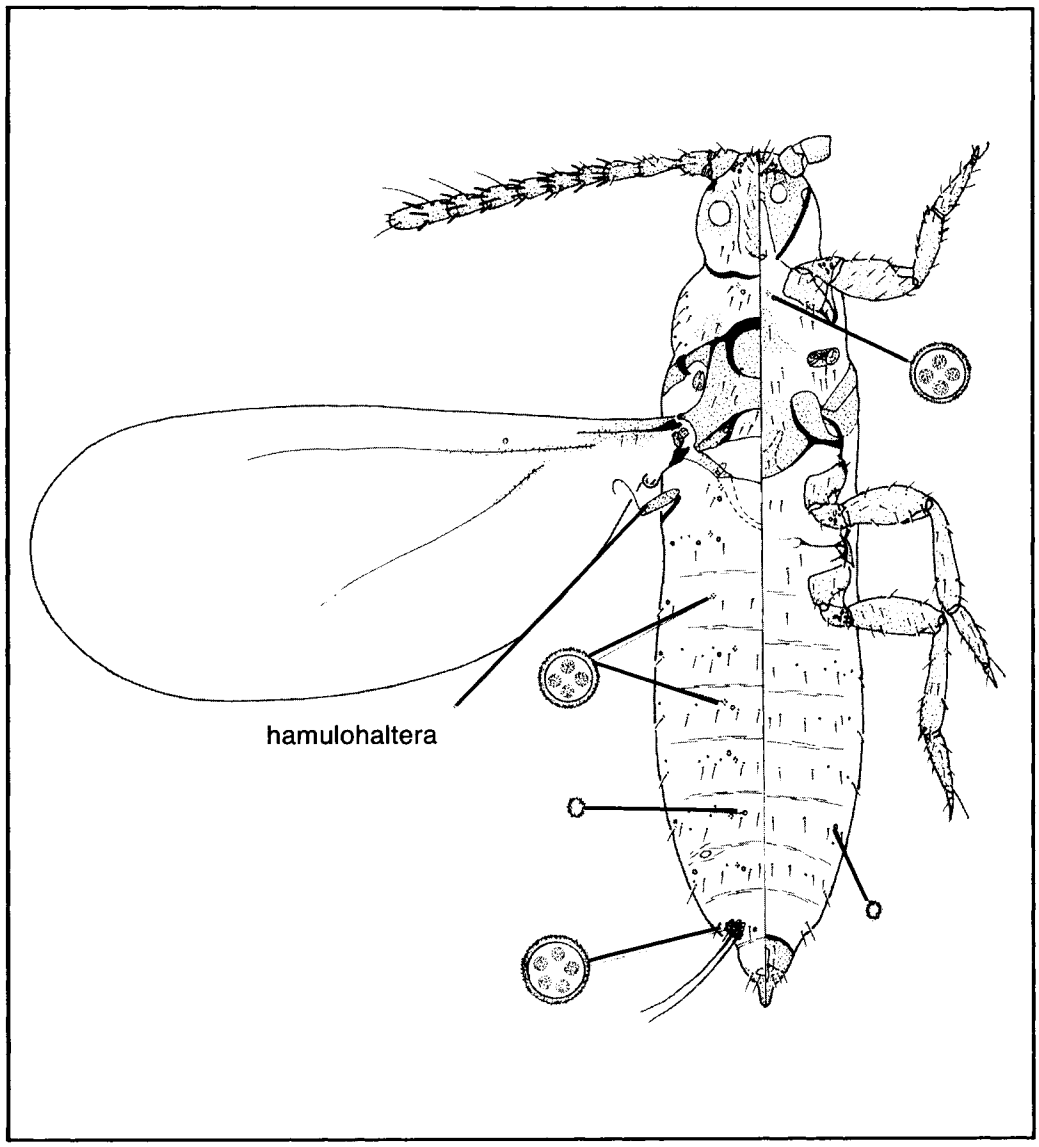

Figure 25.1 *Brevennia rehi* (Lindinger) (Pseudococcidae), male, dorsal (left) and ventral (right) views. (Drawing by D.R. Miller.)

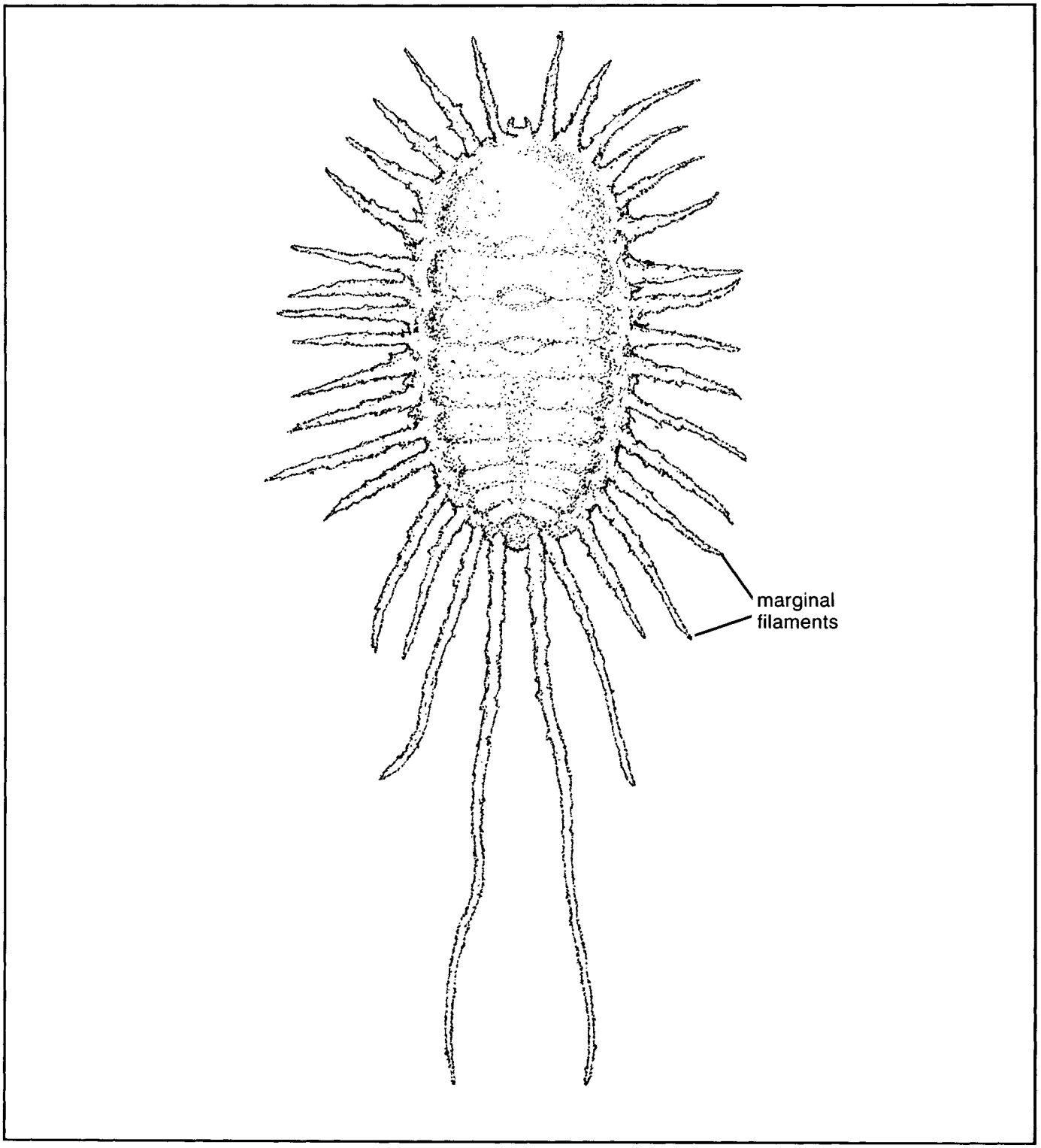

Figure 25.2. **Longtailed mealybug,**
Pseudococcus longispinus (Pseudococcidae),
female, dorsal view. (Drawing by P.J. Hollyoak.)

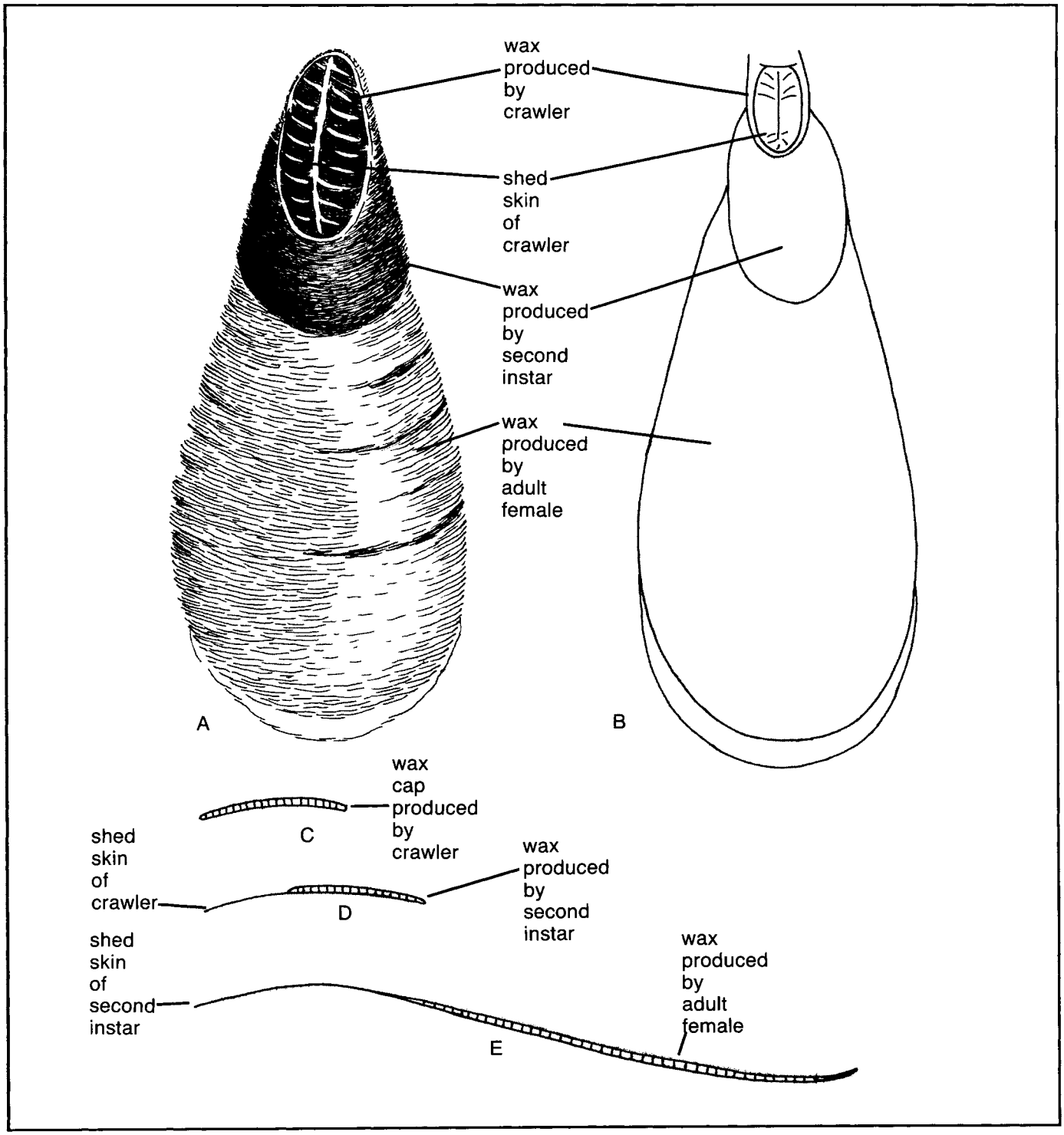

Figure 25.3. An armored scale (Diaspididae): A, scale cover, dorsal view, actual appearance; B, same, diagrammatic; C, D, E, lateral views, diagrammatic, of longitudinal sections through scale cover. (Drawings by J.A. Davidson.)

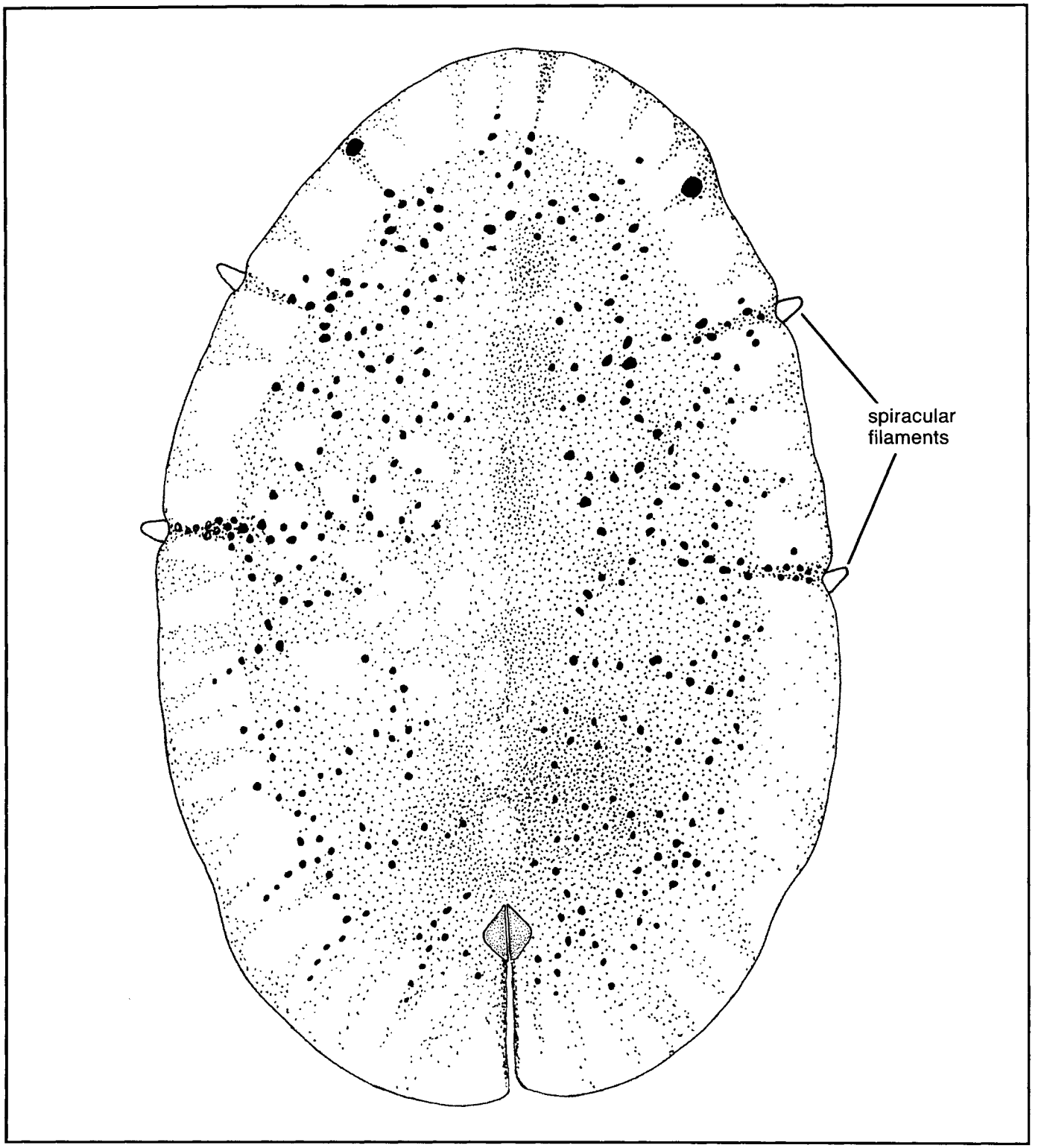

Figure 25.4. **Brown soft scale,** *Coccus hesperidum* (Coccidae), female, dorsal view.

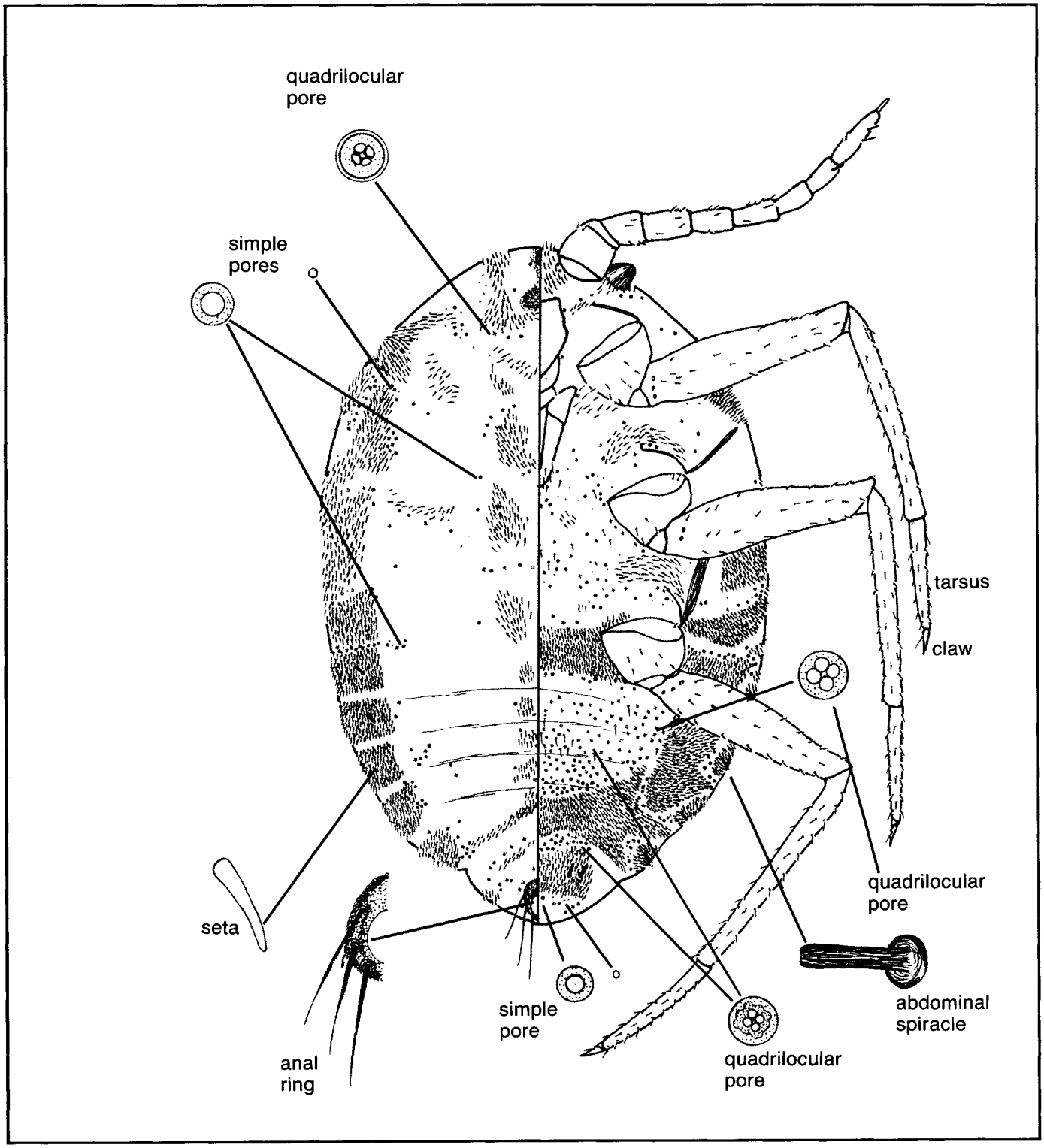

Figure 25.5. **Greenhouse orthezia,** *Orthezia insignis* Browne (Ortheziidae).

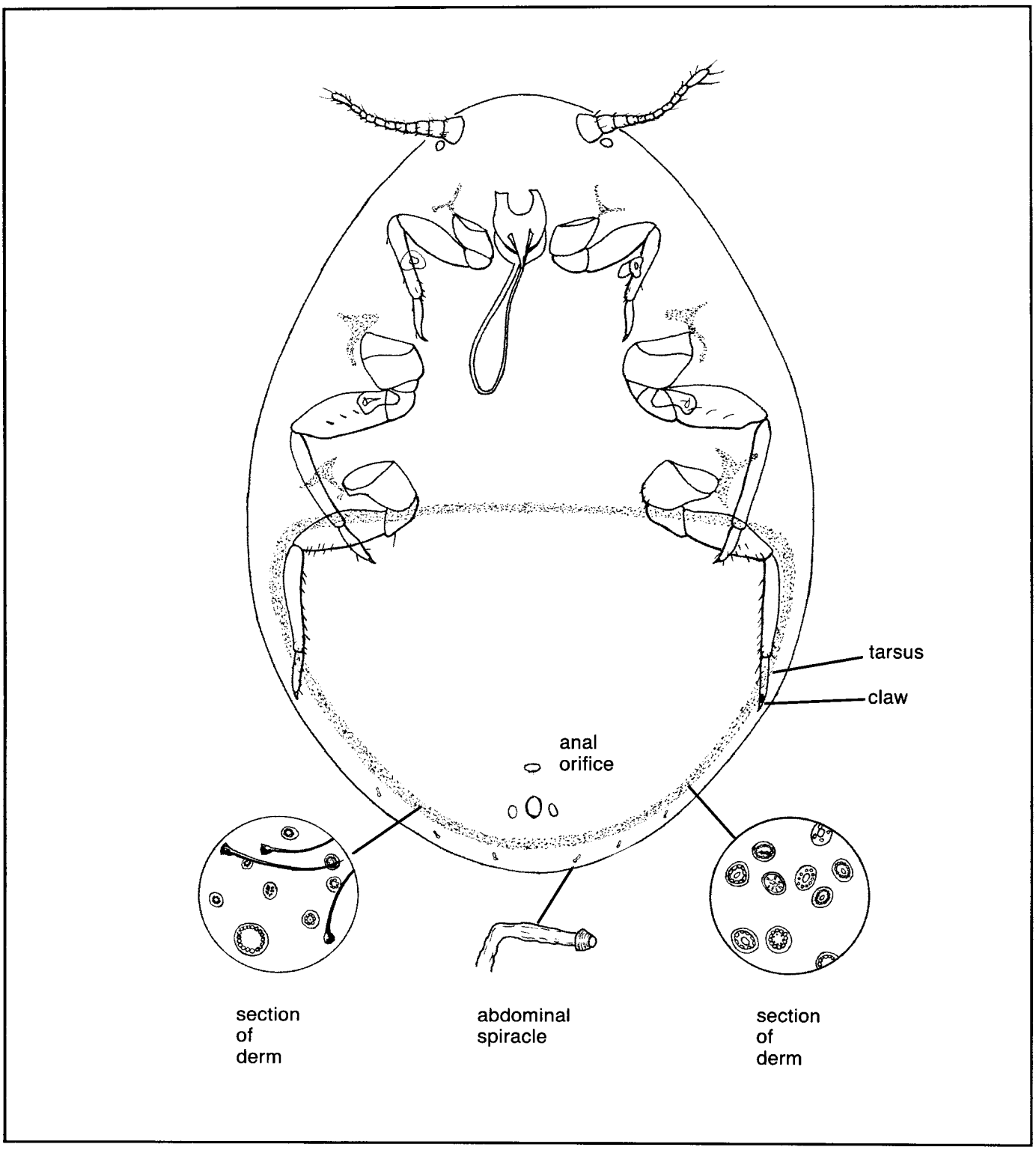

Fig 25.6. *Icerya seychellarum* (Westwood) (Margarodidae).

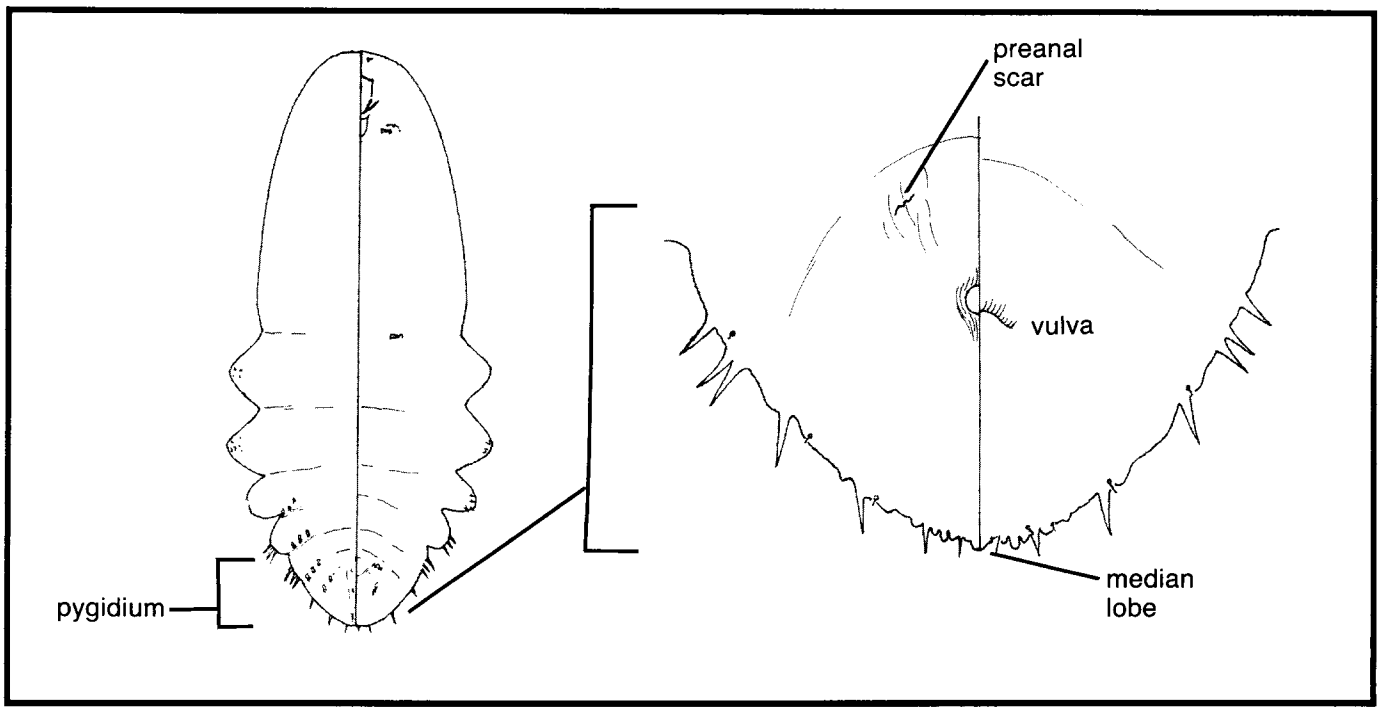

Figure 25.7. **Lesser snow scale,** *Pinnaspis strachani* (Diaspididae).

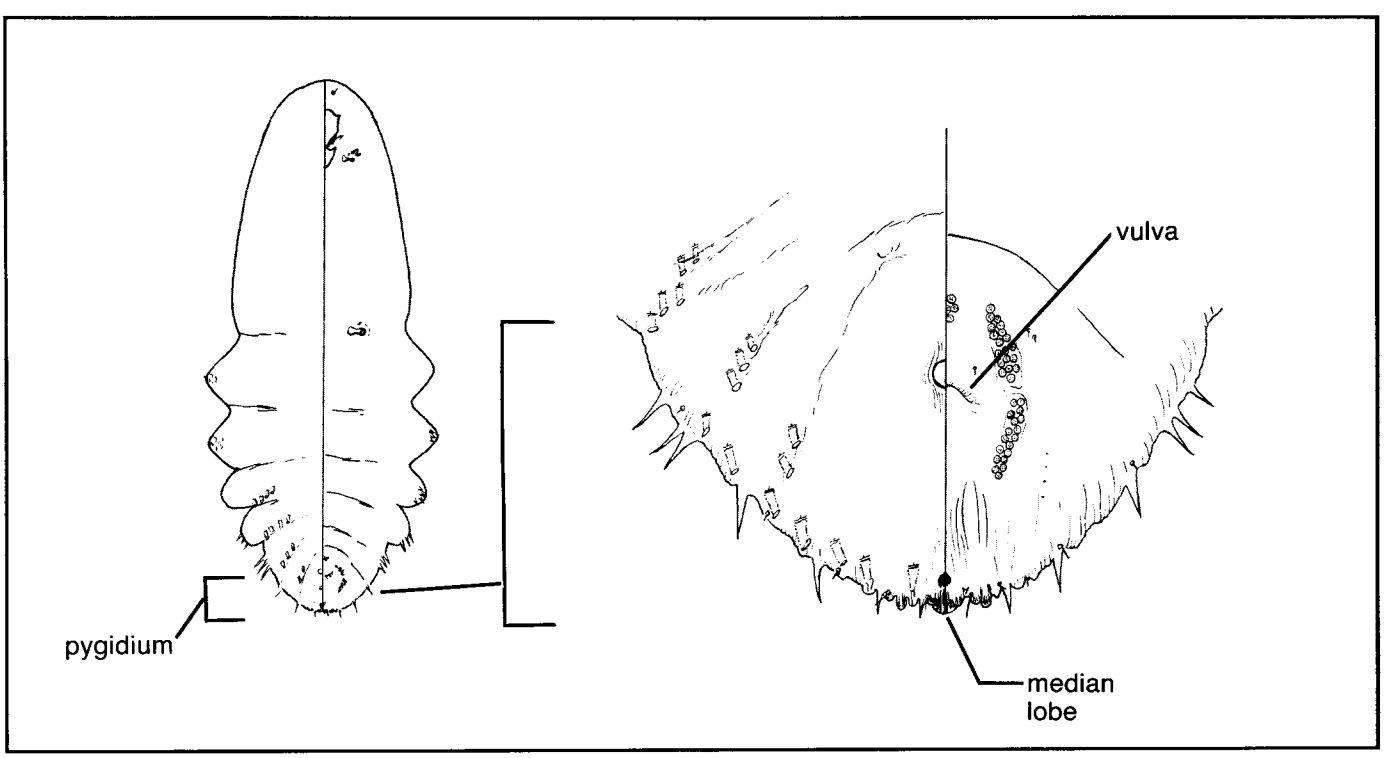

Figure 25.8. **Fern scale,** *Pinnaspis aspidistrae* (Diaspididae).

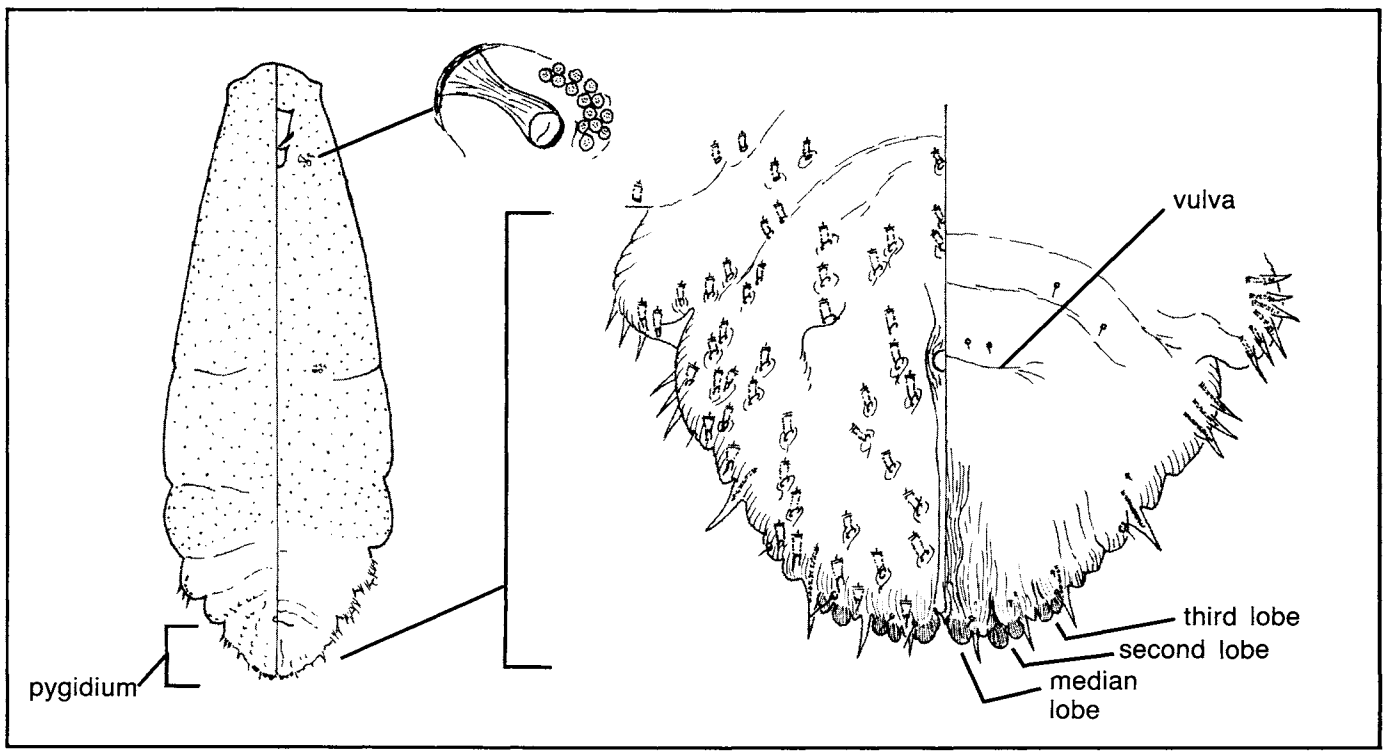

Figure 25.9. **Citrus snow scale,** *Unaspis citri* (Diaspididae).

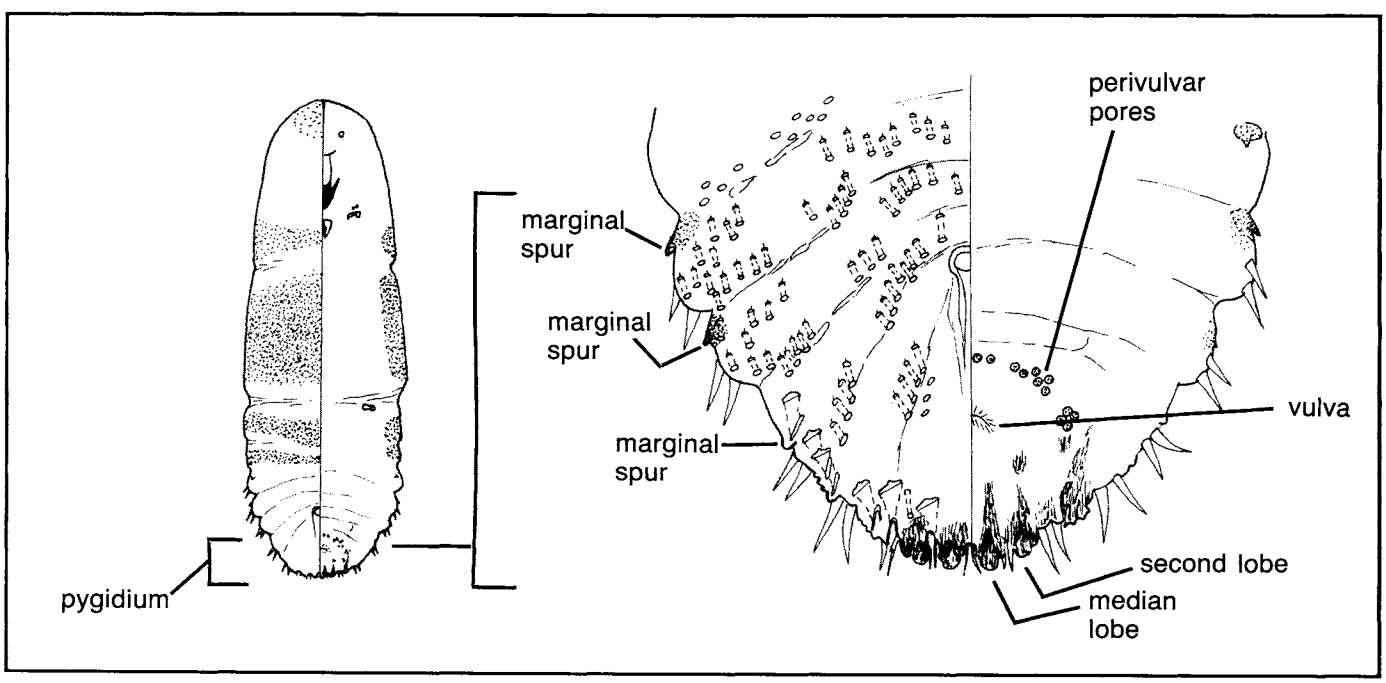

Figure 25.10. **Glover scale,** *Lepidosaphes gloveri* (Diaspididae).

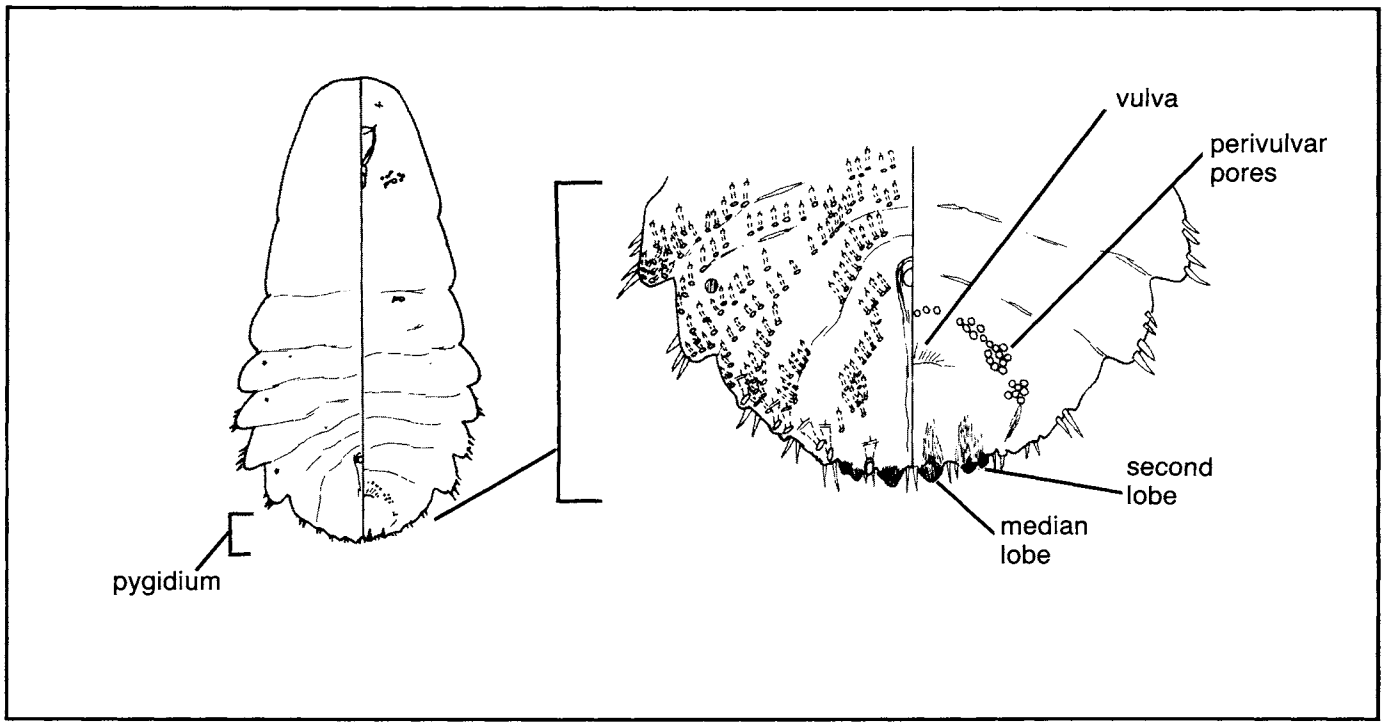

Fig 25.11. **Purple scale,** *Lepidosaphes beckii* (Diaspididae).

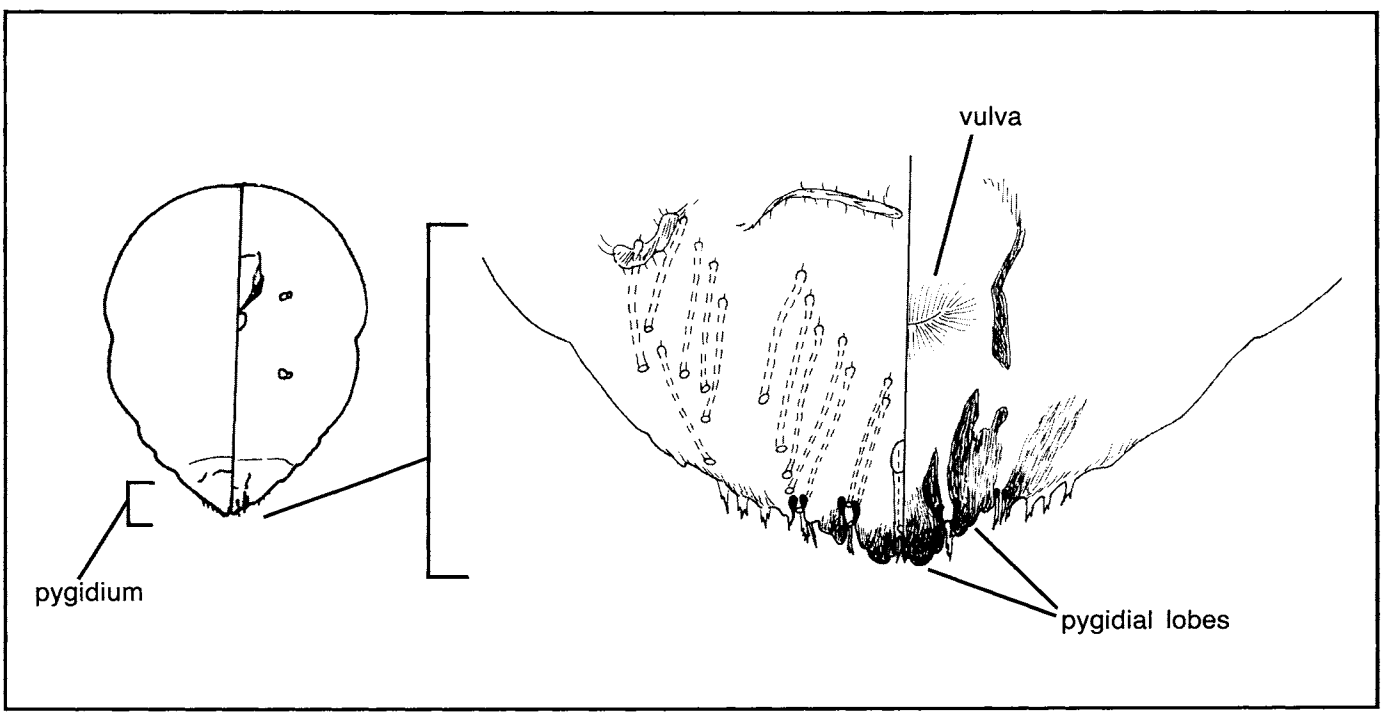

Figure 25.12. **San Jose scale,** *Quadraspidiotus perniciosus* (Diaspididae).

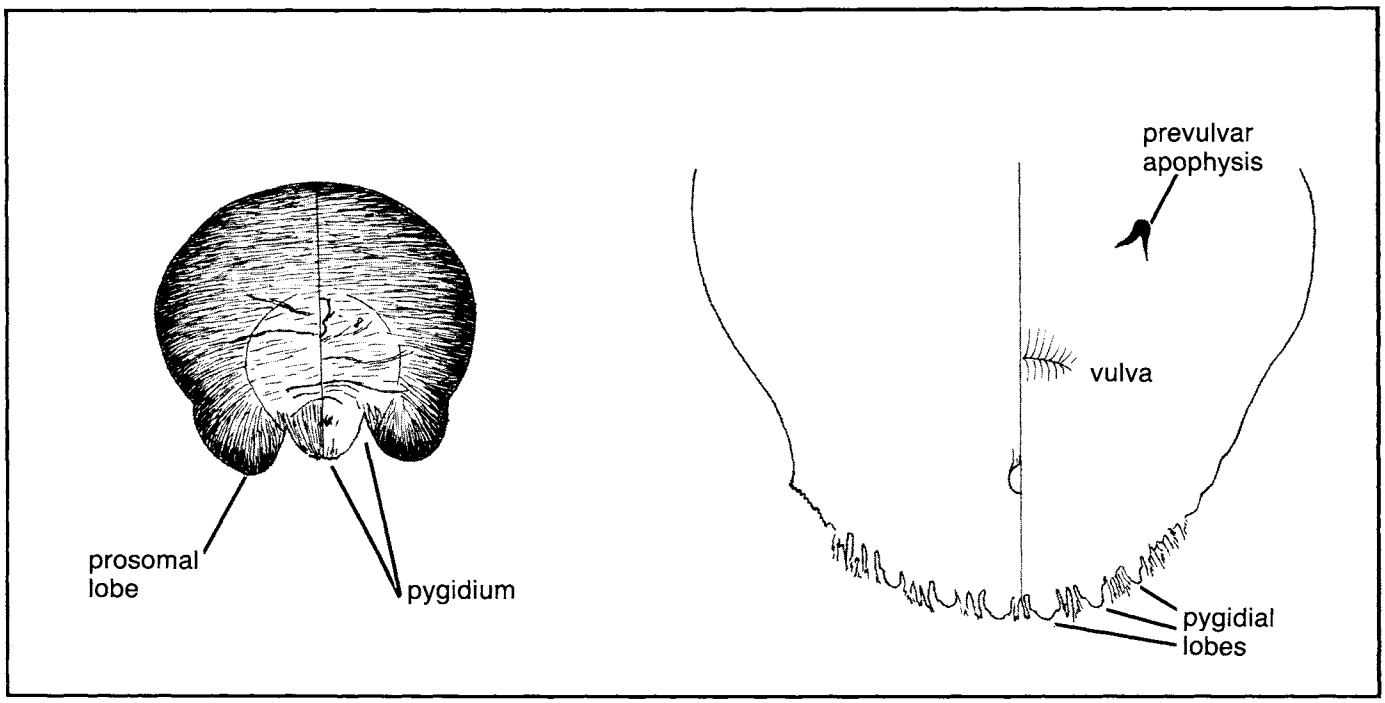

Figure 25.13. **Yellow scale,** *Aonidiella citrina* (Diaspididae): Left, dorsal/ventral habitus; right, dorsal/ventral detail of pygidium.

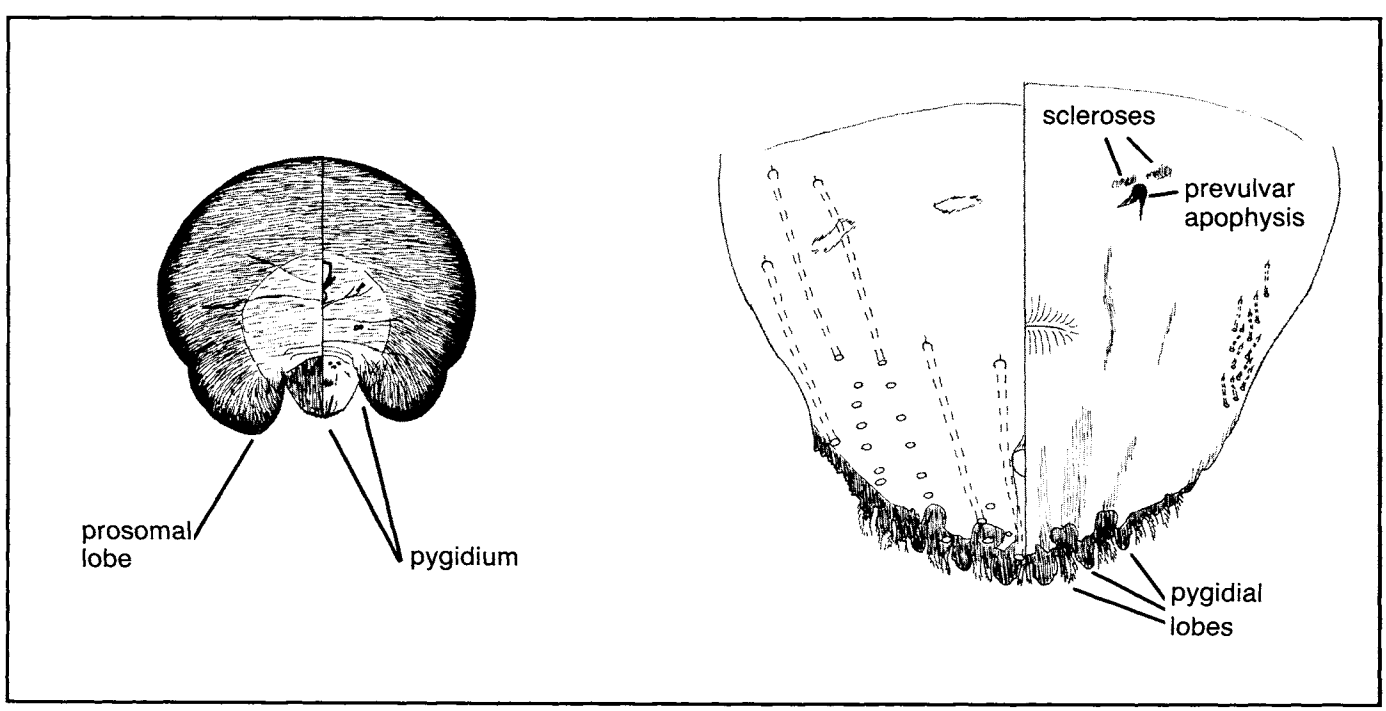

Figure 25.14. **California red scale,** *Aonidiella aurantii* (Diaspididae): Left, dorsal/ventral habitus; right, dorsal/ventral detail of pygidium.

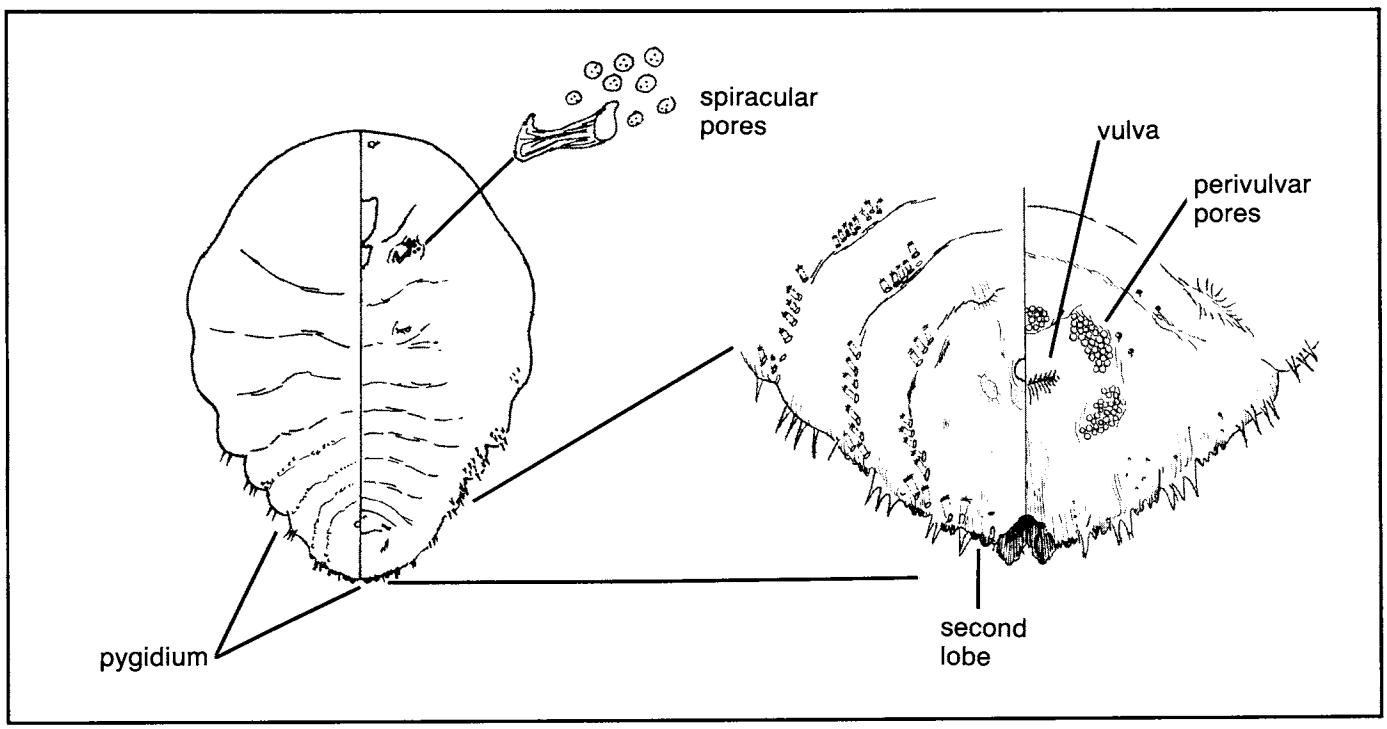

Figure 25.15. **White peach scale,**
Pseudaulacaspis pentagona (Diaspididae).

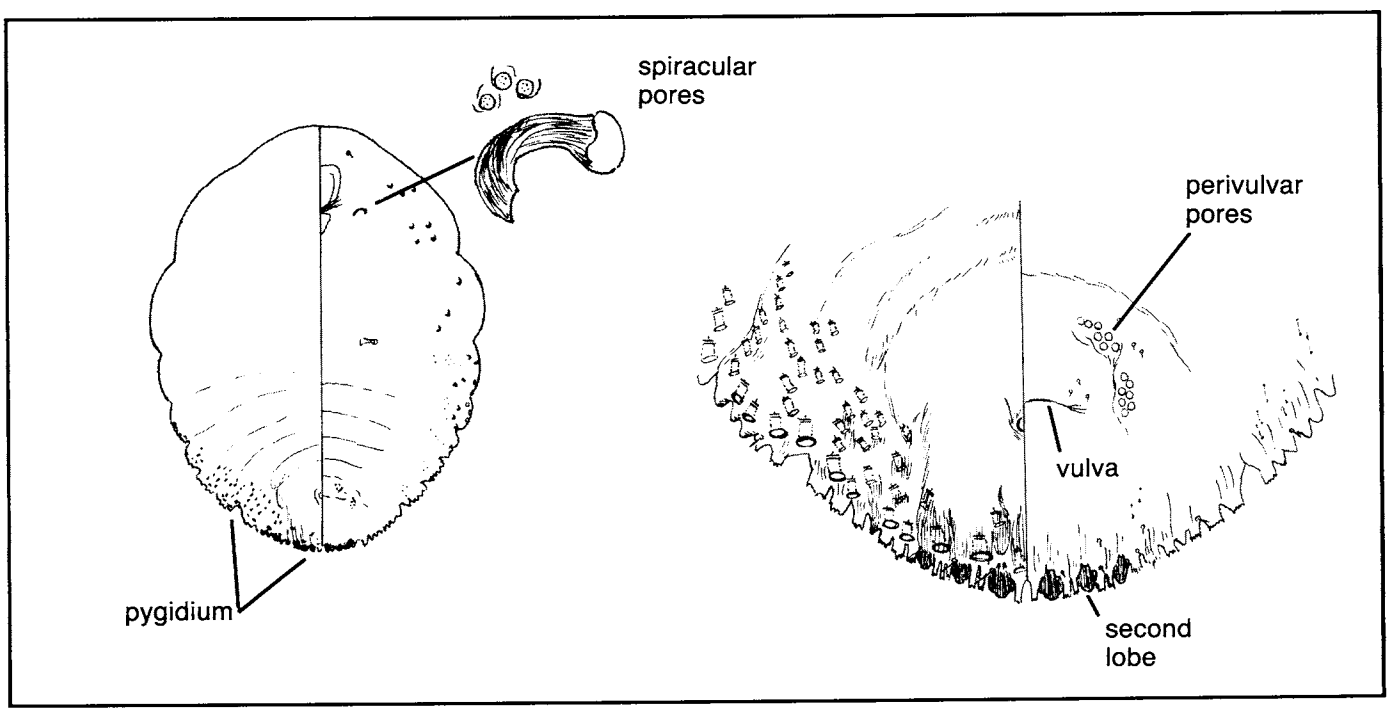

Figure 25.16. **Chaff scale,** *Parlatoria pergandii* (Diaspididae): Left, dorsal/ventral habitus; right, dorsal/ventral detail of pygidium.

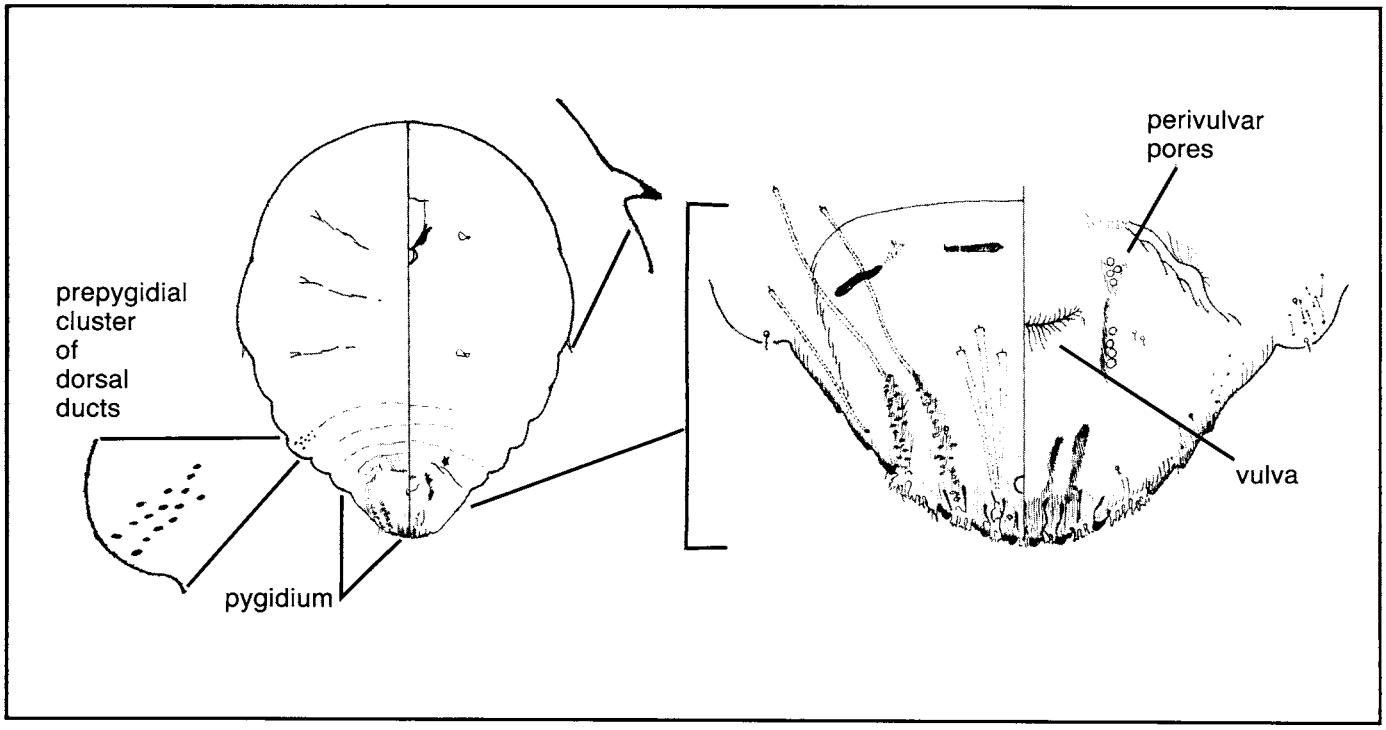

Figure 25.17. **Florida red scale,** *Chrysomphalus aonidum* (Diaspididae)

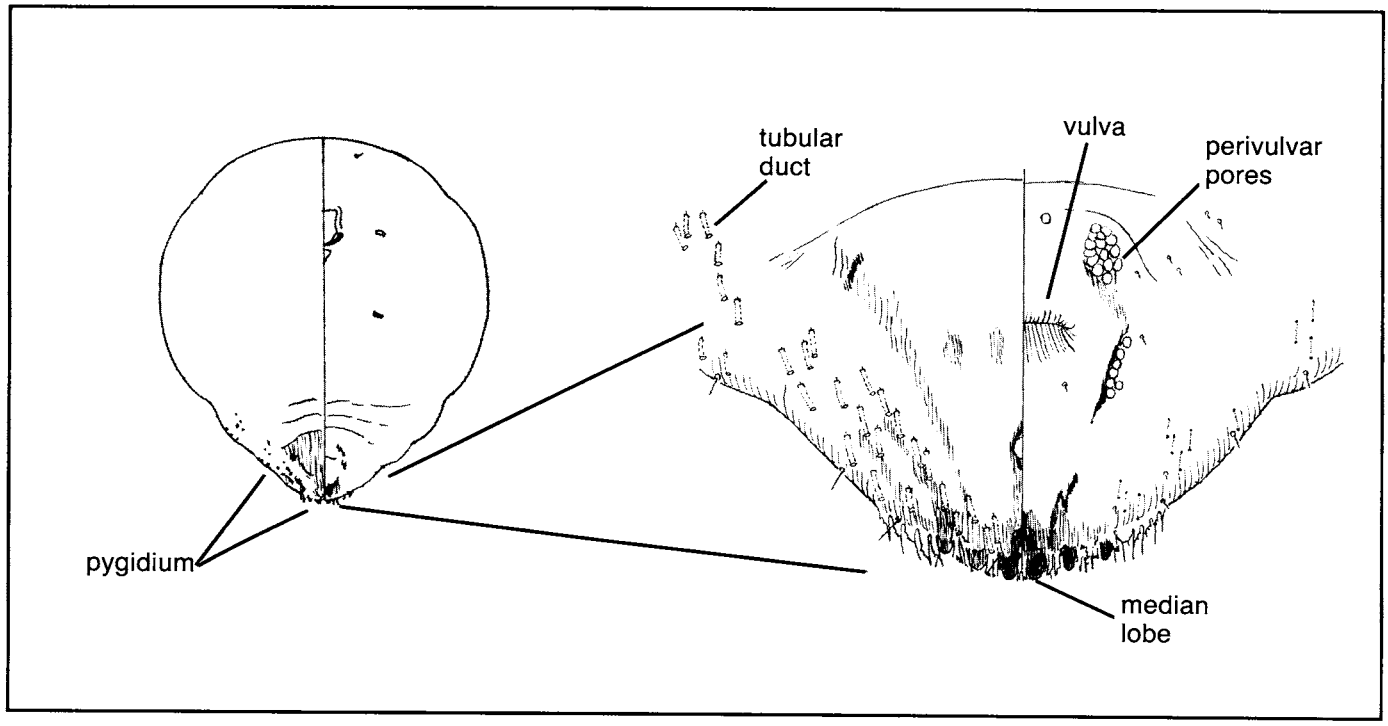

Figure 25.18. **Oleander scale,** *Aspidiotus nerii* (Diaspididae).

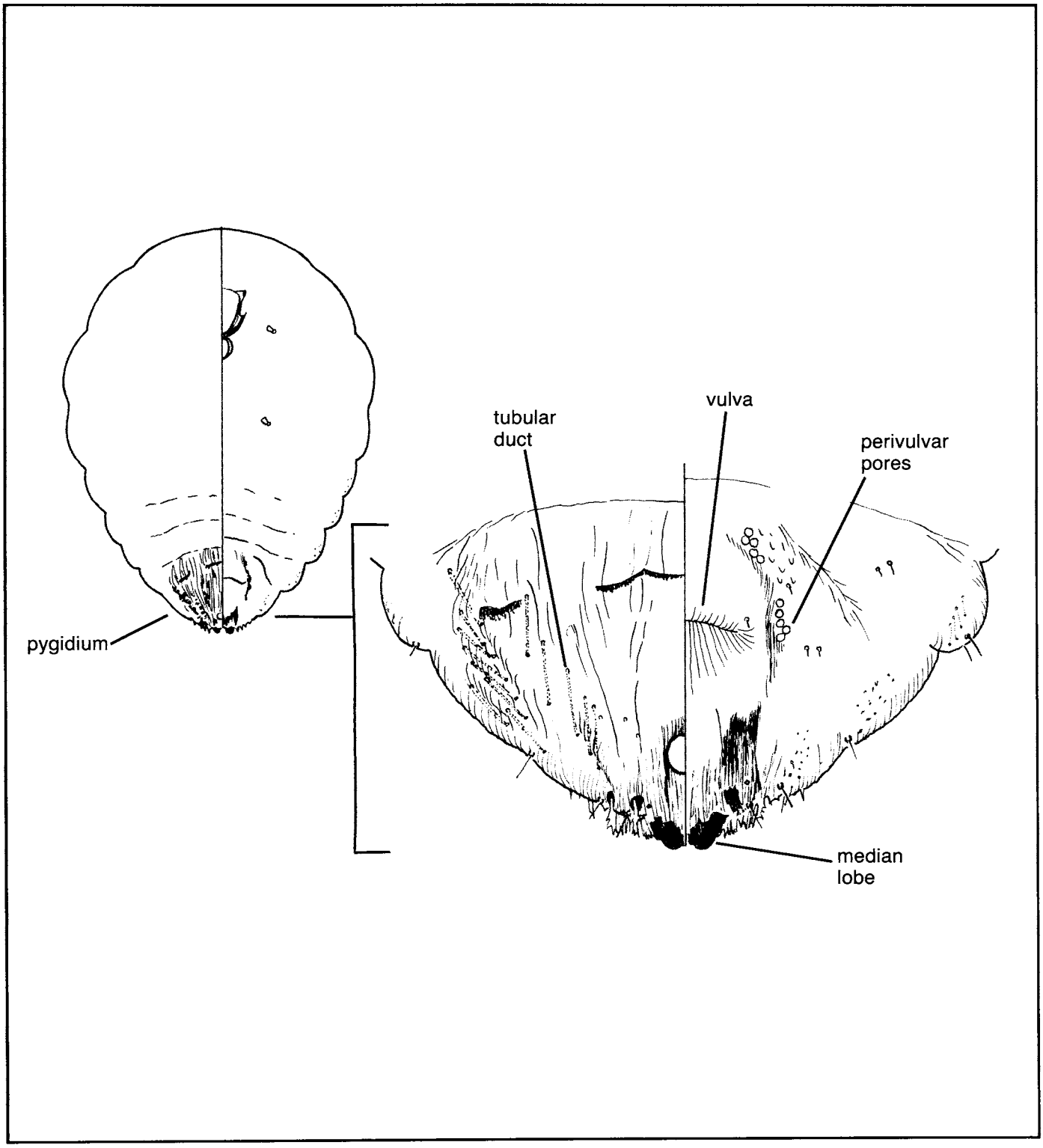

Figure 25.19. **Latania scale,** *Hemiberlesia lataniae* (Diaspididae).

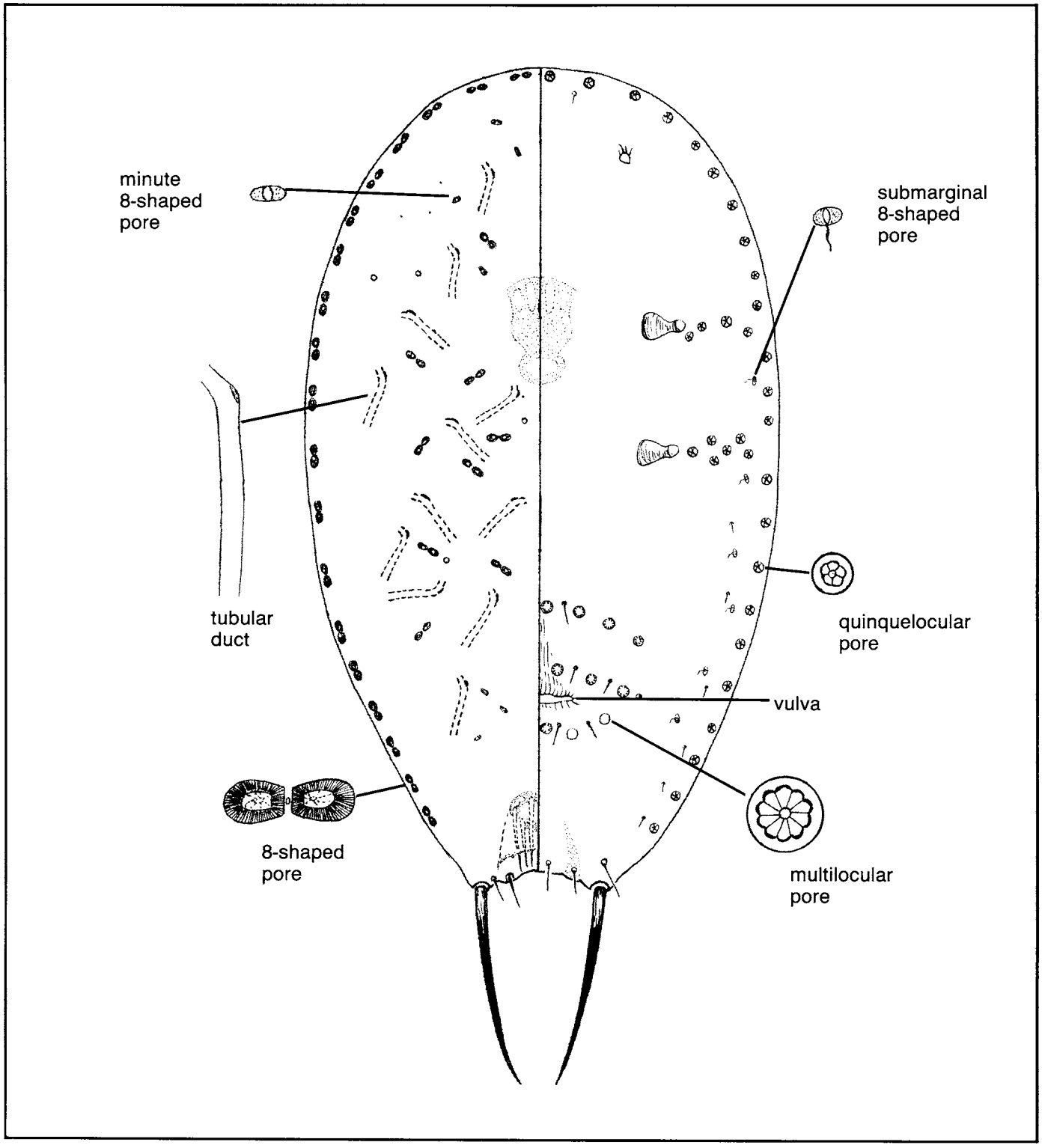

Figure 25.20. A pit scale, *Asterolecanium* sp. (Asterolecaniidae).

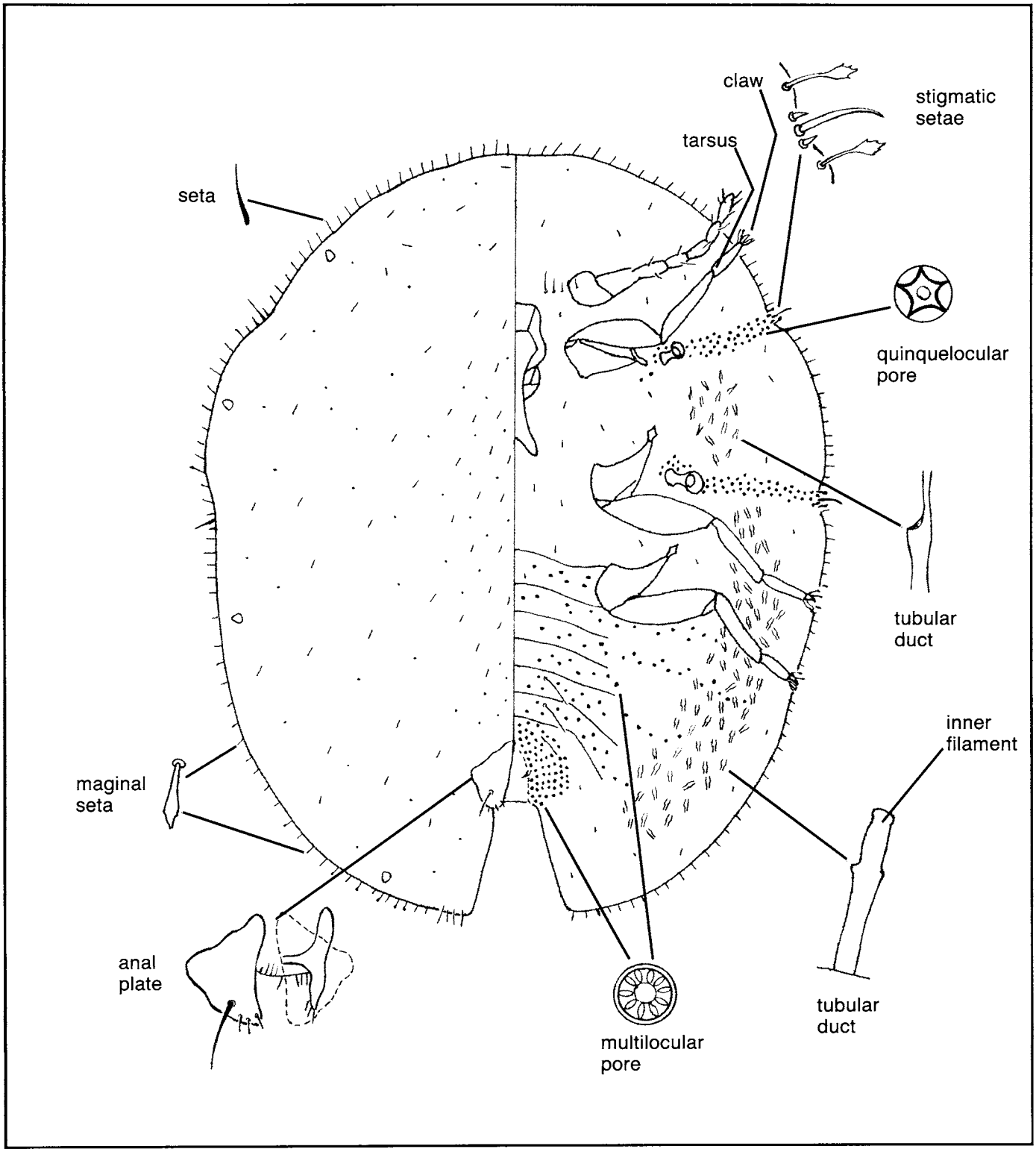

Figure 25.21. **Hemispherical scale,** *Saissetia coffeae* (Coccidae).

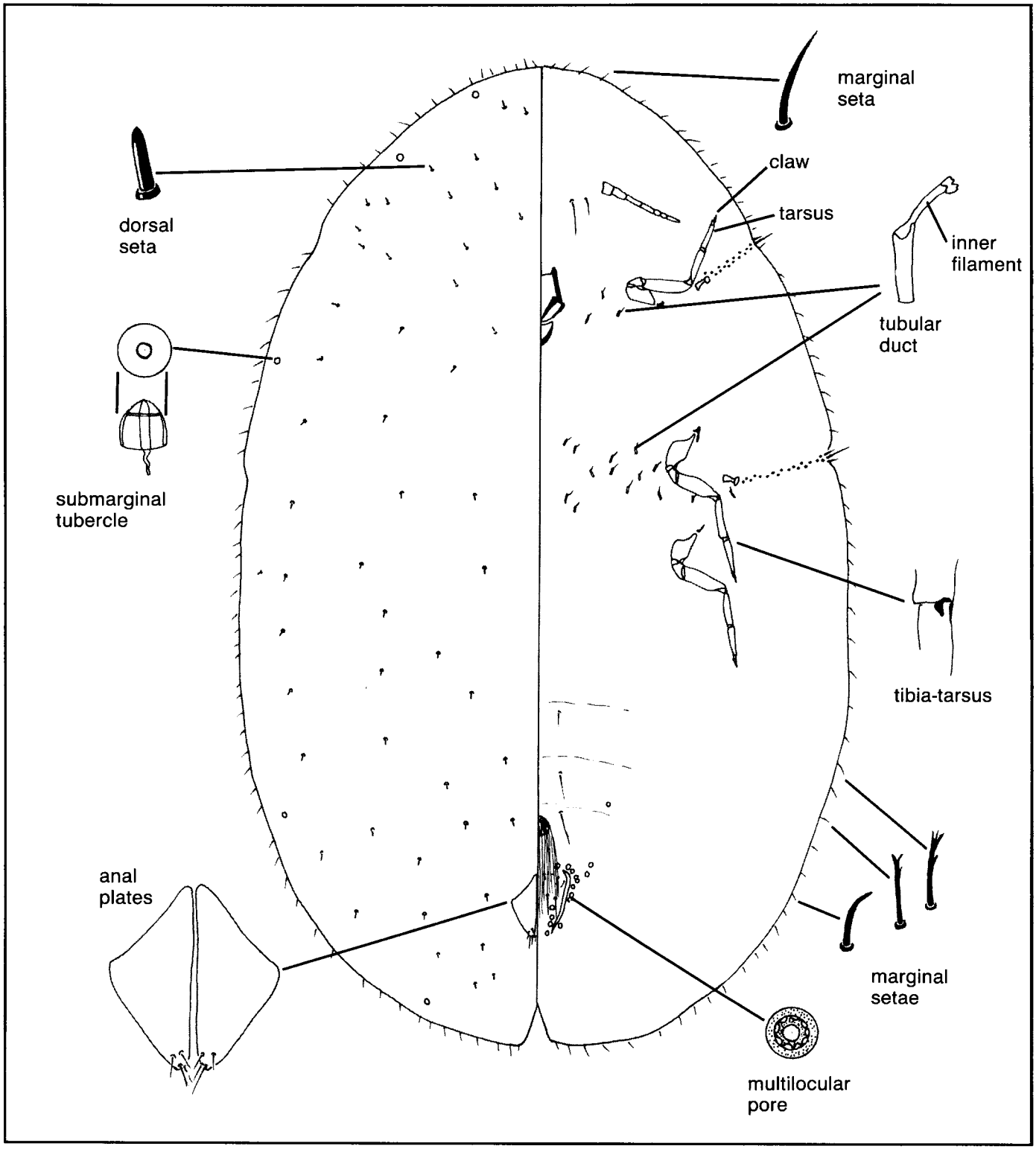

Figure 25.22. **Brown soft scale,** *Coccus hesperidum* (Coccidae).

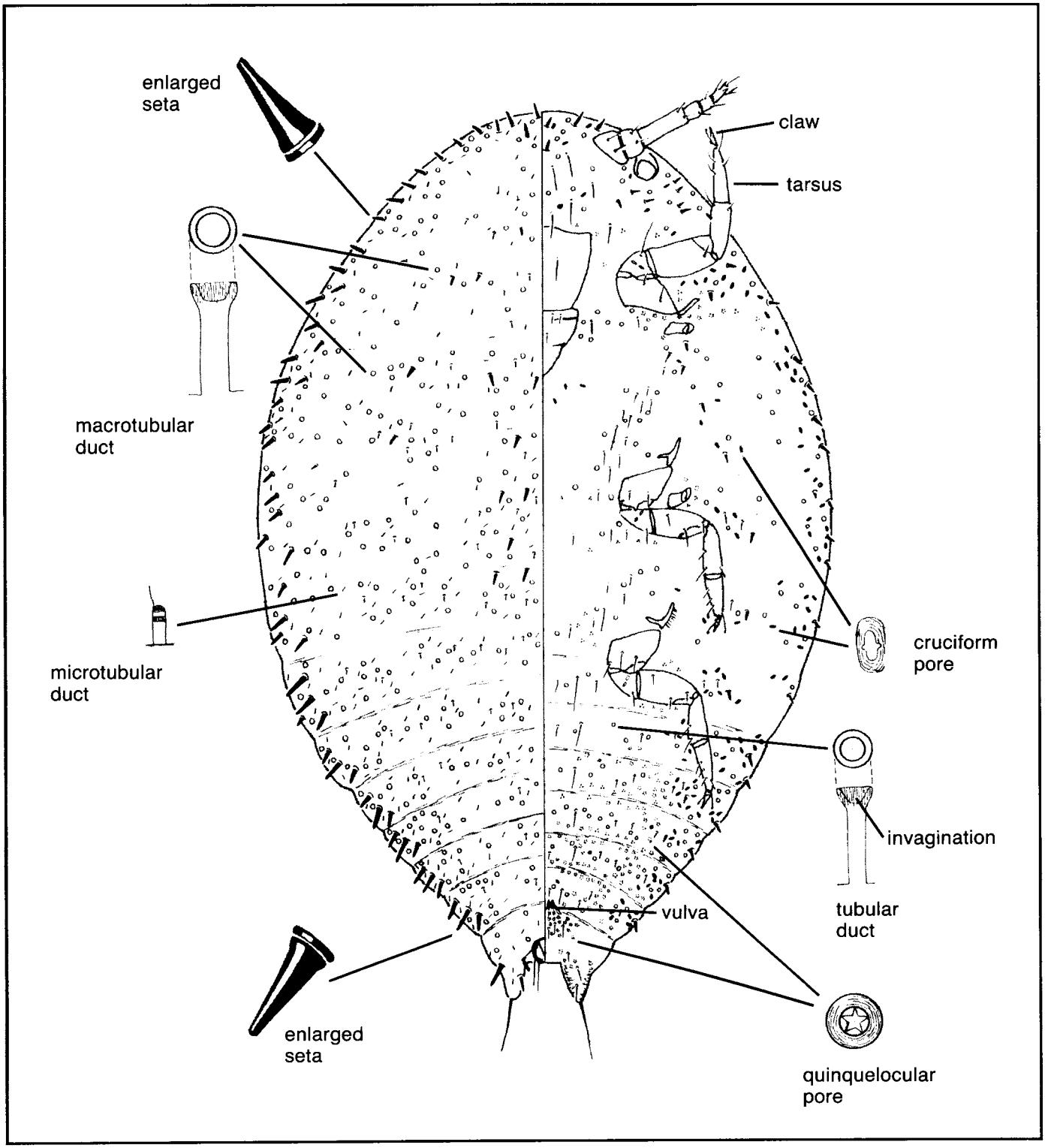

Figure 25.23. *Eriococcus coccineus* Cockerell (Eriococcidae).

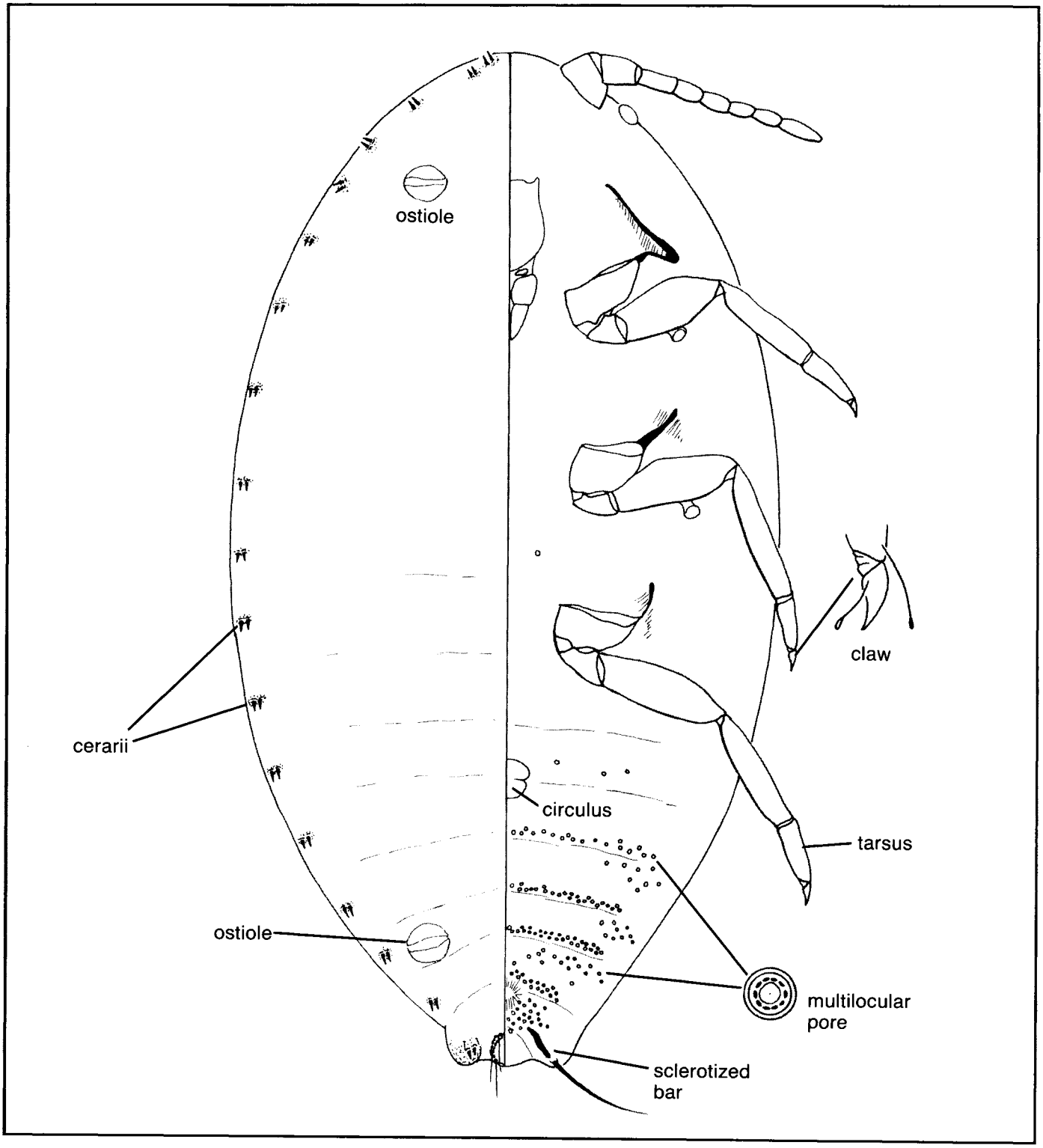

Figure 25.24. **Citrus mealybug,** *Planococcus citri* (Pseudococcidae).

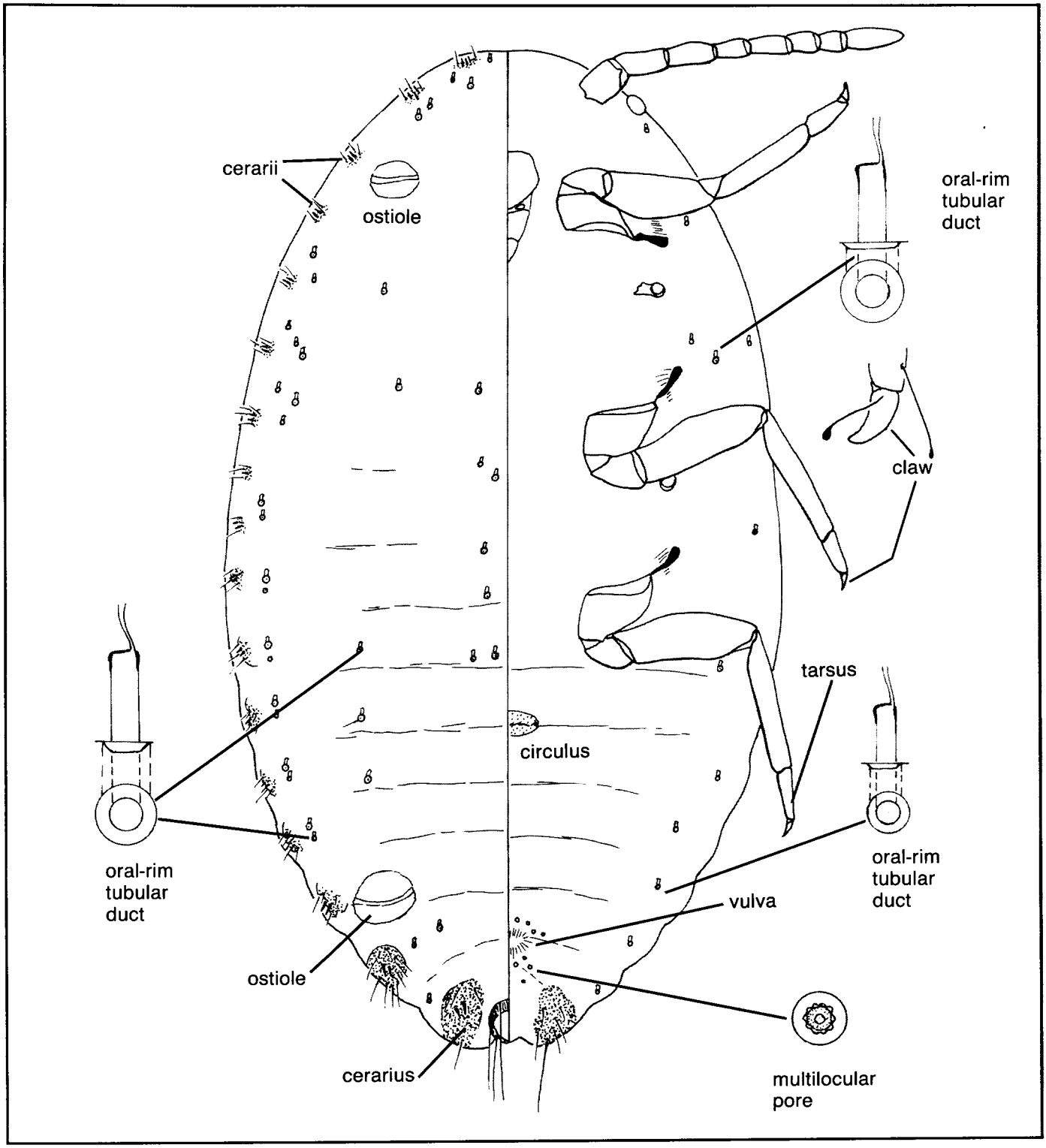

Figure 25.25. **Longtailed mealybug,**
Pseudococcus longispinus (Pseudococcidae).

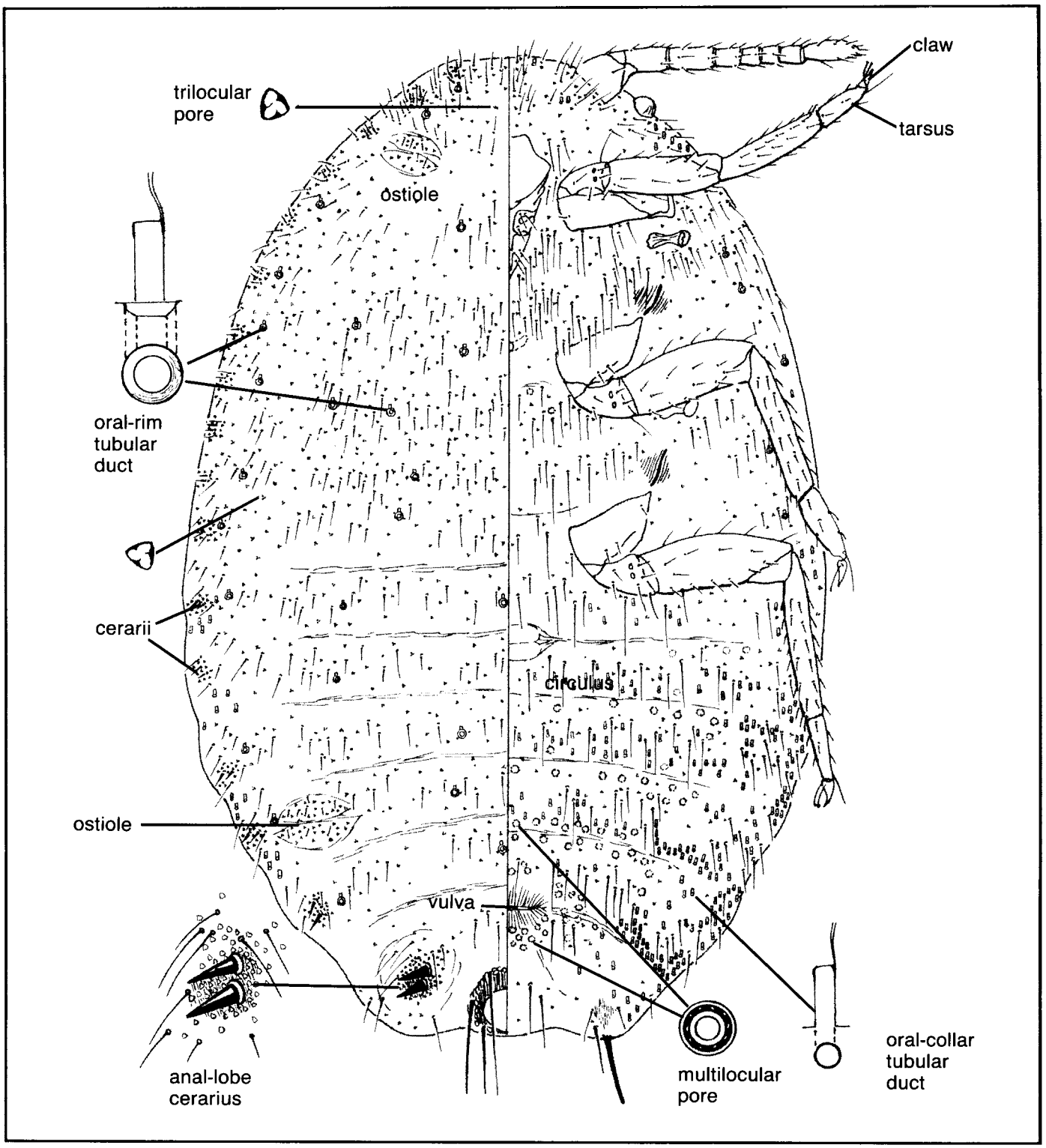

Figure 25.26. **Grape mealybug,** *Pseudococcus maritimus* (Pseudococcidae).

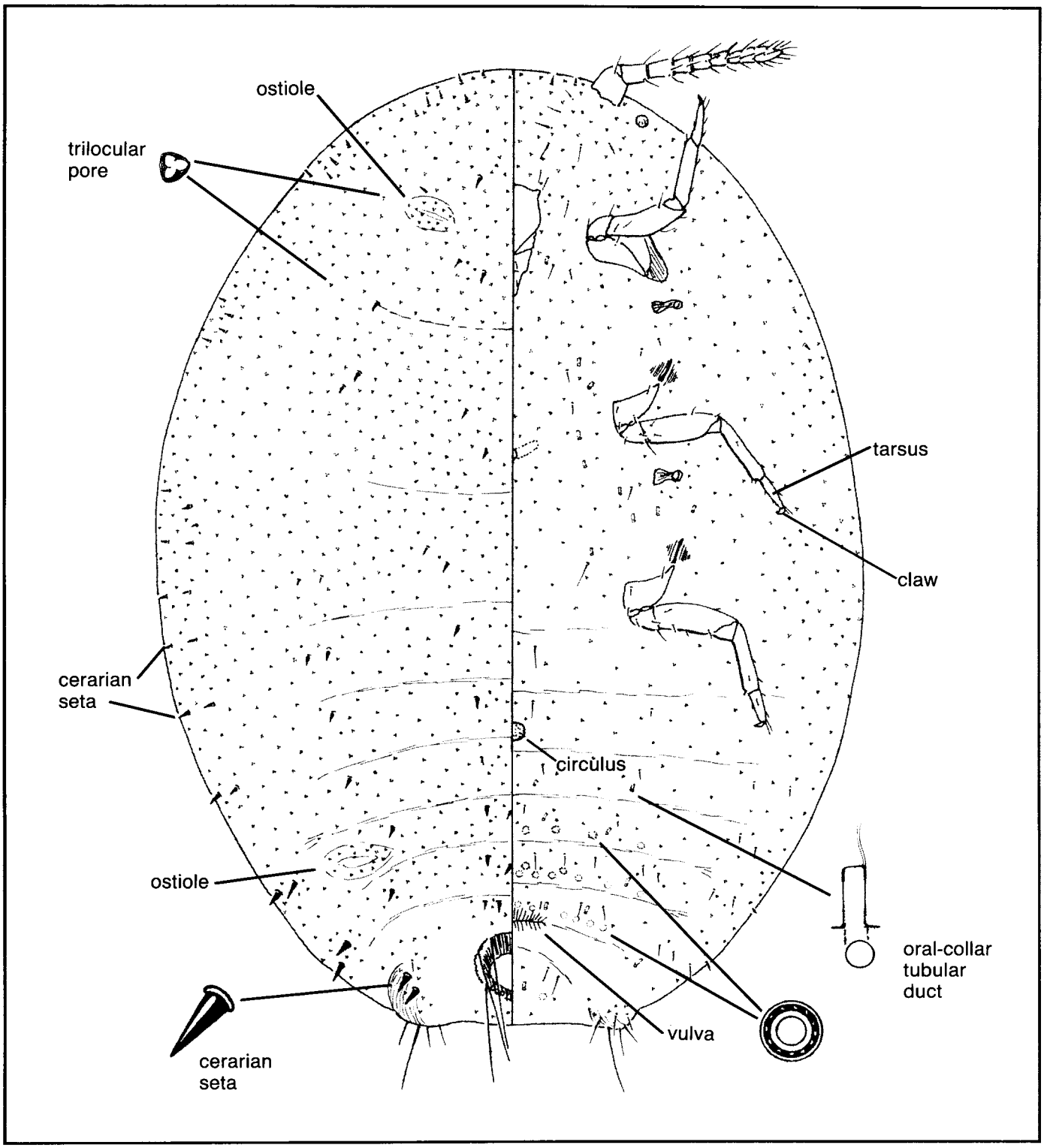

Figure 25.27. **Coconut mealybug,** *Nipaecoccus nipae* (Pseudococcidae).

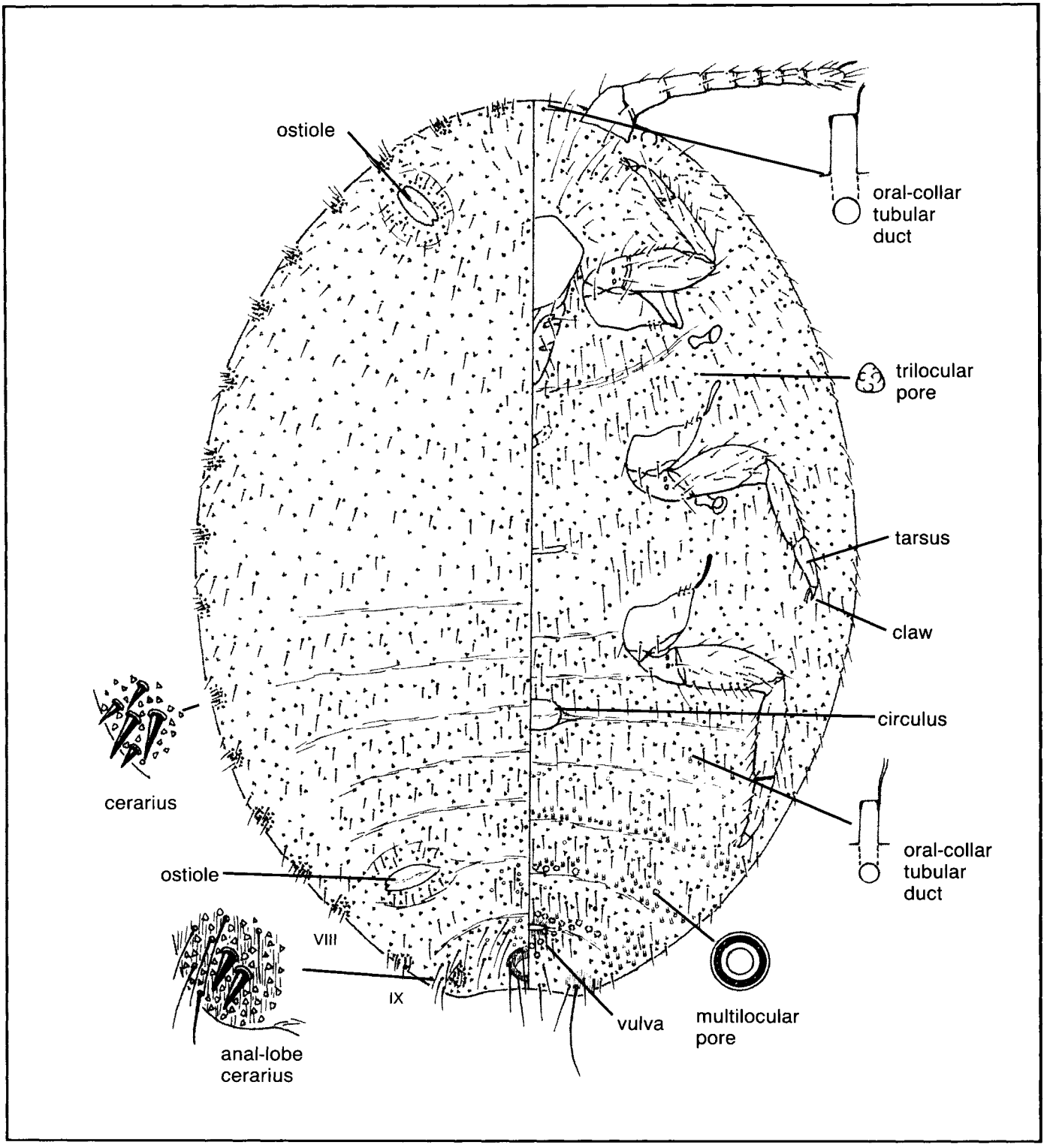

Figure 25.28. **Pineapple mealybug,** *Dysmicoccus brevipes* (Pseudococcidae).

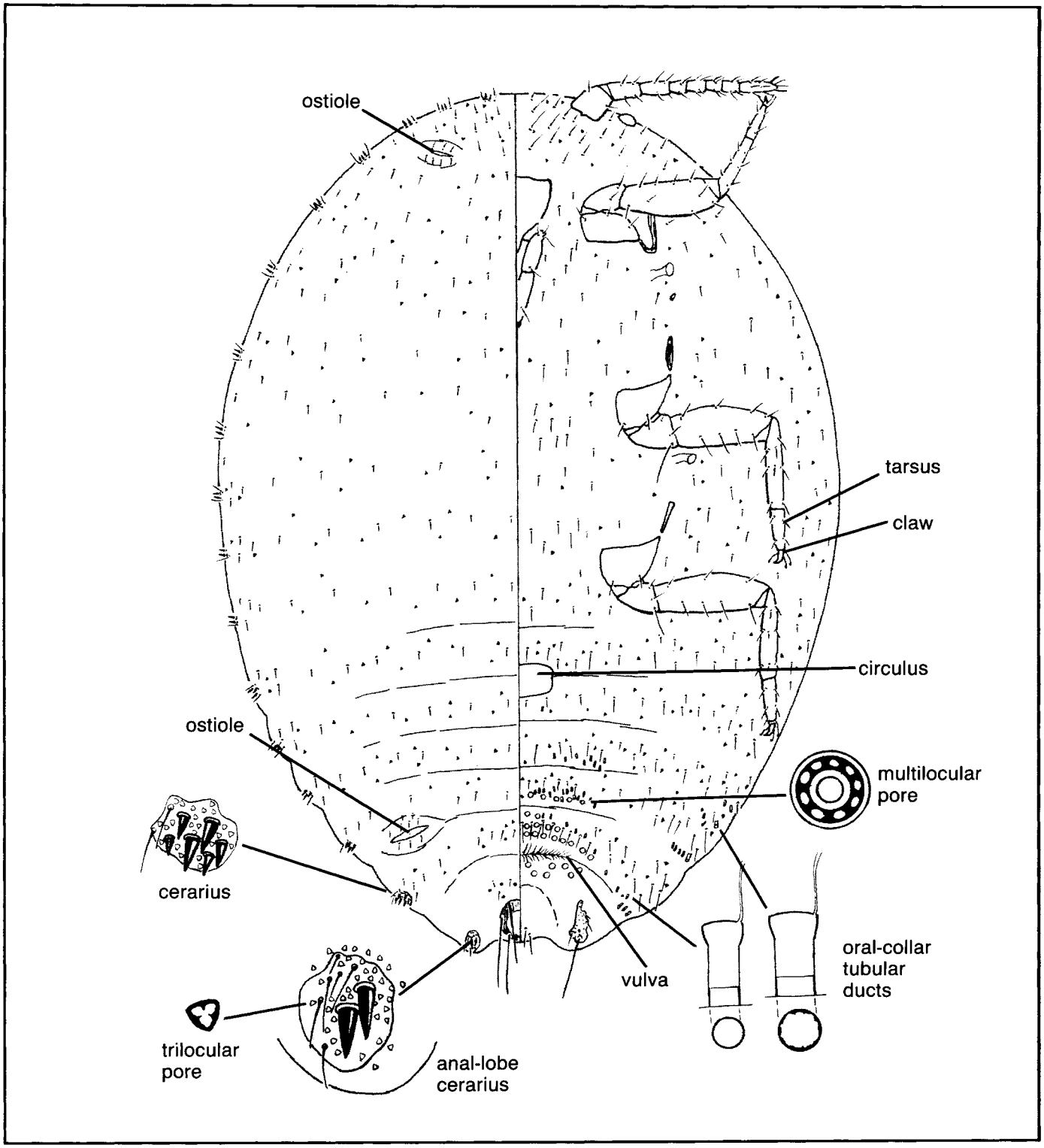

Figure 25.29. **Gray pineapple mealybug,** *Dysmicoccus neobrevipes* (Pseudococcidae).

26 PARASITIC WASPS (APOCRITA, HYMENOPTERA)

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The Order Hymenoptera is among the largest and most highly evolved group within the Class Insecta. More than 100,000 species have been described and ultimately this number will be substantially larger when the taxonomic diversity of this order becomes more fully understood. This order is especially interesting because of its biological diversity. Some species are phytophagous, feeding on many agricultural and ornamental plants, but most of the species are beneficial in that they pollinate angiosperms or prey upon or parasitize destructive insects.

Most of the hymenopterous insects found in stored food are associated with stored-product pests. All the Hymenoptera known to be associated with stored products are members of the Suborder Apocrita (= Clistogastra or Petiolata). These insects may be recognized readily by the characteristic modifications of the thorax and abdomen: The first abdominal segment (propodeum) has become fused with the thorax and separated from the rest of the abdomen by a narrow constriction. The movable portion of the abdomen is called the gaster (the term used in this key) or metasoma *(3)*. Wings, when present, are membranous; hind wings have no more than two closed cells (see fig. 26.2B).

The many species associated with stored products, all belonging to the Suborder Apocrita, do not comprise a homogenous group. Member species belong to several distantly related groups: Ichneumonoidea (Braconidae, Ichneumonidae), Evanioidea (Evaniidae), Chalcidoidea (Chalcididae, Encyrtidae, Eulophidae, Eupelmidae, Eurytomidae, Pteromalidae, Trichogrammatidae), and Chrysidoidea (Bethylidae).

In some species males are rare or unknown, so I have excluded them from consideration here. The following key is based on female wasps. Selected morphological features are shown in figures 26.1 and 26.2, drawings that are based on those of Graham *(2)*. Where specimens for some species were not available for study, I selected characters from the literature. In some instances in this key I have relied heavily on recently published keys, such as that of Evans *(1)* for the Bethylidae. Sometimes it has not been possible to provide keys to species in certain genera because the taxonomy of the group is too uncertain. For example, this key gives generic names only for many pteromalids and trichogrammatids. Specific identifications can be done only by specialists in these groups.

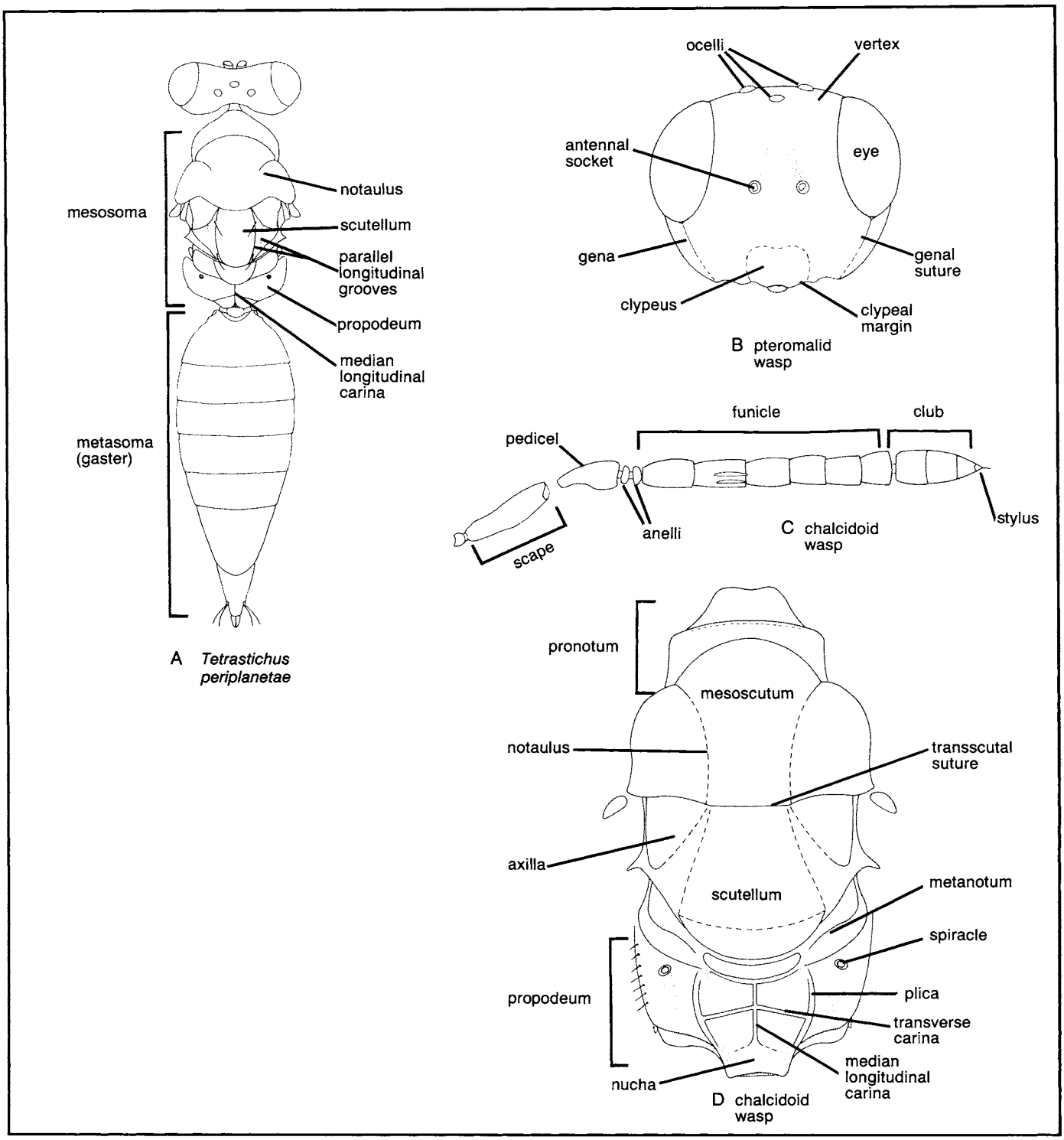


Figure 26.1. Selected morphological features of female Apocrita: A, body, dorsal view; B, head, anterior view; C, antenna; D, thorax, dorsal view. (Drawings by P. Mote.)

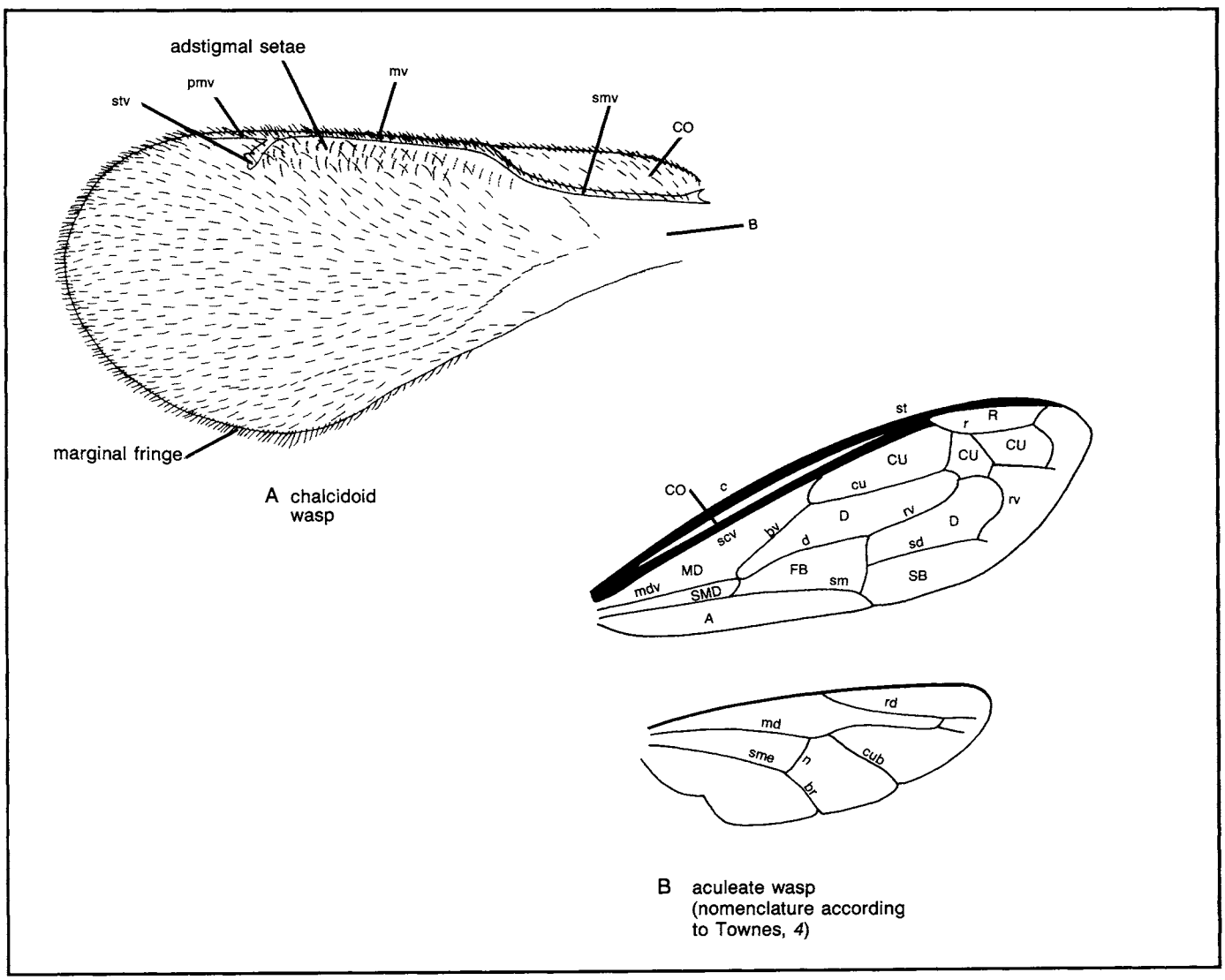


Figure 26.2. Wings of female Apocrita: A, forewing with reduced venation; B, wings with well-developed venation. The abbreviations given here apply to all wing drawings in this chapter. Veins: a, anal; br, brachiella; bv, basal; c, costal; cu, cubital; cub, cubitella; d, discoidal; ic, intercostal; md, mediella; mdv, median; mv, marginal; n, nervellus; pmv, postmarginal; r, radial; rd, radiella; rv, recurrent; scv, subcostal; sd, subdiscoidal; sm, submedius; sme, submediella; smv, submarginal; st, stigma; stv, stigmal; tm, transverse median. Cells: A, anal; AR, areolet; B, basal; CO, costal; CU, cubital; D, discoidal; DC, discocubital; FB, first brachial; FCU, first cubital; FD, first discoidal; M, marginal; MD, median; R, radial; SB, second brachial; SCU, second cubital; SD, second discoidal; SM, submarginal; SMD, submedian; TCU, third cubital; TD, third discoidal. (Drawings by P. Mote.)

KEY TO PARASITICA IN STORED PRODUCTS

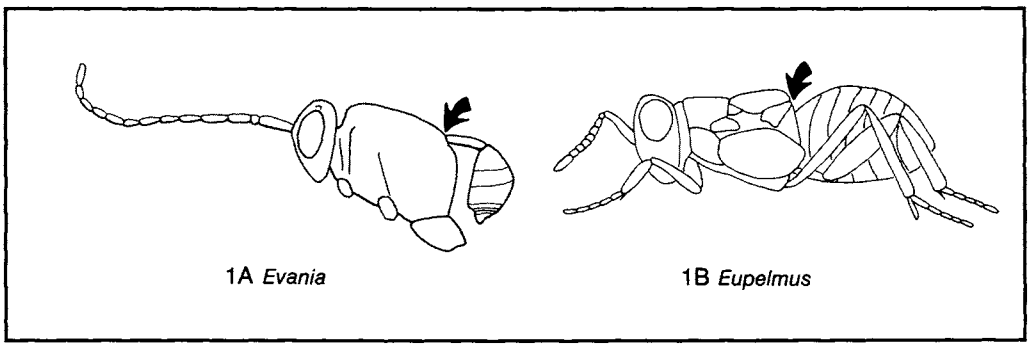
Drawings by G. Gordh, P. Mote, and S. McAlpine.

1 Petiole attached high on propodeum, well removed from coxa III (1A). Evaniidae (**ensign wasps**) ---------- 2

Petiole long, cylindrical; gaster strongly compressed.

Petiole attached near or above base of coxa III (petiole frequently obscured) (1B) ---- 4

Petiole length variable.



1A *Evania* 1B *Eupelmus*

2 Tibia and tarsus III with conspicuous spines-----**lesser ensign wasp,** *Szepligetella sericea*

Distribution: Pacific islands from Hawaii to the Philippines and New Guinea. Hosts: Blattaria (oothecae).

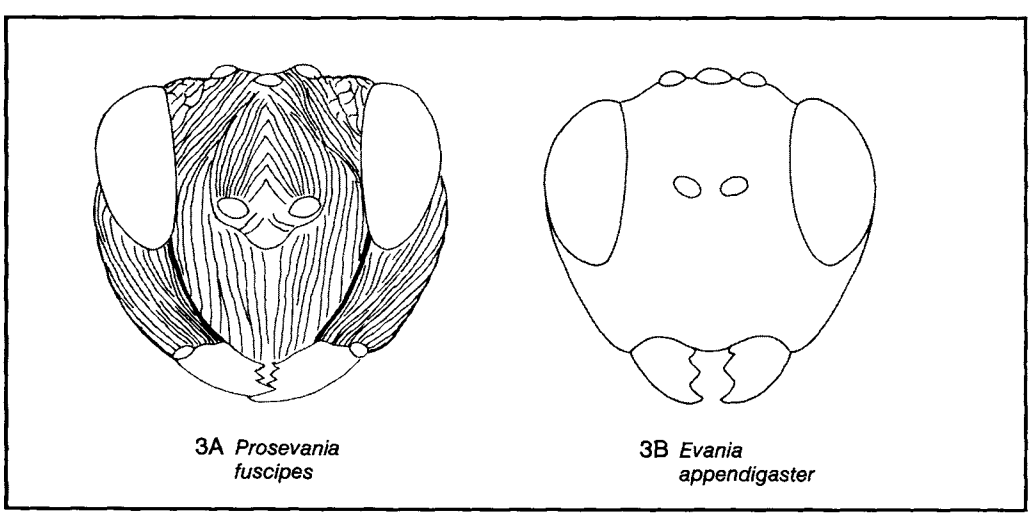
Tibia and tarsus III without conspicuous spines ---------- 3

3 Face and gena with longitudinal oblique striae (3A)----------*Prosevania fuscipes*

Distribution: Asia, Europe, Nearctic, North Africa. Hosts: Blattaria (oothecae).

Face and gena smooth, bearing a few fine punctures (3B) ----------*Evania appendigaster*

Distribution: Worldwide. Hosts: Blattaria (oothecae).



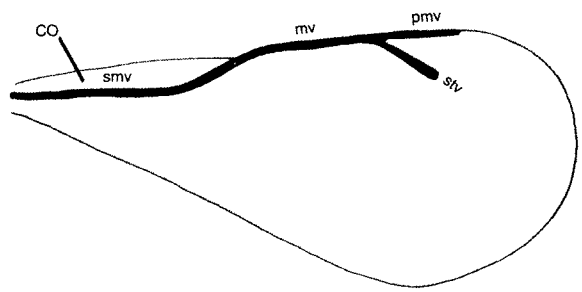
3A *Prosevania fuscipes* 3B *Evania appendigaster*

4 Forewing venation reduced but always with a costal cell, marginal vein, stigmal vein, and usually a postmarginal vein (4A, 12B; compare with 43A&B, 44A&B). Chalcidoidea **(chalcids)**---------- 5

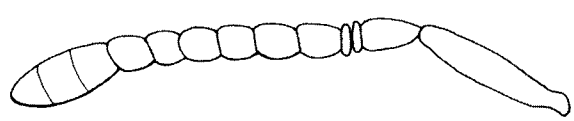
Antenna with 13 or fewer segments, including annular ring segments (4B); antennal club frequently formed from fused segments; postmarginal vein sometimes absent, as in *Tetrastichus* spp. (12D).

Forewing with many veins (4C); or if venation is reduced, then configuration not as above; or wings absent ---------- 35

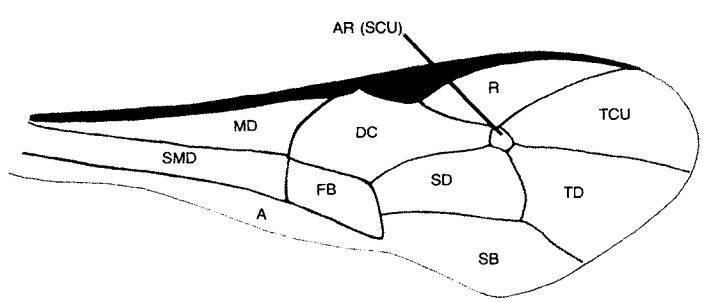
Antenna with 12 or more segments; annular ring segments absent.



4A *Paraolinx typica*



4B *Pteromalus*



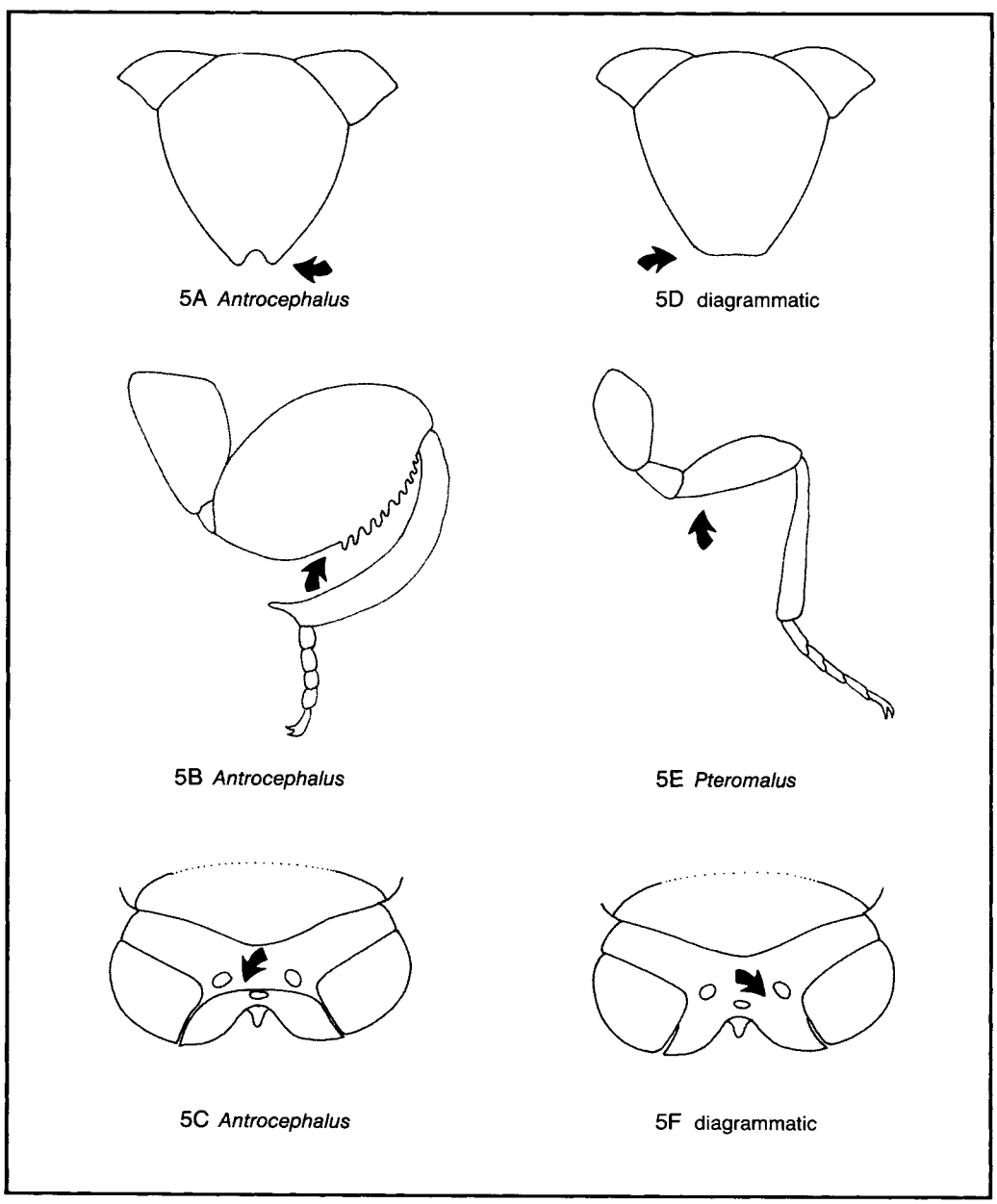
4C ichneumonid wasp

5 Scutellum with 2 toothlike projections (5A). Chalcididae (chalcidids). Genus *Antrocephalus* 6

Body rather robust; coxa and femur III enlarged and plump; femur III often with tubercles along ventral margin (5B); head with a sharp carina along medial margin of compound eye and extending behind median ocellus (5C).

Scutellum without apical projections (5D) ---------- 7

Body not as robust; femur III without tubercles (5E); head usually lacking a sharp carina, but if present, then not extending behind ocellus (5F).



5A *Antrocephalus*

5D diagrammatic

5B *Antrocephalus*

5E *Pteromalus*

5C *Antrocephalus*

5F diagrammatic

6 Median carina of propodeum curved or arched ----------*Antrocephalus mahensis*

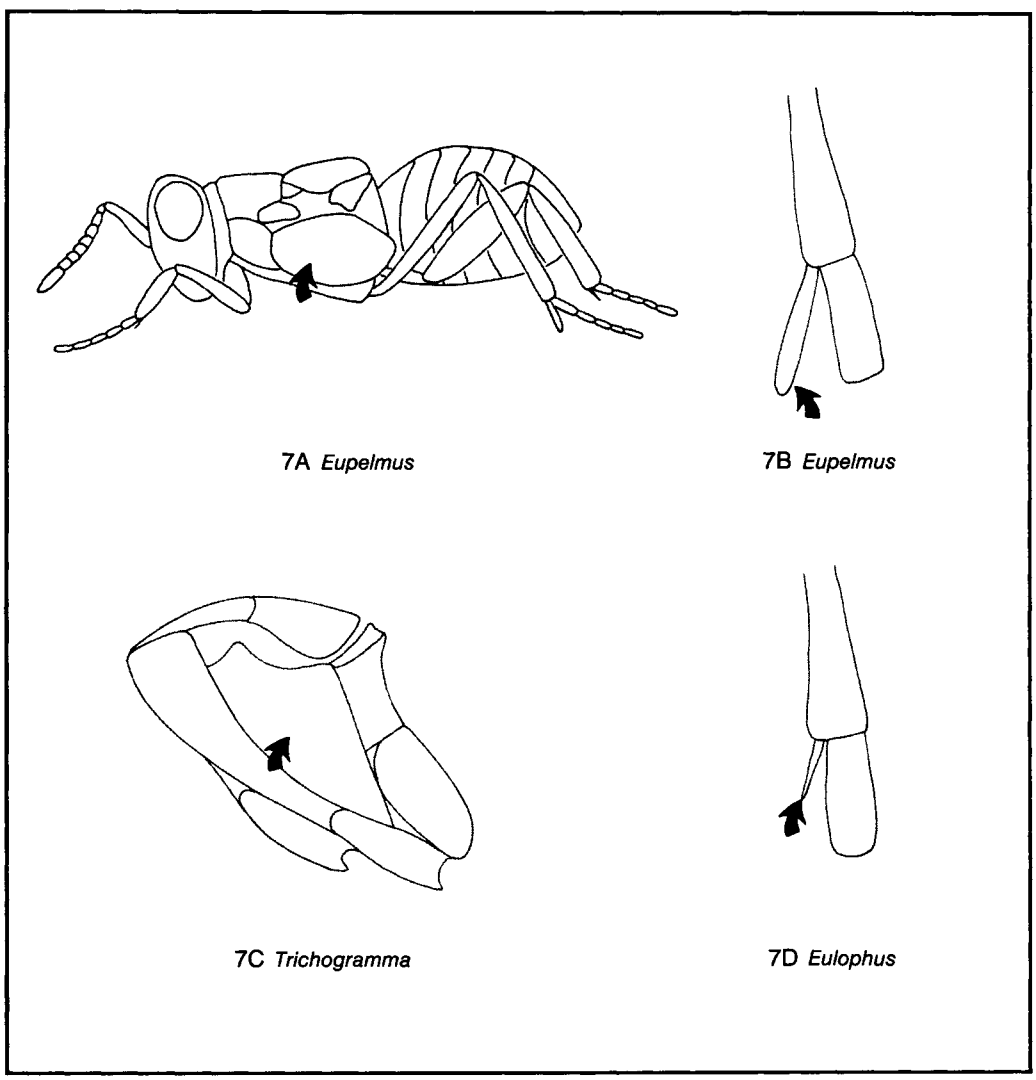
Distribution: Seychelles. Hosts: Pyralidae.

Median carina of propodeum straight ----------*Antrocephalus aethiopicus*

Distribution: Ethiopian. Hosts: Pyralidae.

7 Mesopleuron convex, enlarged, not impressed (7A); pleural sutures not evident in lateral aspect; spur of tibia II enlarged and bluntly rounded apically (7B). Eupelmidae (eupelmids). Genus *Eupelmus* ---------- 8

Mesopleuron not convexly enlarged, usually distinctly impressed (7C); pleural sutures evident; spur of tibia II not enlarged, usually pointed (7D)---------- 9



7A *Eupelmus*

7B *Eupelmus*

7C *Trichogramma*

7D *Eulophus*

8 Gonostyli (ovipositor sheaths) mostly whitish but with base and apex dark--- *Eupelmus javae*

Distribution: Indo-Australian. Hosts: Larval Coleoptera.

Gonostyli mostly bluish with yellow coloration surrounding the medial portion ---------- *Eupelmus cushmani*

Distribution: Nearctic. Hosts: *Araecerus fasciculatus*; also known from *Acanthoscelides ochraceicolor* (Pic), *Anthonomus grandis grandis* Boheman, *Cylindrocopturus adspersus* (LeConte), *C. longulus* (LeConte), *Lixus scrobicollis* Boheman, *Mimosestes nubigens* (Motschulsky), *Trichobaris texana* LeConte.

9 Tarsal formula 3-3-3; body minute, less than 0.75 mm long. Trichogrammatidae (**trichogrammatid wasps**)---------- *Trichogramma*

Distribution: Worldwide. Hosts: Lepidopteran eggs. See 7C.

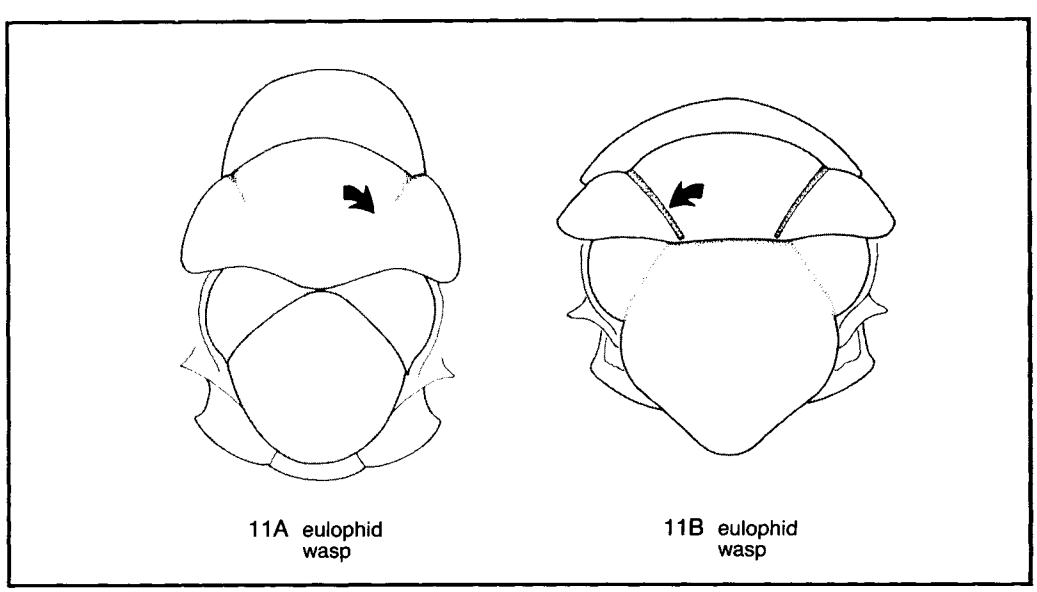
Tarsal formula 4-4-4 or 5-5-5; body length always greater than 1.0 mm---------- 10

10 Tarsal formula 4-4-4. Eulophidae (eulophids)---------- 11
Tarsal formula 5-5-5---------- 16

11 Notauli incomplete, not extending posteriorly to transscutal suture (11A) ---------- *Entedon longiventris*

Distribution: Palearctic. Hosts: Coleopteran larvae.

Notauli complete, extending from posterior margin of pronotum to transscutal suture (11B) 12



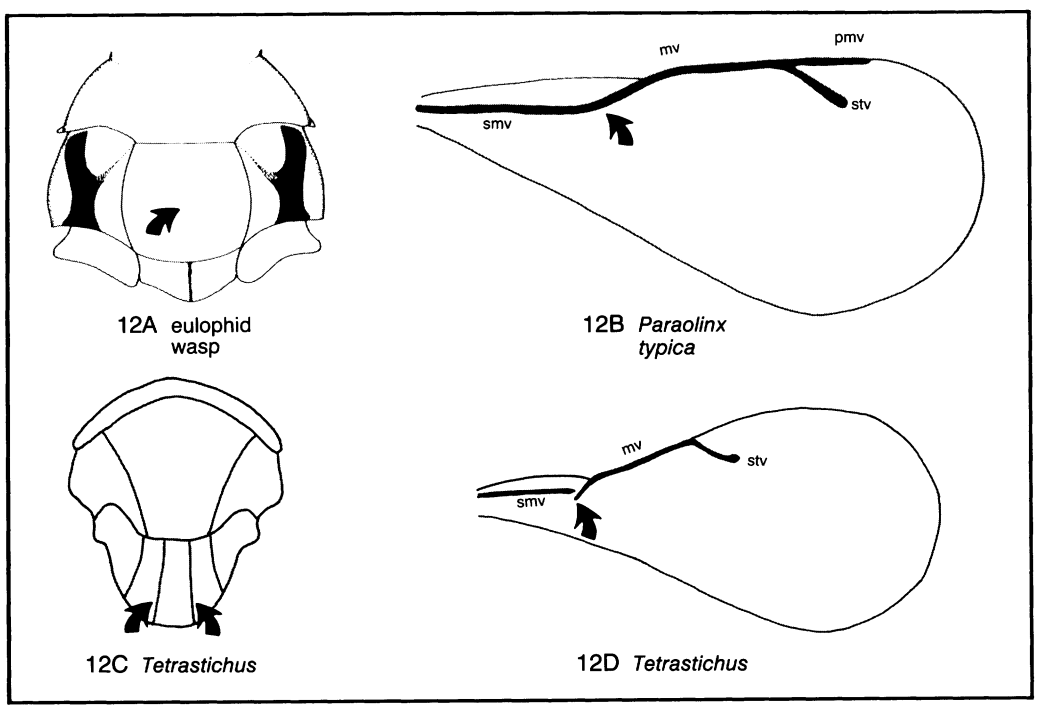
11A eulophid wasp

11B eulophid wasp

12 Scutellum without 2 grooved lines (similar to 12A); postmarginal vein as long as or longer than stigmal vein (12B); submarginal and marginal veins smoothly joined (12B) ----------*Paraolinx typica*

Formerly called *P. nigriventis.*
Distribution: Eastern Nearctic. Hosts: *Grapholita molesta, Pyroderces rileyi.*

Scutellum with 2 longitudinal, parallel, grooved lines (12C); postmarginal vein absent (12D); submarginal and marginal veins not smoothly joined (12D)---------- 13



12A eulophid wasp

12B *Paraolinx typica*

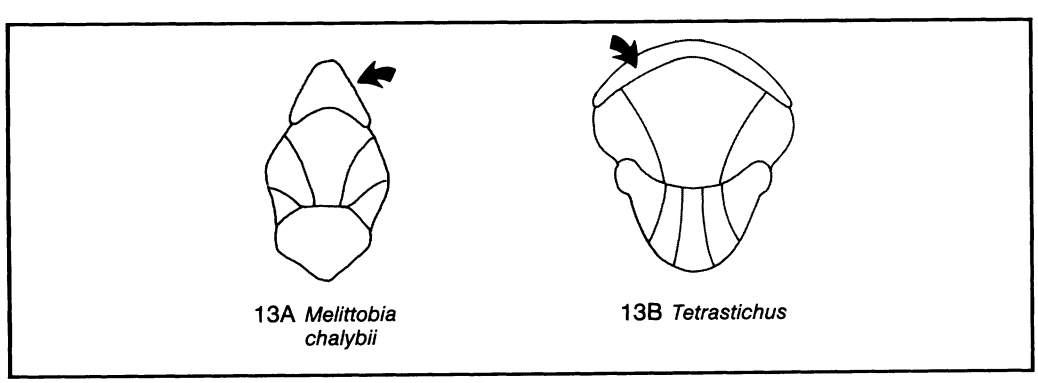
12C *Tetrastichus*

12D *Tetrastichus*

13 Pronotum unusually long, campanulate (13A); thorax depressed; genal suture absent ----------*Melittobia chalybii*

Distribution: Nearctic. Hosts: Blattaria (oothecae), various Hymenoptera.

Pronotum not unusually long (13B); thorax mostly convex; genal suture present --------- 14



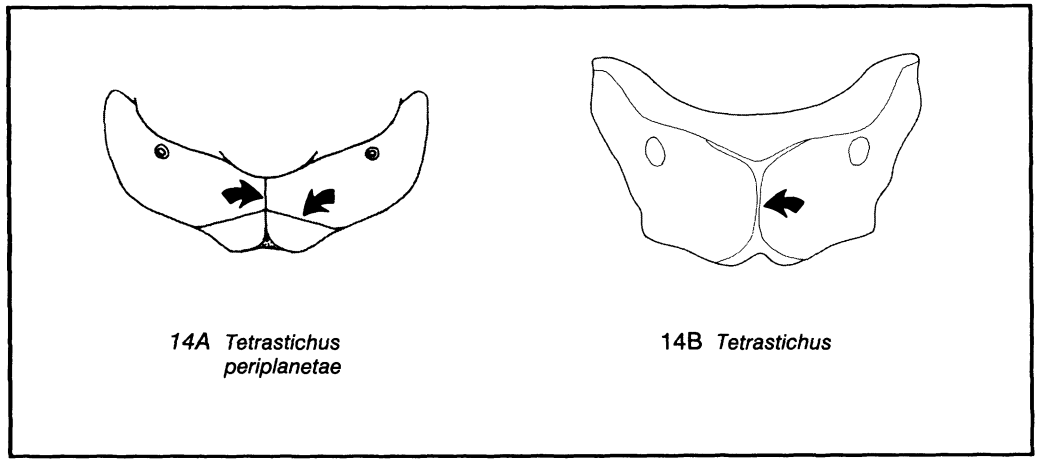
13A *Melittobia chalybii*

13B *Tetrastichus*

14 Propodeum with a median longitudinal carina and 2 lateral (transverse) carinae (14A) ----------*Tetrastichus periplanetae*

Distribution: Ethiopian. Host: *Periplaneta americana*. See also text figure 26.1A.

Propodeum with only a median longitudinal carina (14B) ---------- 15



14A Tetrastichus periplanetae

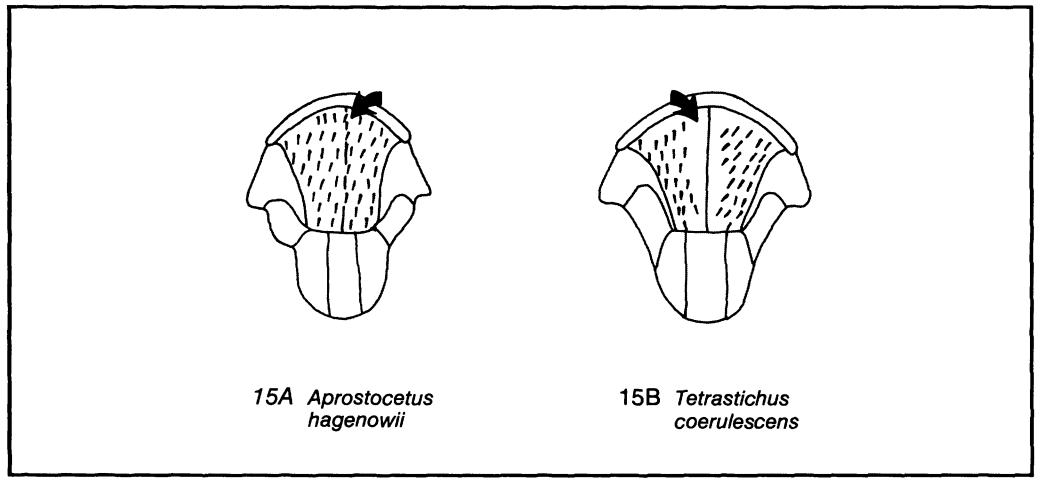
14B *Tetrastichus*

15 Setae on mesoscutum uniformly distributed over surface (contiguous with median longitudinal sulcus) (15A) ---------- *Aprostocetus (Tetrastichodes) hagenowii*

Distribution: Nearctic. Hosts: Blattaria (oothecae).

Setae on mesoscutum arranged in 3 to 5 rows adjacent to notauli (absent from meson) (15B) ----------*Tetrastichus coerulescens*

Distribution: Nearctic. Hosts: Larval Lepidoptera.



15A Aprostocetus hagenowii

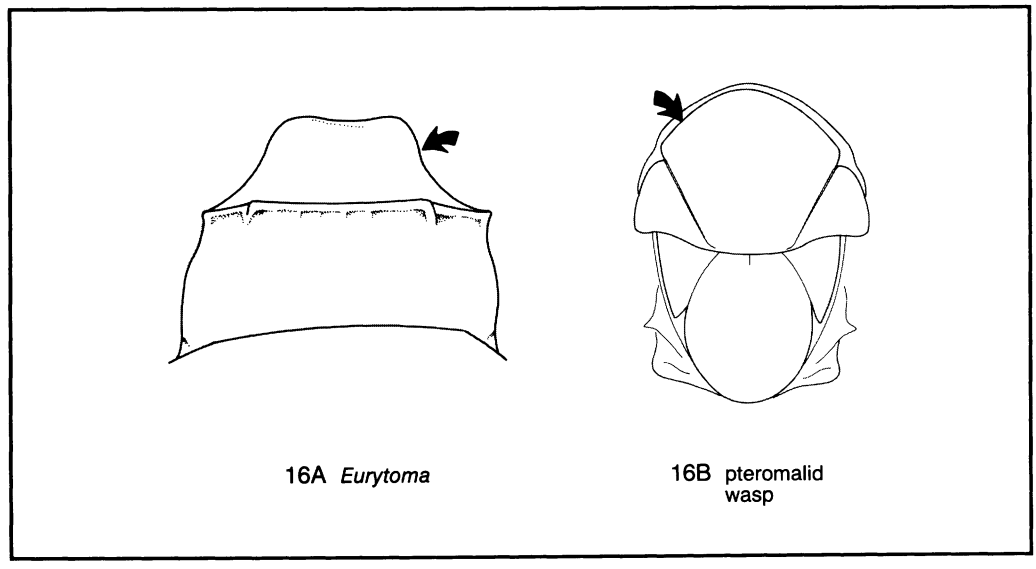
15B *Tetrastichus coerulescens*

16 Pronotum quadrate in outline when viewed from above (16A); gaster compressed. Eurytomidae (**seed chalcids, eurytomids**) ---------- 17

Head and thorax strongly punctate; body without metallic coloration.

Pronotum not quadrate when viewed from above (16B), or if quadrate, then gaster not compressed. Pteromalidae (pteromalids)---------- 19

Head and thorax usually not punctate, but if punctate, then body not robust and usually depressed, with head prognathous; body frequently with metallic or pale coloration.



16A *Eurytoma*

16B pteromalid wasp

17 Metanotum shorter than scutellum when viewed from above; coxa III and petiole each without a dorsal longitudinal channel---------- *Eurytoma tylodermatis*

Distribution: Nearctic. Hosts: Larvae of Lepidoptera and Coleoptera.

Metanotum longer than scutellum when viewed from above; coxa III and petiole with a dorsal longitudinal channel. Genus *Aximopsis* ---------- 18

18 Legs mostly reddish ---------- *Aximopsis tephrosiae*

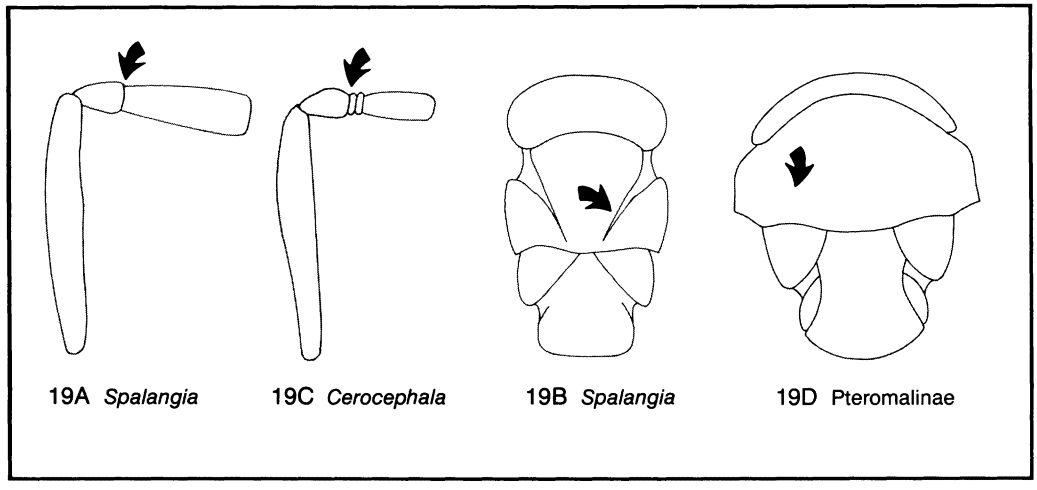
Distribution: Indo-Australia. Host: *Araecerus fasciculatus.*

Legs mostly black---------- *Aximopsis javensis*

Distribution: Indo-Australian. Host: *Araecerus fasciculatus.*

19 Antenna without annular ring segments (19A); notauli complete, extending from pronotum to transscutal suture (19B)---------- 20

Antenna with at least 1 annular ring segment (19C); notauli incomplete, not extending from pronotum to transscutal suture (19D) ---------- 26

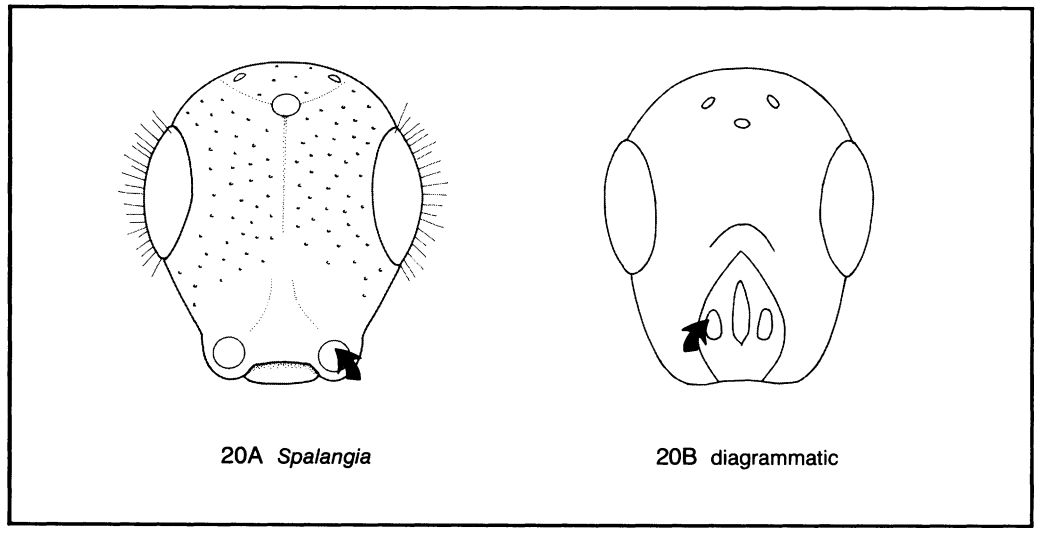


19A *Spalangia* 19C *Cerocephala* 19B *Spalangia* 19D Pteromalinae

20 Antenna inserted at extreme anterior margin of head on facial lobes that extend ventrad of clypeus (20A); tibia III with 1 spur; body black or weakly metallic; head and thoracic dorsum with pits ---------- *Spalangia*

Distribution: Worldwide. Hosts: Puparia of Diptera. See also 19A&B.

Antenna inserted at a point at least slightly separated from extreme anterior margin of head (not inserted on facial lobes) (20B); tibia III with 2 spurs; body usually a pale color, but if dark, then lacking pits on head and thorax---------- 21

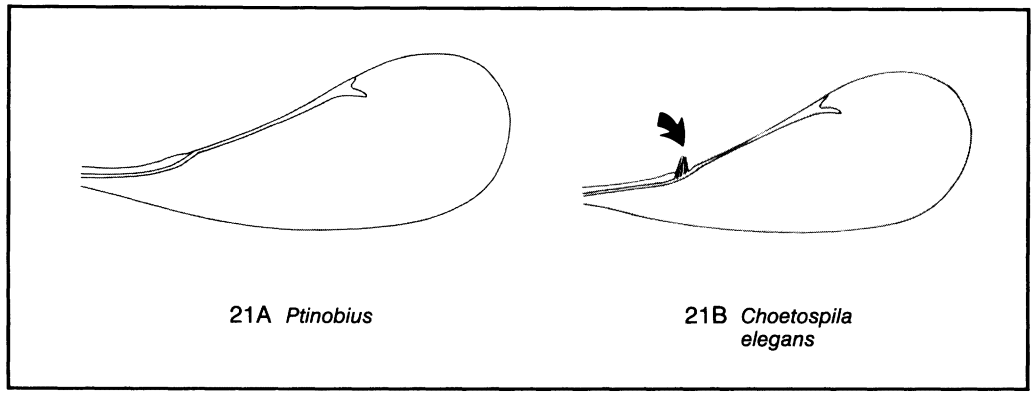


20A *Spalangia* 20B diagrammatic

21 Forewing without a conspicuous tuft of setae at junction of submarginal and marginal veins (21A); eye with conspicuous setae---------- *Ptinobius*

Distribution: Nearctic. Hosts: Coleoptera.

Forewing with a conspicuous tuft of setae at junction of submarginal and marginal veins (21B); eye without conspicuous setae ---------- 22



21A *Ptinobius*

21B *Choetospila elegans*

22 Antennal funicle 5-segmented---------- *Choetospila elegans*

Distribution: Worldwide. Hosts: *Lasioderma serricorne, Stegobium paniceum, Sitophilus granarius, S. linearis, S. oryzae, Sitotroga cerealella.* See couplet illustration 28C in chapter 18.

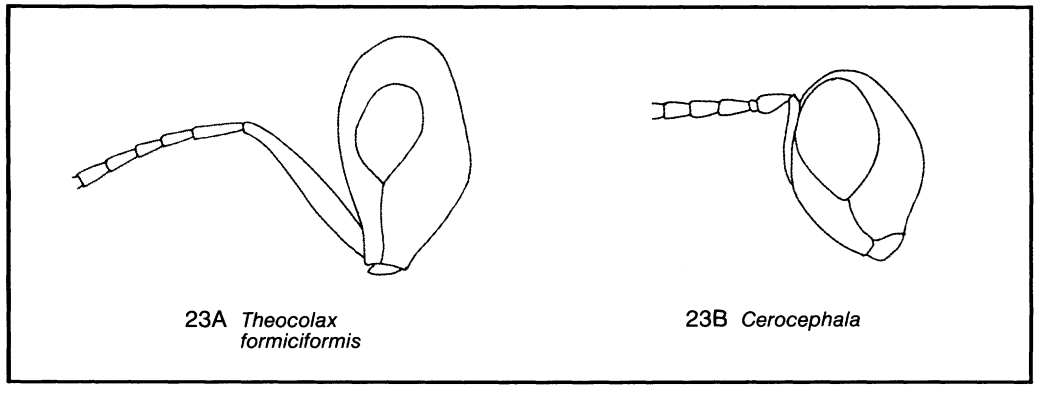
Antennal funicle 6-segmented ---------- 23

23 Antenna inserted well below level of ventral margin of compound eye (23A) ---------- *Theocolax formiciformis*

Usually micropterous. Distribution: Indo-Australian, Palearctic. Hosts: *Anobium* spp.

Antenna inserted at or above ventral margin of compound eye (23B). Genus *Cerocephala*---------- 24

Usually macropterous.



23A *Theocolax formiciformis*

23B *Cerocephala*

24 Pronotum finely and completely longitudinally striate ----------*Cerocephala aquila*

Distribution: Indo-Australian. Hosts: Coleoptera.

Pronotum smooth ---------- 25

25 Antennal scape less than 3.6 times as long as wide; infuscation of forewing weak or absent ----------*Cerocephala cornigera*

Distribution: Palearctic. Host: *Hylesinus orni* (Fuchs).

Antennal scape about 4 times as long as wide; infuscation of forewing beneath stigmal vein well developed----------*Cerocephala rufa*

Distribution: Palearctic. Host: *Anobium punctatum.*

26 Antenna with 3 annular ring segments and 5 funicular segments ---------- 27
Antenna with 2 annular ring segments and 6 funicular segments ---------- 29

27 Mandibles asymmetrical, one with 4 teeth, the other with 3 ----------*Meraporus requisitus*

Distribution: Nearctic. Host: *Sitophilus oryzae.*

Both mandibles with 4 teeth ---------- 28

28 Underside of forewing without long curved setae ----------*Anisopteromalus*

Distribution: Worldwide. Hosts: Coleoptera, Lepidoptera.

Underside of forewing posterior to marginal vein with a row of long curved setae ----------*Zatropis*

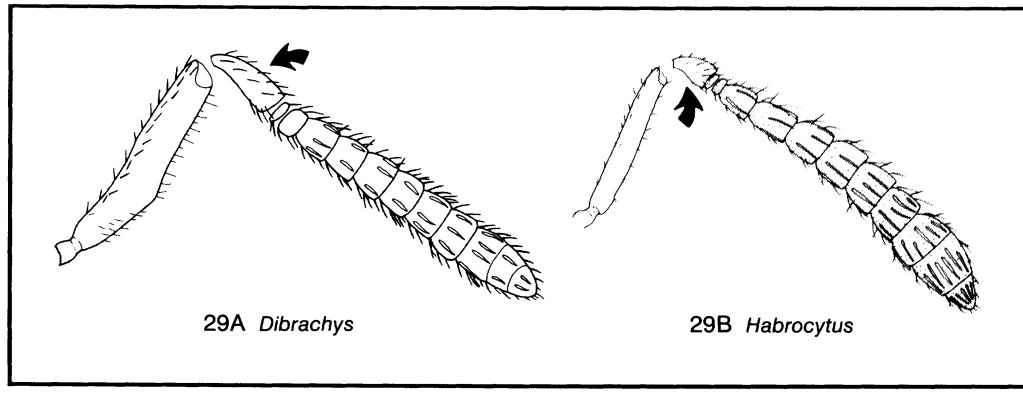
Distribution: Nearctic. Hosts: Coleoptera.

29 Pedicel unusually long (29A) ----------*Dibrachys*

Forewing margin without cilia. Distribution: Worldwide. Hosts: Lepidoptera.

Pedicel not unusually long (similar to 29B)---------- 30

Forewing margin usually with cilia (except *Tritneptis (Systellogaster) ovivora*).



29A *Dibrachys* 29B *Habrocytus*

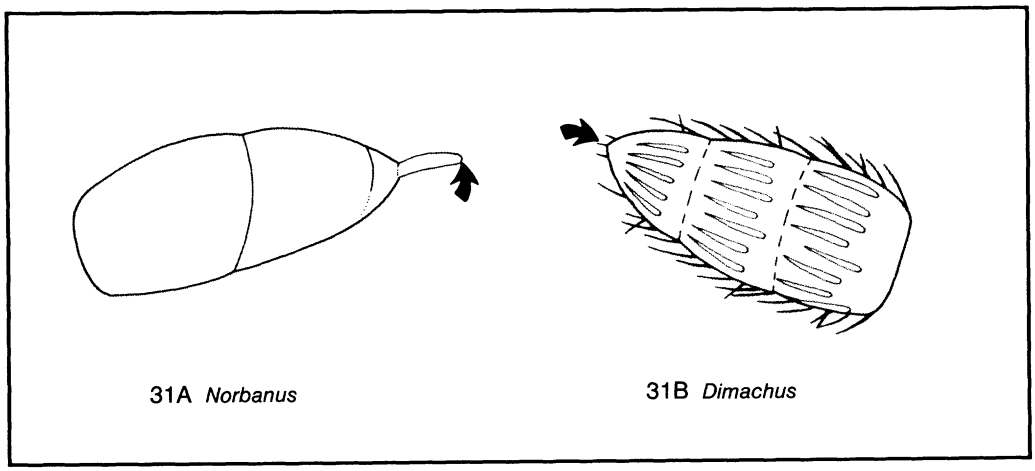
30 Tibia III with 2 apical spurs ---------- 31
Tibia III with 1 apical spur ---------- 32

31 Apex of antennal club with stylus (31A); pronotal collar sharp ----------*Norbanus*

Distribution: Worldwide. Hosts: Cephidae.

Apex of antennal club without stylus (31B); pronotal collar rounded----------*Dimachus*

Distribution: Palearctic. Hosts: probably Anobiidae.



31A *Norbanus* 31B *Dimachus*

32 Forewing with infuscated band ---------- *Tritneptis (Systellogaster) ovivora*

Distribution: Nearctic. Hosts: Blattaria (oothecae).

Forewing hyaline ---------- 33

33 Pronotum sharply margined; clypeus deeply incised ----------*Caenacis*

Distribution: Worldwide. Hosts: Hymenoptera.

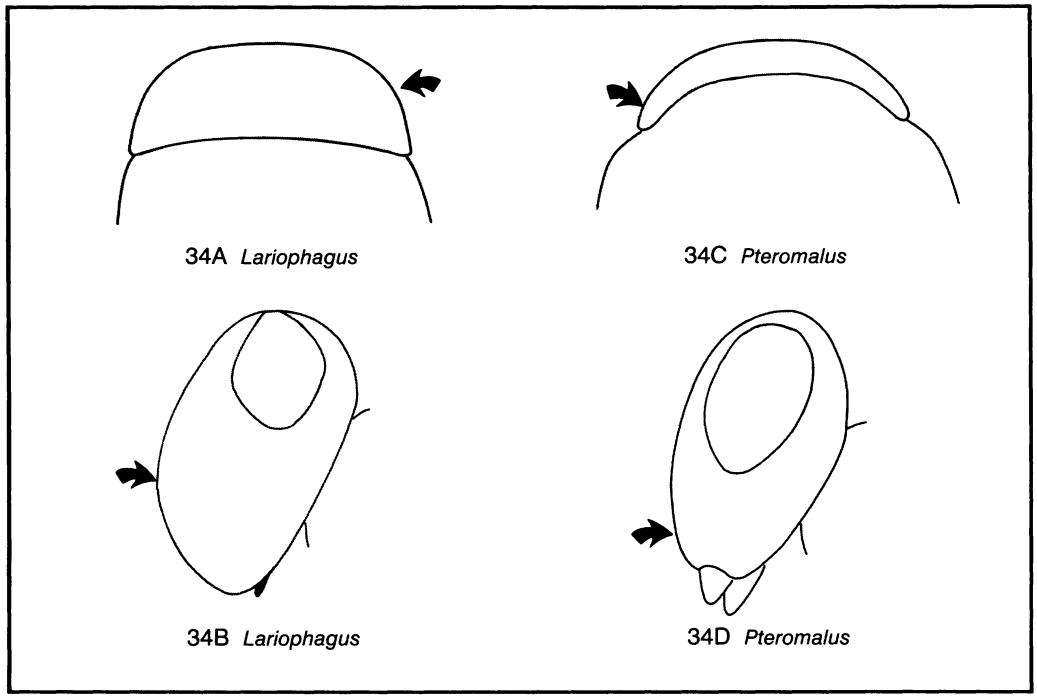
Pronotum not sharply margined; clypeus not deeply incised ---------- 34

34 Pronotum long, rounded (34A); face inflated (34B)----------*Lariophagus*

Distribution: Worldwide. Hosts: Coleoptera.

Pronotum short, transverse (34C); face not inflated (34D)----------*Pteromalus*

Distribution: Worldwide. Hosts: Coleoptera, Lepidoptera. See also 4B, 5E.



34A *Lariophagus*

34C *Pteromalus*

34B *Lariophagus*

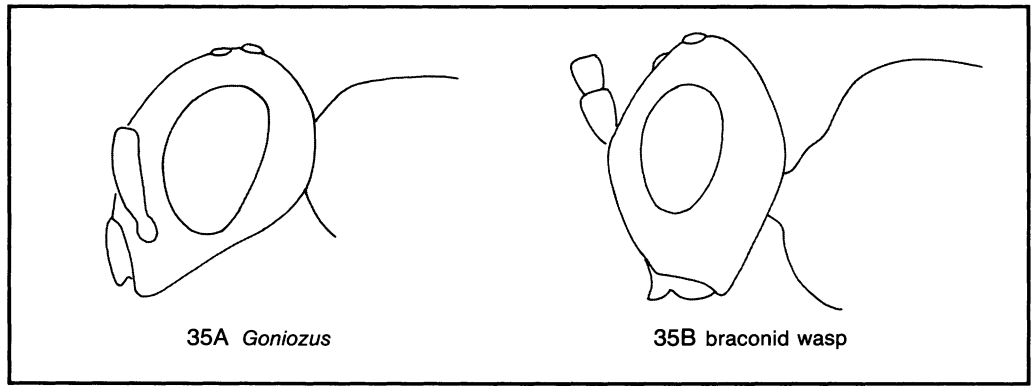
34D *Pteromalus*

35 Head prognathous (35A); body depressed. Bethylidae (**bethylid wasps**)---------- 36

Body shining black; ovipositor modified as a sting.

Head hypognathous (35B); body not depressed. Ichneumonoidea (ichneumonoid parasitic wasps) ---------- 47

Body usually not shining black; ovipositor used as an egg-tube.



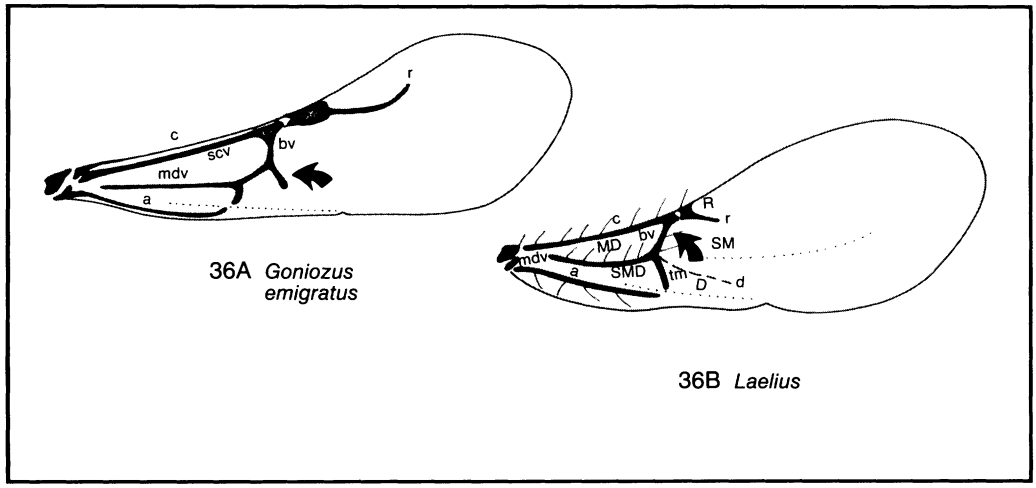
35A *Goniozus*

35B braconid wasp

36 Wing with a vein or a stub of a vein arising from basal vein (36A) ---------- *Goniozus emigratus*

Distribution: Nearctic. Hosts: Larval Lepidoptera.

Predominantly wingless, but if winged, then with basal vein simple or absent, not giving rise to a vein or a stub of a vein (36B) ---------- 37



36A *Goniozus emigratus*

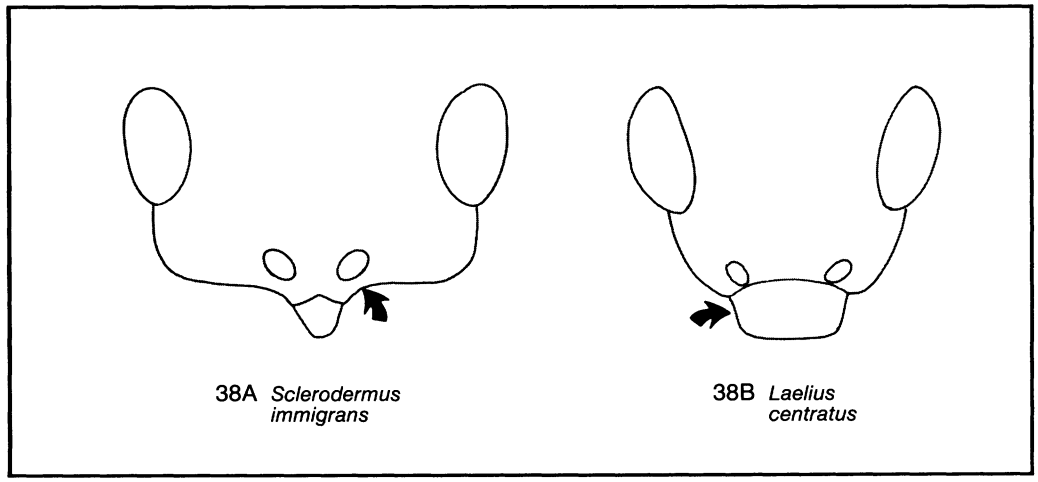
36B *Laelius*

37 Antenna with 13 segments (funicle segment I small in some species) ---------- 38
Antenna with 12 segments ---------- 42

38 Clypeus with median lobe short, truncate (38A) ----------*Sclerodermus immigrans*

Distribution: Hawaii, Oriental. Host: *Caryedon serratus.*

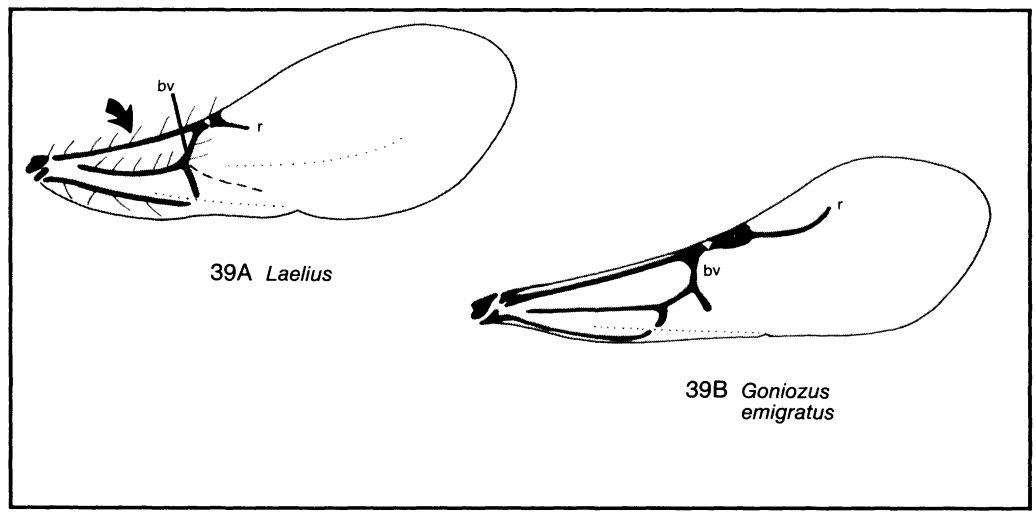
Clypeus with median lobe angularly or narrowly rounded (38B) ---------- 39



38A *Sclerodermus immigrans*

38B *Laelius centratus*

39 Veins with long, conspicuous setae; radial vein very short, at most slightly longer than basal vein (39A). Genus *Laelius* ---------- 40
Veins without long, conspicuous setae; radial vein much longer than basal vein (similar to 39B). Genus *Holepyris* ---------- 41



39A *Laelius*

39B *Goniozus emigratus*

40 Wing hyaline ---------- *Laelius centratus*

Distribution: Nearctic. Hosts: *Trogoderma ornatum, T. simplex, T. variabile.* See 38B.

Wing slightly dusky (infuscated) ---------- *Laelius anthrenivorus*

Distribution: Oriental. Hosts: *Anthrenus* spp.

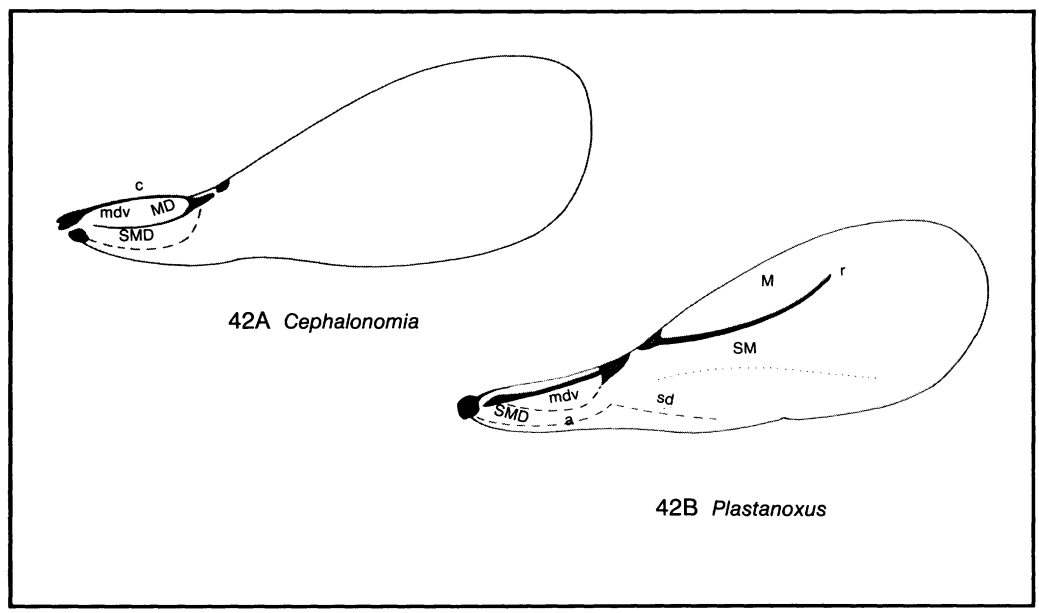
41 Eye setose ---------- *Holepyris sylvanidis*

Distribution: Worldwide. Hosts: *Oryzaephilus surinamensis, Sitophilus oryzae, Tribolium confusum.*

Eye without conspicuous vestiture of setae ---------- *Holepyris hawaiiensis*

Distribution: Worldwide. Host: *Ephestia elutella.*

42 Radial vein absent (42A) or wings absent. Genus *Cephalonomia* ---------- 43
Radial vein present (at least in part) (42B); wings fully developed. Genus *Plastanoxus* 46



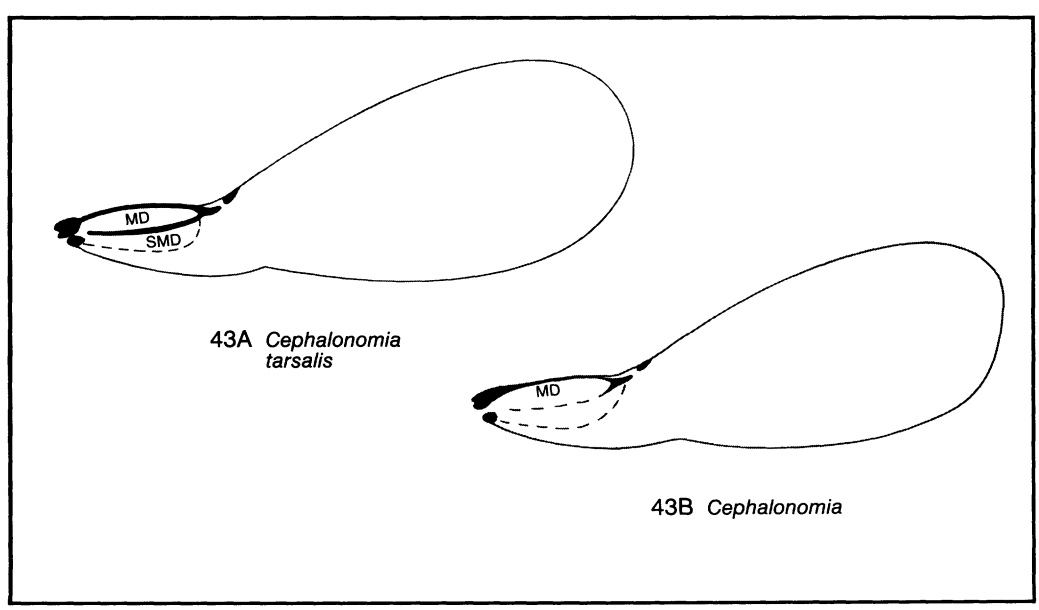
42A *Cephalonomia*

42B *Plastanoxus*

43 Forewing with a closed median cell (43A)----------*Cephalonomia tarsalis*

Distribution: Worldwide. Hosts: *Oryzaephilus surinamensis, Sitophilus oryzae.*

Forewing without a closed median cell (43B) ---------- 44



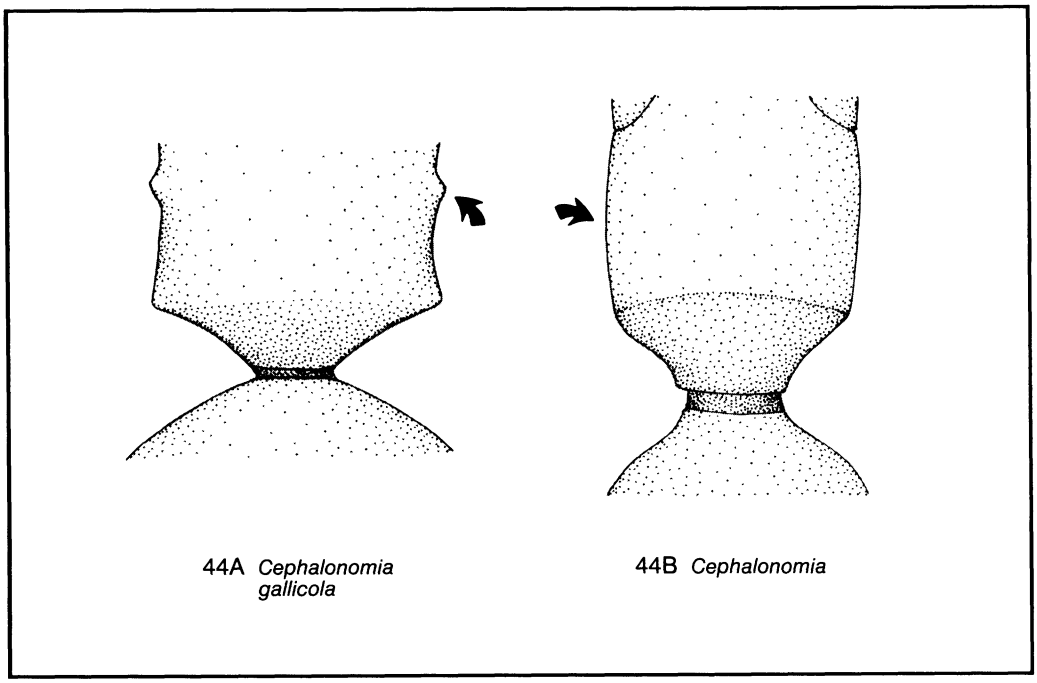
43A *Cephalonomia tarsalis*

43B *Cephalonomia*

44 Propodeum with a small dentiform process on each side (44A) ----*Cephalonomia gallicola*

Distribution: Worldwide. Hosts: Anobiidae, Ptinidae.

Propodeum without dentiform processes (44B)---------- 45



44A *Cephalonomia gallicola*

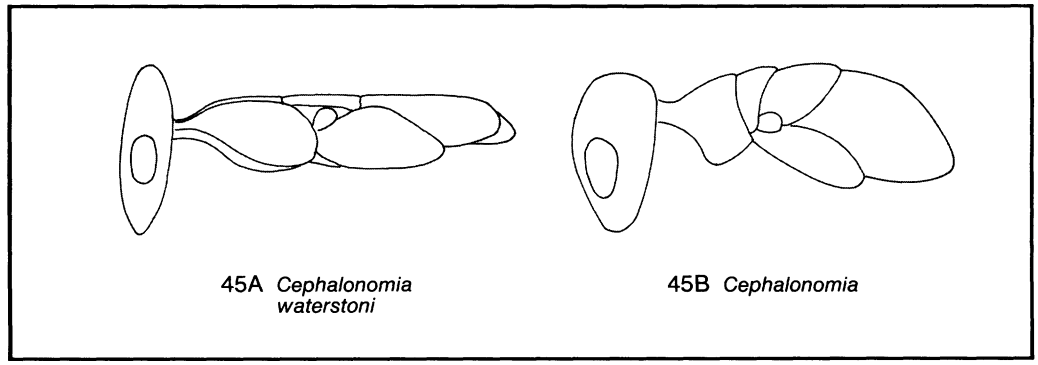
44B *Cephalonomia*

45 Thorax strongly depressed (45A) ----------**parasitic grain wasp,** *Cephalonomia waterstoni*

Distribution: Worldwide. Host: *Cryptolestes ferrugineus.*

Thorax not strongly depressed----------other *Cephalonomia*

Distribution: Worldwide. Hosts: Coleoptera.



45A *Cephalonomia waterstoni*

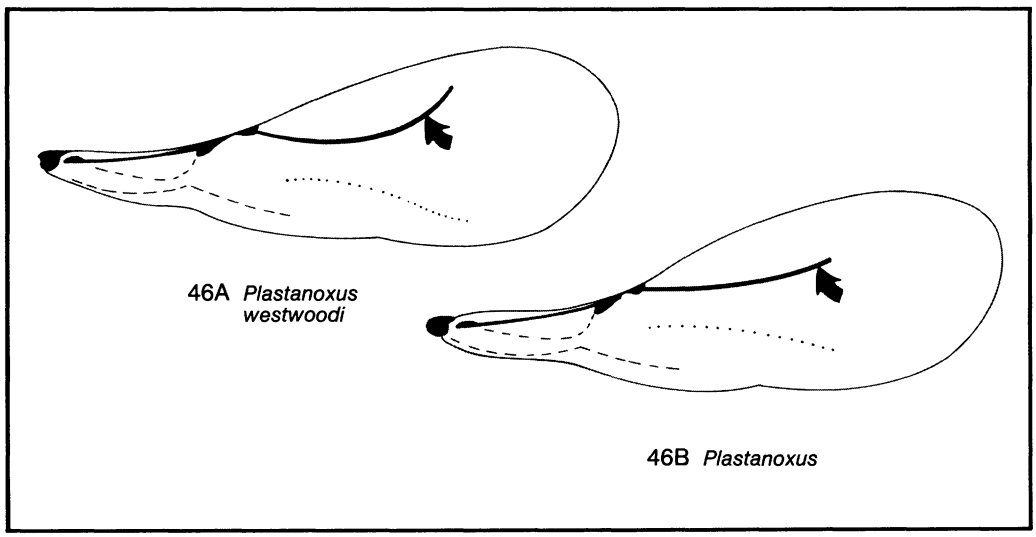
45B *Cephalonomia*

46 Radial vein gently curved (46A) ----------*Plastanoxus westwoodi*

Distribution: Worldwide. Host: *Cryptolestes pusillus.*

Radial vein straight distally (similar to 46B) ----------*Plastanoxus chittendenii*

Distribution: Holarctic. Hosts: *Cis* spp.



46A *Plastanoxus westwoodi*

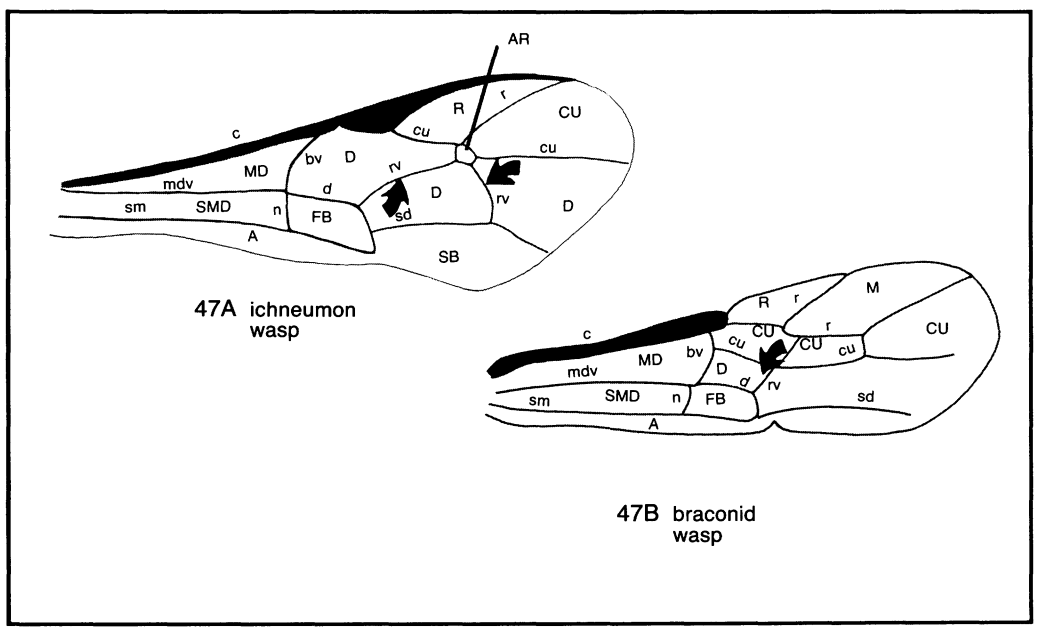
46B *Plastanoxus*

47 Forewing with 2 recurrent veins (47A). Ichneumonidae **(ichneumons)** ---------- 48

Areolet (AR) often present.

Forewing with 1 recurrent vein (47B). Braconidae **(braconid wasps)** ---------- 53

Aerolet absent



47A ichneumon wasp

47B braconid wasp

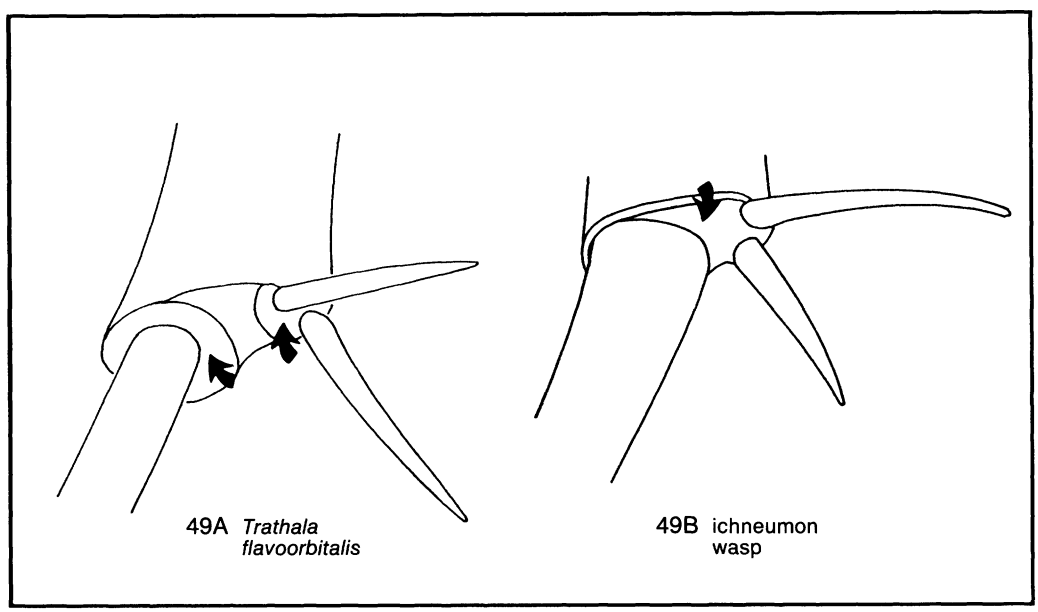
48 Gaster compressed; abdominal segments III and IV deeper than wide ---------- 49
Gaster depressed or cylindrical; abdominal segments III and IV wider than deep- 52

49 Tibial spurs inserted in an area separate from area of tarsal insertion (49A)
---------- *Trathala flavoorbitalis*

Clypeus separated from face by a groove; face usually more or less pale. Distribution: Indo-Australian, Oriental. Host: *Ostrinia nubilalis.*

Tibial spurs and tarsus inserted in a common area of tibia (49B)---------- 50

Clypeus usually confluent with face; face usually black.



49A *Trathala flavoorbitalis*

49B ichneumon wasp

50 Gastral segment I near its basal third circular or depressed oval in cross section
---------- *Venturia canescens*

Gastral tergum I never with a pit in front of spiracle. Distribution: Worldwide. Hosts: *Anagasta kuehniella, Cadra figulilella, Ephestia elutella, Galleria mellonella, Plodia interpunctella.*

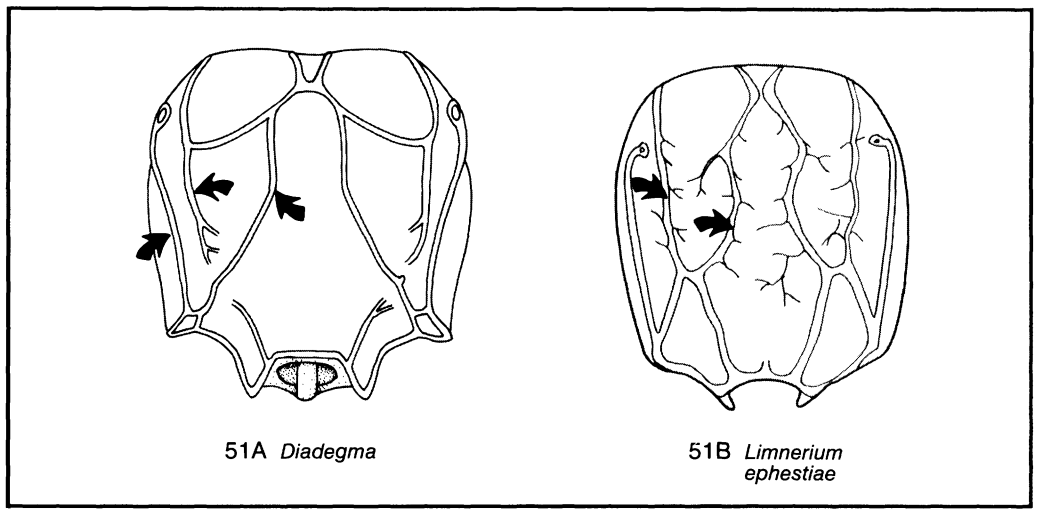
Gastral segment I near its basal third somewhat quadrate, trapezoidal, or triangular in cross section---------- 51

51 Propodeal carina usually strong (51A) ---------- *Diadegma*

Distribution: Worldwide. Hosts: Lepidoptera.

Propodeal carina usually weak (51B) ---------- *Limnerium ephestiae*

Distribution: Worldwide. Hosts: Pyraloidea.



51A *Diadegma*

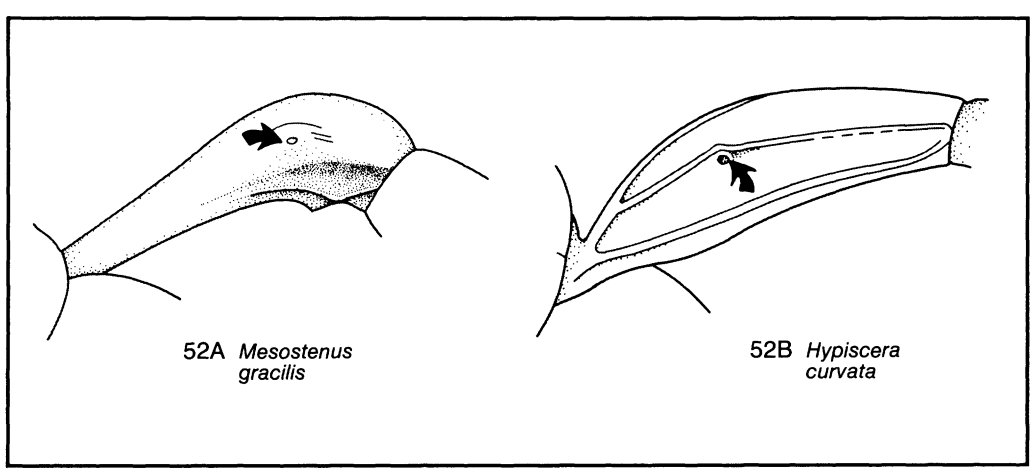
51B *Limnerium ephestiae*

52 Spiracle of gastral tergum I located somewhat behind midlength of tergum (52A) ---------- *Mesostenus gracilis*

Distribution: Worldwide. Hosts: *Anagasta kuehniella, Cadra figulilella, Ephestia elutella, Euzophera semifuneralis* (Walker), *Zophodia convolutella* (Hübner); also known from *Ozamia fuscomaculella clarefacta* Dyar.

Spiracle of gastral tergum I located near or in front of midlength of tergum (52B) ---------- *Hypiscera curvata*

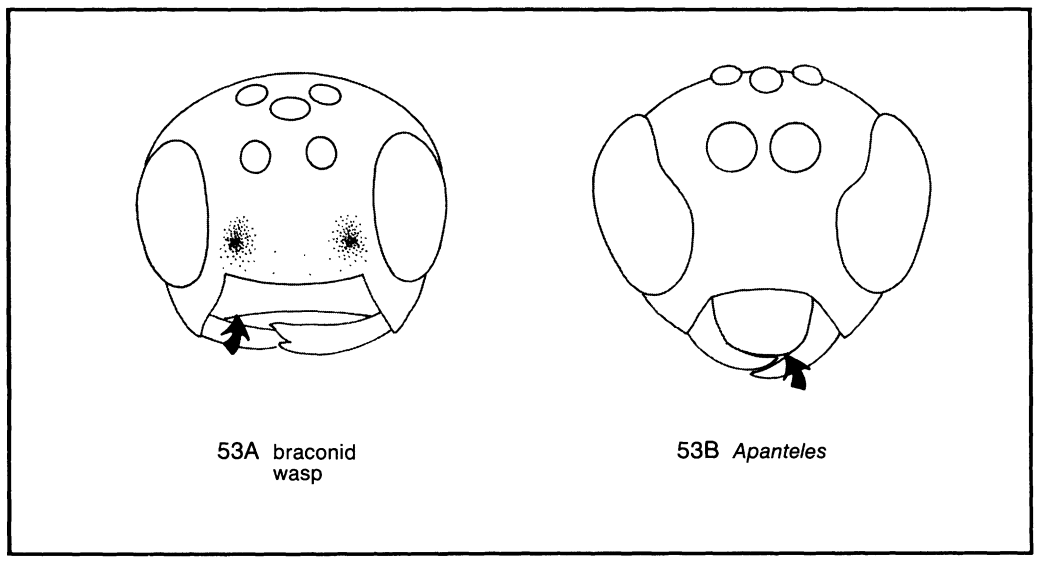
Distribution: Neotropical. Hosts: Lepidoptera.



52A *Mesostenus gracilis*

52B *Hypiscera curvata*

53 Clypeal margin concave (53A) ---------- 54
Clypeal margin arcuate (53B) ---------- 60



53A braconid wasp

53B *Apanteles*

54 Occipital and prepectal carinae absent; maxillary palpus 5-segmented. *Habrobracon* 55
Occipital and prepectal carinae usually present; maxillary palpus 6-segmented---- 58

55 Gastral terga not shining ---------- *Habrobracon crassicornis*

Distribution: Palearctic. Hosts: *Anagasta kuehniella*; also known from *Sparganothis pilleriana* (Denis & Schiffermüller).

Gastral terga shining ---------- 56

56 Antenna 17 to 21 segmented, much longer than head and thorax combined ---------- *Habrobracon kitcheneri*

Distribution: Indo-Australian, Palearctic. Hosts: Lepidoptera.

Antenna 13 to 17 segmented, seldom longer than head and thorax combined ----- 57

57 Antenna 13 to 14 segmented, shorter than head and thorax combined ---------- *Habrobracon hebetor*

Distribution: Worldwide. Hosts: *Anagasta kuehniella, Cadra cautella, Ephestia elutella, Galleria mellonella, Plodia interpunctella, Sitotroga cerealella, Vitula edmandsii serratilineella*.

Antenna 15 to 17 segmented, slightly longer than head and thorax combined ---------- *Habrobracon brevicornis*

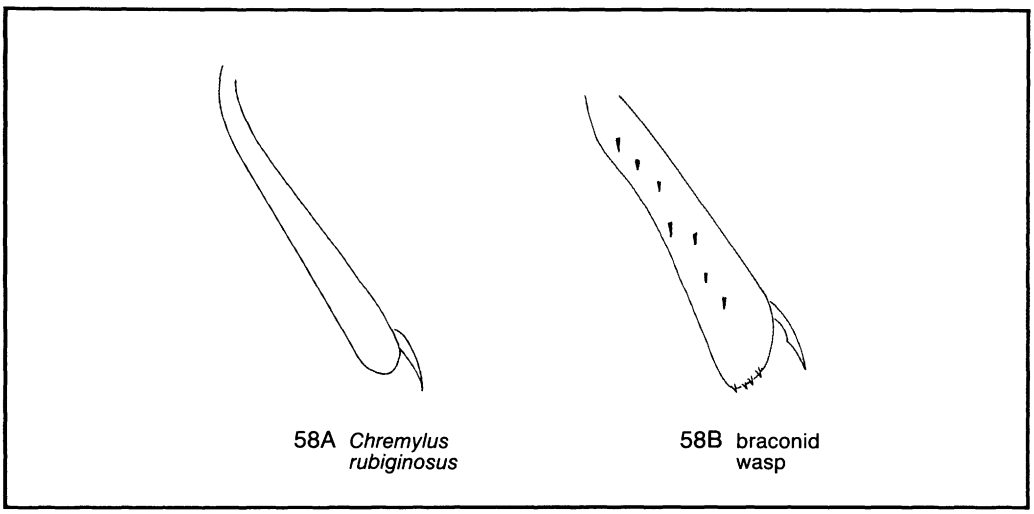
Distribution: Palearctic, probably Nearctic. Hosts: *Ostrinia nubilalis*; also known from *Dioryctria abietella* (Denis & Schiffermüller).

58 Tibia I without a row or cluster of stout spines or pegs on anterior surface (58A) ----------*Chremylus rubiginosus*

Prepectus sometimes margined. Distribution: Palearctic. Hosts: Lepidoptera.

Tibia I with a row or cluster of stout spines or pegs along anterior surface (58B) - 59

Prepectus always margined.



58A *Chremylus rubiginosus*

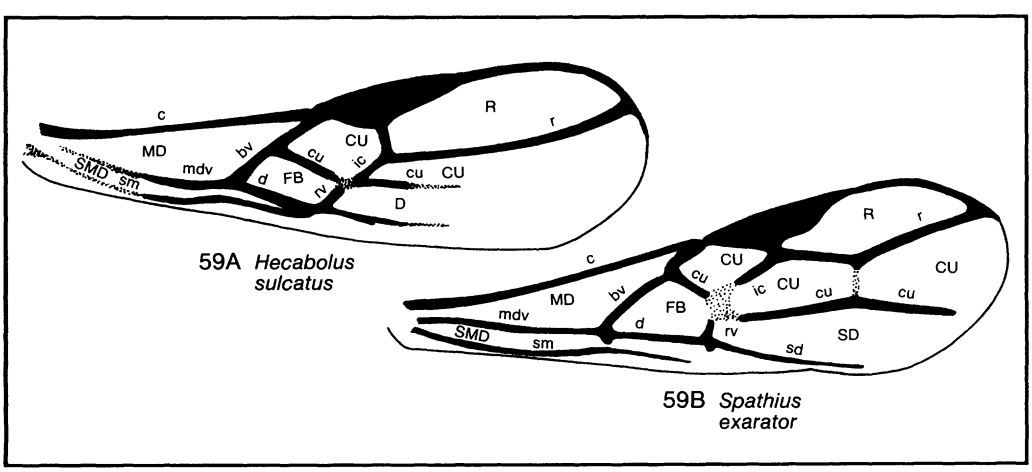
58B braconid wasp

59 Forewing with 2 cubital cells (59A) ----------*Hecabolus sulcatus*

Distribution: Palearctic. Hosts: *Anobium punctatum, Ptinus fur;* also reported from *Anobium rufipes* Fabricius, *A. thomsoni* Kraatz, *Hylesinus varius* Fabricius, *Ochina ptinoides* (Marsham), *Phloeosinus bicolor* (Brullé), *P. thuyae* Perris, *Ptilinus* spp., *Phymatodes alni* (L.).

Forewing with 3 cubital cells (59B) ----------*Spathius exarator*

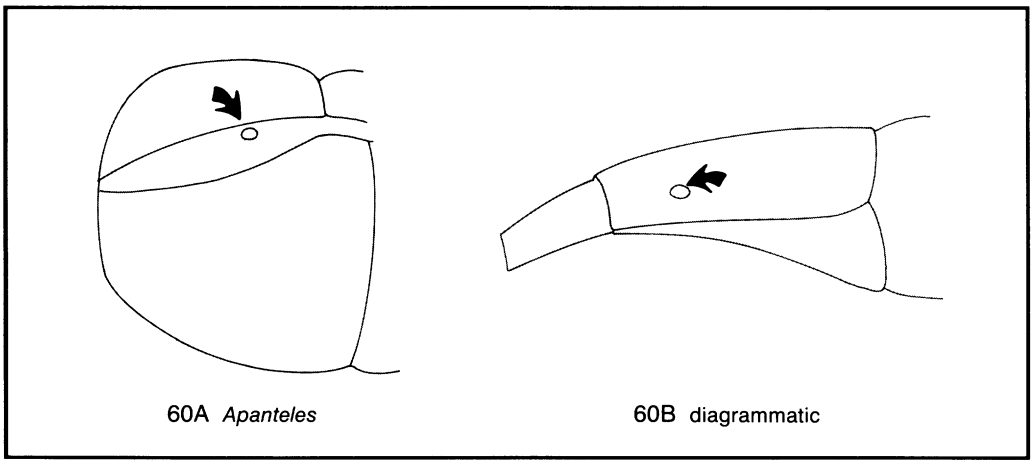
Distribution: Palearctic. Hosts: Coleoptera.



59A *Hecabolus sulcatus*

59B *Spathius exarator*

60 Occipital carina absent; spiracle of gastral tergum I situated on lateral membrane of tergum, removed from sclerotized median plate (60A). Genus *Apanteles*------- 61
Occipital carina present; spiracle of gastral tergum I situated on lateral margin of sclerotized median plate (60B)---------- 63



60A *Apanteles* 60B diagrammatic

61 Mesoscutum dull, strongly and rather coarsely punctate----------*Apanteles araeceri*

Distribution: Indo-Australian. Hosts: *Araecerus fasciculatus*; also reported from *Phalacris immarginatus* Champion.

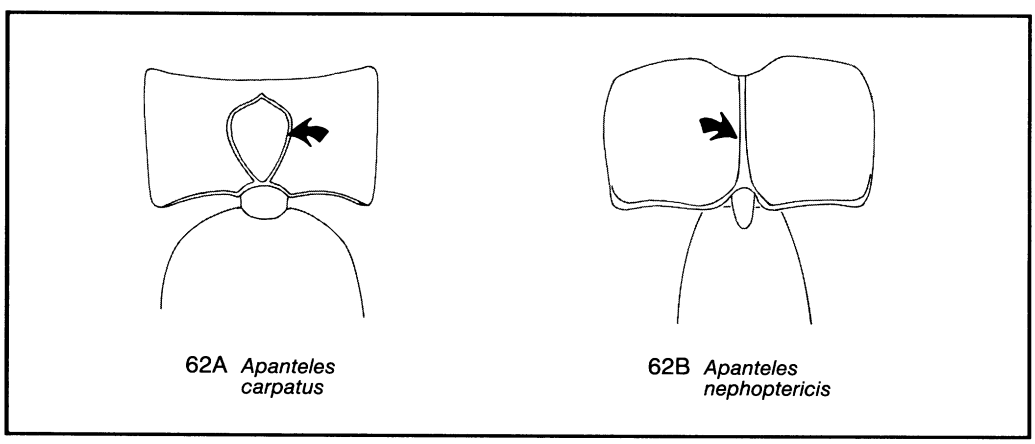
Mesoscutum somewhat shining, not coarsely punctate ---------- 62

62 Propodeum with a distinct areola, usually margined by a strong carina (62A)
----------*Apanteles carpatus*

Distribution: Nearctic. Hosts: *Tineola bisselliella*; also reported from *Phereoica uterella* (Walsingham), *Tinea pellionella* (L.), *Trichophaga tapetzella* (L.).

Propodeum without a distinct areola, but with a median carina from base to apex (62B)
----------*Apanteles nephoptericis*

Distribution: Nearctic. Hosts: *Anagasta kuehniella, Vitula edmandsii serratilineella*.



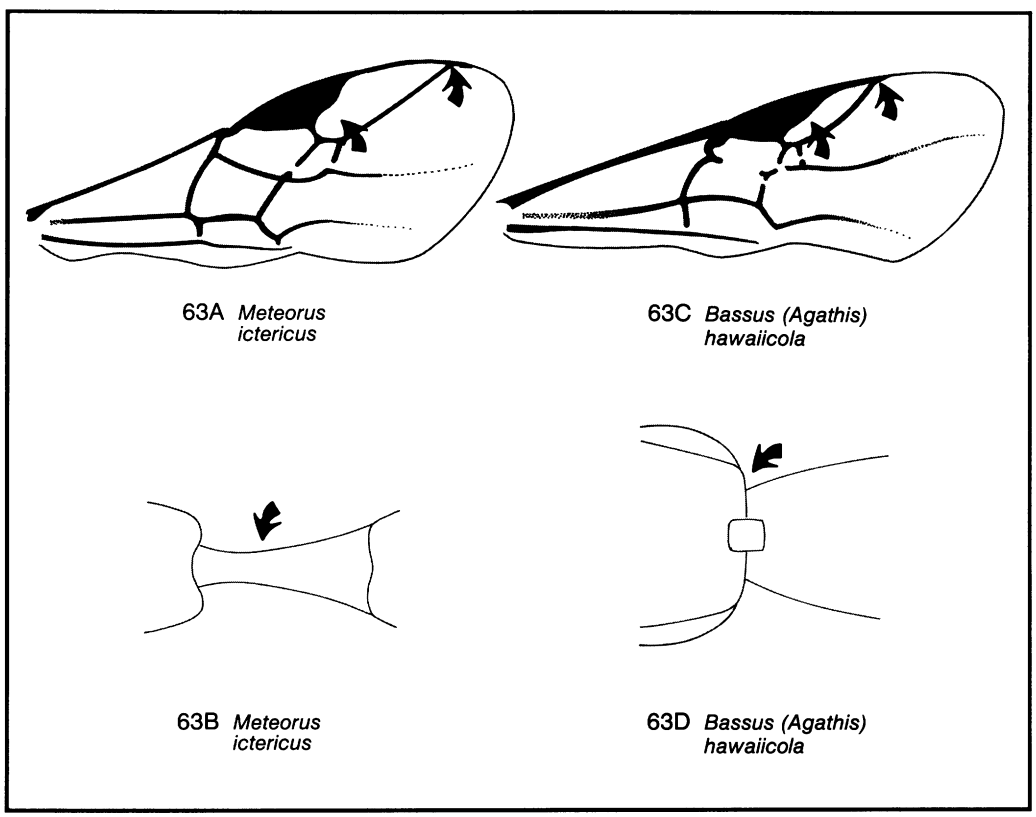
62A *Apanteles carpatus* 62B *Apanteles nephoptericis*

63 Radial cell long, radius nearly reaching wing apex (63A); gaster petiolate (63B) ---------- *Meteorus ictericus*

Distribution: Holarctic. Hosts: Lepidoptera.

Radial cell very narrow, radius meeting wing margin far from apex (63C); gaster sessile 63D)---------- *Bassus (Agathis) hawaiicola*

Distribution: Indo-Australian. Hosts: Lepidoptera.



63A *Meteorus ictericus*

63C *Bassus (Agathis) hawaiicola*

63B *Meteorus ictericus*

63D *Bassus (Agathis) hawaiicola*

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1978. The Bethylidae of America north of Mexico. Mem. American Ent. Inst. 27, 332 p.

2 Graham, M.W.R. de V.
1969. The Pteromalidae of north-western Europe (Hymenoptera: Chalcidoidea). Bul. British Mus. (Nat. Hist.) Ent., suppl. 16, 908 p.

3 Michener, C.D.
1944. Comparative external morphology, phylogeny, and a classification of the bees (Hymenoptera). Bul. American Mus. Nat. Hist. 82(6)151-326.

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1969. The genera of Ichneumonidae, part 1. Mem. American Ent. Inst. 11, 300 p.

Notes and Sketches

Part 3

27 ILLUSTRATIONS OF MAJOR PEST SPECIES

Approximate body length measurements of insects are shown in millimeters in parentheses in the legend of each plate. The scientific illustrators are credited in the appropriate places on the following pages.

MITES (ACARI)

These illustrations, drawn by R.L. Smiley unless otherwise noted, are a continuation from part 1, chapter 1 (Mites), by R.L. Smiley. See figure 1.2 and couplet illustrations 8A, 8B, 11C, 47A, 48A, 48B, and 59A in chapter 1 for additional habitus illustrations of mites.

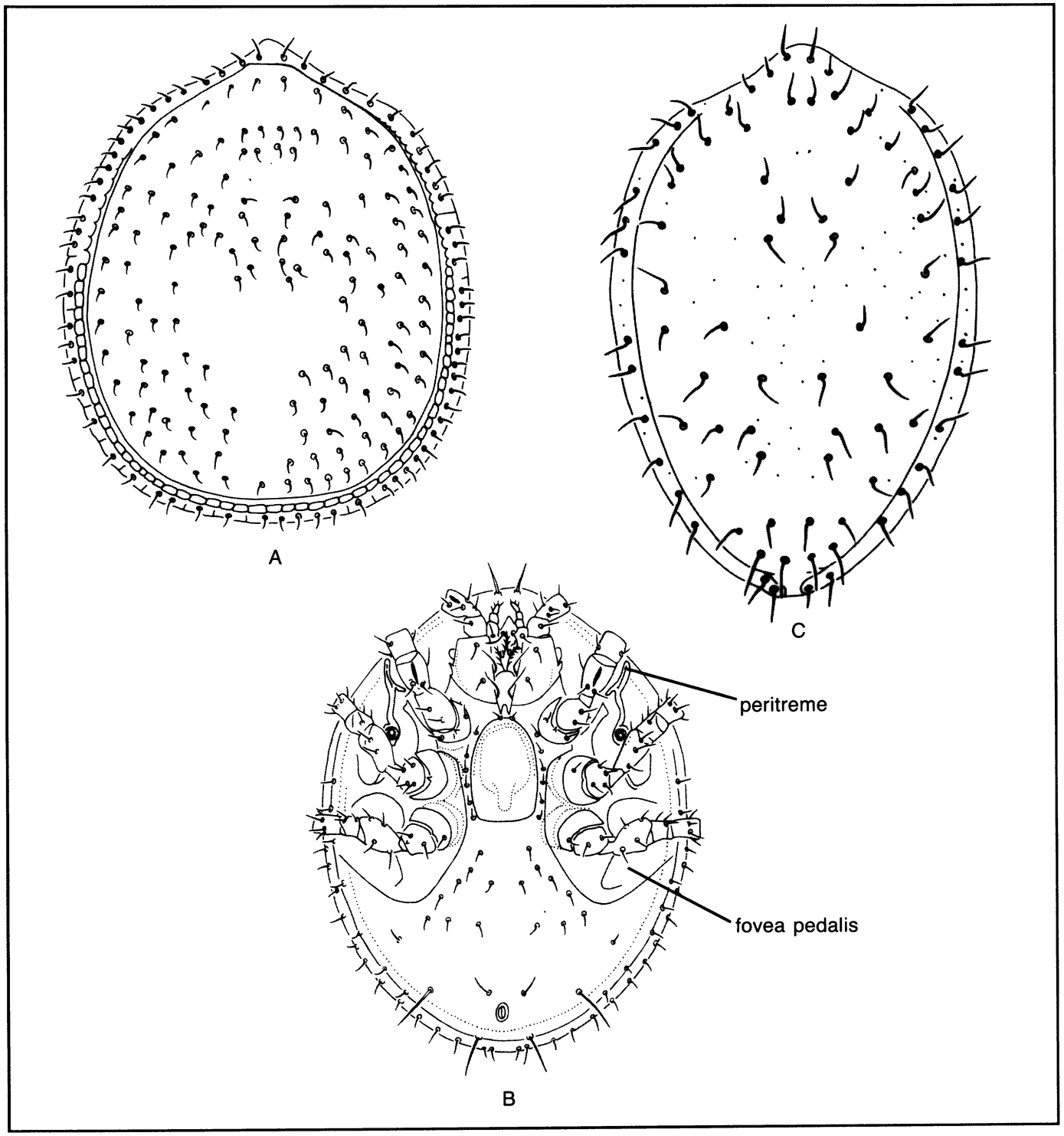


Plate 3. Uropodid mites (Uropodidae): A, *Leiodinychus krameri*, dorsal view of female; B, *Fuscuropoda* sp., ventral view of female; C, *Fuscuropoda marginata,* dorsal view of male.

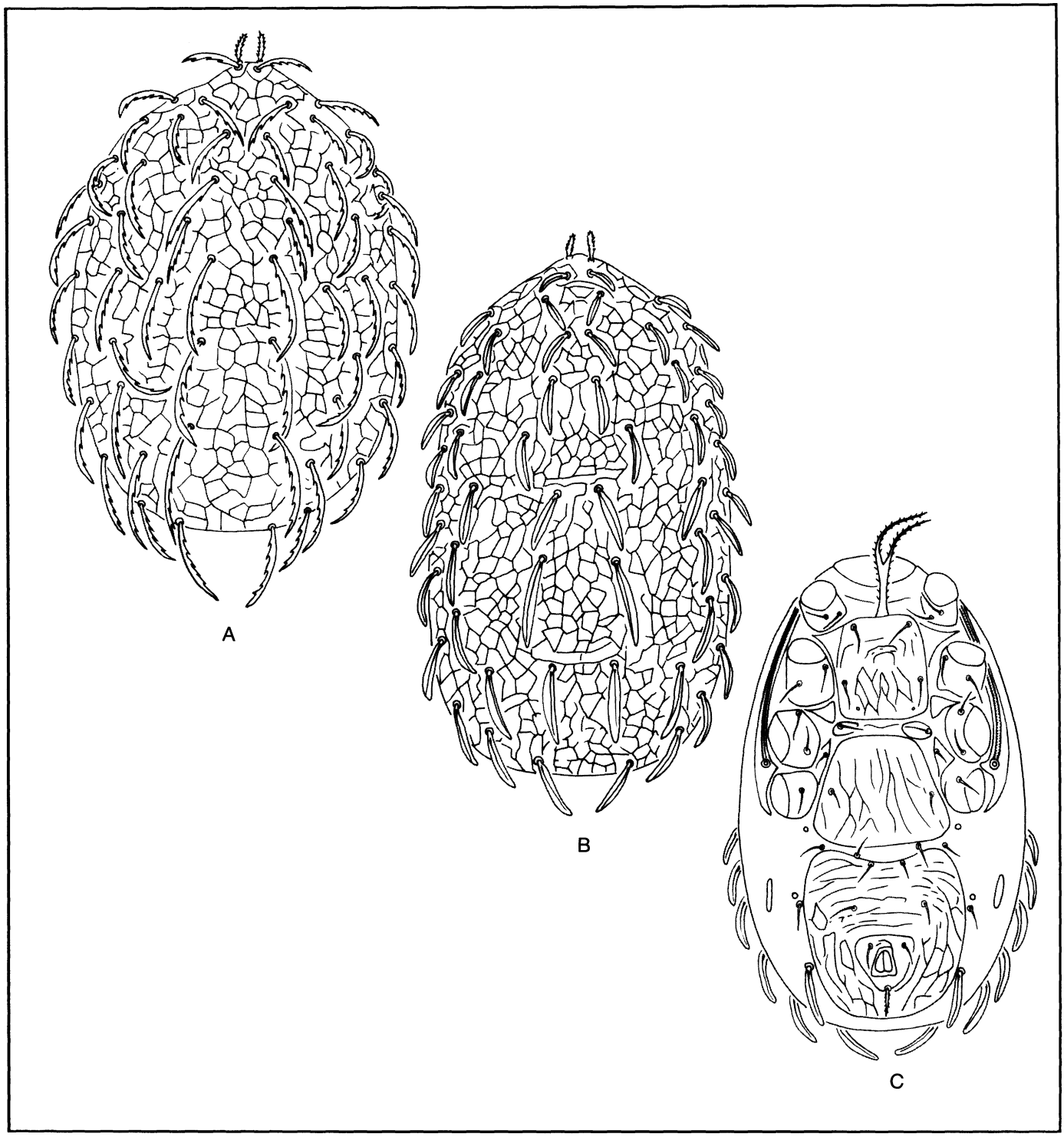


Plate 4. Ameroseiid mites (Ameroseiidae), females: A, *Kleemannia plumigera,* dorsal view; B, *Kleemannia plumosa,* dorsal view; C, same, ventral view.

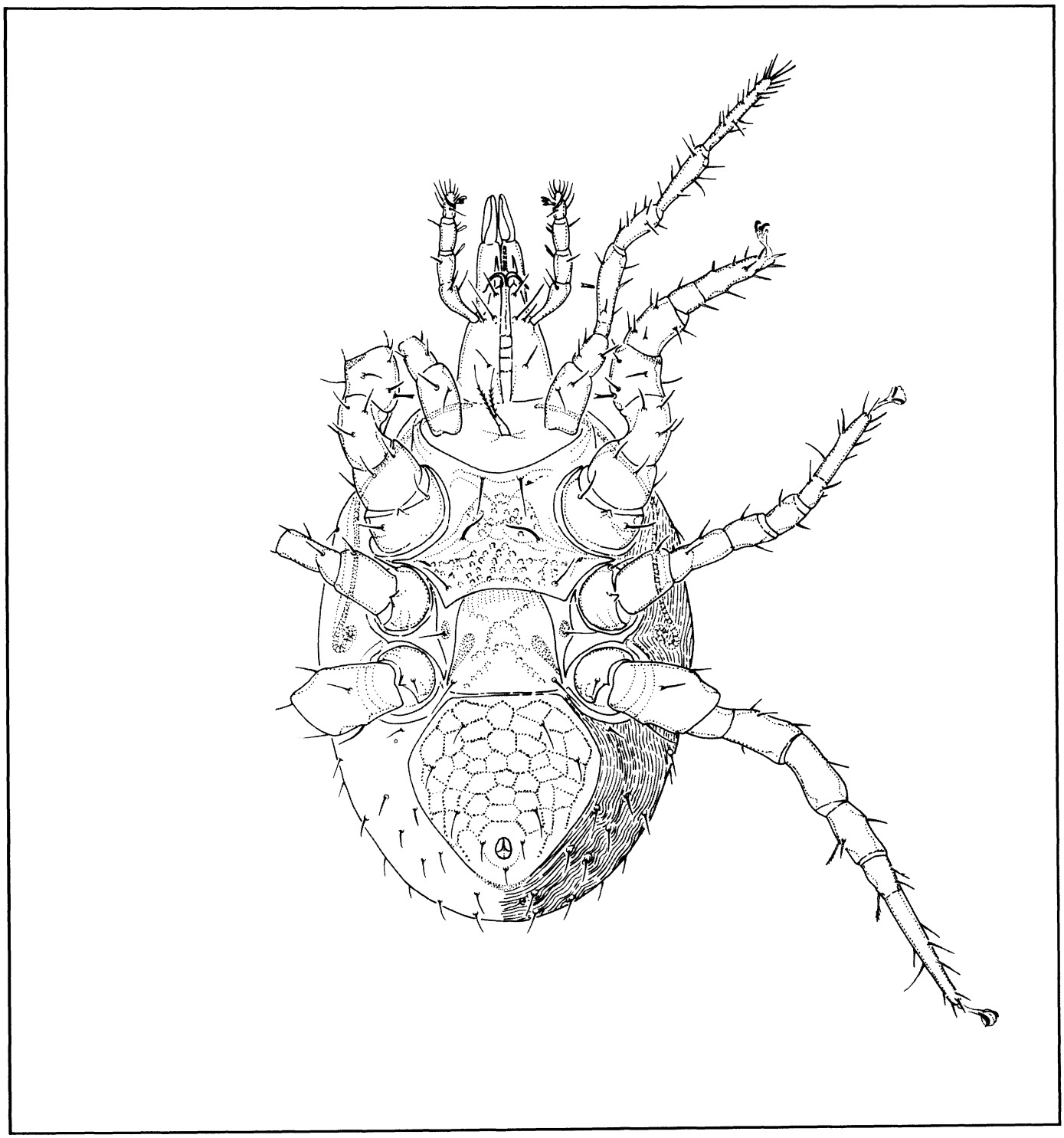


Plate 5. House fly mite, *Macrocheles muscaedomesticae* (Macrochelidae), ventral view of female. (Redrawn from *3* by C. Feller).

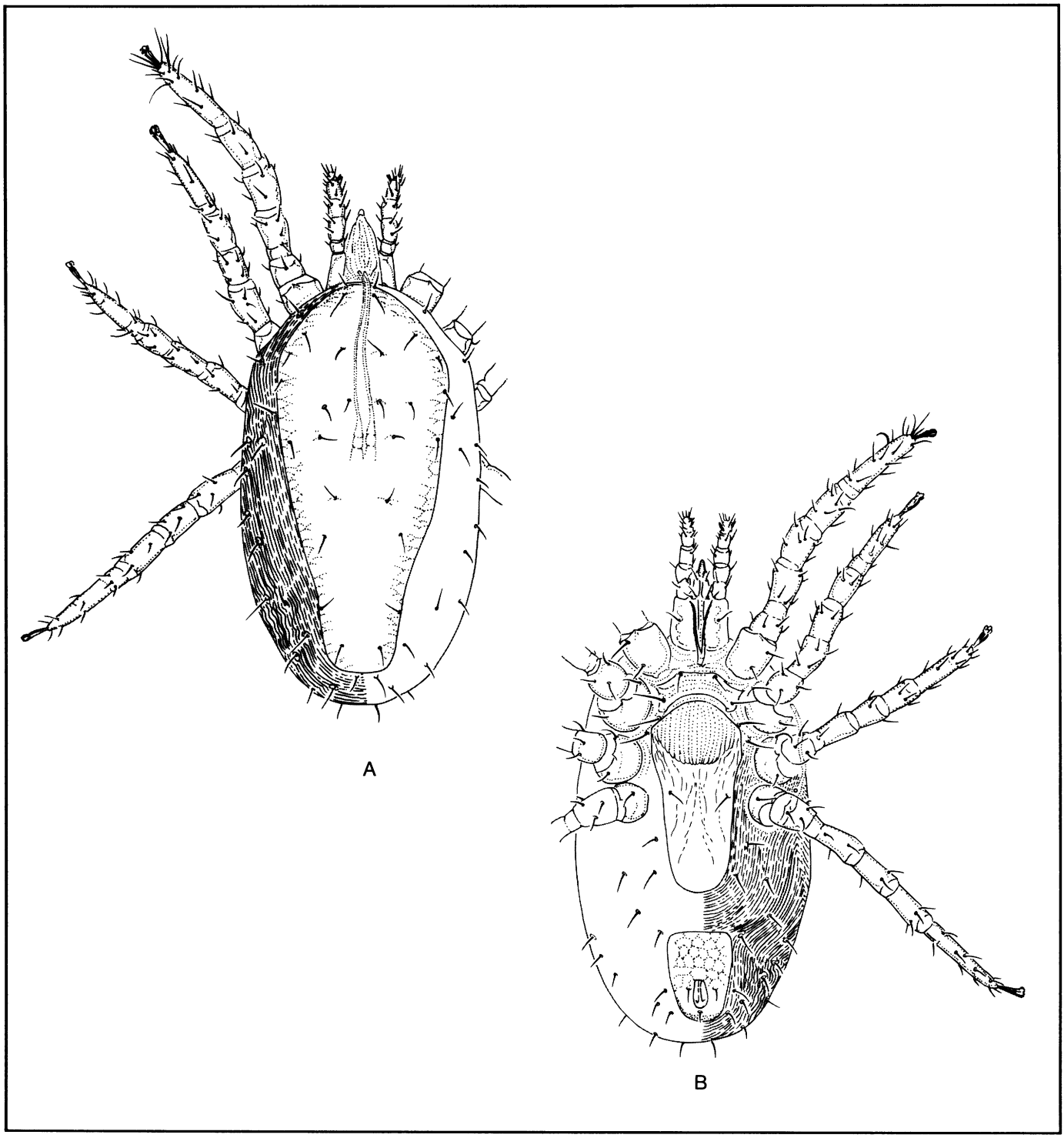


Plate 6. **Chicken mite,** *Dermanyssus gallinae* (Dermanyssidae), female: A, dorsal view; B, ventral view. (Redrawn from *3* by C. Feller.)

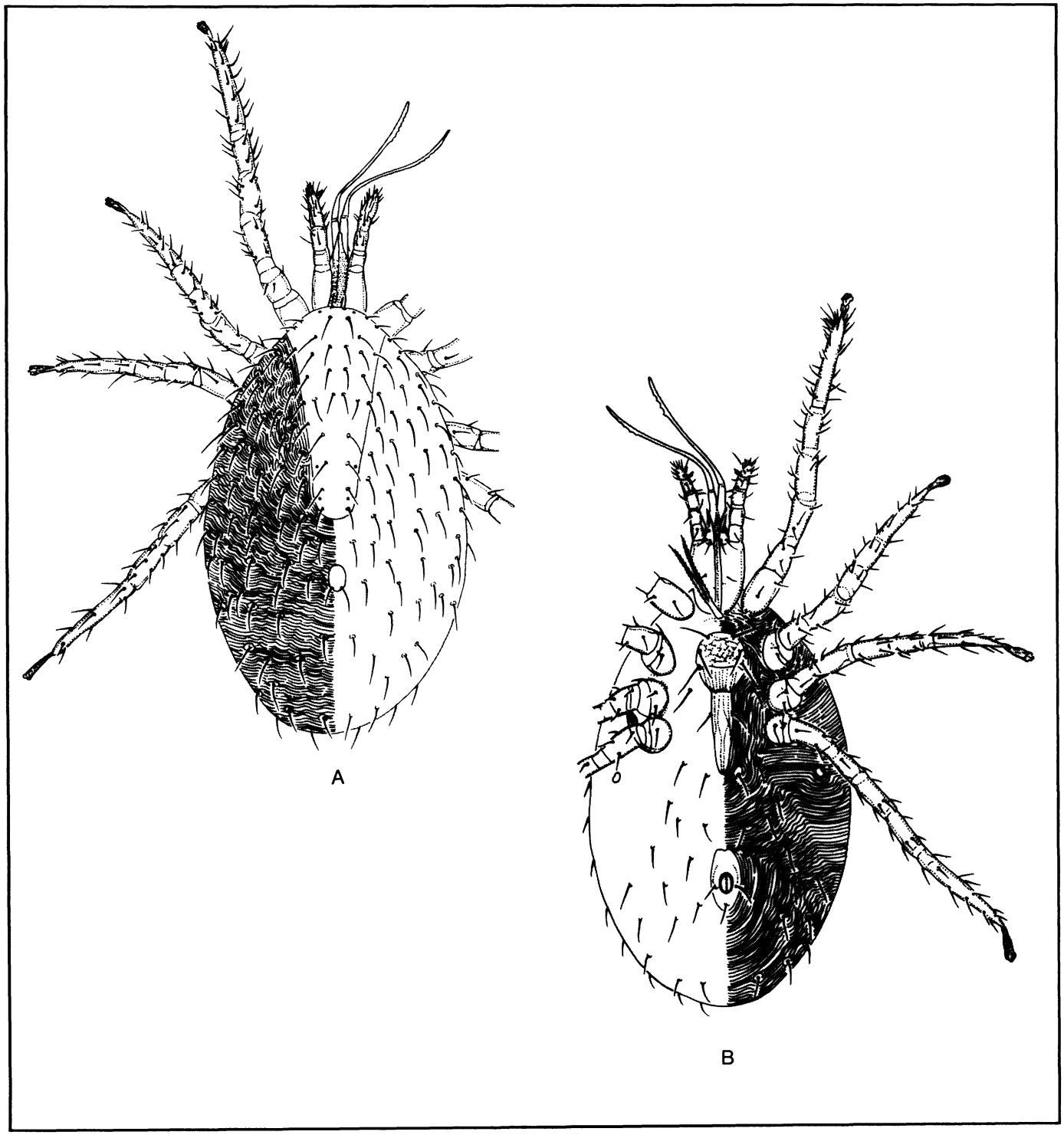


Plate 7. **House mouse mite,** *Liponyssoides sanguineus* (Macronyssidae), female: A, dorsal view; B, ventral view. (Redrawn from *3* by C. Feller.)

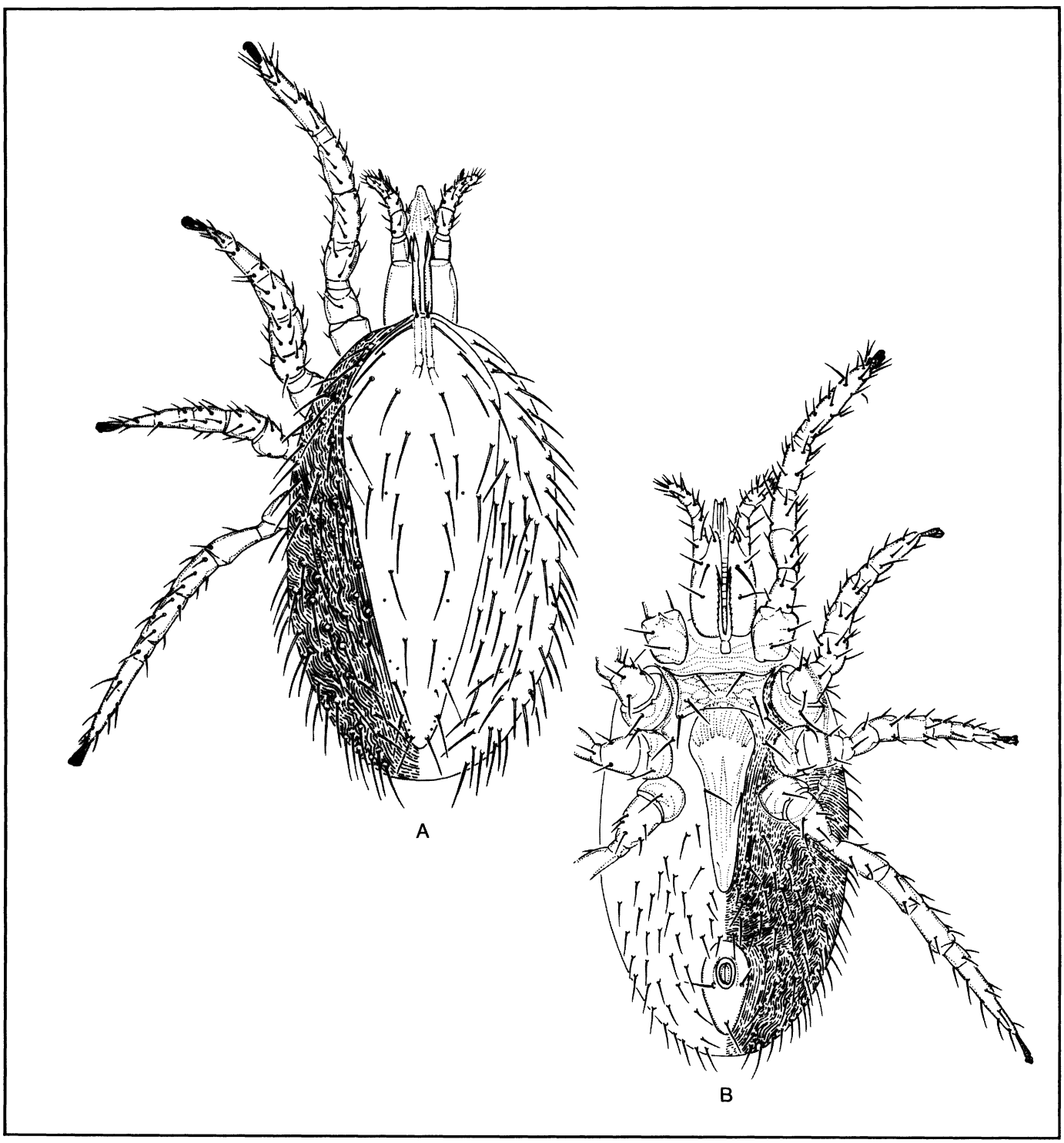


Plate 8. **Tropical rat mite**, *Ornithonyssus bacoti* (Macronyssidae), female: A, dorsal view; B, ventral view. (Redrawn from *3* by C. Feller.) (For the gravid female of *Ornithonyssus sylviarum*, see couplet illustration 11C.)

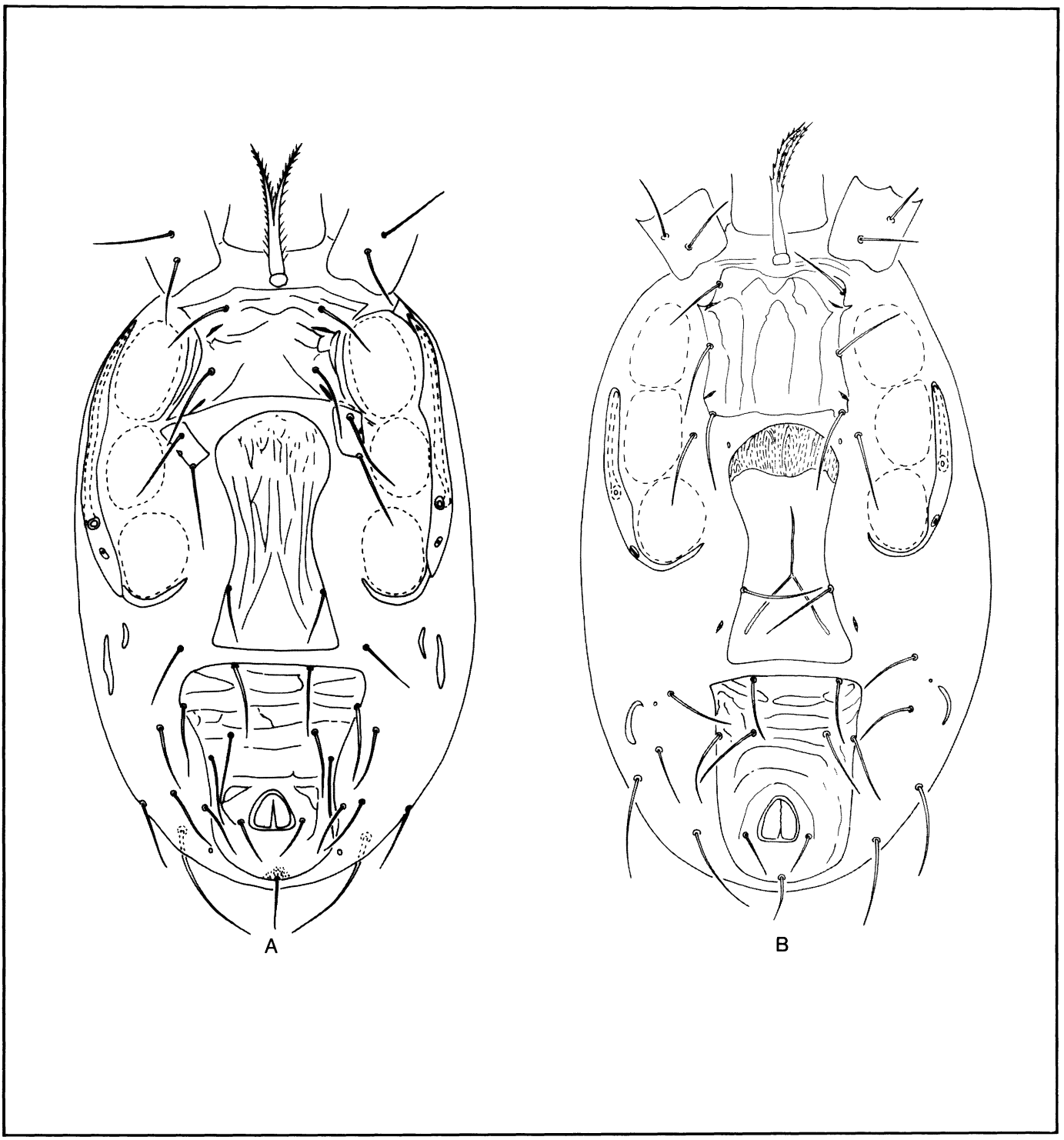


Plate 9. Ascid mites (Ascidae), females, ventral views: A, *Blattisocius dentriticus* (for dorsal view, see couplet illustration 8B); B, *Blattisocius tarsalis.*

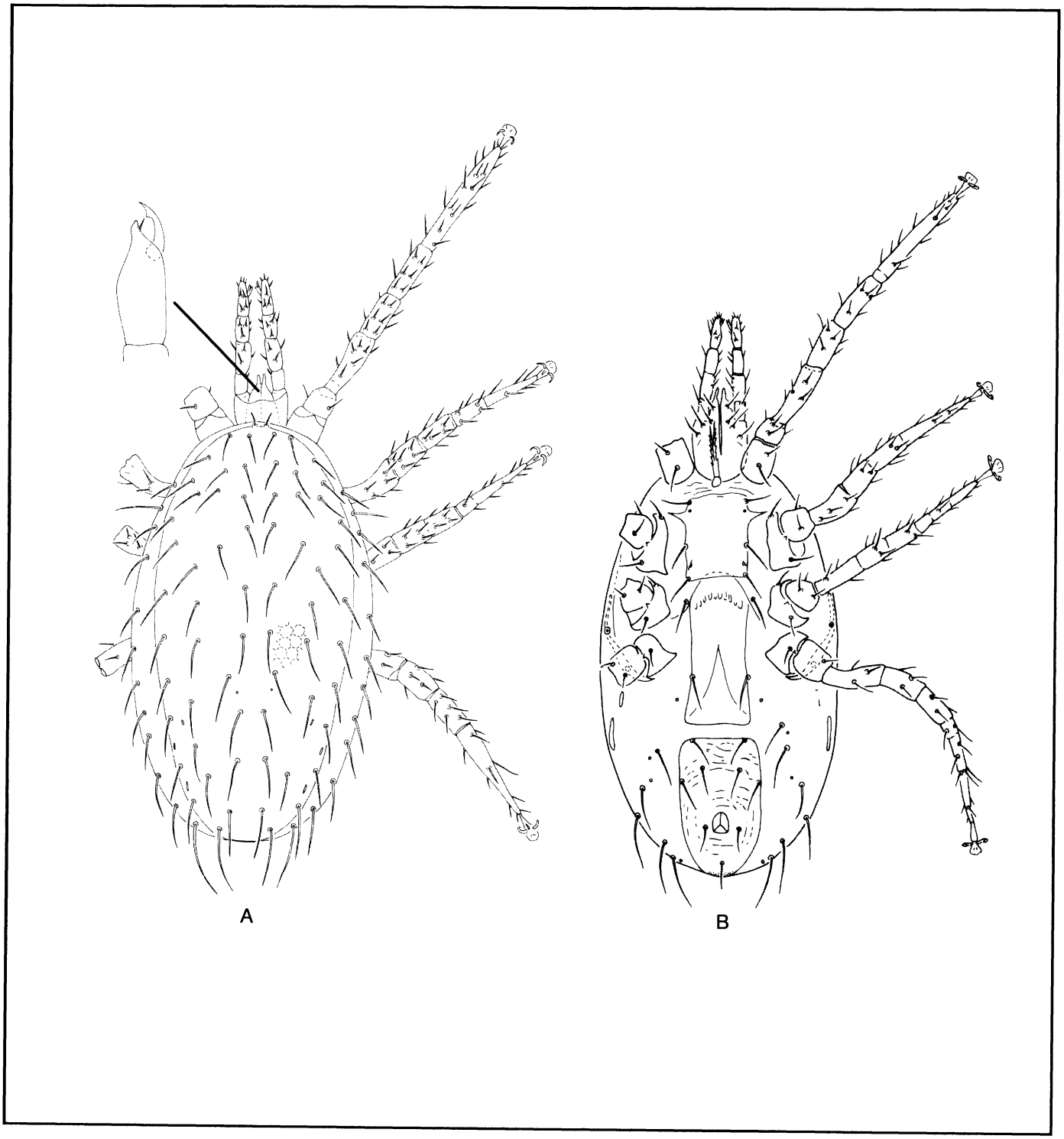


Plate 10. *Blattisocius keegani* (Ascidae), female:
A, dorsal view; B, ventral view.

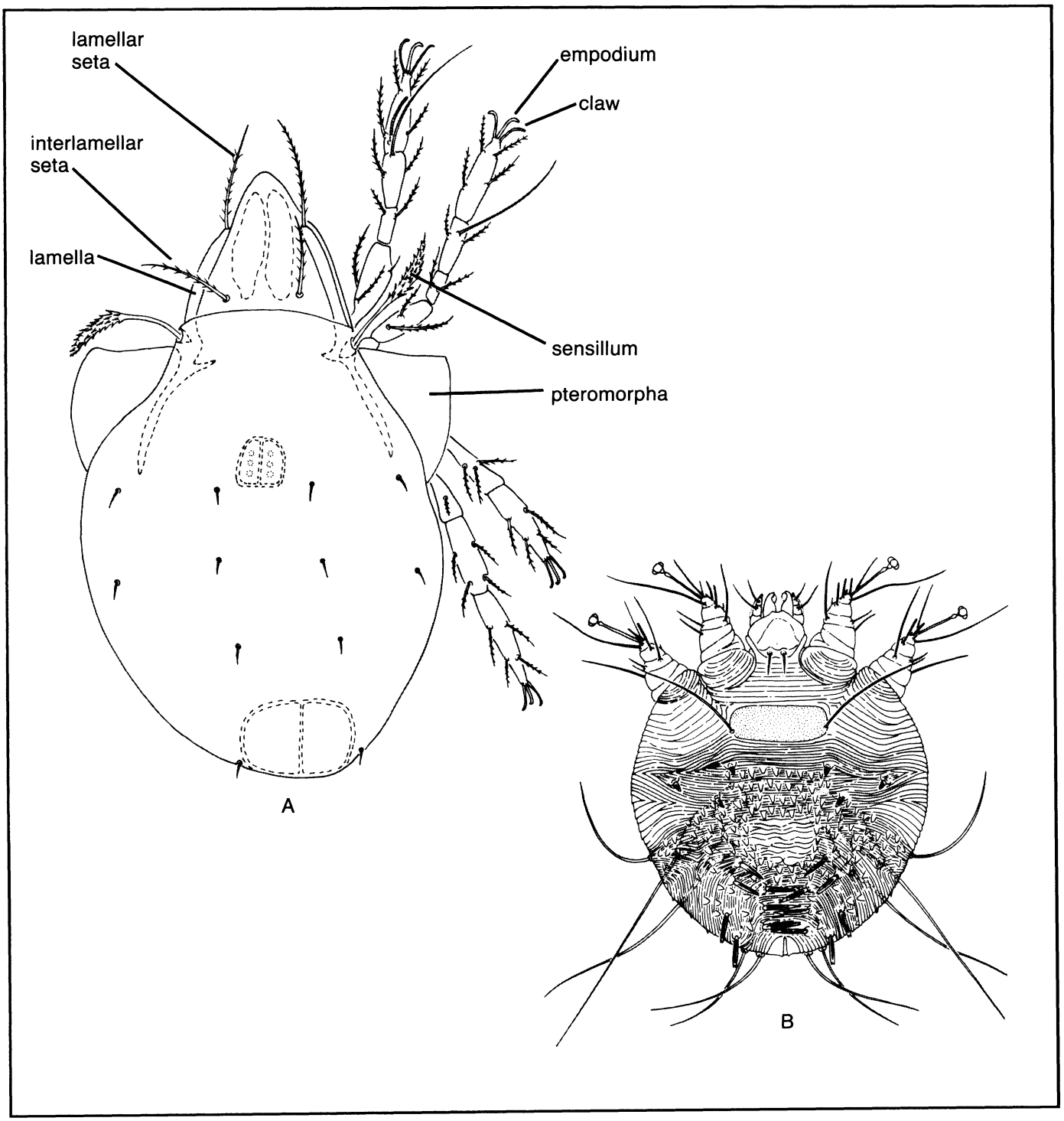


Plate 11. Acariform mites (Acariformes), females, dorsal views: A, a beetle mite, *Scheloribates* sp. (Oribatulidae); B, **itch mite,** *Sarcoptes scabiei* (Sarcoptidae) (redrawn from *3* by C. Feller).

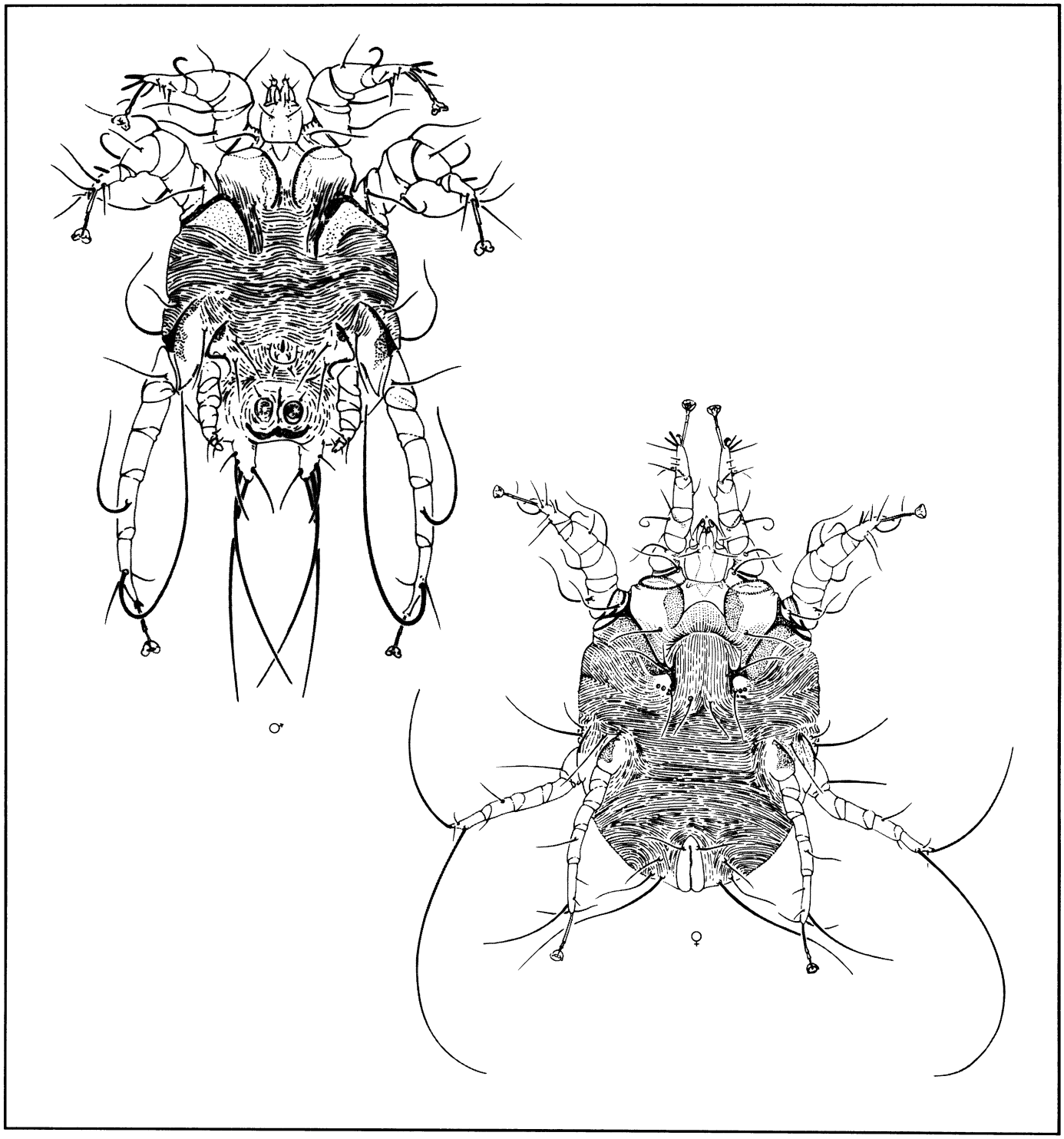


Plate 12. **Scab mite,** *Psoroptes equi* (Psoroptidae), ventral views. (Redrawn from *3* by C. Feller.)

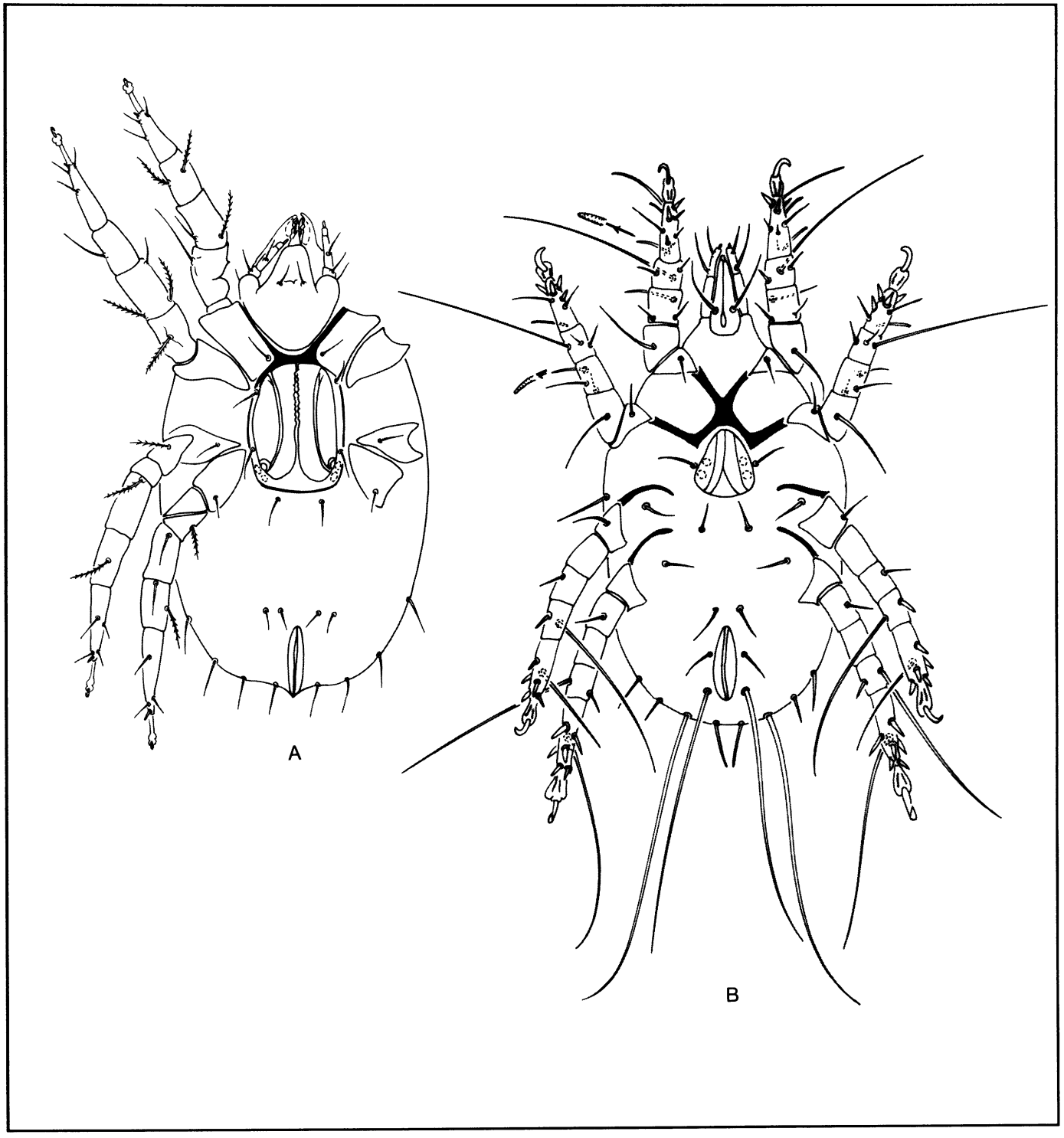


Plate 13. Astigmatid mites (Astigmata), females, ventral views: A, **brown flour mite,** *Gohieria fusca* (Glycyphagidae); B, **driedfruit mite,** *Carpoglyphus lactis* (Carpoglyphidae).

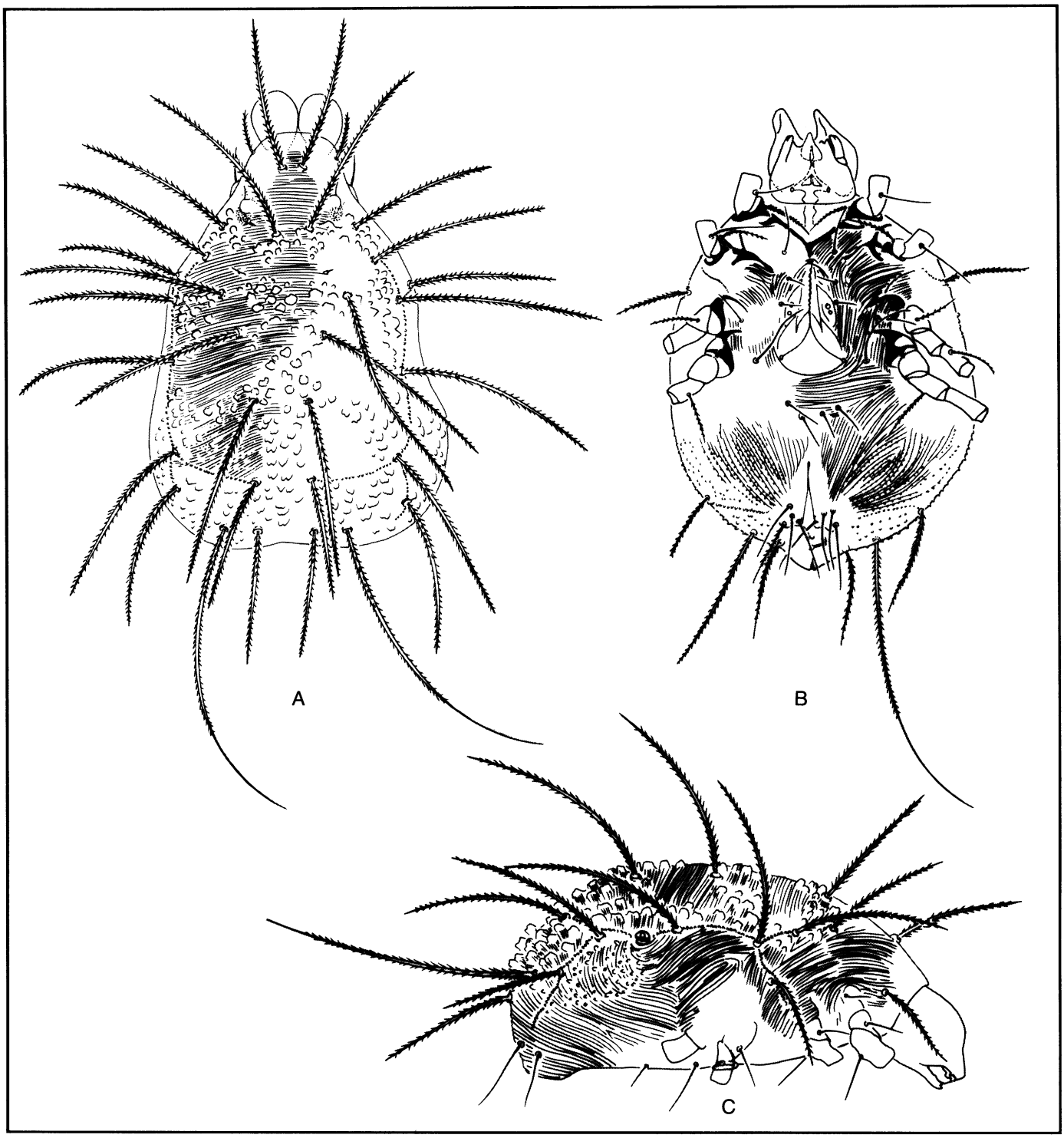


Plate 14. **Warty grain mite**, *Aeroglyphus robustus* (Glycyphagidae), female: A, dorsal view; B, ventral view; C, lateral view. (Redrawn from *2* by C. Feller.)

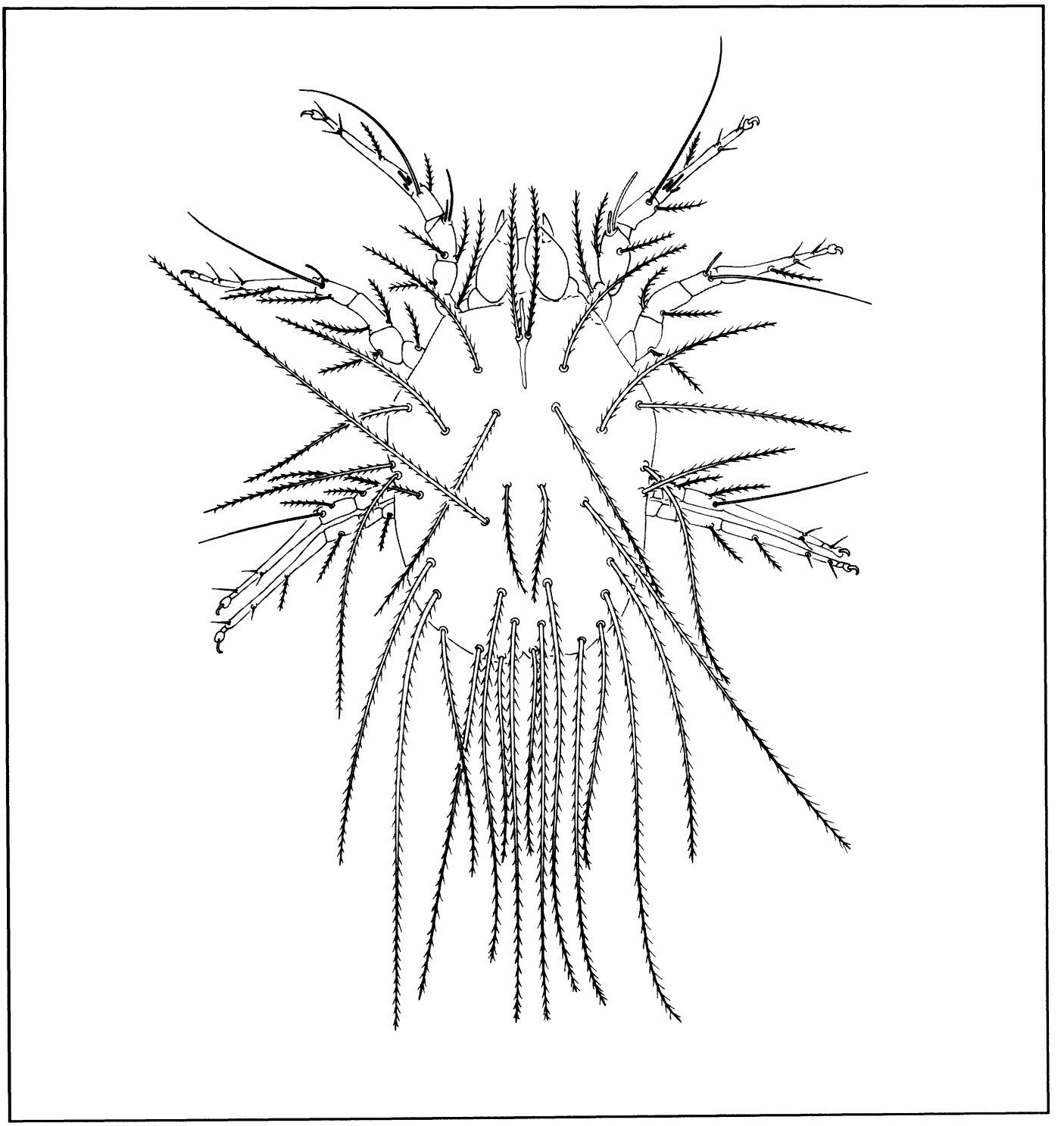


Plate 15. **House mite,** *Glycyphagus domesticus* (Glycyphagidae), male, dorsal view.

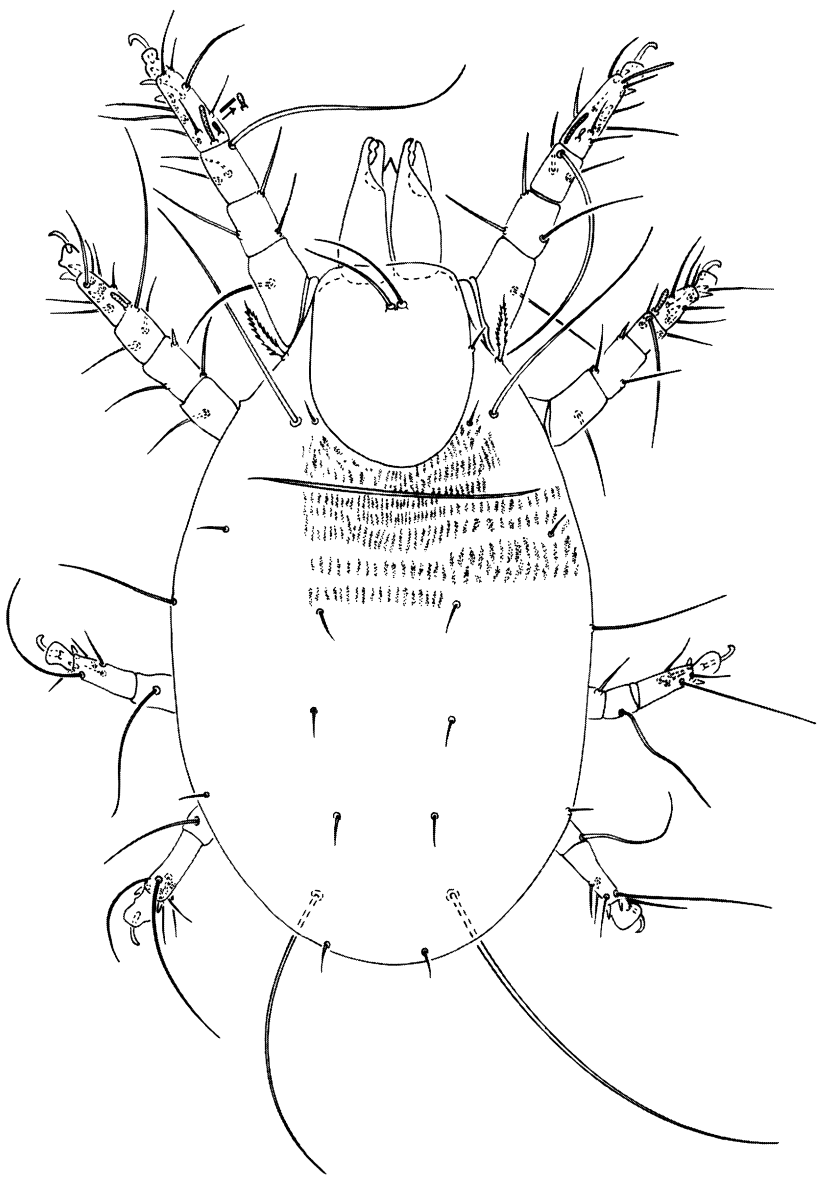


Plate 16. **Scaly grain mite,** *Suidasia nesbitti* (Acaridae), female, dorsal view.

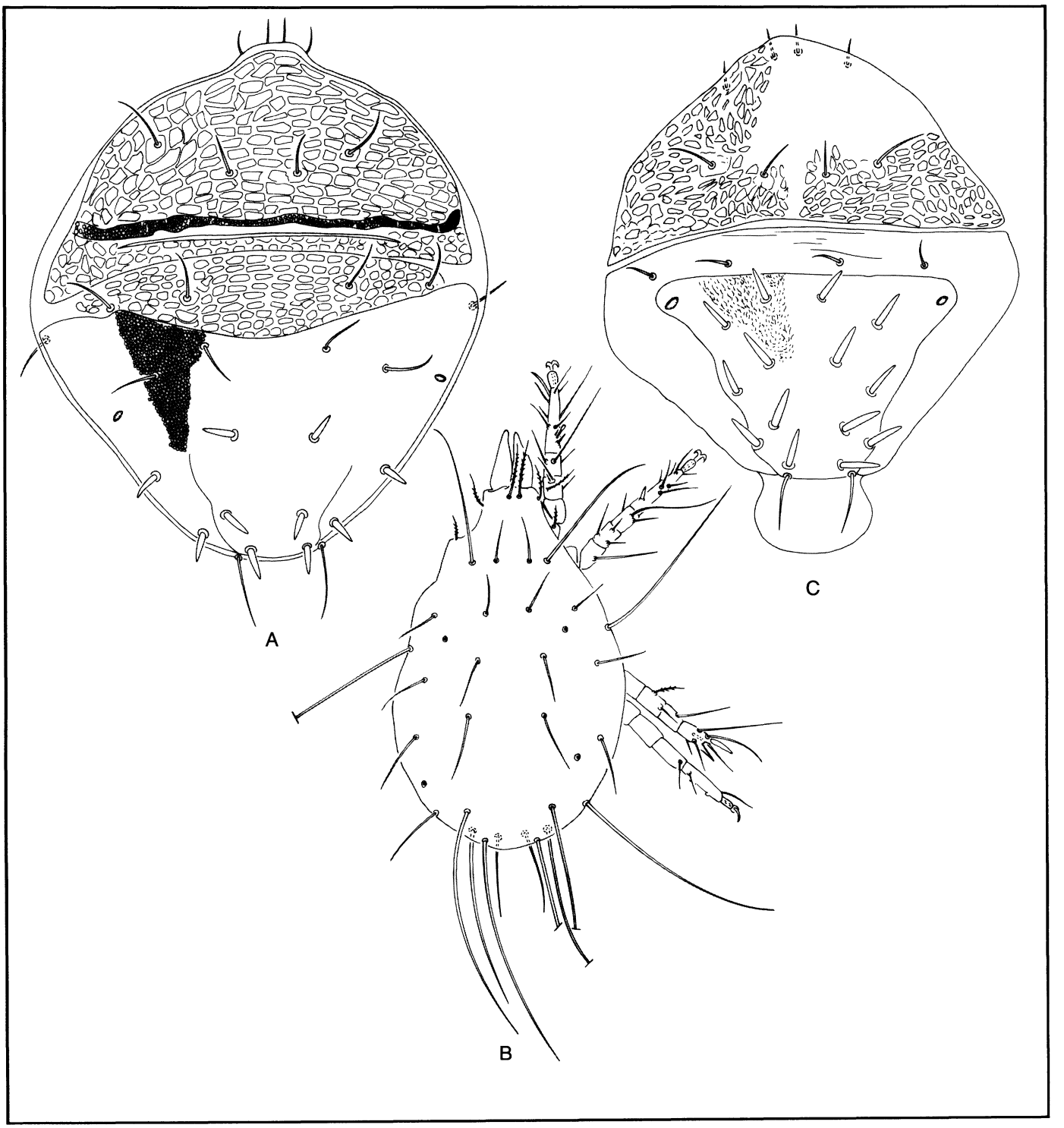


Plate 17. Lardoglyphid mites (Lardoglyphidae), dorsal views: A, *Lardoglyphus zacheri,* hypopus; B, same, male; C, *Lardoglyphus konoi,* hypopus.

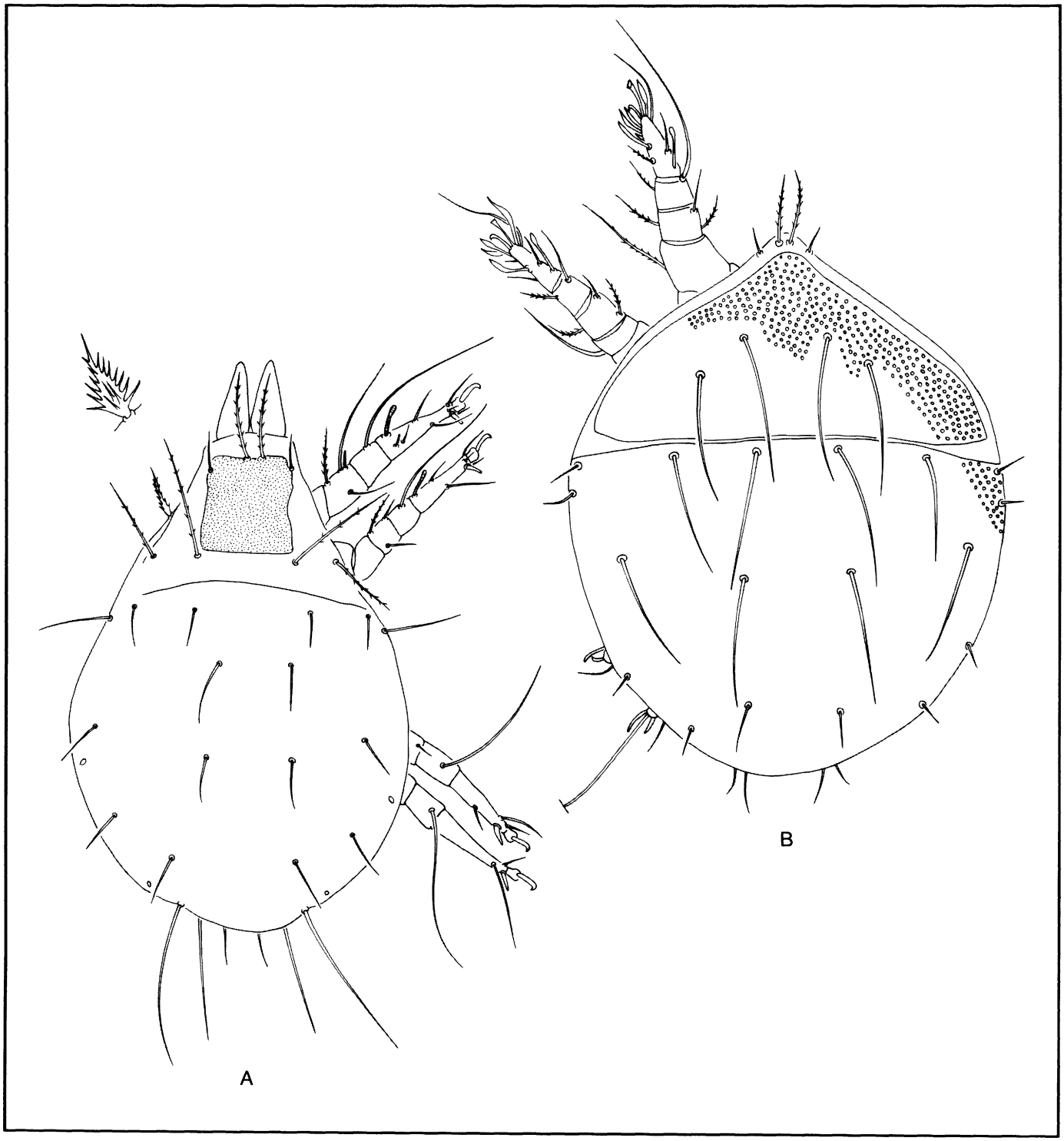


Plate 18. **Grain mite**, *Acarus siro* (Acaridae), dorsal views: A, female; B, hypopus.

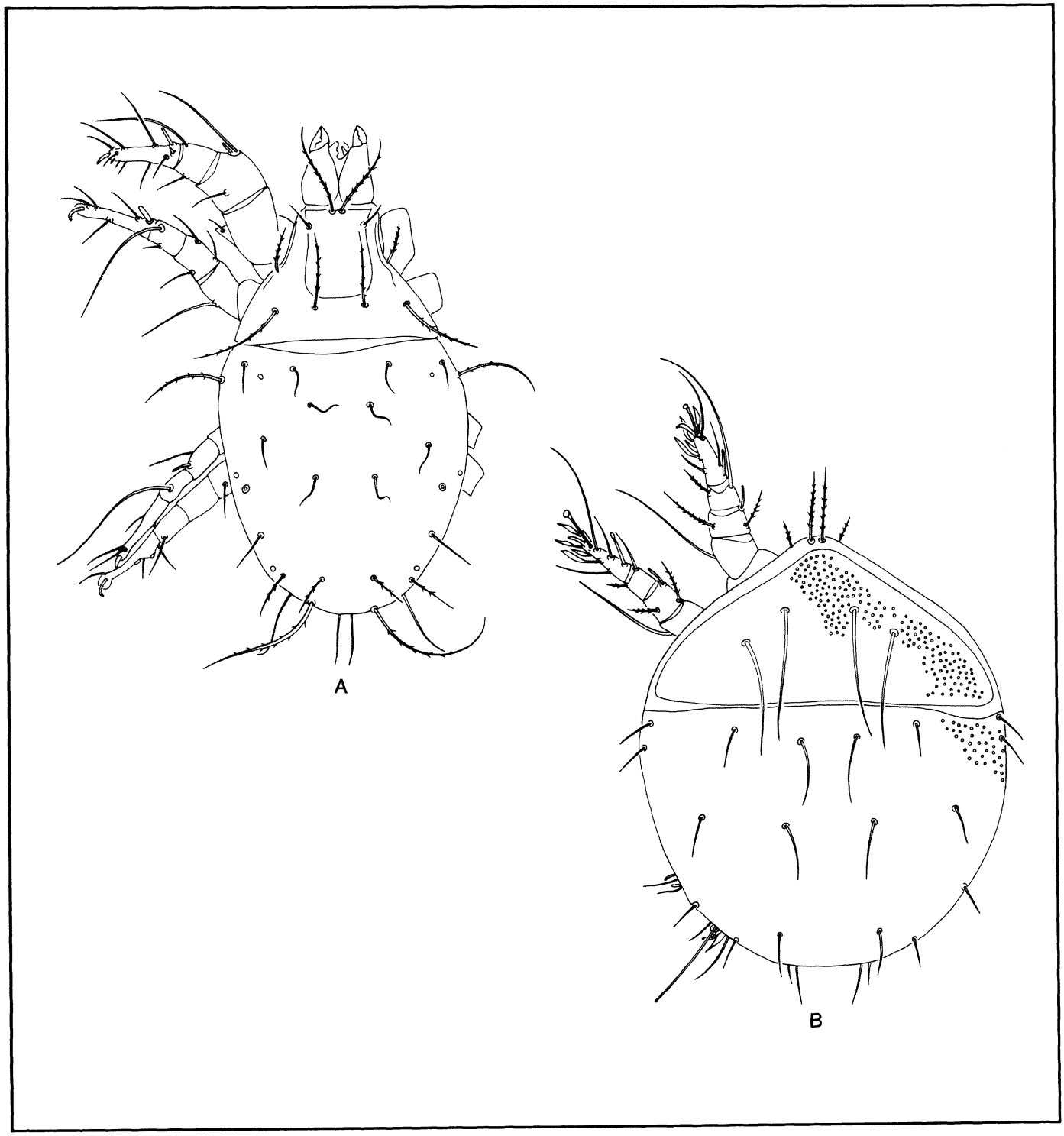


Plate 19. *Acarus farris* (Acaridae), dorsal views:
A, male; B, hypopus.

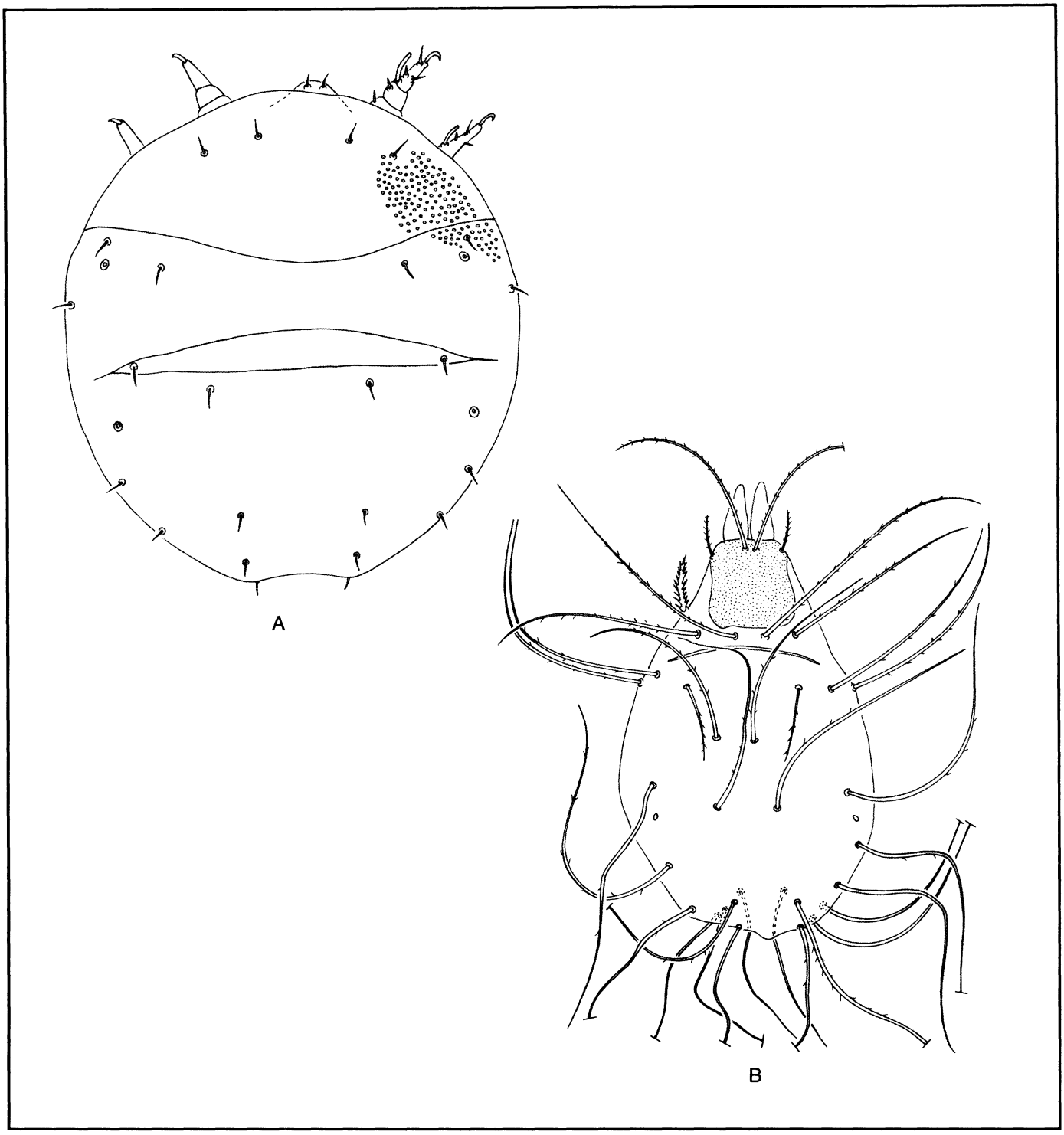


Plate 20. **Acarid mites** (Acaridae), dorsal views: A, *Acarus immobilis,* hypopus; B, **cheese mite,** *Tyrolichus casei,* female.

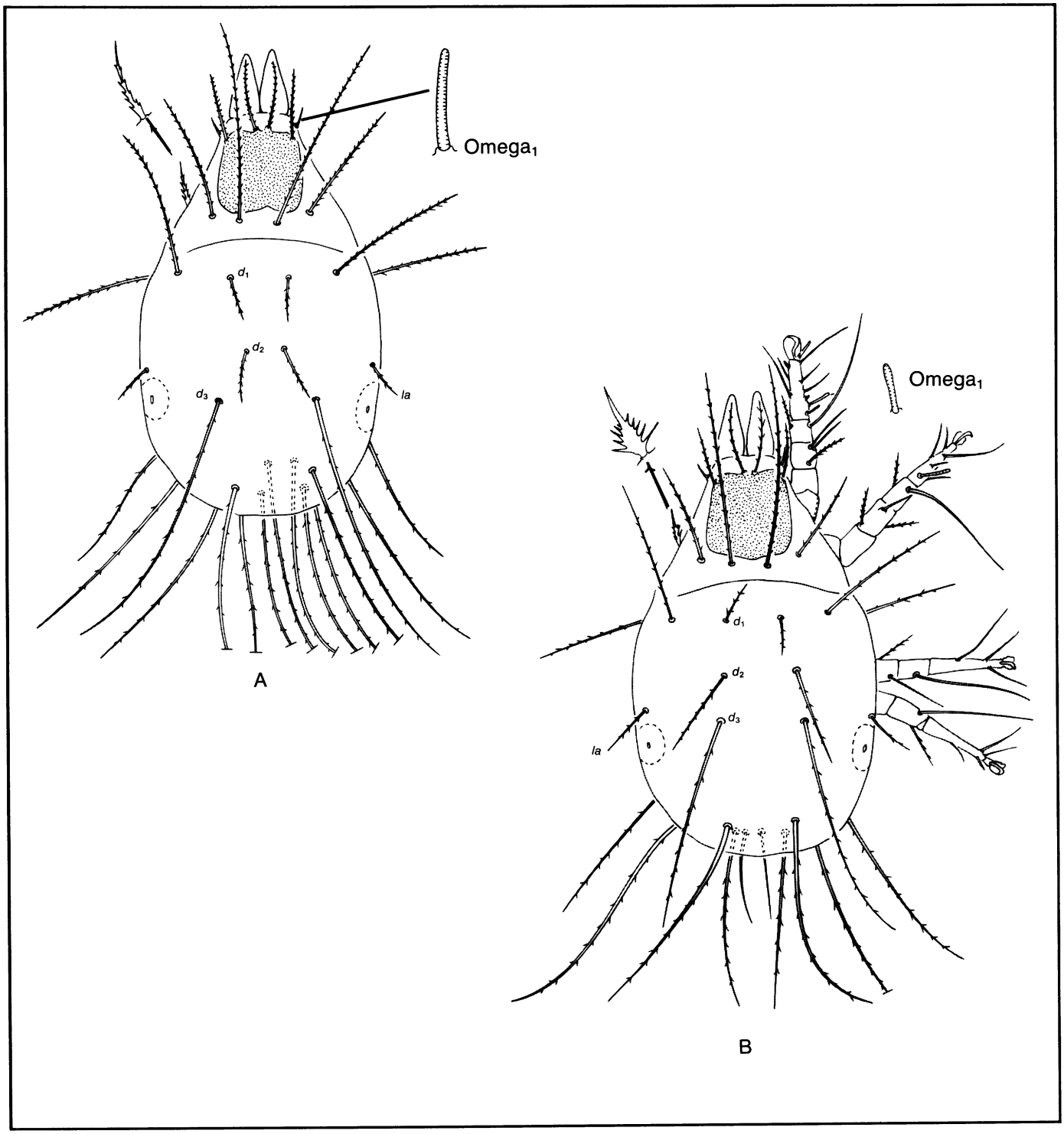


Plate 21. **Acarid mites** (Acaridae), dorsal views of females: A, *Tyrophagus longior;* B, **mold mite,** *Tyrophagus putrescentiae.*

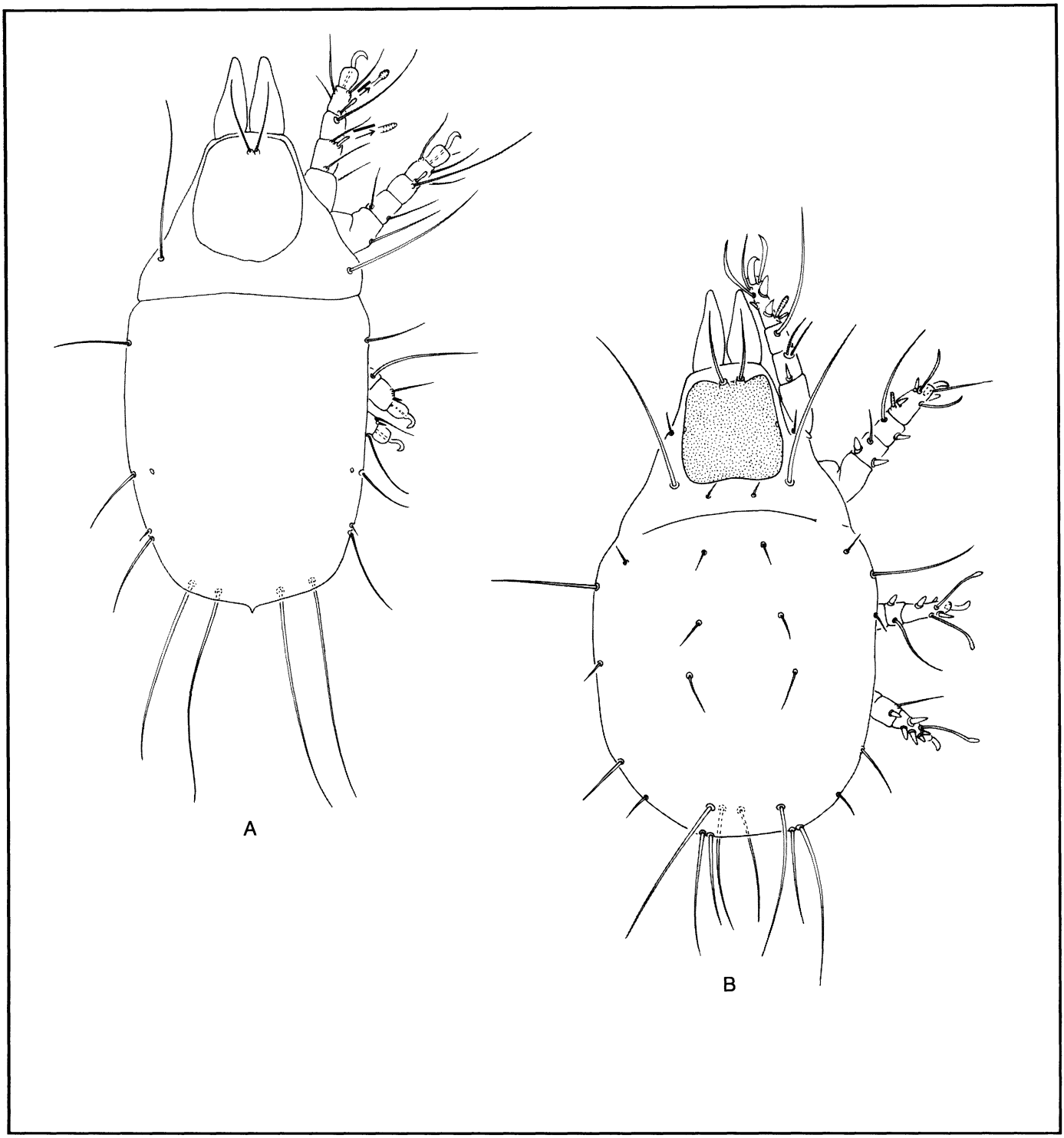


Plate 22. **Acarid mites** (Acaridae), dorsal views of females: A, *Thyreophagus entomophagus;* B, *Rhizoglyphus robini* (see also pl. 23).

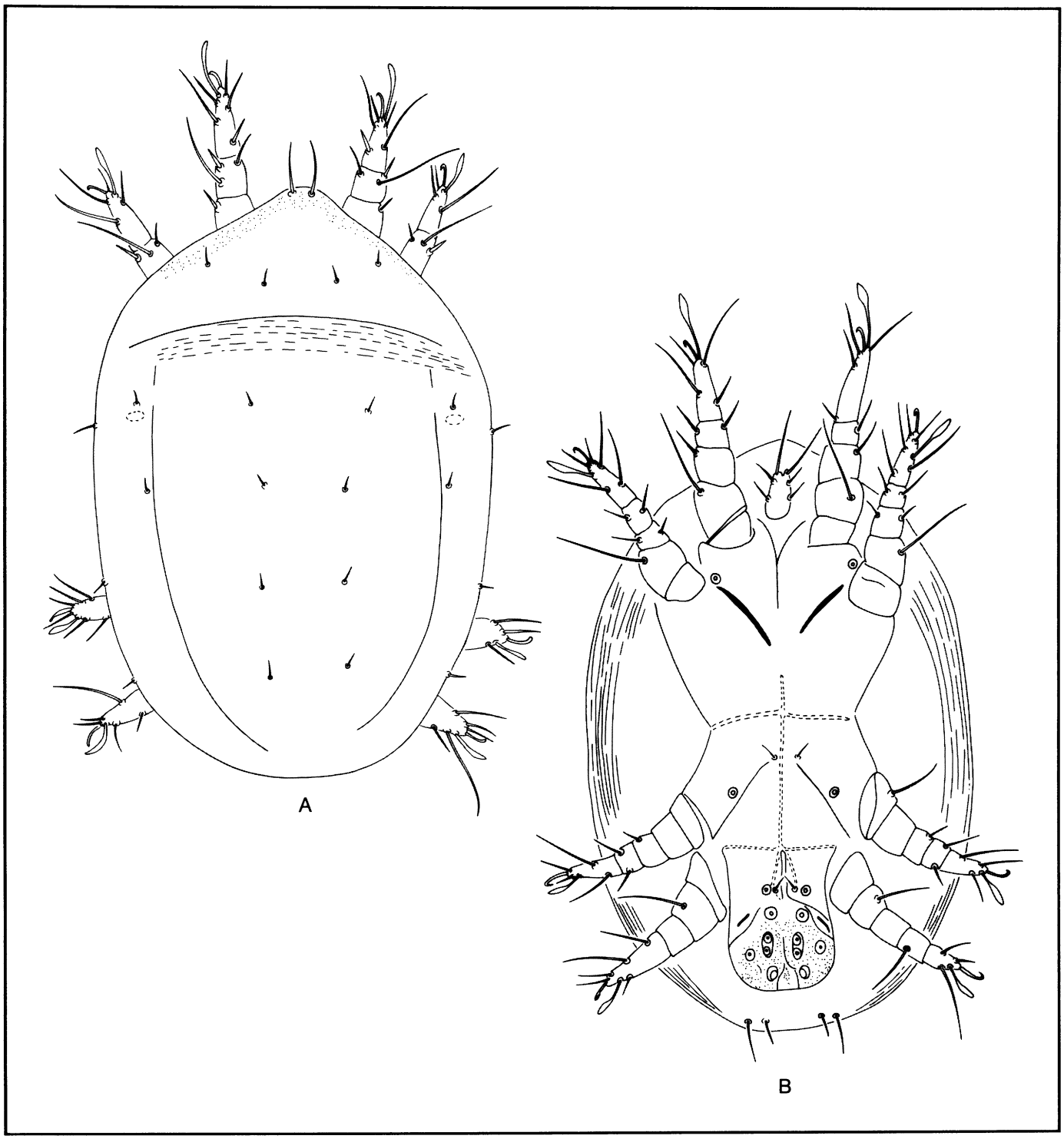


Plate 23. *Rhizoglyphus robini* (Acaridae), hypopus: A, dorsal view; B, ventral view. (See also pl. 22B.)

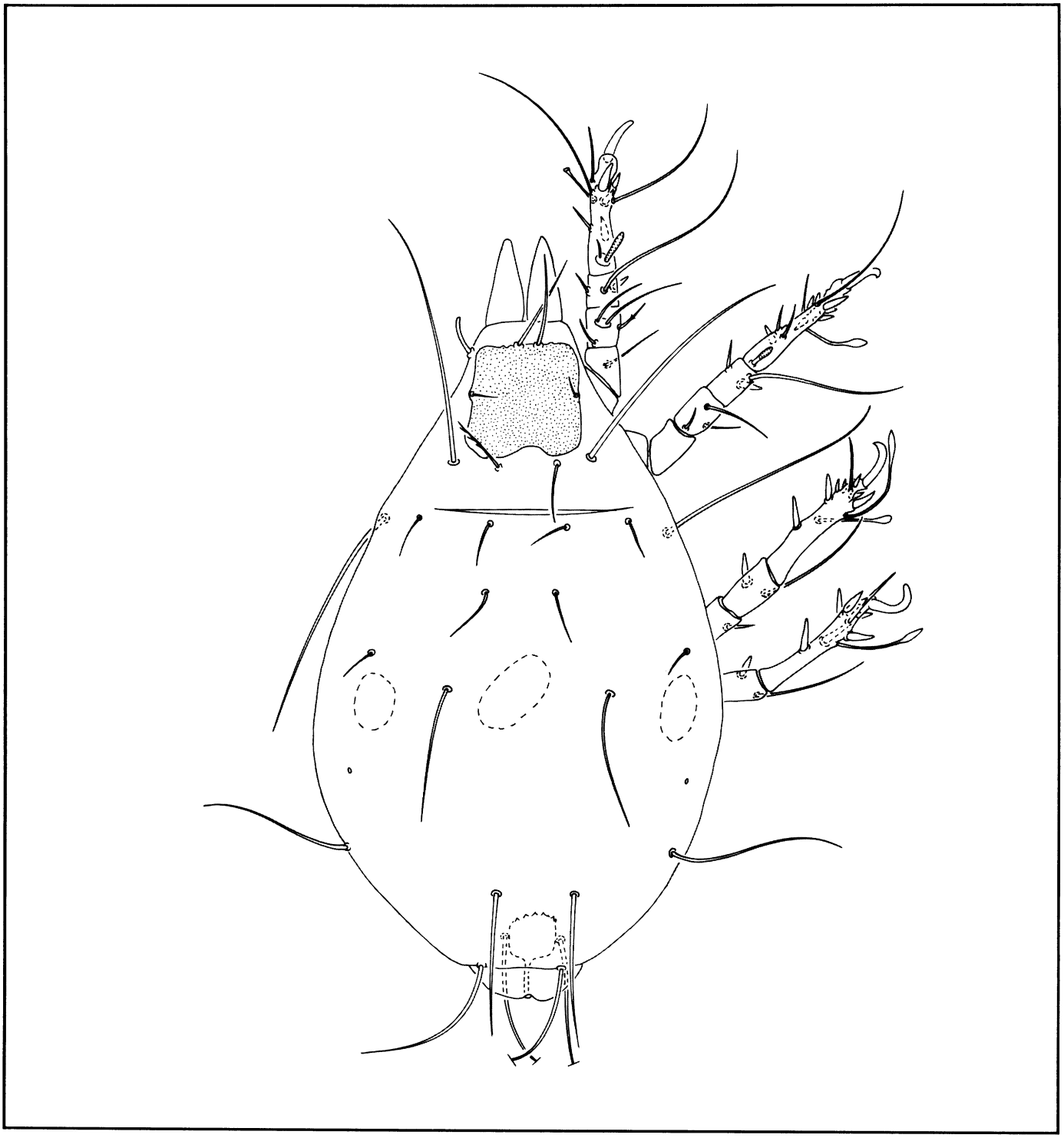


Plate 24. *Caloglyphus berlesei* (Acaridae), dorsal view of gravid female.

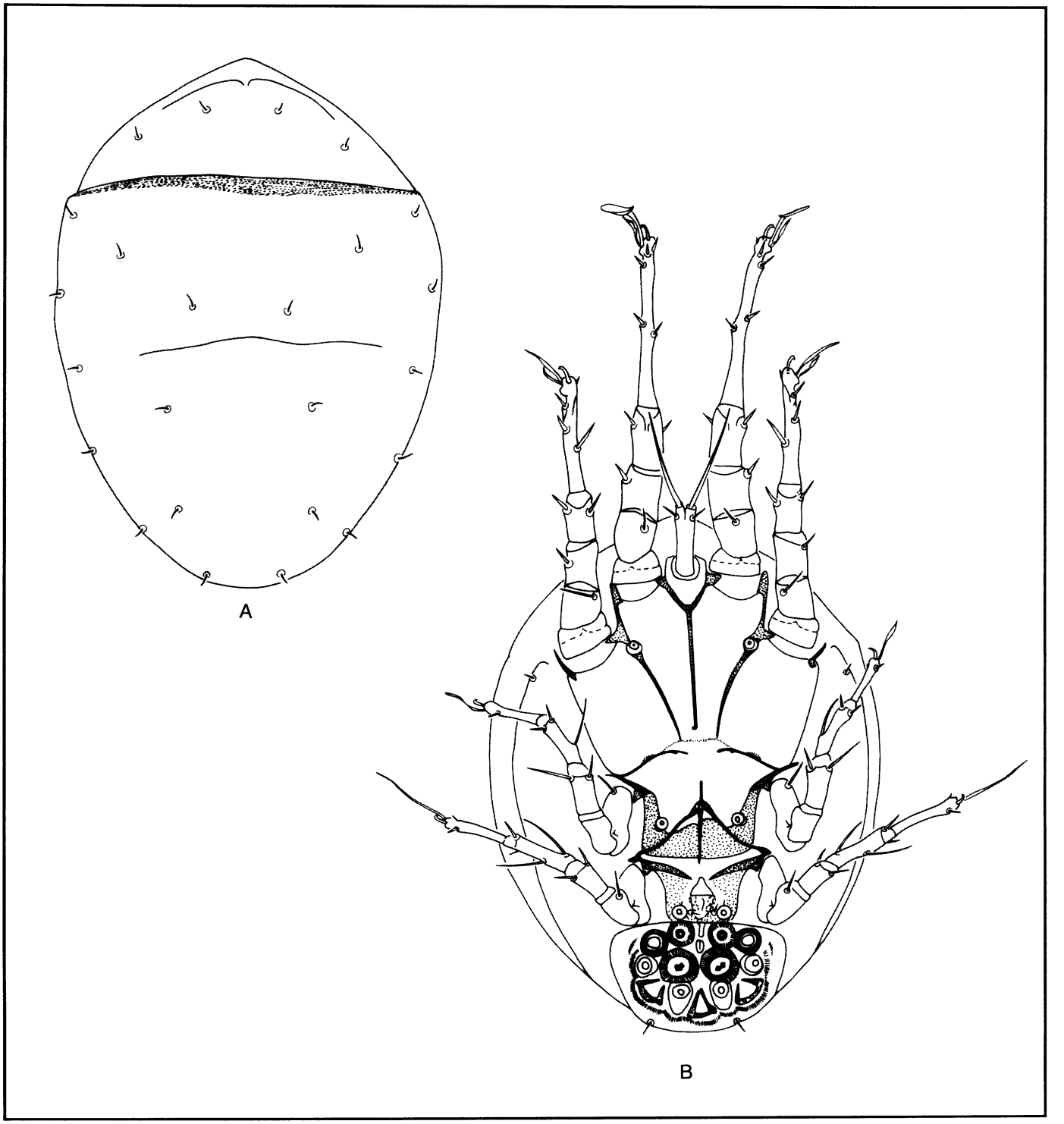


Plate 25. *Histiostoma heinemanni* (Histiostomatidae), hypopus: A, dorsal view; B, ventral view. (See also pl. 26 and 27.) (Redrawn from *15* by C. Feller.)

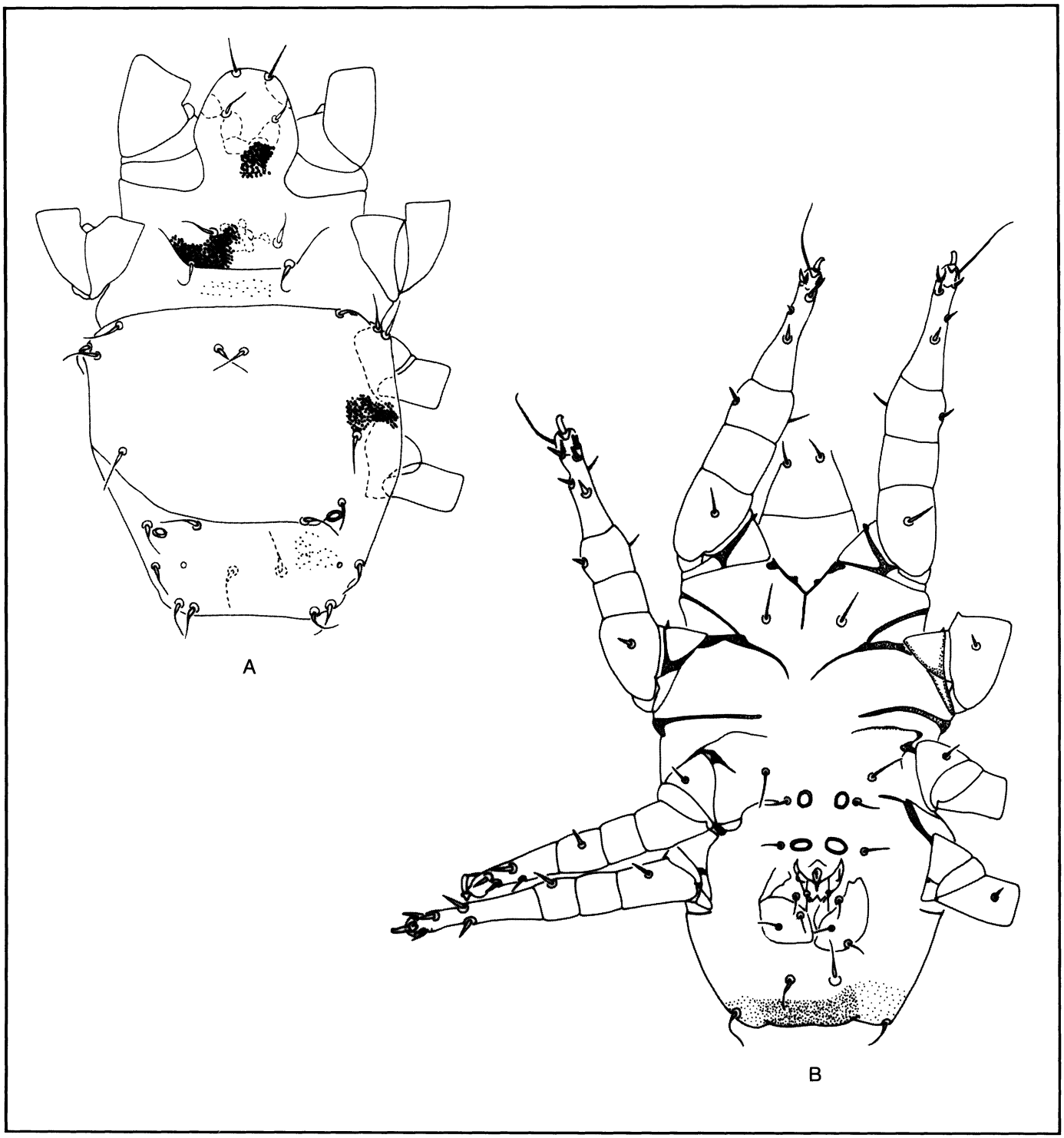


Plate 26. *Histiostoma heinemanni* (Histiostomatidae), male: A, dorsal view; B, ventral view. (See also pl. 25 and 27.) (Redrawn from *15* by C. Feller.)

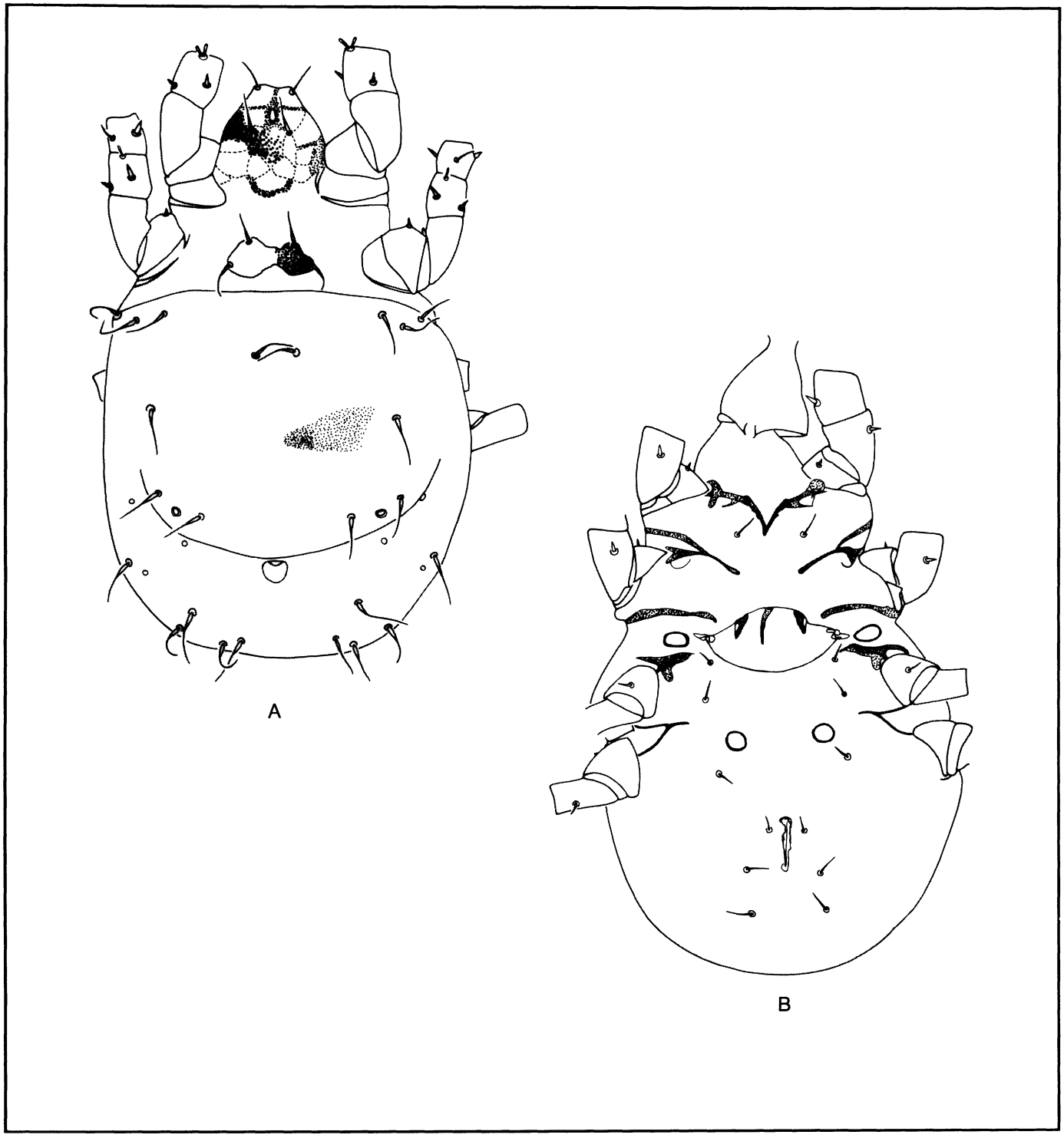


Plate 27. *Histiostoma heinemanni* (Histiostomatidae), female: A, dorsal view; B, ventral view. (See also pl. 25 and 26.) (Redrawn from *15* by C. Feller.)

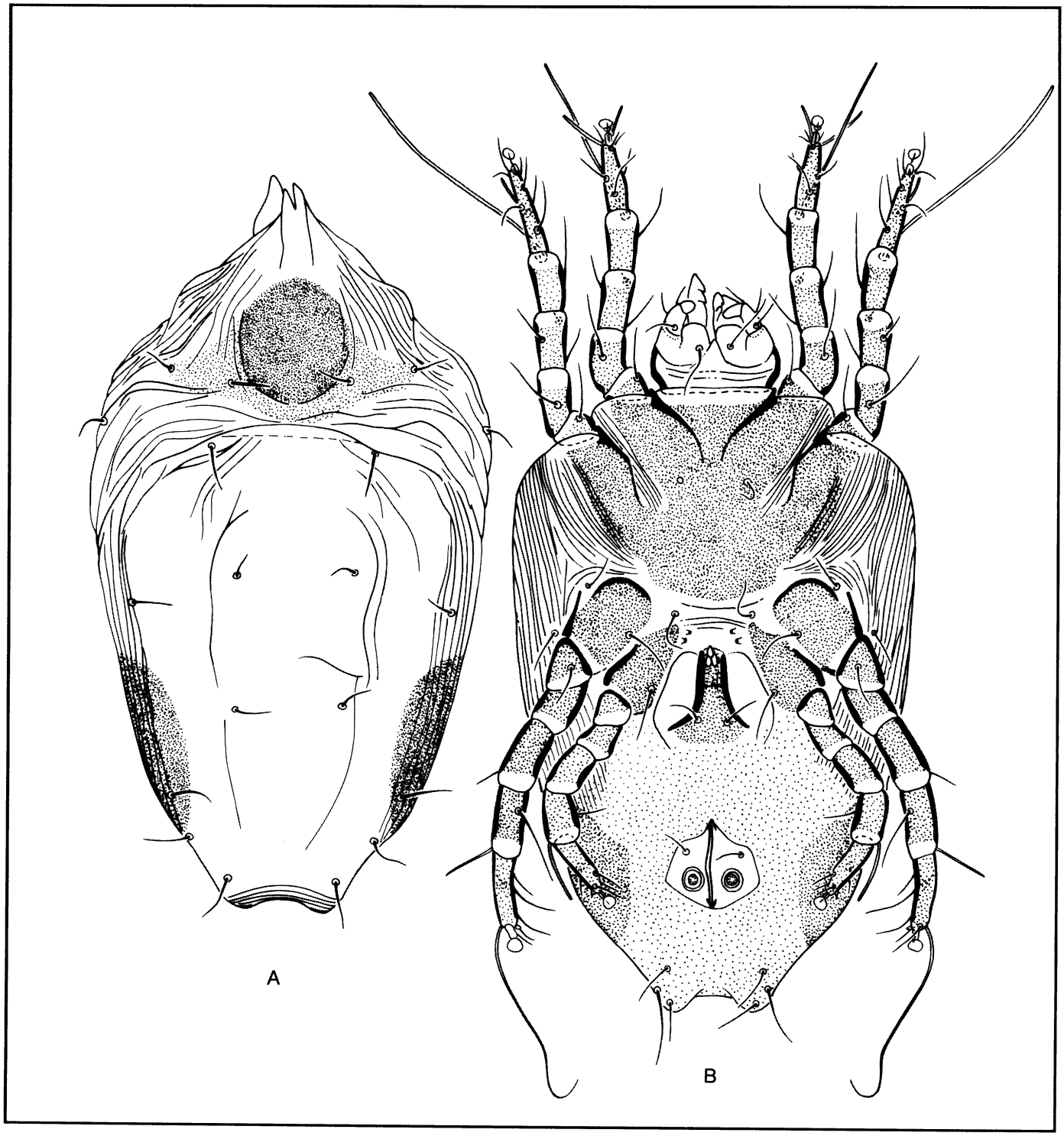


Plate 28. *Euroglyphus longior* (Pyroglyphidae), male: A, dorsal view; B, ventral view. (See also pl. 29.) (Redrawn from *10* by C. Feller.)

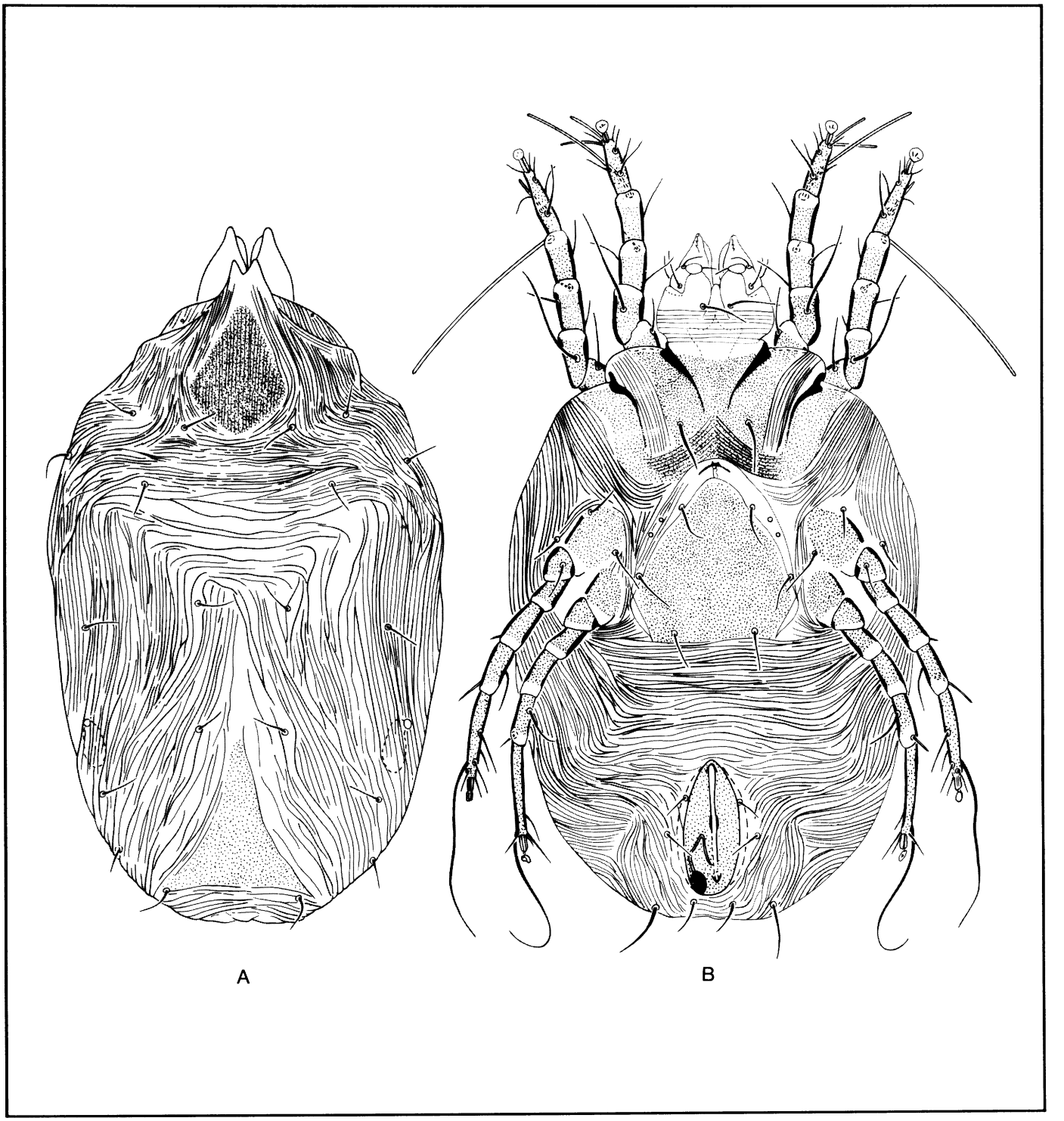


Plate 29. *Euroglyphus longior* (Pyroglyphidae), female: A, dorsal view; B, ventral view. (See also pl. 28.) (Redrawn from *10* by C. Feller.)

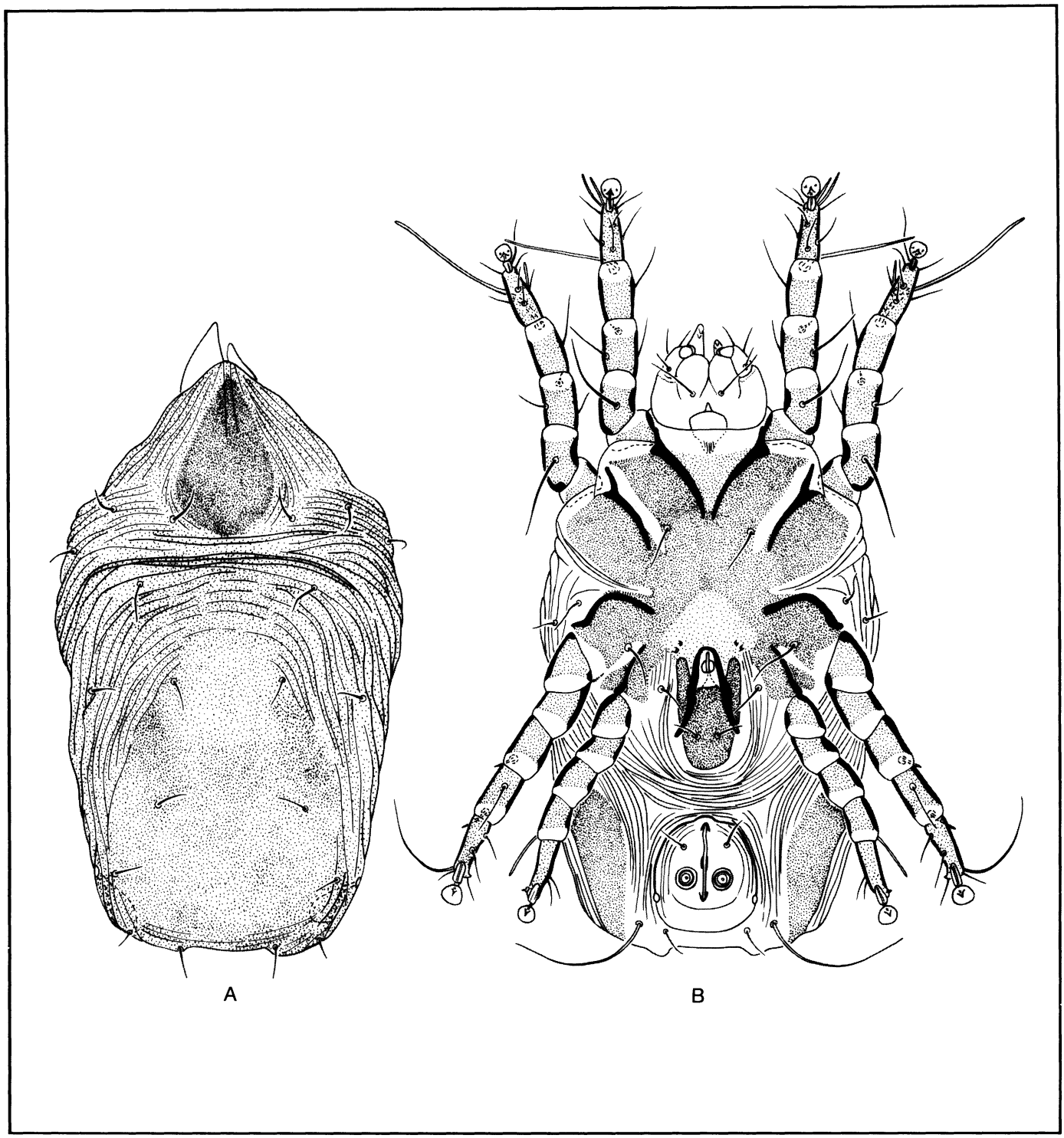


Plate 30. *Euroglyphus maynei* (Pyroglyphidae), male: A, dorsal view; B, ventral view. (See also pl. 31.) (Redrawn from *10* by C. Feller.)

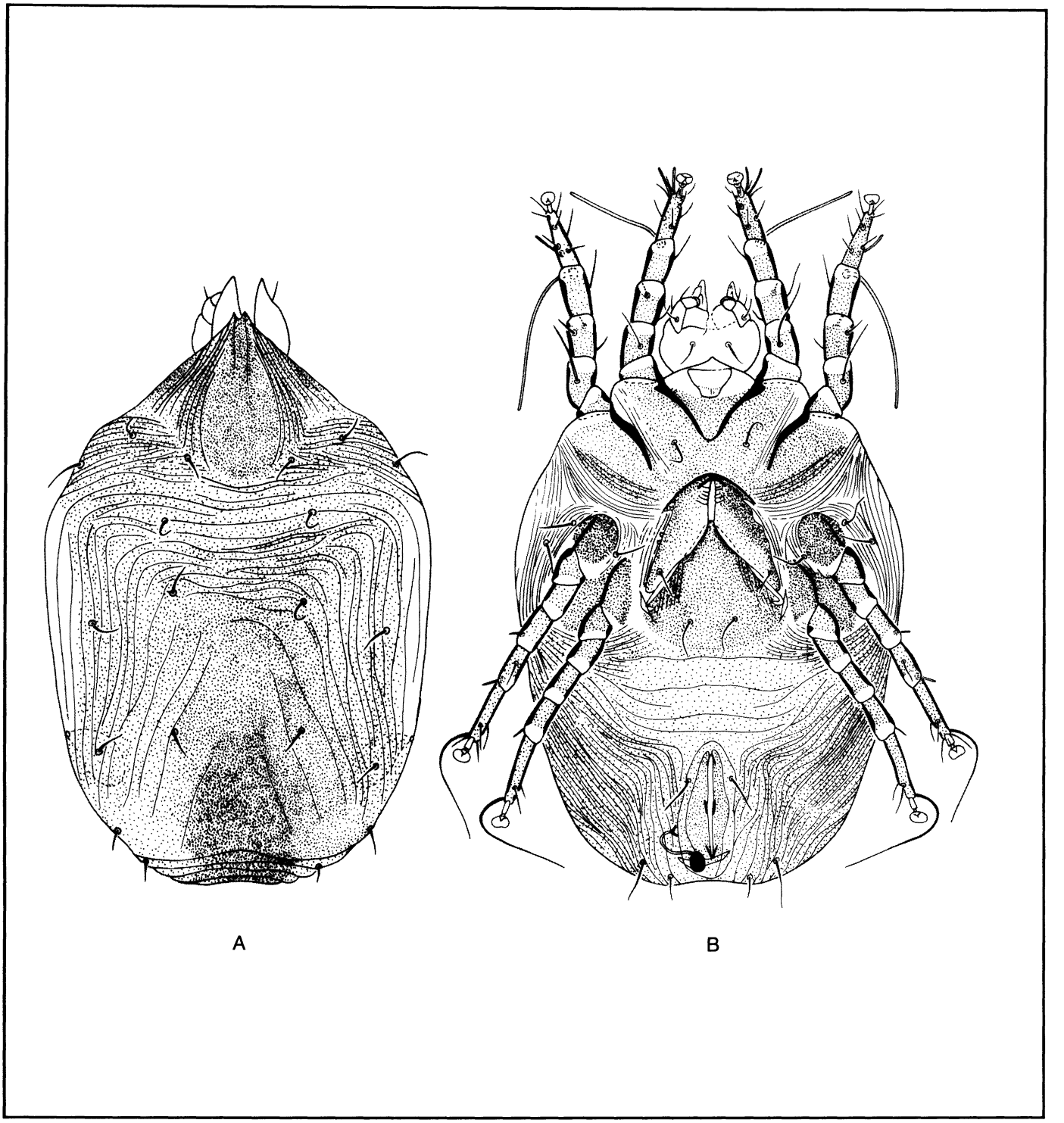


Plate 31. *Euroglyphus maynei* (Pyroglyphidae), female: A, dorsal view; B, ventral view. (See also pl. 30.) (Redrawn from *10* by C. Feller.)

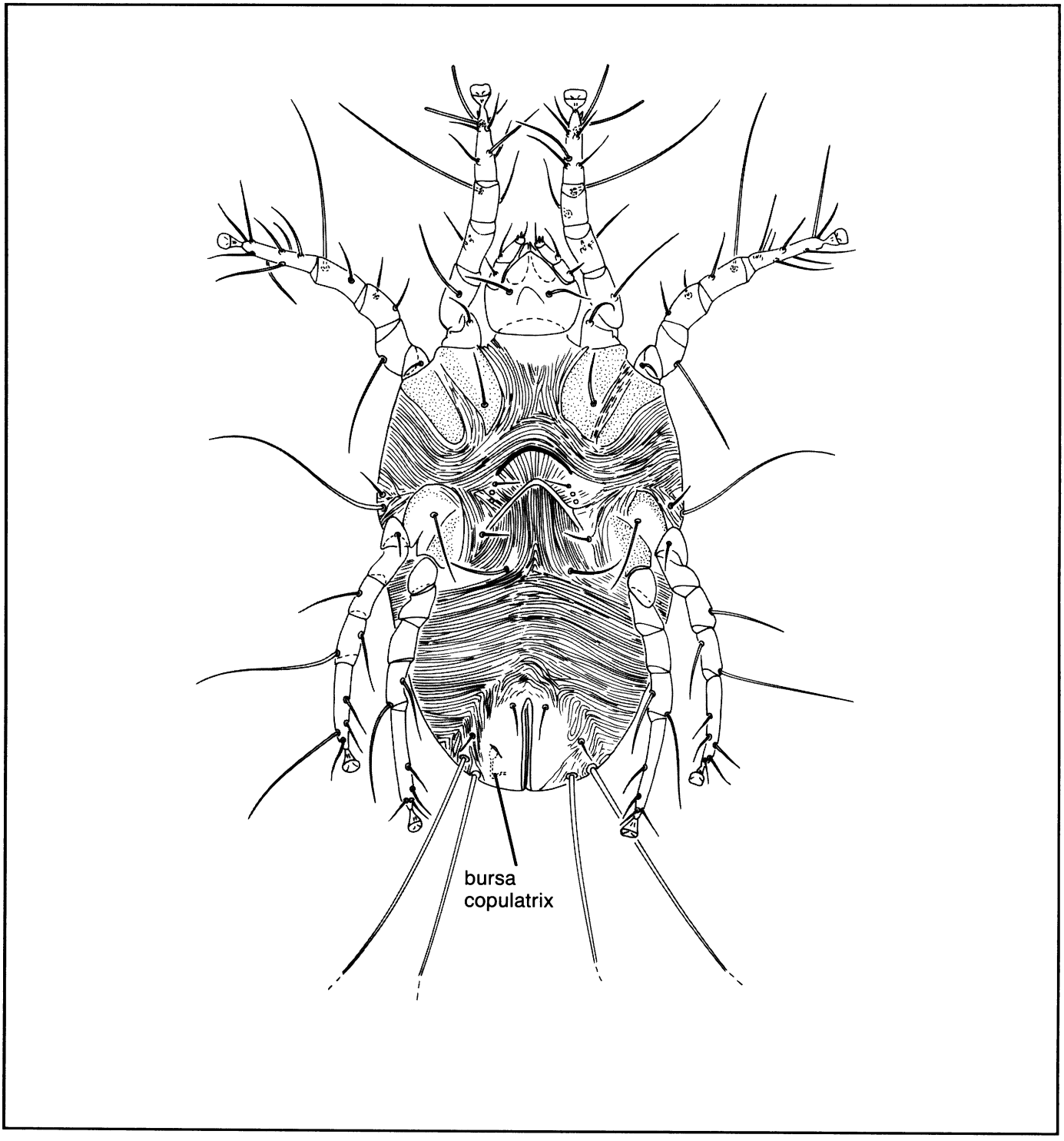


Plate 32. **American house dust mite,** *Dermatophagoides farinae* (Pyroglyphidae), ventral view of female.

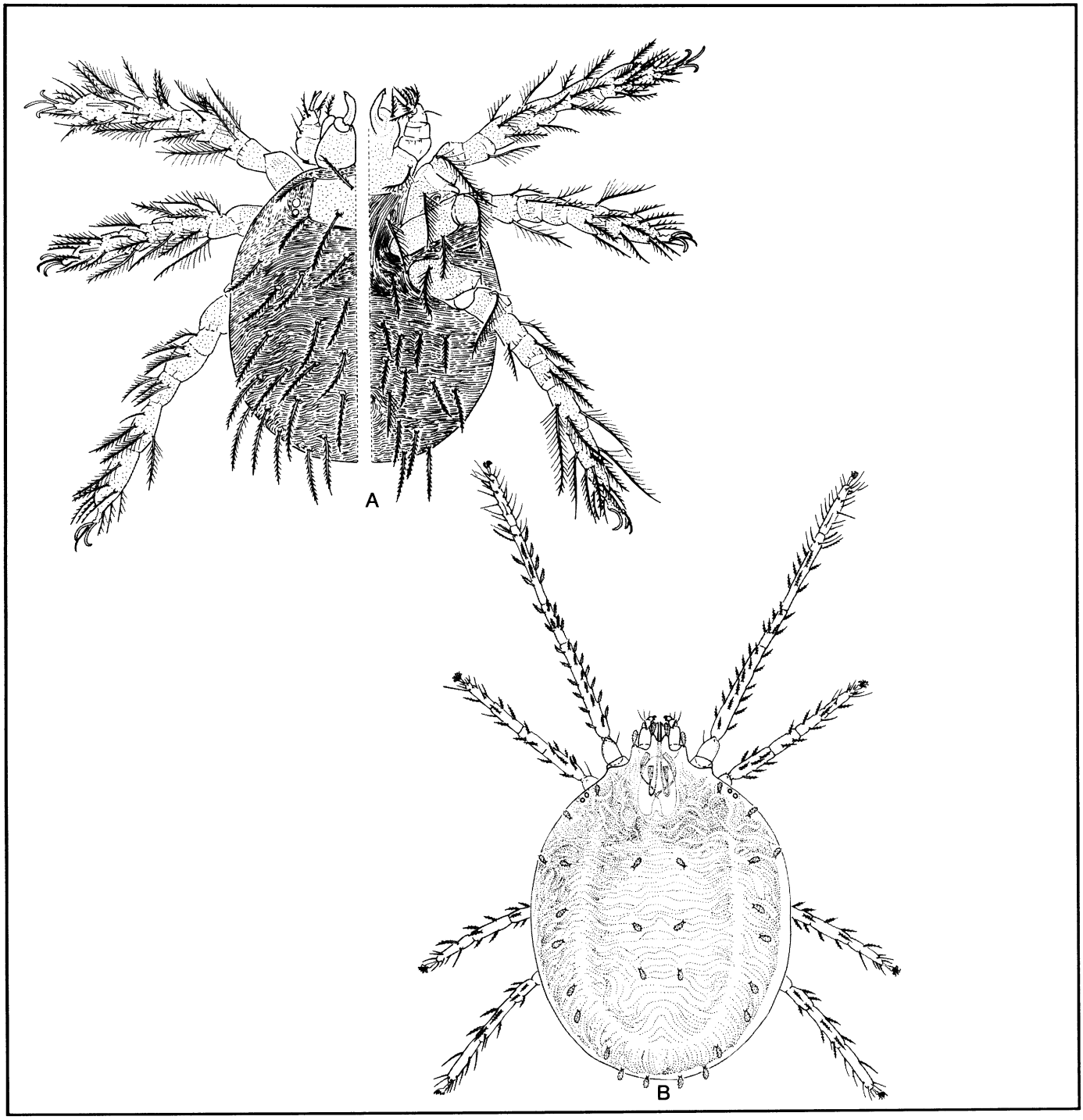


Plate 33. Prostigmatid mites (Prostigmata): A, *Leptotrombidium akamushi* (Trombiculidae), dorsal (left) and ventral (right) views of larva (chigger); B, **clover mite,** *Bryobia praetiosa* (Tetranychidae), dorsal view of female. (Figs. redrawn from *3* by C. Feller.)

Plate 34. *Cheletomorpha lepidopterorum* (Cheyletidae), dorsal view of female (integumental striations not shown). (See couplets 51–53 for illustrations of other cheyletids.)

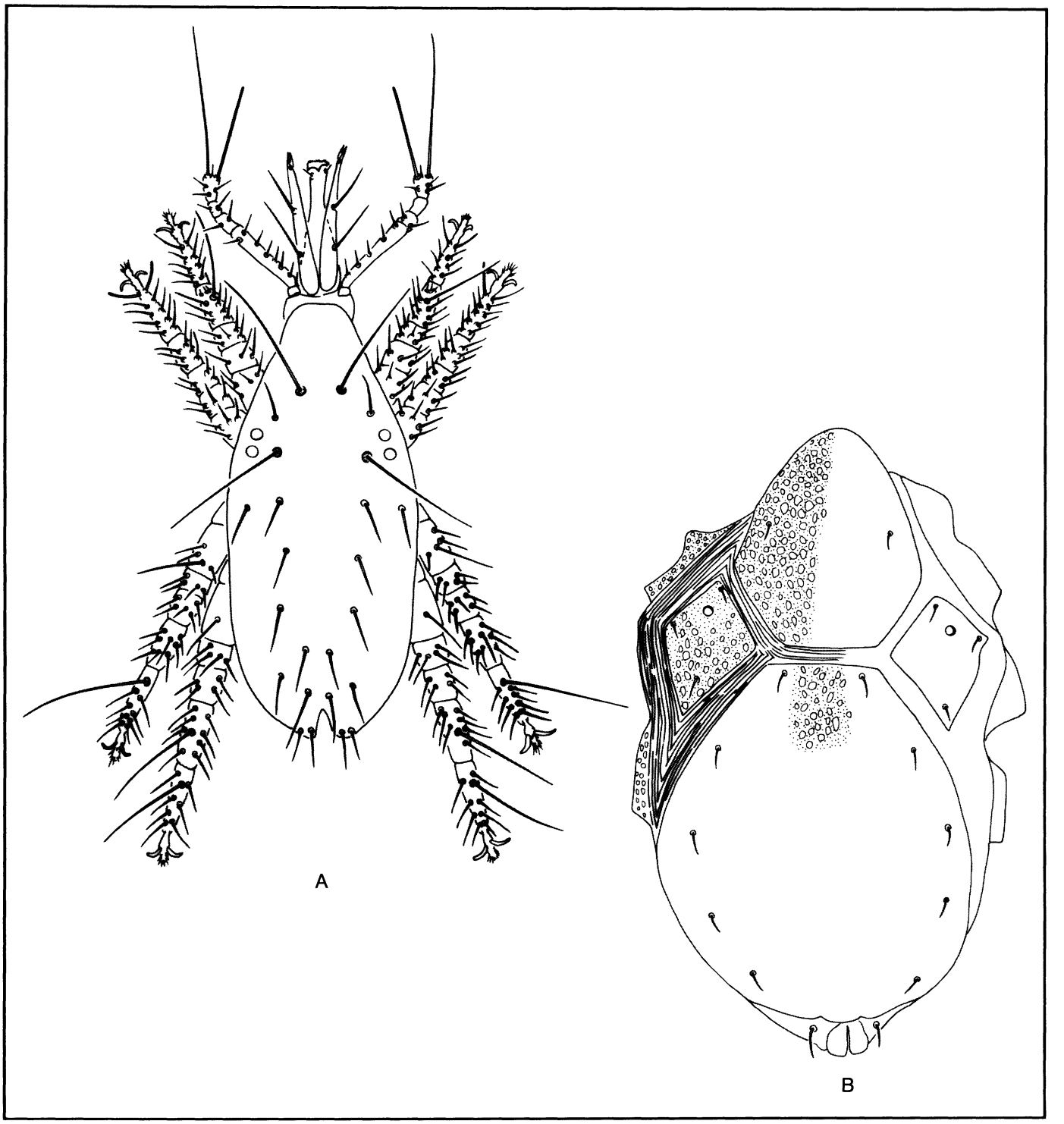


Plate 35. Prostigmatid mites (Prostigmata), dorsal views of females: A, *Spinibdella bifurcata* (Bdellidae); B, *Rhombognathides seahami* (Halacaridae).

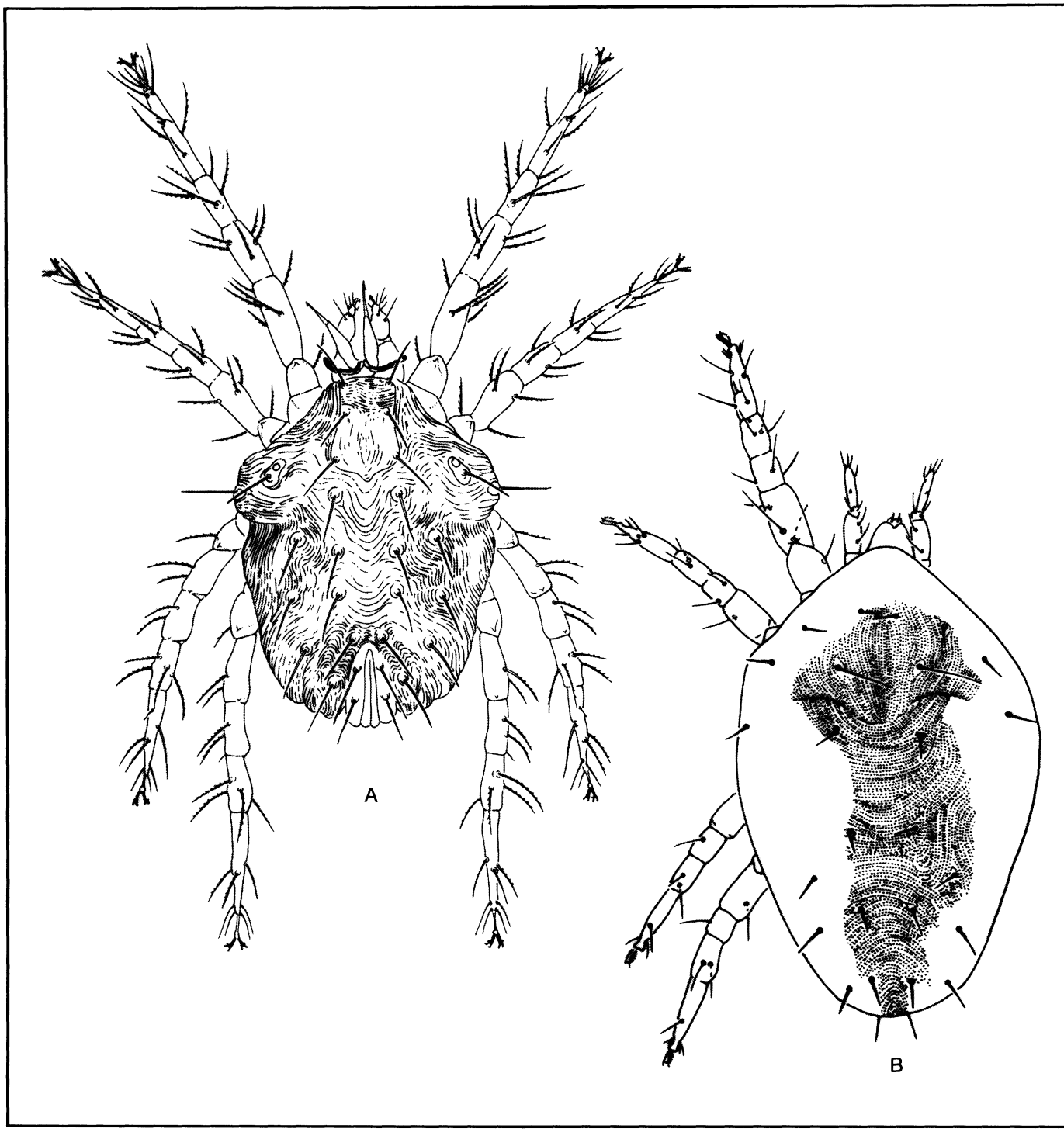


Plate 36. Prostigmatid mites (Prostigmata), females, dorsal views: A, cockroach mite, *Pimeliaphilus cunliffei* (Pterygosomatidae) (redrawn from *1* by C. Feller); B, *Tydeus* sp. (Tydeidae) (redrawn by C. Feller from original by E.W. Baker).

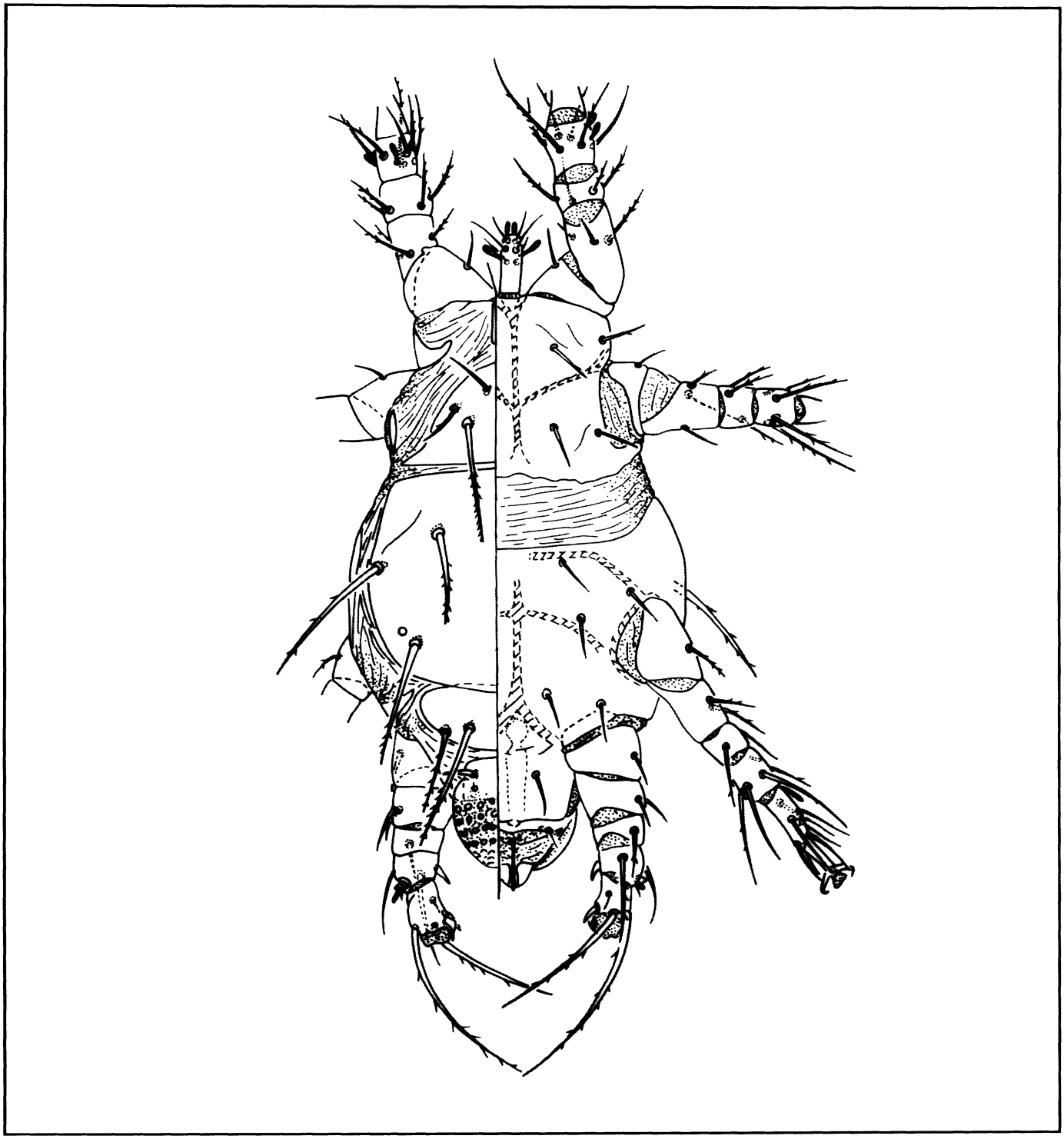


Plate 37. *Scutacarus baculitarsus agaricus* (Scutacaridae), male, dorsal (left) and ventral (right) views. (See also pl. 38.) (Redrawn from *22* by C. Feller.)

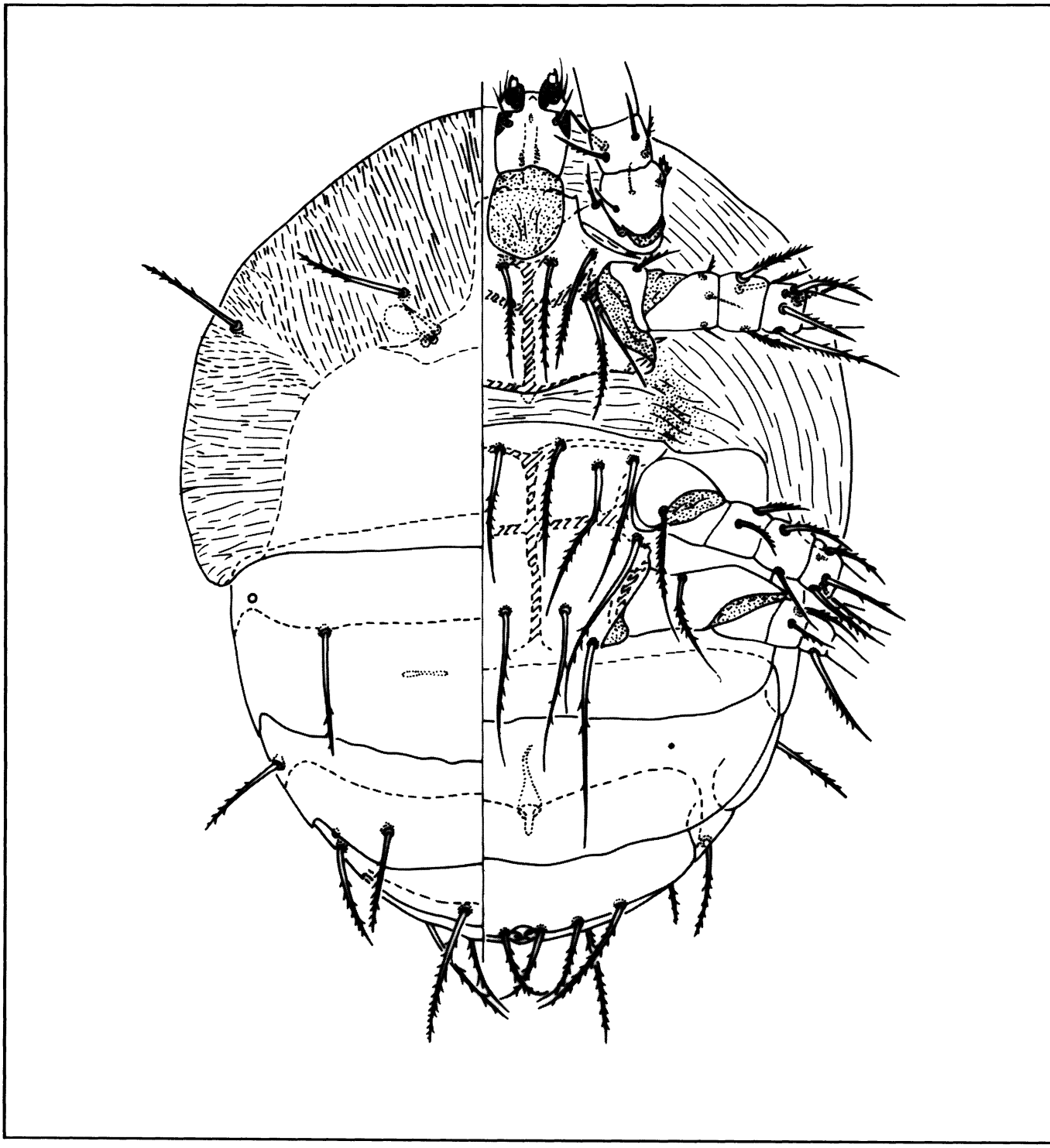


Plate 38. *Scutacarus baculitarsus agaricus* (Scutacaridae), female, dorsal (left) and ventral (right) views. (See also pl. 37.) (Redrawn from *22* by C. Feller).

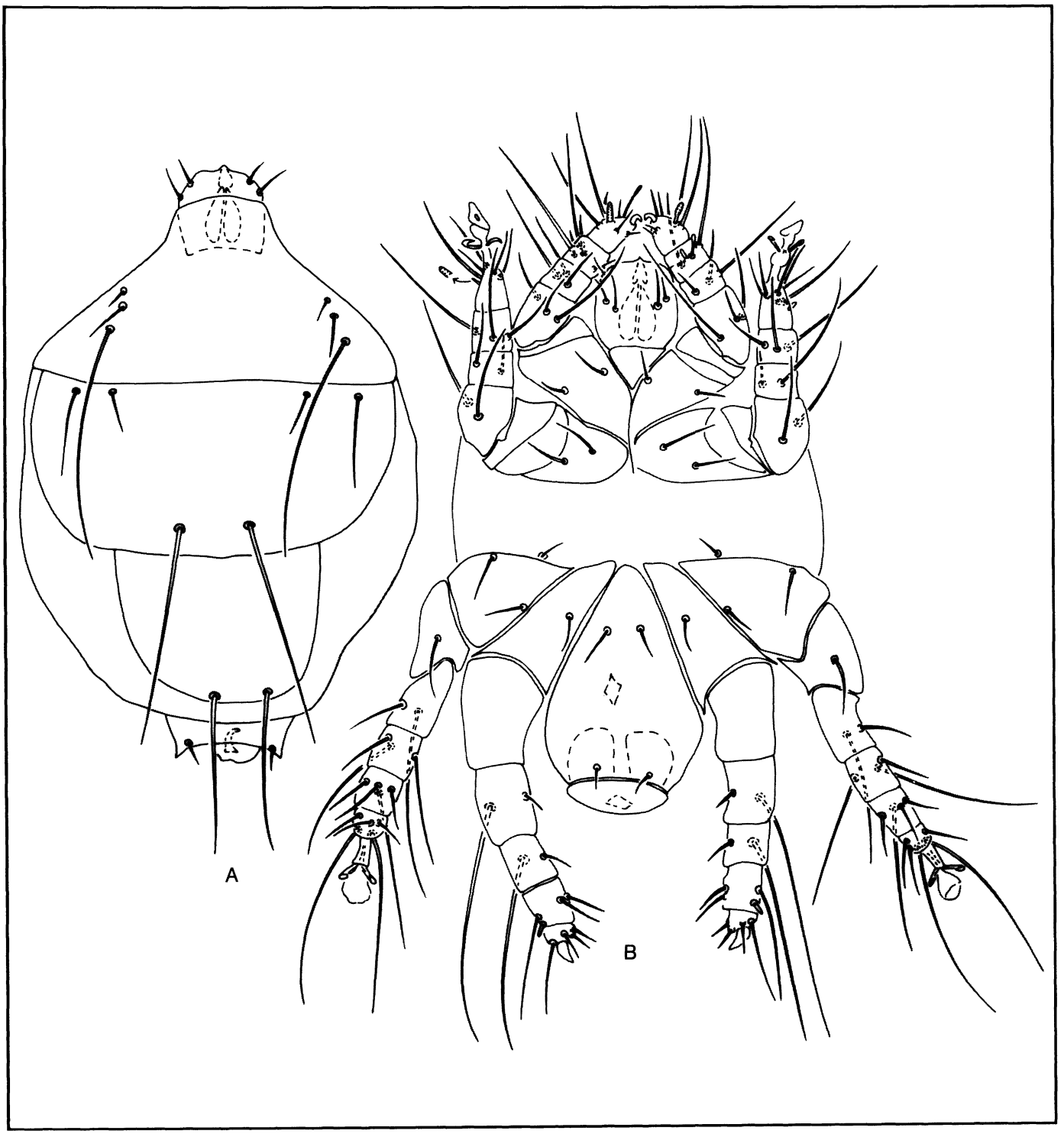


Plate 39. **Straw itch mite,** *Pyemotes tritici* (Pyemotidae), male: A, dorsal view; B, ventral view. (See also pl. 40.)

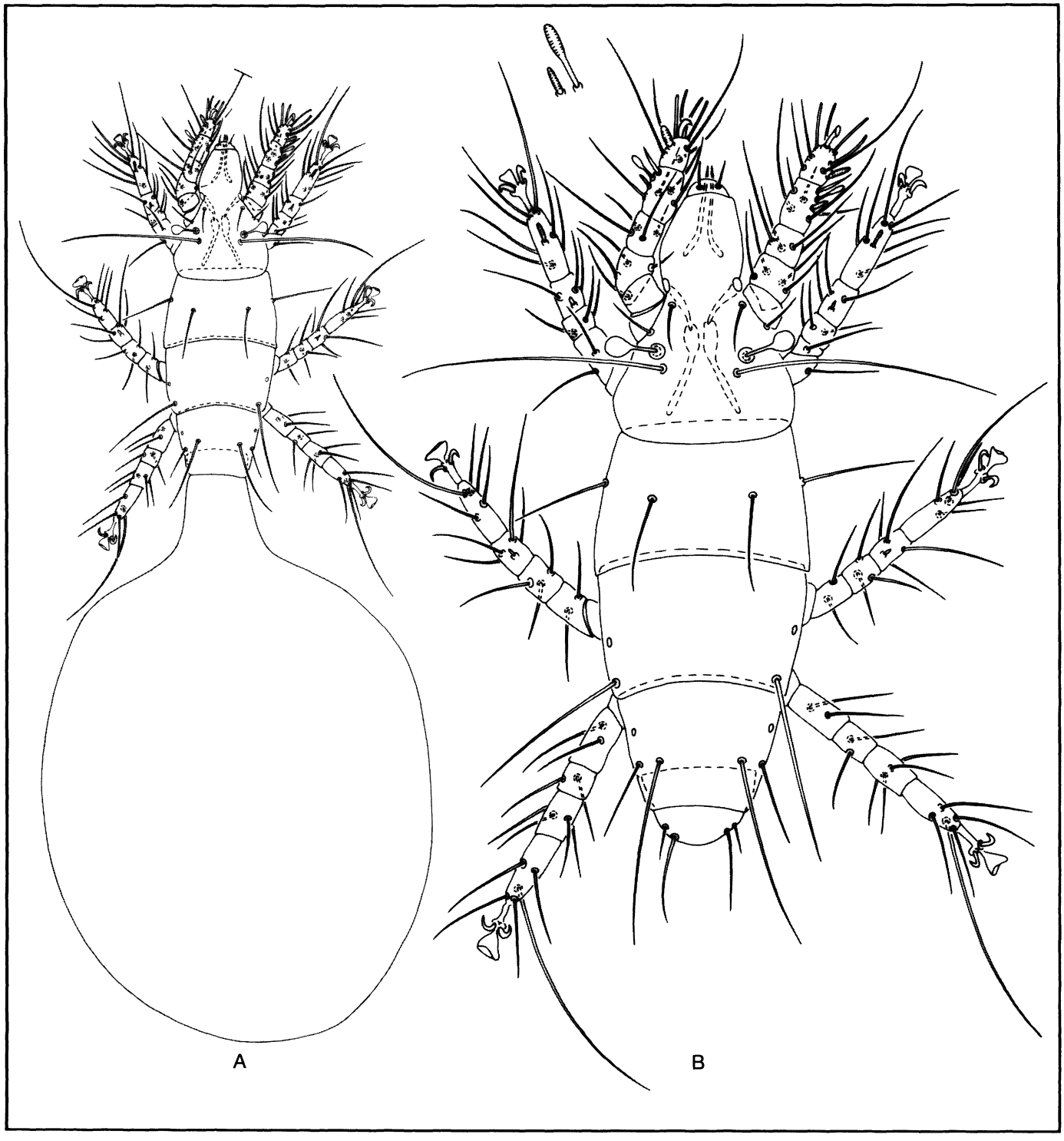


Plate 40. **Straw itch mite,** *Pyemotes tritici* (Pyemotidae), dorsal views of females: A, gravid; B, nongravid. (See also pl. 39.)

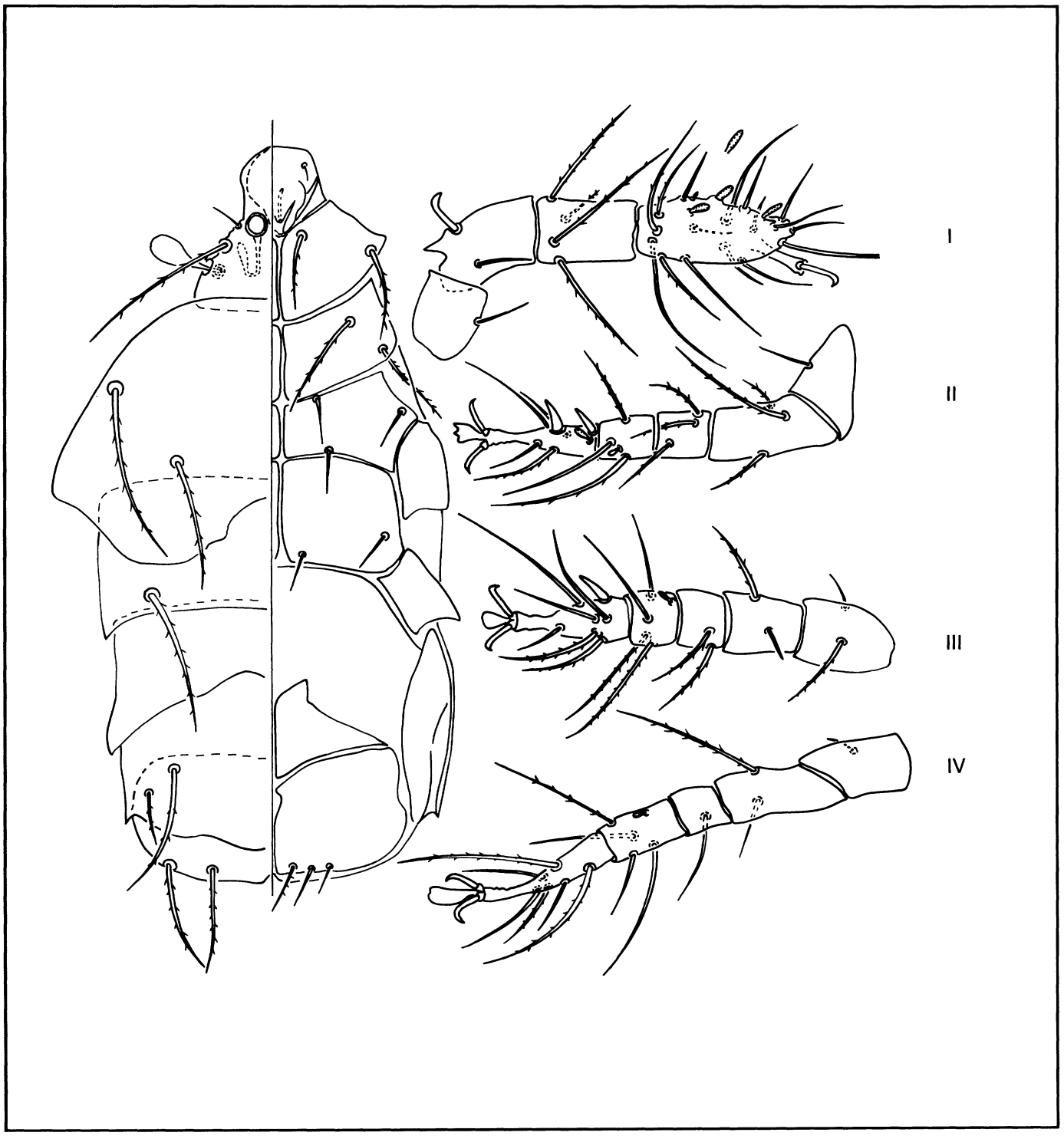


Plate 41. *Pygmephorus sellnicki* (Pygmephoridae), female, dorsal (left) and ventral (right) views; legs I-IV (redrawn from *25* by C. Feller).

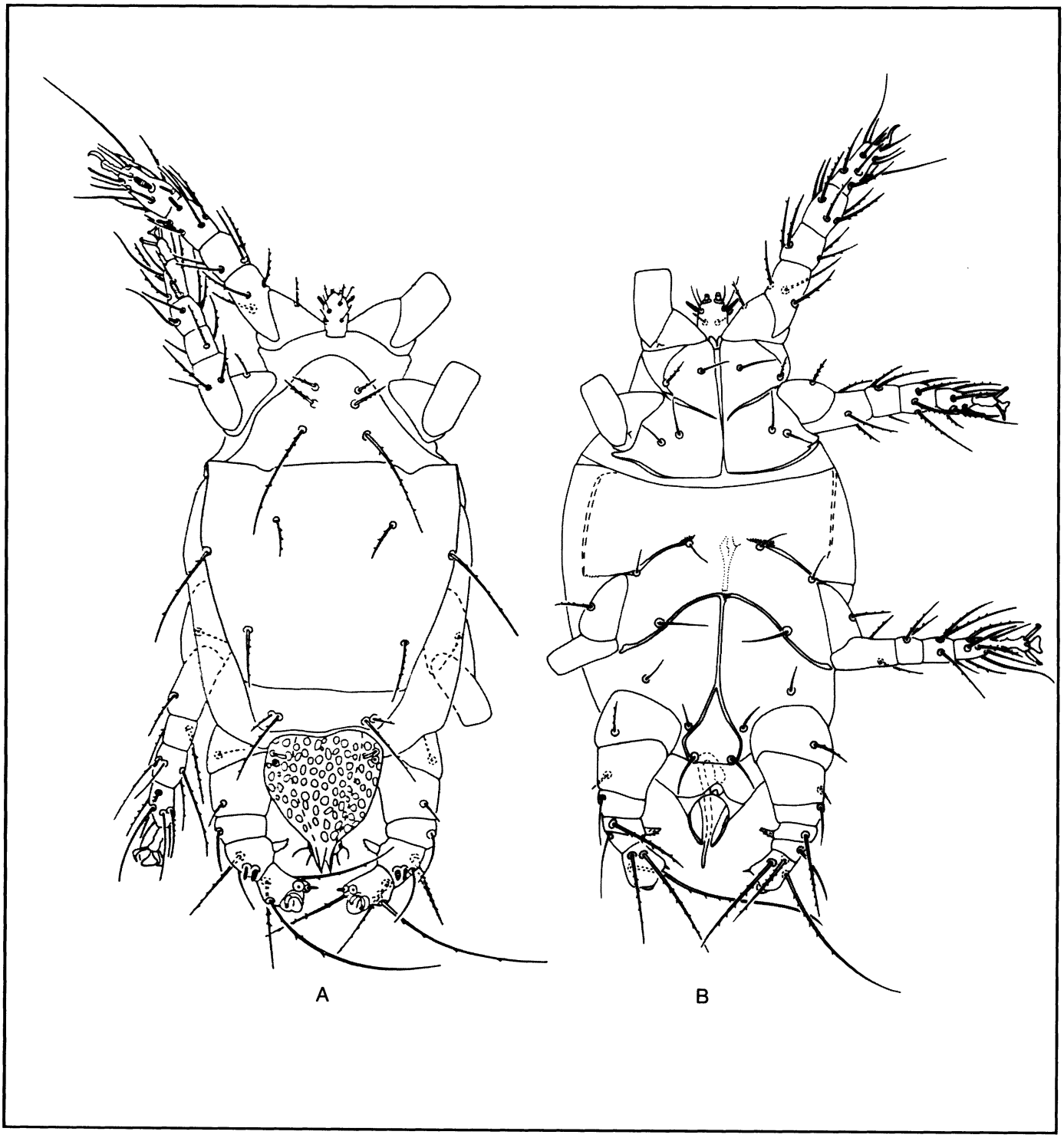


Plate 42. *Pseudopygmephorus smileyi* (Pygmephoridae), male: A, dorsal view; B, ventral view. (See also pl. 43.) (Redrawn from *17* by C. Feller.)

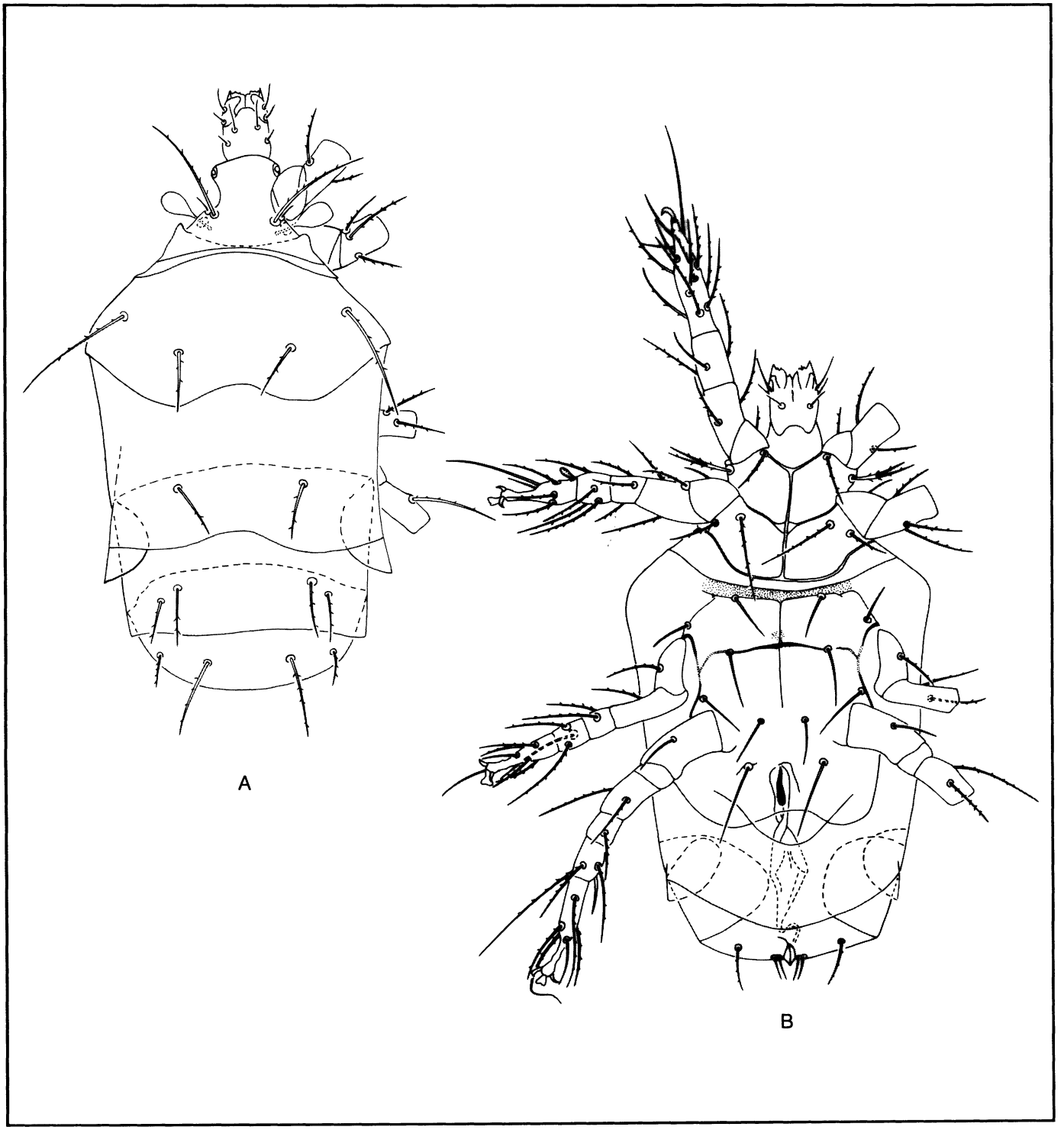


Plate 43. *Pseudopygmephorus smileyi* (Pygmephoridae), female: A, dorsal view; B, ventral view. (See also pl. 42.) (Redrawn from *17* by C. Feller.)

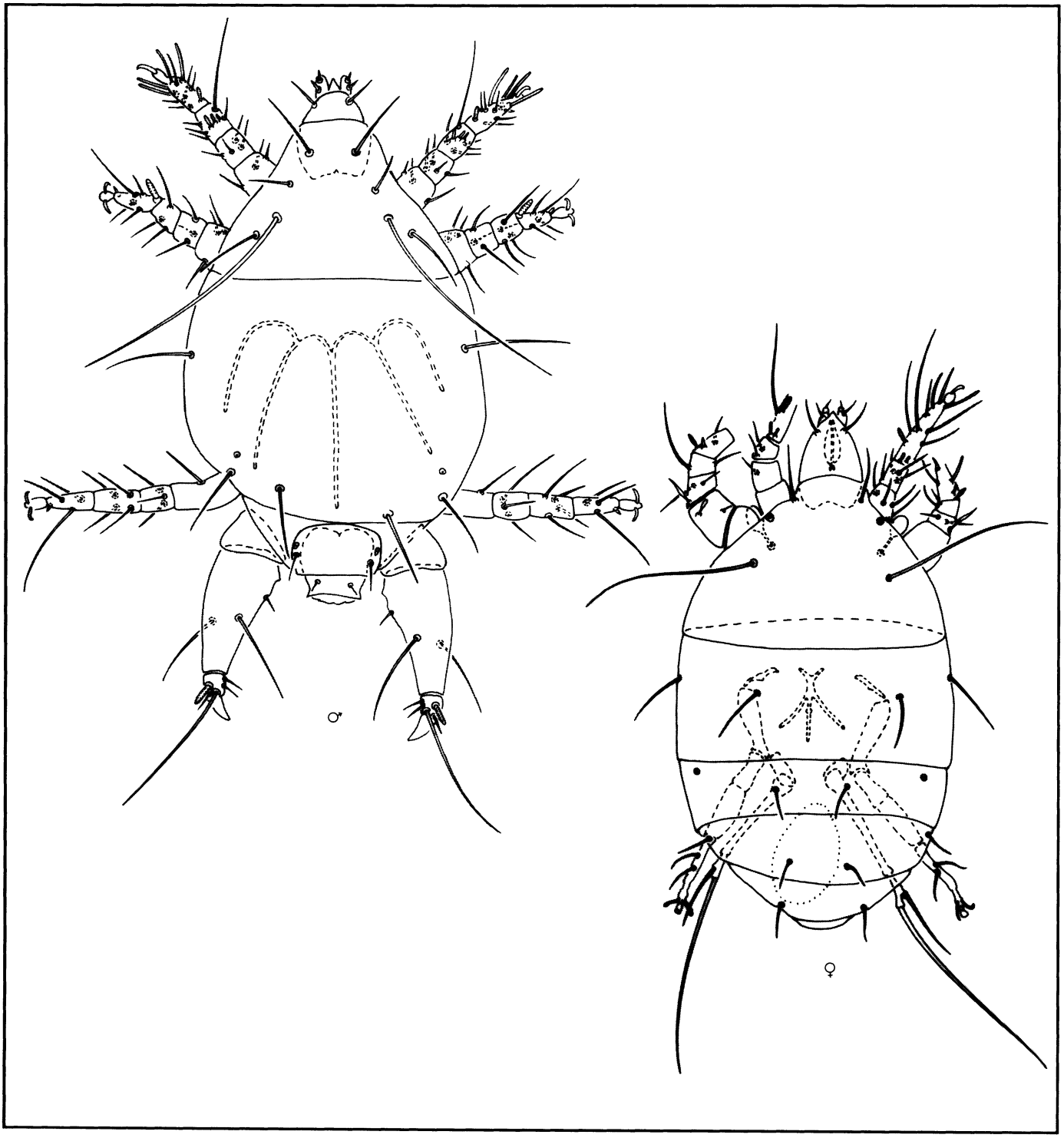


Plate 44. *Tarsonemus scaurus* (Tarsonemidae), dorsal views.

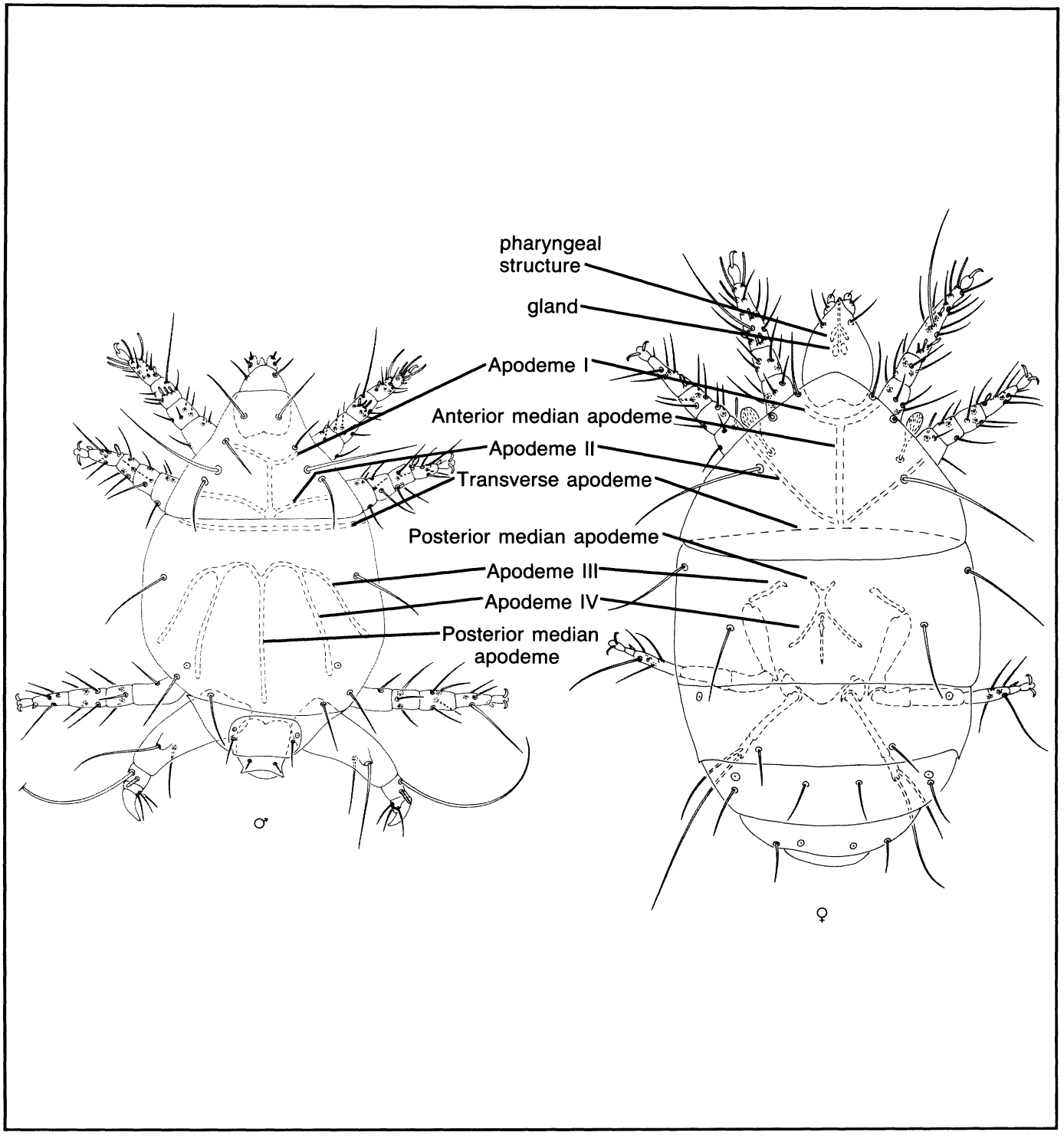


Plate 45. *Tarsonemus granarius* (Tarsonemidae), dorsal views.

COCKROACHES (BLATTARIA)

These illustrations, drawn by A.D. Cushman unless otherwise indicated, are a continuation from part 1, chapter 2 (Cockroaches), by A.B. Gurney and F.W. Fisk.

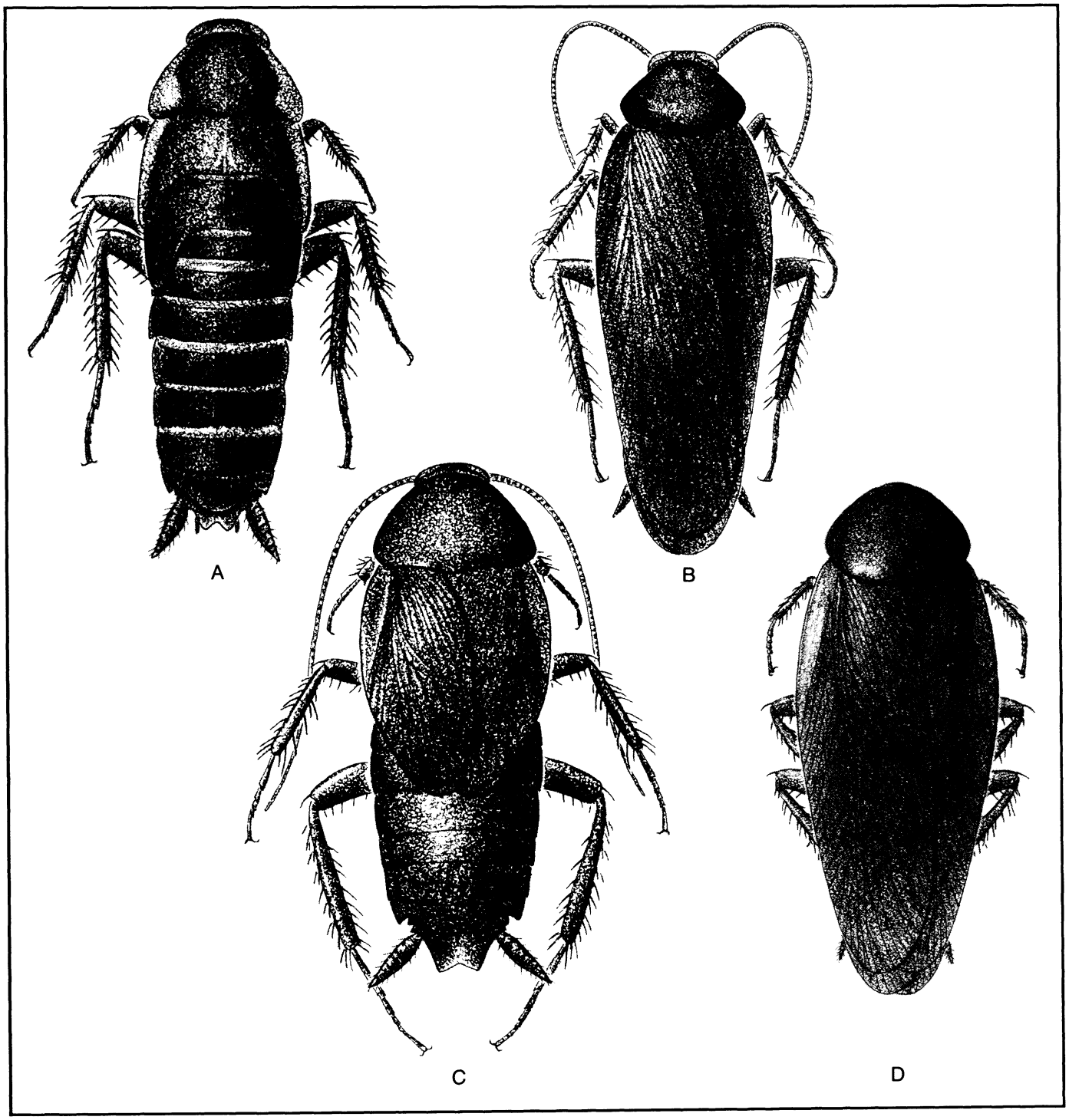


Plate 46. Blattid cockroaches (Blattidae), dorsal views (drawings by C. Feller): A, *Periplaneta japonica,* nymph; B, same, male (31-35); C, same, female (31-35); D, **smokybrown cockroach,** *Periplaneta fuliginosa* (31-35).

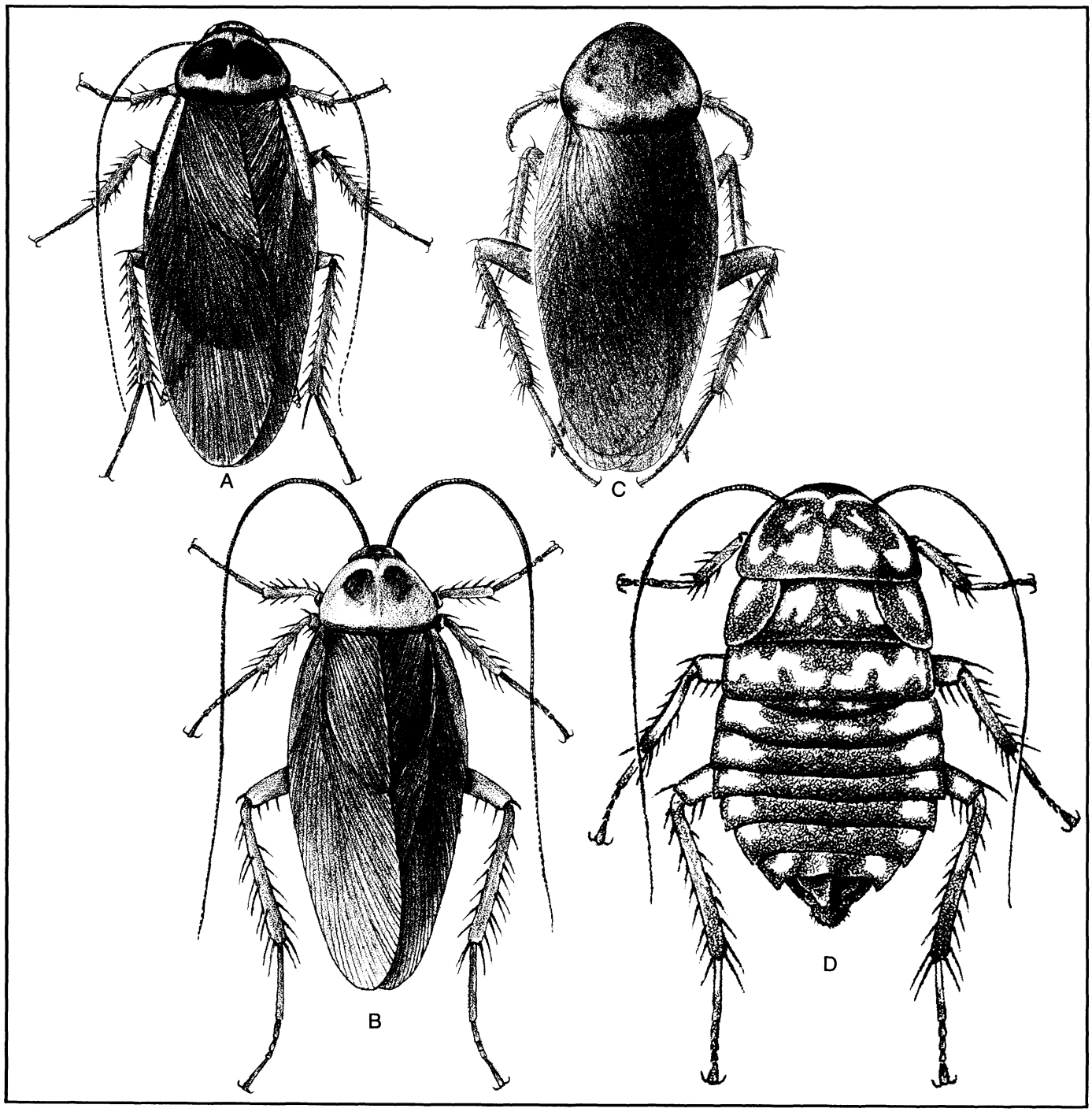


Plate 47. Blattid cockroaches (Blattidae), dorsal views: A, **Australian cockroach,** *Periplaneta australasiae* (27-33); B, **American cockroach,** *Periplaneta americana* (35-40); C, **brown cockroach,** *Periplaneta brunnea* (31-37) (drawing by C. Feller); D, **harlequin cockroach,** *Neostylopyga rhombifolia,* female (20-25).

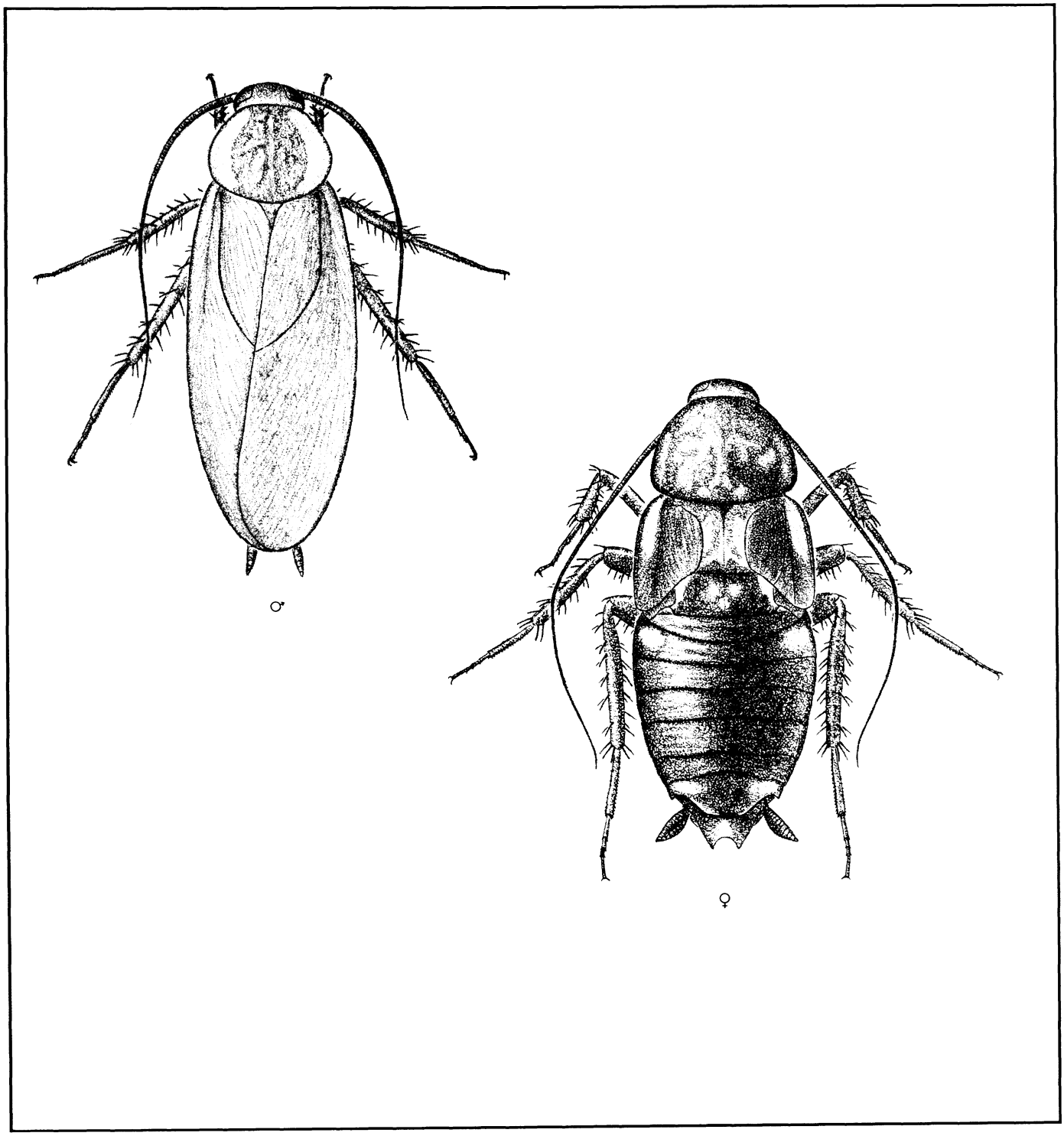


Plate 48. **Turkestan cockroach,** *Blatta lateralis* (Blattidae), dorsal views (male, 19-23; female, 22-25) (drawings by C. Feller).

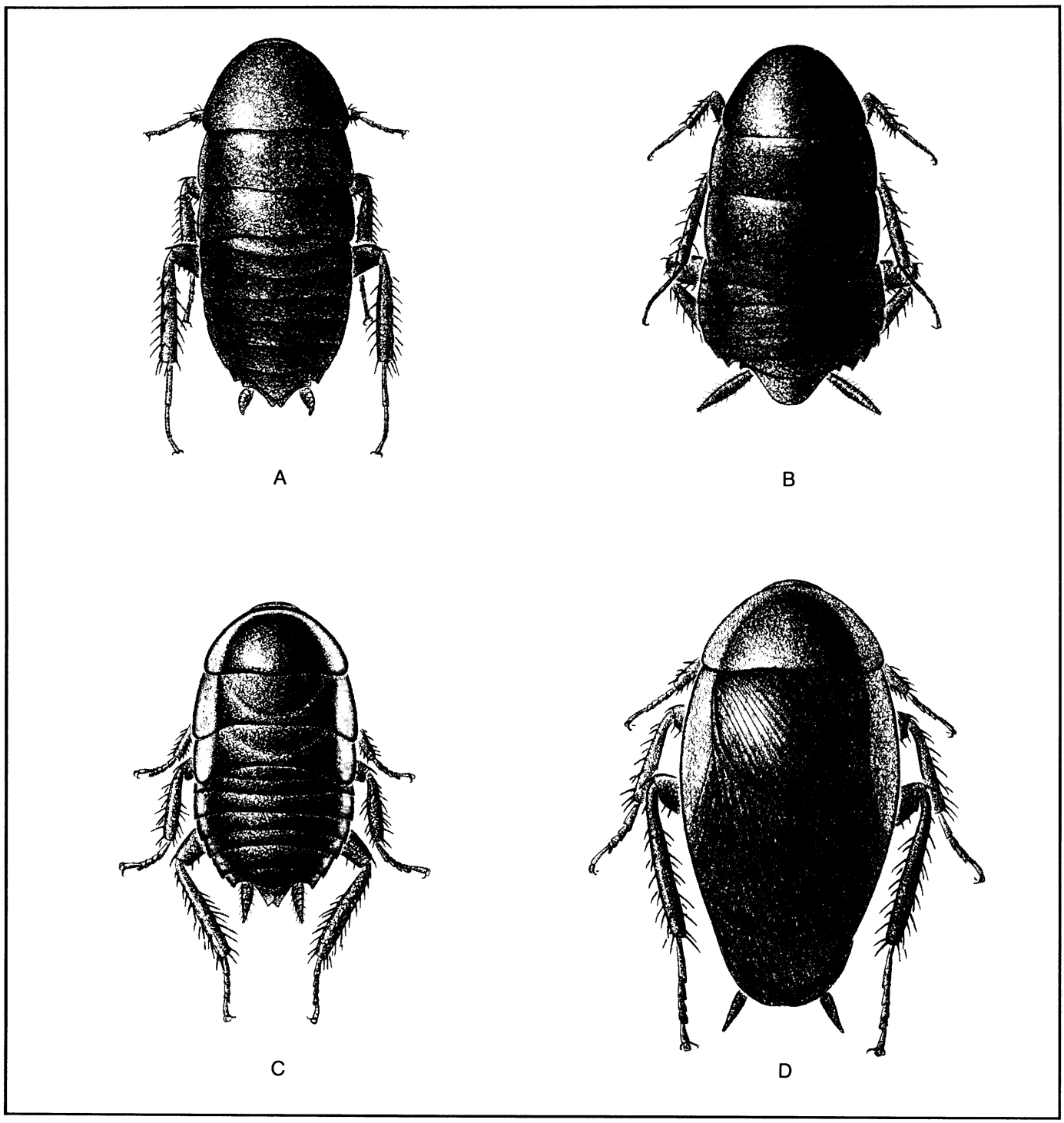


Plate 49. Blattid cockroaches (Blattidae), dorsal views (drawings by C. Feller): A, *Lamproblatta* sp., nymph; B, same, female (16-19); C, *Methana marginalis,* nymph; D, same, adult (28.2).

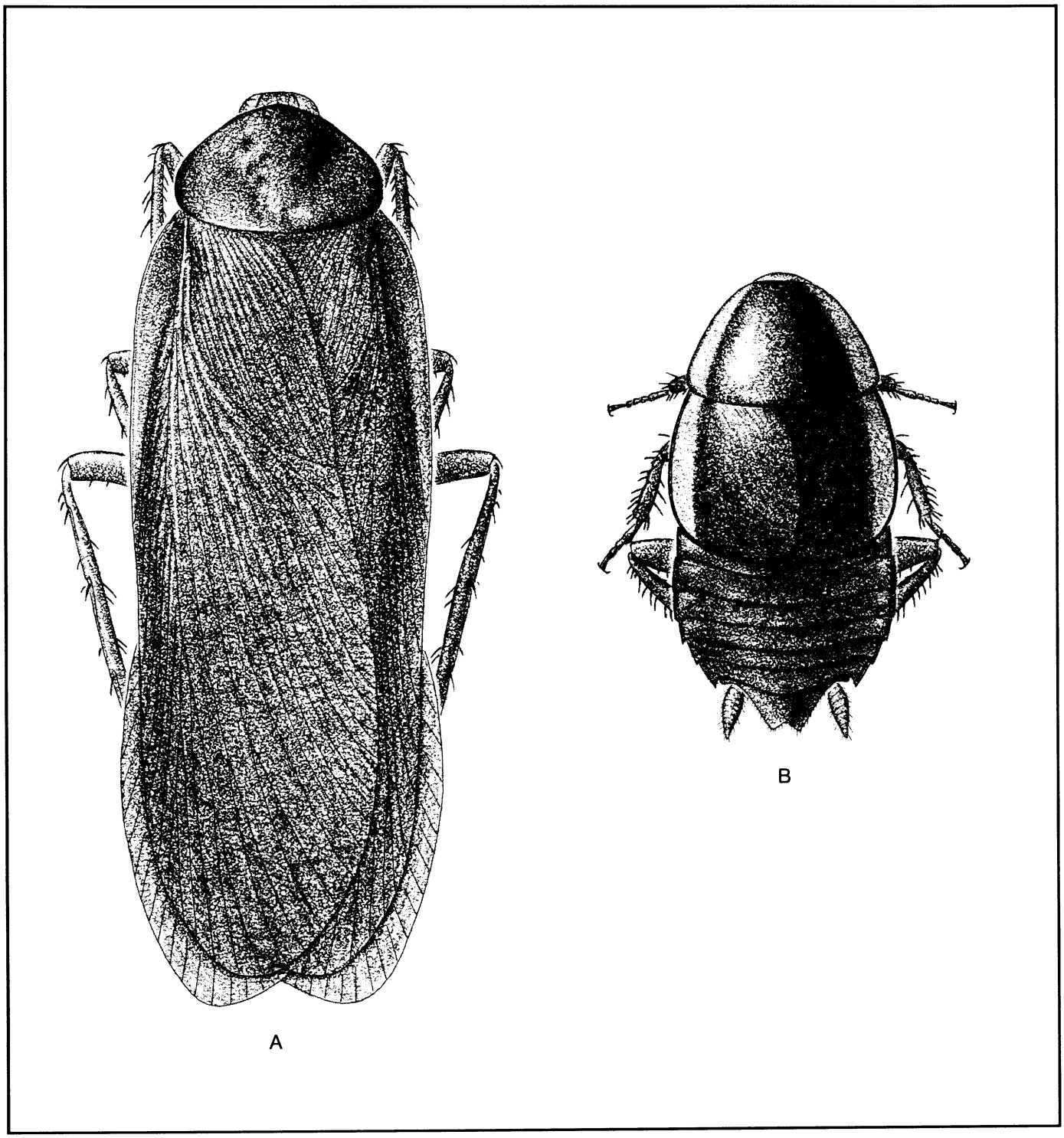


Plate 50. Blattid cockroaches (Blattidae), dorsal views (drawings by C. Feller): A, *Deropeltis erythrocephala,* male (36-40); B, *Pelmatosilpha* sp., female (17-21).

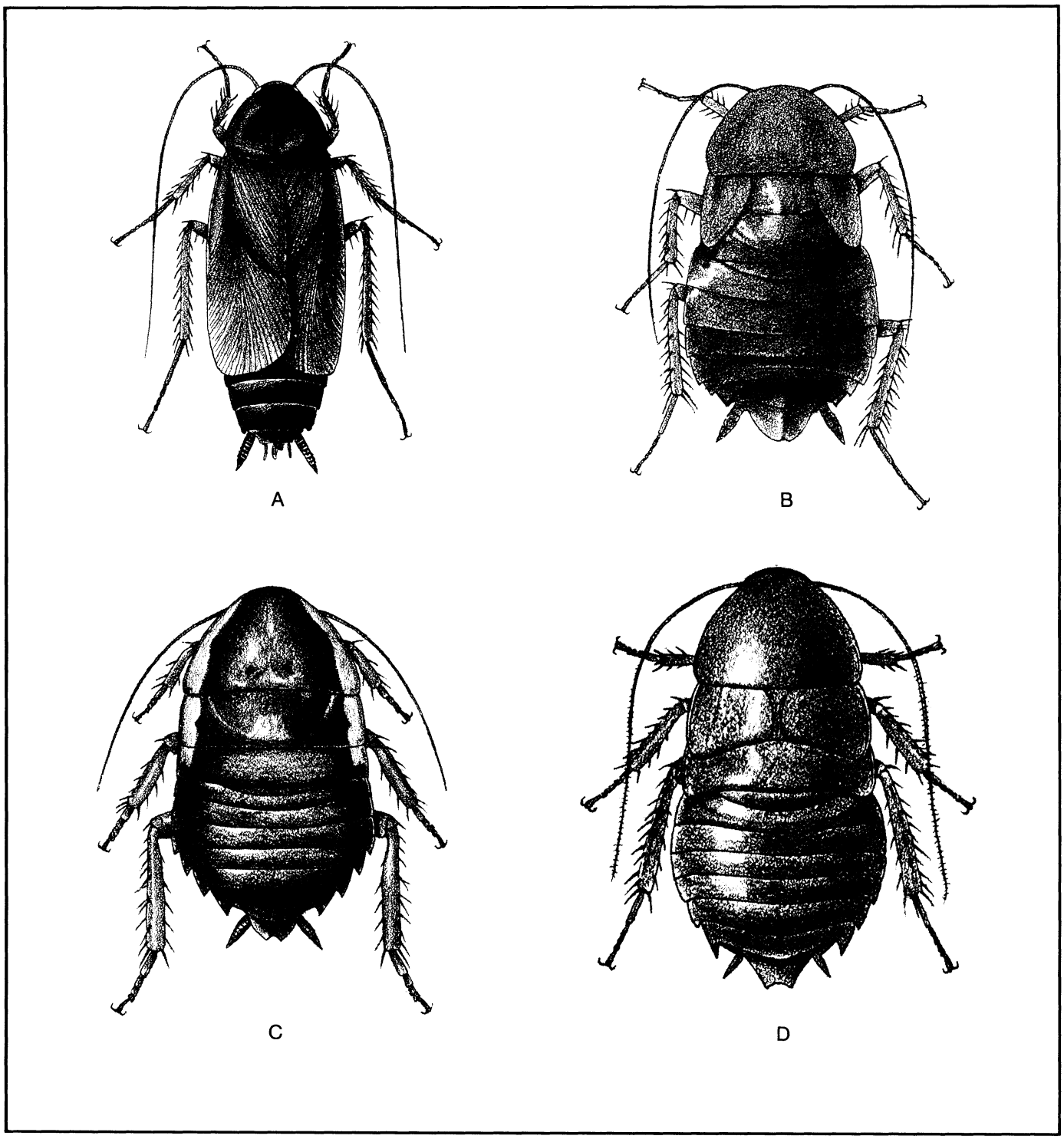


Plate 51. Blattid cockroaches (Blattidae), dorsal views: A, **oriental cockroach,** *Blatta orientalis,* male (20-27); B, same, female (20-27); C, Florida stinkroach, *Eurycotis floridana,* nymph; D, same, adult (30-40).

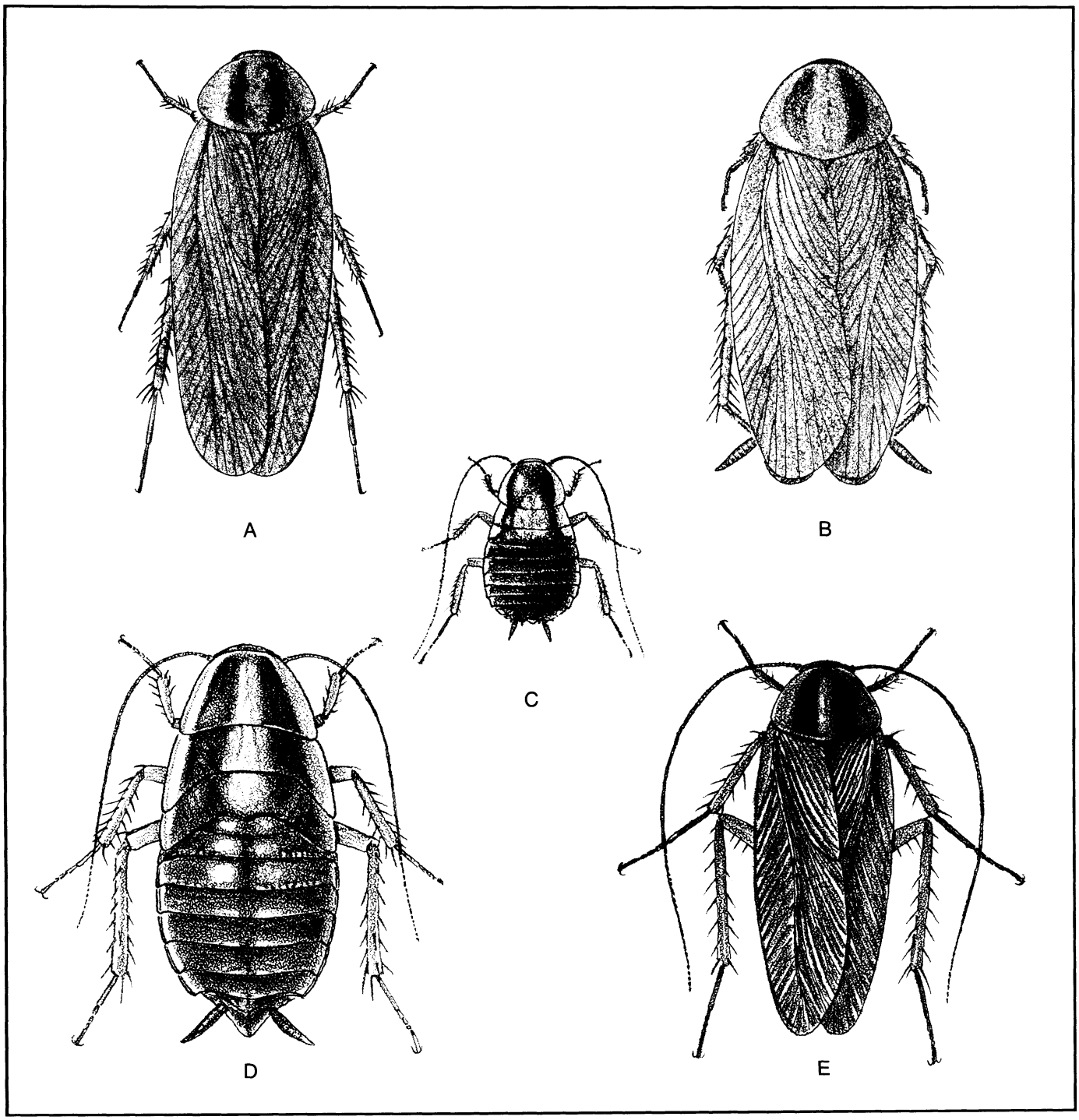


Plate 52. Blattellid cockroaches (Blattellidae), dorsal views: A, **false German cockroach,** *Blattella lituricollis* (11-12); B, field cockroach, *Blattella vaga* (10-15) (drawings A&B by C. Feller); C, **German cockroach,** *Blattella germanica,* nymph; D, same, nymph; E, same, adult (10-15).

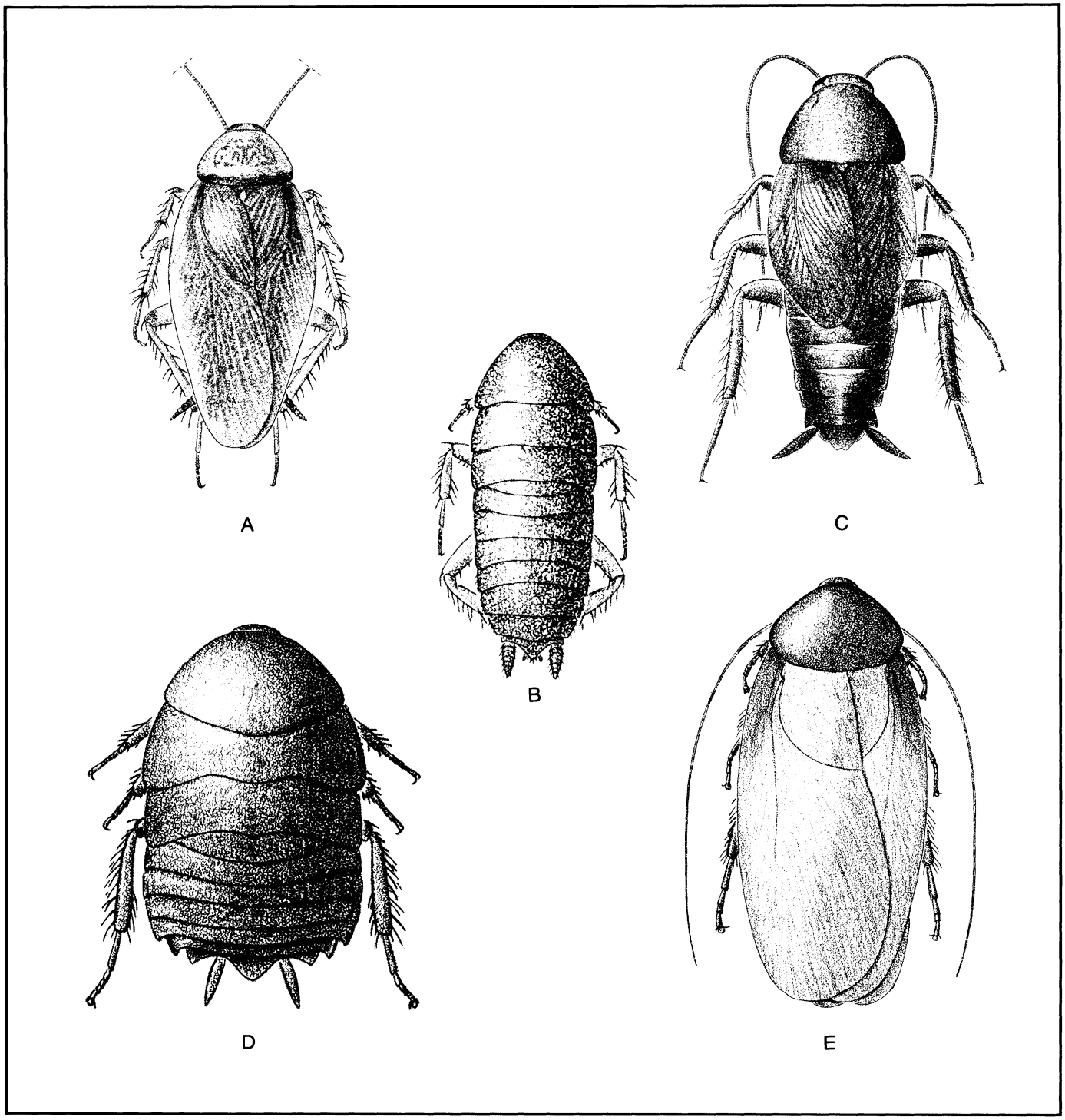


Plate 53. Blattellid cockroaches (Blattellidae), dorsal views (drawings by C. Feller): A, *Lupparia* sp. (10-12); B, *Shawella couloniana,* nymph; C, same, adult (15-22); D, banana cockroach, *Nyctibora noctivaga,* nymph; E, same, adult (33-35).

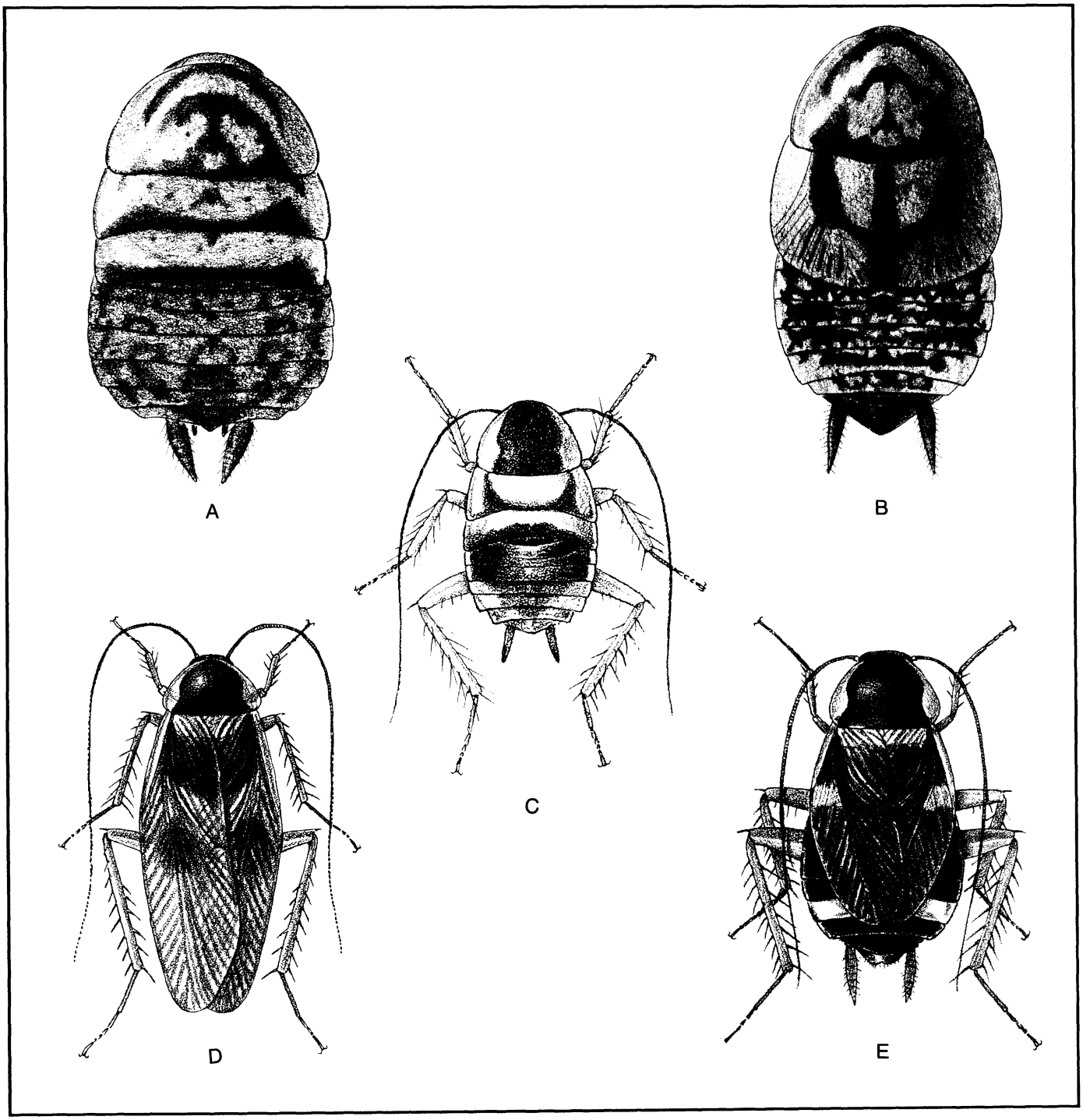


Plate 54. Blattellid cockroaches (Blattellidae), dorsal views: A, little gem cockroach, *Aglaopteryx gemma,* nymph; B, same, adult (7.5-9.3) (drawings A&B by C. Feller); C, **brownbanded cockroach,** *Supella longipalpa,* nymph; D, same, male (10-14); E, same, female (10-14).

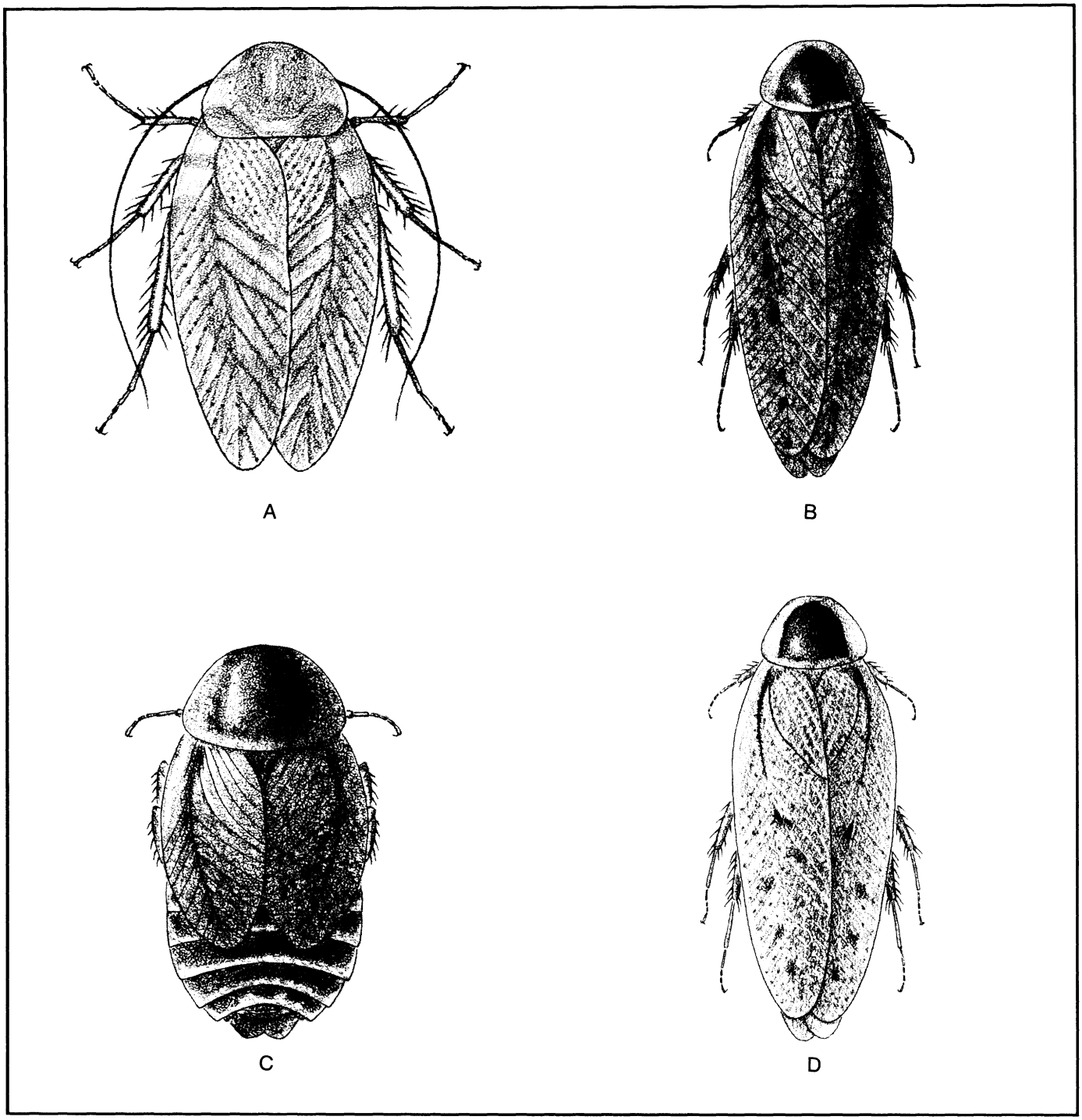


Plate 55. Blattellid cockroaches (Blattellidae), dorsal views: A, **spotted Mediterranean cockroach,** *Ectobius pallidus* (8-9.3); B, dusky cockroach, *Ectobius lapponicus,* male (9.5-11.3); C, same, female (6.8-7.9); D, forest cockroach, *Ectobius sylvestris,* male (7.8-8.5). (Drawings B-D by C. Feller.)

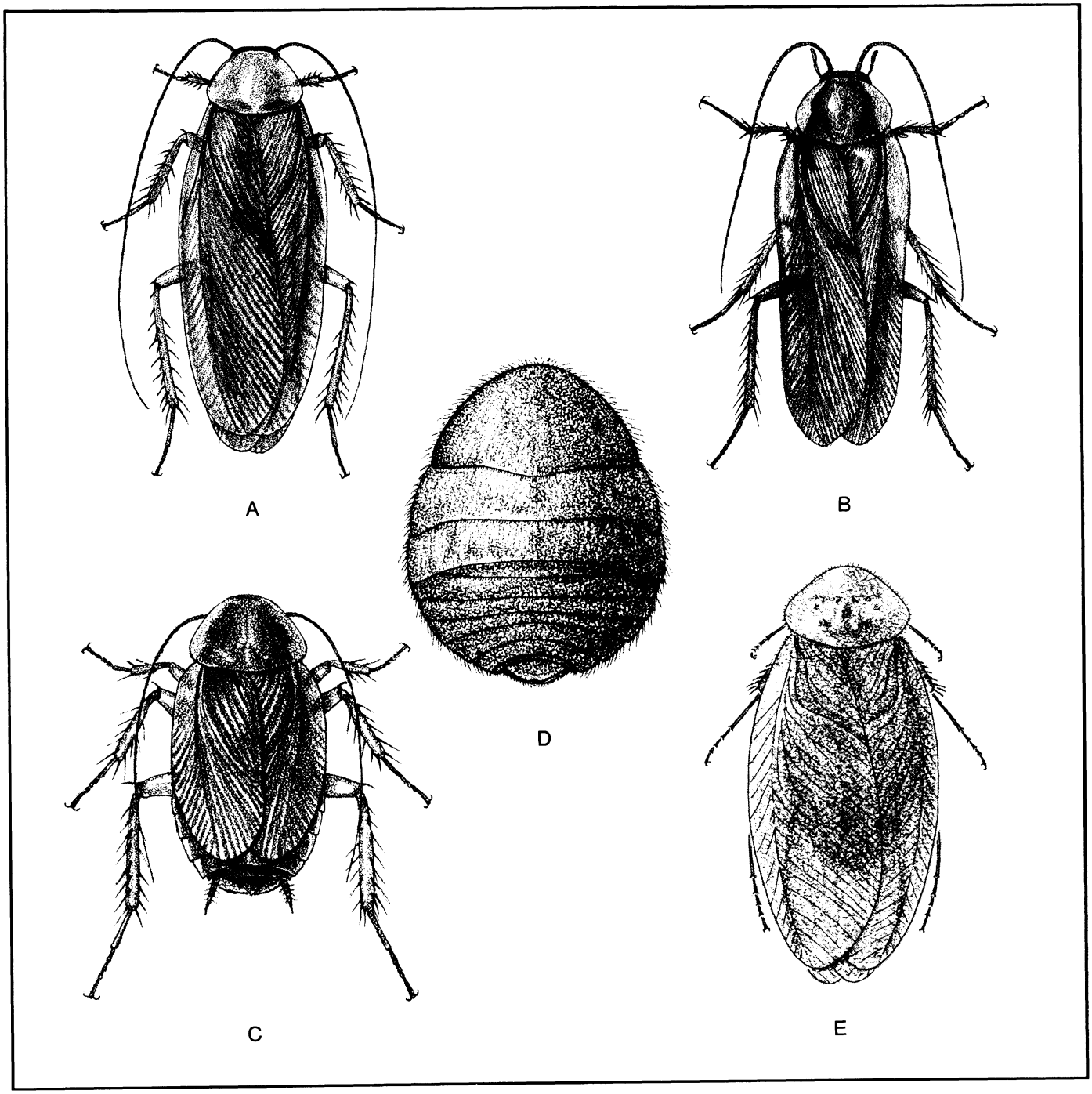


Plate 56. Blattellid and polyphagid cockroaches, dorsal views, A-C, wood cockroaches (Blattellidae): A, Virginia woodroach, *Parcoblatta virginica,* male (11.5-14.2); B, Pennsylvania woodroach, *Parcoblatta pennsylvanica,* male (22-30); C, same, female (13-20); D, sand cockroach, *Arenivaga* sp. (Polyphagidae), nymph; E, same, male (10.5-23.8) (drawings D&E by C. Feller).

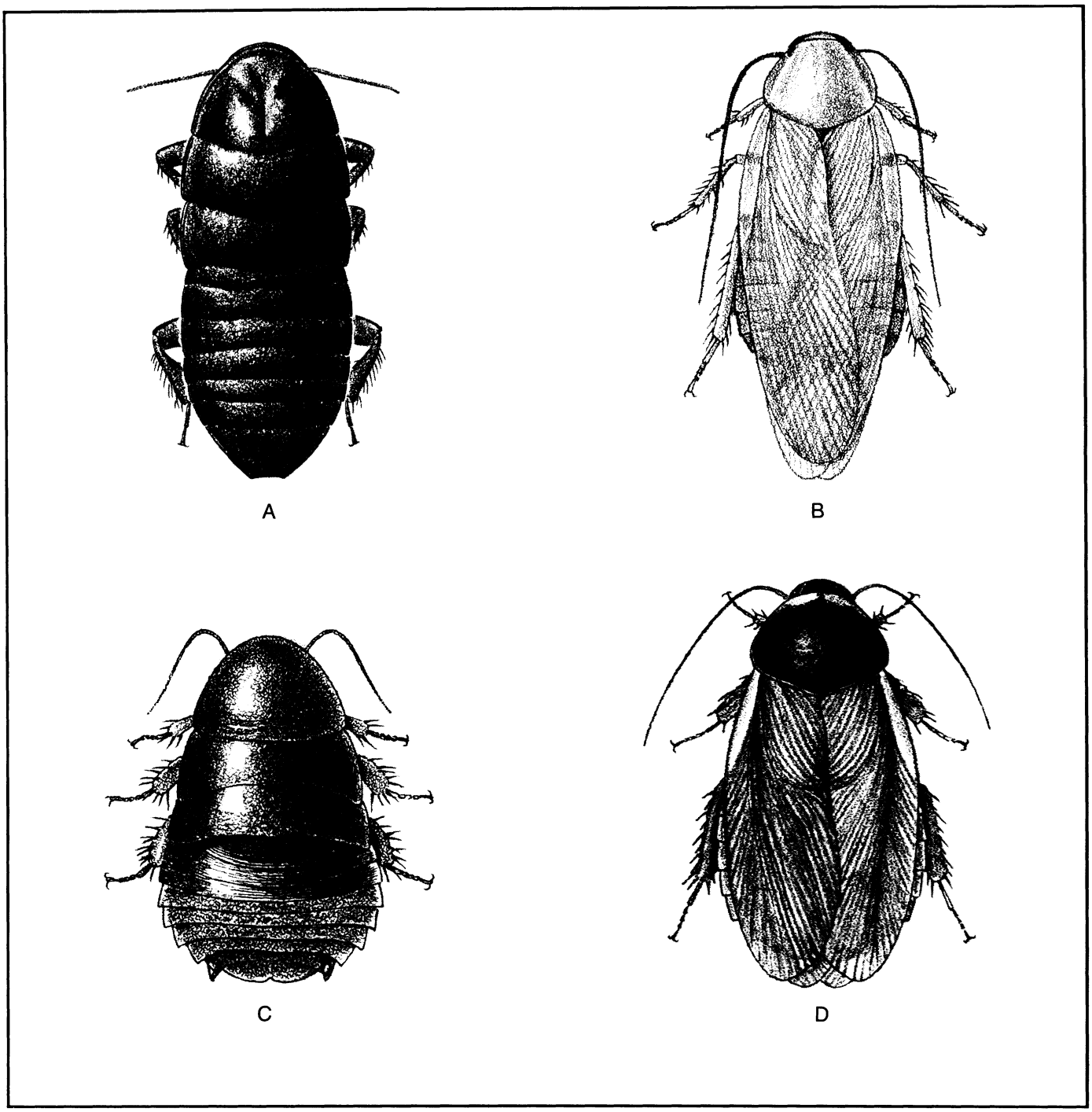


Plate 57. Cryptocercid and blaberid cockroaches, dorsal views: A, brownhooded cockroach, *Cryptocercus punctulatus* (23-29) (Cryptocercidae) (drawing by C. Feller); B-D, Blaberidae; B, **Cuban cockroach,** *Panchlora nivea* (15-20); C, **Surinam cockroach,** *Pycnoscelus surinamensis,* nymph; D, same, female (18-24).

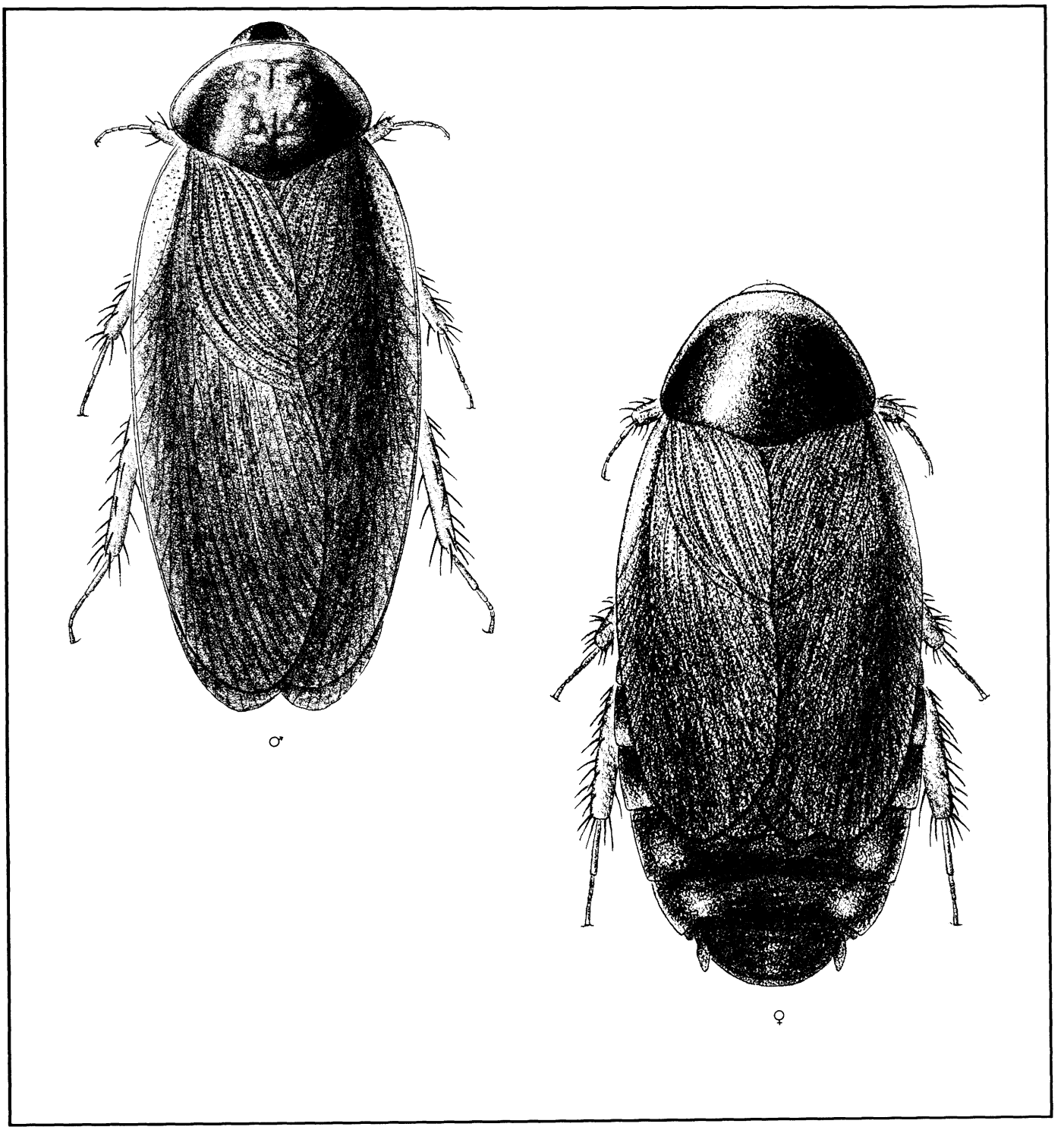


Plate 58. Indian cockroach, *Pycnoscelus indicus* (17-18) (Blaberidae), dorsal views (drawings by C. Feller).

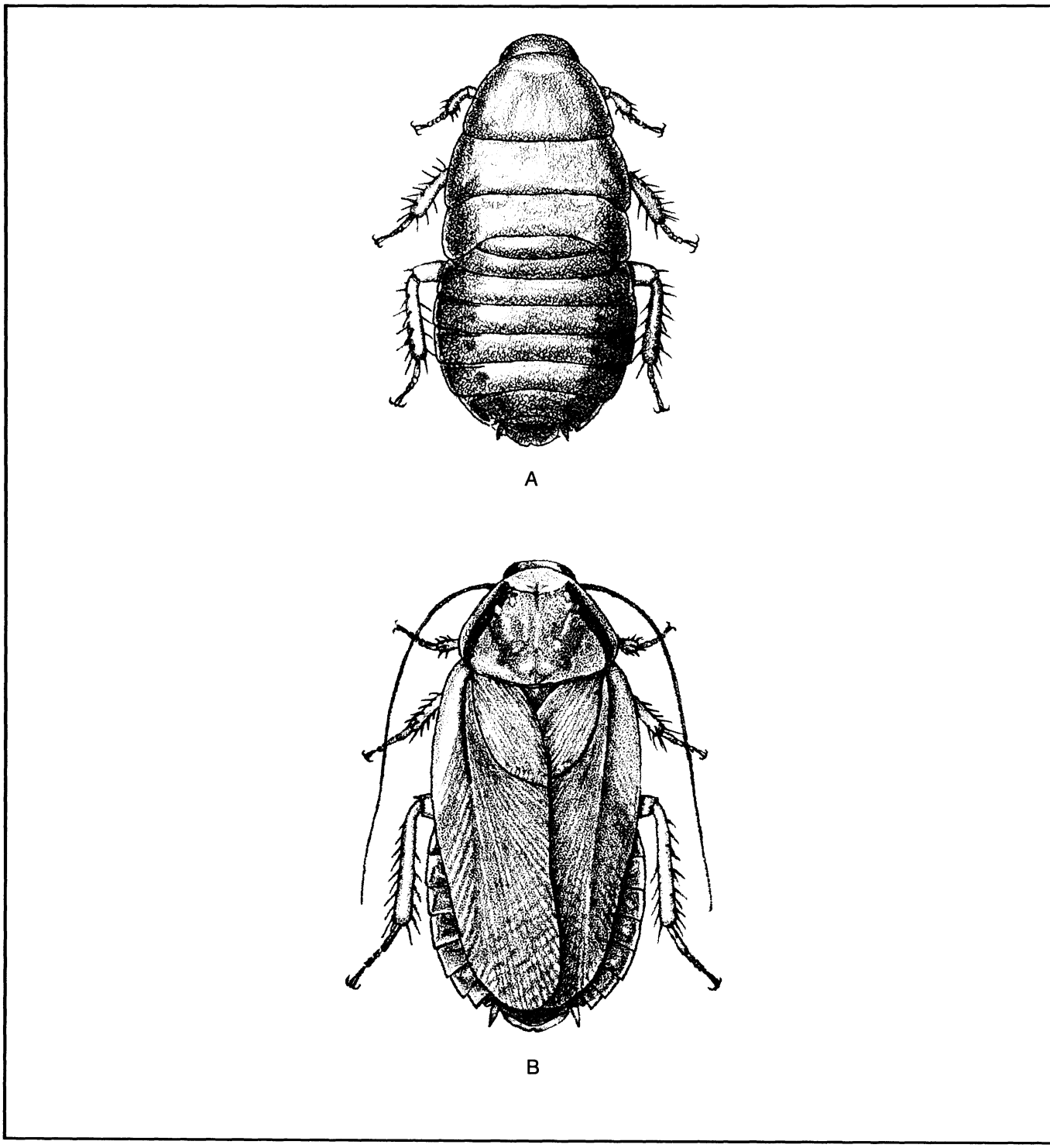


Plate 59. **Cinereous cockroach,** *Nauphoeta cinerea* (Blaberidae): A, nymph; B, adult (25-29).

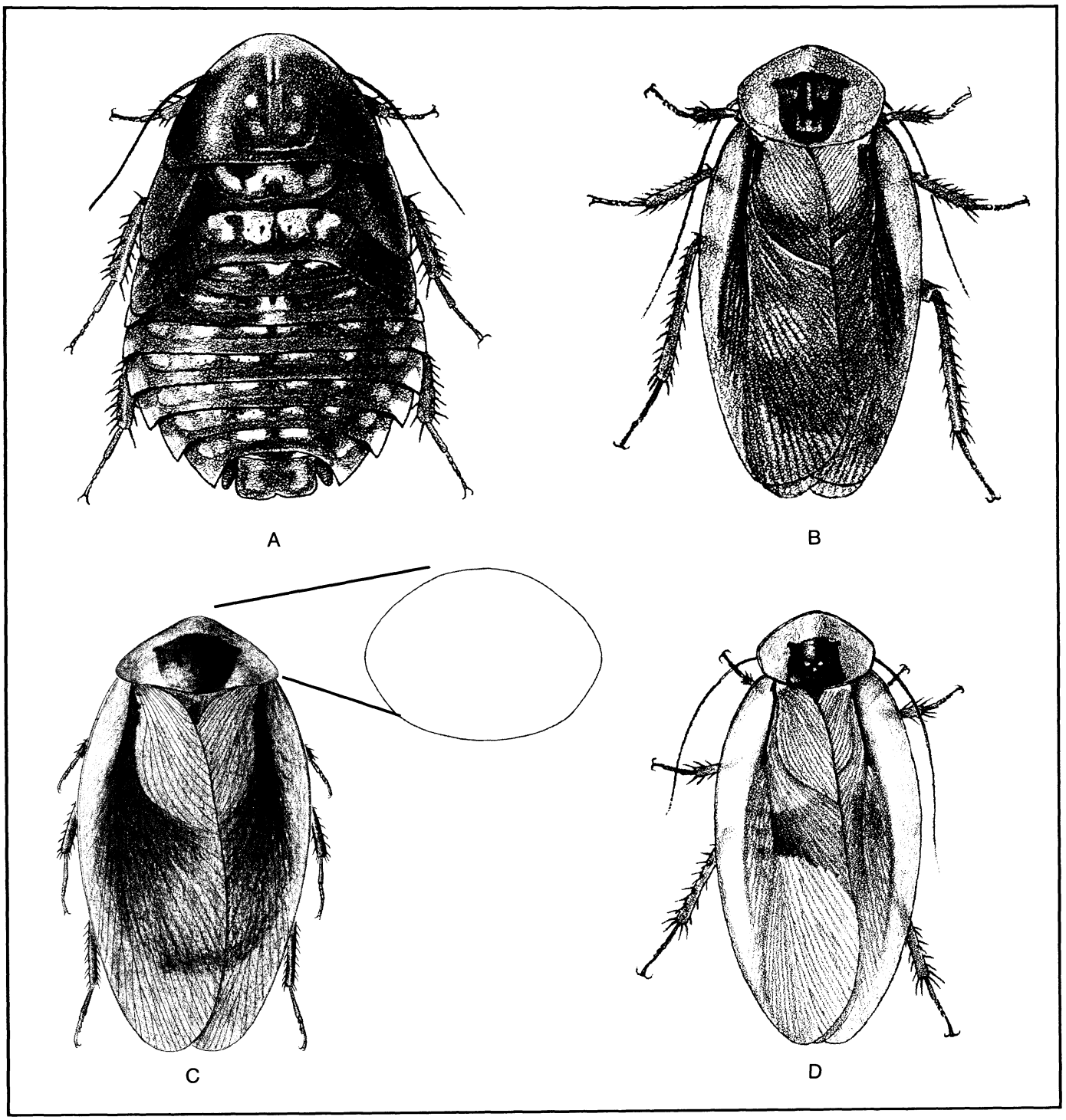
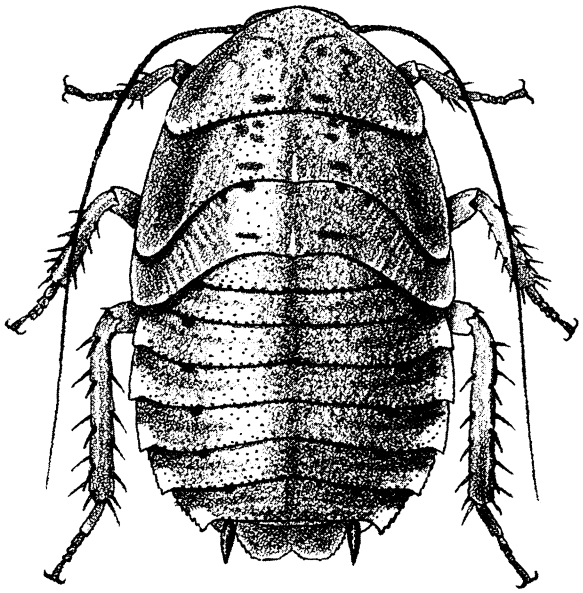
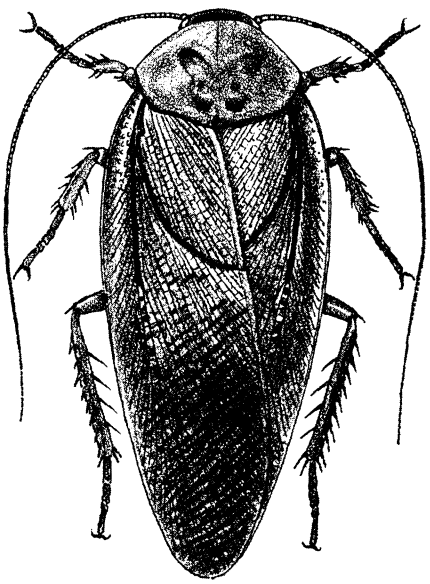


Plate 60. Giant cockroaches, *Blaberus* spp. (Blaberidae), dorsal views: A, *Blaberus craniifer,* nymph; B, same, adult (60-70); C, *Blaberus discoidalis* (49) (inset shows shape of pronotum in full dorsal view) (drawings by C. Feller); D, *Blaberus giganteus* (70-80).



A



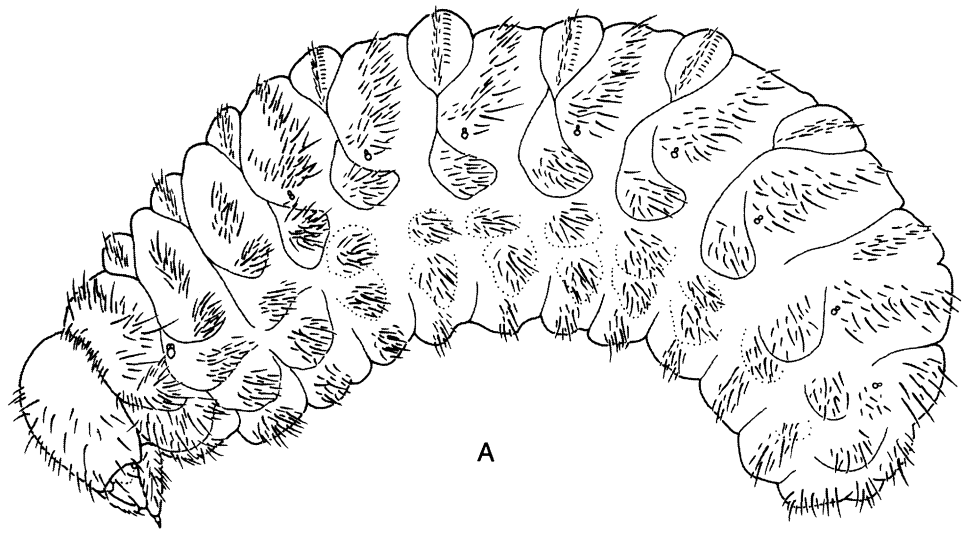
B

Plate 61. **Madeira cockroach,** *Leucophaea maderae* (Blaberidae): A, nymph; B, adult (40-50).

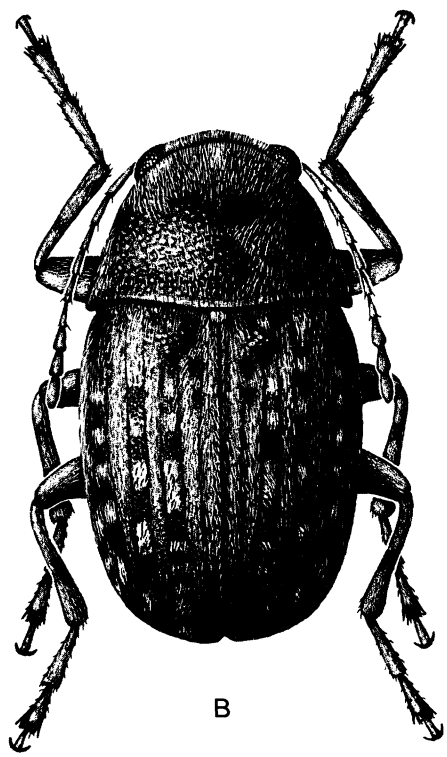
Notes and Sketches

ADULT AND LARVAL BEETLES

This series of illustrations, drawn by A.D. Cushman unless otherwise indicated, is a continuation from part 1, chapters entitled "Adult Beetles (Coleoptera)," by J.M. Kingsolver and "Larval Beetles (Coleoptera)," by D.M. Anderson.



A



B

Plate 62. **Coffee bean weevil,** *Araecerus fasciculatus* (Anthribidae): A, larva (4.5-6) (drawing by M. Ryan); B, adult (2-4.5) (drawing by R. White).

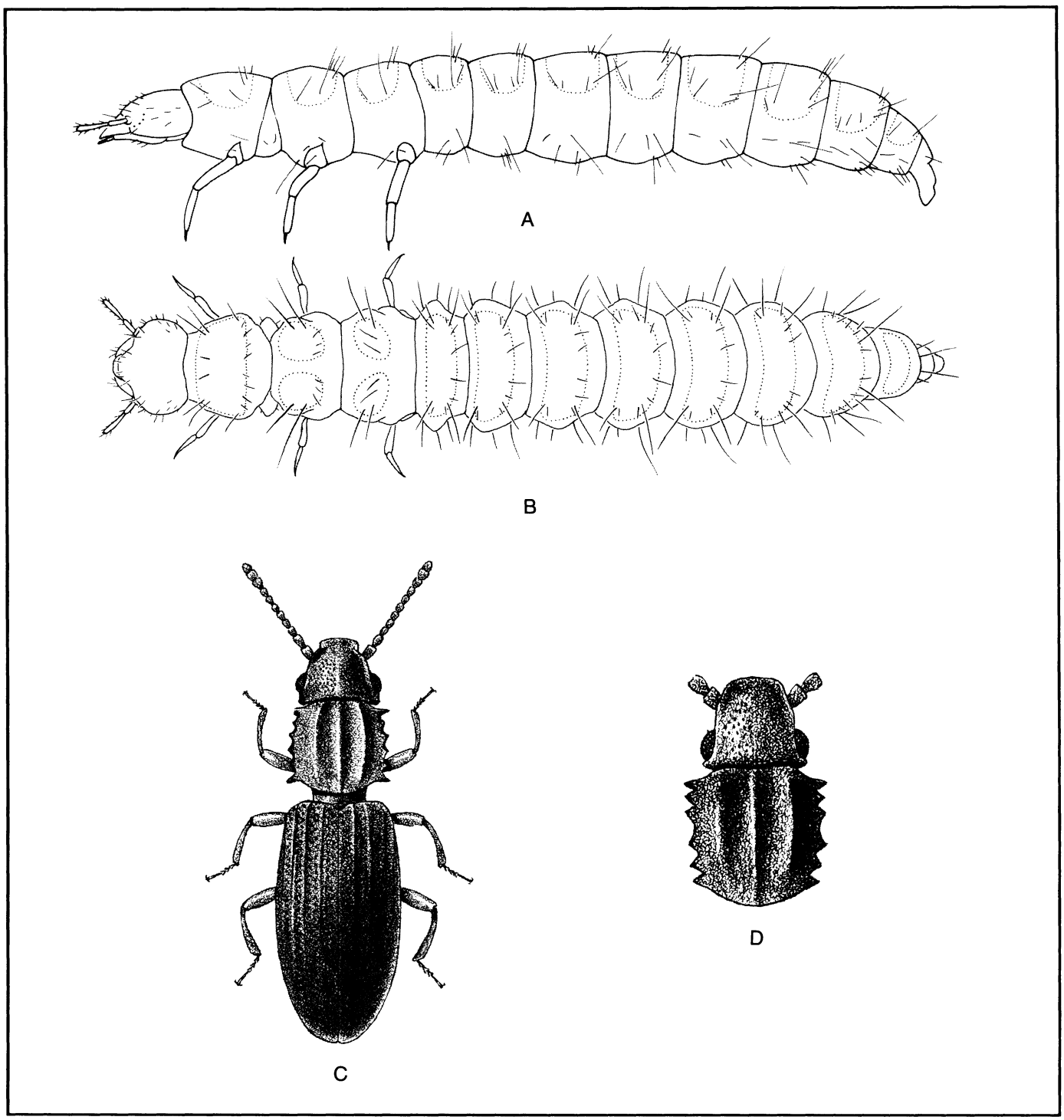


Plate 63. Grain beetles, *Oryzaephilus* (Cucujidae): A-C, **sawtoothed grain beetle**, *O. surinamensis*; A&B, larva (3) (drawings by C. Feller); C, same, adult (1.8-3.5); D, **merchant grain beetle**, *O. mercator* (2.2-3.5).

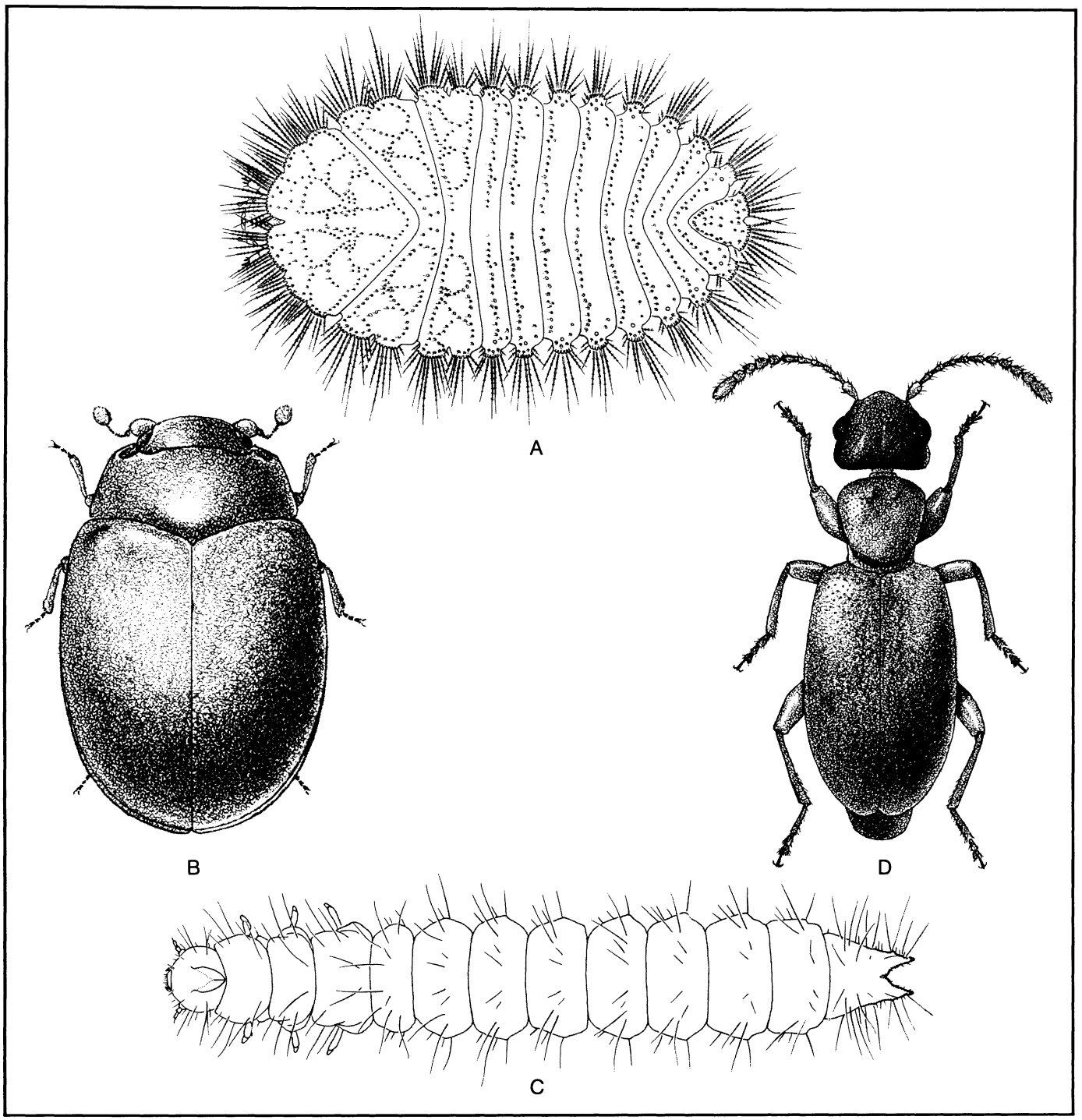


Plate 64. Cerylonid and anthicid beetles: A, oval grain beetle, *Murmidius ovalis* (Cerylonidae), larva (1.9) (drawing by C. Feller); B, same, adult (1.2-1.4); C, *Anthicus* sp. (Anthicidae), larva (5) (drawing by C. Feller); D, **narrownecked grain beetle,** *A. floralis,* adult (2.7-3.5).

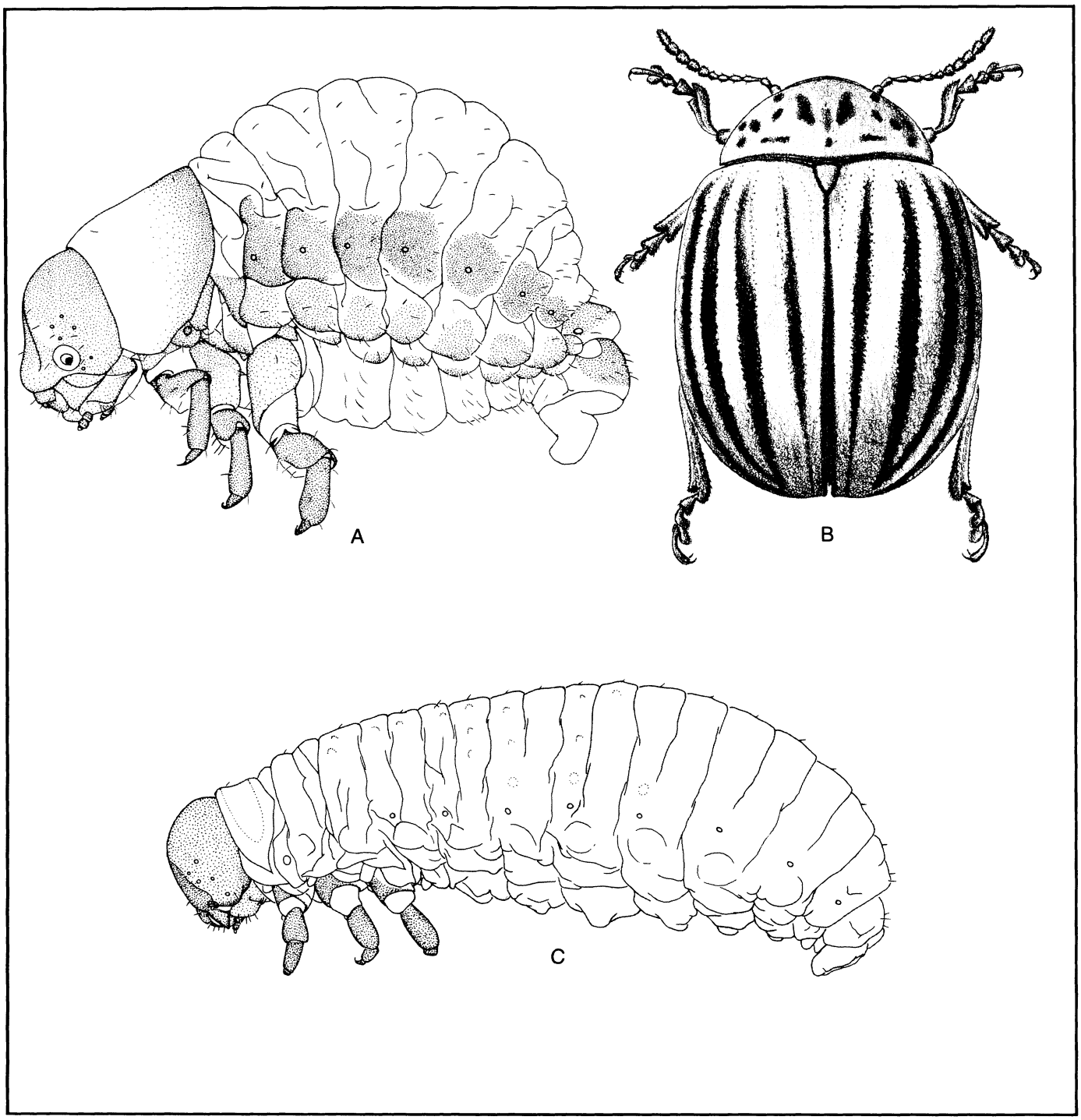
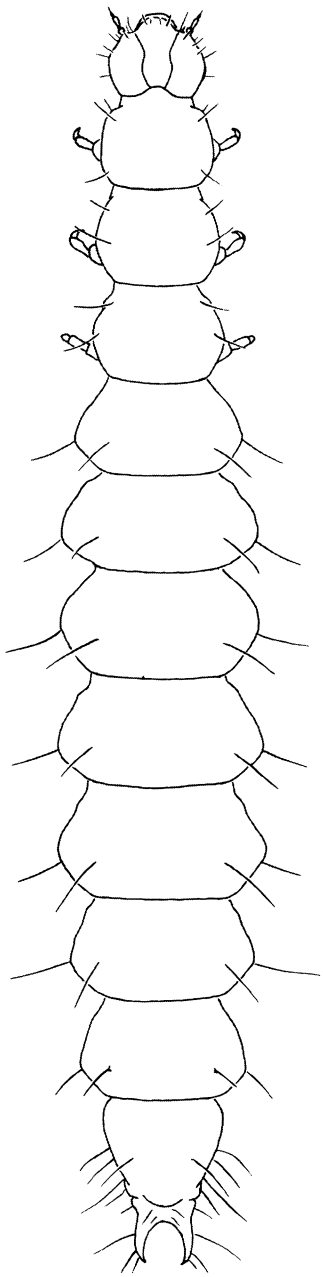
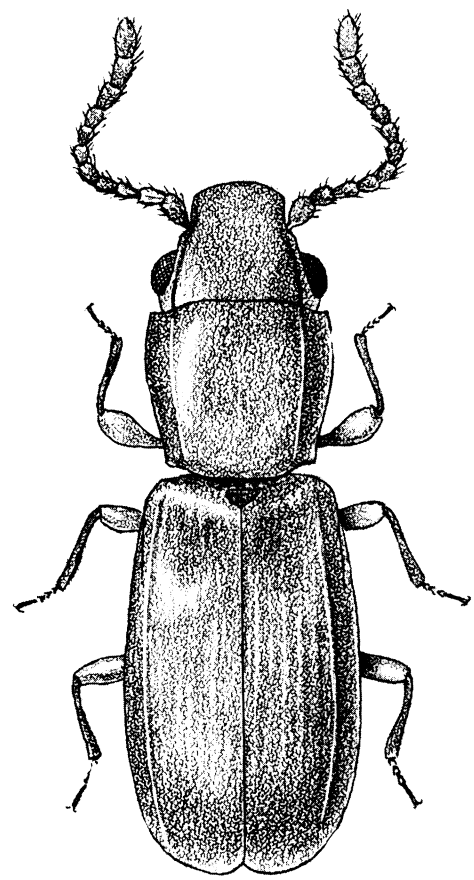


Plate 65. **Leaf beetles** (Chrysomelidae) (drawings by C. Feller): A, **Colorado potato beetle,** *Leptinotarsa decemlineata,* larva (15); B, same, adult (7-10.5); C, **asparagus beetle,** *Crioceris asparagi,* larva (9) (for adults of *C. duodecimpunctata* and *C. asparagi,* see pl. 1N&O).



A



B

Plate 66. Grain beetles, *Cryptolestes* spp. (Cucujidae) (drawings by C. Feller): A, *Cryptolestes* sp., larva (3.5); B, **flat grain beetle,** *C. pusillus,* adult (1.4-1.9).

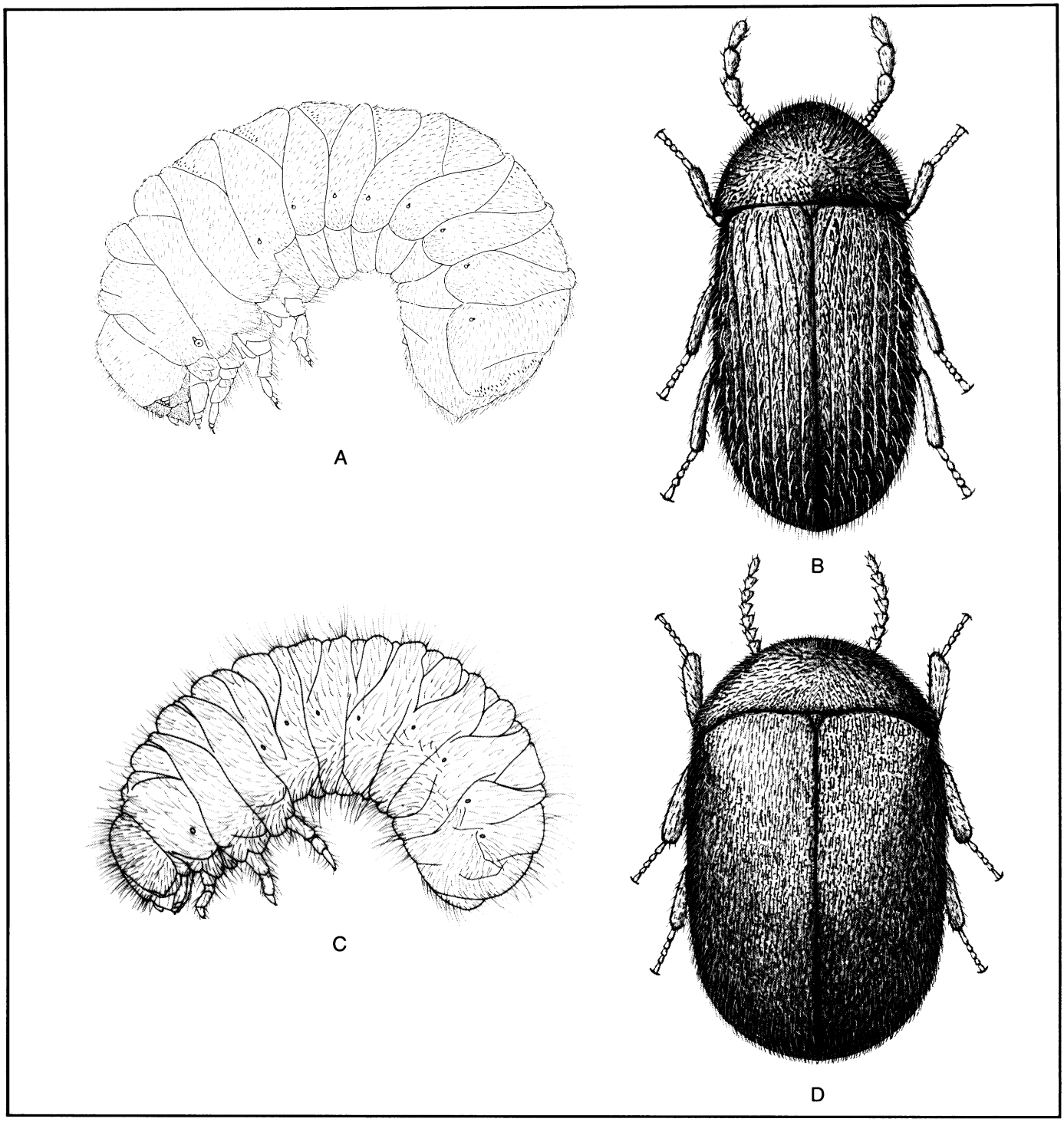


Plate 67. Anobiid beetles (Anobiidae): A, **drugstore beetle,** *Stegobium paniceum,* larva (3-4); B, same, adult (2.2-3.7); C, **cigarette beetle,** *Lasioderma serricorne,* larva (3-4) (drawings A&C by C. Feller); D, same, adult (1.8-3) (drawings B&D by R. White).

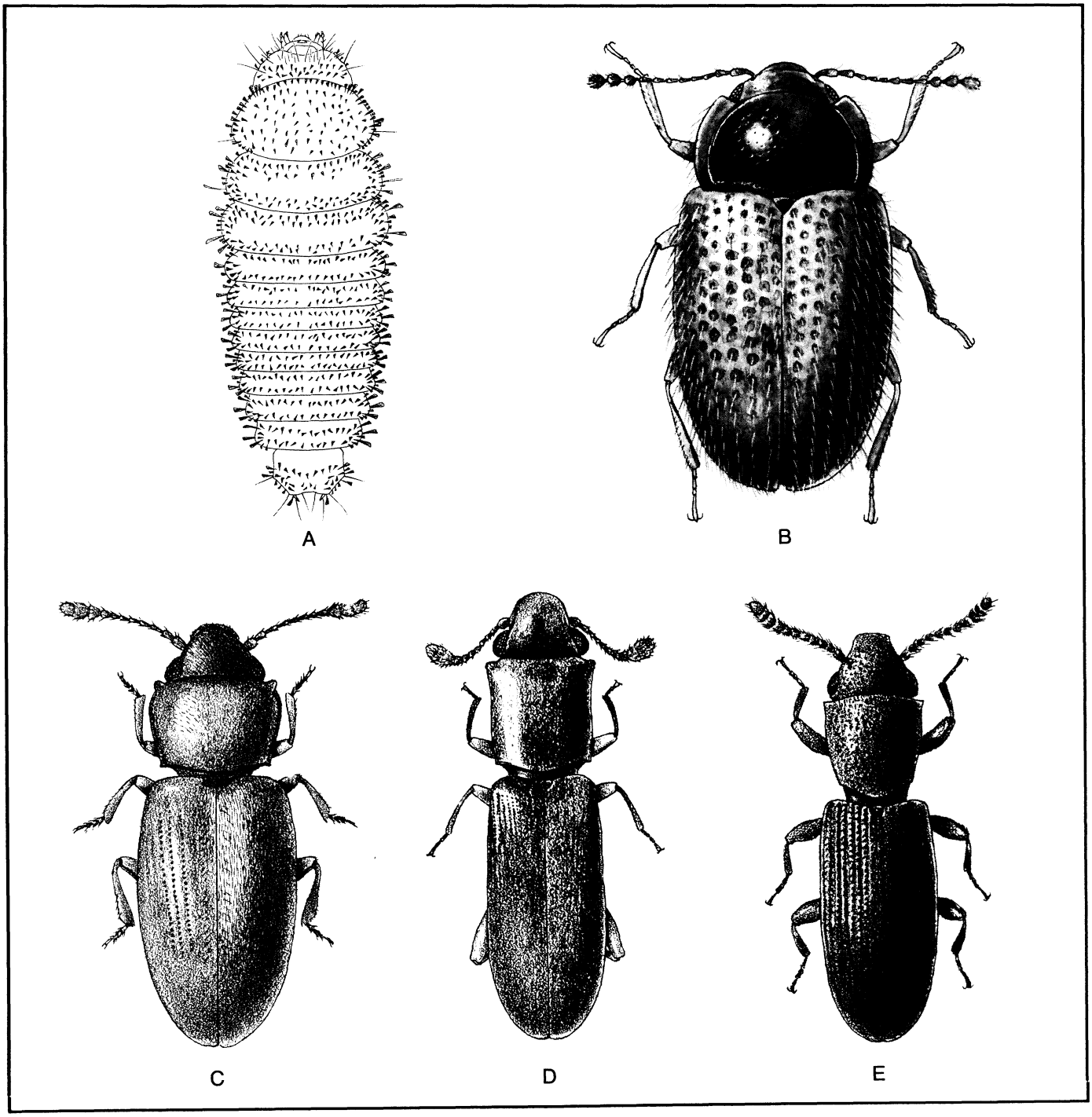
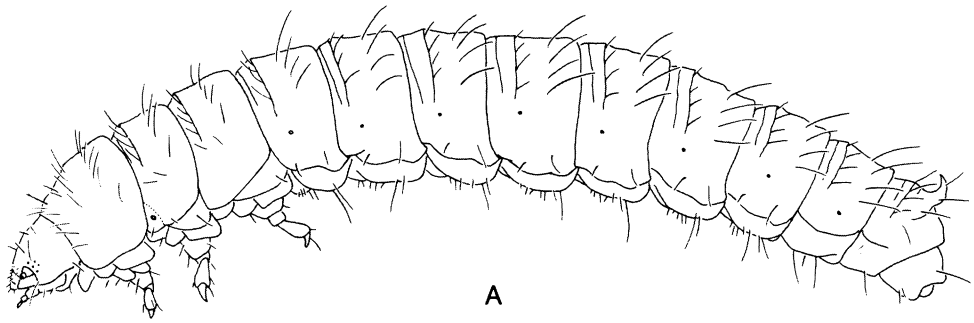
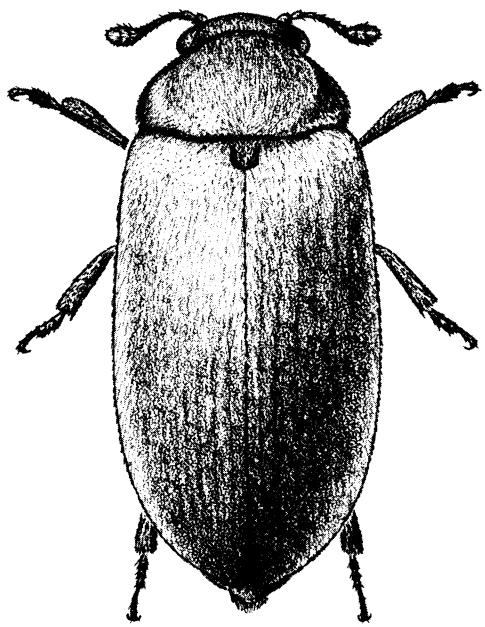


Plate 68. Endomychid and cucujid beetles: A, hairy cellar beetle, *Mycetaea subterranea* (Endomychidae), larva (2.2-2.5) (drawing by C. Feller); B, same, adult (1.5-1.8); C, **foreign grain beetle,** *Ahasverus advena* (Cucujidae), adult (2-3); D, **squarenecked grain beetle,** *Cathartus quadricollis* (Cucujidae), adult (2-2.7); E, *Silvanus planatus* (Cucujidae), adult (2.7-2.9).



A



B

Plate 69. **Raspberry fruitworm**, *Byturus unicolor* (Byturidae): A, larva (6) (drawing by C. Feller); B, adult, (3.8-4).

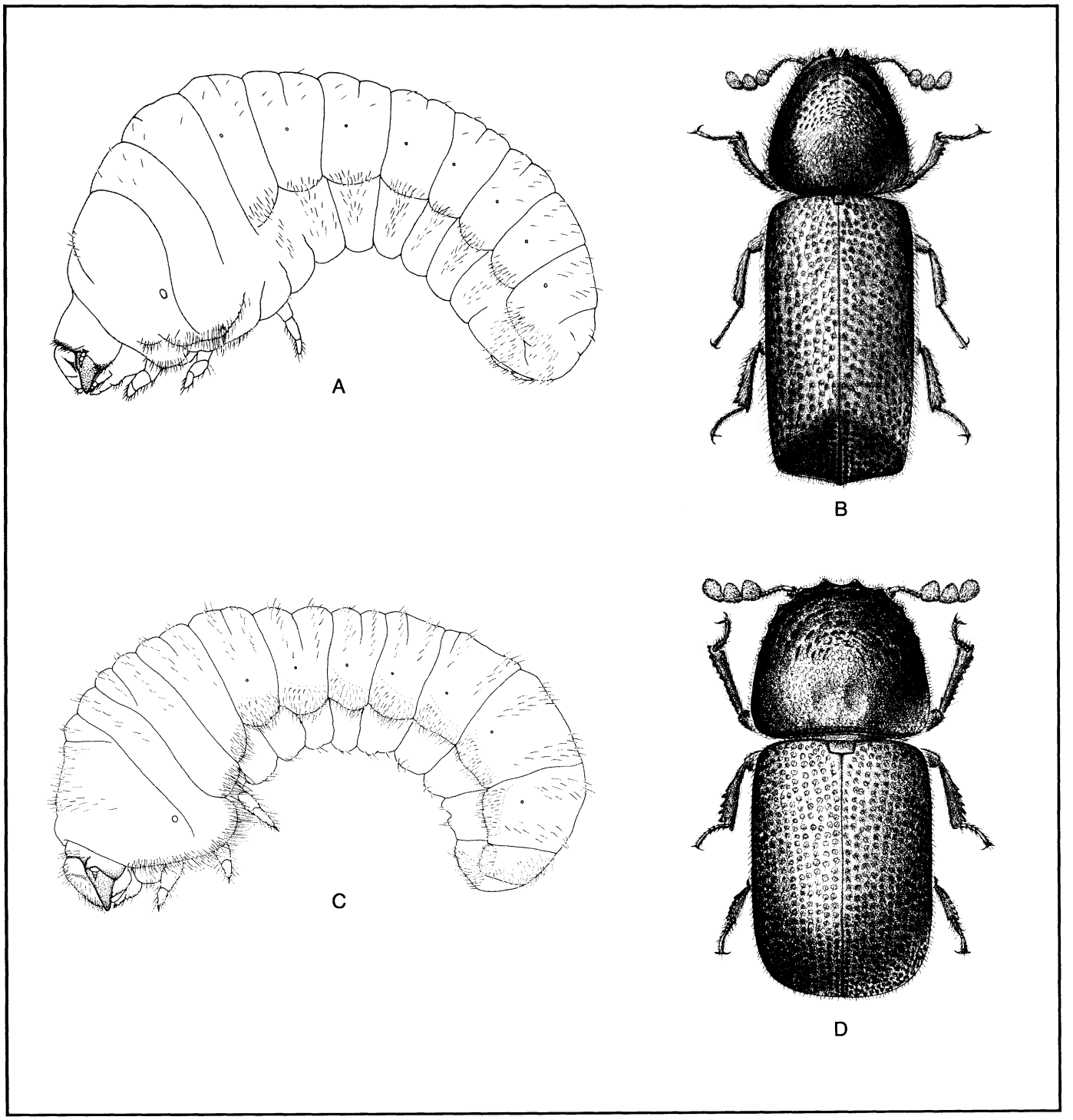


Plate 70. **False powderpost beetles** (Bostrichidae) (drawings by C. Feller): A, **larger grain borer,** *Prostephanus truncatus,* larva (3.6); B, same, adult (3.3-4.5); C, **bamboo powderpost beetle,** *Dinoderus minutus,* larva (3); D, same, adult (2.6-3.5).

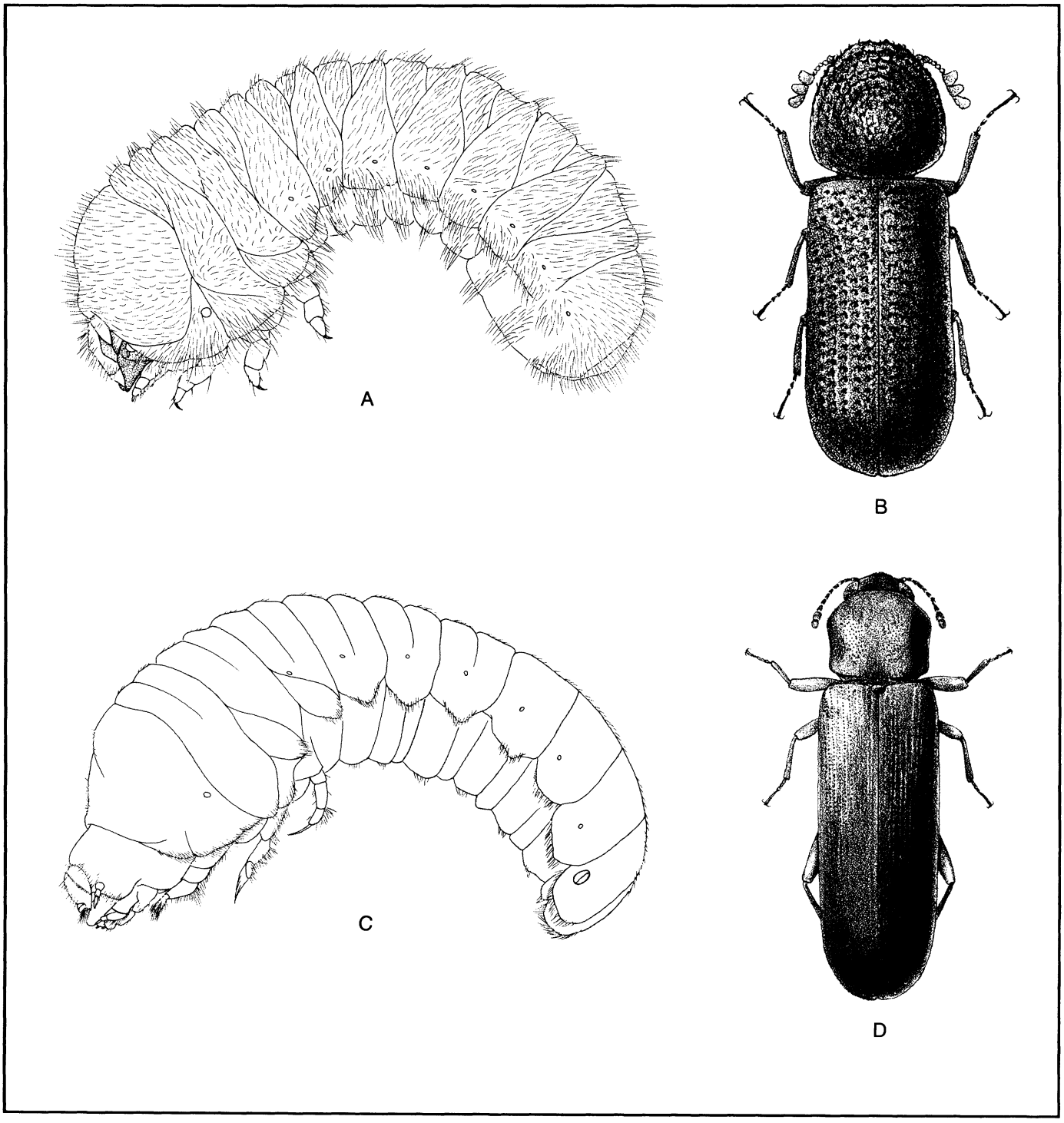


Plate 71. Wood-boring beetles: A, **lesser grain borer**, *Rhyzopertha dominica* (Bostrichidae), larva (3-3.1); B, same, adult (2-3); C, brown powderpost beetle, *Lyctus brunneus* (Lyctidae), larva (6) (drawings A & C by C. Feller); D, same, adult (2-2.7).

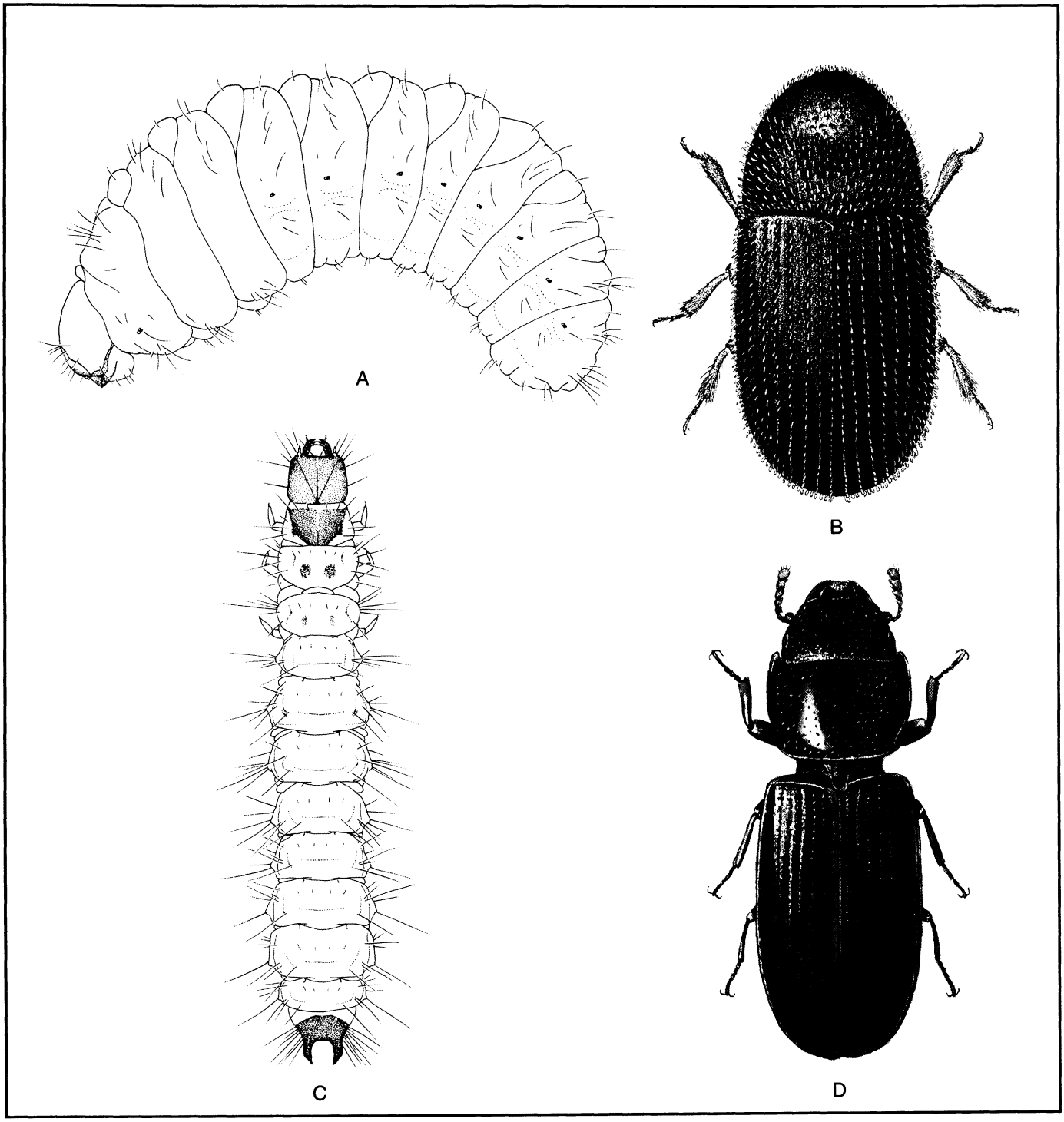
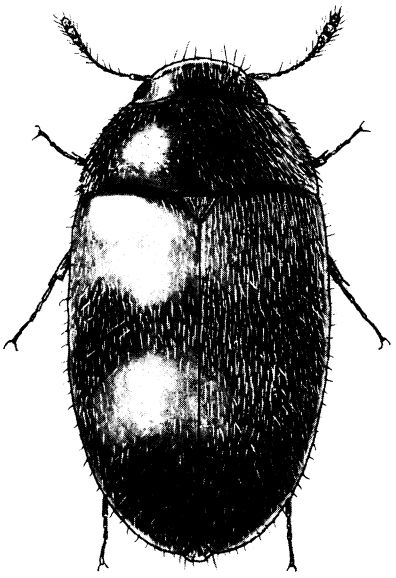
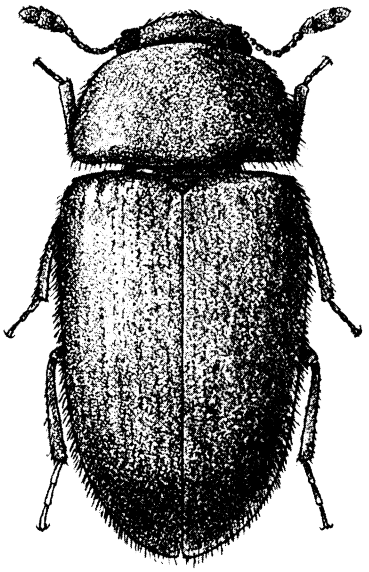


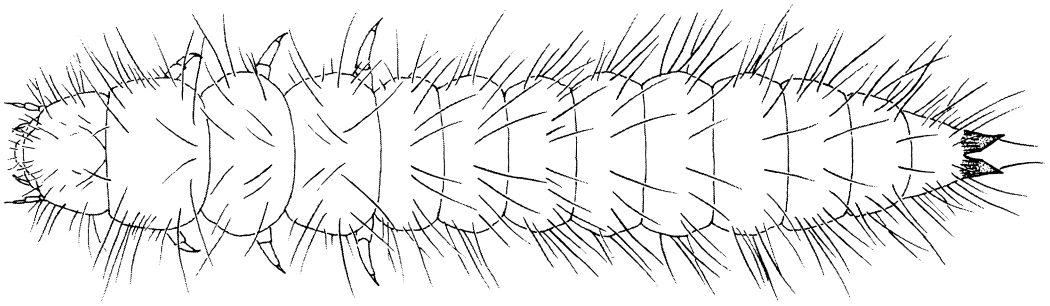
Plate 72. Scolytid and trogositid beetles: A, **coffee berry borer**, *Hypothenemus hampei* (Scolytidae), larva (2); B, same, adult (1.5-1.7); C, **cadelle,** *Tenebroides mauritanicus* (Trogositidae), larva (18-19) (drawings A-C by C. Feller); D, same, adult (5-11).



A



C



B

Plate 73. **Hairy fungus beetles** (Mycetophagidae): A, *Litargus balteatus,* adult (1.7-1.9); B, **hairy fungus beetle,** *Typhaea stercorea,* larva (4-4.5) (drawing by C. Feller); C, same, adult (2-2.3).

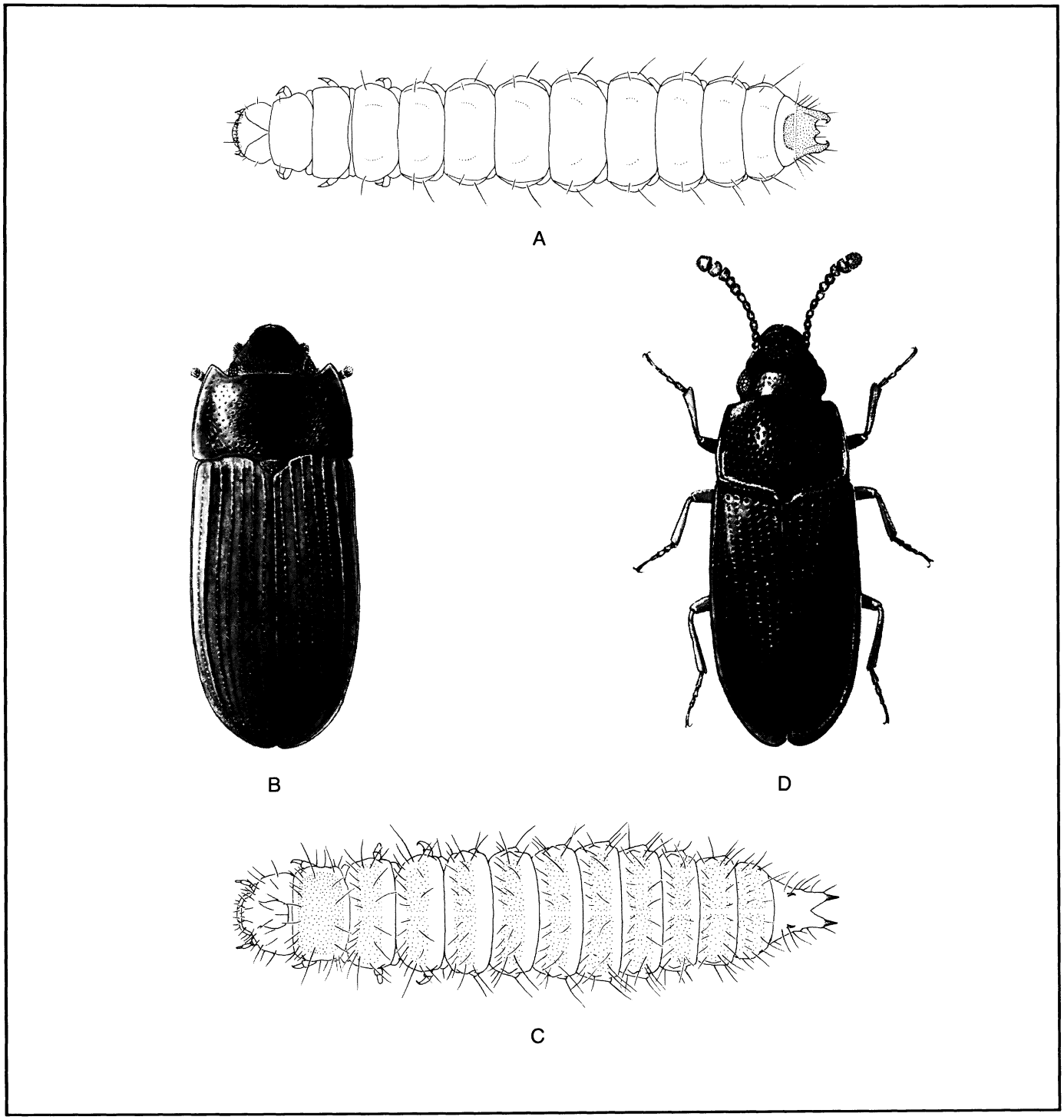


Plate 74. Grain beetles: A, Siamese grain beetle, *Lophocateres pusillus* (Trogositidae), larva (5.4); B, same, adult (2.6-3.2); C, Mexican grain beetle, *Pharaxonotha kirschi* (Languriidae), larva (8.5) (drawings A&C by C. Feller); D, same, adult (4-4.5).

DERMESTID BEETLES (DERMESTIDAE)

This series of illustrations, drawn by A.D. Cushman (unless otherwise noted), is a continuation from part 1, chapter 5 (Dermestid Beetles), by J.M. Kingsolver.

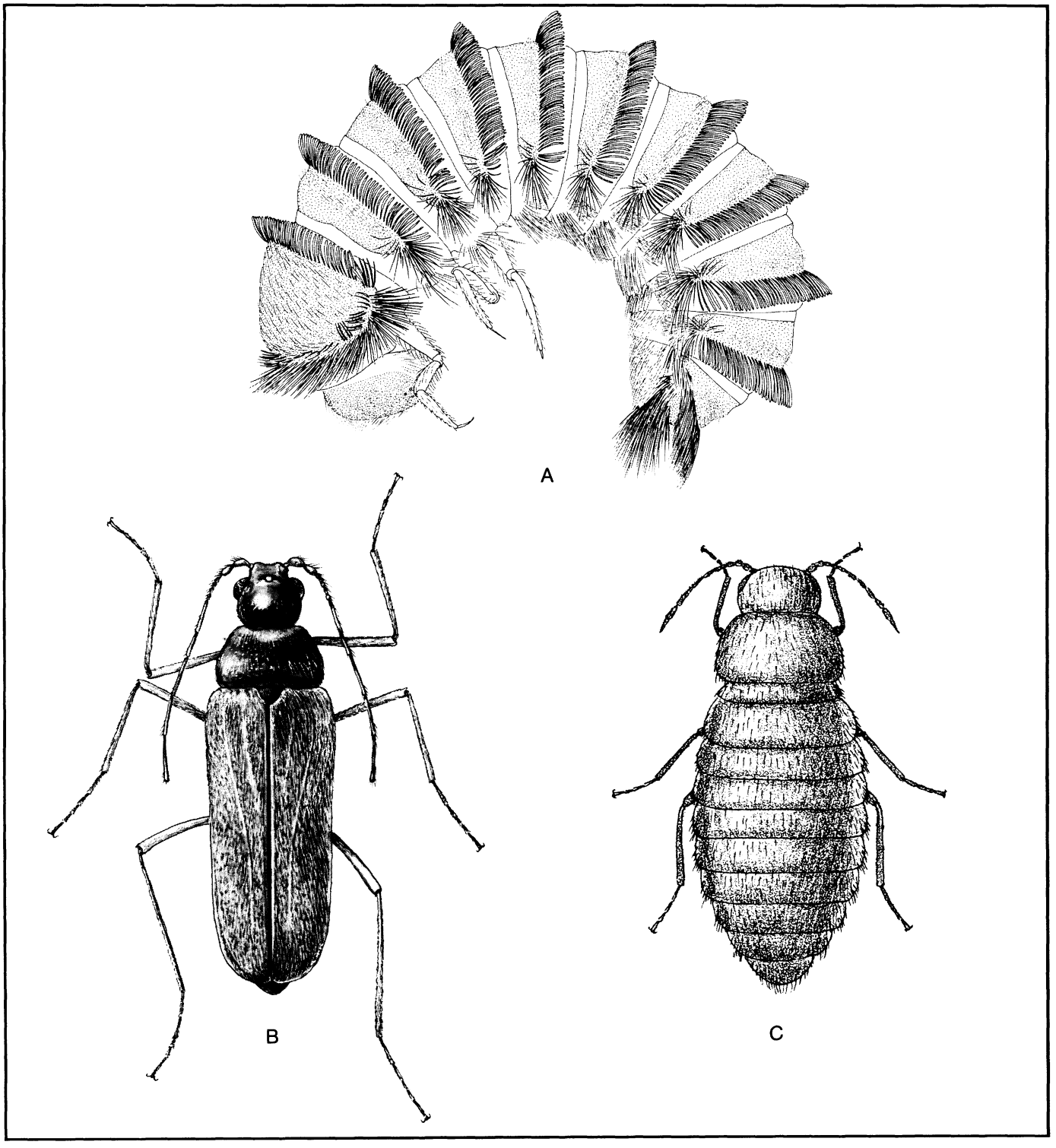


Plate 75. **Odd beetle,** *Thylodrias contractus* (Dermestidae): A, larva (4-4.8) (drawing by C. Feller); B, male (2.3-3); C, female (3.7-4.4).

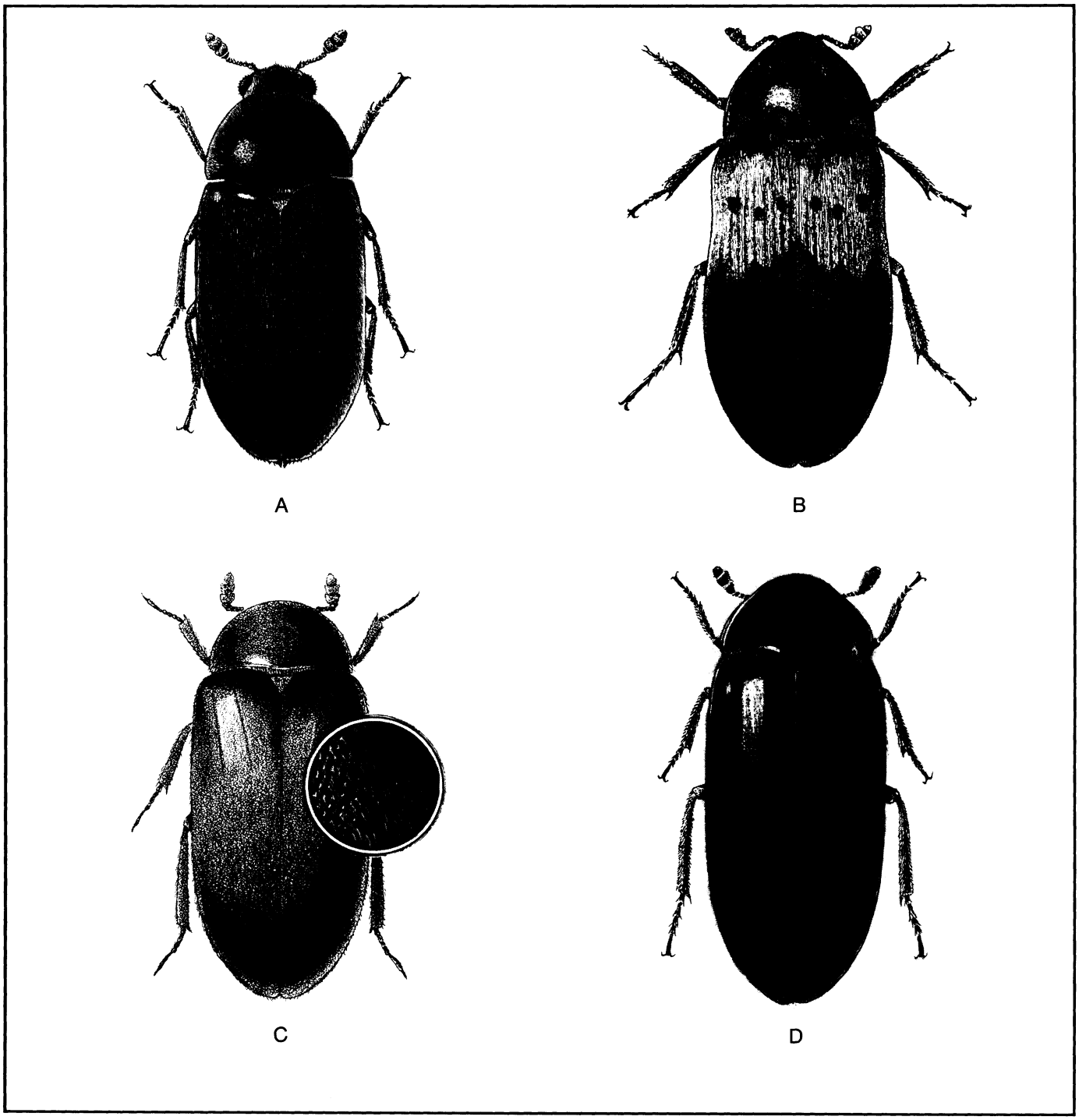


Plate 76. **Dermestid beetles** (Dermestidae): A, **hide beetle,** *Dermestes maculatus* (5.5-10); B, **larder beetle,** *Dermestes lardarius* (7-9); C, *Dermestes haemorrhoidalis* (male, 6.9; female, 7.7); D, Peruvian larder beetle, *Dermestes peruvianus* (male, 8.5; female, 9.6).

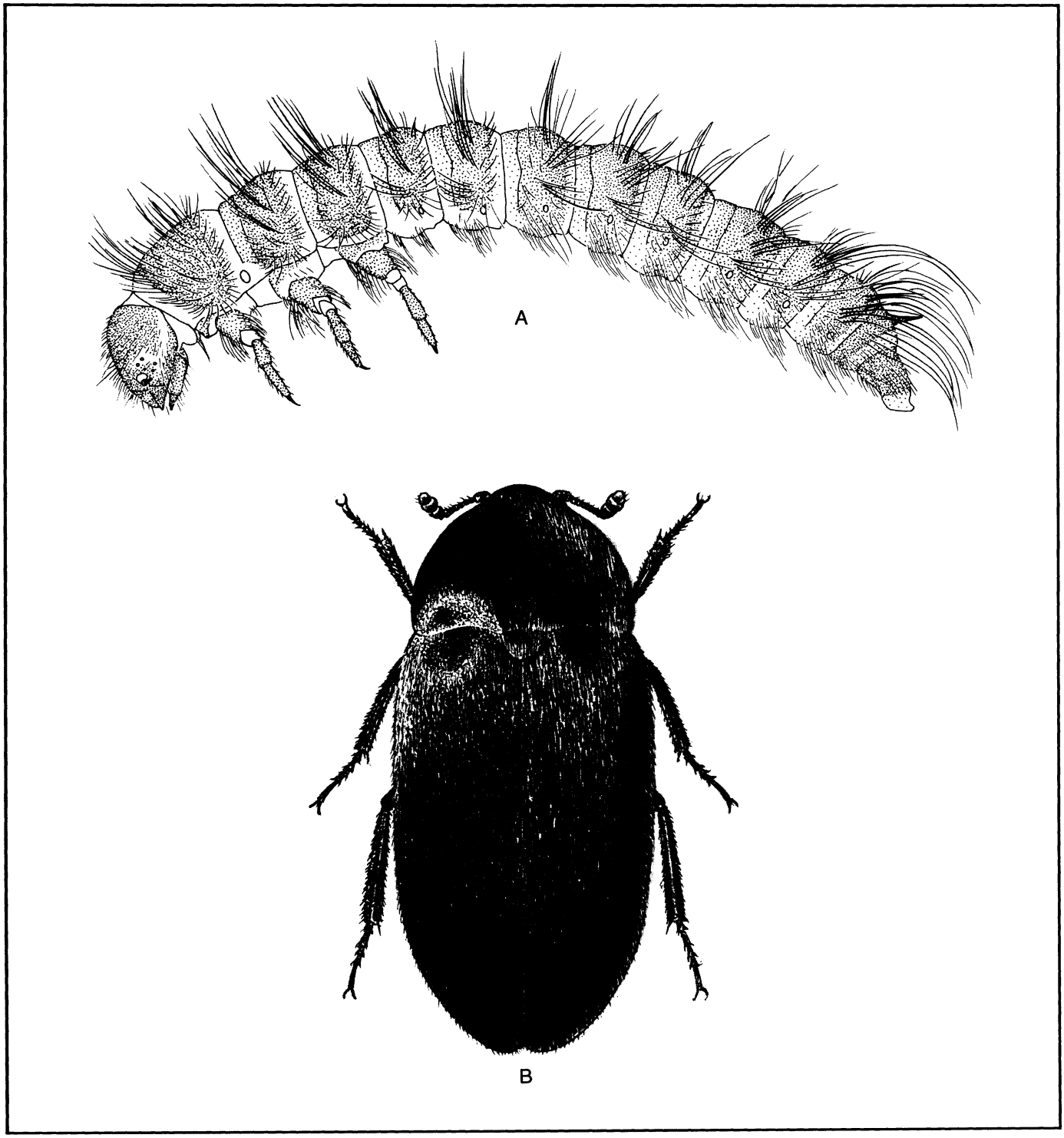


Plate 77. **Black larder beetle,** *Dermestes ater* (Dermestidae): A, larva (15-17) (drawing by C. Feller); B, adult (7-9.5).

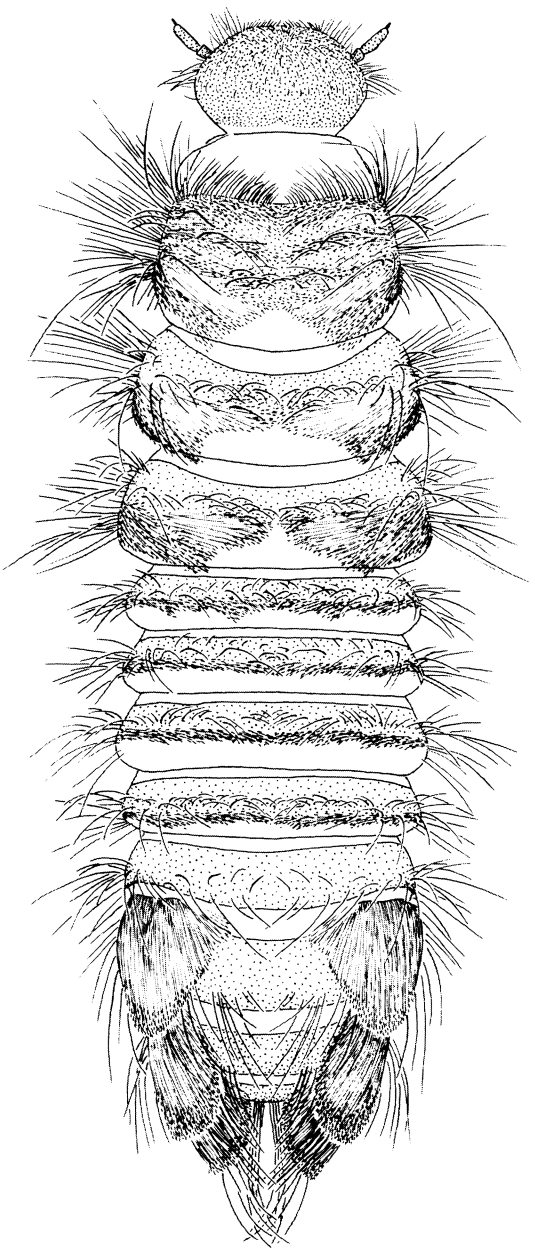


Plate 78. **Varied carpet beetle,** *Anthrenus verbasci* (Dermestidae), larva (4-4.5) (drawing by C. Feller); adult (1.7-3.2) is figured in plate 1A.

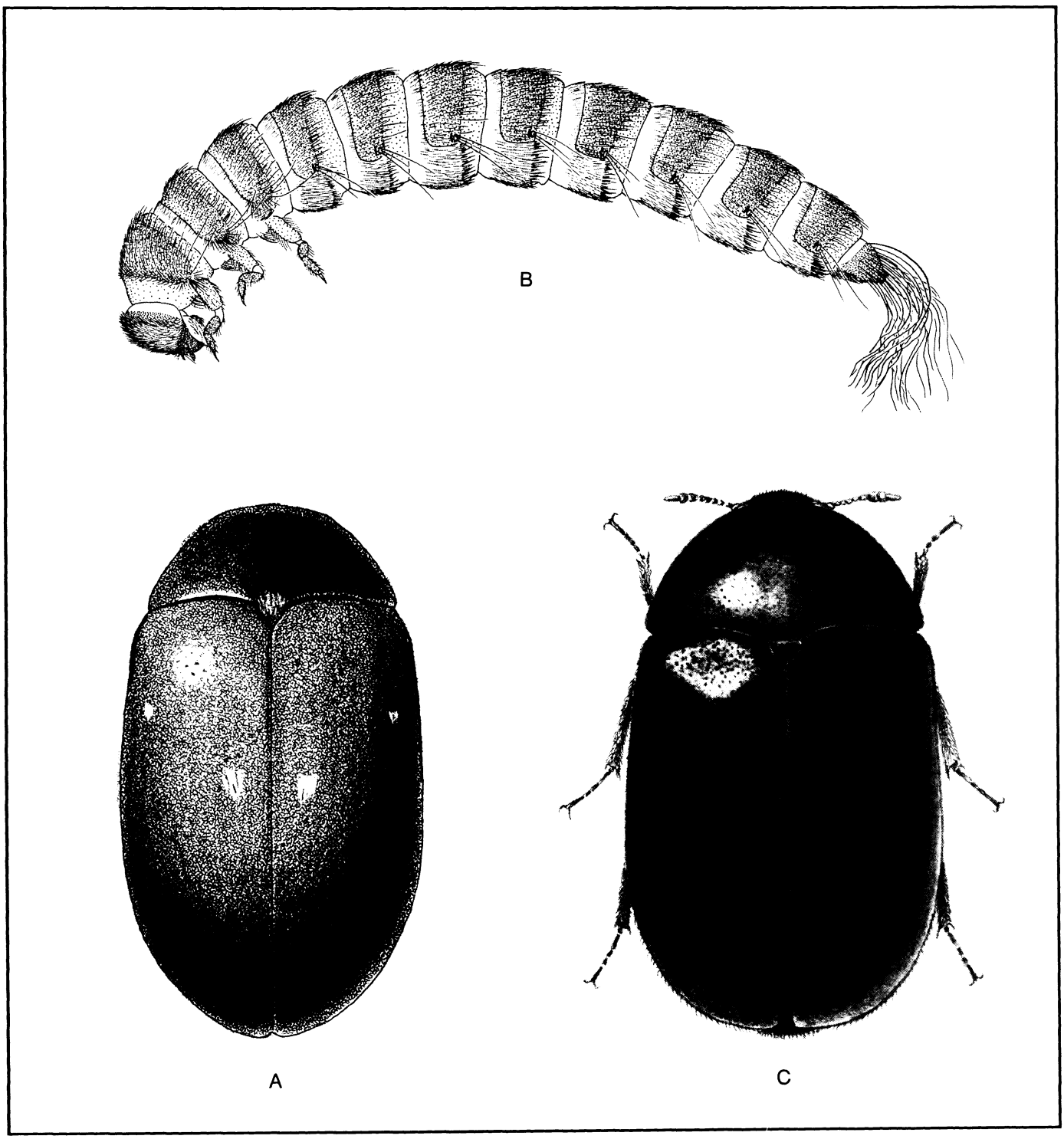


Plate 79. **Dermestid beetles** (Dermestidae): A, *Attagenus pellio* (3.6-5.7); B, **black carpet beetle,** *Attagenus unicolor,* larva (6-8.2) (drawing by C. Feller); C, same, adult (2.8-5).

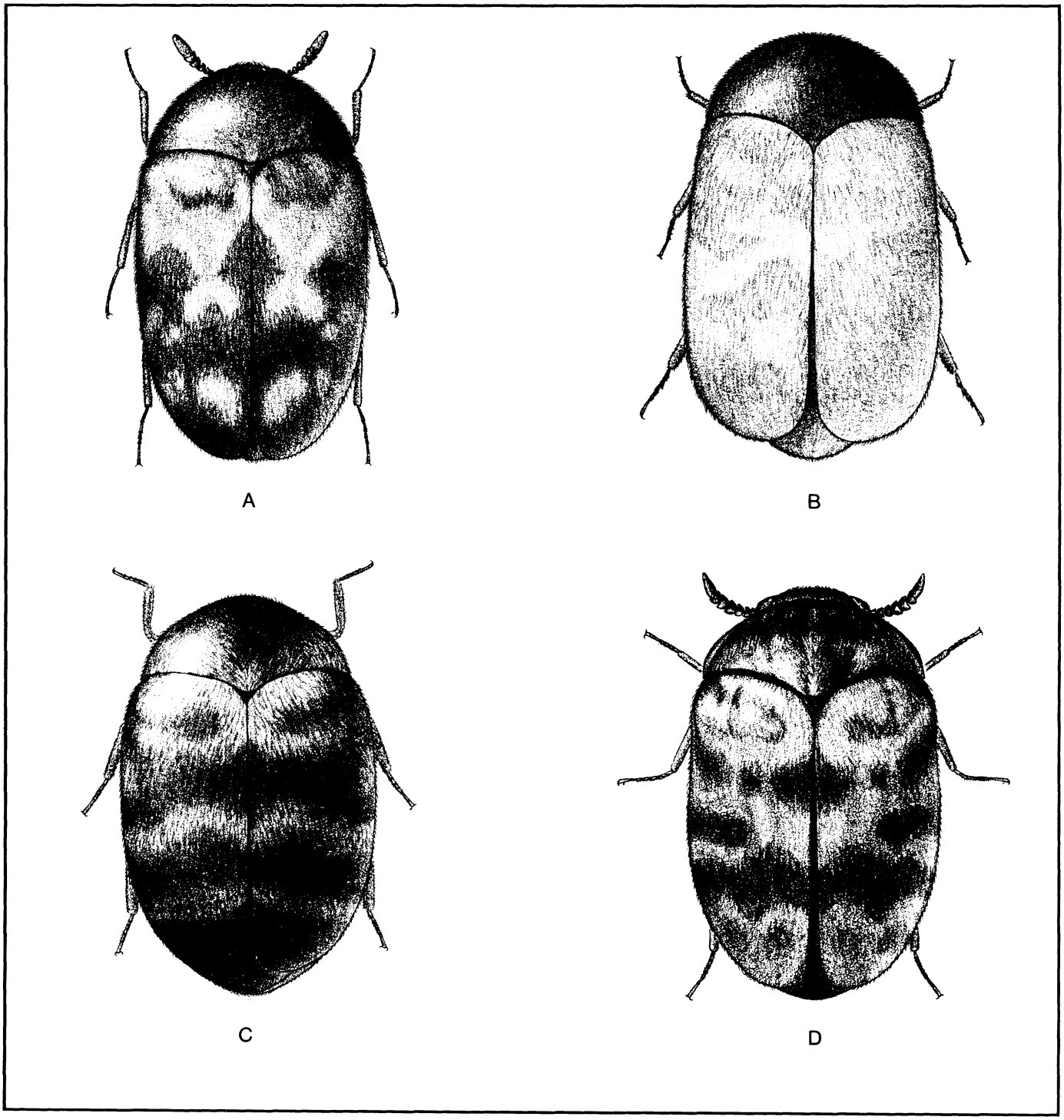


Plate 80. **Dermestid beetles** (Dermestidae) (drawings by C. Feller): A, *Trogoderma simplex* (2.2-4.4); B, **khapra beetle,** *Trogoderma granarium* (1.5-3); C, glabrous cabinet beetle, *Trogoderma glabrum* (2-3.9); D, European larger cabinet beetle, *Trogoderma versicolor* (1.8-4.2).

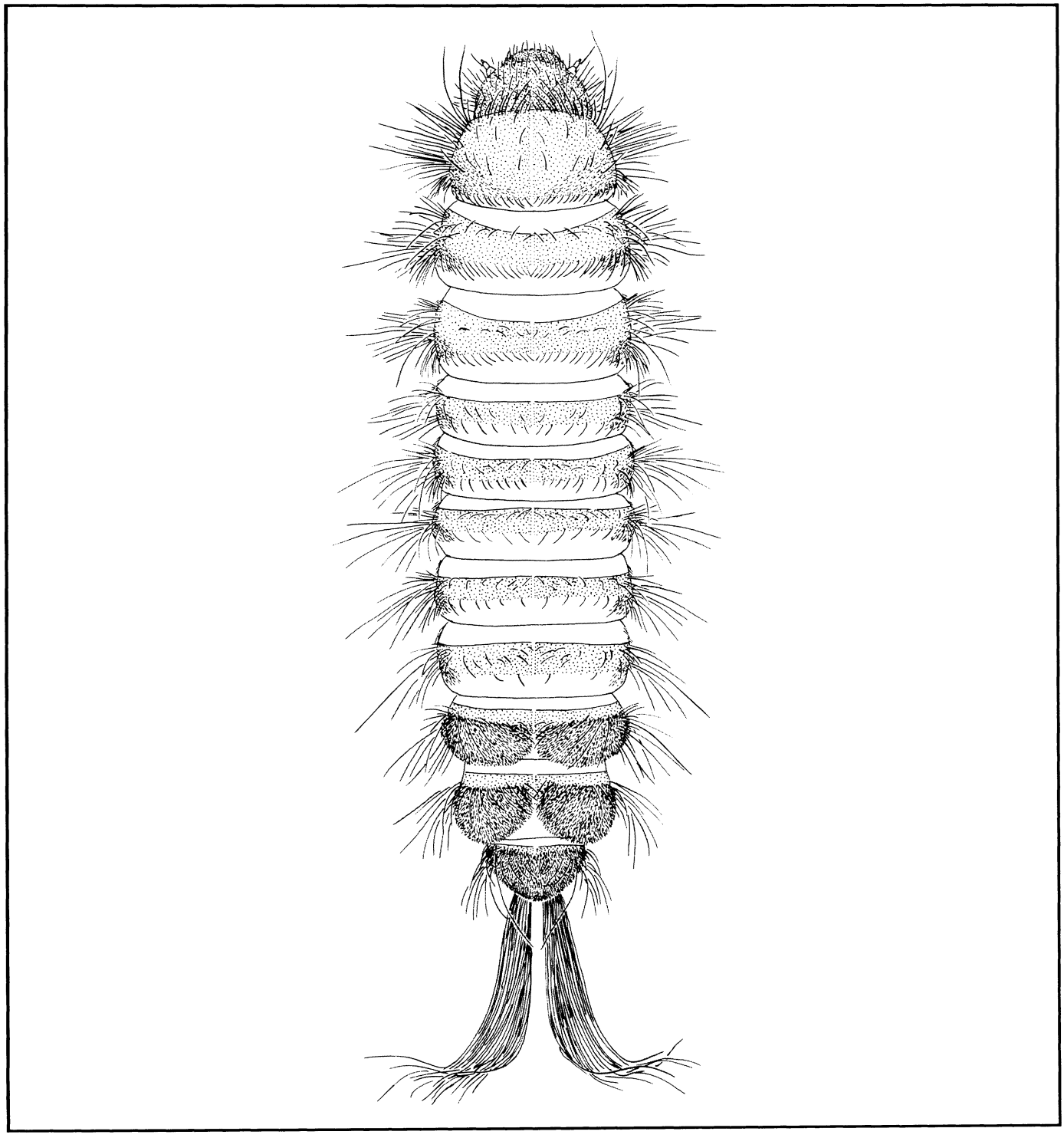


Plate 81. **Warehouse beetle,** *Trogoderma variabile* (Dermestidae), larva (5-6.5) (drawing by C. Feller); adult (2.7-3.5) is figured in plate 1C.

SPIDER BEETLES (PTINIDAE)

This series of illustrations, drawn by A.D. Cushman unless otherwise indicated, is a continuation from part I, chapter 6, by T.J. Spilman.

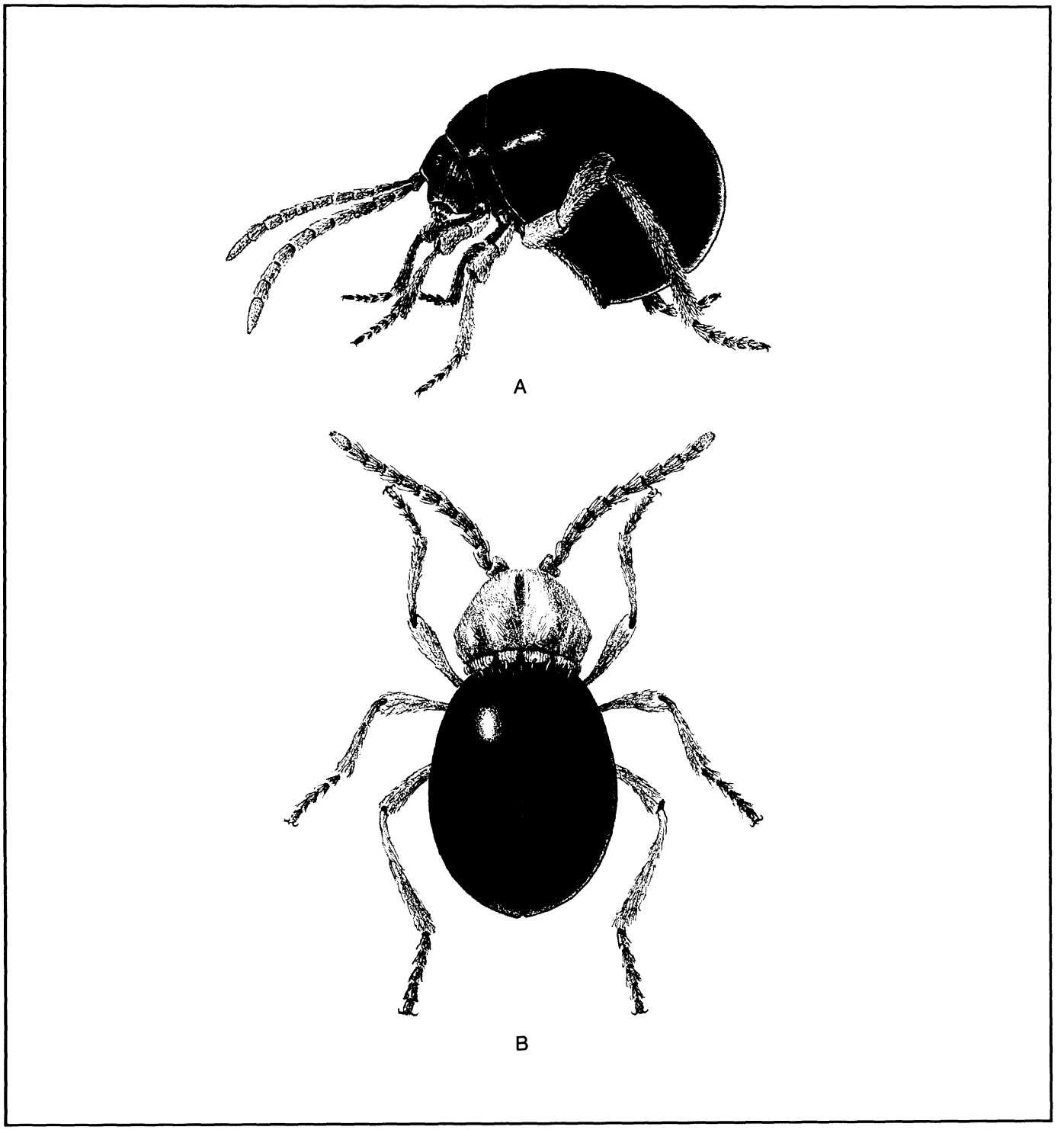


Plate 82. **Spider beetles** (Ptinidae): A, hump beetle, *Gibbium psylloides* (1.7-3.2); B, **American spider beetle,** *Mezium americanum* (1.5-3.5).

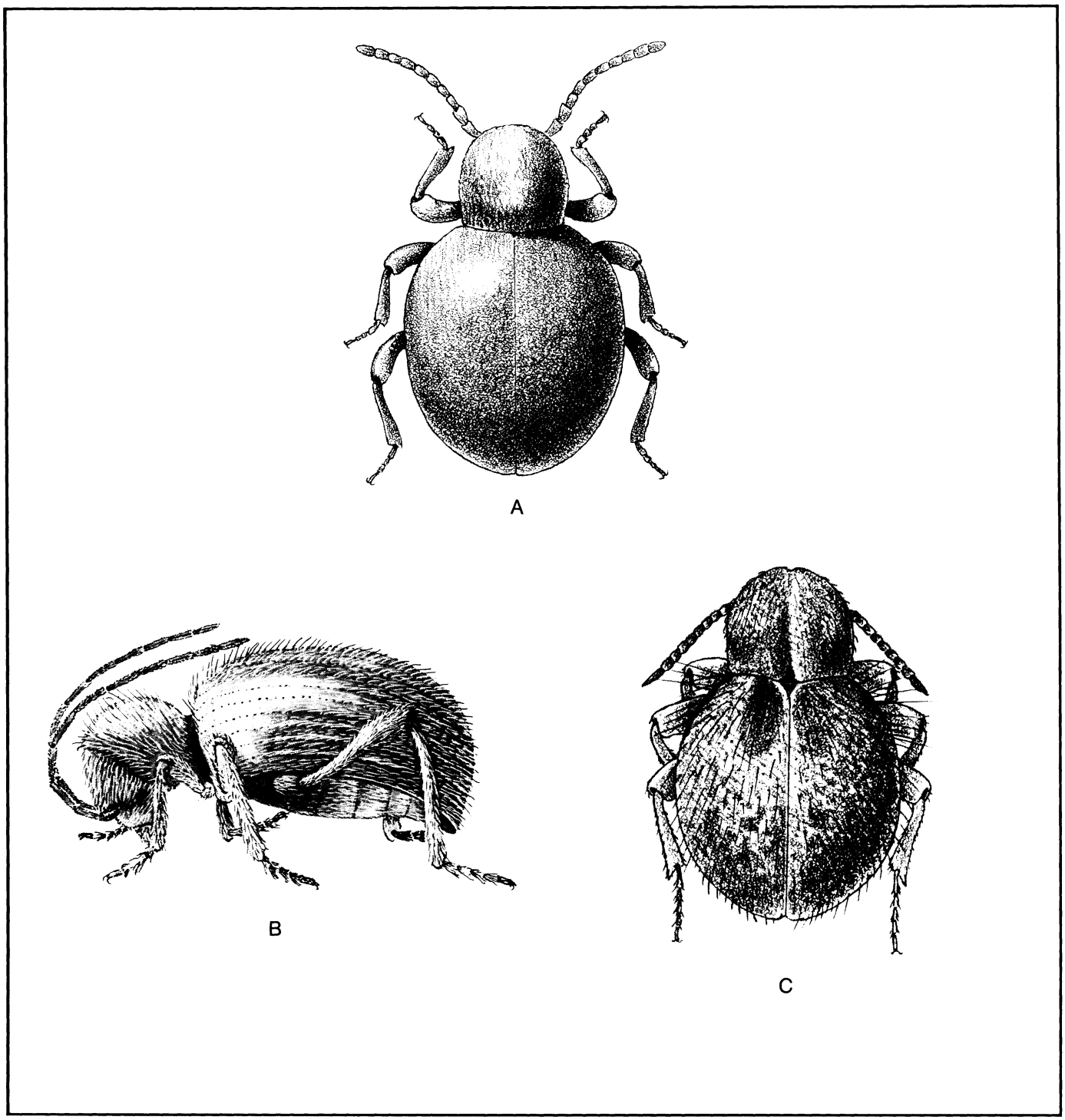


Plate 83. **Spider beetles** (Ptinidae): A, humpbacked spider beetle, *Sphaericus gibboides* (1.6-2.8); B, **golden spider beetle**, *Niptus holoeucus* (3-4.5); C, **globular spider beetle**, *Trigonogenius globulum* (2-4).

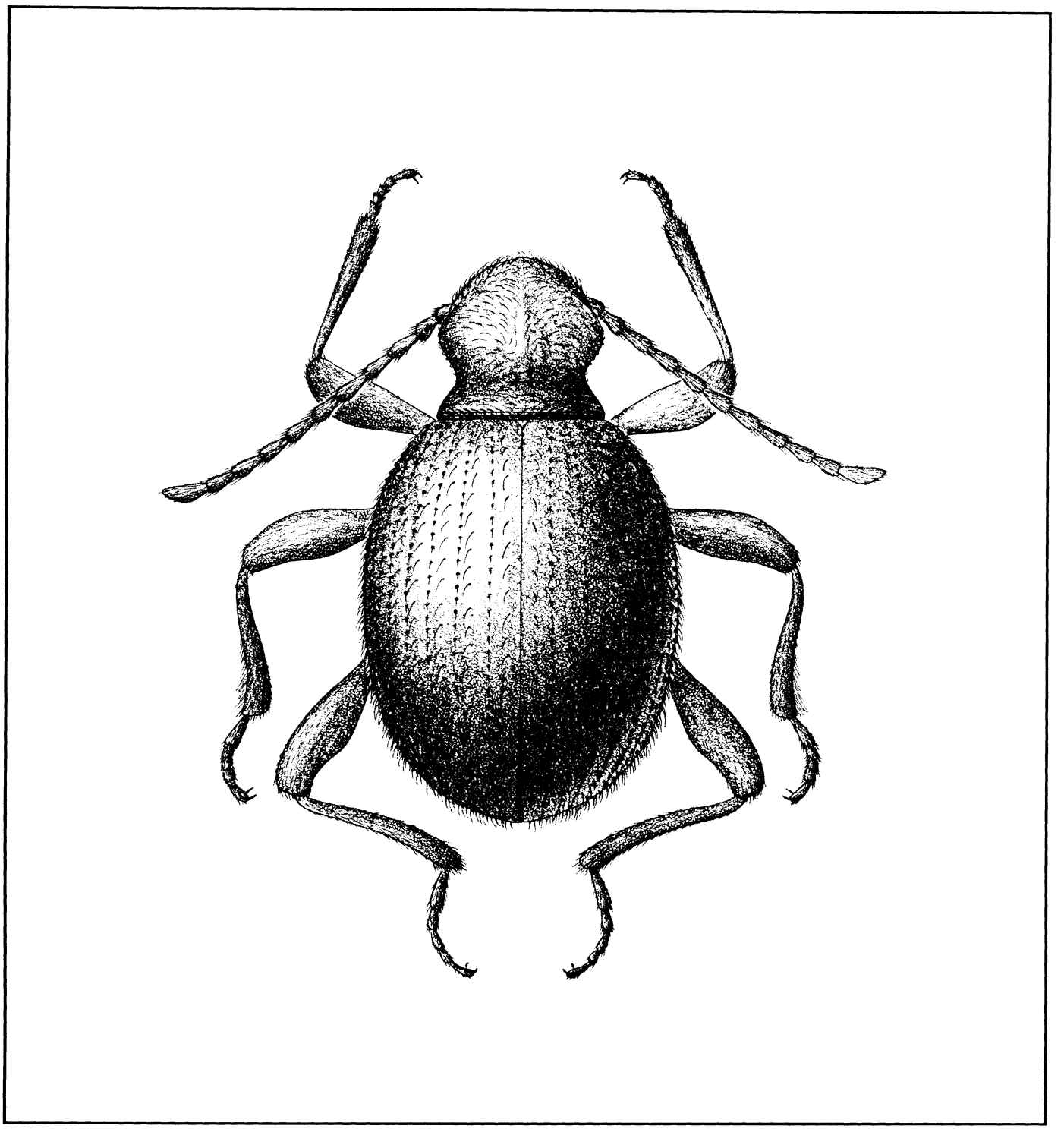
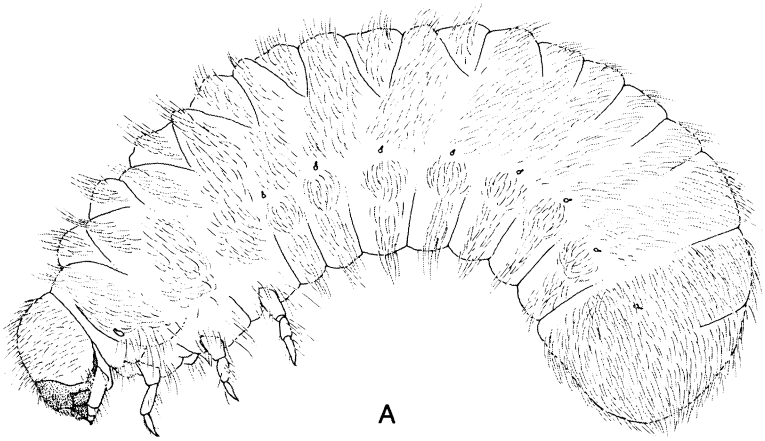
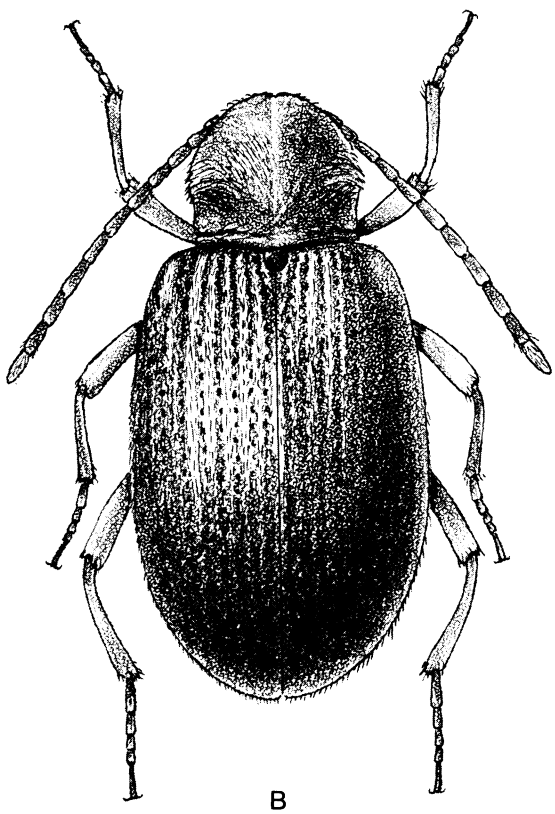


Plate 84. A spider beetle, *Pseudeurostus hilleri* (Ptinidae) (1.9-2.8). (Drawing by C. Feller.)



A



B

Plate 85. **Spider beetles** (Ptinidae): A, *Ptinus* sp., larva (3-5) (drawing by C. Feller); B, **Australian spider beetle,** *Ptinus ocellus,* adult (2.5-4.5).

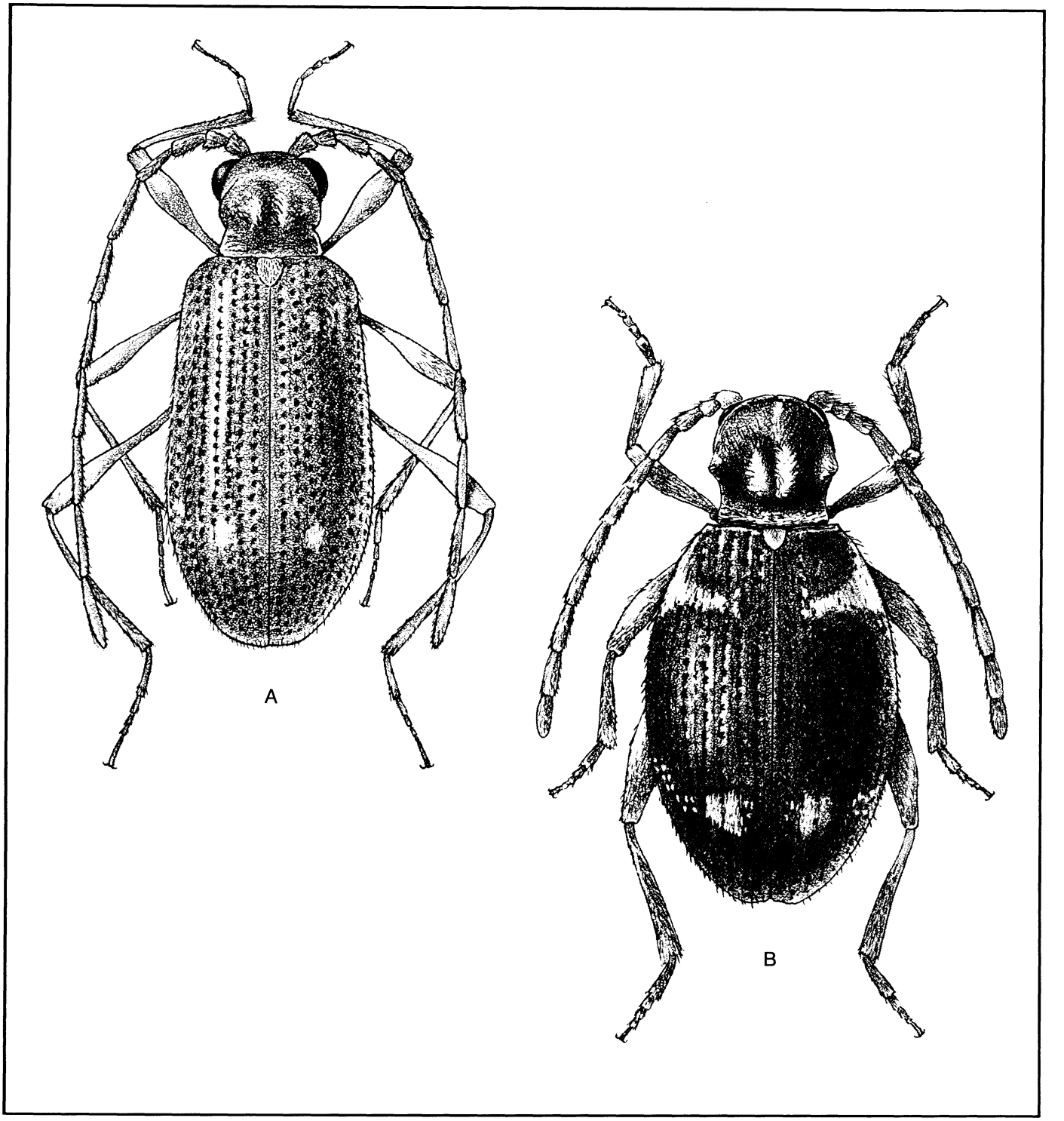
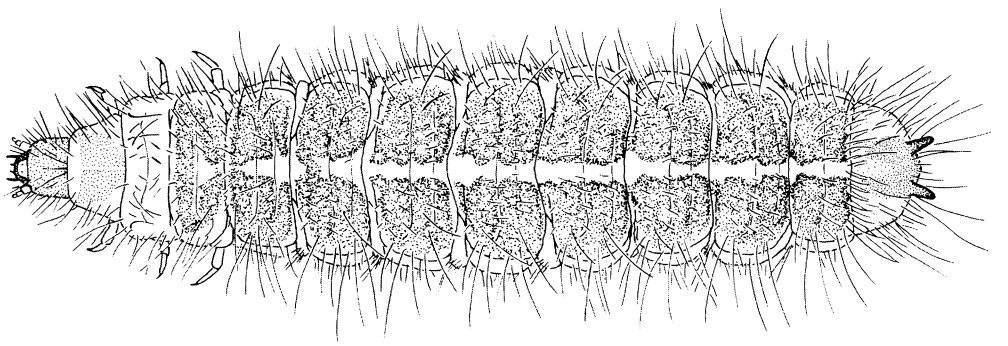


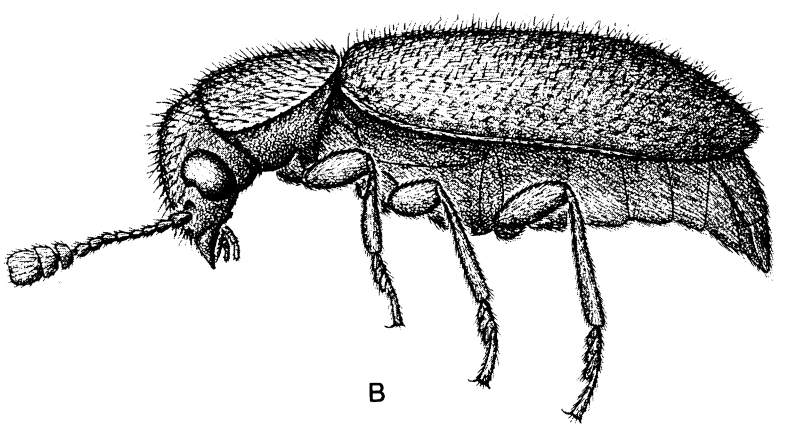
Plate 86. **Whitemarked spider beetle,** *Ptinus fur* (Ptinidae) (2-4.3): A, male; B, female.

CHECKERED BEETLES (CLERIDAE)

This plate, drawn by C. Feller, is a continuation from part 1, chapter 4, by D.M. Anderson and chapter 7, by J.M. Kingsolver.



A



B

Plate 87. **Redlegged ham beetle,** *Necrobia rufipes* (Cleridae): A, larva (9-10); B, adult (4-5).

SAP BEETLES (NITIDULIDAE)

This series of illustrations, drawn by C. Feller, is a continuation from part 1, chapter 4 (Larval Beetles), by D.M. Anderson and chapter 8 (Sap Beetles), by W.A. Connell.

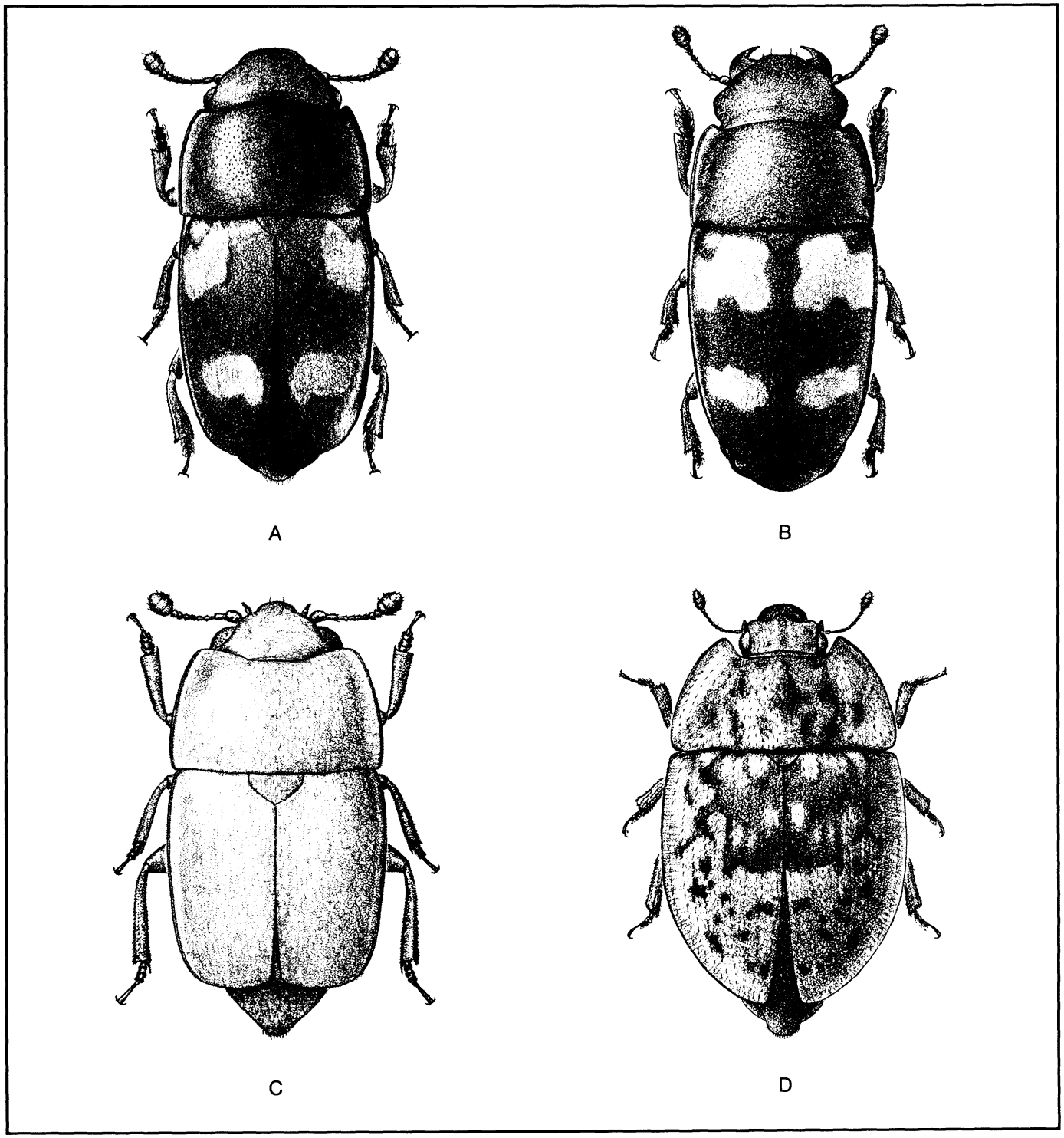


Plate 88. **Sap beetles** (Nitidulidae): A, *Glischrochilus quadrisignatus* (4-7); B, *Glischrochilus fasciatus* (4-7); C, yellowbrown sap beetle, *Haptoncus luteolus* (1.7-2.8); D, *Lobiopa insularis* (4.5-8).

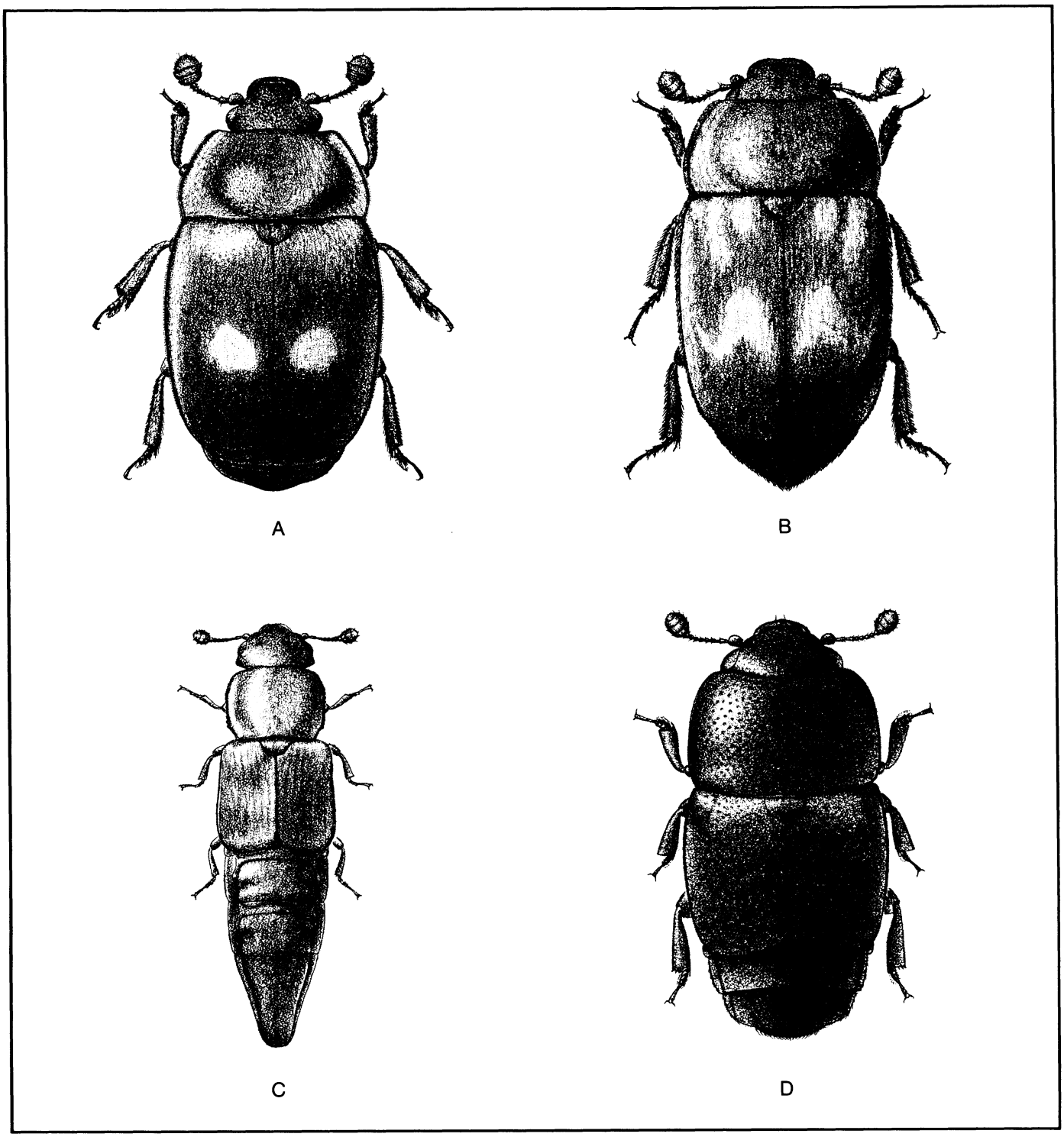
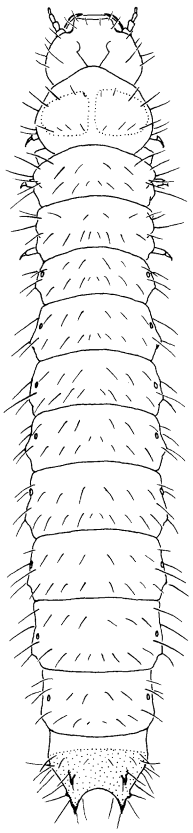
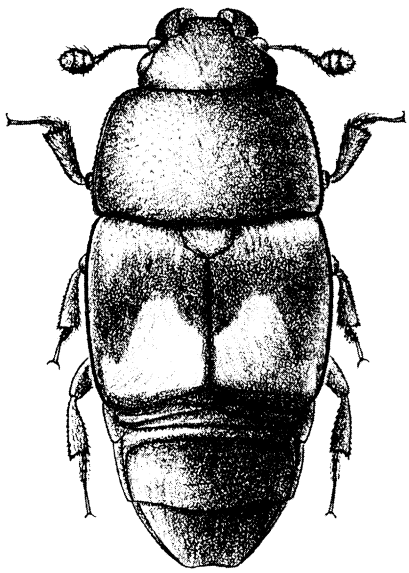


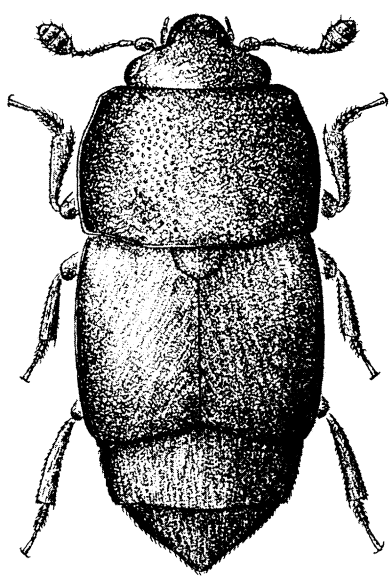
Plate 89. **Sap beetles** (Nitidulidae): A, *Nitidula bipunctata* (3-5); B, *Nitidula ziczac* (3-5); C, *Conotelus stenoides* (3.5-4); D, pineapple sap beetle, *Carpophilus humeralis* (3-4.2).



A



B



C

Plate 90. **Sap beetles** (Nitidulidae): A, **driedfruit beetle,** *Carpophilus hemipterus,* larva (6-9); B, same, adult (2-4); C, *Carpophilus obsoletus* (2.5-4).

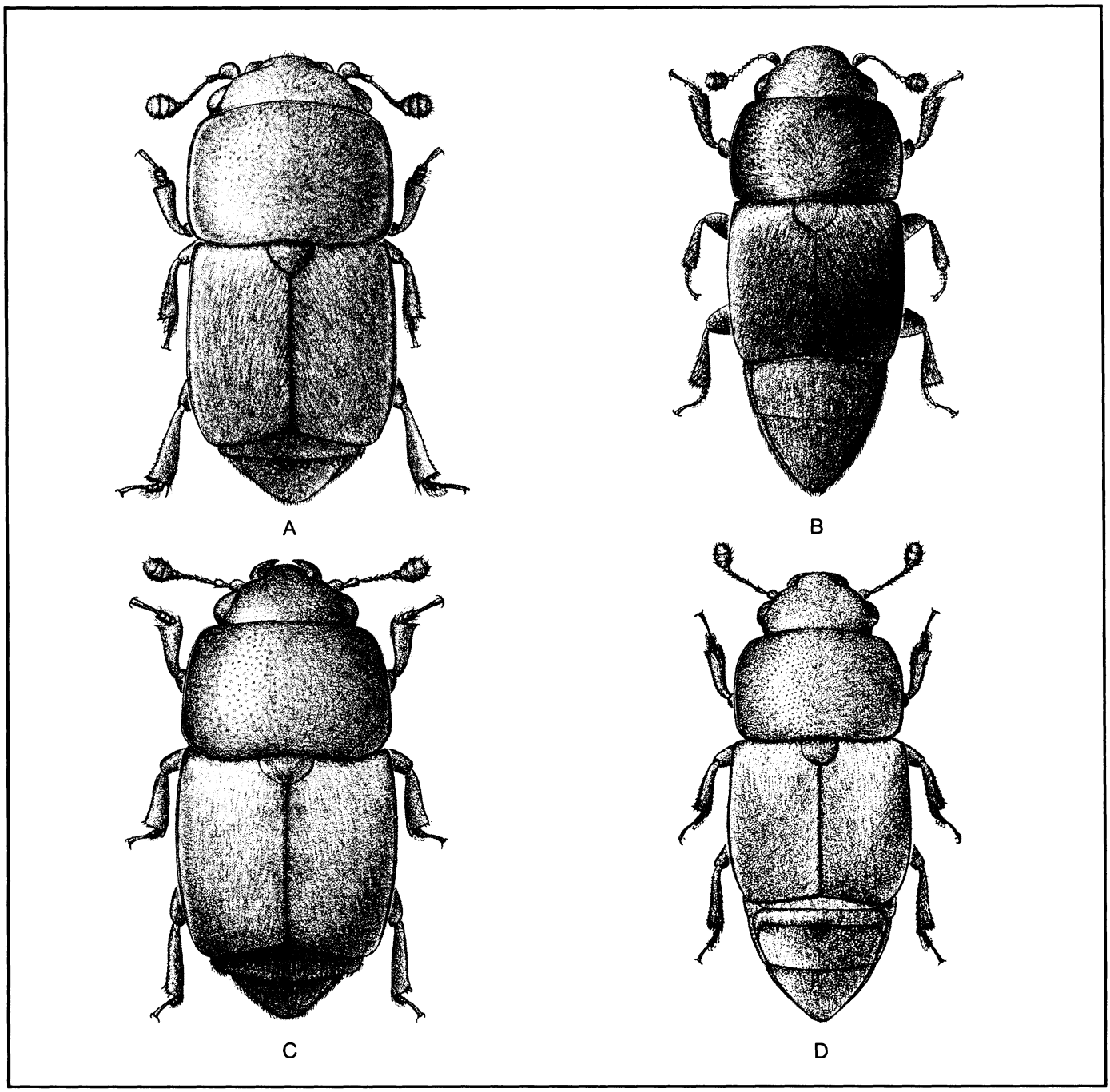


Plate 91. Habitus types (A-D) in the *Carpophilus dimidiatus* group (**sap beetles,** Nitidulidae). All the types and intermediates occur in each species. B and D are illustrated with distended abdomens. The complex consists of *Carpophilus dimidiatus* (2.2-3.2), *Carpophilus freemani* (1.9-2.9), *Carpophilus fumatus* (2.3-3.6), *Carpophilus maculatus* (2.5-3.4), *Carpophilus mutilatus* (2-3.4), and *Carpophilus pilosellus* (1.5-2.5).

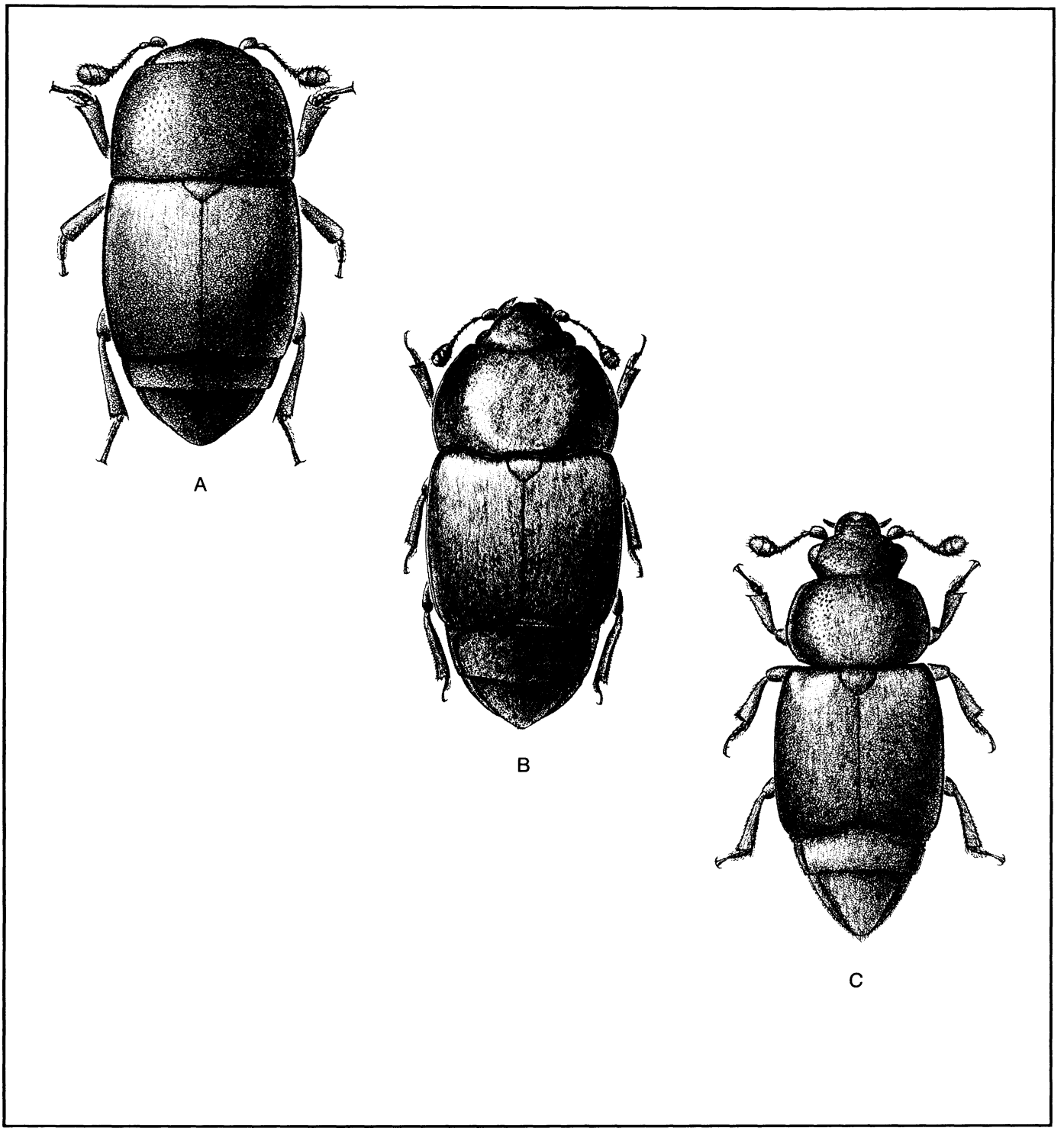
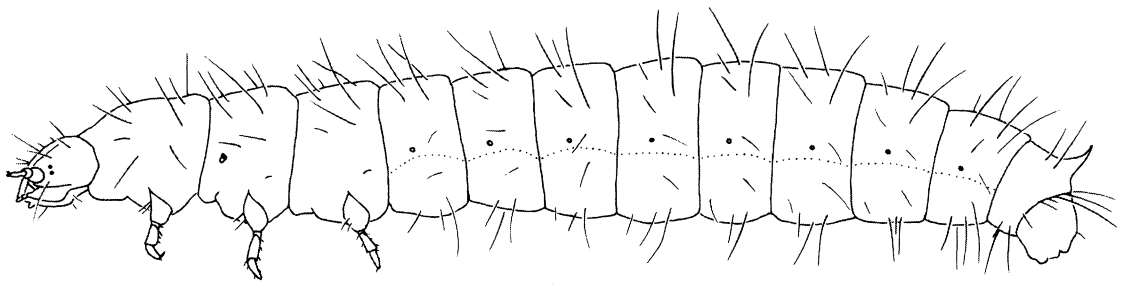


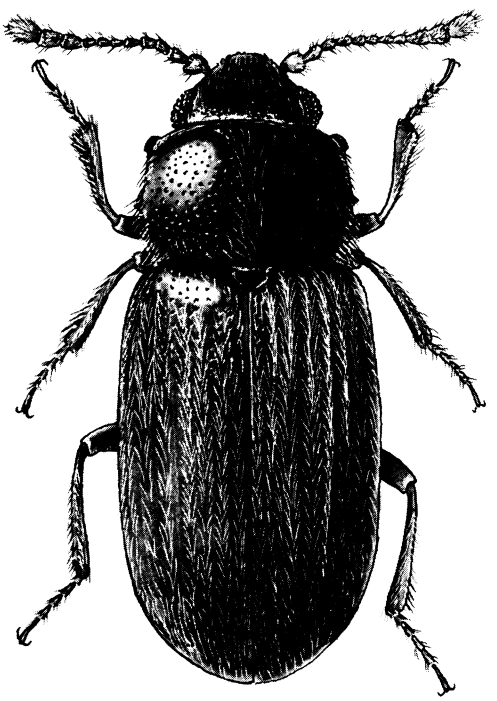
Plate 92. **Sap beetles** (Nitidulidae): A, *Carpophilus marginellus* (2.7-3.5); B, **dusky sap beetle,** *Carpophilus lugubris* (3-4.5); C, *Carpophilus ligneus* (2.5-3.2).

CRYPTOPHAGID BEETLES (CRYPTOPHAGIDAE)

These illustrations are a continuation from Part 1, chapter 4 (Larval Beetles), by D.M. Anderson and chapter 9 (Cryptophagid Beetles), by J.M. Kingsolver.



A

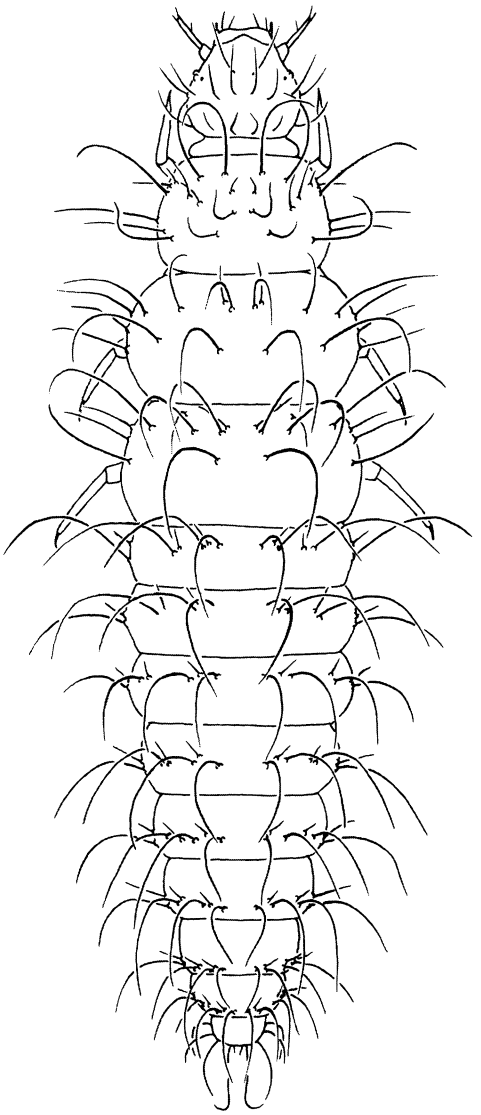


B

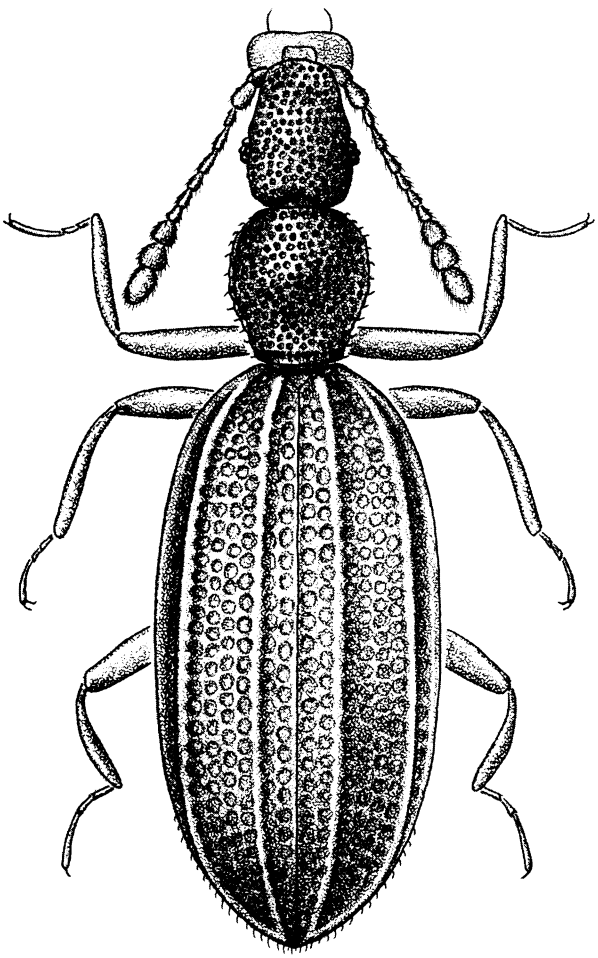
Plate 93. **Silken fungus beetles** (Cryptophagidae): A, *Cryptophagus laticollis,* larva (2.5-3.3) (drawing by C. Feller); B, cellar beetle, *Cryptophagus cellaris,* adult (2.2-2.7) (drawing by A.D. Cushman).

MINUTE BROWN SCAVENGER BEETLES (LATHRIDIIDAE)

These illustrations, drawn by C. Feller, are a continuation from part 1, chapter 3 (Larval Beetles), by D.M. Anderson and chapter 10 (Lathridiid Beetles), by J.M. Kingsolver and F.G. Andrews.



A



B

Plate 94. **Minute brown scavenger beetles** (Lathridiidae): A, *Aridius nodifer,* larva (2.4); B, *Adistemia watsoni,* adult (1.2-1.7).

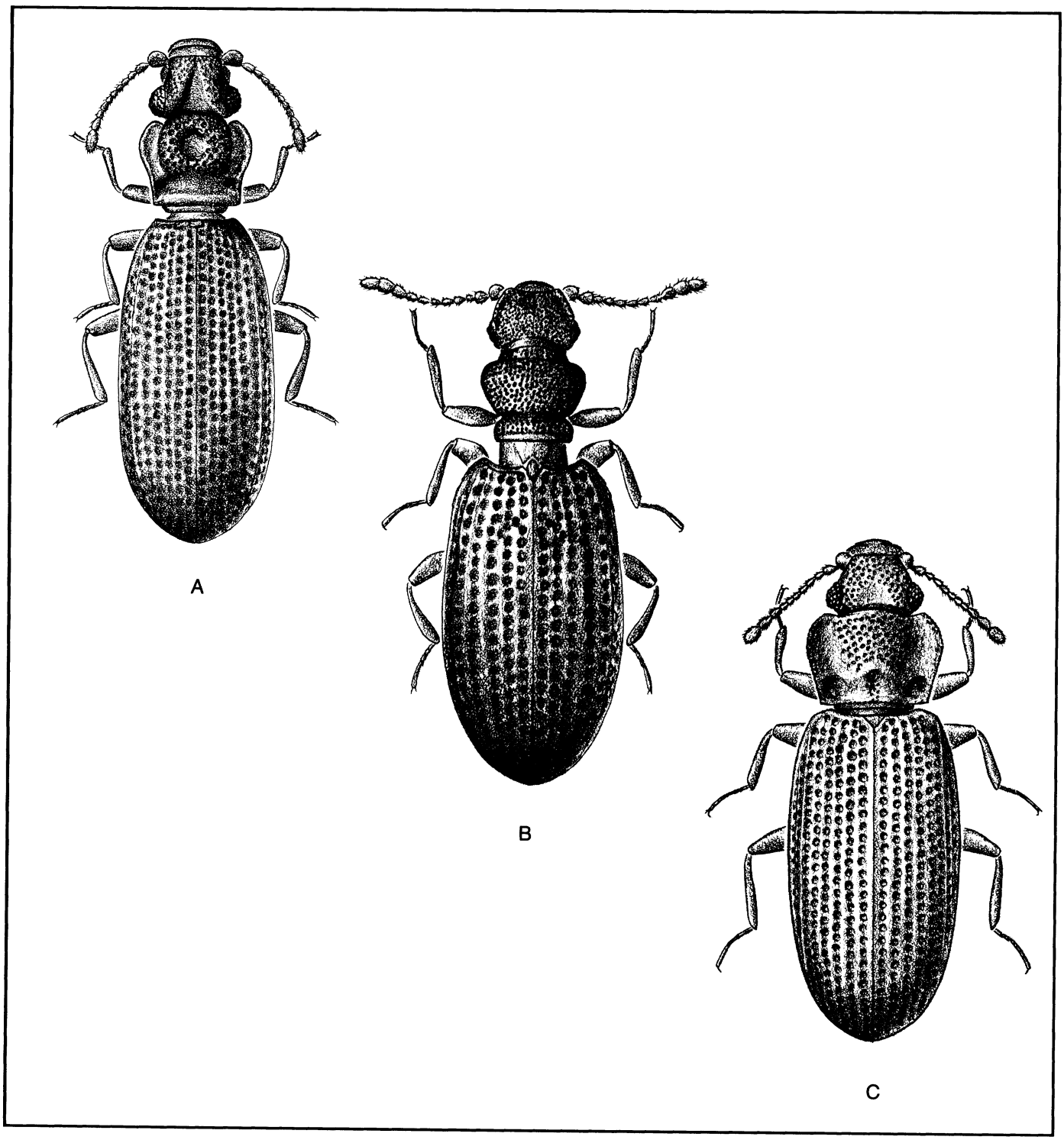
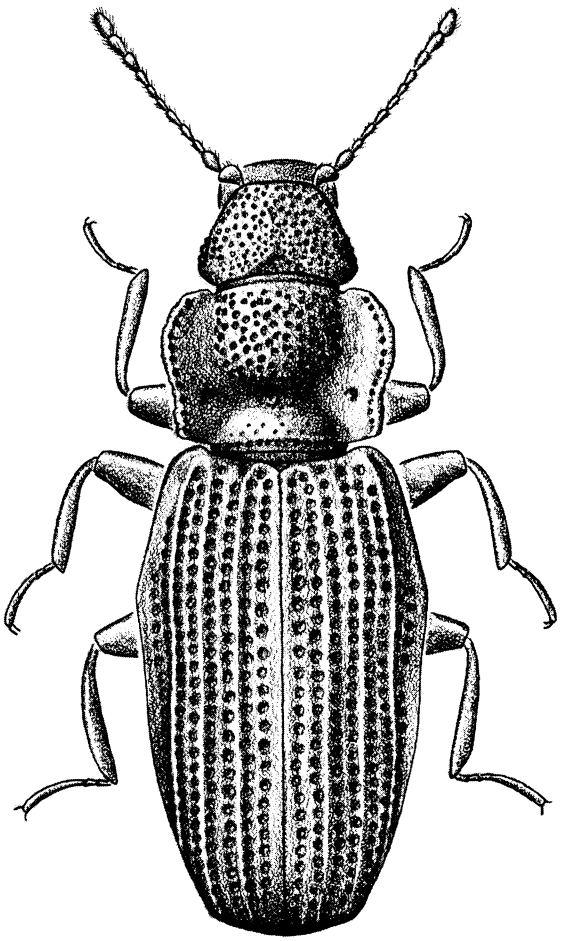
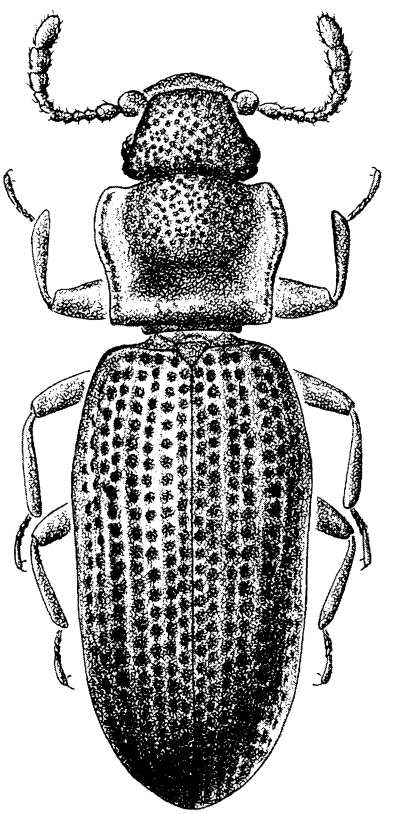


Plate 95. **Minute brown scavenger beetles** (Lathridiidae): A, *Dienerella filum* (1.2-1.6); B, *Dienerella ruficollis* (1-1.2); C, *Dienerella arga* (1.3-1.4).



A



B

Plate 96. **Minute brown scavenger beetles** (Lathridiidae): A, *Dienerella costulata* (1-1.5); B, *Dienerella filiformis* (1.2-1.4).

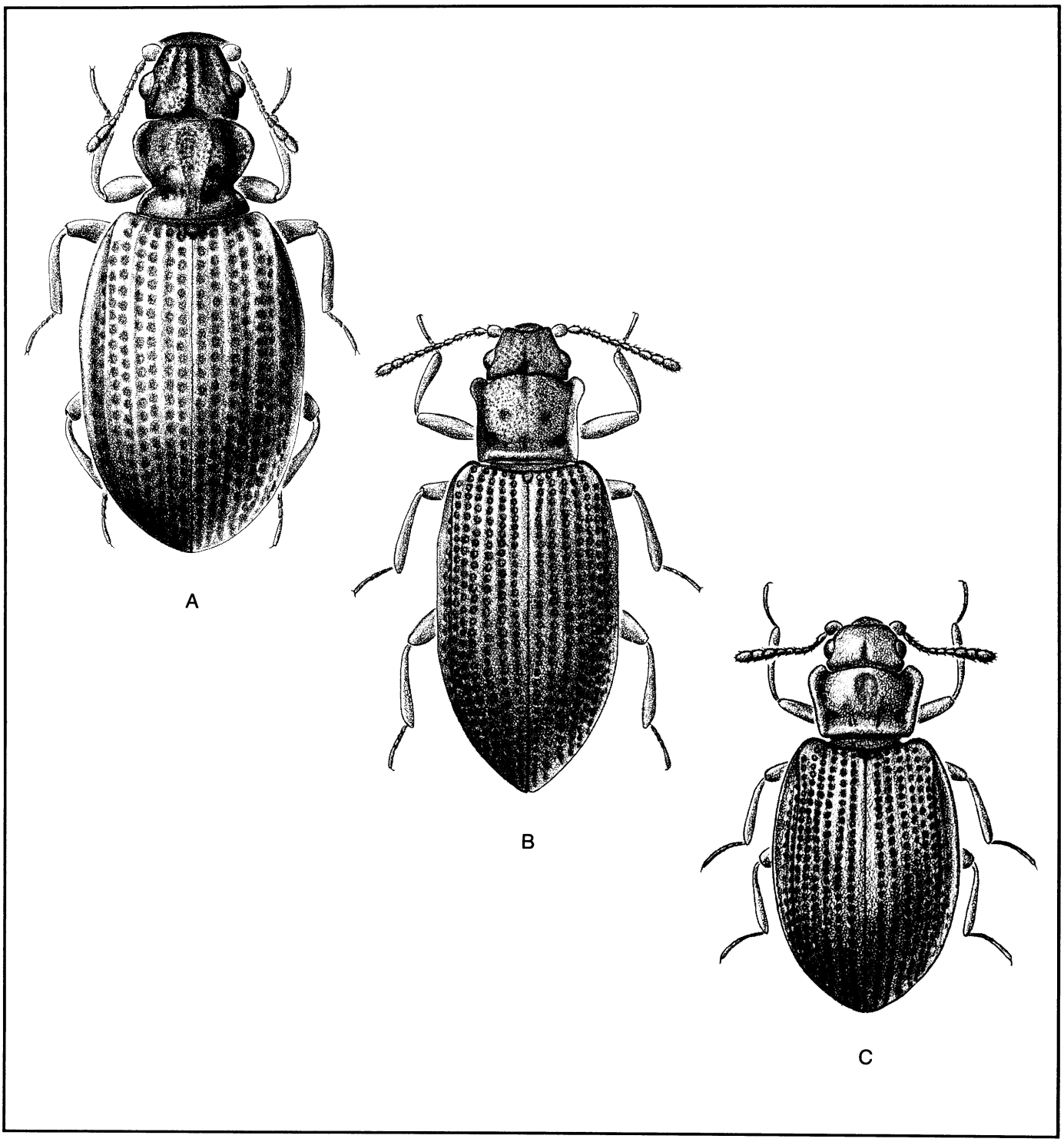


Plate 97. **Minute brown scavenger beetles** (Lathridiidae): A, **plaster beetle,** *Cartodere constricta* (1.2-1.7); B, *Lathridius protensicollis* (2.4-2.6); C, **squarenosed fungus beetle,** *Lathridius minutus* (1.2-2.4).

Notes and Sketches

DARKLING BEETLES (TENEBRIONIDAE)

These illustrations, drawn by A.D. Cushman unless otherwise noted, are a continuation from part 1, chapter 3 (Larval Beetles), by D.M. Anderson and chapter 11 (Darkling Beetles), by T.J. Spilman.

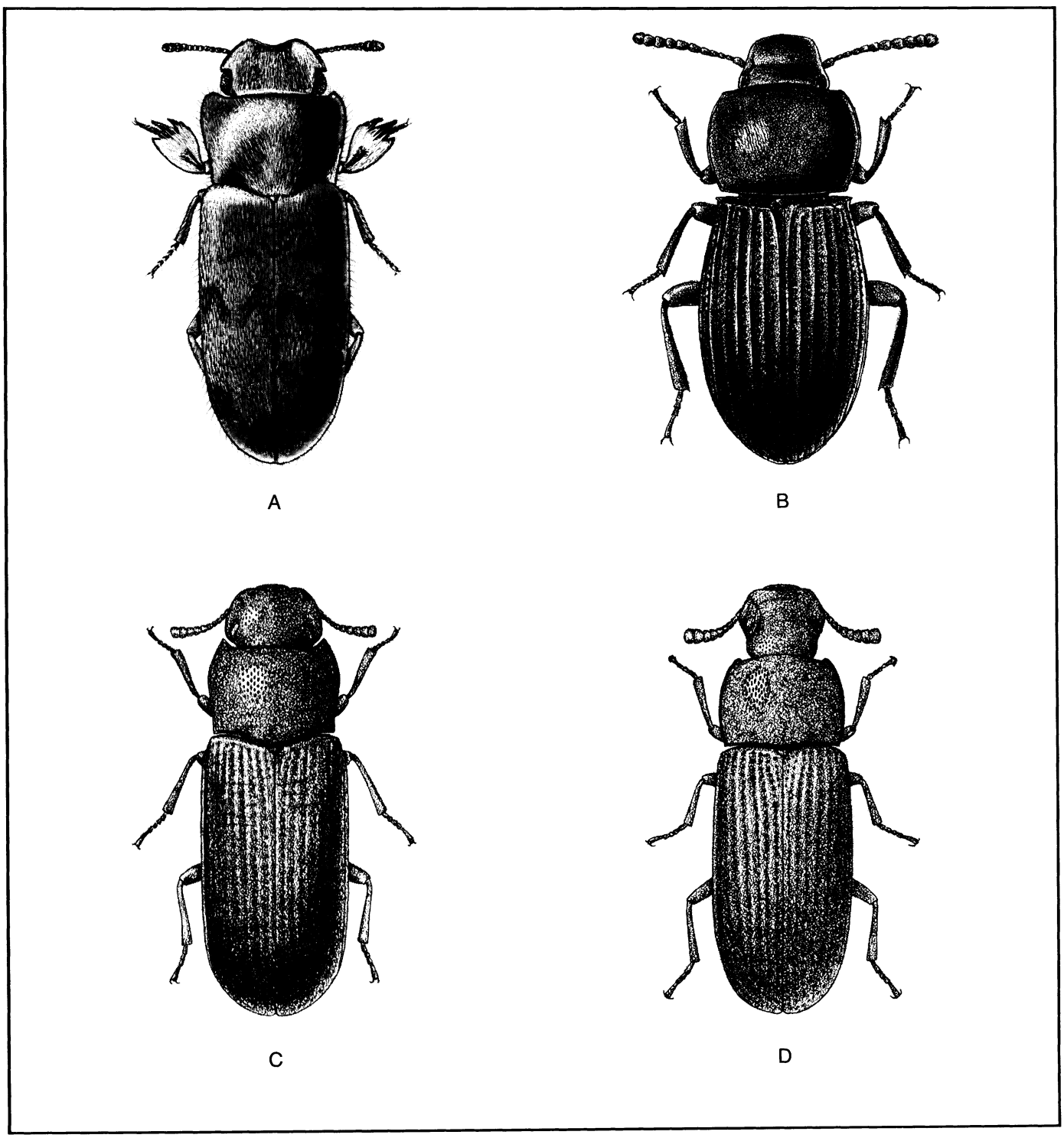
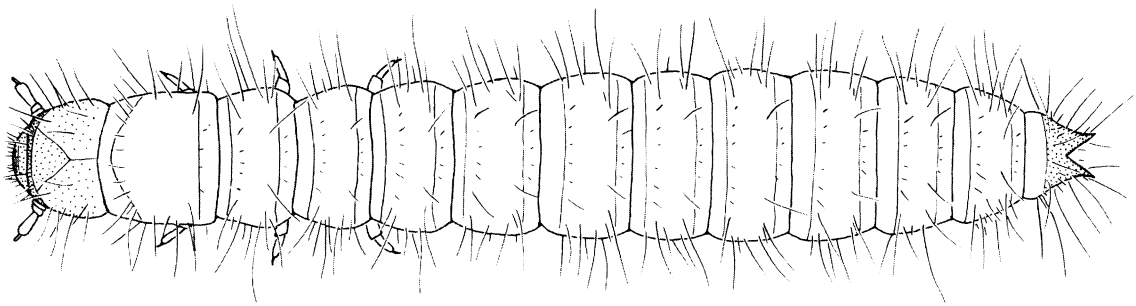
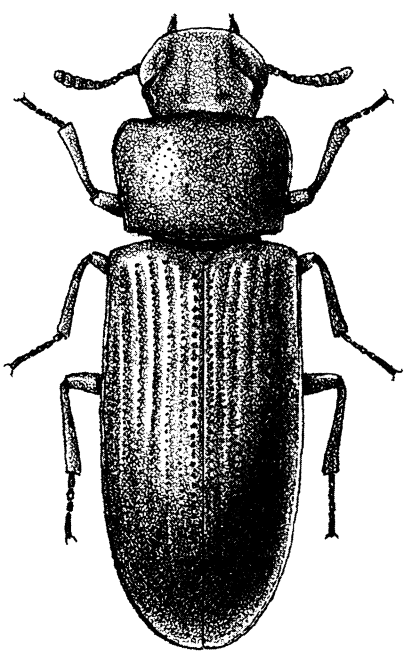


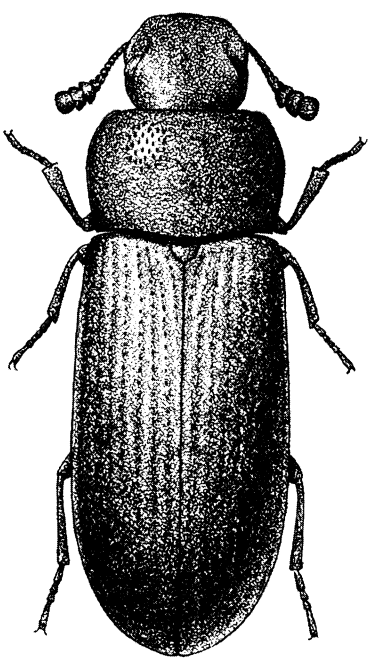
Plate 98. Tenebrionid beetles (Tenebrionidae): A, *Lepidocnemeplatia sericea* (2.6-4.4); B, fig engraver beetle, *Apsena rufipes* (4.2-7); C, giant flour beetle, *Tribolium brevicorne* (5-7); D, false black flour beetle, *Tribolium destructor* (4.5-5.7).



A



B



C

Plate 99. Flour beetles (Tenebrionidae): A, **confused flour beetle,** *Tribolium confusum,* larva (6-7) (drawing by C. Feller); B, same, adult (2.6-4.4); C, **red flour beetle,** *Tribolium castaneum* (2.3-4.4).

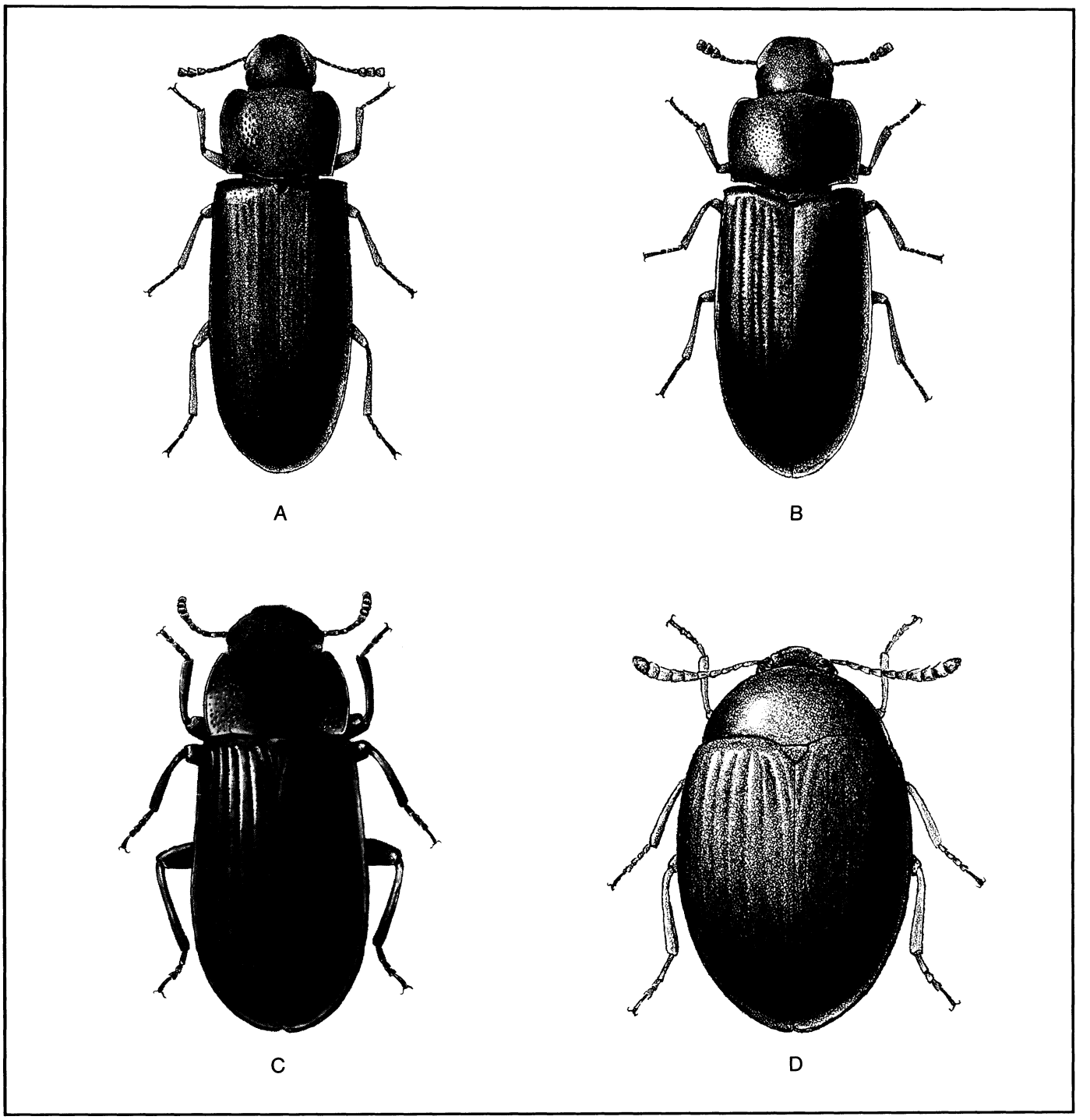


Plate 100. Tenebrionid beetles (Tenebrionidae): A, **American black flour beetle,** *Tribolium audax* (2.8-4.5); B, black flour beetle, *Tribolium madens* (3.9-5.1); C, *Neatus tenebrioides* (10.5-14.5); D, redhorned grain beetle, *Platydema ruficorne* (3.5-5.8).

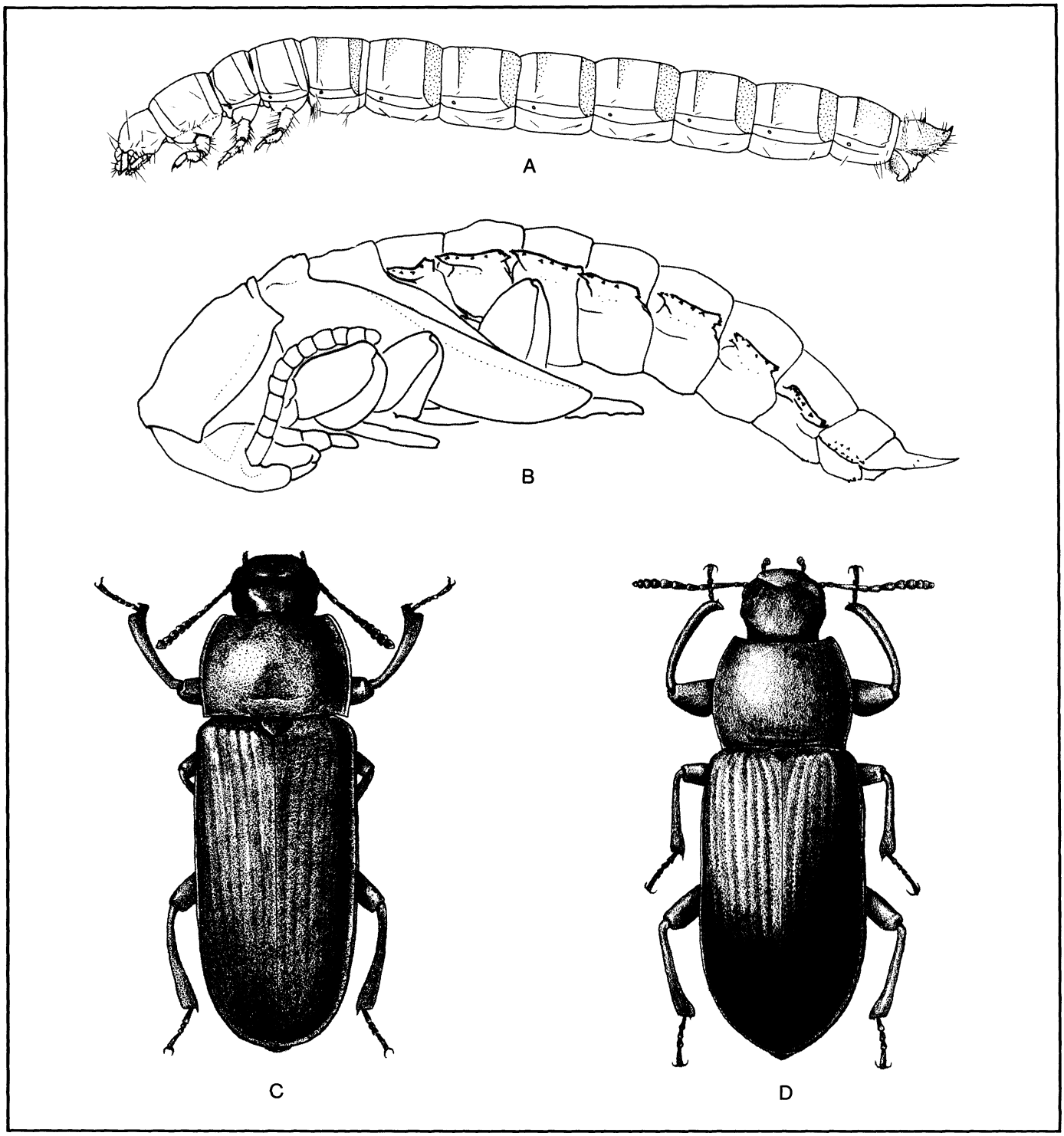


Plate 101. Mealworms (Tenebrionidae): A, **yellow mealworm,** *Tenebrio molitor,* larva (12-32); B, same, pupa (drawings A&B by C. Feller); C, same, adult (15); D, **dark mealworm,** *Tenebrio obscurus* (13.5-18).

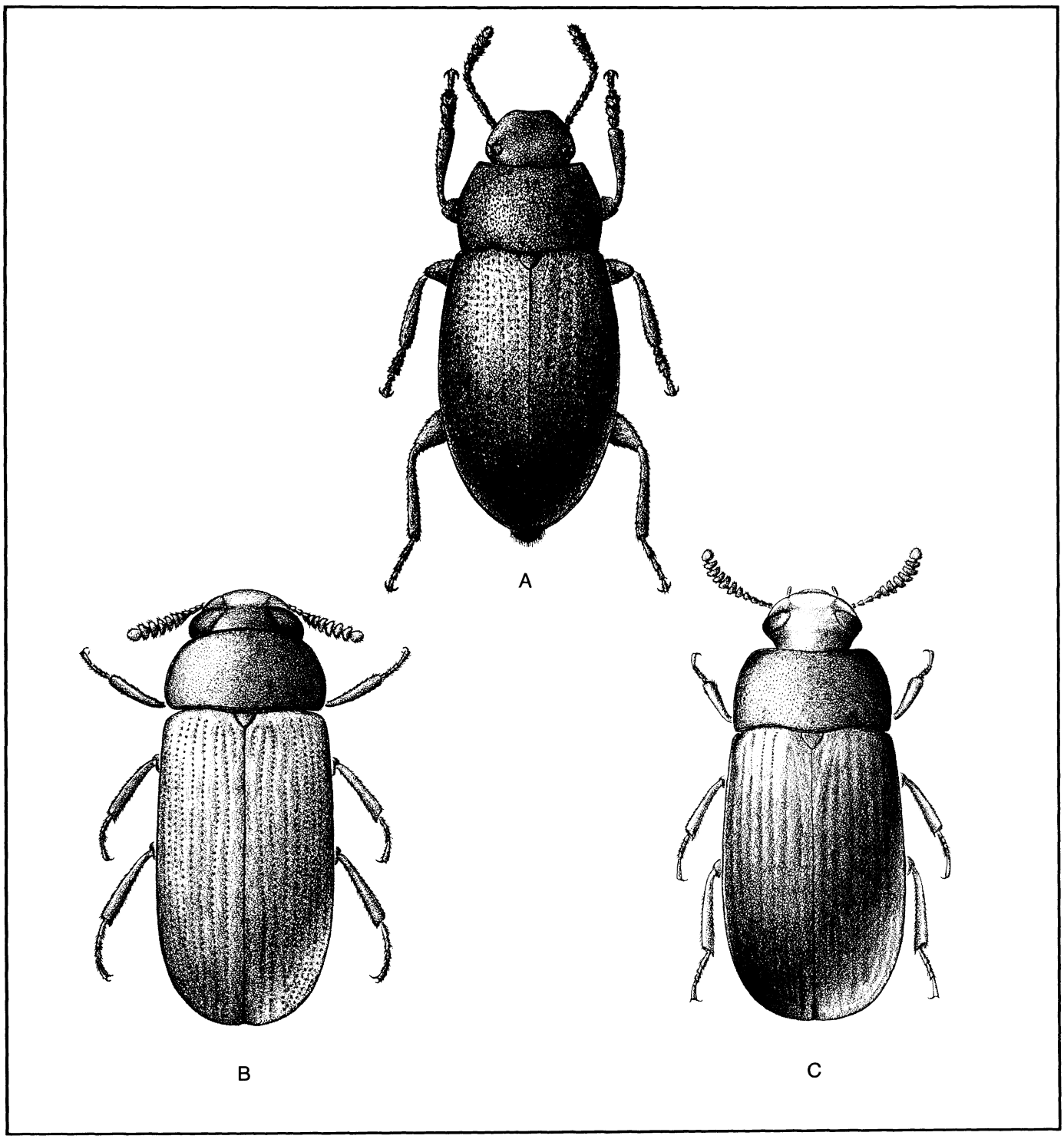


Plate 102. **Darkling beetles** (Tenebrionidae) (drawings by C. Feller): A, fig darkling beetle, *Blapstinus discolor* (4.1-7); B, *Palembus ocularis* (3.5-4.3); C, *Palembus dermestoides* (5.7-6.2).

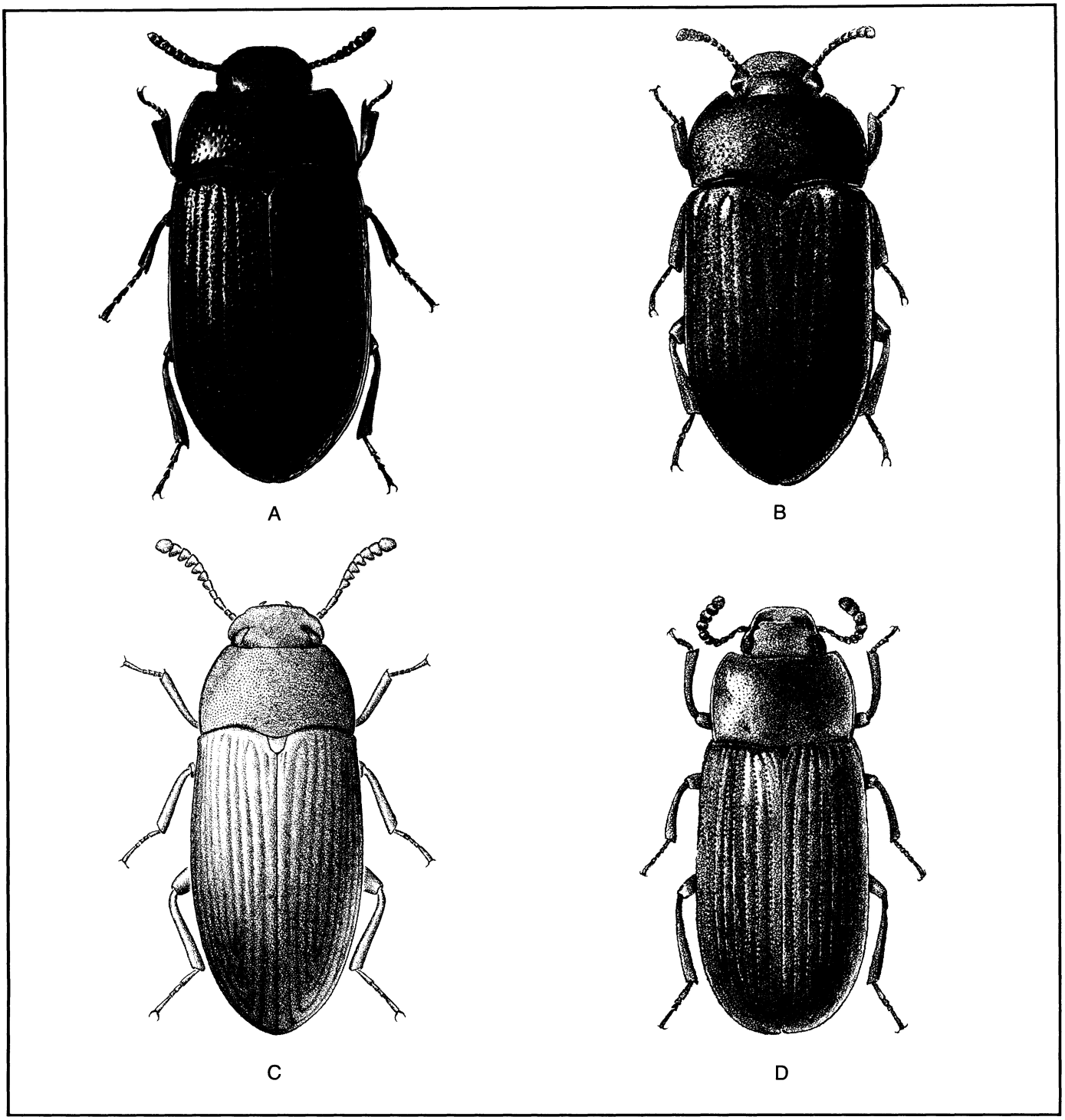


Plate 103. Tenebrionid beetles (Tenebrionidae): A, **lesser mealworm,** *Alphitobius diaperinus* (5.5-7); B, **black fungus beetle,** *Alphitobius laevigatus* (4.5-6.7); C, *Alphitobius viator* (5.5-6.6) (drawing by C. Feller); D, **larger black flour beetle,** *Cynaeus angustus* (4.5-6.1).

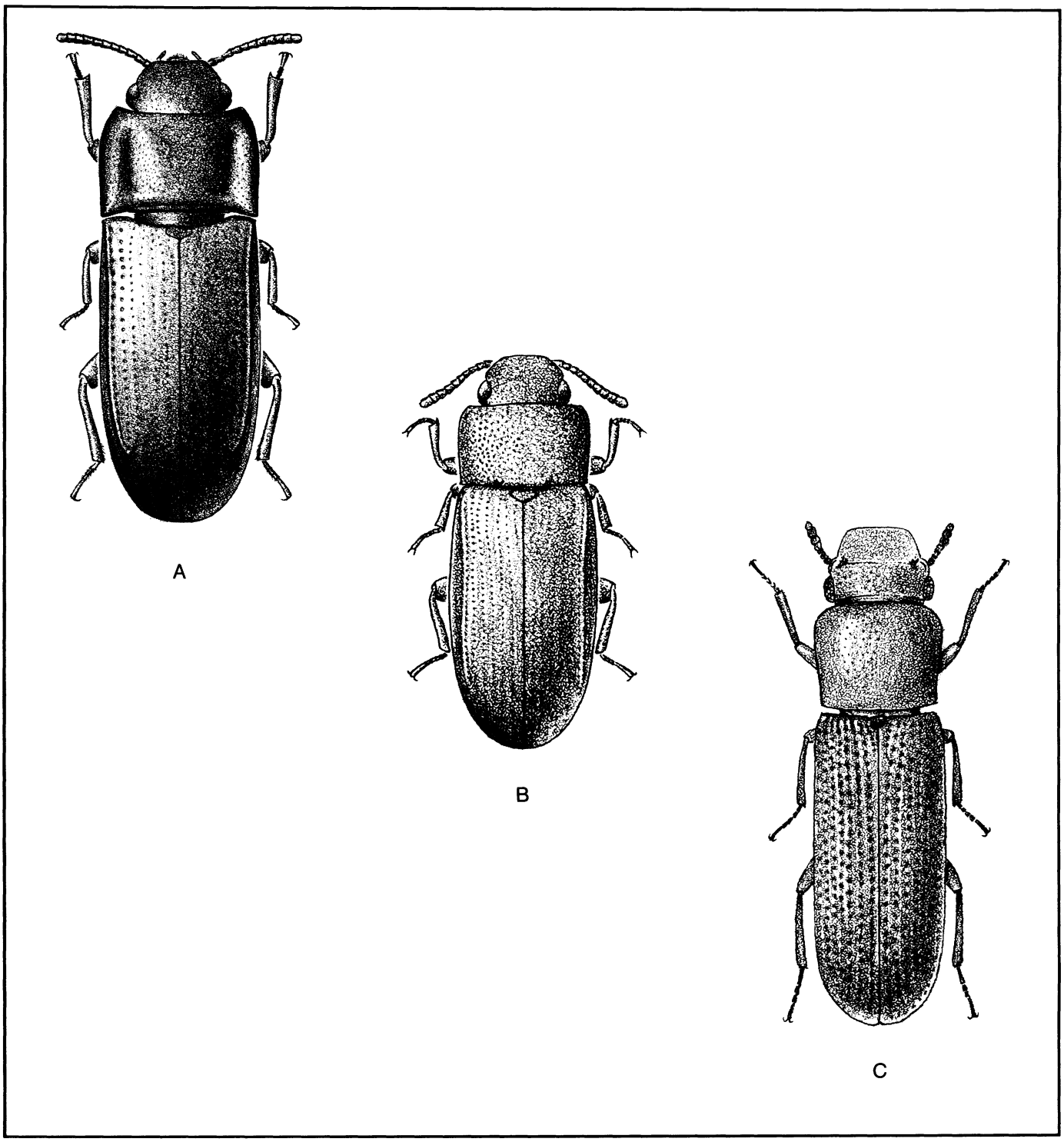


Plate 104. **Darkling beetles** (Tenebrionidae): A, *Coelopalorus foveicollis* (3.6-4.3); B, *Coelopalorus carinatus* (1.9-2.6) (drawings A&B by C. Feller); C, **longheaded flour beetle,** *Latheticus oryzae* (2.3-5.7).

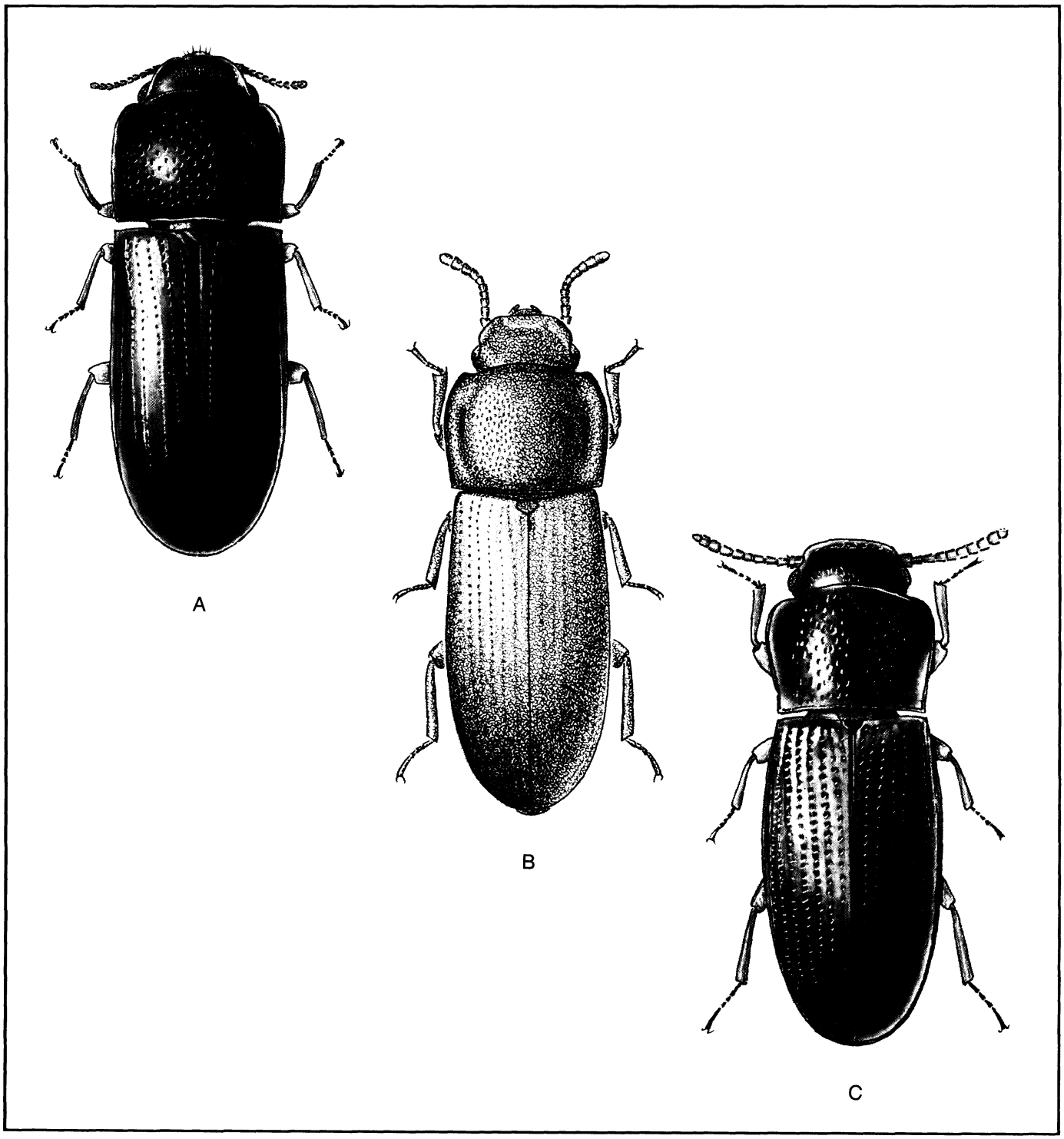


Plate 105. Tenebrionid beetles (Tenebrionidae): A, **depressed flour beetle,** *Palorus subdepressus* (2.7-3); B, *Palorus laesicollis* (2.2-2.9) (drawing by C. Feller); C, **smalleyed flour beetle,** *Palorus ratzeburgii* (2.4-3).

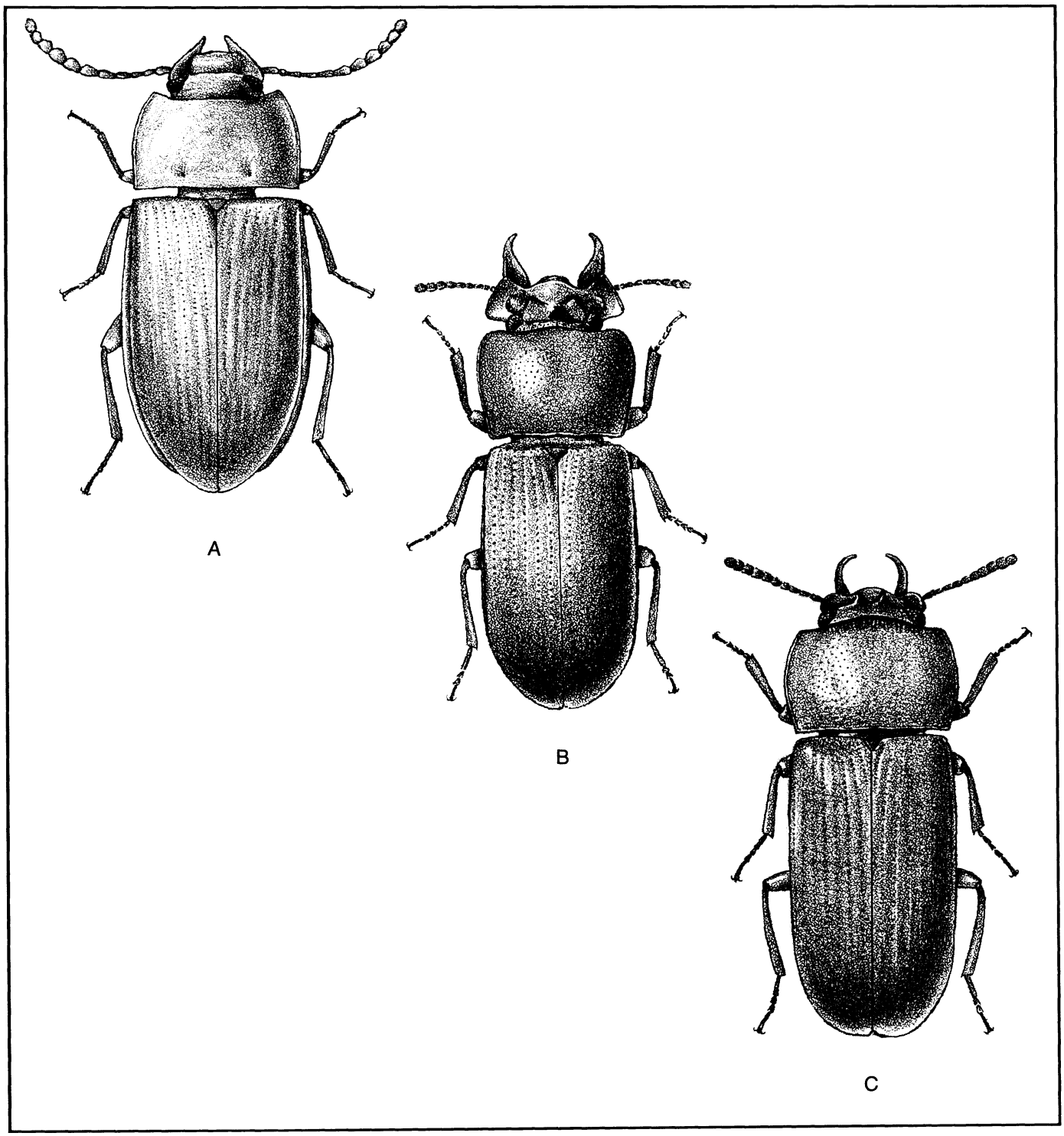


Plate 106. **Darkling beetles** (Tenebrionidae), males: A, *Sitophagus hololeptoides* (5-7.2); B, **broadhorned flour beetle,** *Gnatocerus cornutus* (3.5-4.9); C, **slenderhorned flour beetle,** *Gnatocerus maxillosus* (3-4).

SEED BEETLES (BRUCHIDAE)

These illustrations, drawn by C. Feller unless otherwise noted, are a continuation from part 1, chapter 4 (Larval Beetles), by D.M. Anderson and chapter 12 (Seed Beetles), by J.M. Kingsolver.

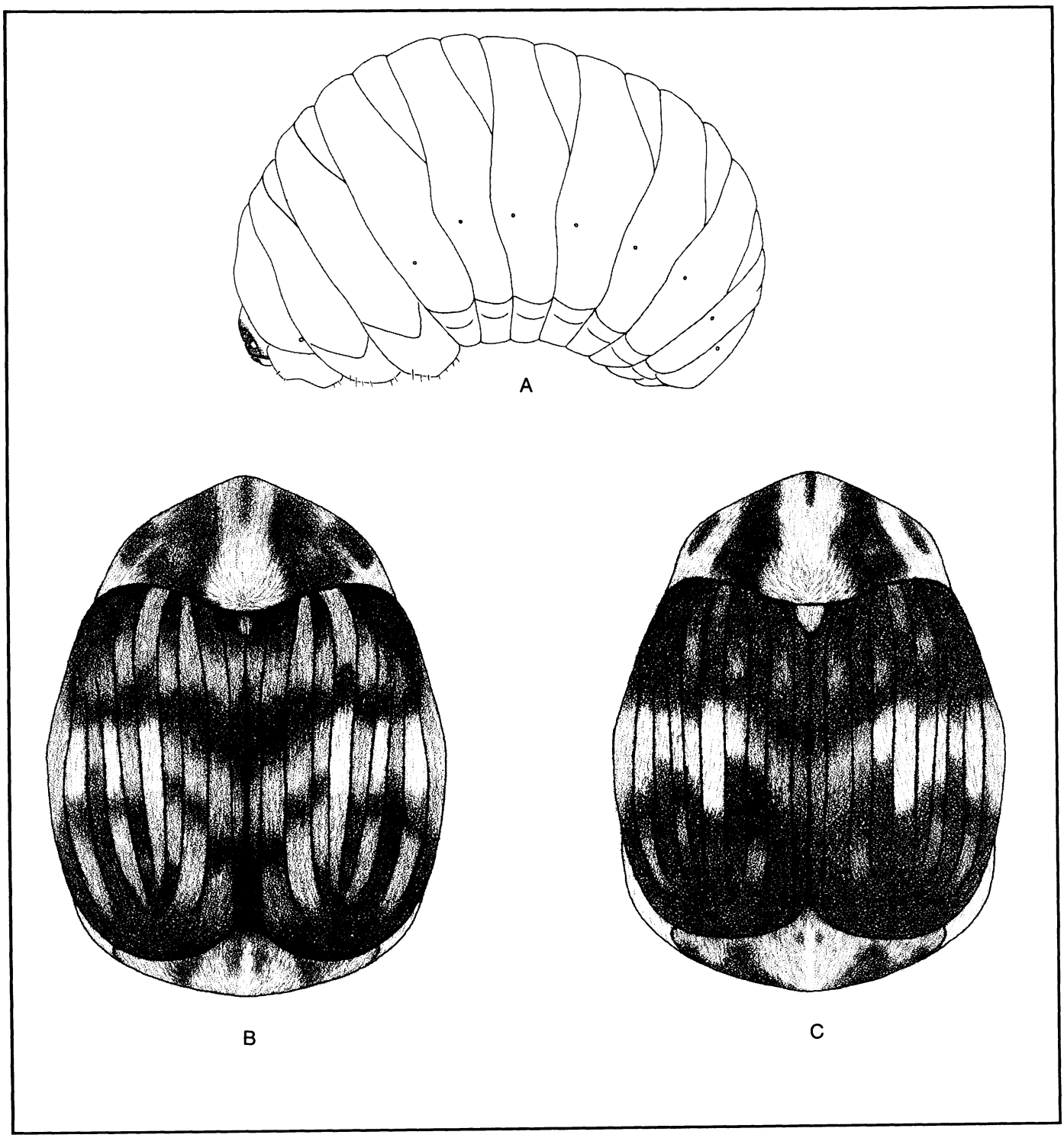


Plate 107. **Mexican bean weevil,** *Zabrotes subfasciatus* (Bruchidae): A, larva (3-3.5); B, male (1.9-2.2); C, female (2.3-2.5).

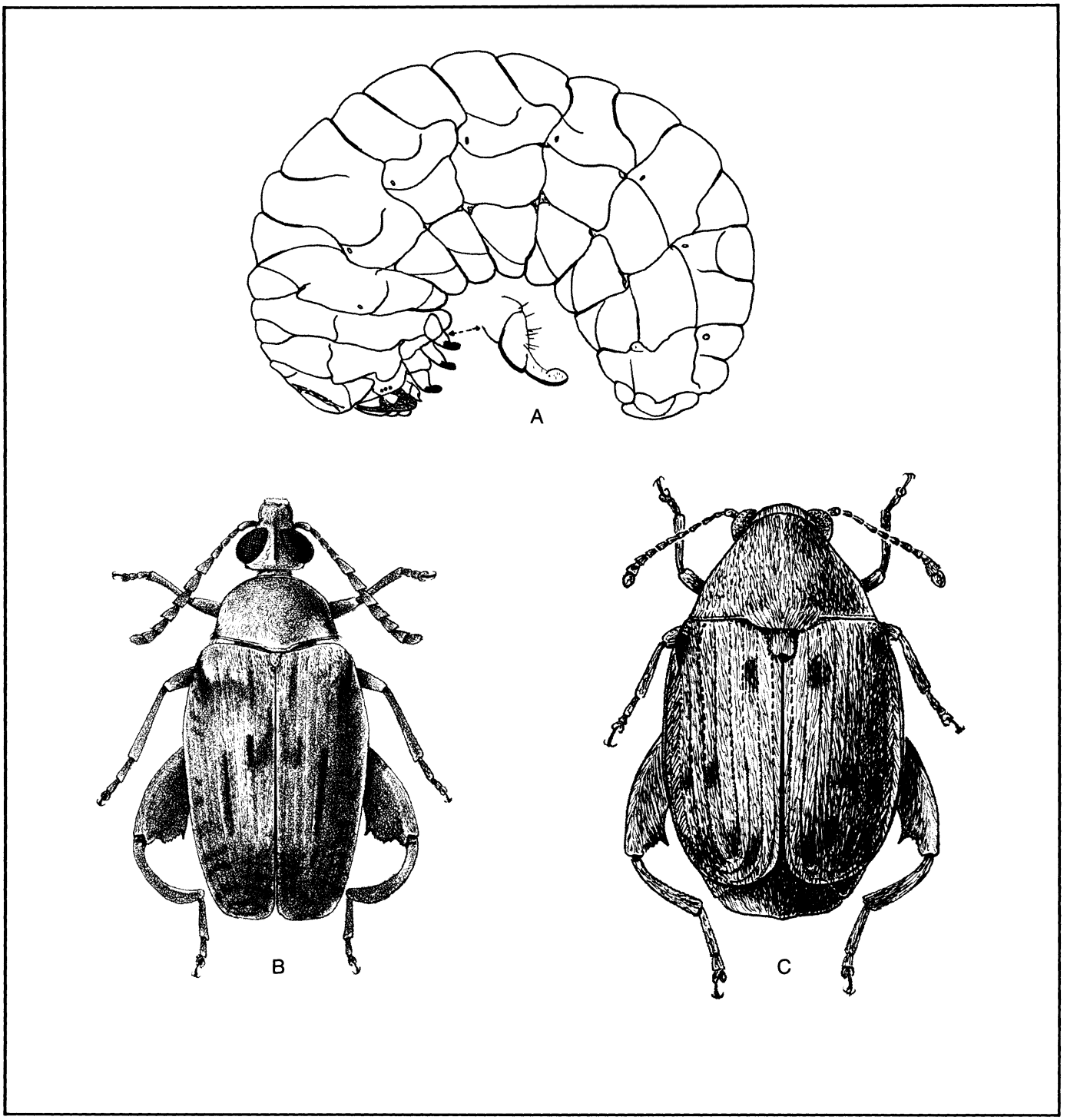
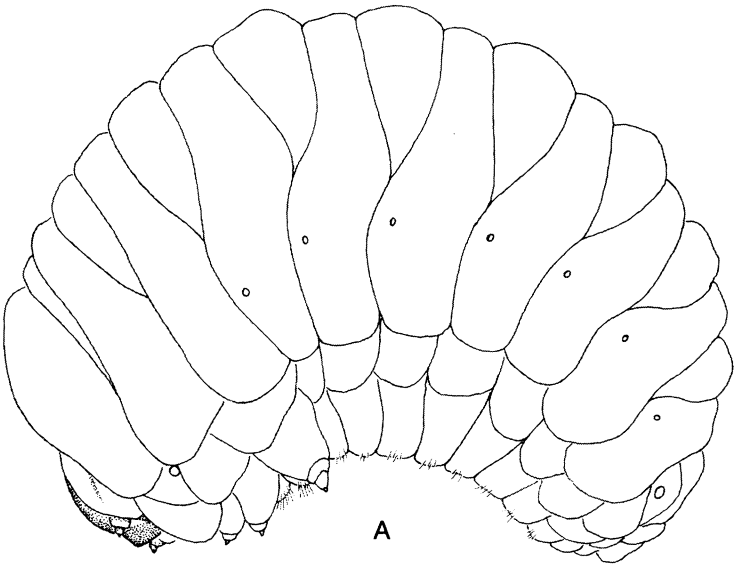


Plate 108. **Seed beetles** (Bruchidae): A, groundnut bruchid, *Caryedon serratus,* larva (6) (drawing by J.M. Kingsolver); B, same, adult (3.5-6.8); C, **bean weevil,** *Acanthoscelides obtectus* (3-4.5) (drawings B&C by A.D. Cushman).



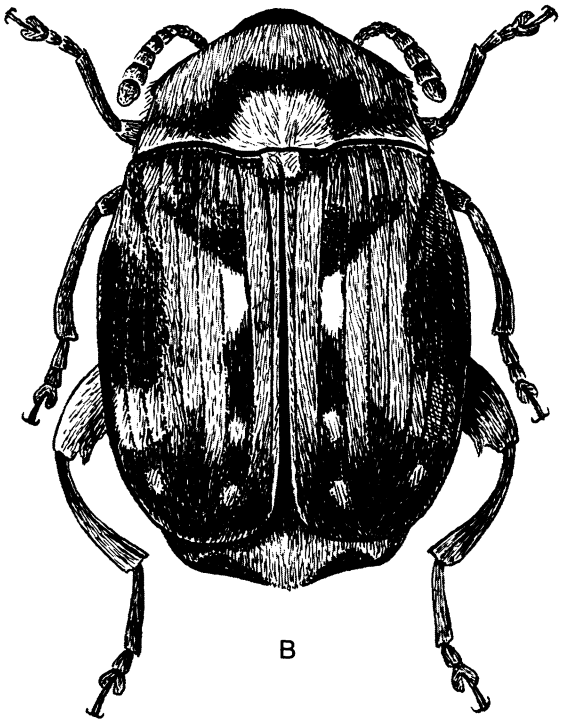
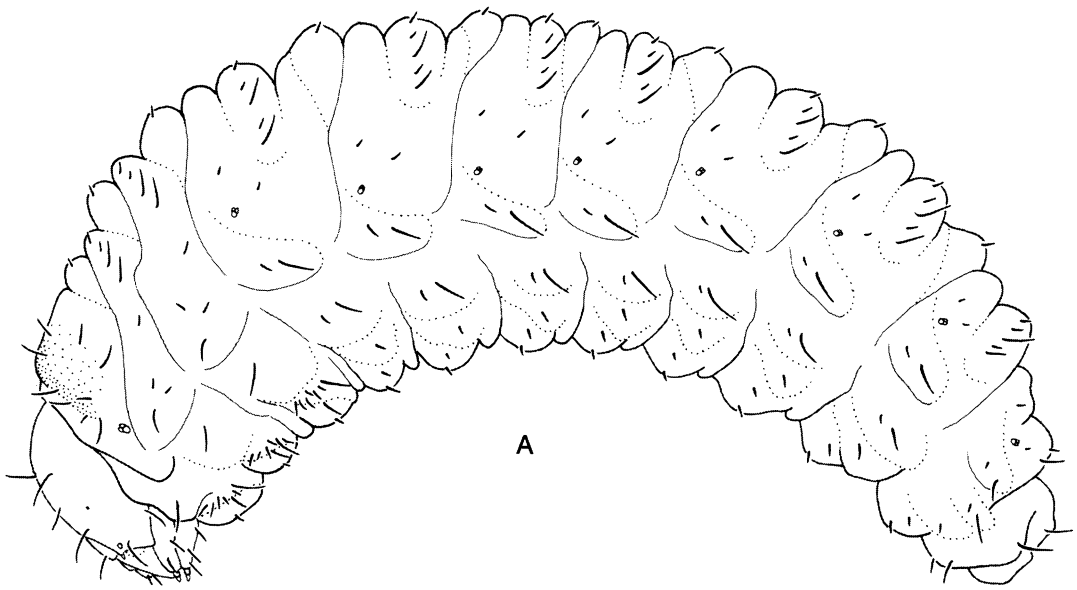


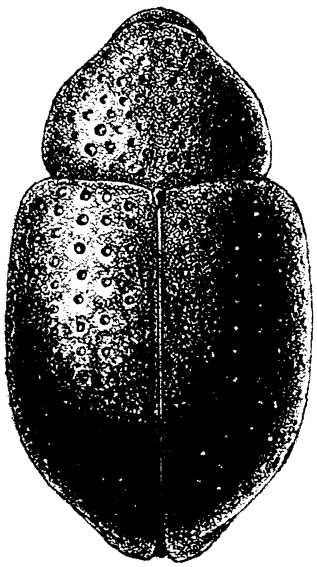
Plate 109. **Pea weevil,** *Bruchus pisorum* (Bruchidae): A, larva (4.5-5); B, adult (4.5-5) (drawing by A.D. Cushman).

WEEVILS (CURCULIONIDAE)

These illustrations, drawn by C. Feller unless otherwise noted, are a continuation from part 1, chapter 4 (Larval Beetles), by D.M. Anderson and chapter 13 (Weevils), by D.R. Whitehead.



A



B

Plate 110. **Cowpea curculio,** *Chalcodermus aeneus* (Curculionidae): A, larva (7) (drawing by M. Ryan); B, adult (4-4.5) (drawing by A.D. Cushman).

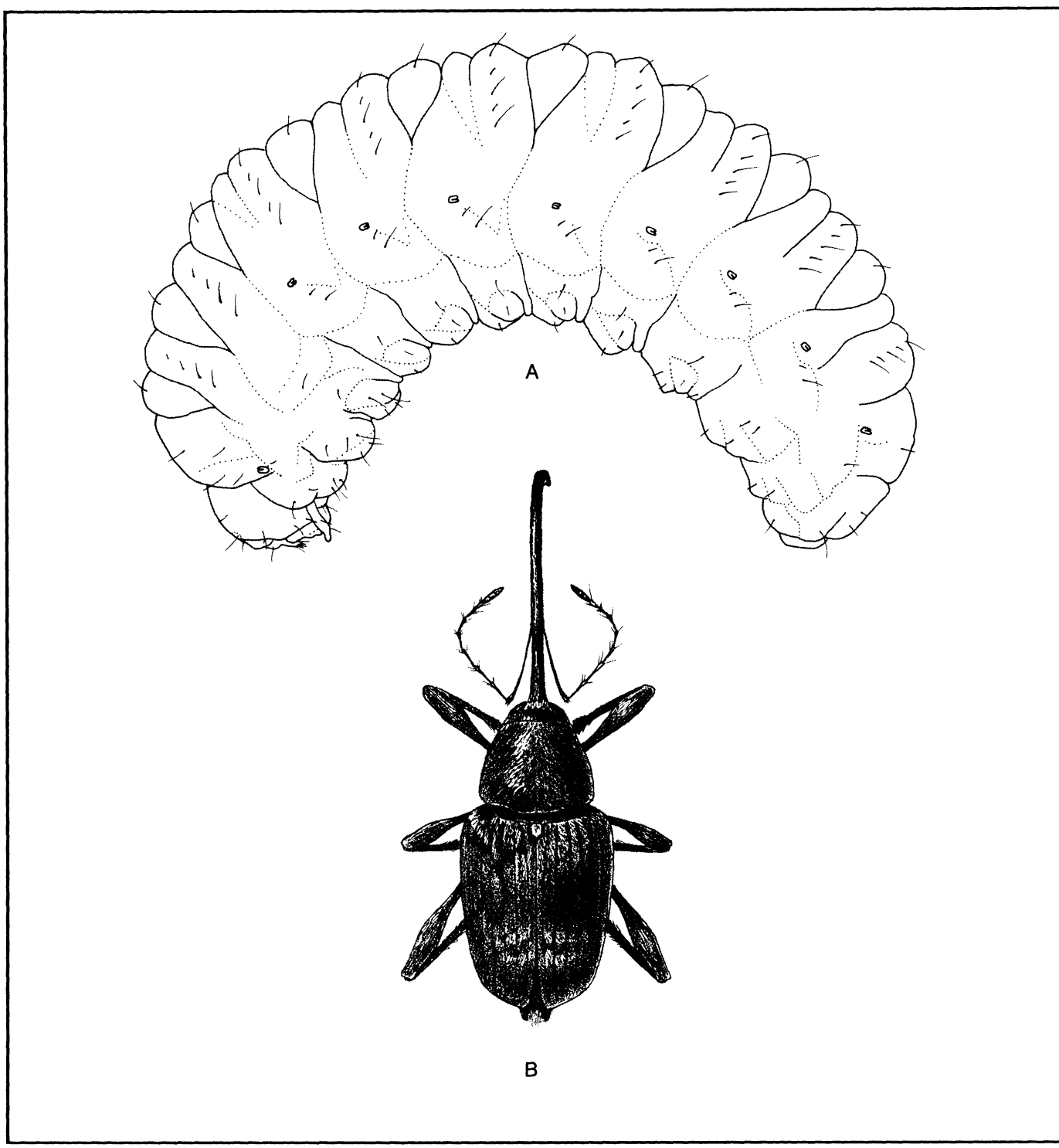


Plate 111. **Pecan weevil,** *Curculio caryae* (Curculionidae): A, larva (15) (drawing by M. Ryan); B, adult (7.5-12) (drawing by A.D. Cushman).

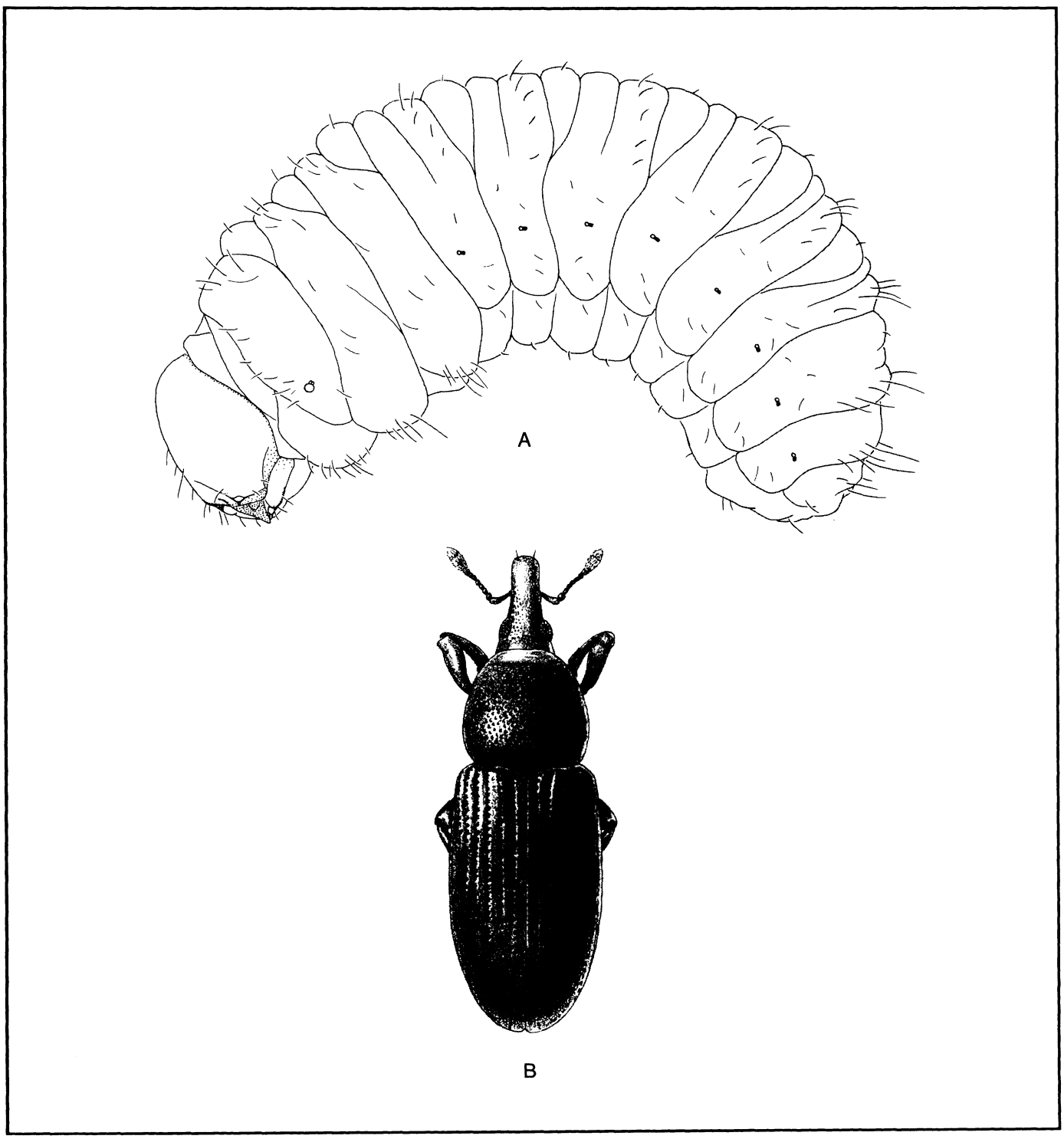


Plate 112. **Broadnosed grain weevil,** *Caulophilus oryzae* (Curculionidae): A, larva (2-2.5); B, adult (2.5-3.5) (drawing by A.D. Cushman).

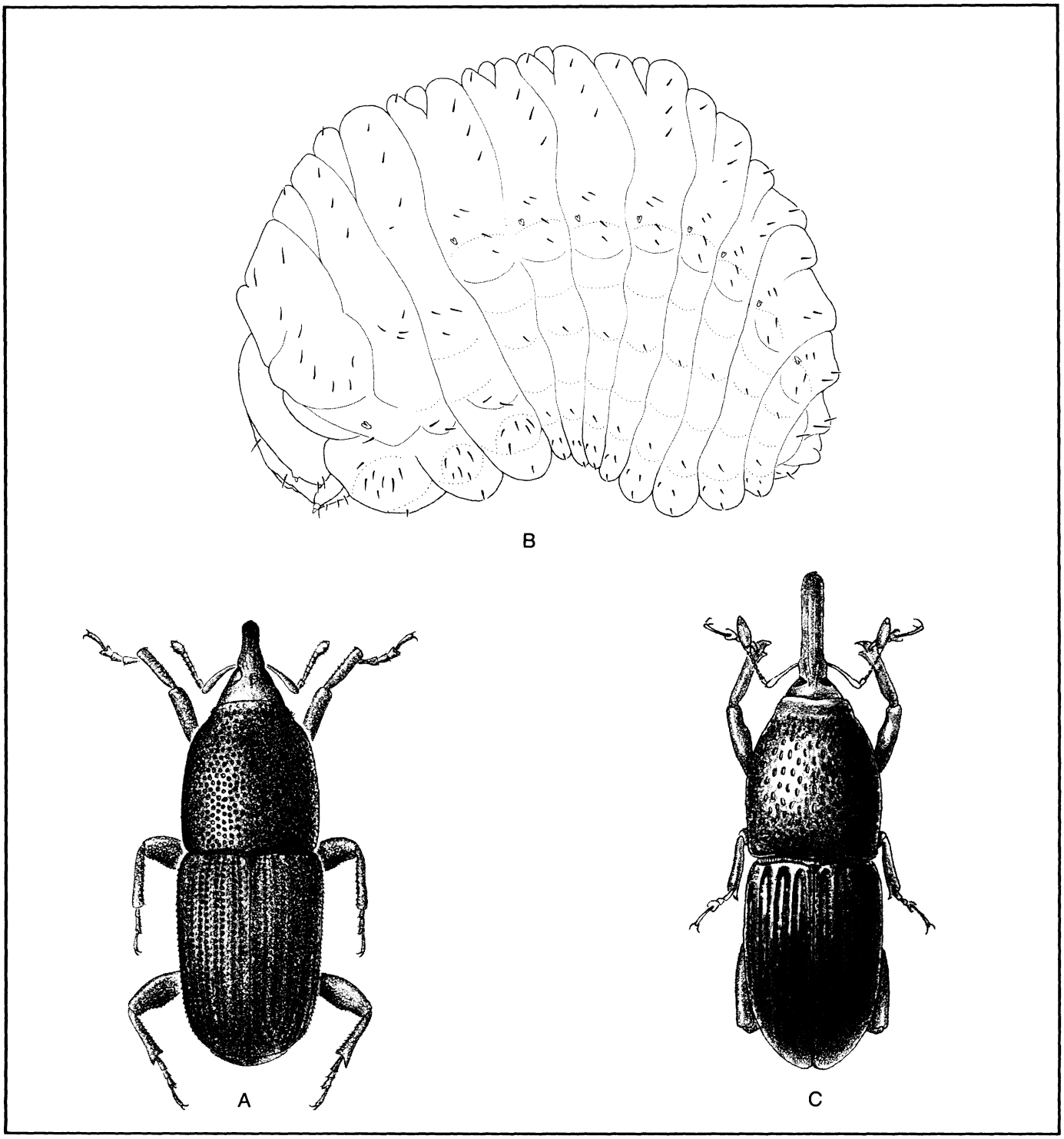


Plate 113. **Weevils** (Curculionidae): A, **tamarind weevil,** *Sitophilus linearis,* adult (3.5-5); B, **granary weevil,** *Sitophilus granarius,* larva (2.5-2.7) (drawing by M. Ryan); C, same, adult (3-4.5) (drawing by A.D. Cushman).

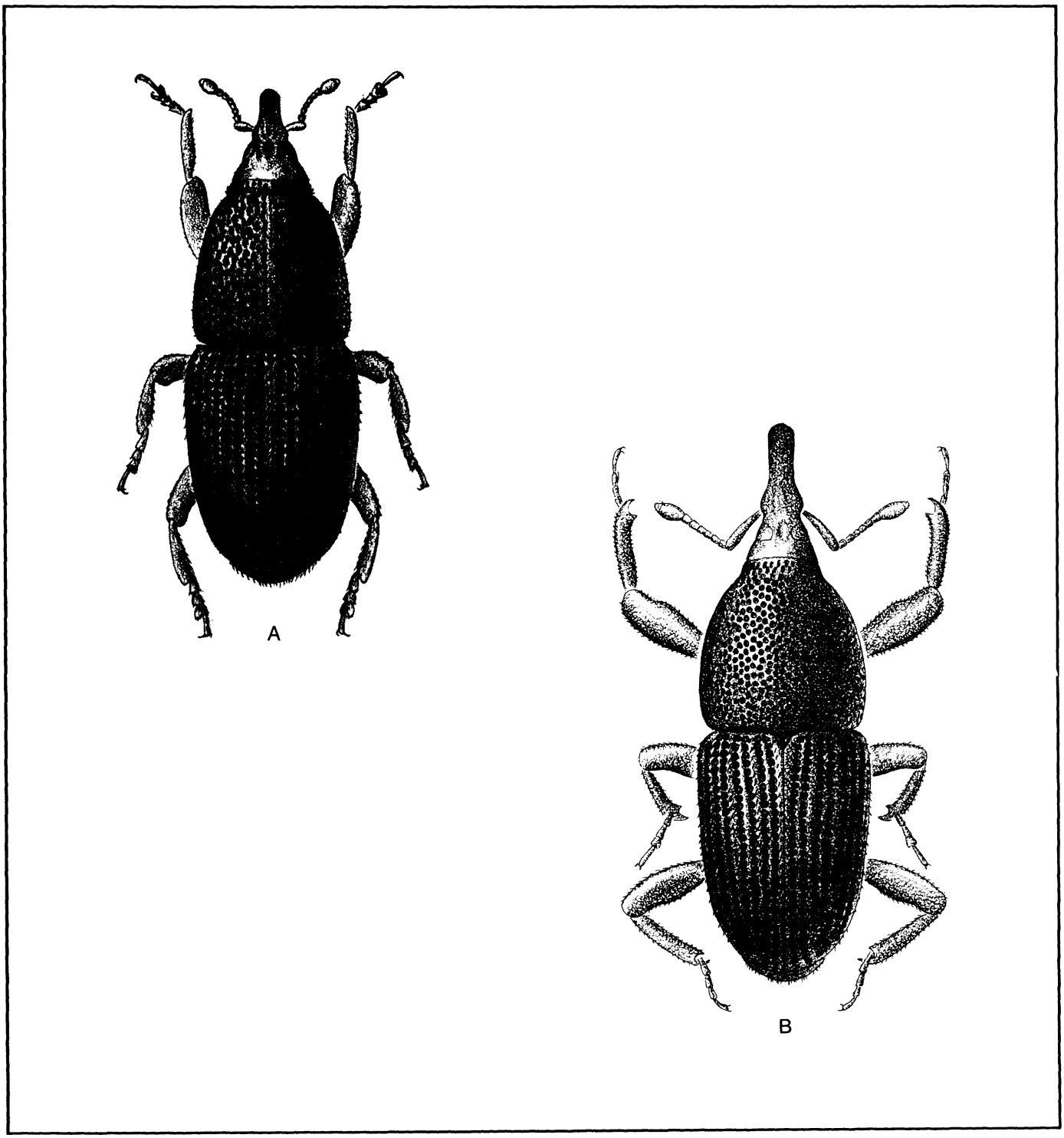


Plate 114. **Weevils** (Curculionidae): A, **rice weevil,** *Sitophilus oryzae* (2.5-4); B, **maize weevil,** *Sitophilus zeamais* (2.5-4.5).

MOTH AND BUTTERFLY LARVAE (LEPIDOPTERA)

This series of illustrations, drawn by C. Feller, is a continuation from part 1, chapter 15 (Larval Moths), by D.M. Weisman.

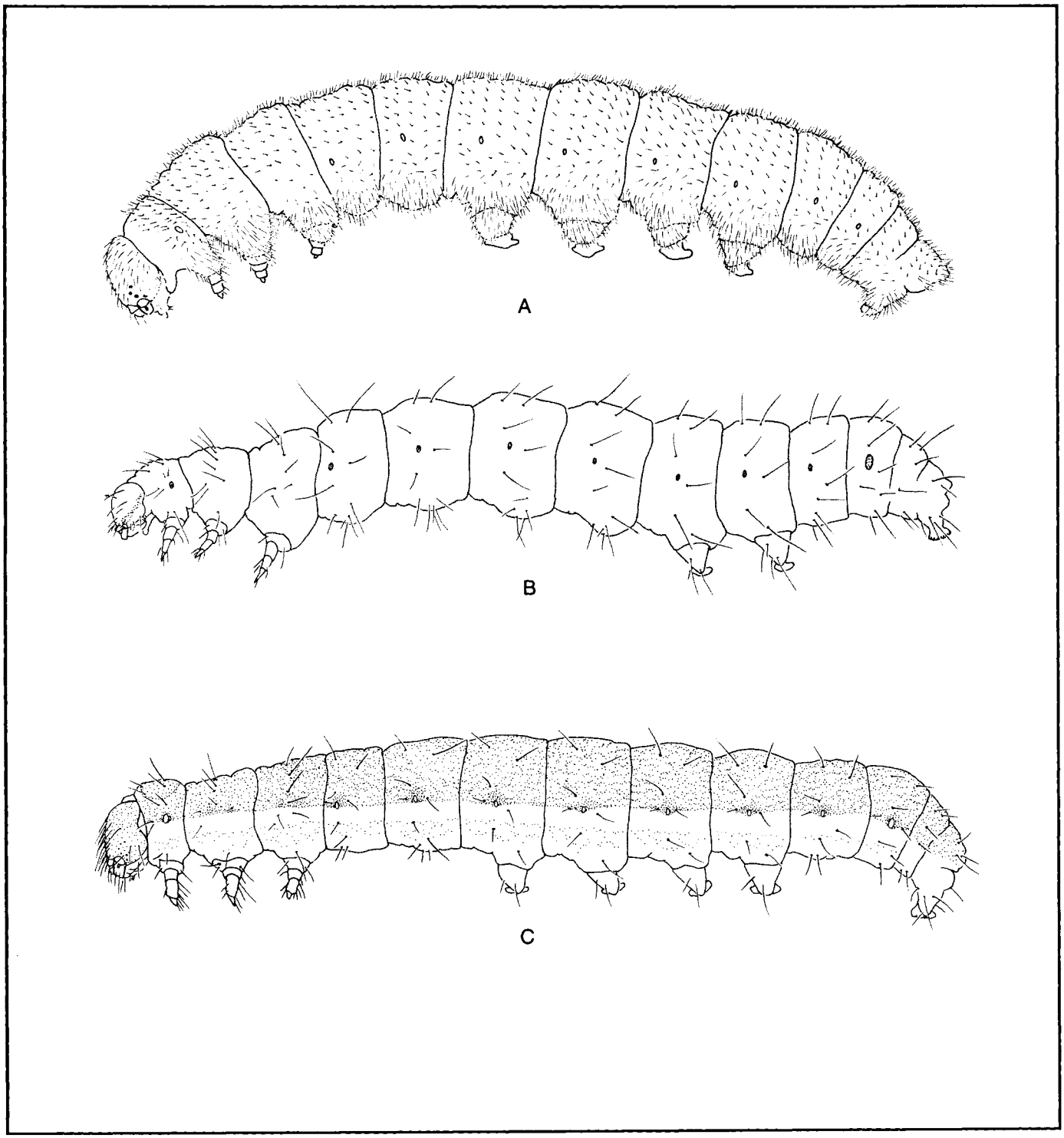


Plate 115. Pierid and noctuid larvae: A, **imported cabbageworm,** *Pieris rapae* (25-30) (Pieridae); B, silver Y moth, *Autographa gamma* (35-45) (Noctuidae); C, cabbage moth, *Mamestra brassicae* (40-45) (Noctuidae).

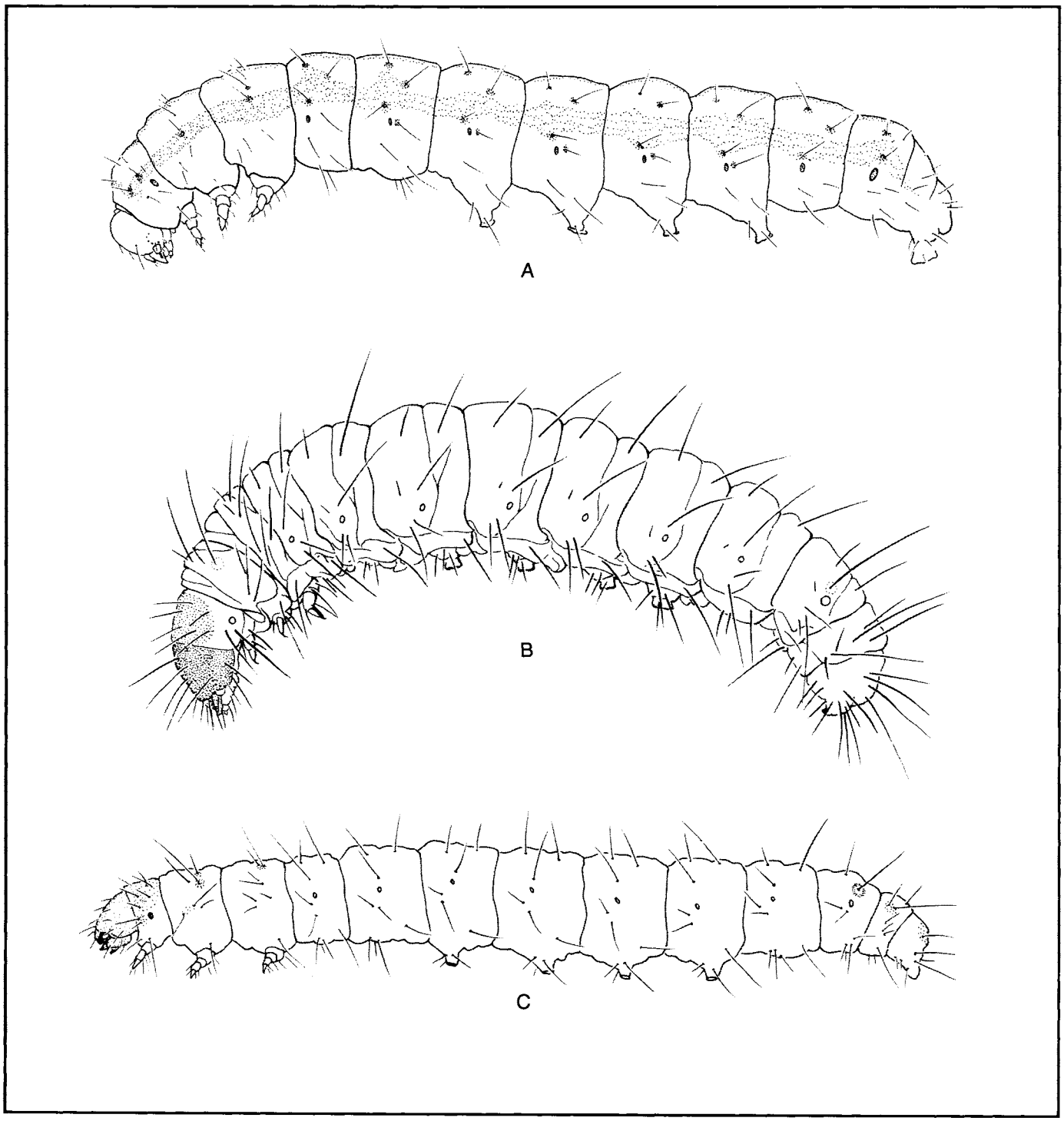


Plate 116. Noctuid and pyralid moth larvae: A, **corn earworm, tomato fruitworm,** *Helicoverpa zea* (25-38) (Noctuidae); B, **Indianmeal moth,** *Plodia interpunctella* (10-15) (Pyralidae); C, **almond moth,** *Cadra cautella* (12-14) (Pyralidae).

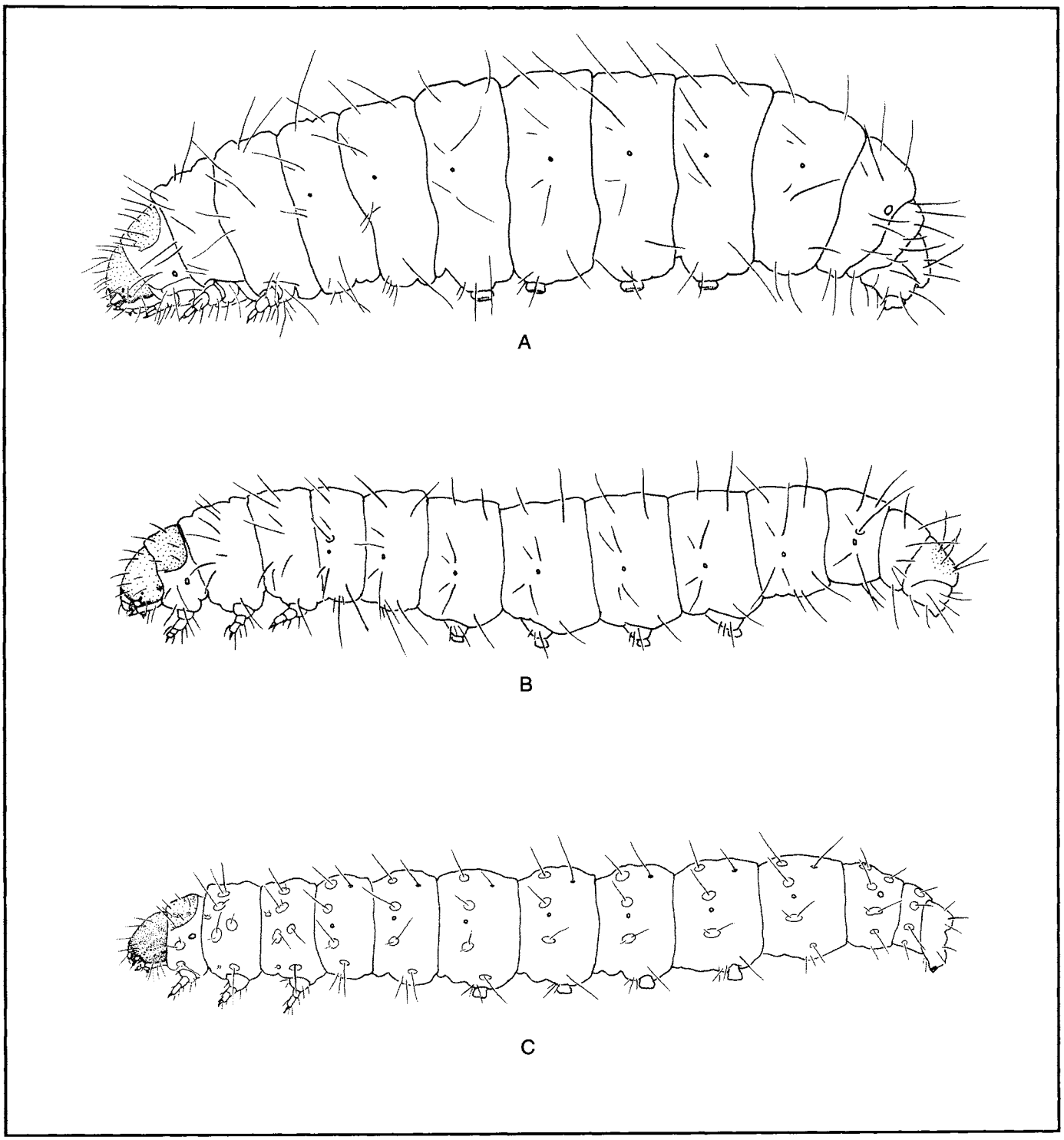


Plate 117. Pyralid moth larvae (Pyralidae): A, **greater wax moth,** *Galleria mellonella* (22-28); B, **rice moth**, *Corcyra cephalonica* (13-15); C, **European corn borer**, *Ostrinia nubilalis* (23-25).

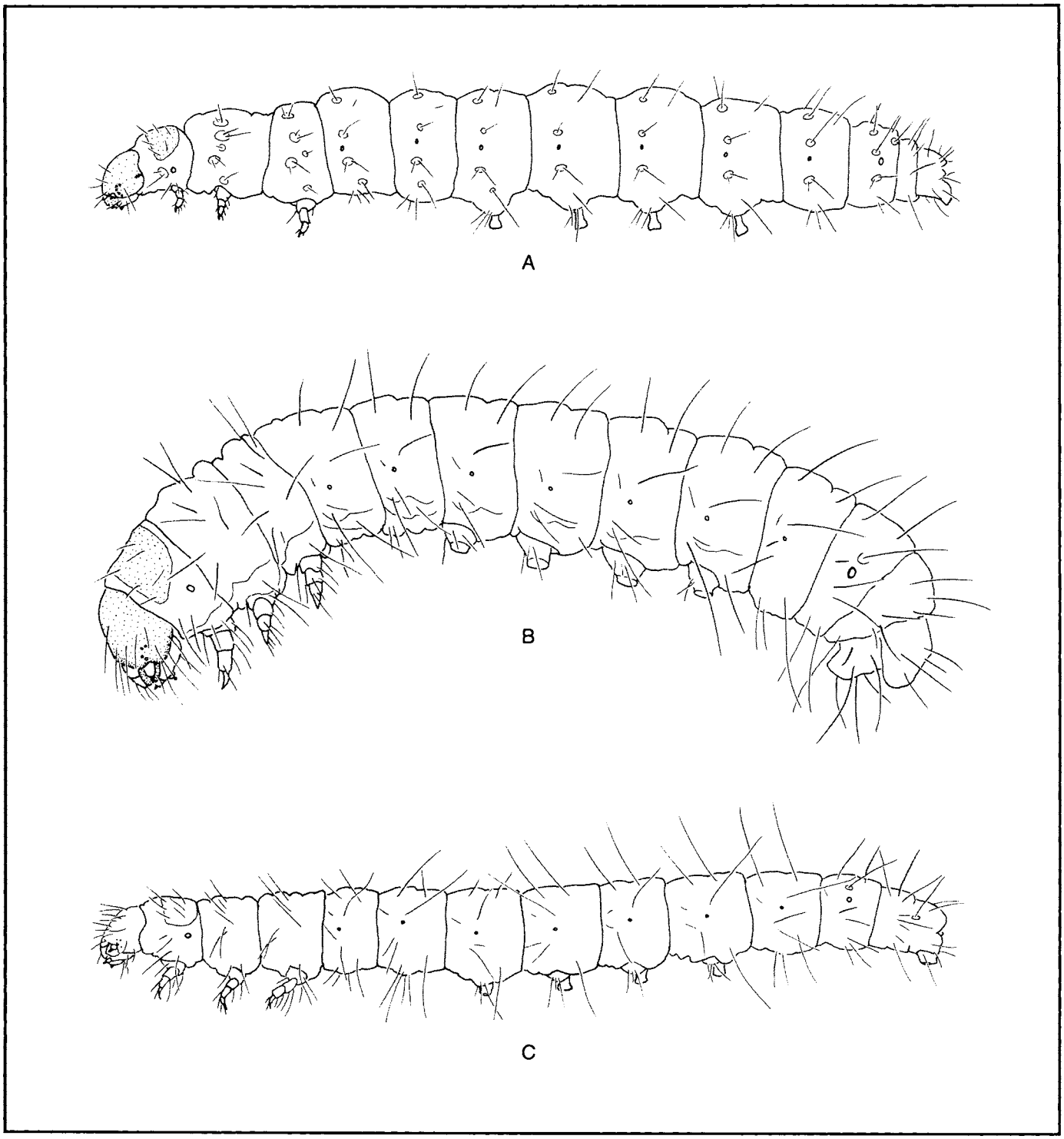


Plate 118. Pyralid moth larvae (Pyralidae): A, **pickleworm,** *Diaphania nitidalis* (25-30); B, **meal moth,** *Pyralis farinalis* (20-25); C, murky meal moth, *Aglossa caprealis* (25-28).

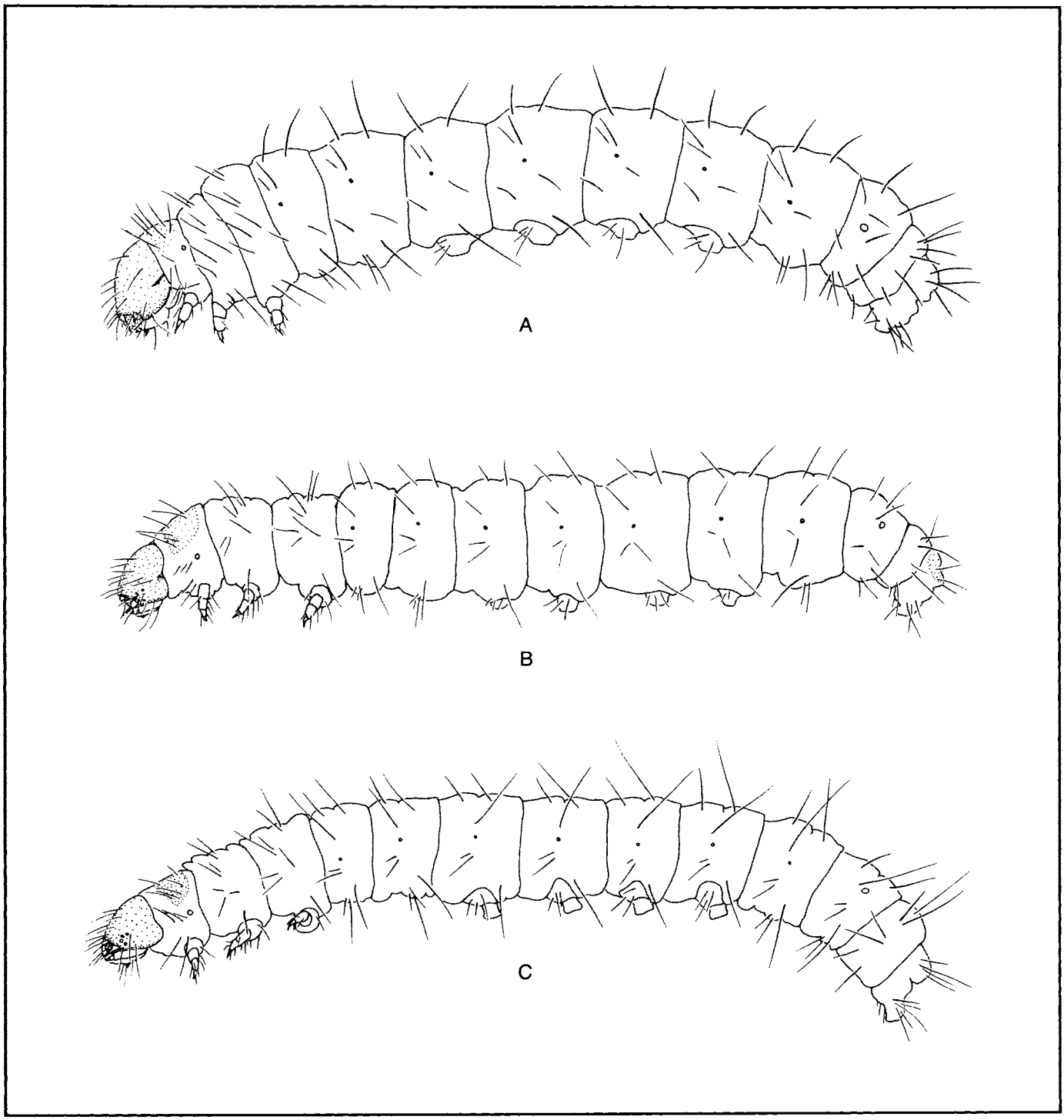


Plate 119. Lepidopterous larvae: A, **webbing clothes moth,** *Tineola bisselliella* (9-10) (Tineidae); B, **codling moth,** *Cydia pomonella* (14-16) (Tortricidae); C, **pink scavenger caterpillar,** *Pyroderces rileyi* (7-8) (Cosmopterigidae).

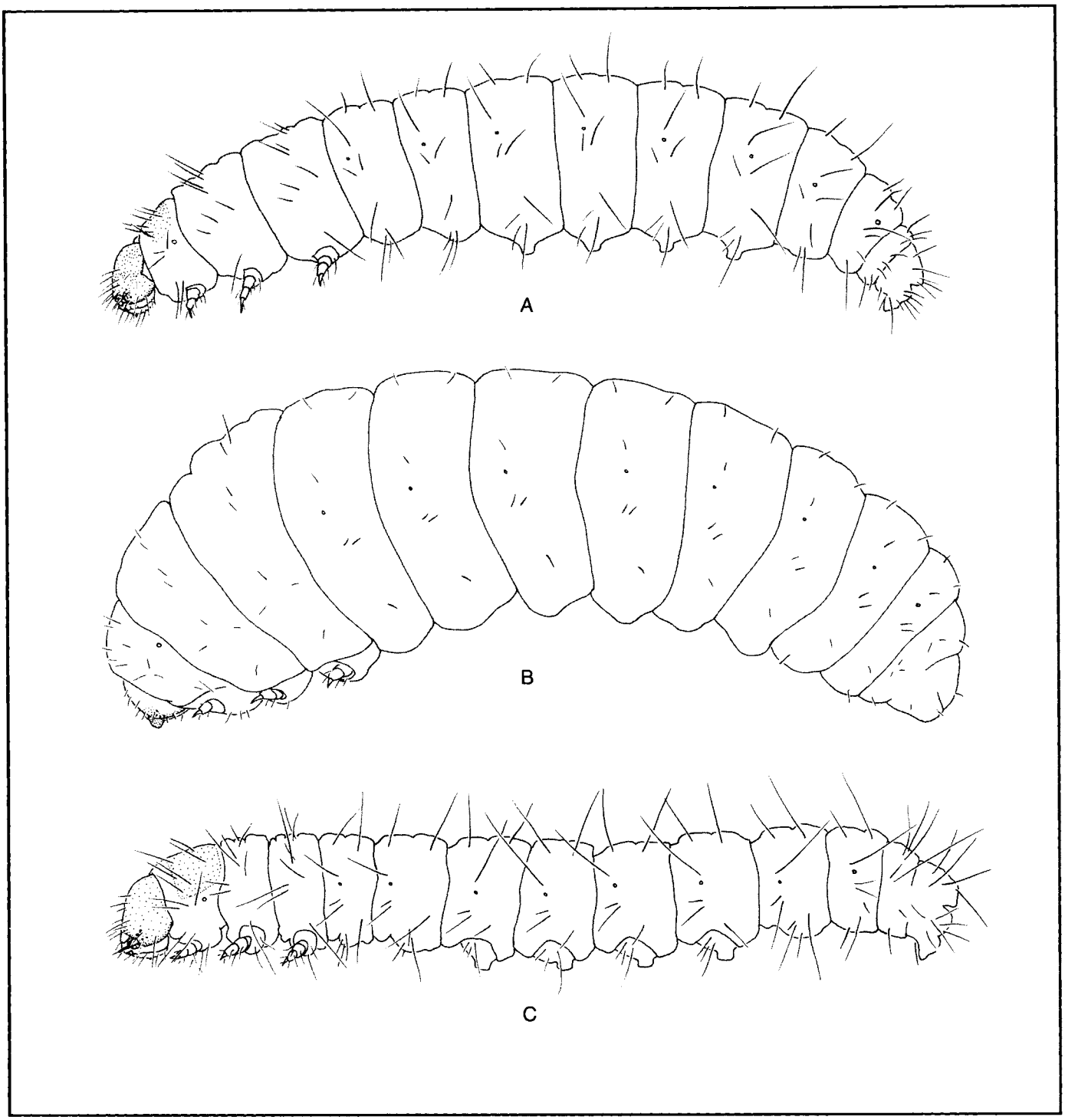
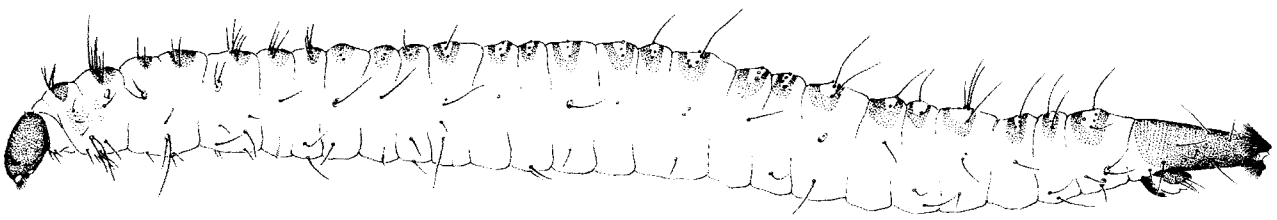


Plate 120. Lepidopterous larvae: A, **apple fruit moth,** *Argyresthia conjugella* (8-10) (Argyresthiidae); B, **Angoumois grain moth,** *Sitotroga cerealella* (4-7) (Gelechiidae); C, **brown house moth,** *Hofmannophila pseudospretella* (14-16) (Oecophoridae).

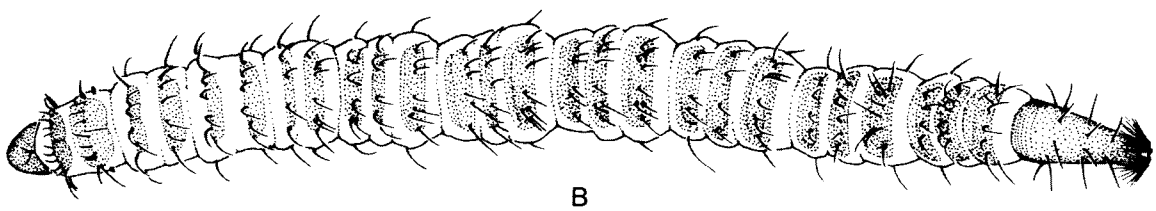
Notes and Sketches

FLIES (DIPTERA)

This series of illustrations, drawn by C. Feller unless otherwise noted, is a continuation from part 1, chapter 16 (Flies), by R.J. Gagné.



A



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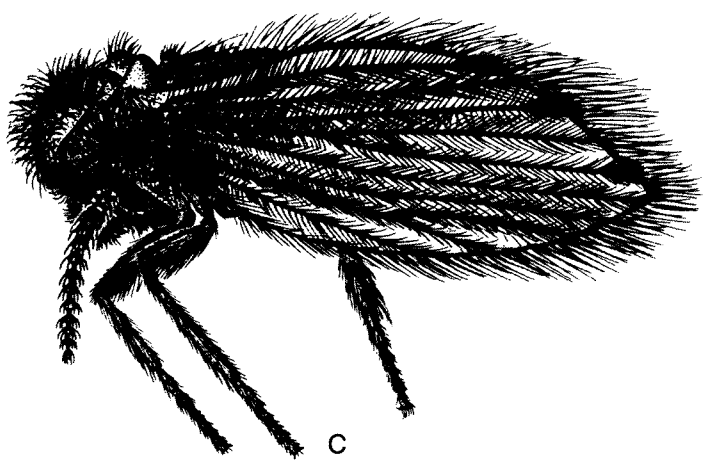


C

P!ate 121. **Moth flies,** *Psychoda* spp. (Psychodinae, Psychodidae): A, larva (4.5-10), lateral view; B, same, dorsal view; C, adult (1.25-1.5).

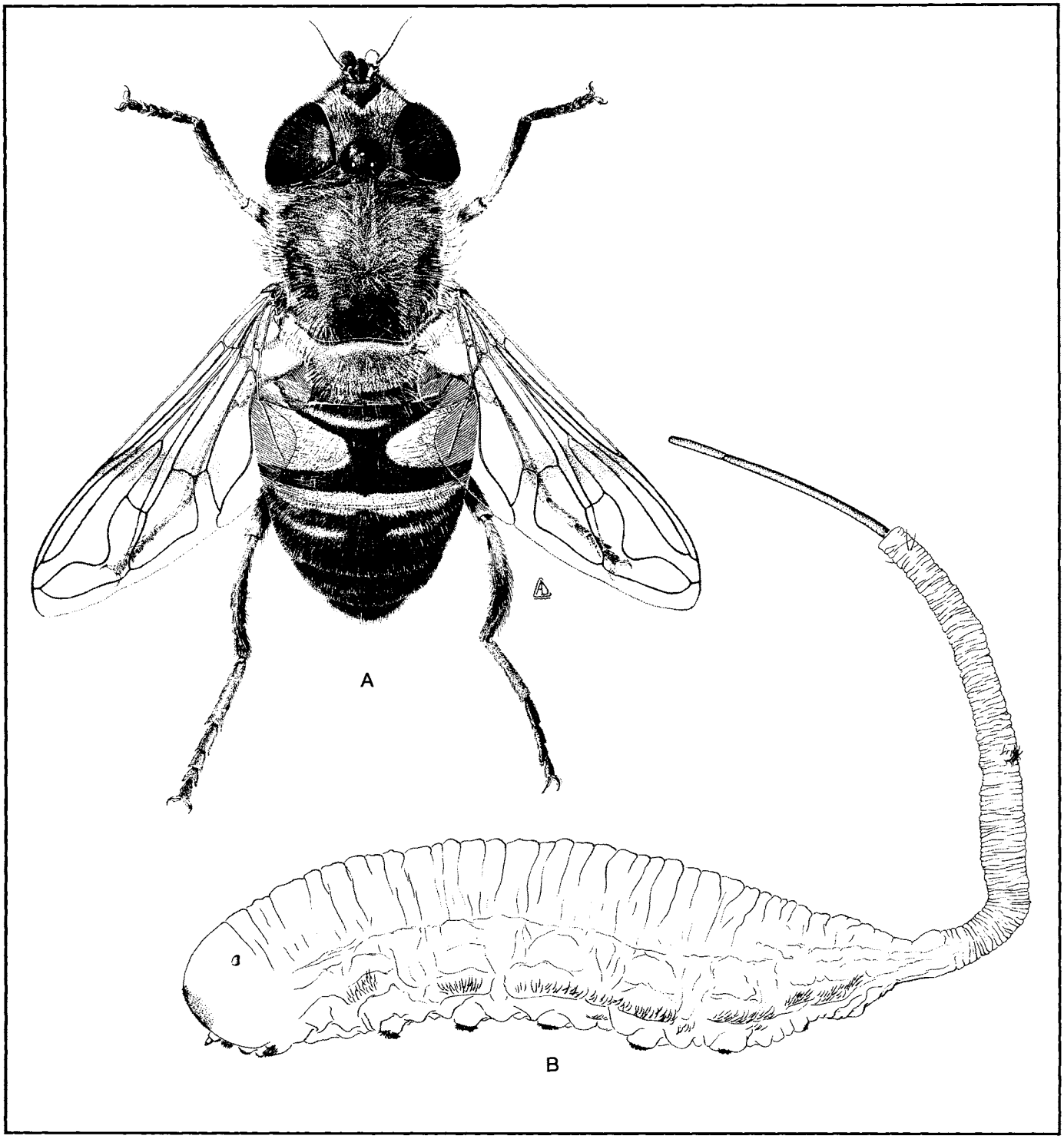


Plate 122. **Drone fly,** *Eristalis tenax* (Syrphidae): A, female (15) (drawing by A.D. Cushman); B, larva (10-15, excluding tail).

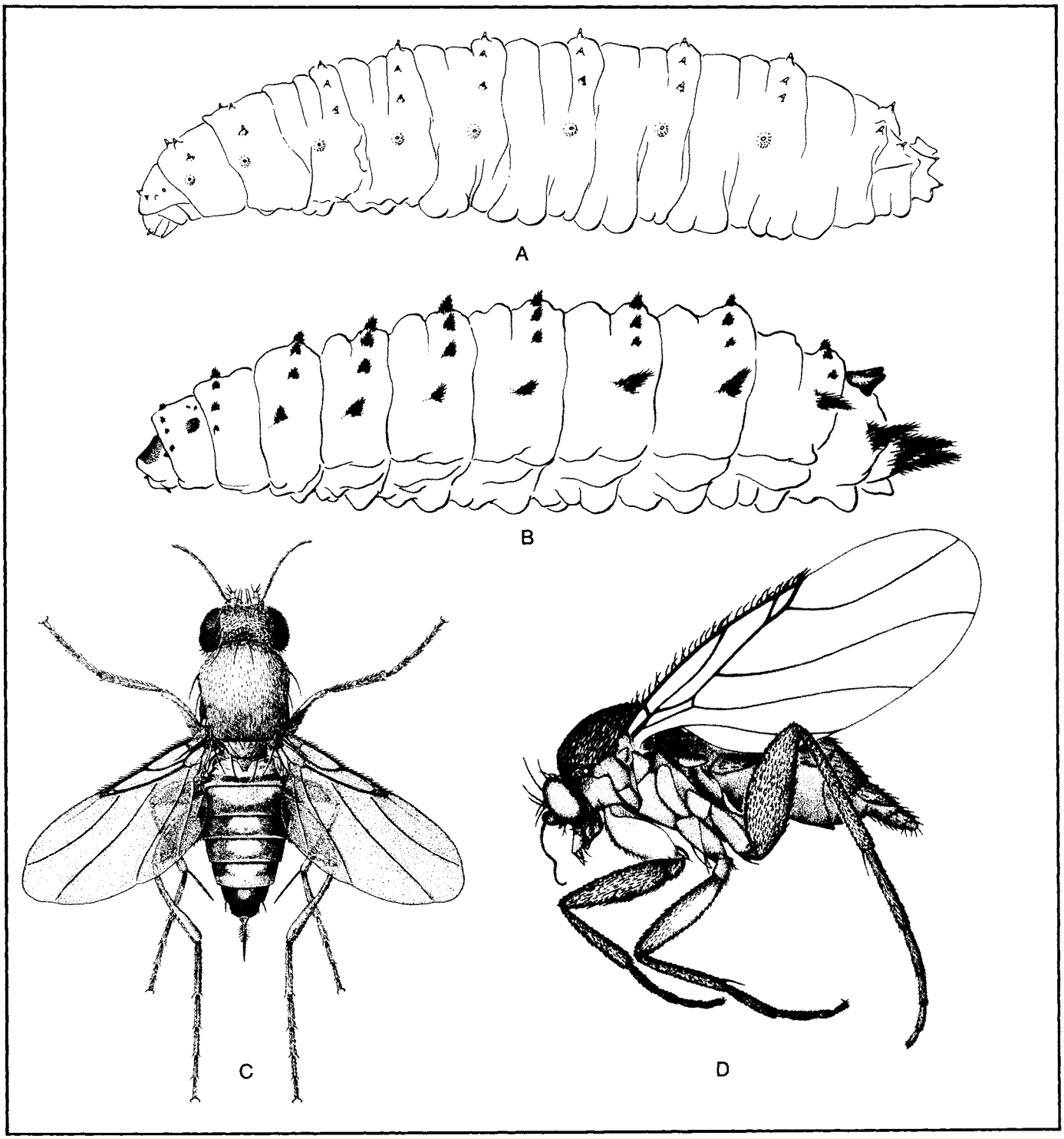


Plate 123. **Humpbacked flies** (Phoridae): A, *Megaselia* sp., larva (3.5-5); B, *Megaselia* sp., larva (3.5-5); C, *Megaselia scalaris,* adult (2-3), dorsal view (drawing by A.D. Cushman); D, *Megaselia* sp., adult, lateral view.

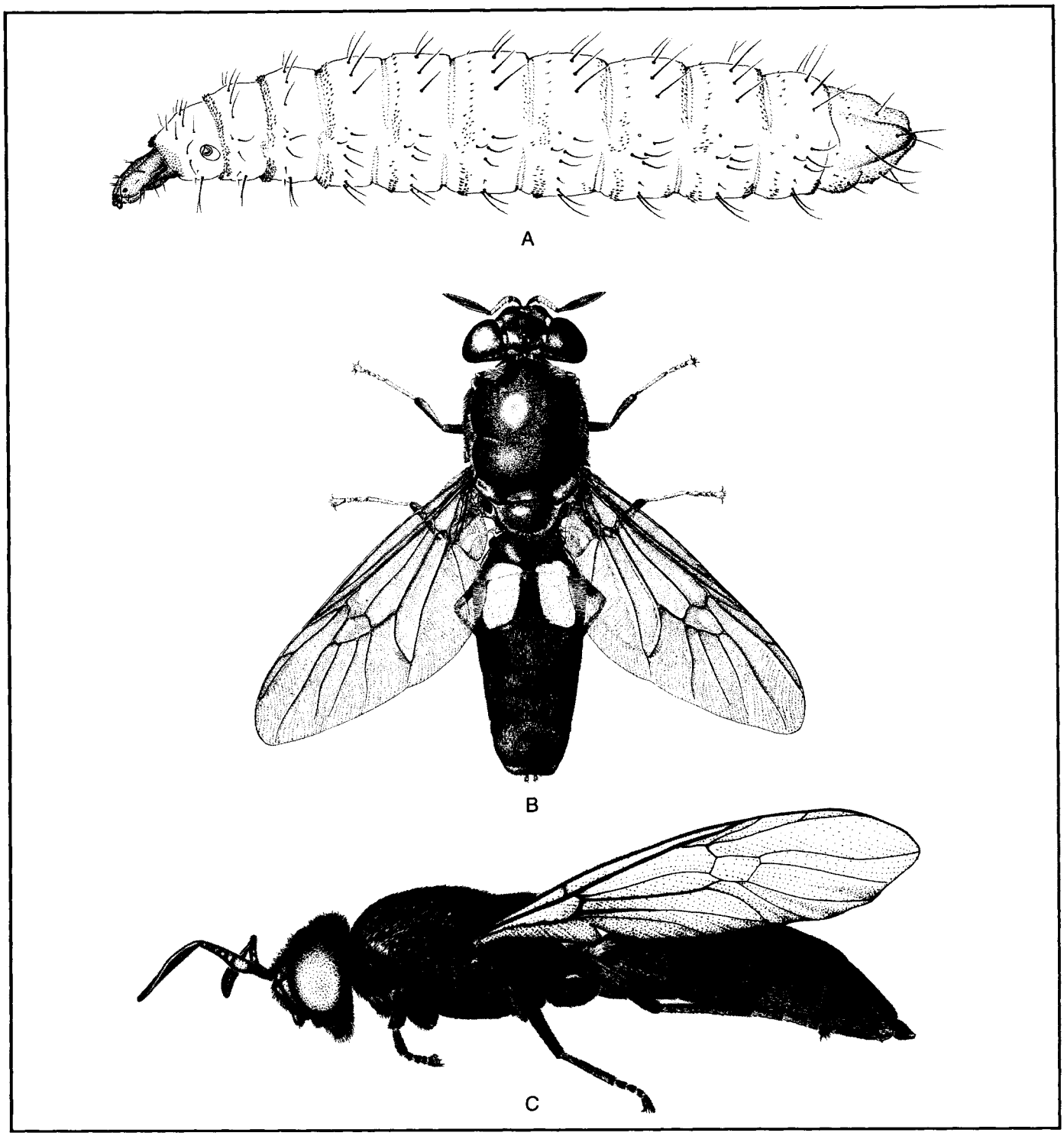


Plate 124. **Black soldier fly,** *Hermetia illucens* (Stratiomyidae): A, larva (15-20); B, female (15-20), dorsal view (drawing by A.D. Cushman); C, same, lateral view.

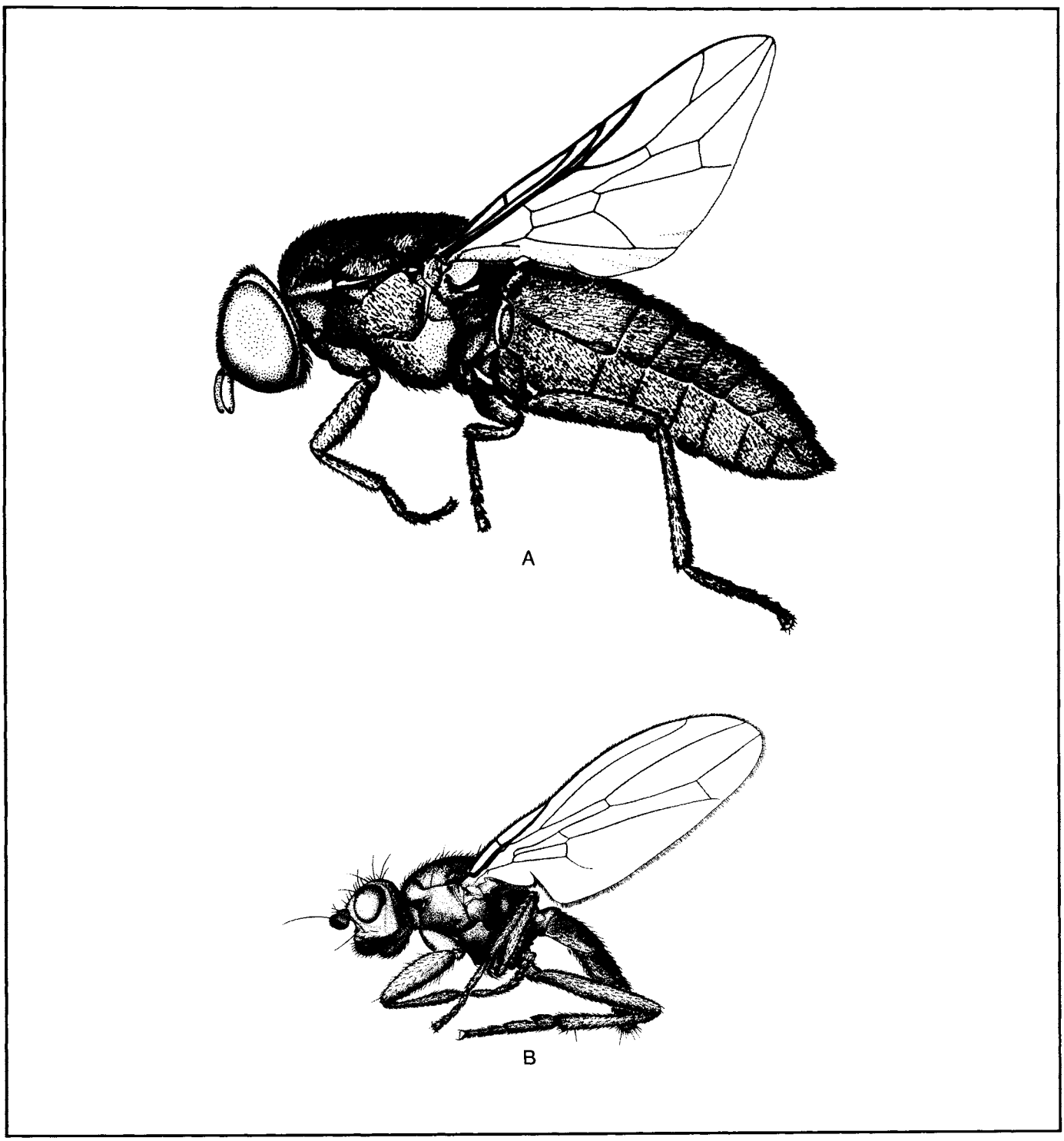


Plate 125. Scenopinid and sphaerocerid flies: A, *Scenopinus* sp. (Scenopinidae), adult (6); B, *Leptocera* sp. (Sphaeroceridae), adult (3).

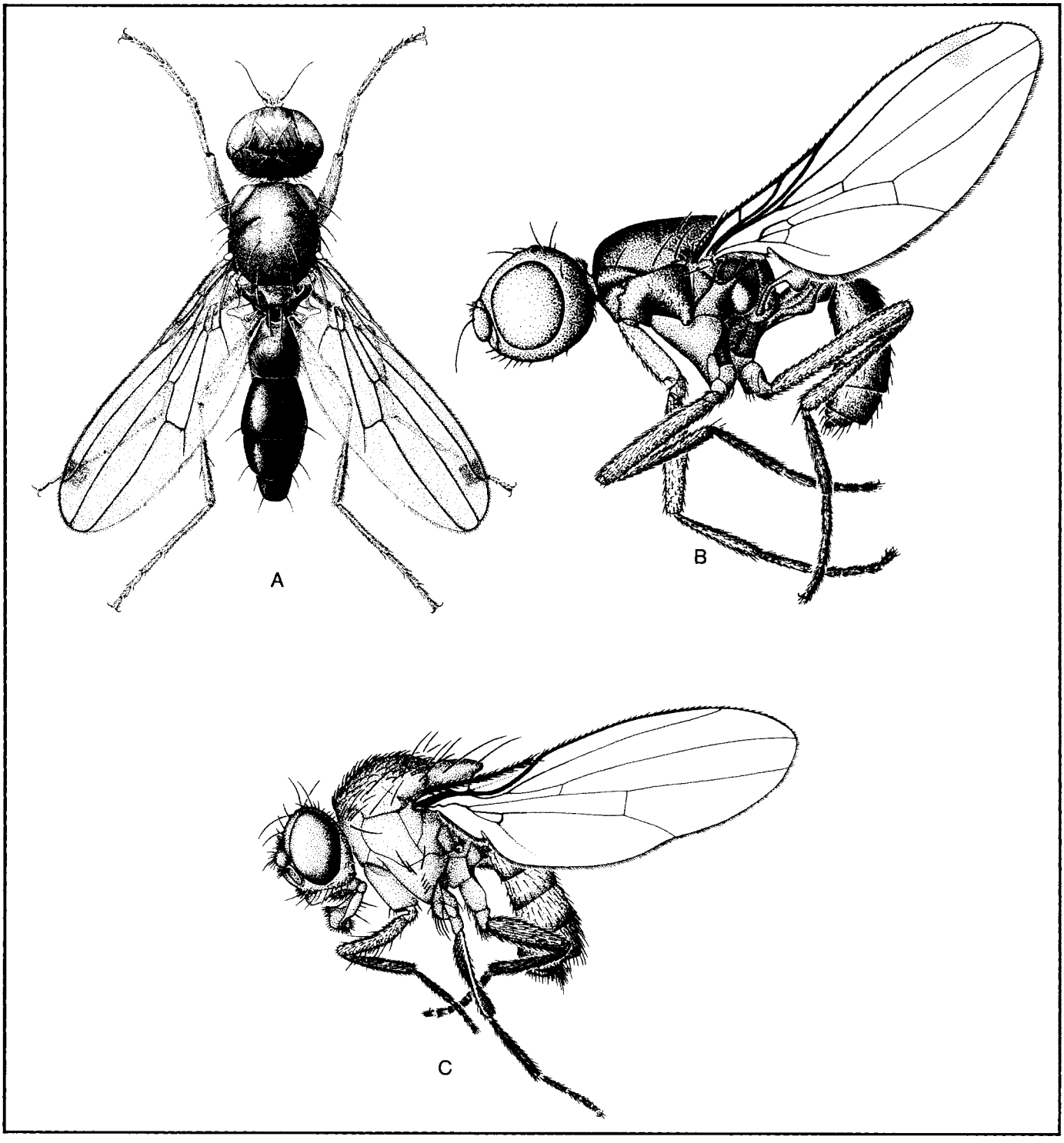


Plate 126. Sepsid and drosophilid flies: A, *Sepsis* sp. (Sepsidae), female (4), dorsal view (drawing by A.D. Cushman); B, same, lateral view; C, *Drosophila* sp. (Drosophilidae), adult (2.5).

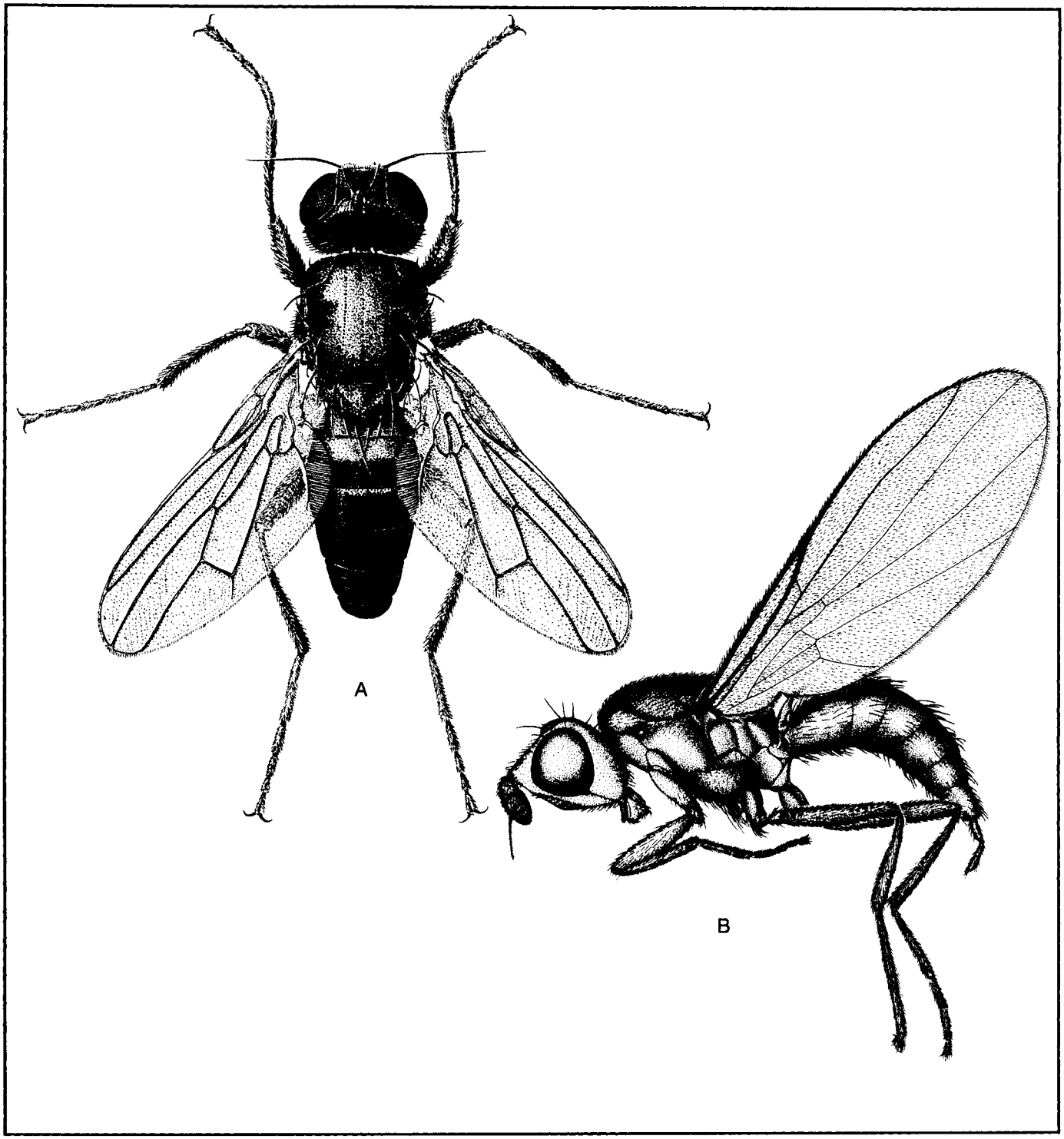


Plate 127. Piophilid and psilid flies: A, **cheese skipper,** *Piophila casei* (Piophilidae), female (2.5-4) (drawing by A.D. Cushman); B, **carrot rust fly,** *Psila rosae* (Psilidae), adult (3).

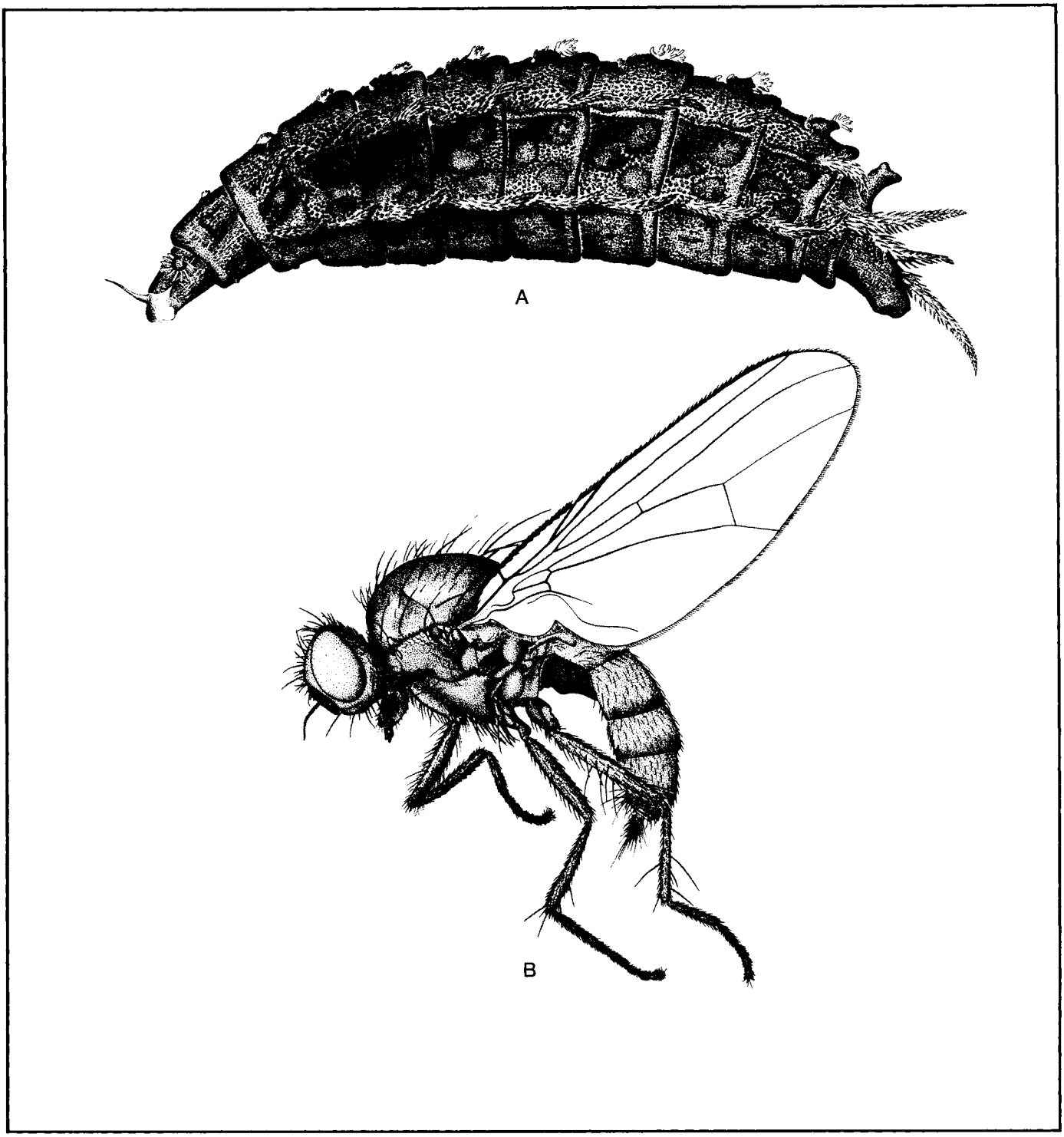
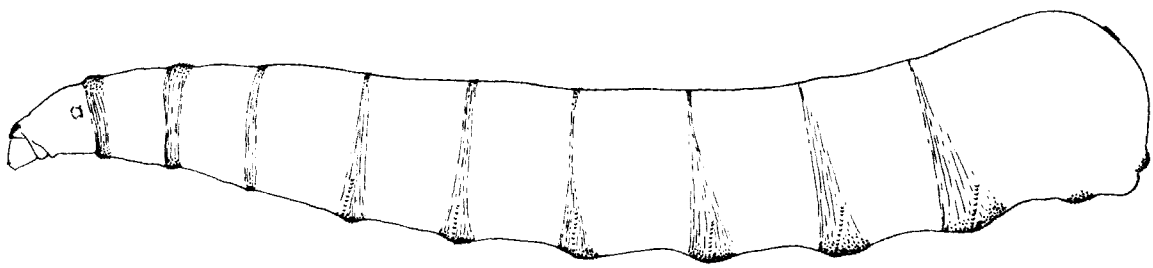
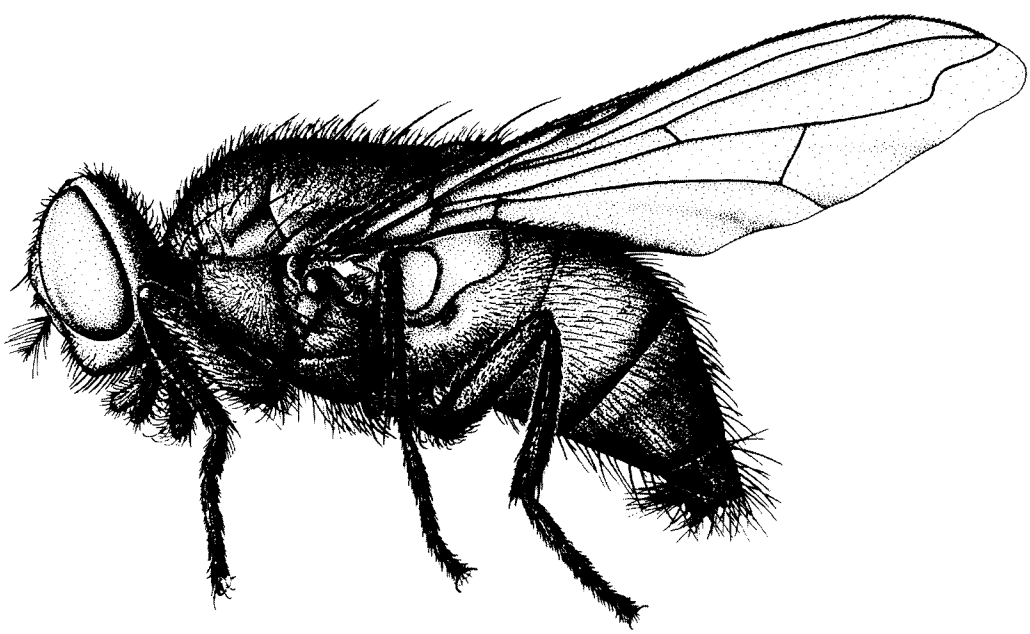


Plate 128. **Little house fly,** *Fannia canicularis* (Muscidae): A, larva (5-8); B, adult (5-7).



A



B

Plate 129. **House fly,** *Musca domestica* (Muscidae): A, larva (10-13); B, adult (6-9).

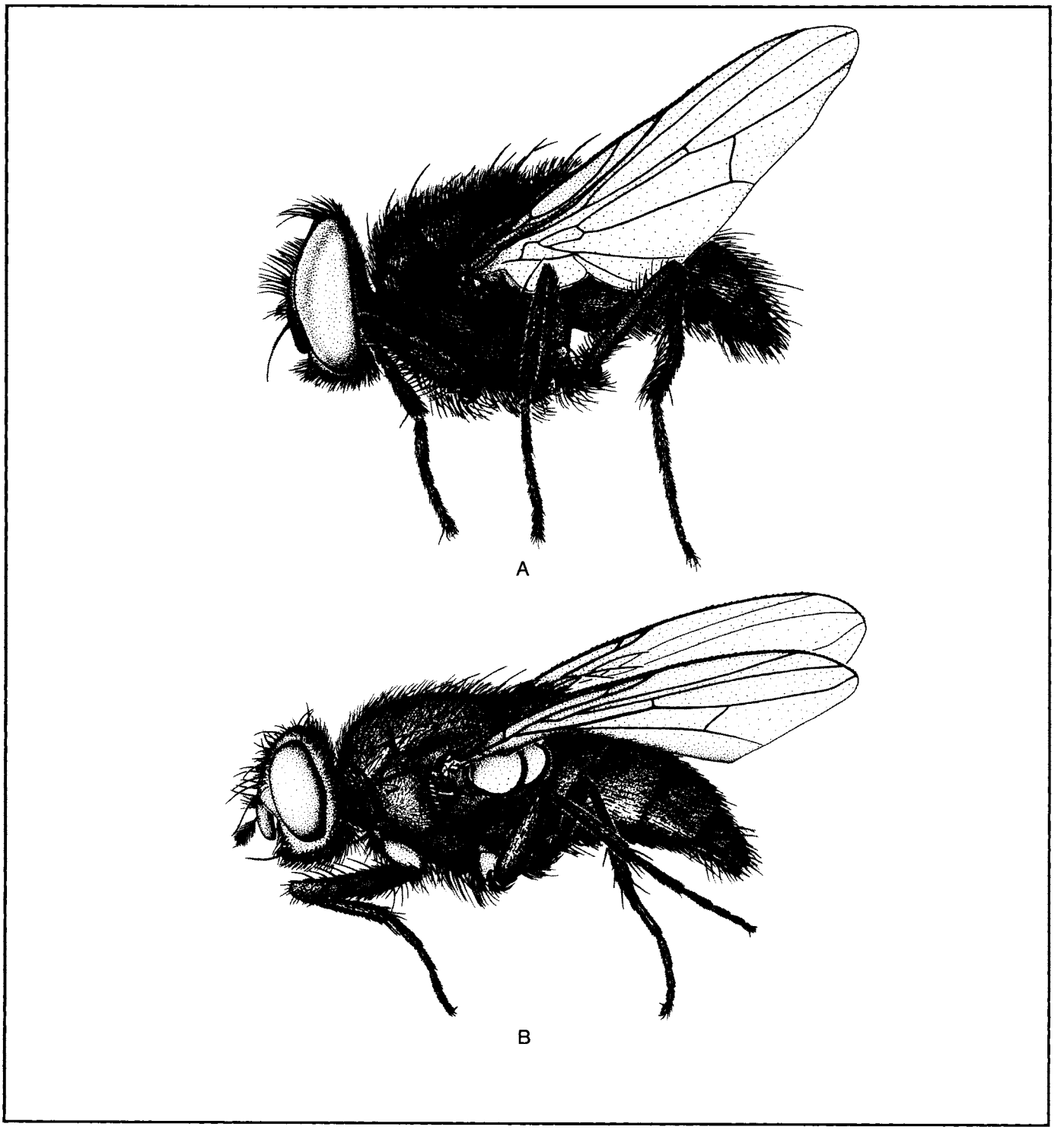


Plate 130. Muscid flies (Muscidae). A, bronze dump fly, *Ophyra aenescens,* adult (7); B, **false stable fly,** *Muscina stabulans,* adult (8).

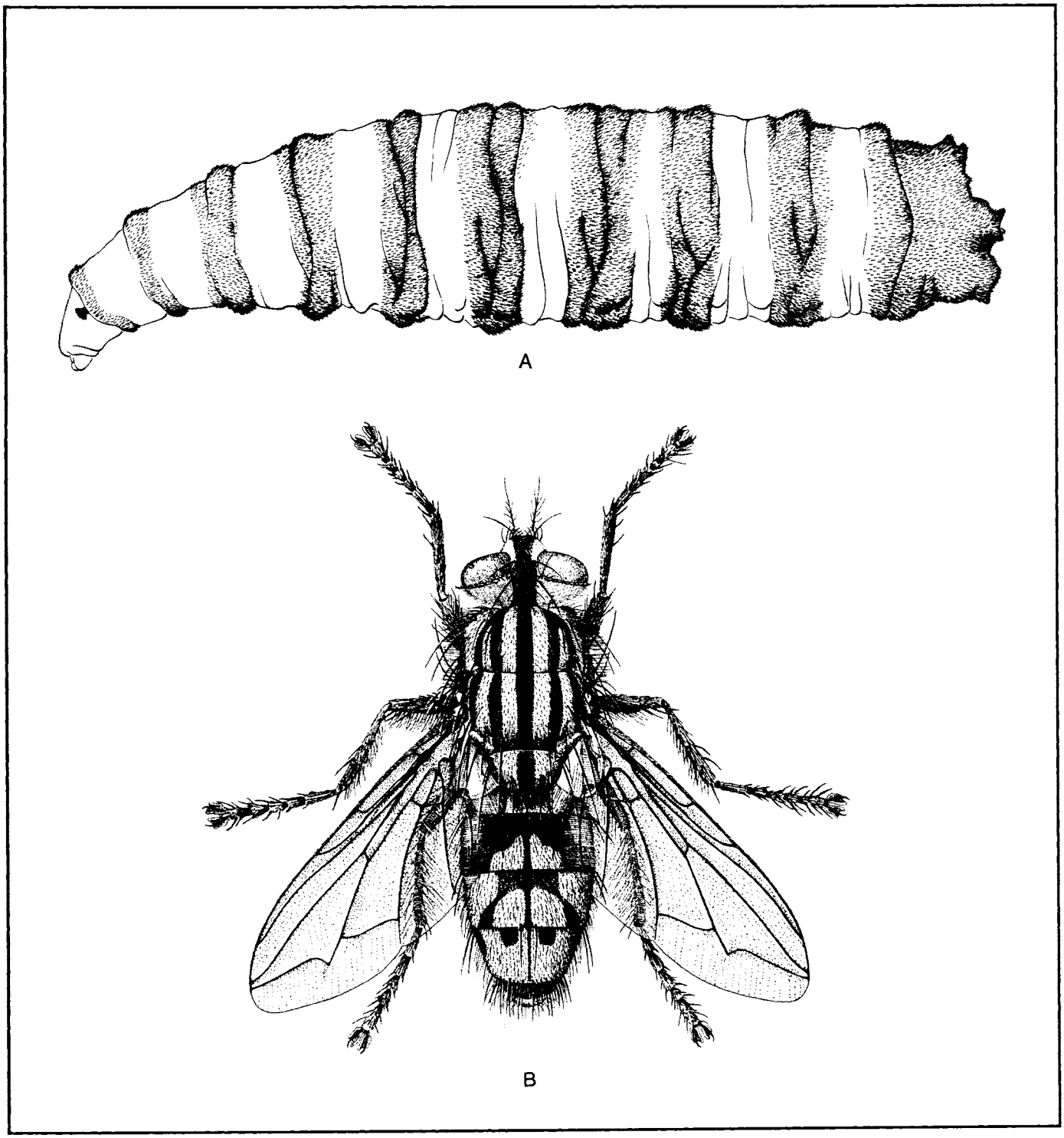


Plate 131. **Flesh flies,** *Sarcophaga* spp. (Sarcophagidae): A, *Sarcophaga* sp., larva (15-20); B, redtailed flesh fly, *Sarcophaga haemorrhoidalis,* adult (10-14) (drawing by A.D. Cushman).

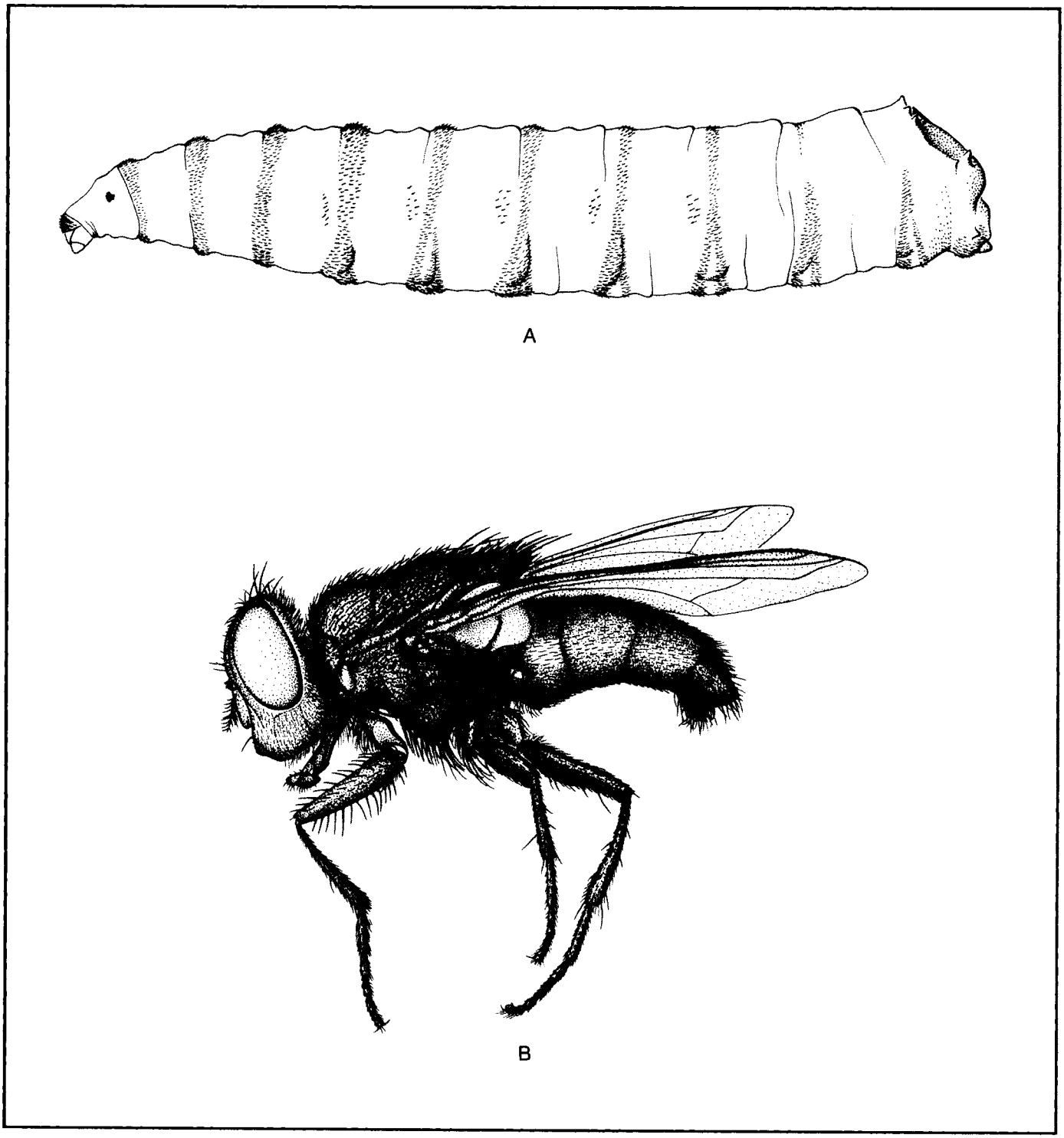


Plate 132. **Secondary screwworm,** *Cochliomyia macellaria* (Calliphoridae): A, larva (12-15); B, adult (8-10).

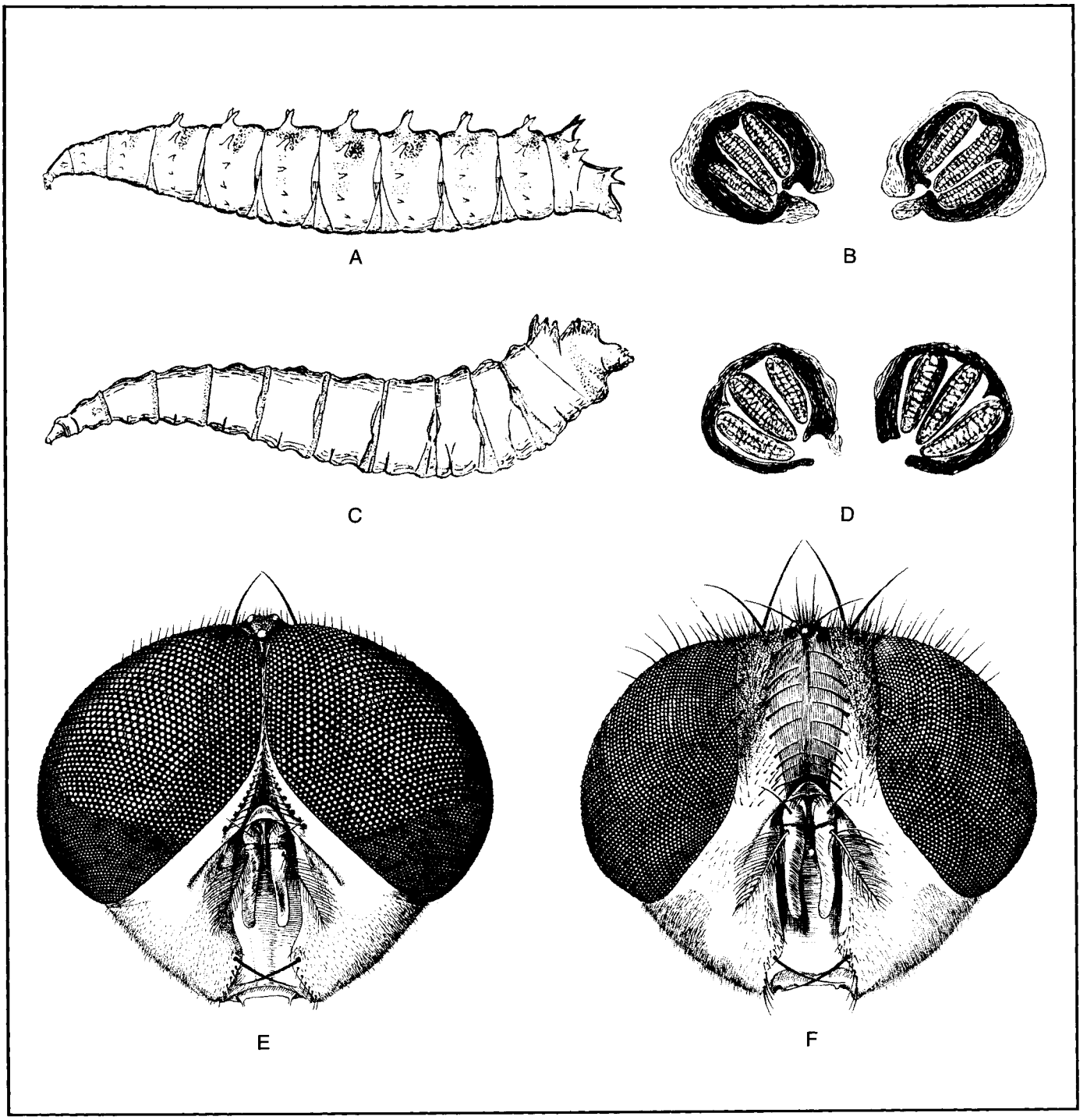
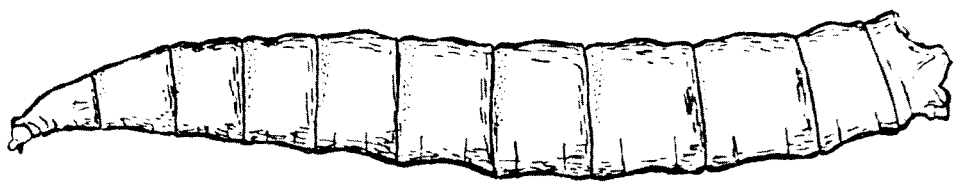
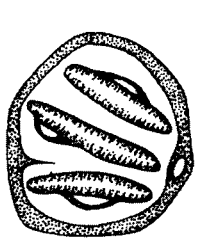
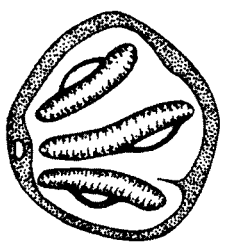


Plate 133. Old World screwworm flies, *Chrysomya* spp. (Calliphoridae) (drawings from 2): A, *Chrysomya albiceps,* larva (14-18); B, same, posterior spiracles; C, *Chrysomya chloropyga,* larva (12); D, same, posterior spiracles; E, *Chrysomya megacephala,* face of male; F, same, face of female.

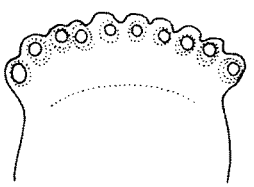


A

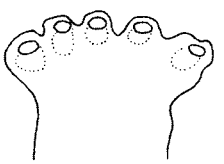




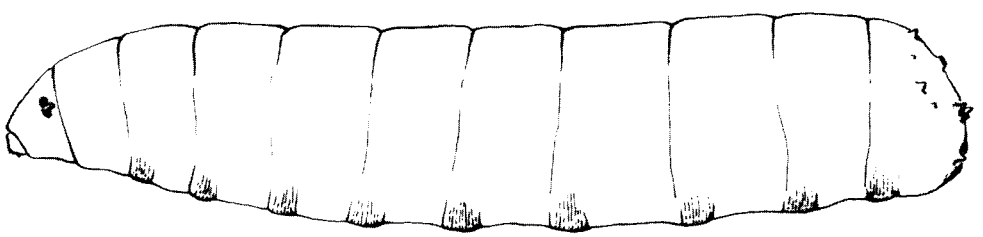
B



C



D



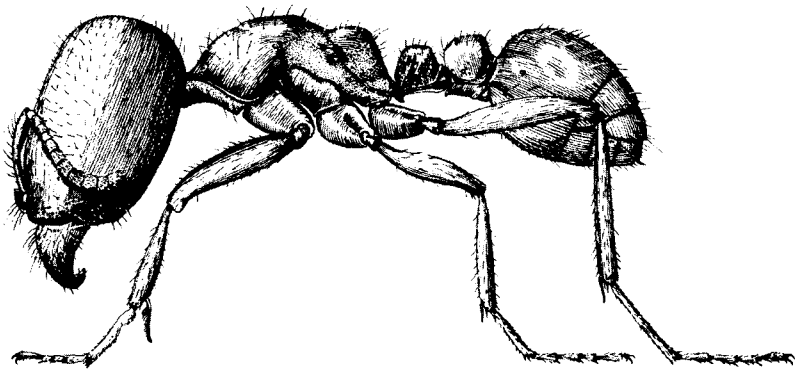
E

Plate 134. Calliphorid and anthomyiid flies: A, green bottle fly, *Phaenicia sericata* (Calliphoridae), larva (10-15) (drawing from 2); B, same, posterior spiracles; C, same, anterior spiracle; D, bronze bottle fly, *Phaenicia cuprina,* anterior spiracle of larva; E, *Hylemya* sp. (Anthomyiidae), larva (10).

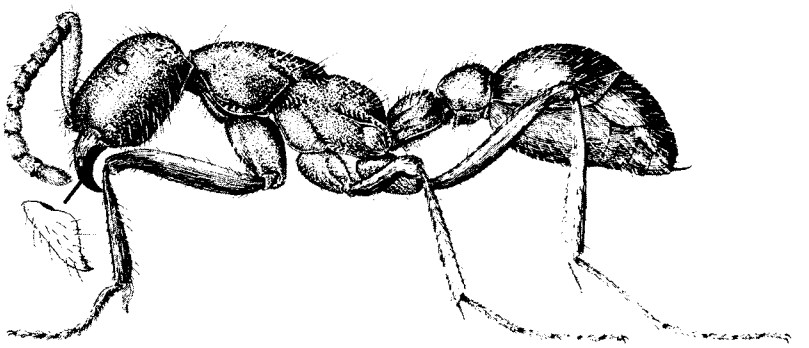
Notes and Sketches

WORKER ANTS (FORMICIDAE)

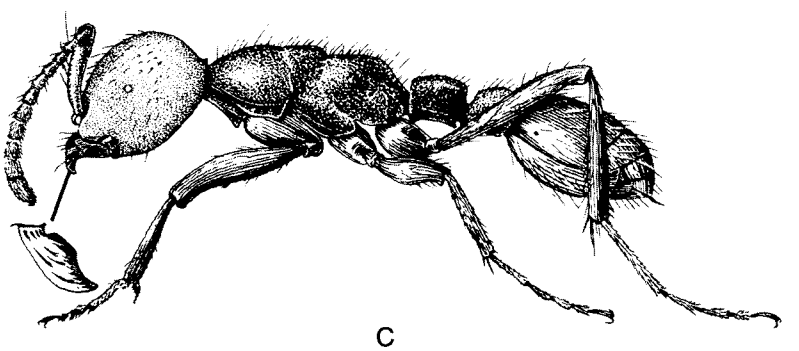
This series of illustrations, drawn by A.D. Cushman unless otherwise noted, is a continuation of chapter 17 (Ants), by D.R. Smith.



A



B



C

Plate 135. Army ants (Dorylinae, Formicidae): A, *Labidus coecus* (2.9-9.7); B, *Neivamyrmex nigrescens* (2.8-5.8); C, *Neivamyrmex opacithorax* (2.2-4.6).

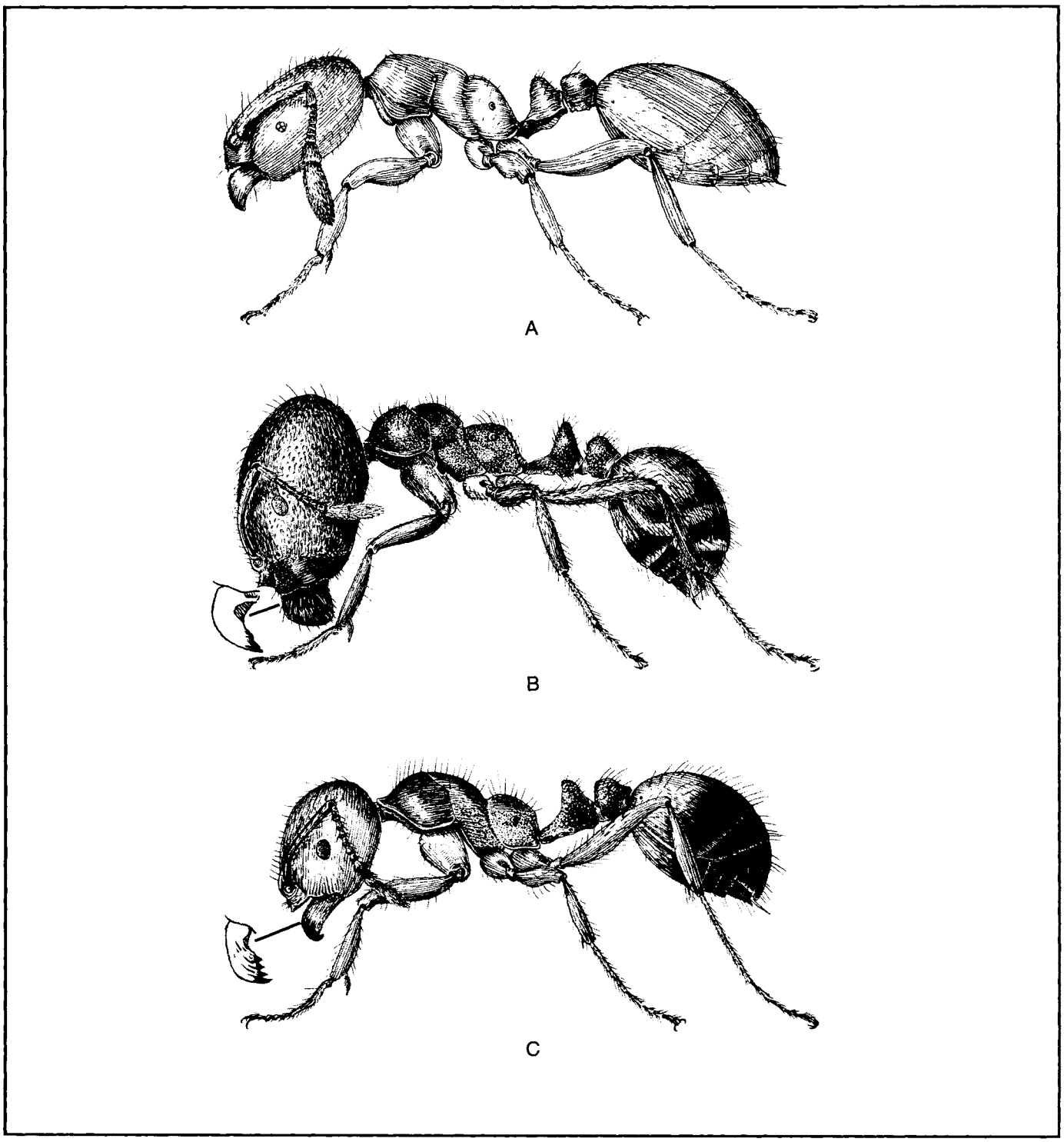
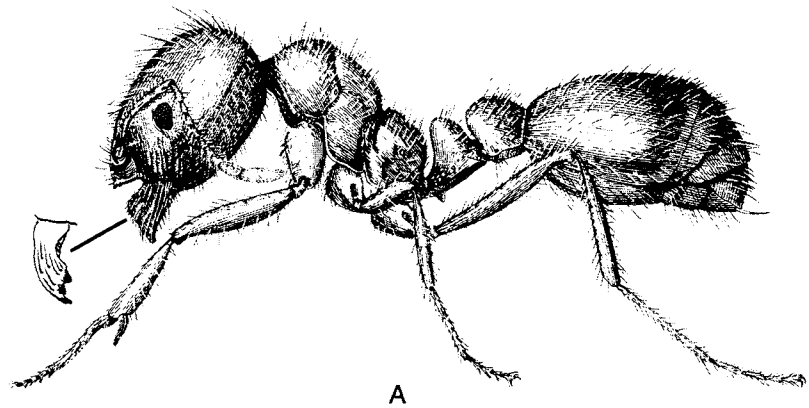
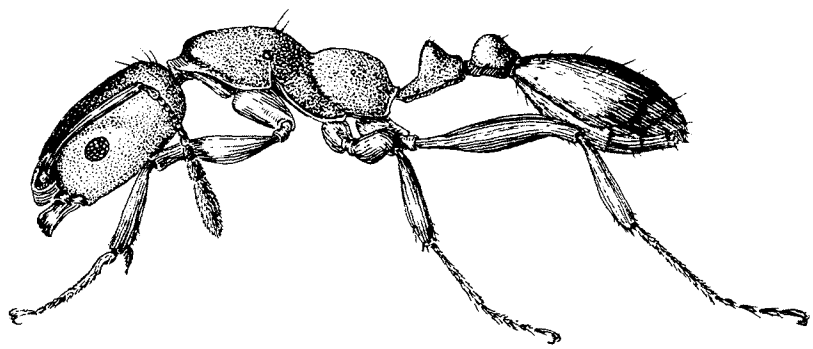


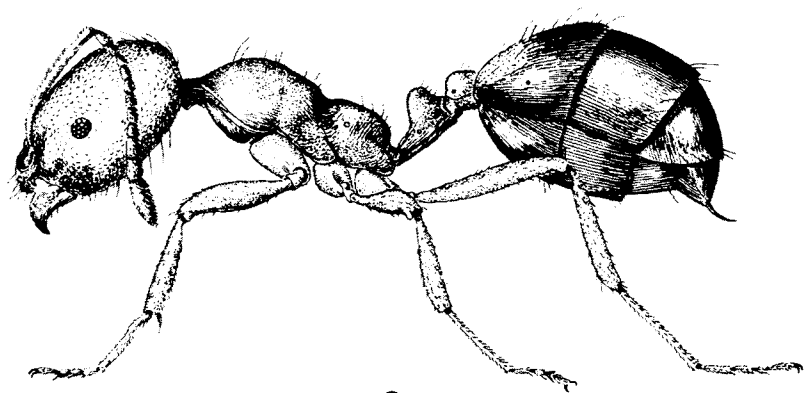
Plate 136. Myrmicine ants (Myrmicinae, Formicidae): A, **thief ant,** *Solenopsis molesta* (1.3-1.8); B, **fire ant,** *Solenopsis geminata* (2.4-6); C, **red imported fire ant,** *Solenopsis invicta* (2.8-6).



A



B



C

Plate 137. Myrmicine ants (Myrmicinae, Formicidae): A, **southern fire ant,** *Solenopsis xyloni* (1.6-5.8); B, **pharaoh ant,** *Monomorium pharaonis* (2); C, *Monomorium destructor* (1.8-3).

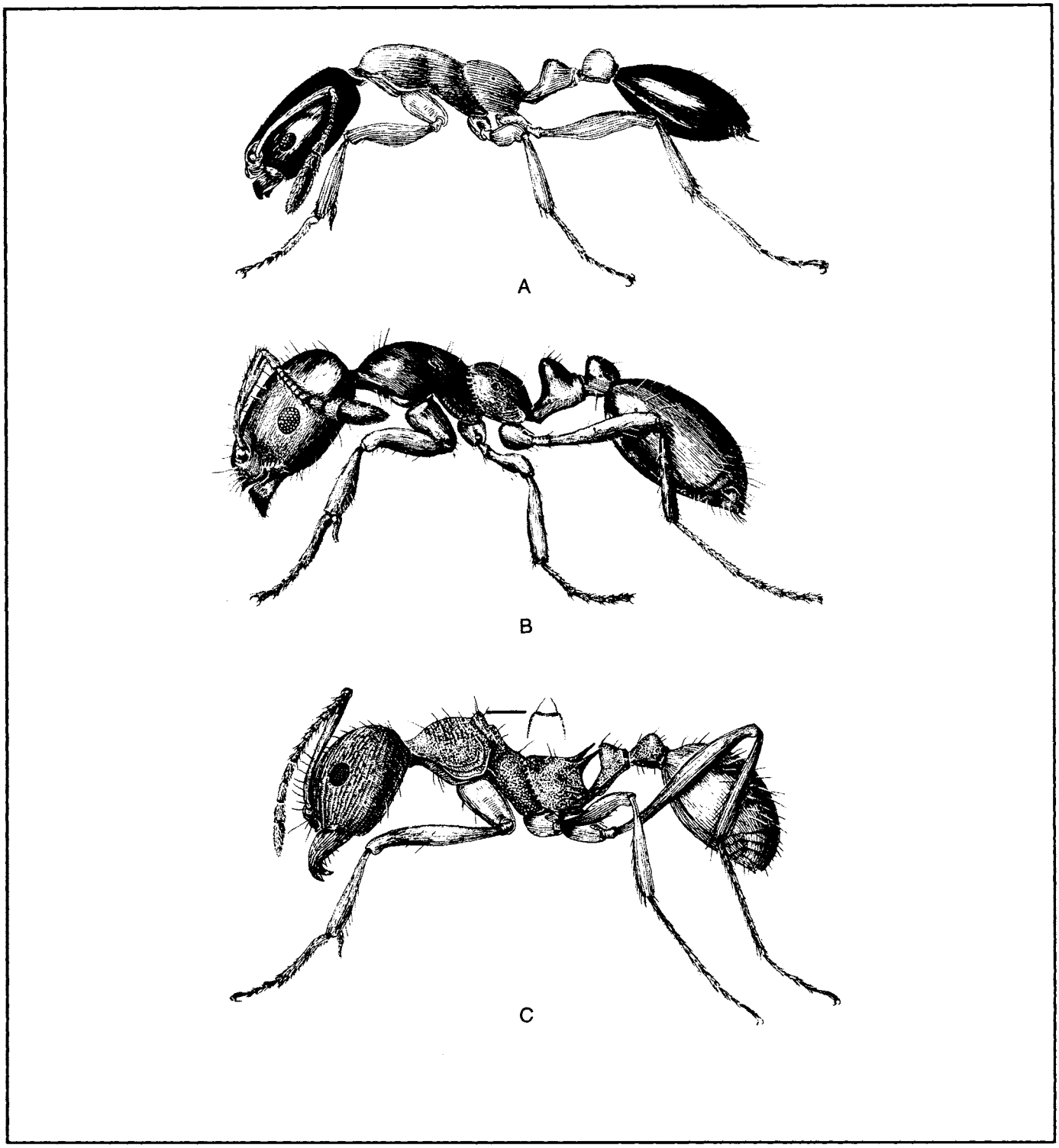


Plate 138. Myrmicine ants (Myrmicinae, Formicidae): A, *Monomorium floricola* (1.4-1.8); B, **little black ant,** *Monomorium minimum* (1.5-2); C, *Aphaenogaster fulva* (3.5-5.8).

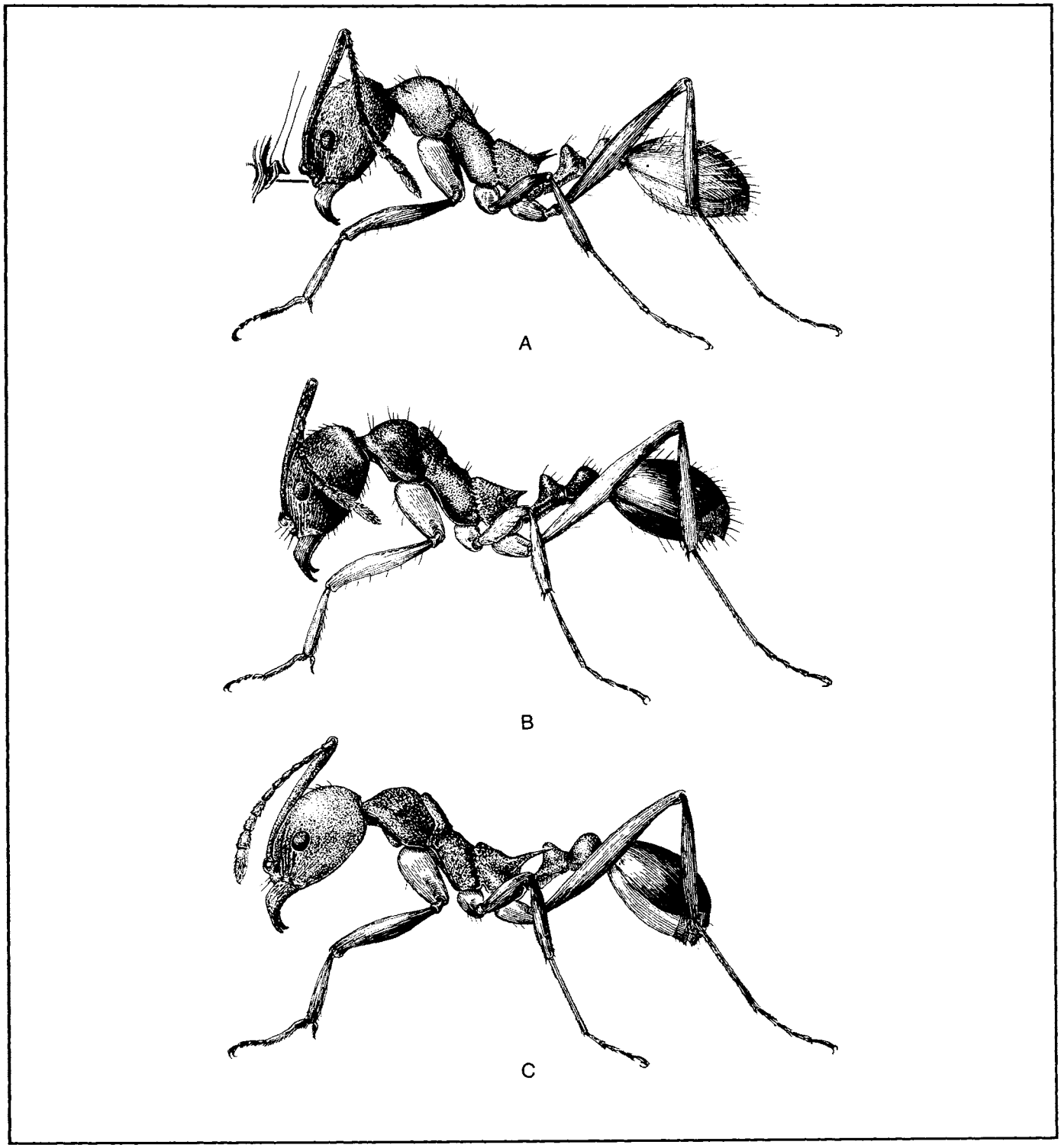


Plate 139. Myrmicine ants (Myrmicinae, Formicidae): A, *Aphaenogaster lamellidens* (4.1-6.5); B, *Aphaenogaster rudis* (4.5-5); C, *Aphaenogaster tennesseensis* (4.1-5.3).

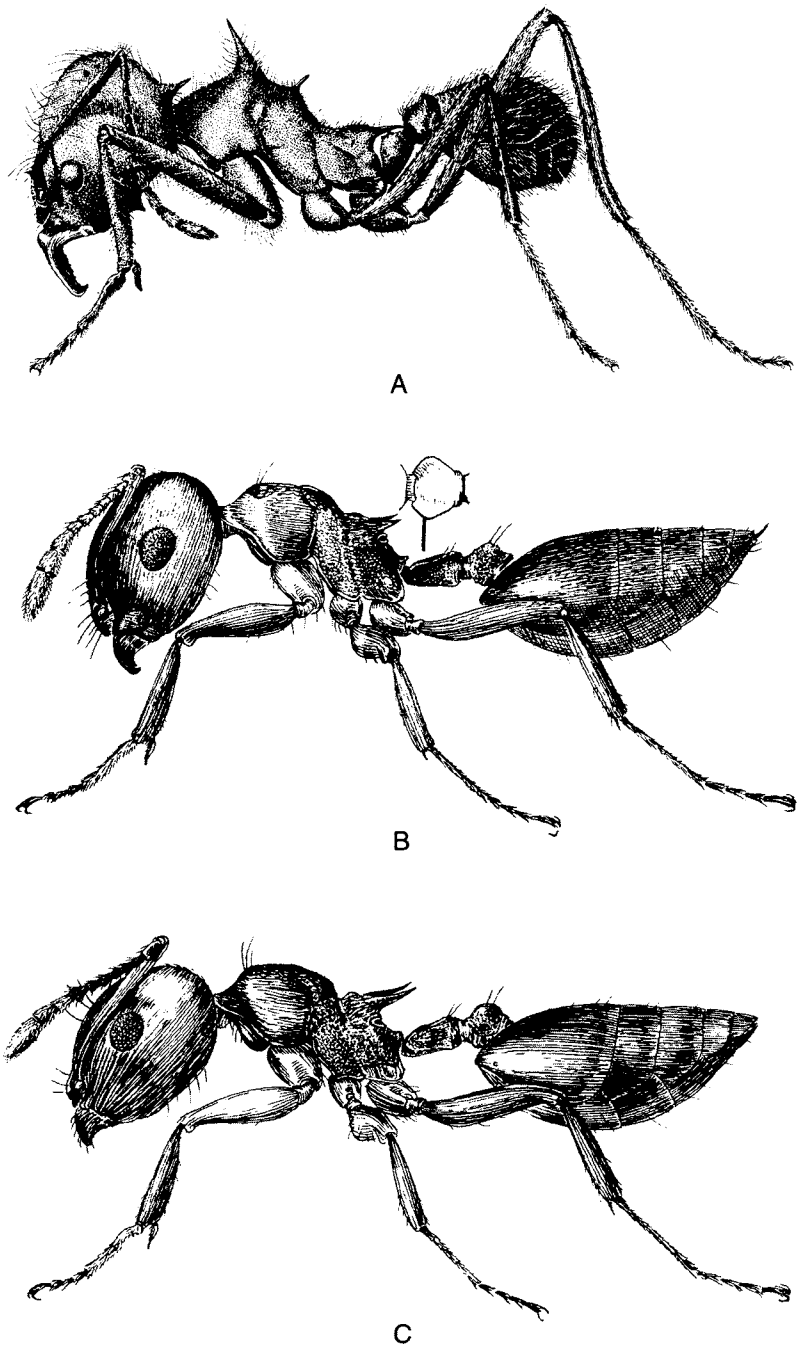


Plate 140. Myrmicine ants (Myrmicinae, Formicidae): A, **Texas leafcutting ant,** *Atta texana* (1.5-12); B, *Crematogaster ashmeadi* (2.6-3.2); C, *Crematogaster cerasi* (2.6-4).

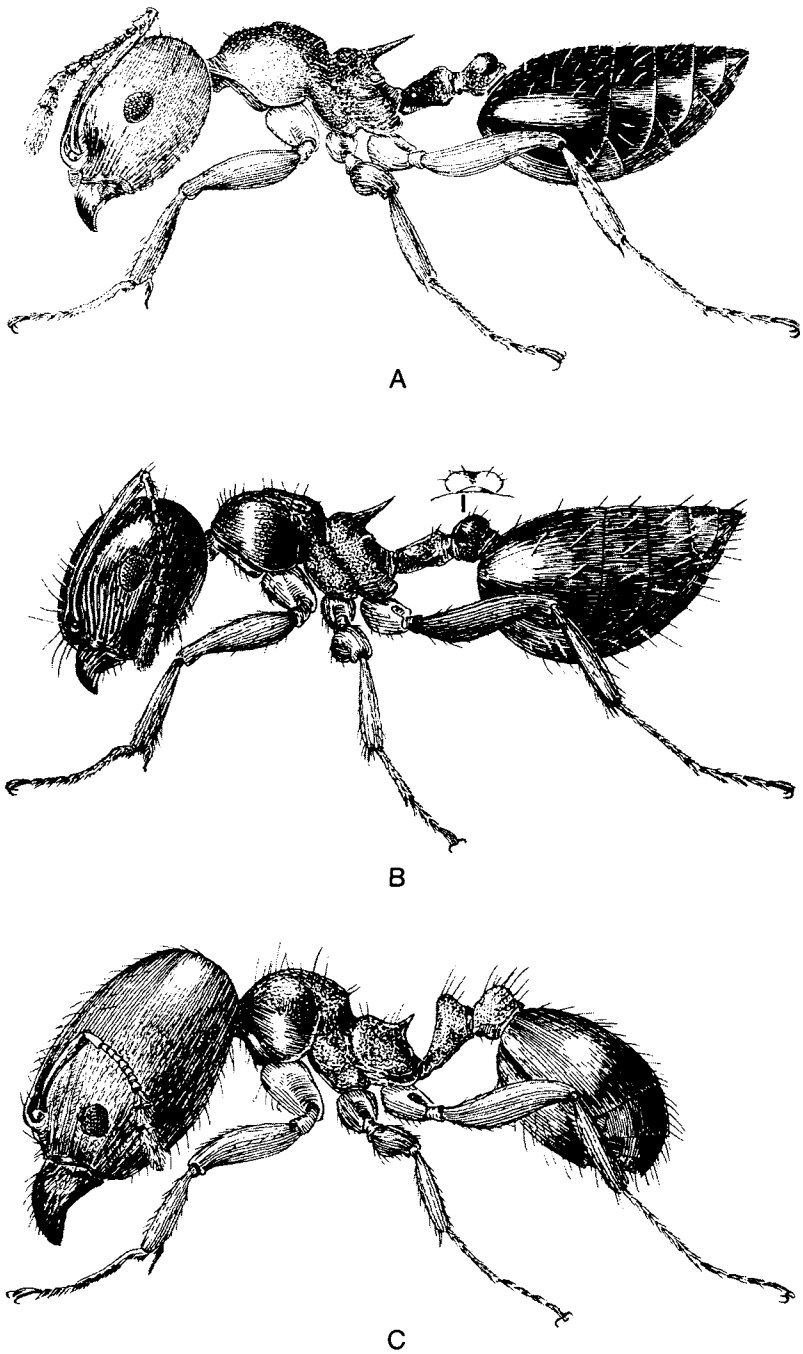
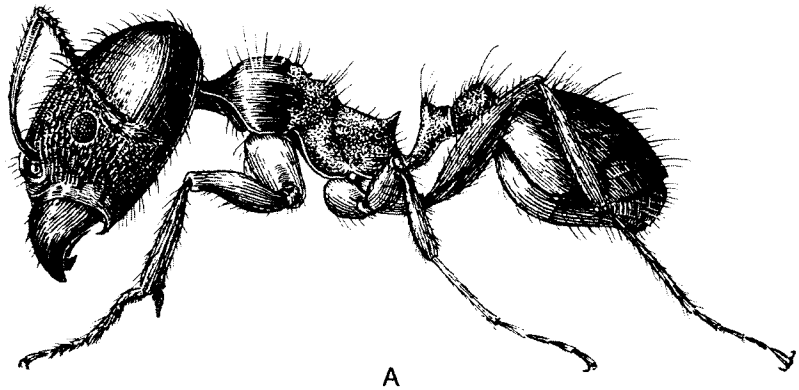
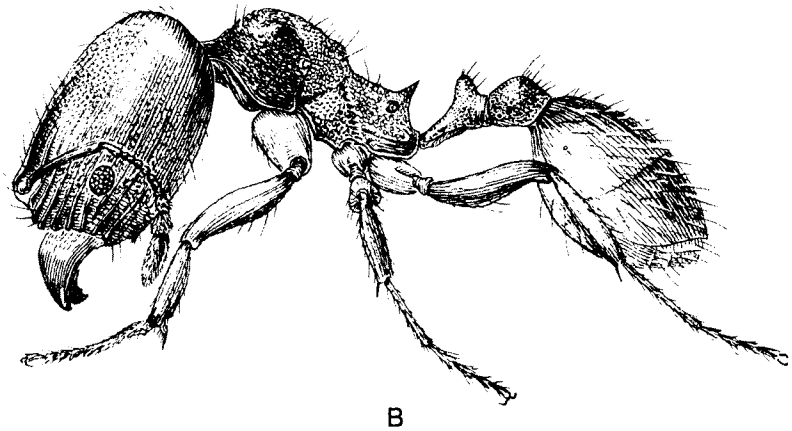


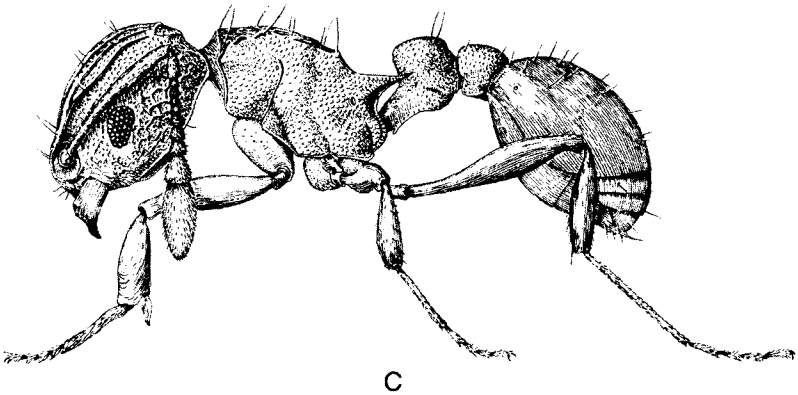
Plate 141. Myrmicine ants (Myrmicinae, Formicidae): A, *Crematogaster clara* (3.3-4); B, *Crematogaster lineolata* (2.5-3.5); C, *Pheidole bicarinata vinelandica* (1.6-3).



A



B



C

Plate 142. Myrmicine ants (Myrmicinae, Formicidae): A, *Pheidole dentata* (2.4-3.8); B, *Pheidole floridana* (1.5-2.6); C, **little fire ant,** *Ochetomyrmex auropunctatus* (1.5).

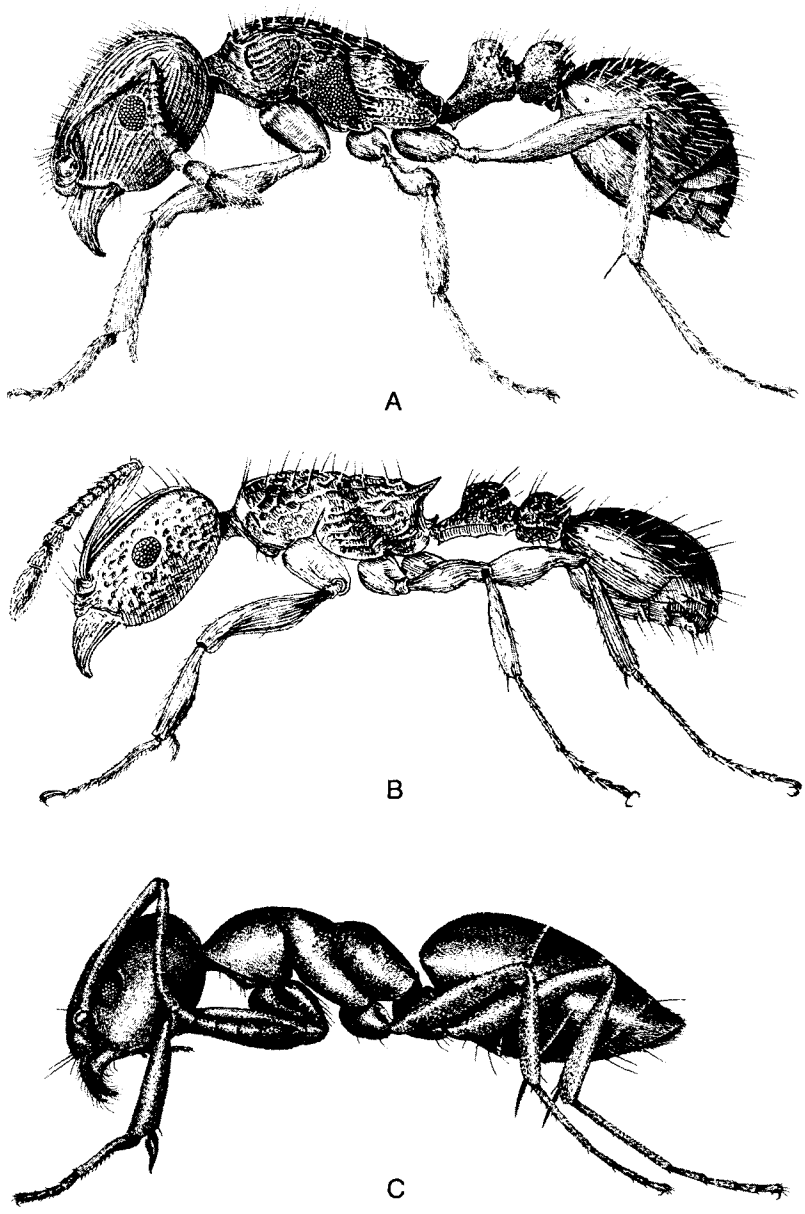


Plate 143. Myrmicine and dolichoderine ants (Formicidae): A, **pavement ant,** *Tetramorium caespitum* (2.5-3) (Myrmicinae); B, **Guinea ant,** *Tetramorium bicarinatum* (3-3.5) (Myrmicinae); C, **odorous house ant,** *Tapinoma sessile* (2.4-3.2) (Dolichoderinae) (drawing by S.H. DeBord).

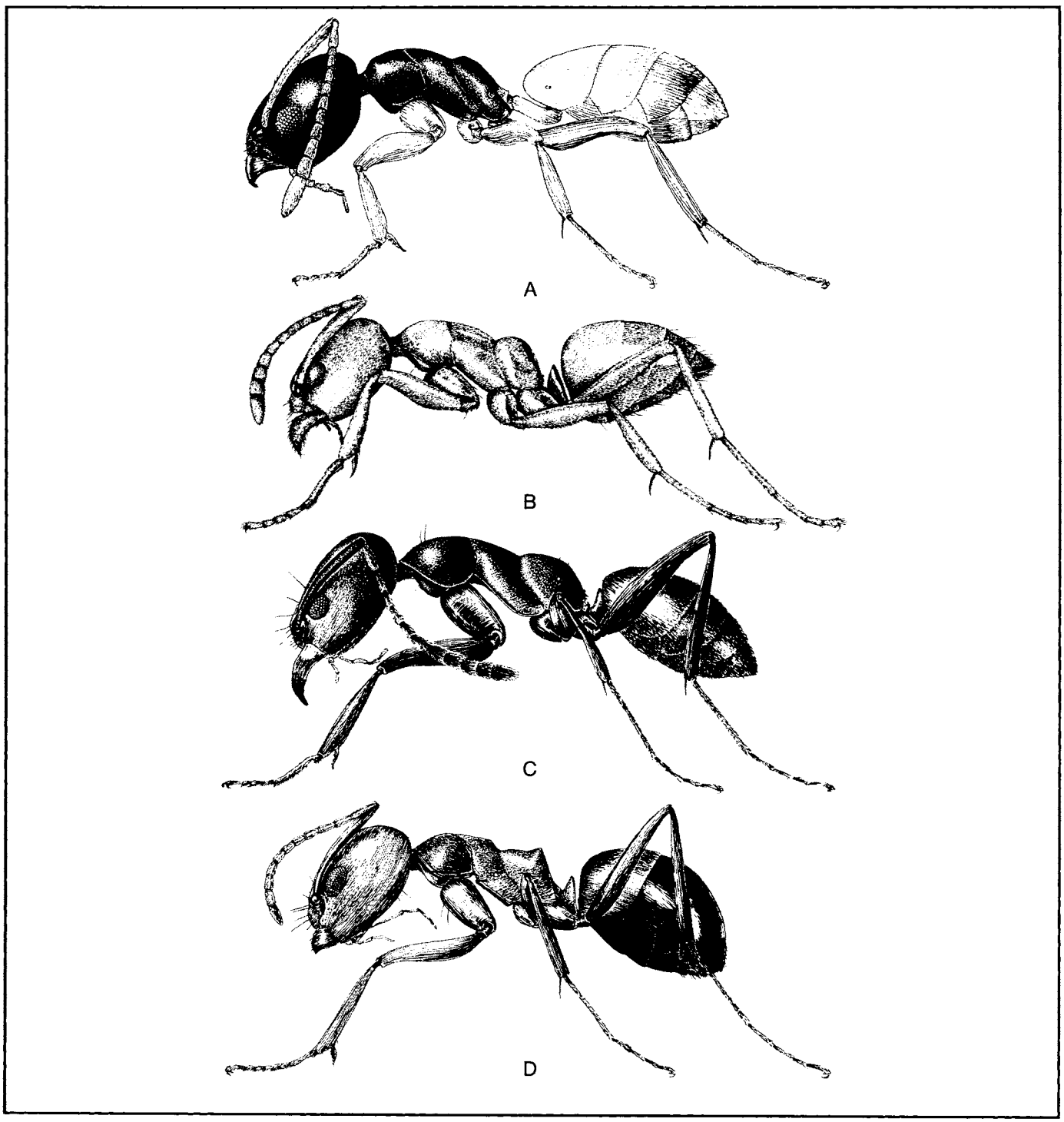


Plate 144. Dolichoderine ants (Dolichoderinae, Formicidae): A, *Tapinoma melanocephalum* (1.3-1.5); B, **Argentine ant,** *Iridomyrmex humilis* (2.2-2.6) (drawing by S.H. DeBord); C, *Iridomyrmex pruinosus* (1.8-2.5); D, **pyramid ant,** *Conomyrma insana* (3).

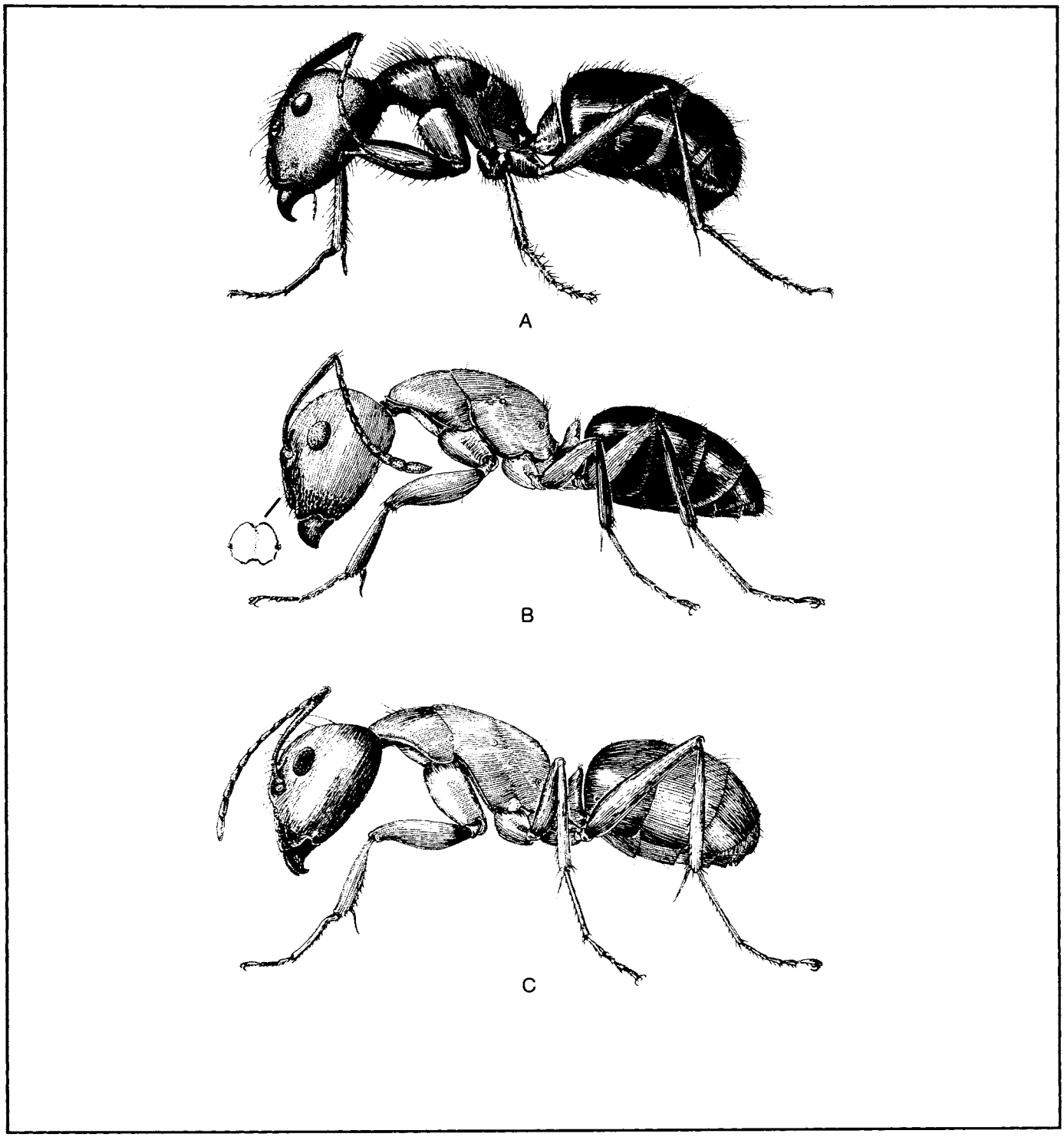
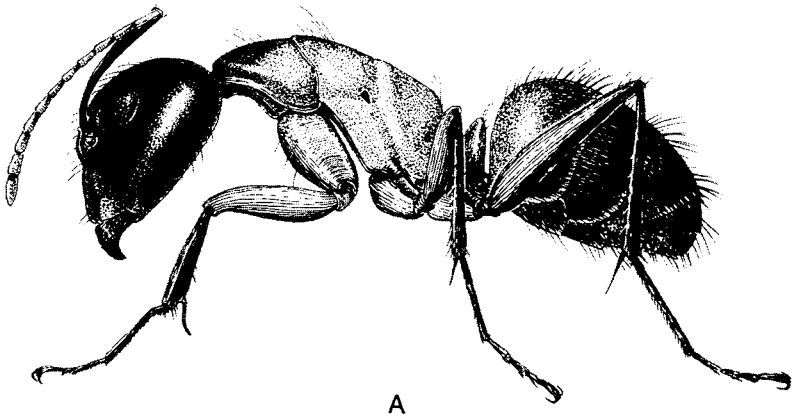
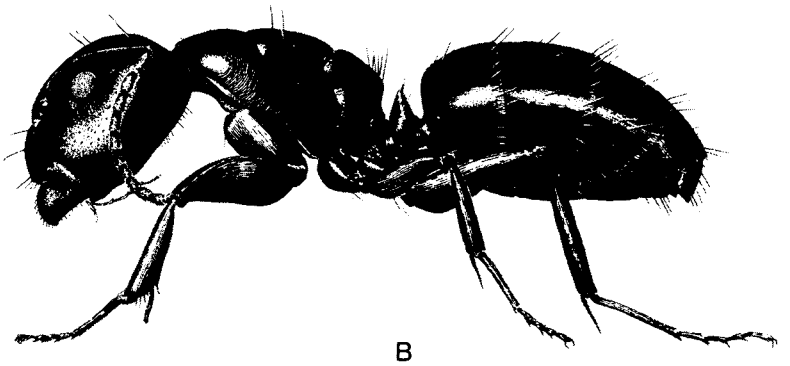


Plate 145. Carpenter ants (Formicinae, Formicidae): A, **Florida carpenter ant,** *Camponotus abdominalis* (5.5-10); B, *Camponotus caryae discolor* (3.5-7.5); C, *Camponotus castaneus* (7-10).



A



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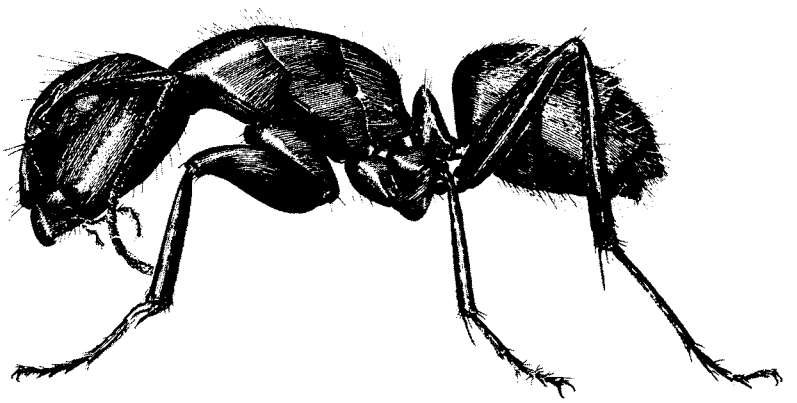


C

Plate 146. Carpenter ants (Formicinae, Formicidae): A, **red carpenter ant,** *Camponotus ferrugineus* (6-13); B, *Camponotus nearcticus* (4.5-7.5); C, **black carpenter ant,** *Camponotus pennsylvanicus* (6-13).

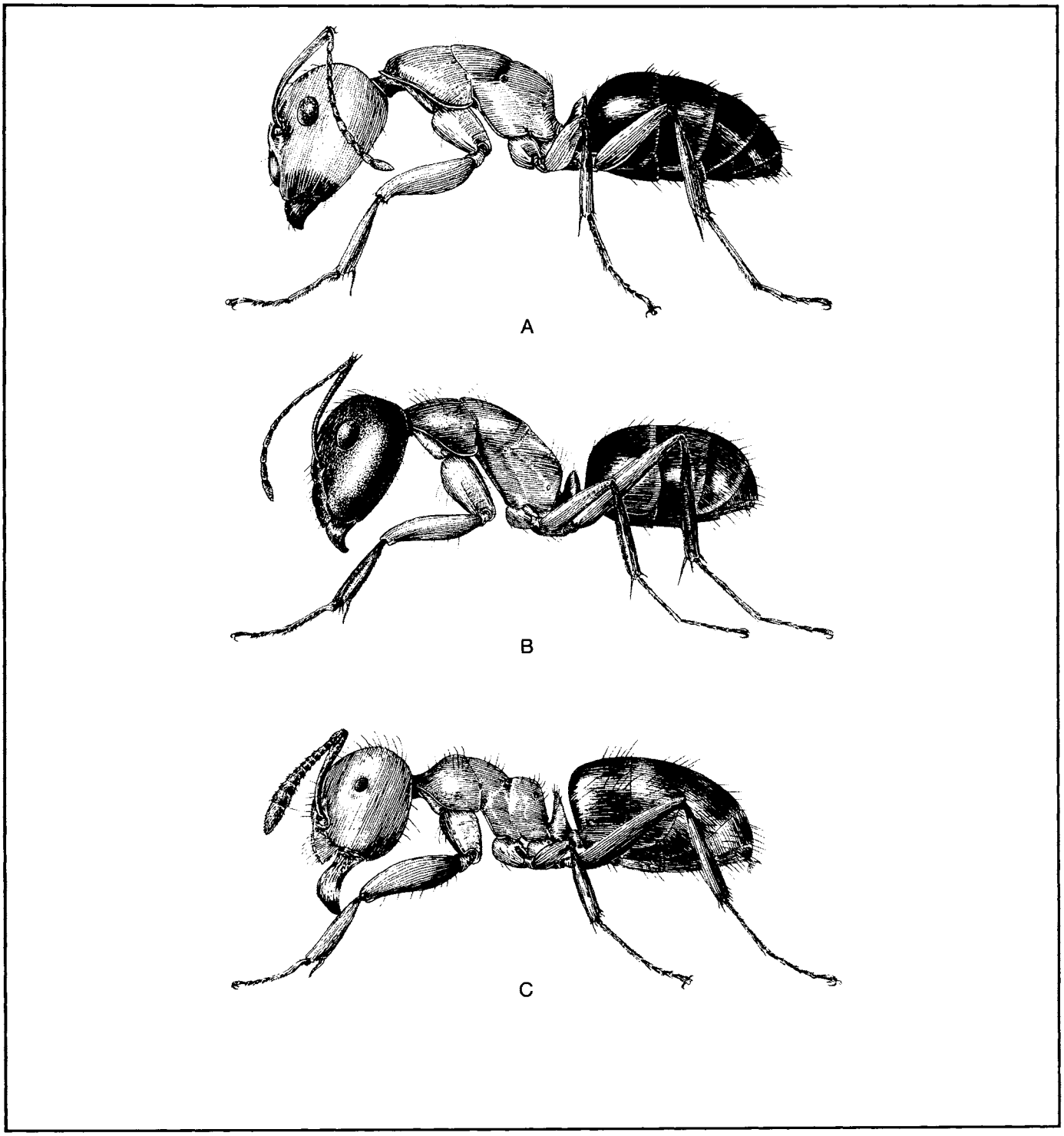


Plate 147. Formicine ants (Formicinae, Formicidae): A, carpenter ant, *Camponotus sayi* (4-9); B, carpenter ant, *Camponotus tortuganus* (6-11); C, **smaller yellow ant,** *Acanthomyops claviger* (3-4).

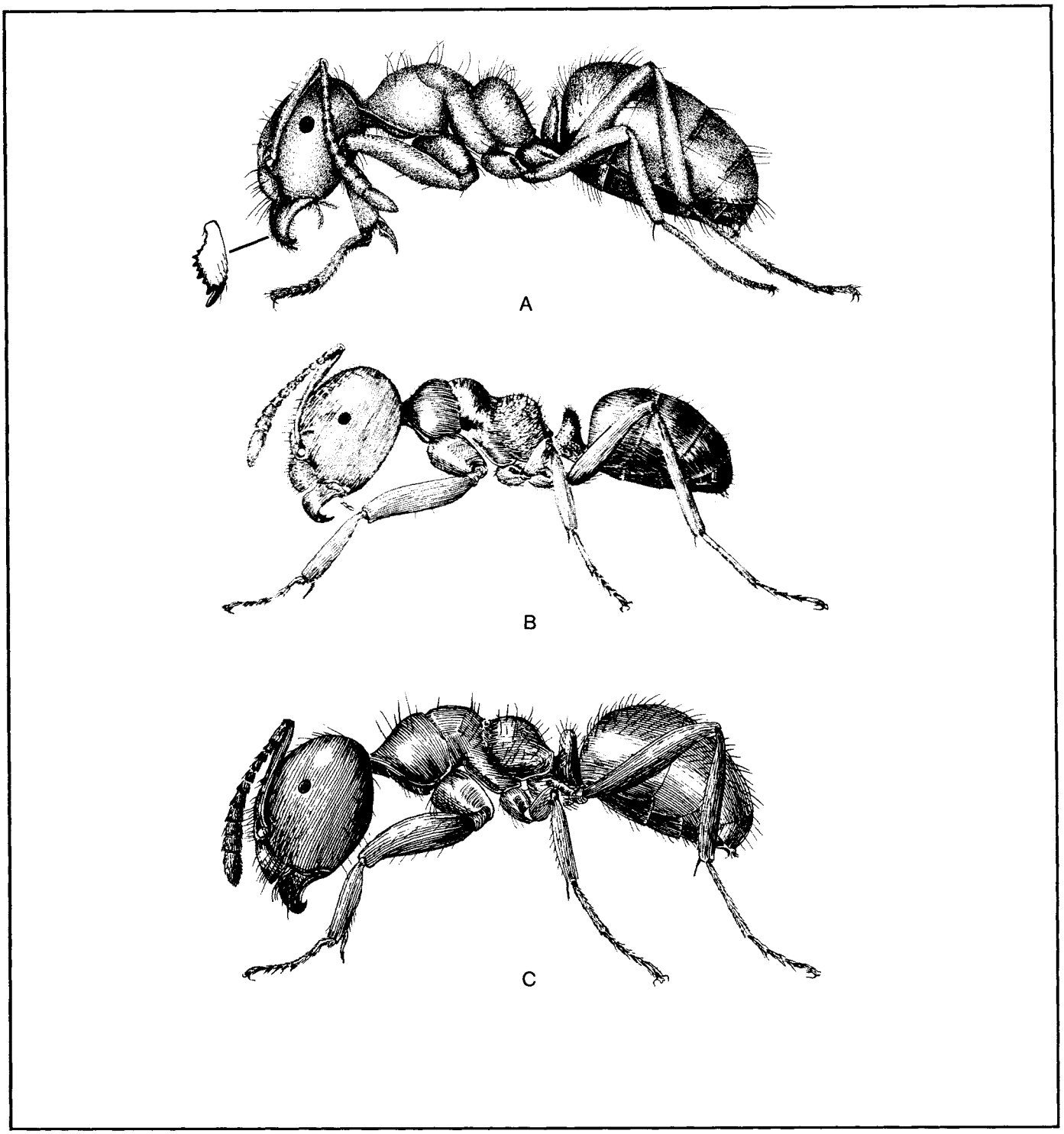
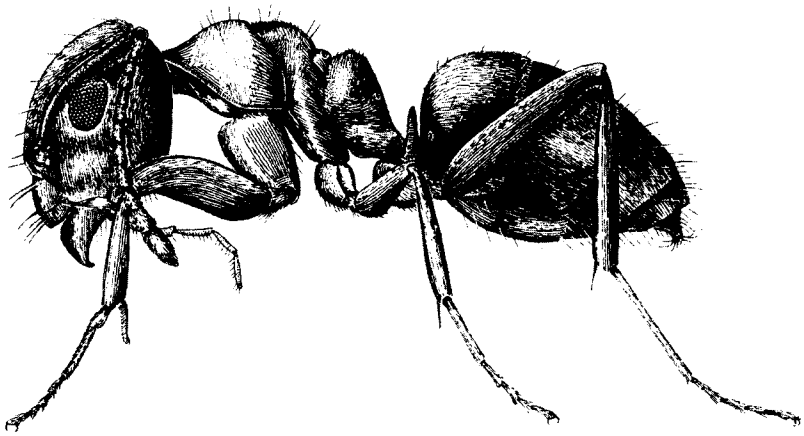
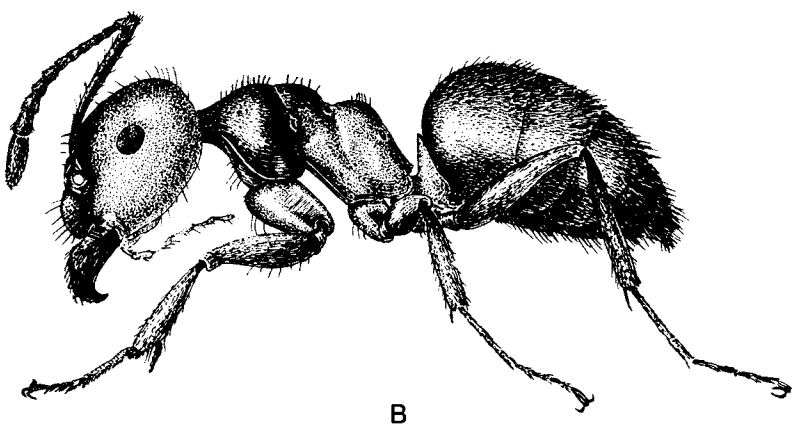


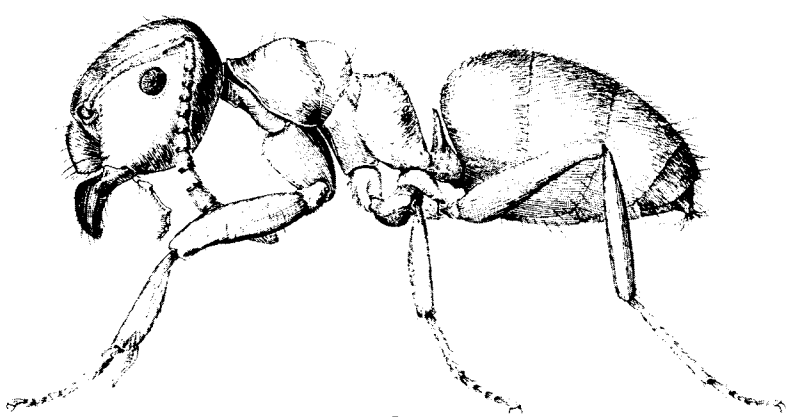
Plate 148. Formicine ants (Formicinae, Formicidae): A, **larger yellow ant,** *Acanthomyops interjectus* (4-4.5) (drawing by S.H. DeBord); B, *Acanthomyops murphyi* (3-3.7); C, *Acanthomyops latipes* (3.5-3.8).



A



B



C

Plate 149. Formicine ants (Formicinae, Formicidae): A, **cornfield ant,** *Lasius alienus* (2-2.5); B, *Lasius neoniger* (2-2.5); C, *Lasius umbratus* (3.3-3.7).

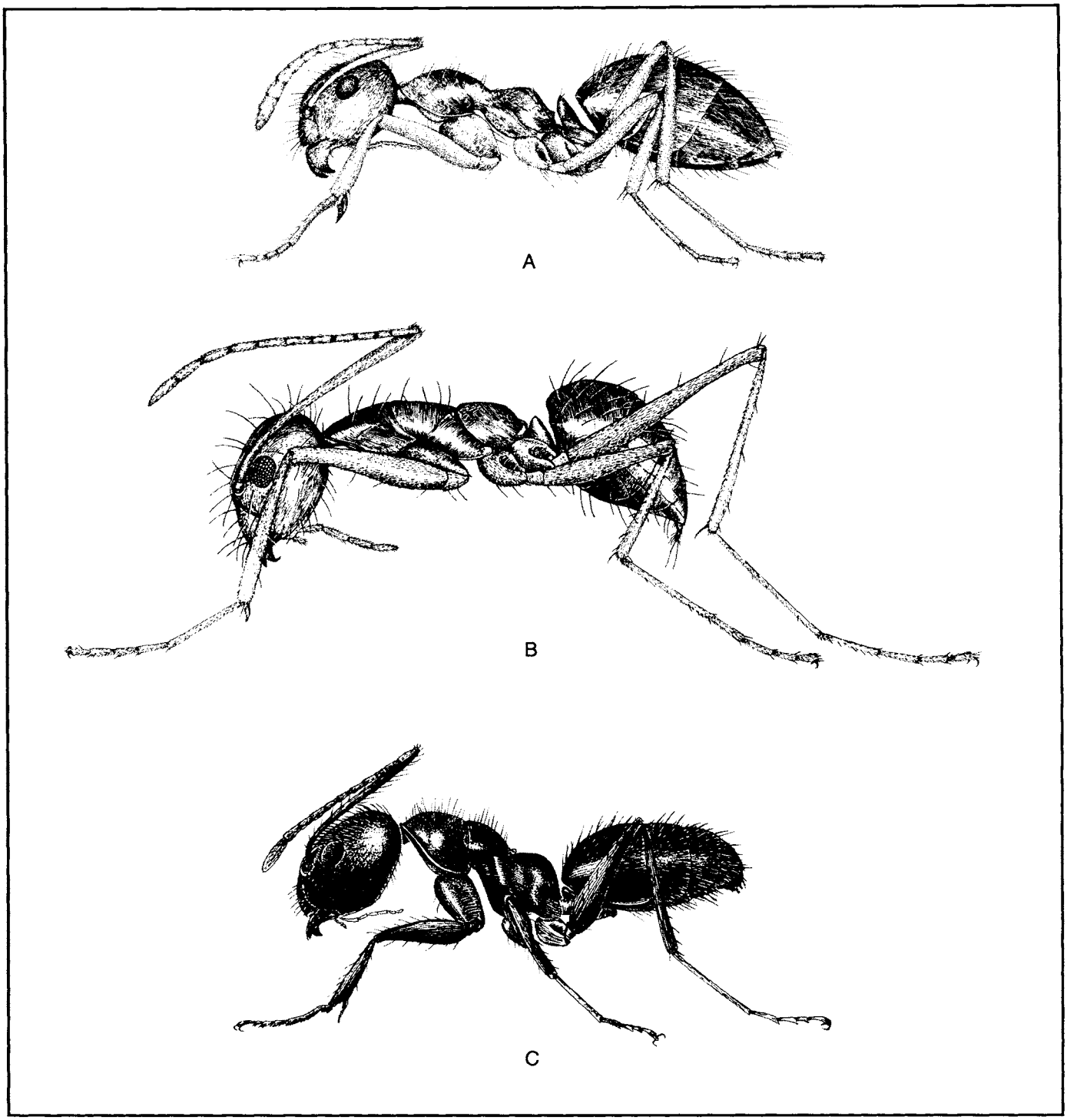


Plate 150. Formicine ants (Formicinae, Formicidae): A, false honey ant, *Prenolepis imparis* (2-4); B, **crazy ant,** *Paratrechina longicornis* (2.2-3) (drawings A&B by S.H. DeBord); C, *Paratrechina* (various species) (2.2-4).

Notes and Sketches

28 ARTHROPOD PESTS OF THE FOOD INDUSTRY: A LIST AND TAXONOMIC BIBLIOGRAPHY

J. Richard Gorham

Food and Drug Administration
Washington DC 20204

CONTENTS

Hundreds of insect and mite species have been associated at one time or another with various aspects of the food industry (***A001-A007, A009-A027***). Since user convenience is an important objective of this list (and of this entire handbook, for that matter), no attempt is made here to record all these species. This list is, however, more inclusive than were the earlier versions (***A012, A013***). Although some rare or unusual species are included, emphasis is given here to the common cosmopolitan pests, to pests likely to be encountered in FDA and USDA operations, and to pests of food stored in the home. Field crop pests have been largely excluded, but many pests associated with other aspects of the food industry, such as storage, transport, processing, vending, and serving, are listed.

A basic tenet of research on the prevention, detection, and control of infestations by food pests is that the investigator must be certain that the offending arthropod is correctly identified. Fortunately, many of our food pests (or even fragments thereof in some cases) can be readily identified. This handbook will be especially helpful in dealing with arthropods in that category. In other instances, the services of a taxonomic specialist may be required to produce a trustworthy identification. Therefore, the simple consultation of the keys in this handbook or of the taxomomic literature listed below cannot guarantee correct identification of every specimen. Rather, the keys and references given here and elsewhere in this handbook are intended to assist the operational entomologist in deciding whether to do the identification at the local level or to submit the specimen to a competent taxonomic authority.

In the list below under the heading "Arthropod Pests of the Food Industry," the references are cited by number and are limited to those that provide keys, illustrations, or other useful details about the identification of a given pest. A few long-standing and widely used synonyms are placed in brackets. Common names in **boldface** have been approved by the Committee on Common Names of Insects (***A008***). Names followed by an asterisk (*) represent taxa that have been keyed out or illustrated here. This list also serves as the taxonomic index for the handbook.

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Arthropod Pests of the Food Industry

Taxon	Common Name	Reference	Page
Acari* [Acarina] (subclass)	**mites**	*A017 B001 B002 B004 B006-B009 B012-B015 AQ02 AQ06*	3, 321, 483

B001 Baker, E.W., T.M. Evans, D.J. Gould, W.B. Hull, and H.L. Keegan.
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Taxon	Common Name	Reference	Page
Acariformes* (order)	acariform mites	*A017 B002 B007*	4, 7, 14, 492
Astigmata* (suborder)	astigmatid mites	*A017 B002 B006 B007*	4, 14, 16, 494
Acaridae*	**acarid mites**	*A017 B007 C011*	4, 22, 23, 497
*Acarus farris** (Oudemans)		*A017 C005*	25, 500
Acarus gracilis Hughes		*A017 C005*	
*Acarus immobilis** Griffiths		*A017 C004 C005*	25, 501
*Acarus siro L**	**grain mite**	*A017 B004 C005 C011*	24, 499
*Aleuroglyphus ovatus** (Troupeau)	**brownlegged grain mite**	*A017 C001 C011*	27
Caloglyphus [Sancassania]*		*C010 C012*	28
Caloglyphus anomalus Nesbitt		*C010*	
*Caloglyphus berlesei** (Michael)		*A017 C006*	28, 505
Caloglyphus hughesi (Samšiňák)		*A017*	
Caloglyphus mycophagus (Mégnin)		*A017 C006*	
Caloglyphus oudemansi (Zakhvatkin)		*A017*	
Caloglyphus rhizoglyphoides (Zakhvatkin)		*A017*	
*Histiogaster**		*C012 C018*	29
Histiogaster carpio Kramer		*C018*	
Mycetoglyphus fungivorus Oudemans		*A017 C012*	
*Rhizoglyphus**		*A017 C012*	28
Rhizoglyphus callae Oudemans		*A017 C008*	28
Rhizoglyphus echinopus (Fumouze & Robin)	**bulb mite**	*A017 C008 C011*	28
Rhizoglyphus phylloxerae Riley		*C002 C006*	
*Rhizoglyphus robini** Claparède		*C008*	28, 503, 504
*Schwiebia**		*C009*	29
*Suidasia nesbitti** Hughes	**scaly grain mite**	*A017*	22, 497
*Suidasia pontifica** Oudemans [*S. medanensis* Oudemans]		*A017 C003*	22
Thyreophagus entomophagus (Laboulbène)		*A017 C014*	28, 503
Thyreophagus gallegoi Portus & Gomez		*C013*	
Tyroborus lini Oudemans		*A017 C012*	
*Tyrolichus casei** Oudemans	**cheese mite**	*A017 C012 C014*	26, 501
Tyrophagus brevicrinatus Robertson		*A017 B007 C015*	
*Tyrophagus longior** (Gervais)		*A017 B004 C006 C007 C014 C015*	26, 502

Taxon	Common Name	Reference	Page
Tyrophagus palmarum Oudemans		*A017 C007 C015*	
Tyrophagus perniciosus Zakhvatkin		*A017 C007 C015*	
*Tyrophagus putrescentiae** (Schrank)	**mold mite**	*A017 C006 C014 C015 C016 C017*	26, 502
Tyrophagus similis Volgin		*A017 C006 C007 C015 C017*	
Tyrophagus tropicus Robertson		*A017 C007 C015*	26

C001 Baker, E.W., M.D. Delfinado, and M.J. Abbatiello.
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Taxon	Common Name	Reference	Page
Carpoglyphidae*	**driedfruit mites**	*A017*	19, 494
*Carpoglyphus lactis** (L.)	**driedfruit mite**	*A017 B004 D001 D002*	19, 494

D001 Baker, E.W., and M.D. Delfinado.
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D002 Chmielewski, W.
1971. Morfologia, biologia i ekologia *Carpoglyphus lactis* (L., 1758) (Glycyphagidae, Acarina). Prace Nauk. Inst. Ochrony Roślin 8(2)63-166.

Taxon	Common Name	Reference	Page
Chortoglyphidae	chortoglyphid mites	*A017 B007*	
Chortoglyphus arcuatus (Troupeau)		*A017*	
Glycyphagidae*	**glycyphagid mites**	*A017*	19, 20, 494-496
*Aeroglyphus robustus** (Banks)	**warty grain mite**	*A017 C001*	20, 495
Austroglycyphagus geniculatus (Vitzthum)		*A017*	
Blomia freemani Hughes		*A017 F001*	

Taxon	Common Name	Reference	Page
Ctenoglyphus plumiger (Koch)		*A017*	
*Glycyphagus domesticus** (De Geer)	**house mite**	*A017 B004 F002*	20, 496
Glycyphagus ornatus Kramer		*A017 F002*	
Glycyphagus privatus Oudemans		*A017*	
*Gohieria fusca** (Oudemans)	**brown flour mite**	*A017*	19, 494
*Lepidoglyphus destructor** (Schrank)		*A017 B004*	20
Lepidoglyphus fustifer (Oudemans)		*A017 B004*	
Lepidoglyphus michaeli (Oudemans)		*A017*	

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F002 Volgin, V.I.
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Taxon	Common Name	Reference	Page
Histiostomatidae* [Anoetidae]	histiostomatid mites	*G002*	29, 506-508
Histiostoma feroniarum (Dufour)		*A017 C006 G001 G002*	
*Histiostoma heinemanni** Hill & Deahl		*G001*	29, 506-508

G001 Hill, A., and K.L. Deahl.
1978. Description and life cycle of a new species of *Histiostoma* (Acari: Histiostomidae) associated with commercial mushroom production. Proc. Ent. Soc. Washington 80(3)317-329.

G002 Hughes, R.D., and C.G. Jackson.
1958. A review of the Anoetidae. Virginia Jour. Sci. (n.s.) 9(1)5-198.

Taxon	Common Name	Reference	Page
Lardoglyphidae*	lardoglyphid mites	*A017 B007*	23, 498
Lardoglyphus angelinae Olsen		*H001*	23
*Lardoglyphus konoi** (Sasa & Asanuma)		*A017 H001*	23, 498
*Lardoglyphus zacheri** Oudemans		*A017 H001*	23, 498

H001 Olsen, A.R.
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Taxon	Common Name	Reference	Page
Psoroptidae*	**scab mites**	*B001*	18, 493
*Psoroptes equi** (Raspail)	**scab mite**	*B001*	18, 493

Pyroglyphidae* [Epidermoptidae]	pyroglyphid mites	*A017 J001 J005*	29, 509-513
*Dermatophagoides farinae** Hughes	**American house dust mite**	*J003 J005*	32, 513
*Dermatophagoides microceras** Griffiths & Cunnington		*J004 J005*	32
*Dermatophagoides pteronyssinus** (Trouessart)	**European house dust mite**	*J003 J005*	31
*Euroglyphus longior** (Trouessart)		*J002 J005*	31, 509, 510
*Euroglyphus maynei** (Cooreman)		*J002 J005*	31, 511, 512
Pyroglyphus africanus (Hughes)		*A017 J005*	

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J005 Wharton, G.W.
1976. House dust mites. Jour. Med. Ent. 12(6)577-621.

Taxon	Common Name	Reference	Page
Sarcoptidae*	sarcoptid mites	*K001*	18, 492
*Sarcoptes scabiei** (De Geer)	**itch mite**	*B001 B004 K001 K002*	18, 492

K001 Fain, A.
1968. Etude de la variabilite de *Sarcoptes scabiei* avec une revision des Sarcoptidae. Acta Zool. Path. Antverp. 47:1-196.

K002 Zumpt, F., ed.
1961. The arthropod parasites of vertebrates in Africa south of the Sahara (Ethiopian Region). Vol. 1. Chelicerata. South African Institute for Medical Research, Johannesburg.

Taxon	Common Name	Reference	Page
Cryptostigmata* [Oribatida] (suborder)	beetle mites	*B003 B006 B007*	4, 14, 16
Aphelacaridae	aphelacarid mites		
Aphelacarus acarinus (Berlese)		*B003*	16
Ceratozetidae	ceratozetid mites		
Trichoribates novus (Sellnick)		*A017 M001*	16

M001 Schweizer, J.
1956. Die Landmilben des schweizerischen Nationalparkes. Sarcoptiformes Reuter 1909. Rés. Rech. Scient. Parc Nat. Suisse 5(n.s.)(34)213-377.

Taxon	Common Name	Reference	Page
Oribatulidae	oribatulid mites		
Phauloppia lucorum (Koch)		*A017*	16
*Scheloribates**		*A017*	492
Scheloribates laevigatus (Koch)		*A017 N001*	16

N001 Schweizer, J.
1949. Die Landmilben des schweizerischen Nationalparkes. Parasitiformes Reuter 1909. Rés. Rech. Scient. Parc Nat. Suisse 2(n.s.)(21)1-99, 1 map.

Taxon	Common Name	Reference	Page
Prostigmata (suborder)	prostigmatid mites	*A017 B006 B007 B009 B011*	4, 14, 32, 514
Acarophenacidae	acarophenacid mites	*O001*	
Acarophenax tribolii Newstead & Duvall		*A017 O001*	

O001 Cross, E.A.
1965. The generic relationships of the family Pyemotidae (Acarina: Trombidiformes). Univ. Kansas Sci. Bull. 45(2)29-275.

Taxon	Common Name	Reference	Page
Bdellidae*	bdellid mites	*A017*	36, 516
*Spinibdella bifurcata** Atyeo		*P001*	36, 516

P001 Atyeo, W.T.
1960. A revision of the mite family Bdellidae in North America and Central America (Acarina, Prostigmata). Univ. Kansas Sci. Bull. 40(8)345-499.

Taxon	Common Name	Reference	Page
Cheyletidae*	cheyletid mites	*Q001 Q005*	35, 515
Acaropsella volgini (Gerson)		*Q005*	
Acaropsellina docta (Berlese)		*Q004 Q005*	
Acaropsellina sollers (Rohdendorf)		*Q004*	
*Cheletomorpha lepidopterorum** (Shaw)		*Q001 Q005*	35, 515
Cheyletus aversor Rohdendorf		*Q005*	
*Cheyletus eruditus** (Schrank)		*B004 Q001 Q002 Q005*	36
*Cheyletus malaccensis** Oudemans		*Q001 Q005*	36

Q001 Baker, E.W.
1949. A review of the mites of the family Cheyletidae in the United States National Museum. Proc. U.S. Nat. Mus. 99(3238)267-320.

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Q003 Summers, F.M.
1975. Males of three species of *Cheyletus*. Proc. Ent. Soc. Washington 77(4)446-455.

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Q005 Summers, F.M., and D.W. Price.
1970. Review of the mite family Cheyletidae. Univ. California Pubs. Ent. 61:1-153.

Taxon	Common Name	Reference	Page
Cunaxidae	cunaxid mites	*R001 R002*	
Cunaxa setirostris (Hermann)		*A017 R002*	

R001 Baker, E.W., and A. Hoffmann.
1948. Acaros de la familia Cunaxidae. An. Esc. Nac. Cien. Biol. 5(3-4)229-273.

R002 Smiley, R.L.
1975. A generic revision of the mites of the family Cunaxidae. Ann. Ent. Soc. America 68(2)227-244.

Taxon	Common Name	Reference	Page
Demodicidae*	**follicle mites**		33
*Demodex canis** Leydig	**dog follicle mite**	*B001*	33
Eriophyoidea*	eriophyoid mites	*T002*	32, 35
Eriophyidae	**eriophyid mites**		
*Eriophyes ficus** Cotte	**fig mite**	*T001 T003*	32

T001 Baker, E.W.
1939. The fig mite, *Eriophyes ficus* Cotte, and other mites of the fig tree, *Ficus carica* Linn. California Dept. Agr. Bull. 28(4)266-275.
T002 Jeppson, L.R., H.H. Keifer, and E.W. Baker.
1975. Mites injurious to economic plants. University of California, Berkeley.
T003 Keifer, H.H.
1938. Eriophyid studies. II. California Dept. Agr. Bull. 27(3)301-323.

Taxon	Common Name	Reference	Page
Erythraeoidea*	erythraeoid mites	*U002*	34
Erythraeidae	erythraeid mites		
Balaustium murorum (Hermann)	wall mite	*B011 U001*	34

U001 Rack, G.
1984. Systematik, Morphologie und Biologie von Milben (Acari) in Häusern und Vorräten sowie Milben von medizinischer Bedeutung. 1. Allgemeines. *Balaustium murorum,* (Hermann, 1804). Der praktische Schädlingsbekämpfer 35(9)457-460.
U002 Southcott, R.V.
1961. Studies on the systematics and biology of the Erythraeoidea, with a critical revision of the genera and subfamilies. Australian Jour. Zool. 9(3)367-610.

Taxon	Common Name	Reference	Page
Eupodidae	**eupodid mites**		
Linopodes antennaepes Banks	longlegged mite	*C006 V001*	

V001 Banks, N.
1894. American Acarina. Trans. American Ent. Soc. 21(June)209-222.

Taxon	Common Name	Reference	Page
Halacaridae*	halacarid mites	*W001*	37, 516
Rhombognathides seahami (Hodge)		*W001*	37, 516

W001 Newell, I.M.
1947. A systematic and ecological study of the Halacaridae of Eastern North America. Bul. Bingham Oceanogr. Collect. 10(3)1-232.

Taxon	Common Name	Reference	Page
Myobiidae*	myobiid mites		36
Myobia musculi (Schrank)		*B001 X001*	33, 36
Radfordia affinis (Poppe)		*X001*	36
Radfordia ensifera (Poppe)		*X001*	36

X001 Vitzthum, H.G.
1929. 5. Ordnung: Milben, Acari. Die Tierwelt Mitteleuropas 3(7)1-112.

Taxon	Common Name	Reference	Page
Pterygosomatidae*	pterygosomatid mites		37, 517
Pimeliaphilus cunliffei Jack	cockroach mite	*Y001*	37, 517

Y001 Jack, K.M.
1961. A re-examination of the genera *Pimeliaphilus* Trägårdh 1905 and *Hirstiella* Berlese 1920 (Acari; Prostigmata). Ann. Mag. Nat. Hist. 13(4)305-314.

Taxon	Common Name	Reference	Page
Pyemotidae*	**pyemotid mites**	*O001*	40, 520, 521
*Pyemotes tritici** Lagrèze-Fossat & Montané [*P. ventricosus* (Newport)]	**straw itch mite**	*Z001*	40, 520, 521

Z001 Cross, E.A., and J.C. Moser.
1975. A new, dimorphic species of *Pyemotes* and a key to previously-described forms (Acarina: Tarsonemoidea). Ann. Ent. Soc. America 68(4)723-732.

Taxon	Common Name	Reference	Page
Pygmephoridae*	mushroom mites	*O001 AA01*	40, 522-524
*Pseudopygmephorus smileyi** Hill & Deahl		*AA02*	40, 523, 524
Pygmephorus mesembrinae Canestrini		*AA01*	
*Pygmephorus sellnicki** Krczal		*C006 AA01 AA03*	40, 522

AA01 Gurney, B., and N.W. Hussey.
1967. *Pygmephorus* species (Acarina: Pyemotidae) associated with cultivated mushrooms. Acarologia 9(2)353-358.

AA02 Hill, A., and K.L. Deahl.
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AA03 Smiley, R.L.
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AA04 Wicht, M.C., Jr.
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Taxon	Common Name	Reference	Page
Scutacaridae*	scutacarid mites		38, 518, 519
*Scutacarus baculitarsus agaricus** Norton & Ide		*AB01*	38, 518, 519

AB01 Norton, R.A., and G.S. Ide.
1974. *Scutacarus baculitarsus agaricus* n. subsp. (Acarina: Scutacaridae) from commercial mushroom houses, with notes on phoretic behavior. Jour. Kansas Ent. Soc. 47(4)527-534.

Taxon	Common Name	Reference	Page
Tarsonemidae*	**tarsonemid mites**	*AC01 AC02*	39, 525, 526
Tarsonemus floricolus Canestrini & Fanzago		*AC02*	
*Tarsonemus granarius** Lindquist		*AC01 AC04*	40, 41, 526
Tarsonemus lukoschusi Hill & Deahl		*AC03*	39
Tarsonemus mercedesae Hill & Deahl		*AC03*	39
*Tarsonemus scaurus** Ewing		*AC01 AC02*	40, 41, 525

AC01 Beer, R.T.
1954. A revision of the Tarsonemidae of the Western Hemisphere (order Acarina). Univ. Kansas Sci. Bull. 36, pt. 2(16)1091-1387.
AC02 Ewing, H.E.
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AC04 Lindquist, E.E.
1972. A new species of *Tarsonemus* from stored grain (Acari: Tarsonemidae). Canadian Ent. 104(11)1699-1707.

Taxon	Common Name	Reference	Page
Tetranychidae*	**spider mites**	*AD01 AD02*	35, 514
*Bryobia praetiosa** Koch	**clover mite**	*B004 AD02*	35, 514
Oligonychus pratensis (Banks)	**Banks grass mite**	*T002 AD01*	
Petrobia latens (Müller)	**brown wheat mite**	*T002 AD01 AD02*	

AD01 Pritchard, A.E., and E.W. Baker.
1955. A revision of the spider mite family Tetranychidae. Pacific Coast Entomological Society, San Francisco.
AD02 Tuttle, D.M., and E.W. Baker.
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Taxon	Common Name	Reference	Page
Trombidioidea*	trombidioid mites		34
Trombiculidae	**chigger mites**		34, 514
*Leptotrombidium**	chigger mites	*B001 K002 AE01*	33, 34

AE01 Wharton, G.W., and H.S. Fuller.
1952. A manual of the chiggers. Entomological Society of Washington, Washington, DC.

Taxon	Common Name	Reference	Page
Tydeidae*	**tydeid mites**	*T002 AF01*	38, 517
*Tydeus**		*AF02*	38, 517
Tydeus interruptus Thor		*A017*	

AF01 Baker, E.W.
1965. A revision of the genera of the family Tydeidae. Adv. Acarol. 2:95-133.
AF02 Baker, E.W.
1970. The genus *Tydeus*: Subgenera and species groups with descriptions of new species (Acarina: Tydeidae). Ann. Ent. Soc. America 63(1)165-177.

Taxon	Common Name	Reference	Page
Parasitiformes* (order)	parasitiform mites	*B006 B010 M001*	4, 7, 40
Mesostigmata* (suborder)	mesostigmatid mites	*B006 B010*	4, 7, 8
Ameroseiidae*	ameroseiid mites	*B006 AG01*	9, 485
*Kleemannia plumigera** Oudemans		*A017*	9, 485
*Kleemannia plumosa** (Oudemans)		*A017*	9, 485

AG01 Lindquist, E.E.
1977. Provisional key to genera of Ameroseiidae. [Unpublished]. 1 pl.

Taxon	Common Name	Reference	Page
Ascidae*	ascid mites	*B006 AH02 AH05*	12, 490, 491
Arctoseius butleri (Hughes)		*A017 AH02*	
Arctoseius cetratus (Sellnick)		*B010 C001 M001 AH01*	
Arctoseius idiodactylus Lindquist		*AH01 AH04*	
*Blattisocius dentriticus** (Berlese)		*B006 AH01-AH03 AH06*	13, 490
*Blattisocius keegani** Fox		*B001 AH01 AH03 AH06 AH08*	14, 491
Blattisocius mali (Oudemans)		*A017 AH03*	
Blattisocius quadridentatus Haines		*AH03*	
*Blattisocius tarsalis** (Berlese)		*A017 B001 AH01-AH03 AH06 AH08*	14, 490
*Lasioseius**		*A017*	13
Lasioseius penicilliger Berlese		*A017 AH02*	
Melichares agilis Hering		*A017 B006*	
Proctolaelaps pomorum (Oudemans)		*A017 B006*	
Proctolaelaps pygmaeus (Müller)		*A017 AH01 AH06 AH07*	

AH01 Chant, D.A.
1963. The subfamily Blattisocinae Garman (=Aceosejinae Evans) (Acarina: Blattisocidae Garman) (=Aceosejidae Baker & Wharton) in North America, with descriptions of new species. Canadian Jour. Zool. 41(2)243-319.

AH02 Evans, G.O.
1958. A revision of the British Aceosejinae (Acarina: Mesostigmata). Proc. Zool. Soc. London 131(2)177-229.

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1978. A revision of the genus *Blattisocius* Keegan (Mesostigmata: Ascidae) with especial reference to *B. tarsalis* (Berlese) and the description of a new species. Acarologia 20(1)19-38.

AH04 Lindquist, E.E.
1961. Taxonomic and biological studies of mites of the genus *Arctoseius* Thor from Barrow, Alaska (Acarina: Aceosejidae). Hilgardia 30(11)301-350.

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1965. Taxonomic concepts in the Ascidae, with a modified setal nomenclature for the idiosoma of the Gamasina (Acarina: Mesostigmata). Mem. Ent. Soc. Canada 47:1-64.

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AH07 Ryke, P.A.J.
1964. Acarina associated with *Protea* flowers in the Cape Province. Jour. Ent. Soc. South Africa 26(2)337-354.

AH08 Westerboer, I. von, and F. Bernhard.
1963. Die Familie Phytoseiidae Berlese 1916. *In* H. Stammer, ed., vol. 2, Mesostigmata. Beiträge zur Systematik und Ökologie mitteleuropäischer Acarina. Geest & Portig, Leipzig.

Taxon	Common Name	Reference	Page
Dermanyssidae*	**dermanyssid mites**	*B006 AI02*	11, 487
*Dermanyssus gallinae** (De Geer)	**chicken mite**	*B004 B006 B010 AI01 AI03 AI04*	11, 487

AI01 Evans, G.O., and W.M. Till.
1962. The genus *Dermanyssus* De Geer (Acari: Mesostigmata). Ann. Mag. Nat. Hist., Ser. 13(5)273-293.

AI02 Evans, G.O., and W.M. Till.
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AI03 Johnston, D.E.
1968. An atlas of Acari. I. The families of Parasitiformes and Opilioacariformes. Acarology Laboratory, Ohio State University, Columbus.

AI04 Moss, W.W.
1968. An illustrated key to the species of the acarine genus *Dermanyssus* (Mesostigmata: Laelapoidea: Dermanyssidae). Jour. Med. Ent. 5(1)67-84.

Taxon	Common Name	Reference	Page
Digamasellidae*	digamasellid mites	*B006 B010*	10
*Digamasellus**		*A017 AJ01*	10

AJ01 Hurlbutt, H.W.
1967. Digamasellid mites associated with bark beetles and litter in North America. Acarologia 9(3)497-534.

Taxon	Common Name	Reference	Page
Laelapidae*	laelapid mites	*B006 B010 X001*	12
*Androlaelaps casalis** (Berlese)		*B010 AI02 AK01*	6, 12
Eulaelaps stabularis (Koch)		*A017 B001 X001*	
Haemogamasus pontiger Berlese		*A017 B001 AI02 AI03*	
Hypoaspis aculeifer (Canestrini)		*A017 B006 AI02*	
Hypoaspis lubrica Voigts & Oudemans		*A017 AI02*	

AK01 Till, W.M.
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Taxon	Common Name	Reference	Page
Macrochelidae*	macrochelid mites	*B006 B010 AL01*	10, 486
Macrocheles matrius (Hull)		*A017*	
*Macrocheles muscaedomesticae** (Scopoli)	house fly mite	*B001 B010*	10, 486

AL01 Krantz, G.W.
1962. A review of the genera of the family Marcrochelidae Vitzthum 1930 (Acari: Mesostigmata). Acarologia 4(2)143-173.

Taxon	Common Name	Reference	Page
Macronyssidae*	**macronyssid mites**	*B006*	11, 488, 489
*Liponyssoides sanguineus** (Hirst)	**house mouse mite**	*B001*	12, 488
*Ornithonyssus bacoti** (Hirst)	***tropical rat mite***	*B001 B004 B006 AI02*	12, 489
*Ornithonyssus sylviarum** Canestrini & Fanzago	***northern fowl mite***	*B001 B004 AI02 AI03*	12, 489
Parasitidae	parasitid mites	*B006 B010*	
Eugamasus butleri Hughes		*A017*	
Phytoseiidae	phytoseiid mites	*B006 AO02*	
Amblyseius		*A017 AO01*	
Neoseiulus barkeri Hughes		*A017*	

AO01 Chant, D.A., and R.I.C. Hansell.
1971. The genus *Amblyseius* (Acarina: Phytoseiidae) in Canada and Alaska. Canadian Jour. Zool. 49(5)703-758.
AO02 Muma, M.H., and H.A. Denmark.
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Taxon	Common Name	Reference	Page
Uropodidae*	uropodid mites	*B006*	8, 484
*Fuscuropoda marginata** (Koch)		*B006 B010 X001*	8, 484
Leiodinychus krameri (G. & R. Canestrini)		*B010 X001*	8, 484
Trematura jacksonia Hughes		*A017 B006*	
Uroseius acuminatus (Koch)		*A017 B010 X001*	
Insecta* [Hexapoda] (class)	**insects**	*AQ01-AQ26*	319-322, 334

AQ01 Bland, R.G., and H.E. Jaques.
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Taxon	Common Name	Reference	Page
Dictyoptera* [Orthoptera, in part] (order)	dictyopterans		45, 46
Blattaria [Blattodea] (suborder)	**cockroaches**	*AQ02 AQ04 AS01-AS08*	46, 47, 527

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Taxon	Common Name	Reference	Page
Blaberidae*	blaberid cockroaches	*AQ02 AQ04*	45, 46, 62, 65, 539-543
Archimandrita tessellata Rehn			
*Blaberus**	giant cockroaches	*AQ18 AS01 AT02*	46, 47, 64, 65, 542
*Blaberus craniifer** Burmeister		*AQ22 AS03 AS07 AT02*	46, 64, 542
*Blaberus discoidalis** Serville		*AS07 AT02*	46, 64, 542
*Blaberus giganteus** L.	giant cockroach	*AS04 AS07*	46, 64, 542
Epilampra abdomennigrum (De Geer)		*AT04*	
Epilampra maya Rehn		*AT01 AT04*	46
*Leucophaea maderae** (Fabricius)	**Madeira cockroach**	*AQ18 AQ20 AQ22 AS01 AS04 AS07 AS08*	46, 64, 542
Nauclidas nigra (Brunner von Wattenwyl)			
*Nauphoeta cinerea** (Olivier)	**cinereous cockroach**	*AQ18 AQ22 AS01 AS04 AS07*	46, 63, 541
*Panchlora nivea** (L.)	**Cuban cockroach**	*AQ18 AQ22 AS01 AS04*	46, 62, 539
*Pycnoscelus indicus** (Fabricius)	Indian cockroach	*AT03*	46, 63, 540
*Pycnoscelus surinamensis** (L.)	**Surinam cockroach**	*AQ18 AS01 AS03 AS04 AS06 AS08 AT03*	46, 62, 63, 539

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Taxon	Common Name	Reference	Page
Blattellidae* [includes Ectobiidae]	blattellid cockroaches	*AQ02 AQ04 AS02*	45, 46, 48, 65, 534-538
*Aglaopteryx** [*Euthlastoblatta*] *gemma* Hebard	little gem cockroach	*AS03 AS04*	46, 48, 536
Blattella asahinai Mizukubo [*B. beybienkoi* Roth]	**Asian cockroach**		46, 58
*Blattella germanica** (L.)	**German cockroach**	*AQ18 AQ22 AS01-AS04 AS06-AS08 AU05 AU09 AU11*	46, 57, 58, 68, 534
*Blattella lituricollis** (Walker)	**false German cockroach**	*AS08 AU01 AU10 AU11*	46, 57, 534
*Blattella vaga** Hebard	field cockroach	*AQ18 AQ22 AS01 AS07 AU05 AU11*	46, 57, 58, 68, 534
Ectobius		*AS01*	
*Ectobius lapponicus** (L.)	dusky cockroach	*AS02 AS05-AS07 AU04*	46, 60, 537
*Ectobius pallidus** (Olivier)	**spotted Mediterranean cockroach**	*AQ18 AQ22 AS02 AS04 AS05-AS07 AU04 AU06*	46, 60, 66, 67, 537
Ectobius panzeri Stephens	lesser cockroach	*AS02 AS05 AS06 AU04*	
*Ectobius sylvestris** (Poda)	forest cockroach	*AS02 AS05 AS07 AU07*	46, 60, 66, 537
Eudromiella			
Ischnoptera deropeltiformis (Brunner)	dark wood cockroach	*AS04*	
Ischnoptera vulpina Hebard			
Lupparia [*Onychostylus*] *vilis* (Brunner)	arboreal cockroach	*AS01 AU02*	46, 48
*Nyctibora noctivaga** Rehn	banana cockroach	*AQ22 AS07 AT02*	46, 48, 535
*Parcoblatta**	wood cockroaches	*AQ18 AQ22 AS01 AS03 AS04*	46, 47, 49, 60, 67
Parcoblatta kyotensis Asahina	Kyoto woodroach	*AU03*	60

Taxon	Common Name	Reference	Page
*Parcoblatta pennsylvanica** (De Geer)	Pennsylvania woodroach	*AS01 AS03 AS07*	61, 538
*Parcoblatta virginica** (Brunner)	Virginia woodroach	*AS03 AS04 AS07*	538
*Shawella couloniana** (Saussure)		*AQ04 AS01 AS07 AU08*	46, 48, 535
*Supella longipalpa** (Fabricius) [*S. supellectilium* (Serville)]	**brownbanded cockroach**	*AQ18 AQ20 AQ22 AS02 AS03 AS04 AS07 AU09 AU10*	46, 59, 66 67, 536

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Taxon	Common Name	Reference	Page
Blattidae*	blattid cockroaches	*AQ02 AQ04 AS02*	45, 46, 48, 65, 528-533
*Blatta lateralis** (Walker)	**Turkestan cockroach**	*AS01 AS05 AV01*	46, 51, 56, 69, 532
*Blatta orientalis** L.	**oriental cockroach**	*AQ18 AQ20 AQ22 AS01 AS03-AS07*	46, 49, 51, 56, 69, 322, 533
*Deropeltis erythrocephala** Fabricius		*AS07 AV04*	46, 49, 532
Eurycotis biolleyi Rehn			
*Eurycotis floridana** (Walker)	Florida stinkroach	*AQ18 AQ22 AS01 AS03 AS04 AS07*	46, 55, 70, 533
*Lamproblatta**		*AS04 AS07*	46, 47, 49, 531
*Methana marginalis** (Saussure)		*AQ04 AV02*	46, 41, 531
*Neostylopyga rhombifolia** (Stoll)	**harlequin cockroach**	*AS01 AS03 AS04 AS07 AS08 AU09*	46, 54, 70, 529
*Pelmatosilpha**		*AT01 AV05*	46, 49
*Periplaneta americana** (L.)	**American cockroach**	*AQ18 AQ20 AQ22 AS01 AS02 AS03 AS06-AS08 AU08 AU09 AV03*	46, 50, 53, 69, 70, 529
*Periplaneta australasiae** (Fabricius)	**Australian cockroach**	*AQ18 AQ20 AQ22 AS01 AS03 AS04 AS06-AS08 AU08 AU09 AV03*	46, 52, 70, 529
*Periplaneta brunnea** Burmeister	**brown cockroach**	*AQ04 AQ18 AQ22 AS01 AS03 AS04 AS07 AS08 AU09 AV03*	46, 53, 70, 529
*Periplaneta fuliginosa** (Serville)	**smokybrown cockroach**	*AQ18 AQ22 AS01 AS03 AS04 AS07 AV03*	46, 50, 70, 528
*Periplaneta japonica** Karny	Japanese cockroach	*AS01 AS07 AV03*	46, 49, 528

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Taxon	Common Name	Reference	Page
Cryptocercidae*	cryptocercid cockroaches	*AQ02*	45, 46, 62, 65, 539
*Cryptocercus punctulatus** Scudder	brownhooded cockroach	*AS03 AS04 AS07*	46, 47, 62, 539
Polyphagidae*	polyphagid cockroaches	*AQ02 AQ04 AS02*	45-47, 61, 65, 538
*Arenivaga**	sand cockroaches	*AS02-AS05 AU08*	46, 47, 61, 538
Polyphaga aegyptiaca (L.)		*AS01 AS02 AS05 AS07 AX01*	47, 61
Polyphaga saussurei (Dohrn)		*AS01 AV01*	61

AX01 Chopard, L.
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Taxon	Common Name	Reference	Page
Coleoptera* (order)	**beetles**	*A016 AQ02 AQ04 AQ10 AQ14 AQ17 AY01-AY11*	75-77, 95, 96, 331-334, 347, 349, 545

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Taxon	Common Name	Reference	Page
Anobiidae*	**deathwatch** and **drugstore beetles**	*AQ01 AQ03 AQ13 AZ01 AZ05*	82, 84, 98, 551
Anobium punctatum (De Geer)	**furniture beetle**	*AQ07 AZ01*	
*Lasioderma serricorne** (Fabricius)	**cigarette beetle**	*AQ07 AQ22 AY09 AZ01 AZ02 AZ03*	84, 97, 335, 551
*Stegobium paniceum** (L.)	**drugstore beetle**	*AQ07 AQ22 AY09 AZ01 AZ02 AZ03*	84, 98, 551
Tricorynus [*Catorama*] *confusus* (Fall)		*AZ01 AZ04 AZ06 AZ07*	84
Tricorynus herbarius (Gorham)	Mexican book beetle	*AZ02 AZ04 AZ06 AZ07*	84
Tricorynus tabaci (Guérin-Méneville)		*AZ02 AZ06 AZ07*	84

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Taxon	Common Name	Reference	Page
Anthicidae*	**antlike flower beetles**	*A016 AQ02 BA01*	80, 105, 548
Anthicus [*Omonadus*] *australis* (King)			
*Anthicus floralis** (L.)	**narrownecked grain beetle**	*A016 AQ07 BA04 BA05 BA06*	80, 105, 548

Taxon	Common Name	Reference	Page
Anthicus troilus Hinton		*A016*	
Notoxus calcaratus Horn		*BA02 BA03*	
Notoxus desertus Casey [*N. constrictus* Casey]		*BA02 BA03*	
Notoxus monodon (Fabricius)		*A016 BA03*	

BA01 Buck, F.D.
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Taxon	Common Name	Reference	Page
Anthribidae*	**fungus weevils**	*A016 AQ02 BB03 BB04*	78, 100, 546
*Araecerus fasciculatus** (De Geer)	**coffee bean weevil**	*AQ07 BB01-BB03 BB05 BB06*	78, 100, 546
Araecerus viellardi (Montrouzier)		*BB06*	

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Taxon	Common Name	Reference	Page
Bostrichidae*	**false powderpost beetles**	*A016 AQ02 BC02*	89, 99, 554, 555
Bostrychoplites cornutus (Olivier)		*BC02*	
Dinoderus bifoveolatus (Wollaston)		*BC02*	
*Dinoderus minutus** (Fabricius)	**bamboo powderpost beetle**	*BC02 BC05*	90, 100, 554
*Prostephanus truncatus** (Horn)	**larger grain borer**	*AQ22 BC02 BC03*	89, 100, 554
*Rhyzopertha dominica** (Horn)	**lesser grain borer**	*AQ07 AQ22 BC02-BC04 BC06*	90, 99, 555
Scobicia declivis (LeConte)	**leadcable borer**	*BC01 BC02*	

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Taxon	Common Name	Reference	Page
Bruchidae*	**seed beetles**	*A016 AO02 BD11*	75-77, 82, 87, 101, 109, 215, 216, 599-602
Acanthoscelides argillaceus (Sharp) [*A. obreptus* Bridwell]		*BD02 BD04*	
*Acanthoscelides obtectus** (Say)	**bean weevil**	*AQ22 AY08 BD01 BD02 BD04 BD09*	218, 601
Acanthoscelides obvelatus Bridwell		*BD02 BD04*	
Acanthoscelides zeteki Kingsolver		*BD02 BD06*	

Taxon	Common Name	Reference	Page
Bruchidius antrolineatus (Pic)		*BD11*	
Bruchidius incarnatus Boheman		*BD01*	
Bruchus affinis Froelich		*BD03*	
Bruchus brachialis Fåhraeus		*BD01 BD03*	
Bruchus dentipes (Baudi)		*BD01 BD03*	
Bruchus emarginatus Allard		*BD01 BD03*	
Bruchus ervi Froelich		*BD01 BD03*	
Bruchus lentis Froelich		*BD01 BD03*	
*Bruchus pisorum** (L.)	**pea weevil**	*AQ07 AQ22 AY09 BD01 BD03*	101, 219, 602
Bruchus rufimanus Boheman	**broadbean weevil**	*AY09 BD01*	
Bruchus rufipes Herbst		*BD03*	
Bruchus signaticornis Gyllenhal		*BD01 BD03*	
Bruchus tristiculus Fåhraeus		*BD01 BD03*	
Bruchus tristis Boheman		*BD03*	
Bruchus viciae Olivier		*BD03*	
Callosobruchus ademptus (Sharp)		*BD05*	
Callosobruchus analis (Fabricius)		*BD03 BD05*	
*Callosobruchus chinensis** (L.)	southern cowpea weevil	*BD01 BD05 BD12*	ii, iii, 220
*Callosobruchus maculatus** (Fabricius)	**cowpea weevil**	*AQ22 AY09 BD01 BD05 BD11 BD13*	ii, iii, 40, 220
Callosobruchus phaseoli (Gyllenhal)		*BD01 BD05*	
Callosobruchus rhodesianus (Pic)		*BD05 BD11 BD12*	
Callosobruchus subinnotatus (Pic)		*BD05 BD11*	
*Caryedon serratus** (Olivier) [*C. gonagra* (Fabricius)]	groundnut bruchid, tamarind seed beetle	*BD01 BD07 BD10 BD11*	87, 101, 218, 601
*Zabrotes subfasciatus** (Boheman)	**Mexican bean weevil**	*BD01 BD08 BD09*	217, 600

BD01 Herford, G.M.
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Taxon	Common Name	Reference	Page
Byturidae*	**fruitworm beetles**	*AQ02*	87, 104
Byturus fumatus Fabricius		*BE02*	
Byturus tomentosus (De Geer)		*BE02*	
*Byturus unicolor** Say [*B. bakeri* Barber, *B. rubi* Barber]	**raspberry fruitworm**	*BE01*	87, 553

BE01 Springer, C.A., and M.A. Goodrich.
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Taxon	Common Name	Reference	Page
Carabidae	**ground beetles**	*A016 AQ02*	
Harpalus rufipes (De Geer)		*A016*	
Laemostenus [*Pristonychus*] *complanatus* (Dejean)		*A016*	
Laemostenus terricola (Herbst)		*A016*	
Plochionus pallens (Fabricius)		*A016*	
Somotrichus unifasciatus (Dejean)		*A016*	
Sphodrus leucophthalmus (L.)		*A016*	
Cerylonidae* [Murmidiidae]	cerylonid beetles	*A016 AQ02 BG01*	80, 96, 548
*Murmidius ovalis** (Beck)	oval grain beetle	*A016 BG02*	80, 96, 548
Murmidius segregatus Waterhouse		*A016*	

BG01 Gupta, T.S., and R.A. Crowson.
1973. A review of the classification of Cerylonidae (Coleoptera, Clavicornia). Trans. Roy. Ent. Soc. London 124(4)365-446.
BG02 Lawrence, J.F., and K. Stephan.
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Taxon	Common Name	Reference	Page
Chrysomelidae*	**leaf beetles**	*A016 AQ02*	81, 82, 107, 549
*Crioceris asparagi** (L.)	**asparagus beetle**		ii, iii, 82, 107, 549
*Crioceris duodecimpunctata** (L.)	**spotted asparagus beetle**		81, 107, 549
*Leptinotarsa decemlineata** (Say)	**Colorado potato beetle**		
Cleridae*	**checkered beetles**	*A016 AQ02 BI01 AQ07*	87, 103, 149, 150, 573, 574
Exkorynetes analis (Klug)		*AQ07*	
*Necrobia ruficollis** (Fabricius)	**redshouldered ham beetle**	*AQ07 AQ22 BI02 BI03*	ii, iii, 150
*Necrobia rufipes** (De Geer)	**redlegged ham beetle**	*AQ07 AQ12 AQ22 BI02 BI03*	ii, iii, 150, 577
*Necrobia violacea** (L.)	blacklegged ham beetle	*AQ07 AQ22 BI02 BI03*	ii, iii, 150
Tarsostenus univitattus (Rossi)		*AQ07*	
Thaneroclerus buqueti (Lefebvre)		*AQ07*	

BI01 Barr, W.F.
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BI02 Knull, J.N.
1951. The checkered beetles of Ohio (Coleoptera: Cleridae). Ohio Biol. Survey Bull. 42:269-350.

BI03 Van Emden, F.I.
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Taxon	Common Name	Reference	Page
Colydiidae	colydiid beetles	*A016 AQ02*	
Aglenus brunneus (Gyllenhal)		*A016*	
Anchomma costatum LeConte			
Colobicus parilis Pascoe		*A016*	
Myrmechixenus			
Sassaka			
Cryptophagidae*	**silken fungus beetles**	*A016 AQ02*	78, 107, 175-177, 581, 582
*Cryptophagus**			78, 107, 176
*Cryptophagus acutangulus** (Gyllenhal)	**acute-angled fungus beetle**	*A016 BK01 BK02*	177
*Cryptophagus cellaris** (Scopoli)	cellar beetle	*A016 BK01 BK02*	178, 582
Cryptophagus croceus Zimmermann		*A016 BK02*	
Cryptophagus dentatus (Herbst) [*C. fumatus* (Marsham)]		*A016 BK01 BK02*	
Cryptophagus distinguendus Sturm		*A016 BK01 BK02*	
Cryptophagus hexagonalis Tournier		*BK01 BK02*	
Cryptophagus laticollis Lucas [*C. affinis* Sturm; *C. inscitus* Casey]		*A016 BK01 BK02*	582
Cryptophagus lecontei Harold		*BK02*	
Cryptophagus obsoletus Reitter		*BK01 BK02*	
Cryptophagus pilosus Gyllenhal		*A016 BK01 BK02*	
Cryptophagus saginatus Sturm		*A016 BK01 BK02*	
Cryptophagus scanicus (L.)		*A016 BK01 BK02*	
Cryptophagus schmidti Sturm		*A016 BK01*	
Cryptophagus scutellatus Newman		*A016 BK01 BK02*	
Cryptophagus setulosus Sturm		*BK01 BK02*	
Cryptophagus subfumatus Kraatz		*A016 BK01 BK02*	
Cryptophagus tuberculosus Mäklin		*BK02*	
*Cryptophagus valens** Casey		*BK02*	178
*Cryptophagus varus** (Woodroffe & Coombs)	**sigmoid fungus beetle**	*BK02*	177

Taxon	Common Name	Reference	Page
Ephistemus			
Henoticus californicus (Mannerheim)		*A016 AQ07*	

BK01 Coombs, C.W., and G.E. Woodroffe.
1955. A revision of the British species of *Cryptophagus* Herbst (Coleoptera: Cryptophagidae). Trans. Roy. Ent. Soc. London 106(6)237-282.
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Taxon	Common Name	Reference	Page
Cucujidae* [Silvanidae]	cucujid beetles	*A016 AQ02*	79, 83, 85, 105, 108, 547, 550, 552
*Ahasverus advena** (Waltl)	**foreign grain beetle**	*AQ07 AQ22 AY09 BL04*	86, 552
*Cathartus quadricollis** (Guérin-Méneville)	**squarenecked grain beetle**	*AQ22 AY09*	86, 552
*Cryptolestes**		*AQ22 AY09*	83, 105, 550
Cryptolestes capensis (Waltl)	Cape grain beetle	*BL01 BL08*	83
Cryptolestes duplicatus (Waltl)		*BL04 BL08*	
Cryptolestes ferrugineus (Stephens)	**rusty grain beetle**	*AQ22 BL01-BL03 BL05 BL08 BL10*	83
Cryptolestes klapperichi Lefkovitch		*BL05*	83
Cryptolestes pusilloides (Steel & Howe)		*BL01 BL08*	83
Cryptolestes pusillus (Schönherr)[*C. minutus* (Olivier)]	**flat grain beetle**	*AQ22 BL01-BL03 BL05 BL08 BL10*	83, 550
Cryptolestes turcicus (Grouvelle)	Turkish grain beetle	*AQ22 BL01 BL02 BL08 BL10*	83
Cryptolestes ugandae (Steel & Howe)		*BL01*	83
Leptophloeus janeti (Grouvelle)		*BL08*	
Monanus concinnulus (Walker)		*BL09*	
Oryzaephilus acuminatus Halstead		*BL07 BL12*	
Oryzaephilus gibbosus Aitken		*BL07*	
*Oryzaephilus mercator** (Fauvel)	**merchant grain beetle**	*AQ07 BL04 BL07 BL08 BL11 BL12*	79, 547
*Oryzaephilus surinamensis** (L.)	**sawtoothed grain beetle**	*AQ07 AQ22 BL04 BL07 BL11 BL12*	40, 79
*Silvanus planatus** Germar		*BL06*	

BL01 Banks, H.J.
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BL02 Biege, C.R., and G.J. Partida.
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Taxon	Common Name	Reference	Page
Curculionidae*	**snout beetles, weevils**	*A016 AQ02 BM07*	78, 109, 11, 223, 224, 603-608

Taxon	Common Name	Reference	Page
Balanogastris kolae (Desbrochers)	kola nut weevil		224
*Caulophilus oryzae** (Gyllenhal)[*C. latinasus* (Say)]	avocado seed weevil	***AQ07 AQ22 AY09 BB02 BM06***	112, 226, 606
Caulophilus rufotestaceus (Champion)		***BM06***	
*Chalcodermus aeneus** Boheman	**cowpea curculio**		111, 225, 604
Conotrachelus		***BM10***	
Craponius inaequalis (Say)	**grape curculio**		224
*Curculio**		***BM10***	224
Curculio caryae (Horn)	**pecan weevil**	***BM02 BM10***	225, 605
Curculio caryatrypes (Boheman)		***BM02 BM10***	
Curculio obtusus (Blanchard)	**hazelnut weevil**	***BM02***	
Curculio occidentis (Casey)	**filbert weevil**	***BM02***	
Curculio sayi (Gyllenhal)	**small chestnut weevil**	***BM02 BM10***	
Dinocleus [*Cleonus*] *pilosus* (LeConte)			
Heilipus	avocado weevils		224
*Sitophilus granarius** (L.)	**granary weevil**	***AQ07 AQ22 AY09 BB02 BM04 BM05***	110, 228, 607
Sitophilus linearis (Herbst)	**tamarind weevil**		227, 607
*Sitophilus oryzae** (L.)	**rice weevil**	***AQ07 AQ22 AY09 BB02 BM01 BM04 BM05 BM08 BM09***	40, 110, 229, 608
*Sitophilus zeamais** Motschulsky	**maize weevil**	***AQ07 AQ22 AY09 BM01 BM04 BM08 BM09***	110, 229, 608

BM01 Boudreau, H.B.
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Taxon	Common Name	Reference	Page
Dermestidae* [including Thorictidae]	**dermestid beetles**	*A016 AQ02 AY08 BN14 BN19*	82, 83, 91, 101, 115, 559-566
Anthrenocerus australis (Hope)		*A016*	
Anthrenus caucasicus Reitter		*A016*	
Anthrenus coloratus Reitter		*A016 BN11 BN22 BN25*	
Anthrenus fuscus Olivier		*A016 BN22 BN25*	
Anthrenus museorum (L.)		*A016 AY07 BN14 BN25*	
Anthrenus pimpinellae Fabricius		*A016 BN22 BN25*	
Anthrenus sarnicus Mroczkowski		*BN22*	
*Anthrenus scrophulariae** (L.)	**carpet beetle**	*A016 AQ22 AY08 BN02 BN14 BN22 BN23 BN25*	ii, iii, 4, 82, 120, 131
*Anthrenus verbasci** (L.)	**varied carpet beetle**	*A016 AQ22 AY08 BN02 BN11 BN14 BN22 BN25*	ii, iii, 4, 120, 131, 563
Anthrenus vorax Waterhouse		*A016 AY08 BN14*	
*Attagenus brunneus** Faldermann [*A. elongatulus* Casey]		*BN06 BN09*	121, 131
Attagenus cyphonoides Reitter		*BN09 BN18*	
Attagenus fasciatus (Thunberg) [*A. gloriosae* (Fabricius)]		*A016 BN06 BN18*	
Attagenus insidiosus Halstead		*BN09*	
Attagenus lobatus Rosenhauer		*A016 BN06*	
*Attagenus pellio** (L.)	felt beetle, fur beetle	*A016 AQ07 AQ22 AY08 AY09 BN02 BN06 BN14 BN18*	121, 130

Taxon	Common Name	Reference	Page
Attagenus schaefferi (Herbst)		*BN06 BN09 BN14 BN24*	
Attagenus smirnovi Zhantiev		*BN09 BN18*	
*Attagenus unicolor unicolor** (Brahm) [*A. megatoma* (Fabricius); *A. piceus* (Olivier) of authors]	**black carpet beetle**	*A016 AQ07 AQ22 AY08 BN02 BN06 BN09 BN14 BN18 BN24*	121, 131, 564
Attagenus unicolor japonicus Reitter		*BN09*	
Attagenus unicolor simulans Solskij		*BN09*	
*Dermestes ater** De Geer	**black larder beetle**	*A016 AQ07 AQ22 AY08 BN01 BN10 BN13 BN14 BN20*	119, 130, 554
Dermestes bicolor Fabricius		*A016*	
Dermestes caninus Germar		*BN09BN14*	
Dermestes carnivorus Fabricius		*AQ07 AY08 BN10 BN13 BN14*	
Dermestes dimidiatus Steven		*A016*	
Dermestes frischii Kügelann		*AQ07 BN10 BN13 BN14*	119, 128
*Dermestes haemorrhoidalis** Küster	sheepskin dermestid	*AQ07 BN01 BN17*	119, 129, 561
*Dermestes lardarius** L.	**larder beetle**	*A016 AQ07 AQ22 AY08 AY09 BN02 BN10 BN13 BN14 BN17 BN20*	118, 130, 561
Dermestes leechi Kalik		*BN01*	
*Dermestes maculatus** De Geer	**hide beetle**	*A016 AQ07 AQ22 AY08 BN02 BN10 BN13 BN19*	117, 128, 561
Dermestes marmoratus Say		*A016 BN10*	
Dermestes murinus L.		*A016 AY08*	
Dermestes mustelinus Erichson		*A016*	
Dermestes nidum Arrow		*A016 BN14*	
*Dermestes peruvianus** (Castelnau)	Peruvian larder beetle	*AQ07 AQ22 BY07 BN01 BN02 BN17 BN20*	119, 129, 561
Dermestes undulatus Brahm		*A016 AY08*	
Megatoma variegata (Horn)		*A016*	
Novelsis aequalis (Sharp)		*BN06 BN12*	
Phradonoma tricolor (Arrow)		*A016*	
Phradonoma villosulum (Duftschmid)		*A016*	
Reesa vespulae (Milliron)			
Thorictodes heydeni Reitter		*BN08*	
*Thylodrias contractus** Motschulsky	**odd beetle**	*A016 AQ22 BN02 BN14*	91, 116, 127, 560
Trogoderma cavum Beal		*BN07*	
*Trogoderma glabrum** (Herbst)	glabrous cabinet beetle	*BN02-BN05 BN15*	124, 134, 565

Taxon	Common Name	Reference	Page
*Trogoderma granarium** Everts	**khapra beetle**	***A016 AQ07 AQ22 AY08 AY09 BN04 BN05 BN14 BN15 BN21***	123, 124, 133, 565
*Trogoderma inclusum** LeConte	larger cabinet beetle	***AQ07 AQ22 AY09 BN02 BN04 BN15 BN16***	ii, iii, 4, 124, 134
*Trogoderma ornatum** (Say)	ornate cabinet beetle	***AQ22 BN02-BN05 BN14 BN16***	ii, iii, 4, 126, 134
*Trogoderma simplex** Jayne	plain cabinet beetle	***AQ22 BN03-BN05 BN15 BN16***	122, 132, 565
Trogoderma sternale Jayne		***A016 BN03 BN15 BN16***	
*Trogoderma variabile** Ballion [*T. parabile* Beal]	**warehouse beetle**	***A016 AQ22 BN02-BN05 BN15 BN16***	ii, iii, 4, 125 134, 566
*Trogoderma versicolor** (Creutzer)	European larger cabinet beetle	***AY08 BN14***	126, 134, 565

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Taxon	Common Name	Reference	Page
Discolomidae [Notiophygidae]			
Parafallia simoni John			
Endomychidae* [Mycetaeidae]	handsome fungus beetles	*A016 AQ02*	85, 99, 552
*Mycetaea subterranea** (Fabricius) [*M. hirta* (Marsham)]	hairy cellar beetle	*A016 AQ07 AQ22*	85, 99, 552
Histeridae	**hister beetles**	*A016 AQ02*	
Acritus analis LeConte			
Carcinops mayeti Marseul		*BQ02 BQ03*	
Carcinops pumilio (Erichson) [*C. quattuordecimstriatus* (Stephens)]		*AQ07 BQ01 BQ02*	
Carcinops troglodytes (Paykull)		*BQ02*	
Dendrophilus punctatus (Herbst)		*BQ01 BQ02*	
Dendrophilus xavieri Marseul		*BQ01 BQ03*	
Gnathoncus nannetensis (Marseul)		*BQ01 BQ03*	
Gnathoncus nanus (Scriba)		*BQ01 BQ03*	
Hypocacculus metallescens (Erichson)		*A023 BQ03*	
Peranus bimaculatus (L.)		*BQ01*	
Saprinus semipunctatus (Fabricius)		*BQ03*	
Saprinus semistriatus (Scriba)		*A023 BQ01 BQ03*	

BQ01 Halstead, D.G.H.
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BQ03 Hinton, H.E.
1945. The Histeridae associated with stored products. Bul. Ent. Res. 35(4)309-340 [key applicable mainly to temperate climates].

Taxon	Common Name	Reference	Page
Languriidae* [Erotylidae]	**lizard beetles**	*A016 AQ02 BR01*	93, 107, 558
Cryptophilus integer (Heer)		*A016*	
*Pharaxonotha kirschi** Reitter	Mexican grain beetle	*A016 AQ22 AY09*	93, 107, 558

BR01 Roberts, A.W.R.
1958. On the taxonomy of Erotylidae (Coleoptera), with special reference to the morphological characters of the larvae. II. Trans. Roy. Ent. Soc. London 110(8)245-285.

Taxon	Common Name	Reference	Page
Lathridiidae* [including Merophysiidae]	**minute brown scavenger beetles**	*A016 AQ02 BS04*	84, 108, 179-181, 583-587
Adistemia rileyi Hinton		*A016*	
*Adistemia watsoni** (Wollaston)		*A016 BS01*	181, 584
Aridius [*Coninomus*] *nodifer* (Westwood)		*A016 BS01 BS03 BS04*	584
Aridius subfasciatus Reitter		*A016*	
Cartodere [*Coninomus*] *constricta** (Gyllenhall)	**plaster beetle**	*A016 AQ07 BS03*	184, 587
Corticaria elongata (Gyllenhal)		*A016 BS01 BS04*	
Corticaria fenestralis (L.)		*A016 BS04*	
Corticaria fulva (Comolli)		*A016 BS01*	
Corticaria punctulata Marsham [*C. pubescens* (Gyllenhal)]		*A016 AQ07 BS01 BS04*	
Corticaria subtilissima Reitter		*A016*	
Cortinicara [*Corticarina*] *gibbosa* (Herbst)		*BS01 BS02*	
Dienerella [*Cartodere; Microgramme*] *arga** (Reitter)		*A016 BS01*	183, 585
*Dienerella costulata** (Reitter)		*A016 BS01*	183, 586
*Dienerella filiformis** (Gyllenhal)		*A016 BS01 BS03*	183, 586
*Dienerella filum** (Aubé)		*A016 BS01*	182, 585
Dienerrella ruficollis (Marsham)		*A016 BS01*	182, 585
Enicmus histrio Joy & Tomlin		*A016*	
Eufalloides holmesi Hinton		*A016*	
Holoparamecus caularum (Aubé)		*A016 BS01*	
Holoparamecus depressus Curtis		*A016*	
Holoparamecus ragusae Reitter		*A016 BS01*	
Holoparamecus singularis (Beck)		*A016 BS01*	
Lathridius [*Enicmus*] *anthracinus* Mannerheim			
*Lathridius minutus** (L.)	**squarenosed fungus beetle**	*A016 BS01 BS03*	184, 587

Taxon	Common Name	Reference	Page
Lathridius protensicollis Mannerheim		*A016 BS01*	184, 587
Lathridius pseudominutus (Strand)			
Lathridius suspectus (Fall)		*A016 BS01*	
Melanophthalma americana (Mannerheim)		*A016 BS01*	
Melanophthalma distinguenda (Comolli)		*A016 BS01*	
Melanophthalma longipennis (LeConte)		*A016 BS01*	
Melanophthalma picta (LeConte)		*A016 BS01*	
Metophthalmus serripennis (Broun)		*A016*	
Migneauxia orientalis Reitter		*A016*	
Thes [Lathridius] bergrothi (Reitter)	**ridgewinged fungus beetle**	*A016 AQ07 BS03*	

BS01 Fall, H.C.
1899. Revision of the Lathridiidae of Boreal America. Trans. American Ent. Soc. 26(Nov.-Dec.)101-190, 3 pl.

BS02 Johnson, C.
1975. *Cortinicara*, a new genus of Corticariinae (Coleoptera: Lathridiidae). Ent. Scandinavica 6(3-4)283-285.

BS03 Walkley, L.M.
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BS04 Watt, J.C.
1969. Keys to genera and some species of New Zealand Lathridiidae. New Zealand Ent. 4(2)49-67.

Taxon	Common Name	Reference	Page
Lyctidae*	**powderpost beetles**	*A016 AQ02*	90, 98
*Lyctus brunneus** (Stephens)	brown powderpost beetle	*AQ07 AQ22 BT01*	90, 555

BT01 Gerberg, E.J.
1957. A revision of the New World species of powder-post beetles belonging to the family Lyctidae. U.S. Dept. Agr. Tech. Bull. 1157:1-55, 14 pl.

Taxon	Common Name	Reference	Page
Mycetophagidae*	**hairy fungus beetles**	*A016 AQ02*	92, 106, 557
*Litargus balteatus** LeConte		*A016 BU03*	93, 106, 557
Mycetophagus quadriguttatus Müller		*A016 AQ07 BU03*	
*Typhaea stercorea** (L.)	**hairy fungus beetle**	*A016 AQ07 AY09 BU01* BU02 *BU03*	92, 106, 557

BU01 Hayashi, N.
1971. On the larvae of Mycetophagidae occurring in Japan (Coleoptera: Cucujoidea). Kontyû 39(4)361-367.
BU02 Klausnitzer, B.
1974. Zur Unterscheidung der Larven von *Typhaea* Curtis und *Mycetophagus* Hellwig (Col., Mycetophagidae). Ent. Nachr. 18(11-12)188.
BU03 Parsons, C.T.
1975. Revision of the Nearctic Mycetophagidae (Coleoptera). Coleop. Bull. 29(2)93-108.

Taxon	Common Name	Reference	Page
Nitidulidae*	**sap beetles**	*A016 AQ02*	87, 102, 575-580
Brachypeplus pilosellus Murray			
*Carpophilus dimidiatus** (Fabricius)	**corn sap beetle**	*A016 AQ07 BV03 BV04*	160, 173, 579
Carpophilus flavipes Murray		*A016*	152
*Carpophilus freemani** Dobson		*BV02*	162, 173, 579
*Carpophilus fumatus** Boheman		*BV03*	152, 163, 172, 579
*Carpophilus hemipterus** (L.)	**driedfruit beetle**	*A016 AQ07 BV02-BV04*	159, 171, 322, 578
*Carpophilus humeralis** (Fabricius) [*Urophorus humeralis* (Fabricius)]	pineapple sap beetle	*A016 BV02-BV04*	157, 167, 577
Carpophilus immaculatus Lucas		*A016*	152
*Carpophilus ligneus** Murray		*A016 AQ07 BV03*	164, 168, 580
*Carpophilus lugubris** Murray	**dusky sap beetle**	*BV02 BV04*	164, 171, 580
*Carpophilus maculatus** Murray		*A016 BV03*	110, 161, 579
*Carpophilus marginellus** Motschulsky		*A016 BV02 BV03*	161, 165, 170, 580
*Carpophilus mutilatus** Erichson		*BV02 BV03*	163, 172
*Carpophilus obsoletus** Erichson		*A016 AQ07 BV03 BV04*	159, 169, 578
*Carpophilus pilosellus** Motschulsky		*BV04*	152, 160, 173, 579
Carpophilus sexpustulatus (Fabricius)		*A016*	152
*Conotelus stenoides** Murray		*BV01 BV04*	156, 167, 577
*Glischrochilus fasciatus** (Olivier)		*A016 BV01 BV02 BV04*	152, 154, 576
*Glischrochilus quadrisignatus** (Say)		*A016 BV01 BV02 BV04*	154, 576
Haptoncus flavidus (Fairmaire)		*A016*	152
*Haptoncus luteolus** (Erichson)	yellowbrown sap beetle	*A016 BV01 BV04*	152, 155, 576

Taxon	Common Name	Reference	Page
*Lobiopa insularis** (Castelnau)		*BV01 BV04*	155, 166, 576
*Nitidula bipunctata** (L.)		*A016 BV04*	152, 157, 577
*Nitidula ziczac** Say		*BV04*	152, 157, 577

BV01 Böving, A.G., and J.G. Rozen.
1962. Anatomical and systematic study of mature larvae of Nitidulidae (Coleoptera). Ent. Meddel. 31:265-299.

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1956. Nitidulidae of Delaware. Univ. Delaware Expt. Sta. Bull. (Tech.) 318:1-67.

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1943. A revision of the Nearctic Nitidulidae (Coleoptera). Bul. Mus. Comp. Zool. 92(3)119-278, 13 pl.

Taxon	Common Name	Reference	Page
Ptinidae*	**spider beetles**	*A016 AQ02 BW05*	89, 97, 137
Gibbium aequinoctiale Boieldieu		*BW08*	140
*Gibbium psylloides** (Czenpinski)	hump beetle	*AY07 AT09 BW03-BW06 BW08*	140, 568
*Mezium affine** Boieldieu	northern spider beetle	*AQ07 AY09 BW03-BW06*	140
*Mezium americanum** (Laporte)	**American spider beetle**	*AY09 BW01 BW04-BW06*	ii, iii, 140, 331, 568
*Niptus hololeucus** (Faldermann)	**golden spider beetle**	*AQ07 AY09 BW01-BW04 BW07*	ii, iii, 142, 569
Pseudeurostus alienus Brown		*AY09 BW01*	
*Pseudeurostus hilleri** (Reitter)		*AQ07 BW03-BW05*	143, 570
Ptinus bicinctus Sturm		*BW01 BW04 BW05*	
*Ptinus clavipes** Panzer [*P. latro* of authors; *P. mobilis* Moore; *P. brunneus* Duftschmid; *P. hirtellus* Sturm]	**brown spider beetle**	*AQ07 AY09 BW03-BW06*	145, 146
*Ptinus fur** (L.) [*P. latro* Fabricius]	**whitemarked spider beetle**	*AQ07 AY09 BW03-BW05*	143-146, 572
*Ptinus gandolphei** Pic		*BW05 BW06*	144
Ptinus japonicus Reitter		*BW04*	
*Ptinus ocellus** Brown [*P. tectus* Boieldieu]	**Australian spider beetle**	*AQ07 AY09 BW01 BW03 BW04 BW05*	143, 571
Ptinus pusillus Sturm		*AQ07 BW03 BW04*	
*Ptinus raptor** Sturm	Canadian spider beetle	*AY08 BW01 BW03-BW05*	144
Ptinus sexpunctatus Panzer		*BW03 BW04*	
*Ptinus villiger** (Reitter)	**hairy spider beetle**	*AY09 BW01 BW02 BW04 BW06*	

Taxon	Common Name	Reference	Page
*Sphaericus gibboides** (Boieldieu)	humpbacked spider beetle	***BW04-BW06***	141, 569
Stethomezium squamosum Hinton		***BW03***	
Tipnus unicolor (Piller & Mitterpacher)		***AQ07 AY09 BW01 BW03 BW04-BW06***	
*Trigonogenius globulum**(Solier)	**globular spider beetle**	***AQ07 AY09 BW01 BW03-BW06***	143, 569

BW01 Brown, W.J.
1940. A key to the species of Ptinidae occurring in dwellings and warehouses in Canada (Coleoptera). Canadian Ent. 72(6)115-122.

BW02 Brown, W.J.
1959. *Niptus* Boield. and allied genera in North America (Coleoptera: Ptinidae). Canadian Ent. 91(10)627-633.

BW03 Hall, D.W., and R.W. Howe.
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BW04 Hinton, H.E.
1941. The Ptinidae of economic importance. Bull. Ent. Res. 31(4)331-381.

BW05 Papp, C.S.
1962. An illustrated and descriptive catalog of the Ptinidae of North America. Deut. Ent. Ztschr. (n.f.) 9(5)367-423.

BW06 Papp, C.S., and G.T. Okumura.
1959. A preliminary study of the Ptinidae of California. California Dept. Agr. Bull. 48(4)228-248.

BW07 Spilman, T.J.
1968. Two new species of *Niptus* from North American caves (Coleoptera: Ptinidae). Southwest. Nat. 13(2)193-200.

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BW08 Bellés, X., and D.G.H. Halstead.
1985. Identification and geographical distribution of *Gibbium aequinoctiale* Boieldieu and *Gibbium psylloides* (Czenpinski) (Coleoptera: Ptinidae). Jour. Stored Products Res. 21(3)151-155.

Taxon	Common Name	Reference	Page
Scarabaeidae	**scarabs**	***A016 AQ02***	334
Cotinus mutabilis (Gory & Percheron) [*C. texana* Casey]	fig beetle	***BX01***	

BX01 Goodrich, M.A.
1966. A revision of the genus *Cotinus* (Coleoptera: Scarabaeidae). Ann. Ent. Soc. America 59(3)550-568.

Taxon	Common Name	Reference	Page
Scolytidae*	**bark beetles**	***A016 AQ02***	90, 112, 556

Taxon	Common Name	Reference	Page
*Hypothenemus hampei** (Ferrari) [*Stephanoderes coffeae* Hagedorn]	**coffee berry borer**	***AQ12 BY01 BY03***	90, 112, 555
Pagiocerus		***BY02***	
Pagiocerus frontalis (Fabricius) [*P. fiorii* (Egger)]		***BY03***	

BY01 Duffy, E.A.J.
1958. Coleoptera: Scolytidae and Platipodidae. Handb. Ident. British Insects 5(15)1-20.

BY02 Schedl, K.E.
1955. The genus *Pagiocerus* Eichh., important pests of maize. Riv. Agr. Subtropic. Tropic. 59:300-307.

BY03 Wood, S.L.
1982. The bark and ambrosia beetles of North and Central America (Coleoptera: Scolytidae), a taxonomic monograph. Great Basin Nat. Mem. 6:1-1359.

Taxon	Common Name	Reference	Page
Staphylinidae	**rove beetles**	***A016 AQ02***	331
Aleochara sparsa Heer		***A016 BZ05***	
Anotylus [*Oxytelus*] *tetracarinatus* (Block)		***A016 AQ07 BZ04 BZ08***	
Atheta celata (Erichson) [*A. arenicola* Thomson]		***A016 BZ05***	
Atheta coriaria (Kraatz)		***A016 BZ05***	
Atheta nigricornis (Thomson)		***A016 BZ05***	
Atheta trinotata (Kraatz)		***A016 BZ05***	
Carpelimus pusillus (Gravenhorst)		***A016 BZ04 BZ08***	
Cilea [*Leucoparyphus*] *silphoides* (L.)		***A016 BZ01 BZ04***	
Crataraea suturalis (Mannerheim)		***A016 BZ05***	
Creophilus maxillosus (L.)	**hairy rove beetle**	***A016 BZ04***	
Falagria concinna Erichson		***BZ05***	
Gabrius nigritulus (Gravenhorst)		***BZ04***	
Leptacinus pusillus (Stephens) [*L. linearis* (Gravenhorst)]		***A016***	
Lithocharis ochracea (Gravenhorst)		***BZ04***	
Oligota apicata Erichson		***A016 BZ05 BZ09 BZ11***	
Oligota chrysopyga Kraatz		***BZ09 BZ11***	
Oligota granaria Erichson		***A016 BZ05 BZ09***	
Oligota parva Kraatz		***A016 BZ05 BZ09 BZ10***	
Oligota pseudoparva Williams		***BZ10***	
Oligota puctulata Heer [*O. ruficornis* Sharp]		***A016 BZ05 BZ09***	
Oligota pusillima Gravenhorst [*O. atomaria* Erichson]		***A016 BZ05 BZ09***	

Taxon	Common Name	Reference	Page
Omalium rivulare (Paykull)		*A016 BZ04 BZ08*	
Oxytelus sculptus Gravenhorst		*A016 BZ04 BZ08*	
Paederus duplex Eppelsheim		*BZ03*	
Philonthus discoideus (Gravenhorst)		*BZ04*	
Philonthus nigriventris Thomson		*BZ04*	
Philonthus sordidus (Gravenhorst)		*A016 BZ04*	
Philonthus varians (Paykull)		*BZ04*	
Phloeostiba plana (Paykull) [*Phloeonomus planus* (Paykull)]		*A016 BZ04 BZ08*	
Proteinus ovalis Stephens		*A016 BZ04 BZ08*	
Quedius fulgidus (Fabricius) [*Q. assimilis* (Nordmann)]		*A016 BZ04 BZ06*	
Quedius fuliginosus (Gravenhorst)		*A016 BZ04*	
Quedius mesomelinus (Marsham)		*A016 BZ04 BZ06*	
Tachyporus		*BZ02 BZ04*	
Xylodromus concinnus (Marsham)		*A016 BZ04 BZ08*	
Xylodromus depressus (Gravenhorst)		*A016 BZ04 BZ08*	

BZ01 Campbell, J.M.
1975. A revision of the genera *Coproporus* and *Cilea* (Coleoptera: Staphilinidae) of America north of Mexico. Canadian Ent. 107(2)175-216.

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1979. A revision of the genus *Tachyporus* Gravenhorst (Coleoptera: Staphylinidae) of America north of Mexico. Mem. Ent. Soc. Canada 109:i-v, 1-95.

BZ03 Fagel, G.
1966. Contribution à la connaissance des Staphylinidae. XCV. Les *Paederus* éthiopiens. Rev. Zool. Bot. Afr. 73:255-272.

BZ04 Freude, H., K.W. Harde, and G.A. Lohse (eds.).
1964. Die Käfer Mitteleuropas, v. 4. Goecke & Evers, Krefeld.

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1972. A Brazilian species of *Oligota* (Col., Staphylinidae) new to science and imported into Britain. Ent. Monthly Mag. 108(1292-1294)38-39.
BZ11 Williams, S.A.
1974. *Oligota* (*Holobus*) *chrysopyga* Kraatz (Col., Staphylinidae) imported into Britain from Brazil. Ent. Monthly Mag. 109(1310-1312)164-165.

Taxon	Common Name	Reference	Page
Tenebrionidae*	**darkling beetles**	*A016 AQ02 CA14*	82, 83, 102, 185, 589-598
*Alphitobius diaperinus** (Panzer)	**lesser mealworm**	*AQ07 AQ22 CA05 CA08 CA16*	194, 208, 595
*Alphitobius laevigatus** (Fabricius) [*A. piceus* (Olivier)]	**black fungus beetle**	*AQ07 AQ22 CA02 CA05 CA08 CA16*	195, 208
*Alphitobius viator** Mulsant & Godart		*CA05*	186, 195, 595
*Alphitophagus bifasciatus** (Say)	**twobanded fungus beetle**	*AQ07 AQ22 CA02 CA08 CA16*	ii, iii, 187, 211
*Apsena rufipes** Eschscholtz	fig engraver beetle		186, 188, 590
Blaps mucronata Latreille	churchyard beetle	*AQ07 CA16*	
*Blapstinus discolor** Horn [*B. fuliginosus* Casey; *B. rufipes* Casey]	fig darkling beetle	*CA03*	193, 207, 594
*Coelopalorus** [*Palorus*] *carinatus* (Blair)		*CA06*	596
*Coelopalorus foveicollis** (Blair)		*CA06 CA13*	186, 196, 596
*Cynaeus angustus** (LeConte)	**larger black flour beetle**	*AY09 BC06*	199, 595
*Gnatocerus cornutus** (Fabricius)	**broadhorned flour beetle**	*AQ07 AQ22 CA02 CA08*	200, 212, 598
*Gnatocerus maxillosus** (Fabricius)	**slenderhorned flour beetle**	*AQ07 AQ22 CA02*	200, 210, 598
*Latheticus oryzae** Waterhouse	**longheaded flour beetle**	*AQ07 AQ22 CA02 CA08 CA16*	199, 204, 596
Lepidocnemeplatia [*Cnemaplatia*] *sericea** (Horn)			186, 187, 590
*Neatus tenebrioides** Palisot			191, 208, 592
*Palembus dermestoides** (Fairmaire)			194, 212, 594
*Palembus ocularis** Casey		*CA15*	194, 211, 594
Palorinus [*Palorus*] *humeralis** (Gebien)		*CA06*	186, 196
*Palorus cerylonoides** (Pascoe)		*CA06*	186, 198
*Palorus ficicola** (Wollaston)		*CA06*	186, 198
*Palorus genalis** Blair		*CA06*	186, 197

Taxon	Common Name	Reference	Page
*Palorus laesicollis** (Fairmaire)		*CA06*	186, 196, 597
*Palorus ratzeburgii** (Wissmann)	**smalleyed flour beetle**	*AQ07 AQ22 CA02 CA06 CA08 CA13*	198, 203, 597
*Palorus subdepressus** (Wollaston)	**depressed flour beetle**	*AQ07 AQ22 CA02 CA06 CA08 CA13*	197, 203, 597
*Platydema ruficorne** (Sturm)	redhorned grain beetle	*AQ22 CA15*	193, 210, 592
*Sitophagus hololeptoides** (Laporte)		*CA04*	199, 210, 598
*Tenebrio molitor** L.	**yellow mealworm**	*CA07 AQ22 CA02 CA08 CA15*	186, 192, 203, 335, 593
*Tenebrio obscurus** Fabricius	**dark mealworm**	*AQ07 AQ22 CA02 CA08 CA15*	192, 203, 593
*Tribolium audax** Halstead	**American black flour beetle**	*CA01 CA07 CA12*	190, 206, 592
*Tribolium brevicorne** (LeConte)	giant flour beetle	*CA09*	188, 206, 590
*Tribolium castaneum** (Herbst)	**red flour beetle**	*AQ07 AQ22 CA02 CA09 CA10 CA12 CA16*	186, 190, 205, 591
*Tribolium confusum** Jacquelin du Val	**confused flour beetle**	*AQ07 AQ22 CA02 CA08 CA09 CA10 CA12 CA16*	186, 189, 206, 591
*Tribolium destructor** Uyttenboogaart	dark flour beetle	*AQ07 AQ22 CA02 CA08 CA10 CA12 CA16*	189, 206, 590
Tribolium freemani Hinton		*CA11*	
*Tribolium madens** (Charpentier)	black flour beetle	*AQ22 CA01 CA07 CA09 CA10 CA12 CA16*	190, 205, 592

CA01 Becker, E.C.
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CA16 Van Emden, F.I.
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Taxon	Common Name	Reference	Page
Trogositidae* [Ostomidae, Ostomatidae, Lophocateridae]	**trogositid beetles**	*A016 AQ02*	91, 103, 556, 558
*Lophocateres pusillus** (Klug)	Siamese grain beetle	*AQ19 AQ23 AY09 CB01 CB02*	93, 104, 558
*Tenebroides mauritanicus** *(L.)*	**cadelle**	*AQ07 AQ19 AQ23 AY09 CB01 CB02*	91, 104, 556

CB01 Barron, J.R.
1971. A revision of the Trogositidae of America north of Mexico (Coleoptera: Cleroidea). Mem. Ent. Soc. Canada 75:1-143.

CB02 Chittenden, F.H.
1911. The Siamese grain beetle (*Lophocateres pusillus* Klug). U.S. Dept. Agr., Bur. Ent. Bull. 96(2)14-18.

Taxon	Common Name	Reference	Page
Lepidoptera* (order)	**moths, butterflies**	*AQ02 AQ05 AQ10 AQ13 AQ17 AQ20 AQ25 CC01 CC02-CC10*	231, 245, 248, 314, 343, 609-615

CC01 Capps, H.W
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CC03 Fracker, S.B.
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CC04 Hinton, H.E.
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CC09 Weisman, D.M.
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CC10 Zimmerman, E.C.
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Taxon	Common Name	Reference	Page
Argyresthiidae* [Yponomeutidae]	**argyresthiid moths**	*AQ02 CC09*	264, 615
*Argyresthia conjugella** (Zeller)	**apple fruit moth**	*CC01 CC09 CD01*	264, 615

CD01 Werner, K.
1958. Die Larvalsystematik einiger Kleinschmetterlingsfamilien (Hyponomeutidae, Orthoteliidae, Acrolepiidae, Tineidae, Incurvariidae und Adelidae). Akademie-Verlag, Berlin.

Taxon	Common Name	Reference	Page
Cosmopterigidae*	cosmopterigid moths	*CC01 CC09*	264, 614
*Pyroderces** *[Sathrobrota] rileyi* Walsingham	**pink scavenger caterpillar**	*AQ07 AQ22 AQ23 CC02 CC04 CC06 CC07*	264, 335, 614
Gelechiidae*	**gelechiid moths**	*CC01 CC04 CC09*	242, 265, 615
Keiferia lycopersicella (Walsingham)	**tomato pinworm**	*CC01 CC09 CE01*	
Phthorimaea [*Gnorimoschema*] *operculella* (Zeller)	**potato tuberworm**	*CC01 CE02*	
*Sitotroga cerealella** (Olivier)	**Angoumois grain moth**	*AQ07 AQ19 AQ23 AQ25 CC01 CC02 CC04 CC09 CC10*	40, 242, 265, 314, 615

CE01 Capps, H.W.
1946. Description of the larva of *Keiferia peniculo* Heinrich, with a key to the larvae of related species attacking eggplant, pepper, potato and tomato in the United States (Lepidoptera: Gelechiidae). Ann. Ent. Soc. America 39(4)561-563.

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1982. The potato moth—*Phthorimaea operculella* Zeller (Lepidoptera, Gelechiidae). Ent. Rev. 61(4)112-116.

Taxon	Common Name	Reference	Page
Libytheidae	snout butterflies	*AQ02*	
Libytheana bachmanii (Kirtland)		*AQ02*	
Noctuidae* [Phalaenidae]	**owlet moths, underwings**	*AQ02 CC01 CC09 CC10 CG03*	247, 610, 611
*Autographa gamma** (L.)	silver Y moth	*CC05 CC09 CG01*	248
Helicoverpa [*Heliothis*] *zea** (Boddie)	**corn earworm, tomato fruitworm, bollworm**	*AQ13 CC01 CC07-CC09 CG02 CG04*	249, 611
*Mamestra brassicae** (L.)	cabbage moth	*CC05 CC09 CG01*	249, 610
*Trichoplusia ni** (Hübner)	**caggage looper**	*CC08 CC09 CG03-CG05*	248

CG01 Beck, H.
1960. Die Larvalsystematik der Eulen (Noctuidae). Akademie-Verlag, Berlin.

CG02 Crumb, S.E.
1926. The Nearctic budworms of the lepidopterous genus *Heliothis*. Proc. U.S. Nat. Mus. 68(2617)1-8, 1 pl.

CG03 Crumb, S.E.
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CG04 Dekle, G.W.
1976. Illustrated key to caterpillars on corn (with photographs of adults). Fla. Dept. Agr. and Consum. Serv. Bull. 4 (revised), Gainesville.

CG05 Eichlin, T.D.
1975. A guide to the adult and larval Plusiinae of California (Lepidoptera: Noctuidae). California Dept. Food Agr. Occ. Papers Ent. 21:1-73.

Taxon	Common Name	Reference	Page
Oecophoridae*	oecophorid moths	*AQ02 CC01 CC04 CC09*	242, 265, 615
*Endrosis sarcitrella** (L.) [*E. lactella* (Schiffermüller)]	**whiteshouldered house moth**	*AQ07 AQ23 CC01 CC02 CC04 CC09 CC10 CH01 CH02 CH03*	243, 265, 314
Hofmannophila [*Borkhausenia*] *pseudospretella** (Stainton)	**brown house moth**	*AQ25 CC01 CC02 CC04 CH02 CH03*	243, 314, 615

CH01 Arbogast, R.T., G. Chauvin, R.G. Strong, and R.V. Byrd.
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CH02 Clarke, J.F.G.
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CH03 Hodges, R.W.
1974. Gelechioidea: Oecophoridae (in part) (fasc. 6.2). *In* The moths of North America north of Mexico. Classey, London.

Taxon	Common Name	Reference	Page
Pieridae*	**whites, sulphur butterflies**	*CC01 CC09 CC10*	246, 610
Pieris brassicae (L.)	cabbageworm	*CC01 CC09*	
Pieris [*Artogeia*] *rapae** (L.)	**imported cabbageworm**	*CC01 CC09*	246, 610

Pyralidae*	**pyralid moths**	*AQ02 CC04 CC09 CC10 CJ04*	232, 247, 611-613
*Achroia grisella** (Fabricius)	**lesser wax moth**	*AQ23 CC02 CC04 CC10 CJ04 CJ07*	236, 256, 314
*Acrobasis nuxvorella** Neunzig	**pecan nut casebearer**	*CC02 CC04 CC06*	250
*Acrobasis vaccinii** Riley	**cranberry fruitworm**	*CJ06*	250
*Aglossa caprealis** Hübner	murky meal moth	*AQ25 CC02 CC04 CC06 CC09 CJ04*	235, 259, 613
Amyelois transitella (Walker)	**navel orangeworm**	*AQ20 CC01 CC02 CC07 CC09 CJ01 CJ10*	237, 251
*Anagasta kuehniella** (Zeller)	**Mediterranean flour moth**	*AQ03 AQ07 AQ19 AQ22 AQ23 AQ25 CC02 CC04 CC06 CC07 CC09 CC10 CJ01 CJ04 CJ05 CJ07 CJ09*	238, 254, 314
*Cadra calidella** (Guenée)	carob moth	*CC02 CC09 CJ01 CJ04 CJ09*	241, 255

Taxon	Common Name	Reference	Page
*Cadra cautella** (Walker)	**almond moth**	*AQ07 CC02 CC04 CC06 CC09 CC10 CJ01 CJ04 CJ07 CJ09*	241, 254
*Cadra figulilella** (Gregson)	**raisin moth**	*AQ20 CC02 CC07 CC09 CC10 CJ03 CJ04 CJ09*	240, 255
*Corcyra cephalonica** (Stainton)	**rice moth**	*AQ07 AQ23 AQ25 CC02 CC04 CC09 CC10 CJ04*	232, 235, 236, 257, 314, 612
*Diaphania hyalinata** (L.)	**mellonworm**	*AQ13 CC09*	258
*Diaphania nitidalis** (Stoll)	**pickleworm**	*AQ13 CC09*	258, 613
*Ephestia elutella** (Hübner)	**tobacco moth**	*AQ23 AQ25 CC02 CC04 CC07 CC09 CC10 CJ04 CJ05*	239, 254, 314
*Ephestiodes gilvescentella** Ragonot [*E. nigrella* Hulst]	**dusky raisin moth**	*AQ20 CC07*	237, 252
*Galleria mellonella** (L.)	**greater wax moth**	*AQ23 CC02 CC04 CC10 CJ04 CJ07*	234, 235, 256, 314, 612
*Ostrinia nubilalis** Hübner	**European corn borer**	*AQ13 CC01 CC09 CG04 CJ05*	258, 327, 612
Paralipsa [*Aphomia*] *gularis** (Zeller)	**stored nut moth**	*AQ07 AQ23 AQ25 CC02 CC04 CC06 CC09 CC10 CJ04*	234, 236, 257, 314
*Plodia interpunctella** (Hübner)	**Indianmeal moth**	*AQ07 AQ19 AQ20 AQ23 AQ25 CC01 CC02 CC04 CC06 CC07 CC09 CC10 CJ01 CJ04 CJ07 CJ08*	237, 253, 314, 592
*Pyralis farinalis** L.	**meal moth**	*AQ03 AQ07 AQ19 AQ23 AQ25 CC02 CC04 CC06 CC09*	233, 259, 314, 322, 613
Vitula edmandsii serratilineella Ragonot	**driedfruit moth**	*CC02 CC06 CJ06 CJ08*	239, 252

CJ01 Aitken, A.D.
1963. A key to the larvae of some species of Phycitinae (Lepidoptera, Pyralidae) associated with stored products, and some related species. Bull. Ent. Res. 54(2)175-188.

CJ02 Allyson, S.
1981. Last instar larvae of Pyraustini of America north of Mexico (Lepidoptera: Pyralidae). Canadian Ent. 113(6)416-518.

CJ03 Donohoe, H.C., *et al.*
1949. Biology of the raisin moth. U.S. Dept. Agr. Tech. Bull. 994:1-23.

CJ04 Hasenfuss, I.
1960. Die Larvalsystematik der Zünsler (Pyralidae). Akademie-Verlag, Berlin.

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1919. Note on the European corn borer (*Pyrausta nubilalis* Hübner) and its nearest American allies, with description of larvae, pupae, and one new species. Jour. Agr. Res. 18(3)171-178, 5 pl.

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CJ10 Wade, W.H.
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Taxon	Common Name	Reference	Page
Tineidae*	tineid moths	*AQ02 CC04 CC09 CK01*	242, 259, 614
Dasyses rugosella (Stainton)			
Decadarchis miniscula (Walsingham)			
Haplotinea insectella (Fabricius)		*CK01 CK02*	
*Monopsis crocicapitella** (Clemens)		*AQ25 CC02*	243, 260
*Nemapogon granella** (L.)	**European grain moth**	*AQ03 AQ07 AQ22 CC02 CC04 CC07 CD01 CK01*	244, 260, 314
*Tineola bisselliella** (Hummel)	**webbing clothes moth**	*AQ07 AQ23 AQ25 CC02 CC04 CC09 CC10 CD01 CK01*	244, 260, 314, 614

CK01 Hinton, H.E.
1956. The larvae of the species of Tineidae of economic importance. Bull. Ent. Res. 47(2)251-346.
CK02 Madrid, F.J., and R.N. Sinha.
1984. *Haplotinea insectella* (Fabricius) (Lepidoptera: Tineidae)—a potential pest of stored cereals in North America. Jour. Stored Prod. Res. 20(2)107-110.

Taxon	Common Name	Reference	Page
Tortricidae* [Olethreutidae]	**leafroller moths**	*AQ02 CC01 CL04*	261, 614
Argyrotaenia velutinana (Walker)	**redbanded leafroller**		
*Cydia [Carpocapsa, Enarmonia, Laspeyresia] caryana** (Fitch)	**hickory shuckworm**	*CL03 CL04*	263
*Cydia nigricana** (Fabricius)	**pea moth**	*CC04 CL02 CL03*	263
*Cydia pomonella** (L.)	**codling moth**	*CC01 CC02 CC04 CC06 CC09 CL01 CL03 CL04*	263

Taxon	Common Name	Reference	Page
Cydia [Melissopus] latiferreana (Walsingham)	**filbertworm**	*CC06 CL03*	262
Endopiza [Paralobesia] viteana Clemens	**grape berry moth**		
*Grapholita [Grapholitha, Laspeyresia] molesta** (Busck)	**oriental fruit moth**	*CL01 CL03*	261
*Grapholita packardi** (Zeller)	**cherry fruitworm**	*CL03*	262
*Grapholita prunivora** (Walsh)	**lesser appleworm**	*CL03*	262

CL01 Baker, C.R.B.
1963. Notes on the larvae and pupae of two fruit moths, *Grapholita funebrana* Treitschke and *G. molesta* Busck (Lepidoptera: Olethreutidae). Proc. Roy. Ent. Soc. London A38(10-12)212-222.

CL02 Hanson, A.J., and R.L. Webster.
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CL03 MacKay, M.R.
1959. Larvae of the North American Olethreutidae (Lepidoptera). Canadian Ent. 91(suppl. 10)1-338.

CL04 Swatschek, B.
1958. Die Larvalsystematik der Wickler (Tortricidae und Carposinidae). Akademie-Verlag, Berlin.

Taxon	Common Name	Reference	Page
Diptera*	**flies**	*AQ02 AQ10 AQ18 AQ19 AQ21 CM01-CM07*	269, 327, 334, 341, 345, 346, 617

CM01 Cole, F.R.
1969. The flies of western North America. University of California, Berkeley.

CM02 Greenberg, B.
1971. Flies and disease, vol. 1. Ecology, classification, and biotic associations. Princeton University, Princeton.

CM03 Hennig, W.
1948 -52. Die Larvenformen der Dipteren. 3 vol. (vol. 1, 1948; vol. 2, 1950; vol. 3, 1952). Akademie-Verlag, Berlin.

CM04 James, M.T.
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CM05 McAlpine, J.F., et al.
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1987. Manual of Nearctic Diptera, vol. 2. Agriculture Canada, Ottawa.

CM07 Oldroyd, H.
1949. Diptera: Introduction and key to families. Handb. Ident. British Insects 9(1)1-49, 1 pl.

Taxon	Common Name	Reference	Page
Agromyzidae*	**leafminer flies**	*AQ02 AQ18 CM01 CM05 CM07 CN01*	289, 631
Liriomyza brassicae (Riley)	**serpentine leafminer**	*CN01*	
Liriomyza sativae Blanchard	**vegetable leafminer**	*CN01*	
Ophiomyia simplex (Loew)	**asparagus miner**	*CN01*	

CN01 Spencer, K.A.
1973. Agromyzidae (Diptera) of economic importance. Series Entomologica, vol. 9. Junk, The Hague.

Taxon	Common Name	Reference	Page
Anthomyiidae*	**anthomyiid flies**	*AQ02 CM01 CM02 CM07 CO03 CO04 CO07*	292, 631
*Hylemya** [*Delia*]			292, 631
Hylemya antiqua (Meigen)	onion maggot	*CM03 CO04*	
Hylemya brassicae (Bouché)	cabbage maggot	*CM03 CO01 CO04*	
Hylemya cinerella (Fallén)		*CM02*	
Hylemya radicum (L.)		*CM02*	
Pegomya hyoscyami (Panzer)	**spinach leafminer**	*CO01 CO04-CO07*	

CO01 Brooks, A.R.
1951. Identification of the root maggots (Diptera: Anthomyiidae) attacking cruciferous garden crops in Canada, with notes on biology and control. Canadian Ent. 83(5)109-120.

CO02 Chillcott, J.G.
1959. The *Pegomyia hyoscyami* (spinach leaf miner) complex in North America (Diptera: Muscidae). Canadian Ent. 91(3)167-170.

CO03 Hennig, W.
1966 -76. Anthomyiidae (63a). *In* Die Fliegen der palaearktischen Region, E. Lindner, ed. Schweizerbart'sche, Stuttgart.

CO04 Huckett, H.C.
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CO05 Huckett, H.C.
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CO06 Huckett, H.C.
1965. The Muscidae of northern Canada, Alaska, and Greenland (Diptera). Mem. Ent. Soc. Canada 42:1-369.

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Taxon	Common Name	Reference	Page
Calliphoridae*	**blow flies**	*AQ02 AQ18 AQ19 AQ21 CM01-CM07 CP01*	270, 279, 293, 629-631
Anastellorhina [*Calliphora*] *augur* (Fabricius)	lesser brown blow fly	*CM02 CP06*	
*Calliphora terraenovae** Macquart	Nearctic blow fly	*CP01 CP03*	284
Calliphora uralensis Villeneuve	Ural blow fly	*CM02*	
*Calliphora vicina** Robineau-Desvoidy [*C. erythrocephala* Meigen]	cosmopolitan blue bottle fly	*CM02 CM04 CP01 CP02*	284
*Calliphora vomitoria** (L.)	Holarctic blue bottle fly	*AQ23 CM02 CM04 CP01 CP02*	284
*Chrysomya**			281, 294
*Chrysomya albiceps** (Wiedemann)	banded blow fly	*CM02 CM04*	
Chrysomya chloropyga (Wiedemann)	greentail blue bottle fly	*CM04*	
Chrysomya marginalis (Wiedemann)		*CM04*	
*Chrysomya megacephala** (Fabricius)		*CM02 CM04*	630
Chrysomya putoria (Wiedemann)		*CM04*	
Chrysomya rufifacies (Macquart)	**hairy maggot blow fly**	*CM04*	
*Cochliomyia macellaria** (Fabricius)	**secondary screwworm**	*AQ23 CM02 CM04 CP01 CP02*	281, 294, 629
Cynomya mortuorum (L.)		*CM02 CP01 CP02 CP06*	
*Cynomyopsis cadaverina** Robineau-Desvoidy	blue bottle fly	*AQ23 CM04 CP01 CP02*	283, 293
*Phaenicia** [*Lucilia*]		*CP06*	282, 293
*Phaenicia cuprina** Wiedemann [*P. pallescens* (Shannon)]	bronze bottle fly	*AQ23 CM02 CM04 CP01 CP02*	283, 631
*Phaenicia sericata** (Meigen)	green bottle fly	*CM02 CM04 CP01 CP02 CP06*	283, 631
*Phormia regina** (Meigen)	**black blow fly**	*AQ19 AQ23 CM02 CM04 CP01 CP02 CP05 CP06*	281, 294, 631
*Pollenia rudis** (Fabricius)	**cluster fly**	*AQ23 CM02 CM04 CP01 CP02 CP03 CP06*	282
*Protophormia terraenovae** (Robineau-Desvoidy)	Holarctic blow fly	*AQ23 CM02 CP01 CP02 CP06*	281
Lucilia caesar (L.)		*CM02 CM04 CP01 CP04 CP06*	
Lucilia illustris (Meigen)		*CM02 CM04 CP01 CP02 CP04 CP06*	

CP01 Hall, D.G.
1948. The blowflies of North America. Thomas Say Foundation, [Entomological Society of America, Lanham MD].

CP02 Hall, R.D., and L.H. Townsend, Jr.
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1965. Pictorial keys to common domestic flies in California. California Vector Views 12(5)1-4.

CP06 Van Emden, F.I.
1954. Diptera: Cyclorrhapha, Calyptrata (I), section (a), Tachinidae and Calliphoridae. Handb. Ident. British Insects 10(4a)1-133.

Taxon	Common Name	Reference	Page
Cecidomyiidae	**gall midges**	*AQ02 AQ18 CM01 CM05 CM07 CQ02-CQ04*	272, 285
Henria psalliotae Wyatt		*CQ05*	
Heteropeza pygmaea Winnertz		*CQ05*	
Lestremia cinerea Macquart		*CQ05*	
Mycophila barnesi Edwards		*CQ05*	
Mycophila fungicola Felt		*CQ01 CQ05*	
Mycophila speyeri (Barnes)		*CQ03 CQ05*	

CQ01 Foote, R.H., and C.A. Thomas.
1959. *Mycophila fungicola* Felt: A redescription and review of its biology (Diptera, Itonididae). Ann. Ent. Soc. America 52(3)331-334.

CQ02 Gagné, R.J.
1981. Cecidomyiidae. *In* Manual of Nearctic Diptera, vol. 1, ed. by J.F. McAlpine *et al.* Agriculture Canada, Ottawa.

CQ03 Hardy, D.E.
1960. Diptera: Nematocera-Brachycera (except Dolichopodidae). *In* Insects of Hawaii, vol. 10, E.C. Zimmerman, ed. University of Hawaii, Honolulu.

CQ04 Harris, K.M.
1966. Gall midge genera of economic importance (Diptera: Cecidomyiidae). Part 1. Introduction and subfamily Cecidomyiinae; supertribe Cecidomyiidi. Trans. Roy. Ent. Soc. London 118(10)313-358.

CQ05 Wyatt, I.J.
1964. Immature stages of Lestremiinae (Diptera: Cecidomyiidae) infesting cultivated mushrooms. Trans. Roy. Ent. Soc. London 116(2)15-27.

Taxon	Common Name	Reference	Page
Chironomidae	**midges**	*CM05*	286
Drosophilidae*	**small fruit flies**	*AQ02 AQ18 AQ19 AQ21 AQ23 CM02 CM05 CM07*	276, 289, 290, 346
*Drosophila**		*CM02*	276
Drosophila funebris (Fabricius)	rotten potato drosophila	*CM02 CM04 CR01*	
Drosophila melanogaster Meigen	drosophilid fruit fly	*CM02 CM04 CR01*	
Drosophila repleta Wollaston	latrine drosophila	*CM02 CR01*	

CR01 Sturtevant, A.H.
1942. The classification of the genus *Drosophila*, with descriptions of nine new species. Univ. Texas Publ. 4213:5-51.

Taxon	Common Name	Reference	Page
Lonchaeidae	lonchaeid flies	*AQ02 CM07 CS01*	
Lonchaea aristella Becker		*CS01*	

CS01 Czerny, L.
1934 [1949]. 43. Lonchaeidae. *In* Die Fliegen der palaearktischen Region, vol. 5, E. Lindner, ed. Schweizerbart'sche, Stuttgart.

Taxon	Common Name	Reference	Page
Muscidae*	muscid flies	*AQ02 AQ18 AQ19 AQ21 CM01-CM07 CO06 CQ01 CT04 CT07 CT10*	277, 288, 291, 292, 625-627
Atherigona orientalis Schiner		*CT05*	
Dasyphora		*CM02 CT03*	
*Fannia**		*CT03*	287, 288, 336, 345
*Fannia canicularis** (L.)	**little house fly**	*AQ21 AQ23 CM02 CM04 CT02 CT03 CT09*	278, 625
Fannia leucosticta (Meigen)		*CM02 CT02 CT09*	
*Fannia scalaris** (Fabricius)	**latrine fly**	*CM02 CM04 CT02 CT03 CT09*	625
Musca autumnalis De Geer	**face fly**	*AQ23 CM02 CT03*	
*Musca domestica** L.	**house fly**	*AQ19 AQ21 AQ23 CM02 CM04 CO06 CT03*	10, 278, 291, 335, 626
Musca sorbens Wiedemann	market fly	*CM02 CM04*	279, 291
*Muscina**		*CT03*	
Muscina assimilis (Fallén)		*CM02 CM04 CT03*	279
Muscina stabulans (Fallén)	**false stable fly**	*AQ21 AQ23 CM02 CM04 CO06 CT03 CT08*	279, 627
*Ophyra**	dump flies	*CT03*	279, 292
*Ophyra aenescens** (Wiedemann)	bronze dump fly	*CT01 CT06*	279, 626

Taxon	Common Name	Reference	Page
Ophyra chalcogaster (Wiedemann)		*CT06*	
*Ophyra leucostoma** (Wiedemann)	dump fly	*CM02 CT01 CT03*	279
Ophyra nigra (Wiedemann)		*CT06*	

CT01 Adams, R.G.
1984. *Ophyra* species as predators in animal houses, with a key to species occurring in Europe (Diptera: Muscidae). Ent. Gaz. 35(4)243-246.

CT02 Chillcott, J.G.
1960. A revision of the Nearctic species of Fanniinae (Diptera: Muscidae). Canadian Ent. 92(suppl. 14)1-295.

CT03 D'Assis Fonseca, E.C.M.
1968. Diptera: Cyclorrhapha, Calyptrata, section (b), Muscidae. Handb. Ident. British Insects 10(4b)1-119.

CT04 Hennig, W.
1955 -64. Muscidae (63b). *In* Die Fliegen der palaearktischen Region, E. Lindner, ed. Schweizerbart'sche, Stuttgart.

CT05 Pont, A.C.
1972. 2. A review of the Oriental species of *Atherigona* Rondani (Diptera, Muscidae) of economic importance. *In* Control of sorghum shoot fly, ed. by M.G. Jotwani and W.R. Young. Oxford & IBH, New Delhi.

CT06 Sabrosky, C.W.
1949. The muscid genus *Ophyra* in the Pacific Region (Diptera). Proc. Hawaiian Ent. Soc. 13(3)423-432.

CT07 Shinonaga, S., and R. Kano.
1971. Fauna Japonica. Muscidae (Insecta: Diptera), vol. 1. Academic Press of Japan, Tokyo.

CT08 Snyder, F.M.
1955. Notes and descriptions of *Muscina* and *Dendrophaonia* (Diptera: Muscidae). Ann. Ent. Soc. America 48(6)445-452.

CT09 Van Emden, F.I.
1941. Keys to the Muscidae of the Ethiopian Region: Scatophaginae, Anthomyiinae, Lispinae, Fanniinae. Bull. Ent. Res. 32(3)251-275.

CT10 Van Emden, F.I.
1965. Diptera. Muscidae, part 1. *In* The fauna of India and the adjacent countries, vol. 7, R.B.S. Sewell and M.L. Roonwal, eds. Zoological Survey of India, Calcutta.

Taxon	Common Name	Reference	Page
Phoridae*	**humpbacked flies,** scuttle flies	*AQ02 AQ18 AQ19 AQ21 AQ23 CM01-CM05 CM07*	273, 288, 290, 345, 620
*Megaselia** [*Aphiochaeta*]			620
Megaselia agarici (Lintner)		*CU04*	
Megaselia bovista (Gimmerthal)		*CU02 CU04*	
*Megaselia halterata** (Wood)	mushroom phorid	*CU04*	327, 620
Megaselia nigra (Meigen)		*CU02 CU04*	

Taxon	Common Name	Reference	Page
*Megaselia rufipes** (Meigen)		*CM02 CU02*	620
Megaselia sandhui Disney		*CU03*	
*Megaselia scalaris** (Loew)		*CU02*	620
Spiniphora bergenstammi (Mik)	snail phorid	*CU01*	

CU01 Borgmeier, T.
1963. Revision of the North American phorid flies. Part I. The Phorinae, Aenigmatiinae and Metopininae, except *Megaselia* (Diptera, Phoridae). Studia Ent. 6(n.s.)(1-4)1-256.

CU02 Borgmeier, T.
1965. Revision of the North American phorid flies. Part III. The species of the genus *Megaselia,* subgenus *Megaselia* (Diptera, Phoridae). Studia Ent. 8(n.s.)(1-4)1-160.

CU03 Disney, R.H.L.
1981. *Megaselia sandhui* sp. n. (Diptera: Phoridae), a pest of cultivated mushrooms in India. Bull. Ent. Res. 71(3)509-512.

CU04 Robinson, W.H.
1977. Phoridae (Diptera) associated with cultivated mushrooms in eastern North America. Proc. Ent. Soc. Washington 79(3)452-462.

Taxon	Common Name	Reference	Page
Piophilidae*	**skipper flies**	*AQ02 AQ18 AQ21 AQ23 CM01-CM05 CM07*	276, 290, 624
*Piophila casei** (L.)	**cheese skipper**	*CM02 CM04 CV01 CV02*	276, 290, 624

CV01 Hennig, W.
1943 [1949]. 40. Piophilidae. *In* Die Fliegen der palaearktischen Region, vol. 5, ed. by E. Lindner. Schweizerbart'sche, Stuttgart.

CV02 Melander, A.L.
1924. Review of the dipterous family Piophilidae. Psyche 31(2)78-86.

Taxon	Common Name	Reference	Page
Psilidae*	rust flies	*AQ02 AQ18 CM01 CM05 CM07*	276, 290
*Psila rosae** (Fabricius)	**carrot rust fly**	*CW01*	276, 290

CW01 Hennig, W.
1941 [1949]. 41. Psilidae. *In* Die Fliegen der palaearktischen Region, vol. 5, E. Lindner, ed. Schweizerbart'sche, Stuttgart.

Taxon	Common Name	Reference	Page
Psychodidae*	**moth flies**	*AQ02 AQ18 AQ21 CM01 CM02-CM05 CM07 CQ01*	271, 286, 344, 346, 618
*Psychoda**	drain flies	*CX01-CX04*	618

CX01 Duckhouse, D.A.
1966. Psychodidae (Diptera, Nematocera) of southern Australia: Subfamily Psychodinae. Trans. Roy. Ent. Soc. London 118(6)153-220.
CX02 Freeman, P.
1950. Family Psychodidae. Handb. Ident. British Insects 9(2)77-96.
CX03 Satchell, G.H.
1954. Keys to the described species of New Zealand Psychodidae with descriptions of eight new species. Trans. Roy. Ent. Soc. London 105(20)475-491.
CX04 Usinger, R.L. (ed.).
1956. Aquatic insects of California with keys to North American genera and California species. University of California, Berkeley.

Taxon	Common Name	Reference	Page
Sarcophagidae*	**flesh flies**	*AQ02 AQ18 AQ21 CM01-CM06 CY02*	279, 293, 628
*Sarcophaga**		*AQ21 CM01 CM02 CP06 CY01*	279, 628
*Sarcophaga haemorrhoidalis** (Fallén)	redtailed flesh fly	*CM02 CP06 CY01*	628
Sarcophaga hirtipes (Wiedemann)		*CY02*	
Sarcophaga melanura Meigen		*CM02 CP06*	

CY01 Aldrich, J.M.
1916. *Sacrophaga* and allies in North America. Thomas Say Foundation, [Entomological Society of America, College Park].
CY02 Rohdendorf, B.B.
1937. Fam. Sarcophagidae. Fauna USSR, vol. 19, No. 1. Academy of Sciences USSR, Moscow.

Taxon	Common Name	Reference	Page
Scatopsidae*	minute black scavenger flies	*AQ02 AQ18 CM01 CM03 CM05 CM07 CQ01 CZ01*	272, 286, 344

CZ01 Duda, O.
1929 [1930]. 5. Scatopsidae. *In* Die Fliegen der palaearktischen Region, vol. 2(1), E. Lindner, ed. Schweizerbart'sche, Stuttgart.

Taxon	Common Name	Reference	Page
Scenopinidae* [Omphralidae]	window flies	*AQ02 AQ18 CM01 CM02 CM03 CM05 CM07 CQ01*	274, 287, 344, 622
*Scenopinus**		*CM01 CM05 DA01 DA02*	274, 287
Scenopinus fenestralis (L.)	cosmopolitan window fly	*A023 DA01 DA02*	
Scenopinus glabrifrons Meigen	European window fly	*A023 DA01 DA02*	

DA01 Hardy, D.E.
1944. A revision of North American Omphralidae (Scenopinidae). Jour. Kansas Ent. Soc. 17(1)31-51.

DA02 Kelsey, L.P.
1969. A revision of the Scenopinidae (Diptera) of the world. U.S. National Museum Bulletin 277. Smithsonian Institution, Washington, DC.

Taxon	Common Name	Reference	Page
Sciaridae* [Lycoriidae]	**darkwinged fungus gnats**	***AQ02 AQ18 CM01 CM03 CM05 CQ01 DB02***	272, 344
Bradysia coprophila (Lintner)			
Lycoriella [*Sciara*] *agraria* (Felt)		***DB01***	
Lycoriella auripila (Winnertz)		***DB01***	
Lycoriella mali (Fitch) [*Neosciara pauciseta* Felt]			
Lycoriella multiseta (Felt)			

DB01 Lengersdorf, F.
1930. 7. Lycoriidae. *In* Die Fliegen der palaearktischen Region, vol. 2(1), E. Lindner, ed. Schweizerbart'sche, Stuttgart.

DB02 Steffan, W.A.
1966. A generic revision of the family Sciaridae (Diptera) of America north of Mexico. Univ. California Pubs. Ent. 44:1-77.

Taxon	Common Name	Reference	Page
Sepsidae*	black scavenger flies	***AQ02 AQ18 CM01-CM05 CM07 CQ01 DC02***	276, 289, 290, 346
*Sepsis**		***CM01 DC01***	

DC01 Hennig, W.
1943 [1949]. 39a. Sepsidae. *In* Die Fliegen der palaearktischen Region, vol. 5, E. Lindner, ed. Schweizerbart'sche, Stuttgart.

DC02 Zuska, J., and D.H. Colless.
1984. Australian Sepsidae (Diptera). J. Australian Ent. Soc. 23(1)59-67.

Taxon	Common Name	Reference	Page
Sphaeroceridae* [Borboridae]	small dung flies	***AQ02 CM01 CM02 CM05 CQ01 DD01 DD03***	275, 622
*Leptocera**		***CM01***	275, 622
Leptocera caenosa (Rondani)		***DD02***	

DD01 Duda, O.
1938. 57. Sphaeroceridae (Cypselidae). *In* Die Fliegen der palaearktischen Region, vol. 6(1), ed. by E. Lindner. Schweizerbart'sche, Stuttgart.

DD02 Roháček, J.
1982. Revision of the subgenus *Leptocera* (s. str.) of Europe (Diptera, Sphaeroceridae). Ent. Abhandl. 47(1)1-44.

DD03 Spuler, A.
1923. North American genera and subgenera of dipterous family Borboridae. Proc. Acad. Nat. Sci. Philadelphia 75:369-378.

Taxon	Common Name	Reference	Page
Stratiomyidae*	**solider flies**	***AQ02 AQ18 AQ21 CM01 CM03-CM05 CM07 CQ01 DE02***	274, 285
*Hermetia illucens** (L.)	**black soldier fly**	***CM04 CQ01 DE01 DE02***	274, 285, 336 621

DE01 James, M.T.
1935. The genus *Hermetia* in the United States (Diptera, Stratiomyidae). Bull. Brooklyn Ent. Soc. 30(4)165-170.
DE02 McFadden, M.W.
1967. Soldier fly larvae in America north of Mexico. Proc. U.S. Natl. Mus. 121(3569)1-72.

Taxon	Common Name	Reference	Page
Syrphidae*	**flower flies**	***AQ02 AQ18 CM01-CM05 CM07 CQ01***	273, 289, 346, 619
*Eristalis [Tubifera] tenax** (L.)	**drone fly**	***CM04 CM05 CX01 DF02 DF03***	273, 289, 619
Ornidia [Volucella] obesa (Fabricius)		***DF01***	

DF01 Curran, C.H.
1926. Partial synopsis of American species of *Volucella* with notes on Wiedemann's types. Ann. Ent. Soc. America 19(1)50-66.
DF02 Dixon, T.J.
1960. Key to and descriptions of the third instar larvae of some species of Syrphidae (Diptera) occurring in Britain. Trans. Roy. Ent. Soc. London 112(13)345-379.
DF03 Telford, H.S.
1939. The Syrphidae of Minnesota. Minnesota Agricultural Experiment Station Tech. Bull 140. St. Paul.

Taxon	Common Name	Reference	Page
Tephritidae* [Trypetidae, Trupaneidae]	**fruit flies**	***AQ02 AQ18 CM01 CM04 CM07***	274, 291, 622
Anastrepha fraterculus (Wiedemann)	South American fruit fly	***AQ18 DG02 DG09 DG10***	
Anastrepha ludens (Loew)	**Mexican fruit fly**	***AQ18 DG02 DG09 DG10***	
Anastrepha obliqua (Macquart) *[A. mombinpraeoptans* Seín]	**West Indian fruit fly**	***DG09 DG10***	
Ceratitis capitata (Wiedemann)	**Mediterranean fruit fly**	***AQ18 DG04 DG07 DG08 DG14***	
Dacus dorsalis Hendel	**oriental fruit fly**	***AQ18 DG03***	
Dacus oleae (Gmelin)	**olive fruit fly**	***AQ18 DG12***	
Rhagoletis cingulata (Loew)	**cherry maggot**	***AQ18 DG05***	

Taxon	Common Name	Reference	Page
Rhagoletis indifferens Curran	**western cherry fruit fly**	*DG05*	
Rhagoletis mendax Curran	**blueberry maggot**	*AQ18 DG06*	
Rhagoletis pomonella (Walsh)	**apple maggot**	*AQ18 DG07 DG13 DG15*	

DG01 Biological Assessment Support Staff.
1982. Pests not known to occur in the United States or of limited distribution, No. 18: South American fruit fly. U.S. Dept. of Agr. APHIS 81-40. Washington, DC.

DG02 Biological Assessment Support Staff.
1982. Pests not known to occur in the United States or of limited distribution, No. 19: Mexican fruit fly. U.S. Dept. of Agr. APHIS 81-40. Washington, DC.

DG03 Biological Assessment Support Staff.
1982. Pests not known to occur in the United States or of limited distribution, No. 20: Oriental fruit fly. U.S. Dept. of Agr. APHIS 81-40. Washington, DC.

DG04 Biological Assessment Support Staff.
1982. Pests not known to occur in the United States or of limited distribution, No. 26: Mediterranean fruit fly. U.S. Dept. of Agr. APHIS 81-41. Washington, DC.

DG05 Bush, G.L.
1966. The taxonomy, cytology, and evolution of the genus *Rhagoletis* in North America (Diptera, Tephritidae). Bull. Mus. Comp. Zool. (Harvard) 134(11)431-562.

DG06 Lathrop, F.H., and C.B. Nickels.
1932. The biology and control of the blueberry maggot in Washington County, Me. USDA Tech. Bul. 275:1-76 [*Rhagoletis mendax* is referred to as the blueberry form of *R. pomonella* in this paper].

DG07 Phillips, V.T.
1946. The biology and identification of trypetid larvae (Diptera: Trypetidae). Mem. American Ent. Soc. 12:1-161.

DG08 Quayle, H.J.
1929. The Mediterranean and other fruit flies. California Agricultural Experiment Station Circular 315. University of California, Berkeley.

DG09 Steyskal, G.C.
1977. Pictorial keys to species of the genus *Anastrepha* (Diptera: Tephritidae). Entomological Society of Washington, Washington, DC.

DG10 Stone, A.
1942. The fruitflies of the genus *Anastrepha.* U.S. Dept. Agr. Misc. Pub. 439. Washington, DC.

DG11 Weems, H.V., Jr.
1963. Mexican fruit fly (*Anastrepha ludens* (Loew)) (Diptera: Tephritidae). Fla. Dept. Agr. and Cons. Serv., Div. Plant Indus. Ent. Cir. 16. Gainesville.

DG12 Weems, H.V., Jr.
1966. Olive fruit fly (*Dacus oleae* (Gmelin)) (Diptera: Tephritidae). Fla. Dept. Agr. and Cons. Serv., Div. Plant Indus., Ent. Cir. 44. Gainesville.

DG13 Weems, H.V., Jr.
1972. Apple maggot, *Rhagoletis pomonella* (Walsh) (Diptera: Tephritidae). Fla. Dept. Agr. and Cons. Serv., Div. Plant Indus., Ent. Cir. 126. Gainesville.

DG14 Weems, H.V., Jr.
1981. Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). Fla. Dept. Agr. and Cons. Serv., Div. Plant Indus., Ent. Cir. 230. Gainesville.

DG15 Westcott, R.L.
1982. Differentiating adults of apple maggot, *Rhagoletis pomonella* (Walsh) from snowberry maggot, *R. zephyria* Snow (Diptera: Tephritidae) in Oregon. Pan-Pacific Ent. 58(1)25-30.

Taxon	Common Name	Reference	Page
Hymenoptera*	**ants, bees, wasps**	*AQ01 AQ02 AQ04-AQ06 AQ15 AQ17 AQ19 DH01 DH02 DH03*	297, 298, 323, 330, 334, 349

DH01 Ferrière, C., and G.J. Kerrich.
1958. Hymenoptera: Chalcidoidea. Agaontidae, Leucospidae, Calcididae, Eucharitidae, Perilampidae, Cleonymidae and Thysanidae. Handb. Indent. British Insects 8(2a)1-40.

DH02 Richards, O.W.
1977. Hymenoptera: Introduction and key to families. Handb. Ident. British Insects 6(1)1-94.

DH03 Short, J.R.T.
1952. The morphology of the head of larval Hymenoptera with special reference to the head of the Ichneumonoidea, including a classification of the final instar larvae of the Braconidae. Trans. Roy. Ent. Soc. London 103(2)27-84.

Taxon	Common Name	Reference	Page
Agaonidae	**fig wasps**	*AQ02*	349
Blastophaga psenes (L.)	**fig wasp**	*AQ20*	
Apidae	honeybees	*AQ02*	
*Apis mellifera** L.	honeybee	*AQ23 DJ01 DJ02*	330, 334, 349

DJ01 Batra, S.W.T.
1976. Honey bees (*Apis* spp.) likely to be intercepted at quarantine stations. Coop. Plant Pest Rpt. 1(48-52)900-902.

DJ02 Economic Insect Survey and Detection.
1972. An African honey bee (*Apis mellifera adansonii*). Coop. Econ. Insect Rpt. 22(12)158-160.

Taxon	Common Name	Reference	Page
Bethylidae*	**bethylid wasps**	*A023 AQ02 DK01-DK04*	450, 465
*Cephalonomia**		*DK01-DK04*	469
*Cephalonomia gallicola** (Ashmead)		*DK02 DK03*	469
*Cephalonomia tarsalis** (Ashmead)		*DK02-DK04*	468

Taxon	Common Name	Reference	Page
*Cephalonomia waterstoni** Gahan	**parasitic grain wasp**	***DK02-DK04***	469
Epyris		***A023***	
*Goniozus emigratus** (Rohwer)		***DK02***	466
*Holepyris hawaiiensis** (Ashmead)		***A023 DK02-DK04***	467
*Holepyris sylvanidis** (Brèthes)		***DK02 DK03***	467
*Laelius anthrenivorus** Trani			467
*Laelius centratus** (Say)		***DK01 DK02***	467
*Plastanoxus chittendenii** (Ashmead)		***DK01-DK03***	470
*Plastanoxus westwoodi** (Kieffer)		***DK01-DK04***	470
Rhabdepyris zeae Turner & Waterson		***A023***	
*Sclerodermus immigrans** Bridwell			466

DK01 Evans, H.E.
1964. A synopsis of the American Bethylidae (Hymenoptera, Aculeata). Bul. Mus. Comp. Zool. (Harvard) 132(1)1-222.

DK02 Evans, H.E.
1978. The Bethylidae of America north of Mexico. Mem. American Ent. Inst. 27:1-332.

DK03 Perkins, J.F.
1976. Hymenoptera: Bethyloidea (except Chrysididae). Handb. Ident. British Insects 6(3a)1-38.

DK04 Richards, O.W.
1939. The British Bethylidae (*s.l.*) (Hymenoptera). Trans. Roy. Ent. Soc. London 89(8)185-344.

Taxon	Common Name	Reference	Page
Braconidae*	**braconid wasps**	***A023 AQ02 DH02 DL01 DL02***	450, 470
*Apanteles araeceri** Wilkins			475
*Apanteles carpatus** (Say)			475
*Apanteles nephoptericis** (Packard)			475
Bassus [*Agathis*] *hawaiicola** (Ashmead)			476
Chelonus sulcatus Jurine		***A023***	
*Chremylus rubiginosus** (Nees)			474
Habrobracon [*Bracon*] *brevicornis** (Wesmael)			473
*Habrobracon crassicornis** (Thomson)			473
*Habrobracon hebetor** (Say)		***A023***	473
*Habrobracon kitcheneri** (Dudgeon & Gough)			473
*Hecabolus sulcatus** Curtis			474
*Meteorus ictericus** (Nees)			476
*Spathius exarator** (L.)			474

DL01 Marsh, P.M.
1963. A key to the subfamilies of the family Braconidae (Hymenoptera). Ann. Ent. Soc. America 56(4)522-527.
DL02 Marsh, P.M.
1971. A key to the Nearctic genera of the families Braconidae, Aphidiidae, and Hybrizontidae (Hymenoptera). Ann. Ent. Soc. America 64(4)841-850.

Taxon	Common Name	Reference	Page
Chalcididae*	chalcidids	*AQ02 DH01*	450, 455
*Antrocephalus aethiopicus** Masi			456
*Antrocephalus mahensis** Masi			456
Encyrtidae	encyrtids	*AQ02*	450
Comperia merceti (Compere)			
Copidosoma koehleri Blanchard		*DN01*	
Copidosoma phthorimaea Logvinovskaya		*DN01*	

DN01 Logvinovskaya, T.V.
1982. A new parasitic wasp, *Copidosoma phthorimaeae* sp. n. (Hymenoptera, Encyrtidae), of the potato moth, *Phthorimaea operculella* Zeller (Lepidoptera, Gelechiidae). Ent. Rev. 61(4)117-119.

Taxon	Common Name	Reference	Page
Eulophidae*	eulophids	*AQ02 DH01*	450, 457
Aprostocetus [Tetrastichodes, Tetrastichus] *hagenowii** (Ratzeburg)			457, 459
*Entedon longiventris** Ratzeburg			457
*Melittobia chalybii** Ashmead			458
*Paraolinx typica** (Howard) [*P. nigriventris* (Girault)]			458
Tetrastichus asthenogmus (Waterston)			
*Tetrastichus coerulescens** Ashmead			457, 459
*Tetrastichus hagenowii** (Ratzeburg)			457, 459
*Tetrastichus periplanetae** Crawford			451, 457, 459
Eupelmidae*	eupelmids	*AQ02 DH01*	450, 456
Anastatus tennipes Bolivar			
*Eupelmus cushmani** (Crawford)			457
*Eupelmus javae** Girault			457
Eurytomidae*	**seed chalcids, eurytomids**	*A023 DQ01 DQ02*	450, 458, 460
*Aximopsis javensis** Girault			460
*Aximopsis tephrosiae** Girault			460
*Eurytoma tylodermatis** Ashmead		*DP01*	460
Systole geniculata Foerster	fennel seed wasp		

DP01 Bugbee, R.E.
1967. Revision of chalcid wasps of genus *Eurytoma* in America north of Mexico. Proc. U.S. Natl. Mus. 118(3533)433-552.

DP02 Burks, B.D.
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Taxon	Common Name	Reference	Page
Evaniidae*	**ensign wasps**	*A023 AQ02 DQ02*	324, 450, 453
*Evania appendigaster** (L.)		*AQ02 DH01 DP02*	453
Evania dimidiata Spinola		*A023*	
*Prosevania fuscipes** (Illiger) [*P. punctata* (Brullé)]			453
*Szepligetella sericea** (Cameron)	**lesser ensign wasp**		453

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Taxon	Common Name	Reference	Page
Formicidae*	**ants**	*AQ02 DR01-DR18*	297, 298, 633-649

DR01 Allred, D.M.
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Taxon	Common Name	Reference	Page
Dolichoderinae*	dolichoderine ants	*AQ02 DR01-DR11 DR14*	307, 642, 643
*Conomyrma insana** (Buckley) [*Dorymyrmex pyramicus* (Roger)]	**pyramid ant**	*DR04 DR05 DR07 DR09 DR11-DR13 DR15*	643
*Iridomyrmex humilis** (Mayr)	**Argentine ant**	*DR03 DR04 DR06 DR08 DR11 DR12 DR17*	307, 324, 643
*Iridomyrmex pruinosus** (Roger)		*DR04-DR08 DR11 DR12 DR15 DR18*	643
*Tapinoma melanocephalum** (Fabricius)		*DR03 DR09 DR11 DR17*	307, 324, 643
*Tapinoma sessile** (Say)	**odorous house ant**	*DR04 DR05 DR07 DR08 DR11 DR12 DR15 DR17 DR18*	307, 324, 643
Technomyrmex albipes (Smith)	whitefooted ant		
Dorylinae*	doryline ants	*DR04 DR08 DR14 DR18*	303, 634
*Labidus coecus** (Latreille)		*DR04 DR11 DR12 DR18 DT01*	634
*Neivamrymex nigrescens** (Cresson)		*DR04 DR11 DR12 DR15 DR18 DT01*	634
*Neivamyrmex opacithorax** (Emery)		*DR04 DR11 DR12 DR18 DT01*	634

DT01 Watkins, J.R., II.
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Taxon	Common Name	Reference	Page
Formicinae*	formicine ants	*DR01-DR11 DR14*	
*Acanthomyops claviger** (Roger)	**smaller yellow ant**	*DR04 DR05 DR11-DR13 DR18 DU03*	646
*Acanthomyops interjectus** (Mayr)	**larger yellow ant**	*DR04 DR05 DR11 DR12 DR16 DR18 DU03*	302, 646
*Acanthomyops latipes** (Walsh)		*DR04 DR05 DR11 DR16 DR18 DU03*	646
*Acanthomyops murphyi** (Forel)		*DR04 DR05 DR11 DR16 DU03*	646
Anoplolepis longipes (Jerdon)	**longlegged ant**	*DR17*	
*Camponotus abdominalis** (Fabricius)	**Florida carpenter ant**	*DR04 DR11*	644
*Camponotus caryae discolor** (Buckley)		*DR04-DR06 DR11-DR13 DR18*	644
*Camponotus castaneus** (Latreille)		*DR04-DR06 DR11 DR12 DR18*	644
*Camponotus ferrugineus** (Fabricius)	**red carpenter ant**	*DR04-DR06 DR11 DR12*	645
Camponotus herculeanus (L.)		*DR07*	
Camponotus modoc Wheeler		*DR07 DU04*	
*Camponotus nearcticus** Emery		*DR04 DR05 DR07 DR11 DR12 DR13 DR18*	645
*Camponotus pennsylvanicus** (De Geer)	**black carpenter ant**	*DR04-DR07 DR11-DR13 DR18*	645
*Camponotus sayi** Emery [*C. rasilis* Wheeler]		*DR04 DR07 DR11 DR12 DR18*	646
*Camponotus tortuganus** Emery		*DR04 DR11*	646
Camponotus vicinus (Mayr)		*DR07*	
*Lasius alienus** (Foerster)	**cornfield ant**	*DR03 DR04 DR06 DR07 DR11-DR13 DR15 DR18 DU02*	648
Lasius brunneus (Latreille)		*DU02*	
*Lasius neoniger** Emery		*DR04 DR06 DR07 DR11 DR12 DR13 DR18 DU02*	648
Lasius pallitarsis (Provancher) [*L. sitkaensis* Pergande]		*DU02*	
*Lasius umbratus** (Nylander)		*DR04-DR06 DR11 DU02*	648
*Paratrechina**		*DR02 DR04-DR06 DR08 DR11 DR18 DU01*	308, 309, 649
*Paratrechina longicornis** (Latreille)	**crazy ant**	*DR03-DR05 DR09 DR11 DR17 DR18 DU01*	309, 649

Taxon	Common Name	Reference	Page
Paratrechina vividula (Nylander)		*DU01*	
*Prenolepis imparis** (Say)		*DR04-DR06 DR08 DR11 DR12 DR18*	649

DU01 Trager, J.C.
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Taxon	Common Name	Reference	Page
Myrmicinae*	myrmicine ants	*AQ02 DR01-DR11 DR14*	303, 305, 635-642
*Aphaenogaster fulva** Roger		*DR04-DR06 DR11 DR12 DR18*	637
*Aphaenogaster lamellidens** Mayr		*DR04 DR05 DR11 DR12*	638
*Aphaenogaster rudis** (Emery)		*DR04 DR05 DR11 DR12*	638
*Aphaenogster tennessensis** (Mayr)		*DR04-DR06 DR11 DR12 DR18*	638
*Atta texana** (Buckley)	**Texas leafcutting ant**	*DR11*	
*Crematogaster ashmeadi** Mayr		*DR04 DR11 DV01*	
*Crematogaster cerasi** (Fitch)		*DR04 DR06 DR11 DV01*	
*Crematogaster clara** Mayr		*DR04 DR11 DV01*	640
*Crematogaster lineolata** (Say)		*DR04-DR06 DR11 DV01*	640
*Monomorium destructor** (Jerdon)		*DR04 DR08 DR09 DR11 DR17*	636
*Monomorium floricola** (Jerdon)		*DR04 DR09 DR11*	637
*Monomorium minimum** (Buckley)	**little black ant**	*DR04-DR08 DR11-DR13 DR15 DR18*	323, 637
*Monomorium pharaonis** (L.)	**pharaoh ant**	*DR03-DR06 DR08 DR09 DR11-DR13 DR17 DR18*	305, 636

Taxon	Common Name	Reference	Page
Ochetomyrmex [*Wasmania*] *auropunctatus** (Roger)	**little fire ant**	*DR08 DR09 DR11*	641
*Pheidole bicarinata vinelandica** Forel		*DR04-DR07 DR11 DR12 DR18 DV04*	640
*Pheidole dentata** Mayr		*DR04 DR11 DR12 DR18 DV04*	641
*Pheidole floridana** Emery		*DR04 DR11 DV04*	641
*Pheidole megacephala** (Fabricius)		*DV04*	
Pogonomyrmex occidentalis (Cresson)		*DR07 DV03*	
*Solenopsis geminata** (Fabricius)	**fire ant**	*DR04 DR09 DR11 DR12 DR17 DV02 DV05 DV06*	635
*Solenopsis invicta** Buren	**red imported fire ant**	*DV02 DV05 DV06*	635
*Solenopsis molesta** (Say)	**thief ant**	*DR04 DR05 DR07 DR08 DR11-DR13 DR15 DR18*	304, 635
Solenopsis richteri Forel	**black imported fire ant**	*DV02*	
*Solenopsis xyloni** McCook	**southern fire ant**	*DR04 DR07 DR11-DR13 DR18 DV02 DV05 DV06*	636
Tetramorium bicarinatum (Nylander) [*T. guineense* (Fabricius)]	**Guinea ant**	*DR03 DR04 DR09 DR11 DR12 DR17*	642
*Tetramorium caespitum** (L.)	**pavement ant**	*DR03-DR05 DR08 DR11*	300, 301, 306, 330, 642

DV01 Buren, W.F.
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Taxon	Common Name	Reference	Page
Ponerinae*	ponerine ants	*DR01-DR11 DR14*	306
Hypoponera punctatissima (Roger)			
Ichneumonidae*	**ichneumons**	*A023 AQ02 DX01 DX02*	450, 470
*Diadegma**		*A023*	472
Diadegma armillata (Gravenhorst)		*A023*	
Diadegma chrysostictus (Gmelin)		*A023*	
*Hypiscera curvata** (Fabricius)			472
*Limnerium ephestiae** (Ashmead)			472
*Mesostenus gracilis** Cresson			472
*Trathala flavoorbitalis** Cameron			471
Venturia canescens (Gravenhorst)		*A023*	471

DX01 Gauld, I.D.
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DX02 Perkins, J.R.
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Taxon	Common Name	Reference	Page
Pteromalidae*	pteromalids	*A023 AQ02 DH01 DY01*	450, 460
*Anisopteromalus**			463
Anisopteromalus calandrae (Howard)		*A023*	
*Caenacis**		*DY01*	464
*Cerocephala aquila** (Girault)			463
*Cerocephala cornigera** Westwood		*DY01*	463
*Cerocephala rufa** (Walker)		*DY01*	463
*Choetospila elegans** Westwood		*A023 DY01*	330, 462
*Dibrachys**		*DY01*	463
Dibrachys cavus (Walker)		*A023*	464
*Dimachus**		*DY01*	
Dinarmus laticeps (Ashmead)		*A023*	
*Lariophagus**		*DY01*	465
*Meraporus requisitus** Tucker			463
*Norbanus**		*DY01*	464
*Pteromalus** [*Habrocytus*]		*DY01*	465
Pteromalus cerealellae (Ashmead)		*A023*	
*Ptinobius**			462
*Spalangia**		*DY01*	461

Taxon	Common Name	Reference	Page
*Theocolax formiciformis** Westwood		*DY01*	462
Tritneptis [*Systellogaster*] *ovivora** (Gahan)			463, 464
*Zatropis**			463

DY01 Graham, M.W.R. de V.
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Taxon	Common Name	Reference	Page
Trichogrammatidae*	**trichogrammatid wasps**	*A023 AQ02 DH01*	415, 457
*Trichogramma**		*DZ01*	457
Trichogramma evanescens Westwood			

DZ01 Doutt, R.L., and G. Viggiani.
1968. The classification of the Trichogrammatidae (Hymenoptera: Chalcidoidea). Proc. California Acad. Sci. 35(20)477-586.

Taxon	Common Name	Reference	Page
Vespidae	vespid wasps	*AQ02 AQ19*	
Dolichovespula [*Vespula*] *arenaria* (Fabricius)	**aerial yellowjacket**	*AQ05 AQ19 EA01 EA02*	
Polistes annularis (L.)	large paper wasp	*AQ19 EA02*	
Polistes apachus Saussure		*EA02*	
Polistes exclamans Viereck	zebra paper wasp	*AQ19 EA02*	
Vespula [*Paravespula*] *germanica* (Fabricius)	**German yellowjacket**	*AQ05 EA01 EA02*	
Vespula maculifrons (Buysson)	**eastern yellowjacket**	*AQ05 AQ19 EA01 EA02*	
Vespula pensylvanica (Saussure)	**western yellowjacket**	*AQ05 AQ19 EA01 EA02*	
Vespula vulgaris (L.)	common yellowjacket	*AQ05 AQ19 EA01 EA02*	

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1977. The social wasps of Georgia: Hornets, yellowjackets, and polistine paper wasps. Univ. Ga. Res. Bull. 207. Athens.

Taxon	Common Name	Reference	Page
Collembola*	**springtails**	*AQ02 AQ19 EB01-EB12*	323, 351

EB01 Christiansen, K., and P. Bellinger.
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EB02 Fjellberg, A.
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EB03 Lubbock, J.
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EB05 Maynard, E.A.
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1941. The collembolan fauna of New Zealand, including a discussion of its distribution and affinities. Trans. Proc. Roy. Soc. New Zealand 70(4)282-431, pl. 39-72.
EB08 Salmon, J.T.
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EB09 Salmon, J.T.
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EB10 Scott, H.G.
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EB11 Scott, H.G., J.S. Wiseman, and C.J. Stojanovich.
1962. Collembola infesting man. Ann. Ent. Soc. America 55(4)428-430.
EB12 Snider, R.J.
1967. Annotated list of Collembola of Michigan. Michigan Ent. 1:179-234.

Taxon	Common Name	Reference	Page
Entomobryidae*	entomobryid springtails	*EB01 EB02 EB04 EC01*	
*Entomobrya atrocincta** Schött		*EB01 EB05 EB11*	358
*Entomobrya griseoolivata** (Packard)		*EB01 EB06 EB11 EB12*	358
*Entomobrya nivalis** (L.)		*EB01 EB02 EB05 EB07 EB11 EB12 EC01*	358
*Entomobrya [Entomobryoides] purpurascens** (Packard)		*EB01 EB05 EB06*	358
*Heteromurus [Alloscopus, Ptenura, Verhoeffiela]**		*EB01 EB02 EB05 EB10*	357
*Lepidocyrtinus domesticus** (Nicolet)			359
*Lepidocyrtus curvicollis** Bourlet		*EB01-EB03 EB05 EB11*	360
Lepidocyrtus cyaneus Tullberg	silvery springtail	*EB01 EB07 EB12*	359
*Orchesella albosa** Guthrie		*EB01 EB06 EB11 EB12*	357

Taxon	Common Name	Reference	Page
*Pseudosinella**		*EB01 EB02 EB04 EB05 EB12*	360
Seira [*Sira, Willowsia*] *buski** (Lubbock)	damp grain springtail	*EB01-EB03 EB05 EB11 EB12*	359
*Seira platani** (Nicolet) [*Willowsia nigromaculata* (Lubbock)]		*EB02 EB05 EB06 EB11 EB12*	359

EC01 South, A.
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Taxon	Common Name	Reference	Page
Isotomidae*	isotomid springtails	*EB01 EB02 EB04 EB08 EB10*	356
Cryptopygus [*Isotoma*] *thermophilus* (Axelson)		*EB01 ED02*	
*Folsomia quadrioculata** (Tullberg)		*EB01 EB02 EB05-EB07 EB12 ED01*	361
Isotomodes [*Dagamaea*] *tenuis** (Folsom)		*EB01 EB06*	361
*Proisotoma frisoni** (Folsom)		*EB01 EB11 ED02*	360
Proisotoma tenella (Reuter) [*Isotoma simplex* Folsom]		*EB01 ED02*	

ED01 Scott, H.G.
1961. The Collembola of New Mexico. V. Isotominae: *Anurophorus, Isotomodes, Folsomia.* Ent. News 72(10)261-267.
ED02 Scott, H.G.
1962. The Collembola of New Mexico. VI. Isotominae: *Guthriella, Proisotoma, Isotomurus.* Ent. News 73(1)17-23.

Taxon	Common Name	Reference	Page
Hypogastruridae*	hypogastrurid springtails	*EB01 EB08*	354
Hypogastrura [*Achorutes*] *armata** (Nicolet)	gray springtail	*EB02 EB05-EB07 EB11 EB12*	355
*Hypogastrura manubrialis** (Tullberg)		*EB01 EB02 EB05 EB07 EB11*	355
Hypogastrura pseudarmata (Folsom)		*EB05 EB11*	355
Onychiuridae*	onychiurid springtails	*EB01 EB02 EB04 EB08 EB10 EF01*	354
*Onychiurus armatus** (Tullberg)		*EB01 EB02 EB05-EB07 EB11*	355
*Onychiurus fimetarius** (L.)		*EB05 EB07 EB11*	355

EF01 Salmon, J.T.
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Taxon	Common Name	Reference	Page
Poduridae*	podurid springtails	*EB01 EB02 EB06 EB07*	353
*Podura aquatica** L.		*EB01 EB02 EB05 EB06 EB08 EB10 EB12*	353
Tomoceridae*	tomocerid springtails	*EB08 EB10*	356
*Tomocerus**		*EB01 EB02 EB05 EB06 EB10 EB12 EH01*	356

EH01 Scott, H.G.
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Taxon	Common Name	Reference	Page
Thysanura*	silverfish	*AQ02 AQ05 AQ07 AQ14 AQ19 EI01*	322, 334, 363, 364

EI01 Delany, M.J.
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Taxon	Common Name	Reference	Page
Lepismatidae*	silverfish	*EI01 EJ03*	364-366,
*Acrotelsa collaris** (Fabricius)		*EJ03*	364, 365
*Ctenolepisma lineata pilifera** (Lucas) [*C. quadriseriata* (Packard)]	fourlined silverfish	*AQ14 EJ01 EJ03*	365-368
Ctenolepisma longicaudata Escherich [*C. urbana* Slabaugh]	gray silverfish	*AQ14 EJ01 EJ03*	364-368
*Ctenolepisma villosa** (Fabricius)			368
*Lepisma saccharina** L.	common silverfish	*AQ14 EI01 EJ01 EJ03*	364, 365, 367
*Namunukulina funambuli** Wygodzinsky		*EJ02*	367
*Peliolepisma calva** Ritter		*EJ03*	367
*Thermobia aegyptiaca** (Lucas)		*EJ03*	369
*Thermobia campbelli** (Barnhart)		*EJ03*	369
*Thermobia domestica** (Packard)	**firebrat**	*AQ14 EI01 EJ01 EJ03*	364, 366, 368, 369

EJ01 Slabaugh, R.E.
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EJ02 Wygodzinsky, P.
1957. Notes and descriptions of Machilidae and Lepismatidae (Thysanura). Proc. Roy. Ent. Soc. London 26B(5-6)89-98.
EJ03 Wygodzinsky, P.
1972. A review of the silverfish (Lepismatidae, Thysanura) of the United States and the Caribbean area. American Mus. Novitates 2481:1-26.

Taxon	Common Name	Reference	Page
Nicoletiidae*	nicoletiid silverfish	*EK01*	364, 365
*Nicoletia phytophila** Gervais [*N. meinerti* Silvestri]		*EK01*	364, 365

EK01 Wygodzinsky, P.
1980. A survey of the Nicoletiinae of Europe (Nicoletiidae, Thysanura, Insecta). American Mus. Novitates 2695:1-24.

Taxon	Common Name	Reference	Page
Psocoptera*	**psocids**	*AQ02 EL01-EL05*	324, 371, 372

EL01 New, T.R.
1974. Psocoptera. Handb. Ident. British Insects 1(7)1-102.
EL02 New, T.R.
1977. Psocoptera of the Oriental Region: A review of published taxonomic information with keys to families and genera. Oriental Insects, suppl. 6:1-83.
EL03 Smithers, C.N.
1969. The Psocoptera of New Zealand. Rec. Canterbury Mus. 8(4)259-344.
EL04 Thornton, I.W.B., S.S. Lee, and W.D. Chui.
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EL05 Turner, B.D.
1975. The Psocoptera of Jamaica. Trans. Roy. Ent. Soc. London 126(4)533-609.

Taxon	Common Name	Reference	Page
Psocomorpha* (suborder)	psocomorph psocids	*EL01-EL03*	374
Ectopsocidae*	ectopsocids	*EL01 EL02 EL04*	395, 396
*Ectopsocopsis cryptomeriae** (Enderlein)			372, 398
*Ectopsocus briggsi** McLachlan		*EL01 EL03 EL04 EM01*	399
*Ectopsocus maindroni** Badonnel		*EL01 EL04*	401
*Ectopsocus pumilis** Banks		*EM01*	372, 401
*Ectopsocus richardsi** (Pearman)		*EL01 EM01*	399
*Ectopsocus vachoni** Badonnel		*EL01*	400

EM01 Broadhead, E., and A.M. Richards.
1980. The Peripsocidae and Psocidae (Psocoptera) of East Africa. System. Ent. 5(4)357-397.

Taxon	Common Name	Reference	Page
Hemipsocidae*	hemipsocids	*EL02 EL04*	396
*Hemipsocus africanus** Enderlein			396
Lachesillidae*	lachesillids	*EL01 EL02 EL04 EL05*	395, 396

Taxon	Common Name	Reference	Page
*Lachesilla nubilis** (Aaron)		*EN01*	397
*Lachesilla pedicularia** (L.)	**cosmopolitan grain psocid**	*EL01 EL04 EN01*	395, 397
*Lachesilla rena** Sommerman		*EN01*	397

EN01 Sommerman, K.M.
1946. A revision of the genus *Lachesilla* north of Mexico (Corrodentia: Caeciliidae). Ann. Ent. Soc. America 39(4)627-661.

Taxon	Common Name	Reference	Page
Troctomorpha* (suborder)	troctomorph psocids	*EL01-EL03*	374, 383
Liposcelidae*	liposcelids	*EL01-EL03*	374
*Belaphotroctes ghesquierei** Badonnel			386
*Belaphotroctes simulans** Badonnel			386
*Embidopsocus minor** Pearman			386
*Embidopsocus oleaginus** (Hagen)			386
*Liposcelis albothoracicus** Broadhead		*EL01*	388
*Liposcelis bostrychophilus** Badonnel		*EL01 EP01*	372, 394
*Liposcelis bouilloni** Badonnel			389
*Liposcelis corrodens** Heymons	**booklouse**		372, 393
*Liposcelis entomophilus** (Enderlein)		*EL01 EP01*	388
*Liposcelis exiguus varians** Badonnel		*EP01*	391
*Liposcelis kidderi** (Hagen)			372, 390
*Liposcelis liparus** Broadhead		*EL01 EP01*	387
*Liposcelis mendax** Pearman		*EL01 EP01*	391, 392
*Liposcelis minutus** Badonnel			394
*Liposcelis obscurus** Broadhead		*EL01*	392
*Liposcelis paetulus** Broadhead		*EL01 EP01*	392
*Liposcelis paetus** Pearman		*EL01 EP01*	392
*Liposcelis pubescens** Broadhead		*EL01 EP01*	391
*Liposcelis rufus** Broadhead		*EL01 EP01*	390
*Liposcelis simulans** Broadhead		*EL01 EP01*	372, 390
*Liposcelis decolor** Pearman		*EL01 EP01*	390
*Liposcelis transvaalensis** (Enderlein)		*EP01*	388

EP01 Broadhead, E.
1950. A revision of the genus *Liposcelis* Motschulsky with notes on the position of this genus in the order Corrodentia and on the variability of ten *Liposcelis* species. Trans. Roy. Ent. Soc. London 101(10)335-388, 3 pl.

Taxon	Common Name	Reference	Page
Pachytroctidae*	pachytroctids	*EL01 EL02 EL04*	384
*Nanopsocus oceanicus** Pearman			372, 384
Sphaeropsocidae*	sphaeropsocids	*EL01*	384
*Badonnelia titei** Pearman		*EL01*	384
Trogiomorpha* (suborder)	trogiomorph psocids	*EL01-EL03*	373, 374
Lepidopsocidae*	lepidopsocids	*EL01-EL04*	377
*Lepolepis bicolor** Broadhead		*EL01*	378
*Soa flaviterminata** Enderlein		*EL01*	378
Psoquillidae*	psoquillids	*EL01-EL04*	378
*Psoquilla marginepunctata** (Hagen)		*EL01*	379
*Rhyopsocus bentonae** Sommerman			380
*Rhyopsocus disparilis** Pearman		*EL01*	380
*Rhyopsocus peregrinus** (Pearman)		*EL01*	379
Psyllipsocidae*	psyllipsocids	*EL01-EL04*	374
*Dorypteryx domestica** (Smithers)			376
*Dorypteryx pallida** Aaron			375
*Psocatropos microps** (Enderlein)		*EL05*	372, 376
*Psocatropos pilipennis** Enderlein			376
*Psyllipsocus ramburi** Sélys-Longchamps		*EL01 EL03 EL04*	375
Trogiidae*	**trogiids**	*EL01-EL03*	378
Cerobasis [*Myopsocnema*] *annulata** (Enderlein)			383
*Lepinotus inquilinus** Heyden		*EL01 EL03*	382
*Lepinotus patruelis** Pearman		*EL01 EL03*	382
*Lepinotus reticulatus** Enderlein	**reticulatewinged trogiid**	*EL01 EL03*	381
*Trogium pulsatorium** (L.)	**larger pale trogiid**	*EL01 EL03*	383
Thysanoptera*	**thrips**	*AQ02 EQ01-EQ03*	325, 329, 403

EQ01 Bailey, S.F.
1957. The thrips of California. Part 1. Suborder Terebrantia. Bull. California Insect Survey 4(5)143-220.
EQ02 Mound, L.A., G.D. Morison, B.R. Pitkin, and J.M. Palmer.
1976. Thysanoptera. Handb. Indent. British Insects 1(11)1-79.
EQ03 Stannard, L.J.
1968. The thrips, or Thysanoptera, of Illinois. Illinois Nat. Hist. Survey Bull. 29(4)215-552.

Taxon	Common Name	Reference	Page
Terebrantia* (suborder)		*AQ02 EQ01-EQ03*	404
Aeolothripidae*		*AQ02 EQ01-EQ03*	405
Aeolothrips		*EQ01 EQ03*	
*Rhipidothrips brunneus** Williams		*EQ01 EQ02*	405
*Rhipidothrips gratiosus** Uzel		*EQ01 EQ02*	657
Thripidae*		*EQ01-EQ03 ER02 ER03*	405
Panchaetothripinae [Heliothripinae]			408
*Caliothrips [Heliothrips] fasciatus** (Pergande)	**bean thrips**	*EQ01 EQ03 ER01 ER02 ER05*	408
*Heliothrips haemorrhoidalis** (Bouché)	**greenhouse thrips**	*EQ01-EQ03 ER01 ER02 ER03 ER05*	408
*Hercinothrips [Heliothrips] femoralis** (O.M. Reuter)	**banded greenhouse thrips**	*EQ01-EQ03 ER01-ER03 ER05*	409
*Selenothrips rubrocinctus** (Giard)	**redbanded thrips**	*ER01 ER02 ER05*	409
Thripinae*			408
*Anaphothrips obscurus** (Müller)	**grass thrips**	*EQ01-EQ03 ER01 ER03*	406
*Chirothrips aculeatus** Bagnall		*EQ01 EQ02 ER06*	411
Chirothrips manicatus Haliday	timothy thrips	*EQ01-EQ03 ER03 ER06*	
*Chirothrips mexicanus** Crawford		*EQ01 EQ03 ER01 ER02 ER06*	411
*Frankliniella**		*EQ01 EQ03 ER01 ER02 ER04*	409
Frankliniella fusca (Hinds)	**tobacco thrips**	*EQ03 ER02*	
*Frankliniella minuta** (Moulton)		*EQ01 ER01 ER04*	409
Frankliniella occidentalis (Pergande)	**western flower thrips**	*EQ01 ER01 ER03*	
Frankliniella tritici (Fitch)	**flower thrips**	*EQ03 ER02*	
Frankliniella williamsi Hood		*ER01 ER02*	
*Limothrips angulicornis** Jablonowski		*EQ01 EQ03 ER01*	412
*Limothrips cerealium** (Haliday)	**grain thrips**	*EQ01-EQ03 ER01-ER03*	412
*Scirtothrips [Euthrips] citri** (Moulton)	citrus thrips	*EQ01 ER01*	413

Taxon	Common Name	Reference	Page
*Thrips hawaiiensis** (Morgan)	**Hawaiian flower thrips**	*ER01 ER03*	407, 413
*Thrips tabaci** Lindeman	**onion thrips**	*EQ01-EQ03 ER01-ER03*	407

ER01 Kono, T., and C.S. Papp.
1977. Handbook of agricultural pests. Department of Food and Agriculture, Sacramento.

ER02 Medina Gaud, S.
1961. The Thysanoptera of Puerto Rico. Univ. Puerto Rico Agr. Expt. Sta. Tech. Paper 32:1-160.

ER03 Mound, L.A., and A.K. Walker.
1982. Terebrantia (Insecta: Thysanoptera). Fauna of New Zealand 1:1-113.

ER04 Sakimura, K., and K. O'Neill.
1979. *Frankliniella*, redefinition of genus and revision of *minuta* group species (Thysanoptera: Thripidae). U.S. Dept. Agr. Tech. Bull. 1572:1-49.

ER05 Wilson, T.H.
1975. A monograph of the subfamily Panchaetothripinae (Thysanoptera: Thripidae). Mem. American Ent. Inst. 23:1-354.

ER06 Zur Strassen, R.
1960. Key to and catalogue of the known species of *Chirothrips* Haliday, 1836 (Thysanoptera: Thripidae). J. Ent. Soc. South Africa 23(1)144-176.

Taxon	Common Name	Reference	Page
Tubulifera* (suborder)		*AQ02 EQ02 EQ03 ER02*	404
Phlaeothripidae*		*EQ02 EQ03 ER02*	404
*Gynaikothrips ficorum** (Marchal)	**Cuban laurel thrips**	*EQ02 ER01 ER02*	413
*Haplothrips gowdeyi** (Franklin)	**black flower thrips**	*ER01 ER02*	414
*Haplothrips mali** (Fitch)	**black hunter thrips**	*EQ03 ER01*	414
Homoptera*	aphids, scales, and others	*AQ02*	326, 329, 415, 421, 422
Aphididae*	**aphids**	*AQ02*	326, 329, 415
Acyrthosiphon scariolae (Nevski) [*Macrosiphum barri* Essig]		*ET02*	
*Aphis fabae** Scopoli	**bean aphid**	*ET02*	417
*Brevicoryne brassicae** (L.)	**cabbage aphid**	*ET02 ET03*	417
Lipaphis [Hyadaphis] *erysimi* (Kaltenbach) [*Rhopalosiphum pseudobrassicae* (Davis)]	**turnip aphid**	*ET02 ET03*	
Macrosiphum dactynotus (Thomas) [*M. ambrosiae* (Thomas)]	ambrosia aphid	*ET02 ET03*	
Macrosiphum euphorbiae (Thomas) [*M. solanifolii* (Ashmead)]	**potato aphid**	*ET02*	

Taxon	Common Name	Reference	Page
*Myzus persicae** (Sulzer)	**green peach aphid**	*ET01-ET03*	329, 418
*Phorodon humuli** (Schrank)	**hop aphid**	*ET02*	418

ET01 Mason, P.W.
1940. A revision of the North American aphids of the genus *Myzus*. U.S. Dept. Agr. Misc. Publ. 371:1-30.
ET02 Palmer, M.A.
1952. Aphids of the Rocky Mountain Region. Thomas Say Foundation, [Entomological Society of America, College Park].
ET03 Smith, C.F., L.F. Martorell, M.E. Perez E.
1963. Aphididae of Puerto Rico. Univ. Puerto Rico Agr. Expt. Sta. Tech. Paper 37:1-121.

Taxon	Common Name	Reference	Page
Coccoidea*	scale insects	*AQ02 EU01*	326, 327, 421, 422

EU01 Howell, J.O., and M.L. Williams.
1976. An annotated key to the families of scale insects (Homoptera: Coccoidea) of America, north of Mexico, based on characteristics of the adult female. Ann. Ent. Soc. America 69(2)181-189.

Taxon	Common Name	Reference	Page
Asterolecaniidae*	**pit scales**	*AQ02 EU01 EV01*	424, 439

EV01 Russell, L.M.
1941. A classification of the scale insect genus *Asterolecanium.* U.S. Dept. Agr. Misc. Publ. 424:1-322.

Taxon	Common Name	Reference	Page
Coccidae*	**soft scales**	*AQ02 EU01*	422, 425, 429, 440, 441
Coccus hesperidum L.	**brown soft scale**	*EW01*	425, 429, 441
*Saissetia coffeae** (Walker)	**hemispherical scale**	*EW01*	425, 440

EW01 Williams, M.L., and M. Kosztarab.
1972. Morphology and systematics of the Coccidae of Virginia with notes on their biology (Homoptera: Coccoidea). Virginia Polytechnic Institute and State University, Blacksburg.

Taxon	Common Name	Reference	Page
Dactylopiidae	**dactylopiid scales**	*AQ02 EU01*	422
Dactylopius coccus Costa	**cochineal insect**		
Diaspididae*	**armored scales**	*AQ02 EU01*	422
*Aonidiella aurantii** (Maskell)	**California red scale**		424, 435
*Aonidiella citrina** (Coquillett)	**yellow scale**		424, 435

Taxon	Common Name	Reference	Page
*Aspidiotus nerii** Bouché	**oleander scale**		424, 437
*Chrysomphalus aonidum** (L.)	**Florida red scale**		424, 437
*Hemiberlesia lataniae** (Signoret)	**latania scale**		424, 437
*Lepidosaphes beckii** (Newman)	**purple scale**		423, 434
*Lepidosaphes gloveri** (Packard)	**Glover scale**		423, 433
*Parlatoria pergandii** Comstock	**chaff scale**		424, 436
*Pinnaspis aspidistrae** (Signoret)	**fern scale**		423, 432
*Pinnaspis strachani** (Cooley)	lesser snow scale		423, 432
*Pseudaulacaspis pentagona** (Targioni-Tozzetti)	**white peach scale**		424, 436
*Quadraspidiotus perniciosus** (Comstock)	**San Jose scale**		423, 434
*Unaspis citri** (Comstock)	**citrus snow scale**		423, 433
Eriococcidae*	**eriococcid scales**	*AQ02 EU01*	425, 442
Margarodidae*	**margarodid scales**	*AQ02 EU01*	423, 431
Ortheziidae*	**ensign scales**	*AQ02 EU01 EY01*	422, 430

EY01 Morrison, H.
1952. Classification of the Ortheziidae. U.S. Dept. Agr. Tech. Bull. 1052:1-80

Taxon	Common Name	Reference	Page
*Pseudococcidae	**mealybugs**	*AQ02 EU01*	422, 425-427, 443-448
*Dysmicoccus brevipes** (Cockerell)	**pineapple mealybug**		426, 447
*Dysmicoccus neobrevipes** Beardsley	**gray pineapple mealybug**		426, 448
*Nipaecoccus nipae** (Maskell)	**coconut mealybug**		425, 446
*Planococcus citri** (Risso)	**citrus mealybug**		425, 443
*Pseudococcus longispinus** (Targioni-Tozzetti)	**longtailed mealybug**		425, 427, 444
*Pseudococcus maritimus** (Ehrhorn)	**grape mealybug**		425, 445
Hemiptera*	**true bugs**	*AQ02 FC01-FC03*	326, 329

FC01 China, W.E., and N.C.E. Miller.
1959. Check-list and keys to the families and subfamilies of the Hemiptera-Heteroptera. Bull. British Mus. (Nat. Hist.) Ent. 8(1)1-45.

FC02 Slater, J.A., and R.M. Baranowski.
1978. How to know the true bugs (Hemiptera-Heteroptera). Brown, Dubuque.

FC03 Southwood, T.R.E., and D. Leston.
1959. Land and water bugs of the British Isles. Warne, London.

Taxon	Common Name	Reference	Page
Anthocoridae [Cimicidae]	**flower bugs, minute pirate bugs**	*AQ02 FC01-FC03*	
Lyctocoris campestris (Fabricius)		*FC02 FC03 FD02*	
Xylocoris flavipes (Reuter)	**warehouse pirate bug**	*FC03 FD01*	
Xylocoris galactinus (Fieber)		*FC03 FD02*	

FD01 Arbogast, R.T., M. Carthon, and J.R. Roberts, Jr.
1971. Developmental stages of *Xylocoris flavipes* (Hemiptera: Anthocoridae), a predator of stored-product insects. Ann. Ent. Soc. America 64(5)1131-1134.

FD02 Blatchley, W.S.
1926. Heteroptera or true bugs of eastern North America, with special reference to the faunas of Indiana and Florida. Nature, Indianapolis.

Taxon	Common Name	Reference	Page
Joppeicidae	joppeicids	*A023 FC01*	
Joppeicus paradoxus Puton		*A023 FE01*	

FE01 Davis, N.T., and R.L. Usinger.
1970. The biology and relationships of the Joppeicidae. Ann. Ent. Soc. America 63(2)577-587.

Taxon	Common Name	Reference	Page
Lygaeidae	**seed bugs, lygaeid bugs**	*AQ02 FC01 FC03*	
Elasmolomus [*Aphanus*] *sordidus* (Fabricius)			
Miridae	**plant bugs**	*AQ02 FC01-FC03*	
*Lygus lineolaris** (Palisot de Beauvois)	**tarnished plant bug**	*FC02 FG01*	328

FG01 Kelton, L.A.
1980. The plant bugs of the Prairie Provinces of Canada. Heteroptera: Miridae. Insects Arachnids Canada 8:1-408.

Taxon	Common Name	Reference	Page
Reduviidae	**assassin bugs**	*A023 AQ02 FC01-FC03*	
Amphibolus venator (Klug)		*A023 FH01*	
Coranus aegyptius (Fabricius)		*A023 FH02*	
Peregrinator [*Allaeocranum*] *biannulipes* (Montrouzier)		*FH03*	
Reduvius personatus (L.)	**masked hunter**	*FC02 FC03 FH04*	

FH01 Dispons, P.
1951. Révision du genre *Amphibolus* Klug (Hem. Reduviidae) en Afrique du Nord. Bull. Soc. Ent. France 56(5)71-73.

FH02 Dispons, P., and W. Stichel.
1959. Familia Reduviidae Latreille (Hemiptera-Heteroptera). Illustrierte Bestimmungstabellen der Wanzen II. Europa 3:81-96.

FH03 Distant, W.L.
1904. Rhynchota. II (Heteroptera). *In* The Fauna of British India, including Ceylon and Burma. Taylor and Francis, London.

FH04 Wygodzinsky, P., and R.L. Usinger.
1964. The genus *Reduvius* Fabricius in western North America (Reduviidae, Hemiptera, Insecta). American Mus. Novitates 2175:1-15.

Taxon	Common Name	Reference	Page
Orthoptera*	orthopterans	*AQ02 AS04*	325, 331, 671
Gryllacrididae	**cave crickets, camel crickets**	*AS04*	
Pristoceuthophilus [*Ceuthophilus*] *pacificus* (Thomas)	mushroom camel cricket	*AS04*	
Dermaptera*	**earwigs**	*AQ02 AS04 FK01 FK02*	323, 331

FK01 Hincks, W.D.
1956. Dermaptera and Orthoptera. Handb. Ident. British Insects 1(5)1-21.

FK02 Langston, R.L., and J.A. Powell.
1975. The earwigs of California (order Dermaptera). Bull. California Insect Surv. 20:1-25.

Taxon	Common Name	Reference	Page
Carcinophoridae (including Labiduridae in part)	ringlegged earwigs	*AQ02*	
Euborellia [*Anisolabis*] *annulipes* (Lucas)	**ringlegged earwig**	*AS04 FK01 FK02*	
Chelisochidae	**black earwigs**	*AQ02 FK01*	
Chelisoches flavipennis (Fabricius)			
Forficulidae	European earwigs	*AQ02 FK01*	
Forficula auricularia L.	**European earwig**	*FK01 FK02*	
Labiduridae	**striped earwigs**	*AQ02 FK01*	
Labidura riparia (Pallas)	**shore earwig**	*FK01*	
Labiidae	**little earwigs**	*AQ02 FK01*	
Marava [*Prolabia*] *arachidis* (Yersin)	chief earwig	*AS04 FK01 FK02*	
Isoptera*	**termites**	*AQ02 AS04*	325, 330
Araneae* [Araneida]	**spiders**	*AQ02*	4, 321
Opiliones* [Phalangida]	**daddylonglegs, harvestmen**	*AQ02 FQ01 FQ02*	320

FQ01 Sankey, J.H.P., and T.H. Savory.
1974. British harvestmen. Arachnida: Opiliones. Keys and notes for the identification of the species. Synopses British Fauna (n.s.) 4:1-76.

FQ02 Todd, V.
1948. Key to the determination of the British harvestmen (Arachnida, Opiliones). Ent. Monthly Mag. 84(1008)109-113.

Taxon	Common Name	Reference	Page
Leiobunidae	leiobunids		
Leiobunum blackwallii (Meade)		*FQ01 FQ02*	
Leiobunum rotundum (Latreille)		*FQ01 FQ02*	
Phalangiidae	phalangiids		
Platybunus triangularis (Herbst)		*FQ01 FQ02*	
Pseudoscorpiones* [Chelonithida]	**pseudoscorpions**	*AQ02 FT01-FT04*	321

FT01 Beier, M.
1932. Cheliferinea. Pseudoscorpionidea II. Das Tierreich 58:i-xxi, 1-294.

FT02 Hoff, C.C.
1949. The pseudoscorpions of Illinois. Bull. Illinois Nat. Hist. Surv. 24(4)407-498.

FT03 Manley, G.V.
1969. A pictorial key and annotated list of Michigan pseudoscorpions (Arachnida: Pseudoscorpionida). Michigan Ent. 2(1-2)2-13.

FT04 Nelson, S., Jr.
1975. A systematic study of Michigan Pseudoscorpionida (Arachnida). American Midl. Nat. 93(2)257-301.

Taxon	Common Name	Reference	Page
Cheiridiidae	cheiridiids	*FT01*	
Cheiridium museorum (Leach)			
Cheliferidae	cheliferids	FT03	
*Chelifer cancroides** (L.)	house pseudoscorpion, book pseudoscorpion	*FT01-FT04*	321
Paisochelifer callus Beier		*FT02-FT04*	
Chernetidae	chernetids	*FT03*	
Lamprochernes minor Hoff		*FT02-FT04*	
Withiidae [Withiinae of Cheliferidae]	withiids		
Allowithius congicus Beier		*FT01*	
Allowithius kaestneri Vachon			
Withius piger (Simon) [*W. subruber* (Simon)]		*FT01*	
Isopoda	**pillbugs, sowbugs**	*AQ02 FW01 FW02*	

FW01 Edney, E.B.
1953. The woodlice of Great Britain and Ireland. A concise systematic monograph. Proc. Linn. Soc. London 164(1)49-98.
FW02 Sutton, S.
1972. Woodlice. Ginn, London.

Taxon	Common Name	Reference	Page
Armadillidiidae	armadillidiids		
Armadillidium vulgare (Latreille)	greenhouse pillbug	*FW01 FW02*	
Porcellionidae	porcellionids		
Porcellio laevis Latreille	dooryard sowbug	*FW01 FW02*	

Notes and Sketches

APPENDIX

U.S. DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE — PLANT SCIENCES INSTITUTE
SYSTEMATIC ENTOMOLOGY LABORATORY-TAXONOMIC SERVICES UNIT

IDENTIFICATION REQUEST

NOTE:
- Please *type or print* all information.
- Do not write in shaded areas.
- Give explanations where requested in "Remarks" section at bottom of form.
- Attach additional pages if (and only if) more space is needed.

TSU LOT NO.	TSU PRIORITY
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DATE IDENTIFICATION REQUIRED *(month, day, year)* If less than two months, explain below.	
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FS ☐	FS	**IN** ☐	Individual
DD ☐	U.S. Military	**CO** ☐	Commercial Organization
OF ☐	Other Federal	**FN** ☐	Non-U.S.
SA ☐	State Agricultural Agency	**CI** ☐	CICP

LEVEL/TYPE OF IDENTIFICATION NEEDED

☐ Family ☐ Genus ☐ Species

☐ Positive or negative verification of ecological group:

☐ phytophagous ☐ parasitic ☐ predaceous

☐ saprophagous ☐ aphidophagous ☐ other:

OTHER INFORMATION REQUESTED—Will be supplied as conditions allow, as determined by taxonomist. Note reasons information is needed.

SOURCE OF PROJECT SUPPORT

☐ ARS ☐ APHIS ☐ FS ☐ CSRS Regional project no:

☐ Hatch ☐ EPA ☐ DOI ☐ NIH ☐ NSF ☐ FAO

☐ USAID ☐ Other *(Specify)*

REASON FOR IDENTIFICATION *(Check and complete as appropriate)*

a Biological control
- **1** ☐ Scientific name of target pest:
- **2** ☐ General quarantine or biocontrol research
- **3** ☐ Identity of host of natural enemy
- **4** ☐ Recovery of released natural enemy
- **5** ☐ Suspected contaminant in culture
- **6** ☐ Quarantine reference collection
- **7** ☐ Voucher specimen of field release
- **8** ☐ Holding living material pending identification

b ☐ Damaging crop, plants—*identify host plants:*

c ☐ Suspected pest of regulatory concern—*give details below*

d ☐ Stored product pest—*commodity affected:*

e ☐ Livestock, wildlife, or domestic animal pest—*host:*

f ☐ Danger to human health

g ☐ Household pest—*damage:*

h ☐ Possible immigrant—*new to:*

i ☐ Reference collection—*for:*

j ☐ Survey—*explain in detail below*

k ☐ Thesis problem—*describe project below* ☐ M.S. ☐ Ph.D.

l ☐ Other—*explain below*

SPECIMENT DISPOSITION—See Instruction Sheet. If you wish specimens returned, please provide justification below. Duplicate specimens encouraged — see instruction sheet.
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DESCRIPTION OF PROJECT—Include Project Title and name of Project Leader. **(Reference previous communications pertaining to this submittal)**

REMARKS *(Explanations, tentative identification, etc.)*

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United States Department of Agriculture | Agricultural Research Service | Beltsville Area Plant Sciences Institute | Systematic Entomology Laboratory Beltsville, Maryland 20705

IDENTIFICATION REQUEST — INFORMATION/INSTRUCTIONS

The *Systematic Entomology Laboratory* (SEL) of the *Plant Sciences Institute* (PSI), is the primary U.S. Federal agency responsible for providing identifications and other taxonomic services for insects and related organisms. The *Taxonomic Services Unit* (TSU) is the unit within SEL that receives, sorts, and distributes the specimens and reports the identifications. We are pleased to be of assistance; however, it is appropriate that you determine if sources of identifications are available in your area or country *before submitting material.*

1. Use this form for submission of each *lot—not* for individual specimens. Retain Part III for your records. Send Part I *in advance* and Part II enclosed with your submittal (or send Parts I and II with your submittal) to:

   Taxonomic Services Unit, Systematic Entomology Laboratory
   Plant Sciences Institute
   Building 046, Room 101A, Beltsville Agricultural Research Center-West
   Agricultural Research Service, USDA
   Beltsville, Maryland 20705
   U.S.A.

2. Each specimen or collection of specimens, whether on a pin, in a vial, or on a slide, *must* be labeled with complete collection data — specific locality (country, state, or other political subdivision, and city or pertinent local landmark), date of collection, name of collector, family, genus, and species names of host *(if known)*, and voucher number *(if appropriate)*. Include duplicate data labels when submitting specimens in alcohol, in the event the taxonomist wishes to keep part of the material. Each specimen should have a brief, unique number to facilitate reporting of identifications. Specimen label data should be recorded in the event the specimens are kept for the U.S. National Museum. See reverse side for preparation of specimens. Please see our statement on parasitic Hymenoptera for information on our requirements on host data for parasitic wasps.

3. A brief description of your project will enable us to place the proper priority on your request. Early submittals, and submittals of small lots as studies progress, will ensure faster service. *Please*, do not wait until your project is complete to submit specimens for identification.

4. Lots relating to agricultural interests are given highest priority. Requests for information on hosts, distribution, identification characteristics, literature references, etc., are generally answered at the option of the taxonomists based on their evaluation of the request and time available. To provide the requested information the taxonomist often must spend considerable time and effort. Please request only the information that is critically needed.

5. Inquiries on the status of an identification request may be made by —
   Correspondence to Taxonomic Services Unit at the above address
   Telephone — Mary Lacey (301) 344-3041
   Telemail — MLACEY or PPQ.ARS.MLACEY; ASRR - MLACEY; BITNET - MLACEY@UMDARS

   Please refer to the TSU "lot" number when known.

6. In recent years the cost of returning specimens has become a major bugetary concern. With the current budget restraints, we ask that you help us keep costs to a minimum. Therefore, we would be grateful if you would retain duplicate specimens in your collection so that material we identify can be retained in the U.S. National Collection or discarded. If it is important that material be returned, please indicate your need and we will attempt to accommodate your request. Specimens that represent new species, new host records, or new distribution records may be retained at the discretion of the taxonomist for placement in the U.S. National Collection of Insects in the Smithsonian Institution. Approximately 25,000 specimens are added to the National Collection every year as a result of the SEL identification service. The opportunity to retain specimens of interest is one way in which our collaborators can be recompensed for their assistance.

7. Users of this service should appropriately cite the taxonomist who provided the identifications in their publications and reports. If the identifier cannot be given after the name of the taxon (*e.g.*, in tables or lists), a footnote or other means of acknowledgment should be used. Proper formatting, as appropriate, is as follows:
   Name of taxonomist, Systematic Entomology Laboratory, Agricultural Research Service, U.S. Department of Agriculture
   Name of taxonomist, Department of Entomology, Smithsonian Institution
   Cooperating entomologists at other institutions should be listed in similar format.

8. We would greatly appreciate your sending reprints of publications and other documents in which our identifications are used to the *TSU, SEL* at the above address and to the taxonomist(s) who provided the determination(s).

Form ARS-748A (9/88)

The insect and mite taxonomic service program of the Systematic Entomology Laboratory, with the aid of entomologists in the Smithsonian Institution and other cooperators, provides identifications of about one-third million specimens per year (about 30,000 scientific names, or 17,000 consignments or lots) for an extremely wide variety of users. Unfortunately, some specimens must be returned unidentified because the poor condition of a specimen may prevent its identification, the classification of a group may need or be undergoing revision, the quantity of material may be too large for us to accept, or the request may not be in line with our priorities. We also lack specialists or cooperators for some groups (*see list below*).

Immature stages are accepted for identification, but the classification of immature forms is so poorly known in many groups that even identification to family is not possible. For this reason we urge all collectors to *rear some of the specimens* and *submit adults with the associated immature stages.*

Preparation of Specimens Submitted for Identification. . .Because of a lack of sufficient technical assistance to prepare specimens for identification, we are including the following instructions to help you prepare specimens in a condition suitable for study.

PINNED—Most specimens should be pinned; those too small or fragile for direct pinning should be double mounted on minuten nadeln or carefully glued to paper points. Glue the point to the ***right side*** of the specimen, using care that the glue does not conceal critical characters. Do not glue tiny *moths* or *flies* to points; use minuten nadeln. Specimens should be pinned while fresh. *Moths* should be submitted with wings spread. Examination of properly prepared genitalia is necessary to identify many insects to genus or species level. Specific instructions for preparing genitalia will be supplied upon request. Puparia, pupal skins, cocoons, etc., should be placed in a gelatin capsule or glued to a card either separately or pinned below the adult.

SLIDE MOUNTS—Submit *mites, fleas, thrips, aphids, whiteflies, psychodid flies,* most *scales,* and *mosquito larvae* on microscope slides, if you can prepare good slides. This will enable us to identify the material more quickly. Some *trichogrammatid* and *mymarid wasps* and other minute insects must also be mounted on slides. Larval *ticks* are acceptable as slide mounts if they are not engorged. Specific instructions for slide-mounting the above groups will be supplied upon request.

ALCOHOL—Submit the following specimens in alcohol: *ichneumonid wasps, mayflies, bat flies,* all *soft-bodied insects* (including all *larvae* and *pupae*), and most *insects under 2 mm* in length, except as indicated below. Also, specimens in the groups listed under *Slide Mounts* should be preserved in 70% alcohol if not slide-mounted. Adult *whiteflies* may be submitted in alcohol, but identification of this stage usually is not possible. **Never** submit adults of the following in alcohol: *moths, bees, true bugs, psychodids and all other flies except minute Nematocera flies.* **Place Only One Kind of Insect in Each Vial.** Use neoprene-, rubber-, or silicone-stoppered vials rather than screw-capped or shell vials. Use clear glass vials of sufficient size to allow the use of forceps or an eye dropper to remove the specimens; however, if the vial is too large, very small specimens will be difficult to find. Do not use methanol or formalin solutions: use 70, 80, or 95% ethanol if possible. Isopropanol, the drugstore variety, is adequate only for temporary storage. To prevent dilution of the alcohol and subsequent decomposition of specimens, fresh alcohol must be placed in the vials within 24 hours after *initial immersion* of specimens. All vials containing soft-bodied insects should be shipped exclusive of all air bubbles. Insert a paperclip or pin with the stopper to eliminate all air bubbles; then remove the paperclip or pin.

PREPARATION of SPECIFIC FORMS—Kill *larvae* by placing them in boiling water or in an alcohol-glacial acetic acid mixture, then transfer them to 70% alcohol. *Ichneumonid wasps* and *mayflies* should be killed and preserved in 95% ethanol; *thrips* should be killed and preserved in AGA (9 parts 70% alcohol:1 part glycerine:1 part glacial acetic acid). Nymphal, adult, and engorged larval *ticks* should be preserved in 70-80% ethanol.

DRY, UNMOUNTED—If *whiteflies and diaspidid scales* are not mounted on slides, they should be submitted on host plants placed between pieces of dry paper towel, blotters, or other absorbent paper. Do not place specimens belonging to these families in plastic bags.

PILLBOXES—Pillboxes and matchboxes are **NOT** acceptable containers for submitting insects, but they may be used to submit associated plant samples, galls, or similar material. Soft tissue paper or cellucotton, *not cotton,* should be used in such boxes.

Identification Capability. . .Adults and immatures of all groups of insects and related arthropods are accepted for identification by SEL taxonomists, except those listed below. Groups marked by an asterisk are accepted but referred to cooperators outside the Institute. Identification of these is at the *discretion of the cooperator.* Groups *not marked* by an asterisk are usually returned unidentified. With appropriate justification, we may attempt to identify some of these groups or may provide names and addresses of other experts.

INSECT GROUPS

*Anoplura
Collembola
Diplura

COLEOPTERA[1]
Amphizoidae
Anthicidae
*Buprestidae
Carabidae
Cicindelidae
*Cleridae
Dryopidae
Dytiscidae
Elmidae
Georyssidae
Gyrinidae
Haliplidae
Hydraenidae
Hydrophilidae
Hydroscaphidae
Lagriidae
Limnichidae
Melandryidae
Mordellidae
Nitidulidae[2]
Noteridae
*Oedemeridae

*Ephemeroptera
*Mallophaga
*Mecoptera

Pedilidae
Psephenidae
Rhysodidae
Silphidae
Sphaeriidae
Staphylinidae[3]

DIPTERA
Acroceridae
Apioceridae
Asilidae
*Blephariceridae
Bombyliidae
*Camillidae
*Celyphidae
*Ceratopogonidae
Chironomidae
*Coelopidae
*Culicidae
*Curtonotidae
*Diastatidae
*Drosophilidae

*Neuroptera
*Odonata
*Plecoptera

*Dryomyzidae
Empididae
*Ephydridae
*Heleomyzidae
*Lauxaniidae
Mydidae
Nemestrinidae
*Ptychopteridae
Scenopinidae
*Tanyderidae
*Tipulidae
*Trichoceridae
*Trixoscelididae

Protura
*Psocoptera
*Siphonaptera

HEMIPTERA
*Tingidoidea

HOMOPTERA
Coccoidea
Psyllidae

LEPIDOPTERA (adults)
Bombycoidea
Copromorphoidea
*Cossoidea
*Eriocranioidea
*Hepialoidea

Thysanura
*Trichoptera

Hesperioidea
*Incurvarioidea
*Micropterygoidea
*Nepticuloidea
*Papilionoidea[4]
*Sesiidae
Sphingidae
*Tineioidea
Tortricoidea
Yponomeutoidea
Zygaenoidea

1 There are also several minor families for which no specialist is available.
2 USDA material will be accepted.
3 ARS Biological Control material will be accepted
4 True butterflies (Papilionoidea)—from outside North America only will be identified if (1) voucher specimens may be retained, (2) the specimens have been reared or parasitized, and (3) all specimens are fully labeled, including food plant data.

NON-INSECT GROUPS

*Araneida (spiders)
*Argasidae ("softbacked ticks")
Chelonethida (pseudoscorpions)
Chilopoda (centipedes)
Crustacea (includes sowbugs & pillbugs)
Diplopoda (millipedes)
Gastropoda (snails & slugs)
Hydrachnellae (water mites)
*Ixodidae ("hardbacked ticks")
*Oligochaeta (earthworms)
Pedipalpida ("whip scorpions")
*Phalangida ("daddy longlegs")
Scorpionida (scorpions)
Solpugida (solpugids)
Symphyla ("symphylans")

INDEX

A

B

C

D

E

F

G

H

I

J

K

L

M

N

O

P

Q

R

S

T

U

V

W

X

Y

Z