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

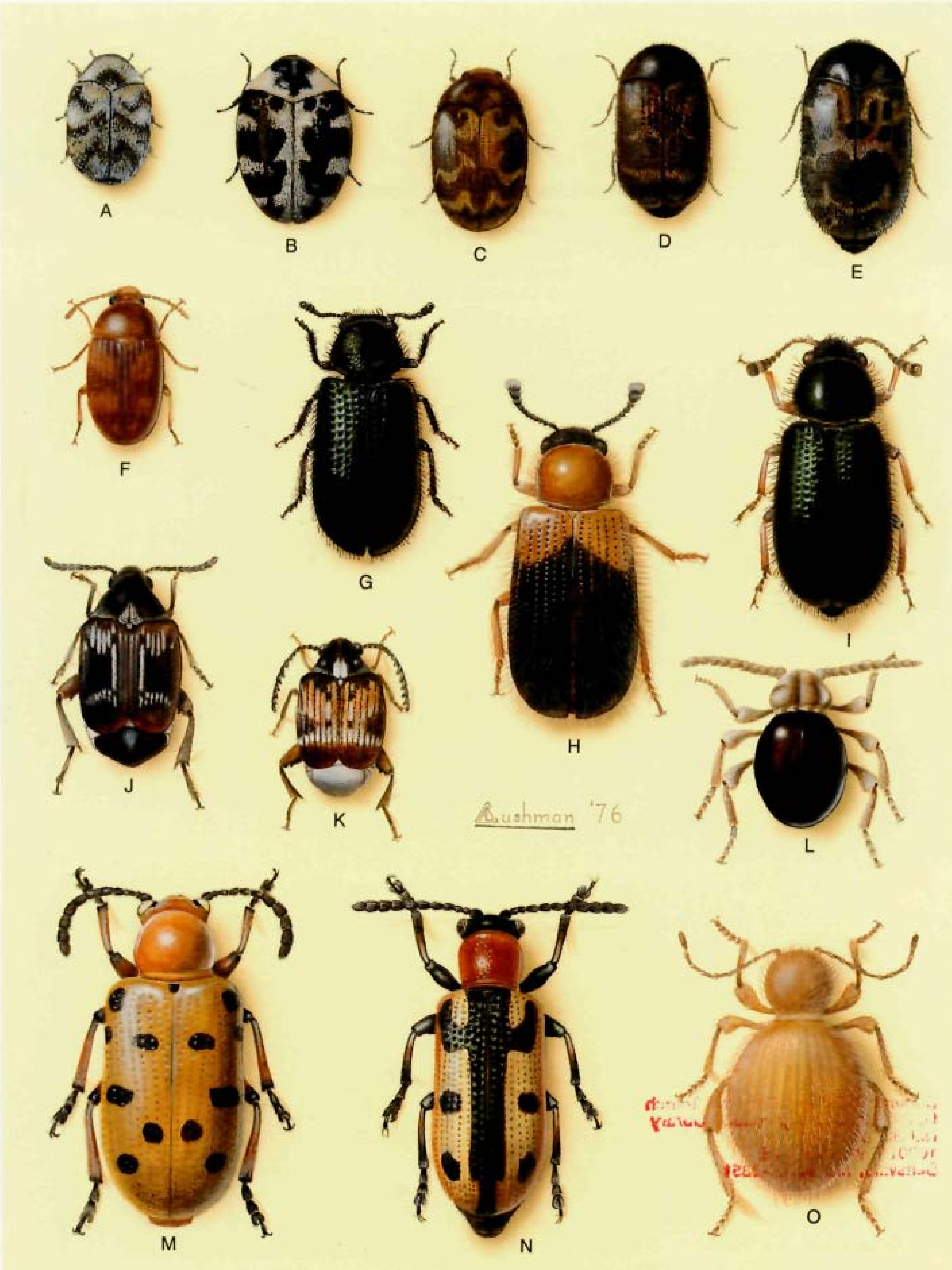
Insect and Mite Pests in Food

An Illustrated Key

Volume 1

003

Plate 1. Some beetles (Coleoptera) associated with the food industry (body lengths for each species are shown in millimeters in parentheses): A, **varied carpet beetle,** *Anthrenus verbasci* (1.7-3.2) (Dermestidae); B, **carpet beetle,** *Anthrenus scrophulariae* (2-3.8) (Dermestidae); C, **warehouse beetle,** *Trogoderma variabile* (2.7-3.5) (Dermestidae); D, larger cabinet beetle, *Trogoderma inclusum* (2.5-5) (Dermestidae); E, ornate cabinet beetle, *Trogoderma ornatum* (1.6-4) (Dermestidae); F, **twobanded fungus beetle,** *Alphitophagus bifasciatus* (2.2-3) (Tenebrionidae); G, blacklegged ham beetle, *Necrobia violacea* (4-4.5) (Cleridae); H, **redshouldered ham beetle,** *Necrobia ruficollis* (4-6) (Cleridae); I, **redlegged ham beetle,** *Necrobia rufipes* (3.5-7) (Cleridae); J, **cowpea weevil,** *Callosobruchus maculatus* (3-4.5) (Bruchidae); K, Chinese pea weevil, *Callosobruchus chinensis* (2.5-3.5) (Bruchidae); L, **American spider beetle,** *Mezium americanum* (1.5-3.5) (Ptinidae); M, **spotted asparagus beetle,** *Criocerus duodecimpunctata* (6-6.5) (Chrysomelidae); N, **asparagus beetle,** *Criocerus asparagi* (5.6-6.5) (Chrysomelidae); O, **golden spider beetle,** *Niptus hololeucus* (3-4.5) (Ptinidae).


A
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Dedication

This Handbook is
dedicated to
PROFESSOR MARION W. BOESEL
and to the memory of
PROFESSORS
DONALD J. BORROR
DWIGHT M. DELONG
C. CLAYTON HOFF
and
ROBERT A. HEFNER

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J. Richard Gorham
Editor

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Abstract

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The publication, presented in two volumes, is a comprehensive treatise on the occurrence and identification of food-contaminating arthropods (insects and their relatives). It provides the user a rapid and accurate means of identifying more than 600 species of pests encountered throughout the food industry. Diagnostic keys and useful illustrations of both adult and immature stages of these pests are presented. Volume 1, arranged phylogenetically, consists of part 1 and includes keys to the major anthropod pests of stored food. Volume 2, also arranged phylogenetically, consists of parts 2 and 3. It begins with a general key to arthropod classes and insects orders. Except for chapter 7 in volume 1 and chapter 25 in volume 2, all the keys in parts 1 and 2 are illustrated by drawings associated with key couplets. The keys in part 1 are illustrated by additional drawings in part 3 (ch. 27). The two volumes complement each other and should be used simultaneously to permit the user to see at the same time both the couplet drawings (vol. 1) and the plate illustrations (vol. 2). Thus, the user can see at the same time both the specific features described in the key couplet and the general habitus of the arthropod being studied.

KEYWORDS: arthropod, stored-food pests, food pests, food insects, moths, Lepidoptera, food industry, beetles, cockroaches, weevils, ants, silverfish, psocids, thrips, aphids, parasitic wasps, springtails, scale insects

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Foreword

Responsibility for assuring safe and nutritious food supplies for the American people is shared by the Departments of Agriculture and Health and Human Services. While prevention of problems is the ideal, much past effort has been expended upon corrective constraints against foods that never should have been allowed to become defective in the first place.

In keeping with the increasing emphasis on prevention, this timely publication *Insect and Mite Pests in Food: An Illustrated Key* is a fundamental technical document to assist scientists in achieving early detection and before-the-fact prevention, as well as after-the-fact correction, of certain defects in food.

CONTENTS

Volume 1

Volume 2

Preface

Although most users of this handbook will be able to use it effectively without any editorial explanations, a few comments concerning the organization might be helpful to some and at least of passing interest to others. All aspects of this project have been designed with the user in mind. Our objective was to make the handbook convenient to use.

Because of the sheer volume of the material to be included in the handbook, it is being published in two volumes, each of which is intended to complement the other. Volume 1 consists of part 1 (ch. 1-17) and includes keys to major arthropod pests of stored food. The arrangement of these chapters is essentially phylogenetic, beginning with the mites and ending with the ants.

Volume 2 consists of part 2 (ch. 18-26) and part 3 (ch. 27, 28, appendix, and the index). Part 2 is also arranged phylogenetically, beginning with a general key to arthropod classes and insect orders. Except for chapters 7 and 25, all the keys in parts 1 and 2 have drawings associated with the key couplets. The keys in part 1 are further illustrated by additional drawings in part 3 (ch. 27). Since the couplet illustrations for part 1 are in volume 1 and the plate illustrations in volume 2, the identifier will need to use both volumes simultaneously. This permits the user to see at the same time both the specific features described in the key couplet and the general habitus of the arthropod under consideration.

Plate 1 is the only exception to this arrangement. Since it is the frontispiece of volume 1 and since all the taxa illustrated therein are keyed out in volume 1, the user occasionally will need to turn back to the frontispiece when keying out certain beetles in chapters 3, 5-7, 11, and 12. Chapter 14 refers to the frontispiece (plate 2) of volume 2.

With a few exceptions, the plates are arranged according to the order of appearance of each taxon in the keys of part 1. In both the couplet illustrations and in the habitus drawings of the plates, the figures are oriented so that the anterior aspect of the drawing points either up or to the left. (In a few instances, the couplet illustrations are shown head-to-head or tail-to-tail to facilitate comparison of structures.) In deference to the tradition of lepidopterists, the drawings of moth genitalia (ch. 14) are oriented so that anterior points down. The tradition of coccoidologists has also been respected in that the key to scale insects (ch. 25) uses text figures rather than couplet illustrations.

Approximately 650 taxa are keyed out in the handbook. The major cosmopolitan pests are invariably included in their respective chapters. Accidental pests are not included, as well as most field crop pests, except for those that are commonly, if inadvertently, carried into processing or storage situations. These keys, from the most general to the most specific, deal with insects and mites associated with food, not with insects and mites in general.

The geographic scope of this handbook is basically worldwide, since all the major cosmopolitan pests are included. However, with regard to those pests that are not cosmopolitan, the various specialists have selected those geographic parameters that are consistent with their own knowledge of the arthropods involved. The bionomic notes given for most species inform the reader about host materials and geographic distribution.

With the combined help of the key couplets, the couplet illustrations, the bionomic notes in the couplets, and the habitus drawings, the identifier may arrive at a confident identification. If, however, after reaching this point, the user still has some doubt about the identity of a particular specimen, he or she has two options. One is to send the specimen to a specialist to identify (see the appendix for instructions).

The second option is to consult scientific literature. To help you do this I provided a list of taxonomic aids in chapter 28 for most of the taxa included in this handbook as well for many (approximately 400) that are not. This list also serves as a taxonomic index to the handbook, with the entries, including complete scientific names and common names (if any), arranged by order and family. (Throughout the handbook, the common names approved by the Entomological Society of America are shown in boldface type.) In addition, the scientific and common names are listed alphabetically in the general index. Occasionally, the complete scientific name (genus, species, author) is used in the text. Such taxa are mentioned for illustrative purposes only, as they have no relation to stored food and therefore do not appear in chapter 28. The authors of these taxa are given for the convenience of the reader.

Many people were involved in making this handbook possible. In addition to the authors and the illustrators, others gave support to the completion of the book. For example, the book could not have been written without the administrative support of both the Food and Drug Administration and the Agricultural Research Service. In addition, many scientists, each an expert in his or her field, gave advice and suggestions to help us achieve a high level of accuracy and utility in the preparation of the keys. In short, thanks to all of you who assisted in making *Insect and Mite Pests in Food: An Illustrated Key* an informative and useful reference in its field.

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Introduction

This comprehensive treatise on the identification of food-contaminating arthropods (insects and their relatives) and their occurrence in food was prepared for an international audience of entomologists, food inspectors, commercial food processors, instructors in pest identification and pest management, pesticide applicators, and others involved in maintaining the purity of processed foods. We hope that this handbook will increase the efficiency of food inspection and will help guarantee the purity of foods imported into, exported from, and transported within the United States and other countries.

Precise identification of pests and suspected pests is essential in the food industry, just as it is in the production and postharvest segments of agriculture. For example, consider the most recent, expensive visit of the khapra beetle to the United States—identifications were needed of the difficult-to-identify larvae so that the extent of the infestation could be determined and control measures taken before the pest could spread throughout the country. In the food industry, particularly, rapid and accurate identification, often of only a fragment of an insect or other arthropod, must be made by persons lacking specialized training in insect/arthropod systematics. This handbook will help provide the basis for this capability, both as a reference tool and as an instructional aid.

For the first time, the combined expertise of leading specialists in the United States has been marshaled to produce a comprehensive and fully detailed manual for quick and positive identification of more than 600 species of pests encountered throughout the many facets of the food industry. No manual of this kind has ever been published before in the United States, although a few similar works have been published in England and Canada. In addition to the more numerous and better known arthropod groups such as beetles, moths, and flies, the poorly known groups such as mites, thrips, and scale insects are included. The emphases placed on diagnostic keys and useful illustrations of both adult and immature stages are special features. The two volumes, prepared largely by research entomologists of the Agricultural Research Service's Systematic Entomology Laboratory of the Biosystematics and Beneficial Insects Institute, with some sections prepared by other specialists, were designed for practical use. A prime objective was to enable frontline nonspecialists to identify authoritatively a large number of species. This will save not only their time but also the time of systematists who otherwise would be required to identify those specimens.

The practically oriented food inspector, quarantine officer, pest control operator, and others in this field should pause to consider the nature and quality of the research that makes a tool such as this available. We, current researchers and users of research, are the inheritors of more than 200 years of basic systematic work. While many difficult problems remain in the classification of pests and related species, especially at the subspecific level, much of the fundamental classification that we use today was developed over that two-century timespan. Many classifications were not developed with the present or any other practical objective in mind but are the products of basic research.

These points are particularly important when one considers that pest-identification requirements change as our food habits change; as shipping, packaging, storage, processing, and other procedures change; as new crops and foods are developed; as international pathways of commerce change; and even as the pests themselves change in their host preferences, distribution, population characteristics, and resistance to pesticides. The strengthened regulatory arms provided by scientifically based identification may become even more critical in the future as the use of certain pesticides is restricted. We can also anticipate dealing with increased numbers of diverse kinds of organisms, as well as their natural enemies, such as parasitic forms. We can feel confident that these two volumes will provide answers for many important questions for years to come. At the same time, we need to be prepared for unpredictable future needs by maintaining our systematics research and service capability.

A definitive work of this nature requires a diverse mix of knowledge and capability—practical knowledge of which species need to be identified and which need to be excluded; a solid understanding of the identity of not only those species but also of closely related or similar forms; the ability to present this broad range of specialized detail in a useful manner; and skill in scientific illustration and in organizational and editorial capability. Speaking for the authors, I would like to thank the editor, J. Richard Gorham, for his leadership of this project, and to thank the primary illustrators Candetta Feller and Arthur D. Cushman, both formerly with the Systematic Entomology Laboratory, for their outstanding contributions to this project.

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Part 1

1 MITES (ACARI)

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The key presented here to selected orders, suborders, families, genera, and species of mites associated with foods is based largely on *A Manual of Acarology* by G.W. Krantz (*20*) and on *The Mites of Stored Foods and Houses* by A.M. Hughes (*18*). (References *3, 4,* and *7* were among other important references consulted.) Several systems of subordinal nomenclature are being used by acarologists. The system used in this key, along with other systems that have been proposed, is given in table 1.1.

The central objective of the key is to help the user to identify those kinds of mites commonly associated with food. Some mites, because of their potential for occurrence in food-storage situations, are phoretic or parasitic on certain insects, birds, and mammals and are included here. Since bionomic information is sometimes a helpful adjunct in the process of making an identification, I have included as annotations to the key couplets whatever reliable information was available on foods, food habits, food associations, specific behaviors, and geographic distribution.

The characters of the adult stage form the basis for most of the key couplets. The occasional references to characters of the hypopodes (formerly, hypopi) are provided merely as supplemental information. Zakhvatkin (*28*) should be consulted for keys to hypopodes. The hypopus (deutonymph or second nymphal stage) occurs only in the Astigmata and then only occasionally. It differs widely in both morphology and behavior from earlier and later stages in the developmental cycle.

As arachnids, spiders, mites, and ticks have a kind of abdominal segmentation that is inconspicuous or apparently absent. In the subclass Araneae (spiders), the head and thorax are combined in a single unit, the cephalothorax, that is joined to the abdomen by a slender pedicel. The subclass Acari includes the ticks (fig. 1.1) and mites (fig. 1.2). The acarine body, in contrast to the rather distinct body regions of insects, is composed mainly of the idiosoma. The mouthparts are borne on the gnathosoma, an anterior region that is more or less distinct from the idiosoma. Terminology for the subdivisions of the mite body is given here.

Region of mouth and mouthparts	Gnathosoma		Prosoma	Proterosoma
Region of legs I and II	Propodosoma	Podosoma		
Region of legs III and IV	Metapodosoma		Idiosoma	Hysterosoma
Posterior region	Opisthosoma			

Table 1.1.
Equivalent names for some of the higher taxa, mainly suborders, of the subclass Acari

System I	System II[3]	System III[4]	System IV[5]	System V[6]
Order Parasitiformes				
Onychopalpida[1]				
Holothyroidea[2]	Tetrastigmata	Holothyrida	Holothyrina	Holothyrina[7]
Notostigmata[2]	Notostigmata	Opilioacarida	Opilioacarida	Opilioacarida[7]
Parasitiformes[2]				
Ixodides[1]	Metastigmata	Ixodida	Ixodida	Ixodida[8]
Mesostigmata[1]	Mesostigmata	Gamasida	Mesostigmata	Mesostigmata
Order Acariformes				
Trombidiformes[1,2]	Prostigmata	Actineida	Prostigmata	Prostigmata
Tetrapodili[2]				Eriophyoidea
Sarcoptiformes[1,2]				
Acaridiae	Astigmata	Acaridida	Astigmata	Astigmata
Oribatei	Cryptostigmata	Oribatida	Oribatida	Cryptostigmata

[1]These are the suborders of Baker and Wharton (*4*).
[2]Vitzthum (*27*) used 6 suborders.
[3]Evans, Sheals, and Macfarlane (*8*); Evans and Till (*9*) confer ordinal status on these suborders.
[4]van der Hammen (*14*); Krantz (*20*).
[5]Acarology Laboratory, Ohio State University (D. E. Johnston, personal communication, 1982).
[6]This subordinal system is used in this key; it was recommended, in part, by G.W. Krantz (personal communication, 1980).
[7]Since it is very unlikely that users of this key would ever encounter mites belonging to either of these rare and exotic suborders, they have been omitted from the key.
[8]Ticks, of course, do not infest food; but since they are so widely distributed, they are included here to show how they may be distinguished from mites.

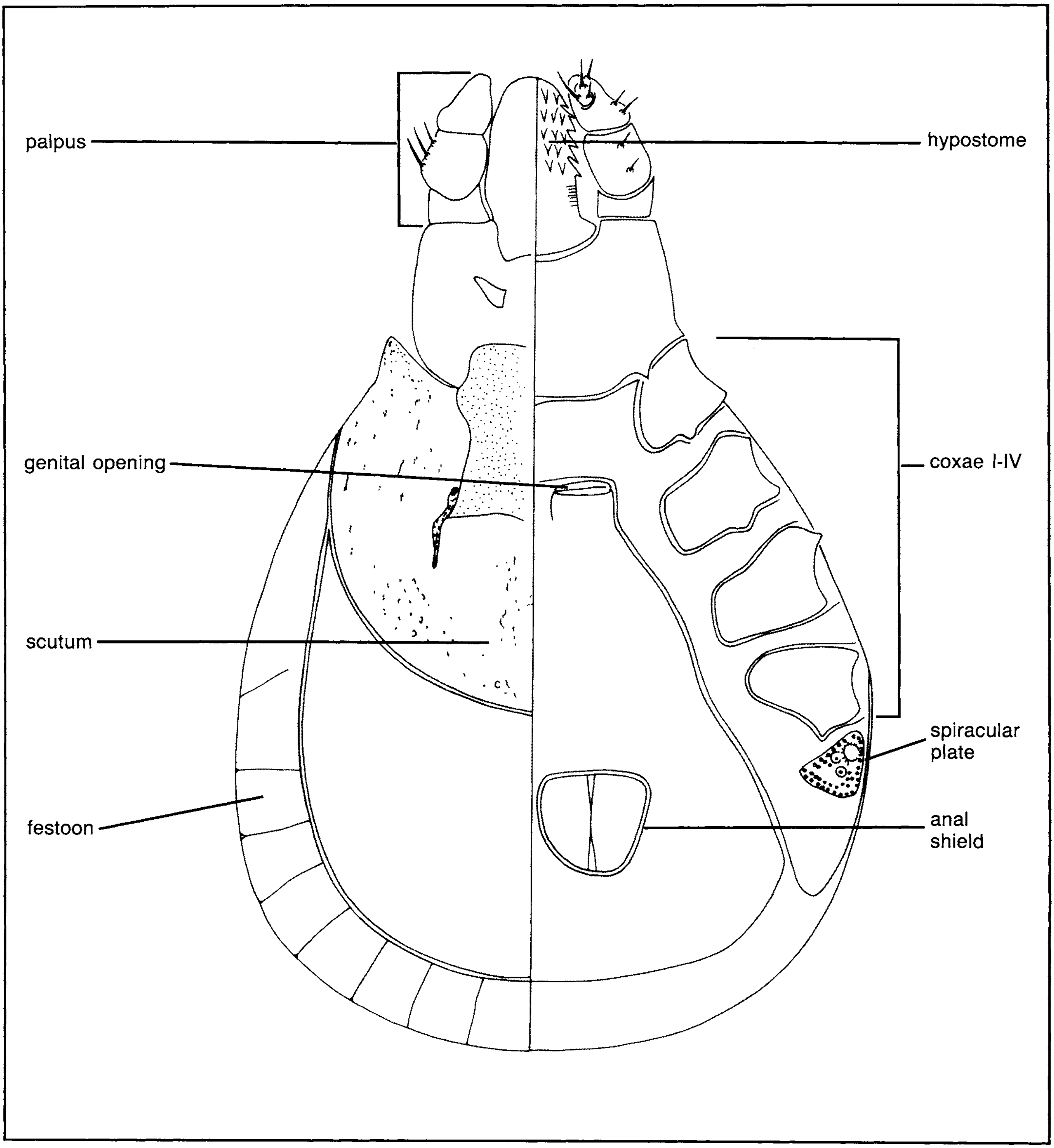


Figure 1.1. Ixodid tick (Ixodida) (diagrammatic): Left, dorsal; right, ventral. (Drawing by R.L. Smiley.)

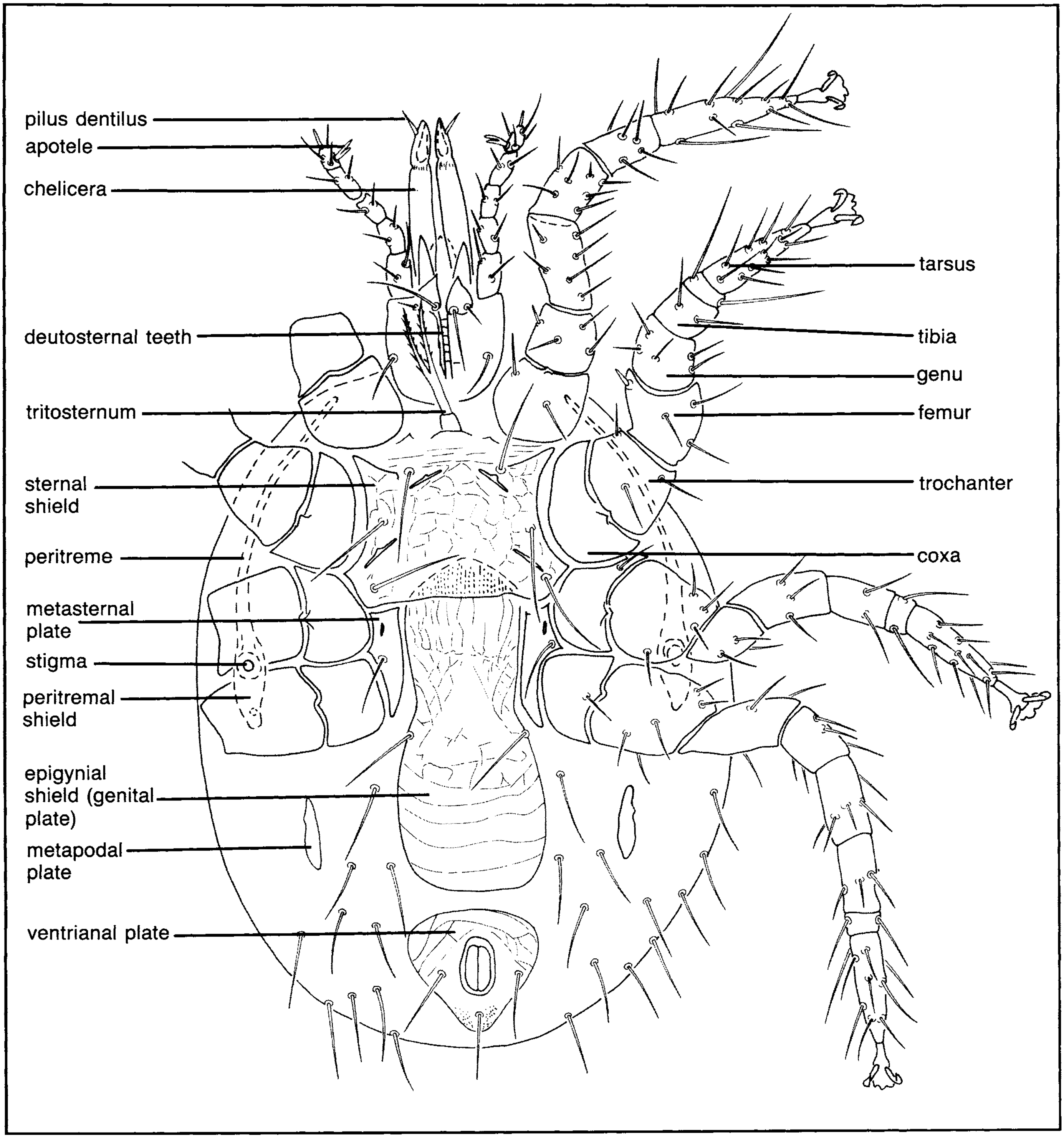


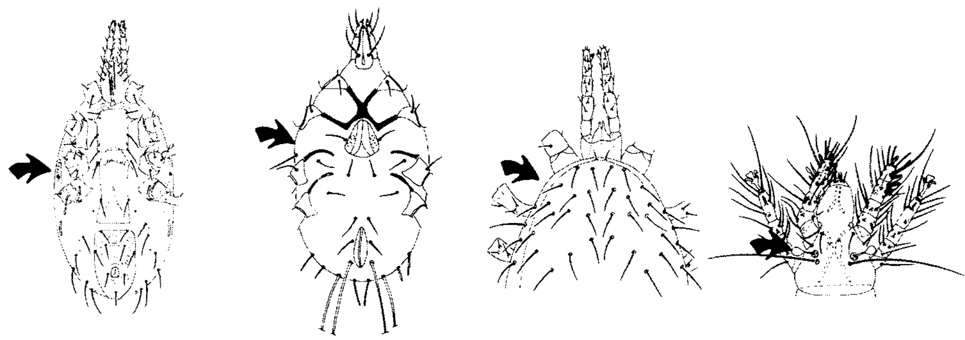
Figure 1.2. Mesostigmatid mite, *Androlaelaps casalis* (Laelapidae, Mesostigmata), ventral view of female (see pl. 3, 11, and 45 for other structural details). (Drawing by R.L. Smiley.)

KEY

Drawings by R.L. Smiley and C. Feller unless otherwise noted.

1 With 1 to 4 pairs of lateroventral hysterosomal stigmata (1A); sensillum (propodosomal trichobothrium) absent (1B). Order Parasitiformes-- 2

Without hysterosomal stigmata (1C) (except for certain Cryptostigmata that may have inconspicuous stigmata); sensillum present (1D) or absent. Order Acariformes - 17

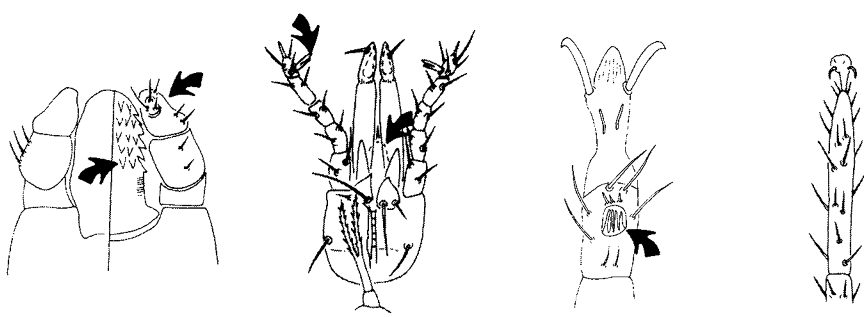


1A *Blattisocius keegani* 1C *Carpoglyphus lactis* 1B *Blattisocius keegani* 1D *Pyemotes tritici*

Order Parasitiformes

2 Large leathery Acari (usually more than 1 mm long), with sclerotized plates or shields (see scutum, fig. 1.1); palpus without tined apotele (2A); hypostome with retrorse teeth (2A); spiracular (stigmal) plate (surrounds stigma) oval, rounded, comma-shaped, or subtriangular (fig. 1.1) and located between coxae III and IV or behind coxa IV; Haller's organ (on dorsum of tarsus) present (2B); external parasites --**ticks,** Suborder Ixodida

Small nonleathery Acari (usually less than 1 mm long), with or without sclerotized plates or shields; palpus with tined apotele (2C); hypostome without retrorse teeth (2C); stigma located between coxae II and III or between III and IV, and sometimes surrounded by an elongate peritremal shield (fig. 1.2); Haller's organ absent (2D); parasitic or free living. Suborder Mesostigmata (mesostigmatid mites) ------------- 3



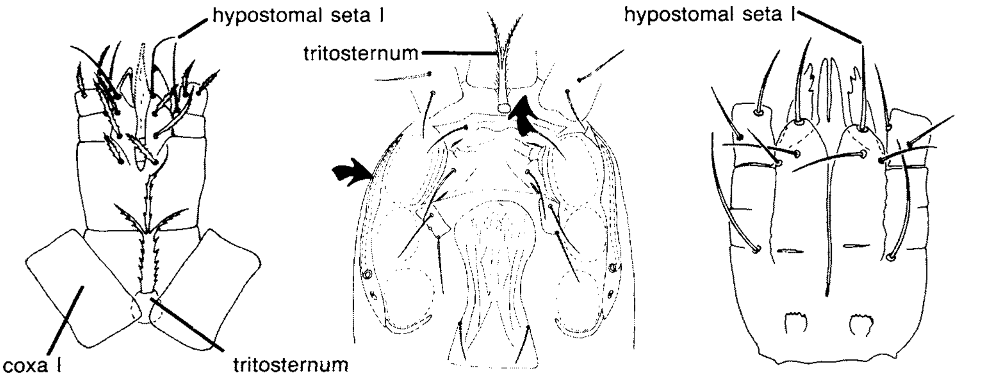
2A ixodid tick 2C *Androlaelaps casalis* 2B ixodid tick 2D *Blattisocius keegani*

Suborder Mesostigmata

3 Coxa I partially contiguous with and partially covering base of tritosternum (3A); hypostomal setae I-III arranged in a row (3A); peritreme elongate and often strongly convoluted (pl. 3B); coxae III and IV with foveae pedales (leg grooves) (pl. 3B). Uropodidae (uropodid or tortoise mites) ---------- 4

The uropodids of interest here are found in damp, moldy grain in ships and warehouses; they are probably mycophagous.

Coxa I not contiguous with and not overlapping tritosternal base (3B); hypostomal setae I-III not arranged in a row (3C); peritreme elongate but not convoluted (3B); coxae III and IV without foveae pedales (3B) ---------- 5



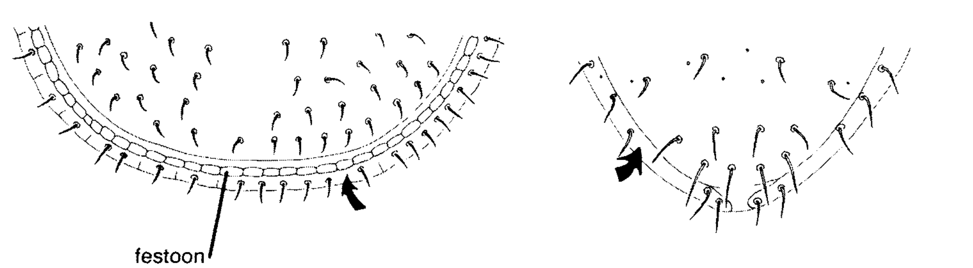
3A *Fuscuropoda* 3B *Blattisocius dentriticus* 3C *Kleemannia plumosa*

4 Idiosoma broadly rounded at posterior margin (pl. 3A); dorsal shield bordered, at least posteriorly, with a single row of platelets (festoons) (4A) ---------- *Leiodinychus krameri*

Distribution: cosmopolitan.

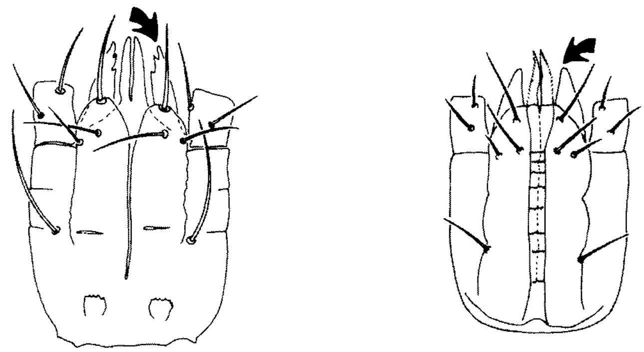
Idiosoma tapered at posterior margin (pl. 3C); dorsal shield not bordered by a row of platelets (4B) ---------- *Fuscuropoda marginata*

Distribution: Europe, United States.



4A *Leiodinychus krameri* 4B *Fuscuropoda marginata*

5 Corniculus forked distally (5A). Ameroseiidae (ameroseiid mites) ------------------------ 6
Corniculus not forked (5B)-- 7



5A *Kleemannia plumosa*

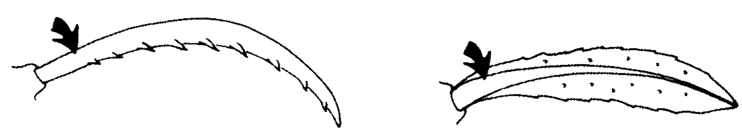
5B *Lasioseius*

6 Dorsal setae narrow and pectinate, without thickened midrib (6A); pl. 4A
---*Kleemannia plumigera*

Distribution: England, Germany, Ireland, Netherlands.
Food habits: mycophagous.

Dorsal setae broad and serrate, each with a thickened midrib (6B); pl. 4B&C
---*Kleemannia plumosa*

Distribution: Australia, Canada, England, Germany, Iceland, Ireland, Israel, Netherlands, United States.
Food habits: mycophagous.



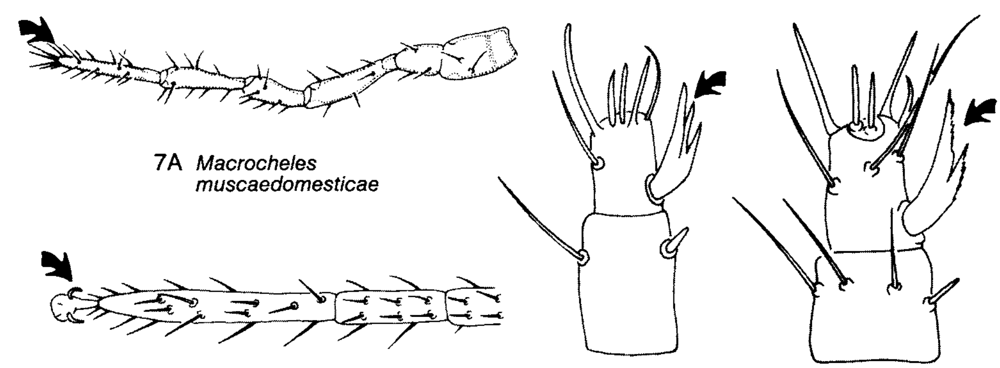
6A *Kleemannia plumigera*

6B *Kleemannia plumosa*

7 Tarsus I without claws (7A); apotele of palpal tarsus 3-tined (7B); pl. 5. Macrochelidae (macrochelid mites)-------------------------- house fly mite, *Macrocheles muscaedomesticae*

Distribution: cosmopolitan. Foods: eggs of house flies (*Musca domestica*) and related muscids. Habits: phoretic on muscid flies.

Tarsus I with claws (7C); apotele of palpal tarsus 2-tined (7D)---------------------------- 8



7A *Macrocheles muscaedomesticae*

7C *Blattisocius keegani*

7B *Macrocheles muscaedomesticae*

7D *Blattisocius keegani*

8 Dorsal propodosoma with scleronoduli (8A); dorsum covered with subequal propodosomal (podonotal) and hysterosomal (opisthonotal) shields (8A). Digamasellidae (digamasellid mites) ---*Digamasellus*

Distribution: probably cosmopolitan. Food habits: probably predaceous on small arthropods.

Dorsal propodosoma without scleronoduli (8B); dorsal shield usually undivided (8B) and often reduced (see 11B); if dorsal shield is divided, then anterior (podonotal) shield is much larger than posterior (opisthonotal) shield (see 11A)------------------ 9

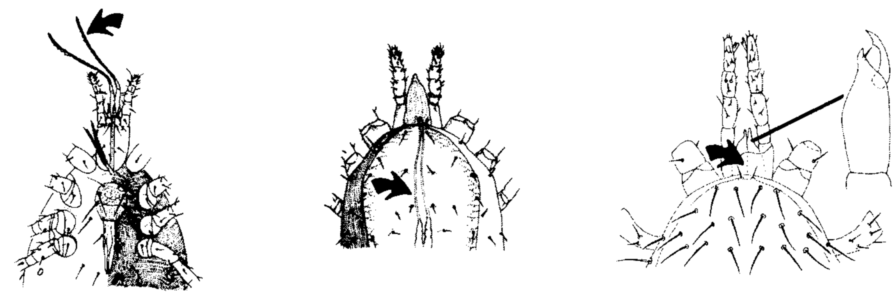
8A *Digamasellus*

8B *Blattisocius dentriticus*

9 Chelicera slender (9A), whiplike or needlelike, originating from and retractable into propodosoma (9B)--- 10

9A&B adapted from 3.

Chelicera stout, originating from and retractable into gnathosoma (9C) --------------- 13



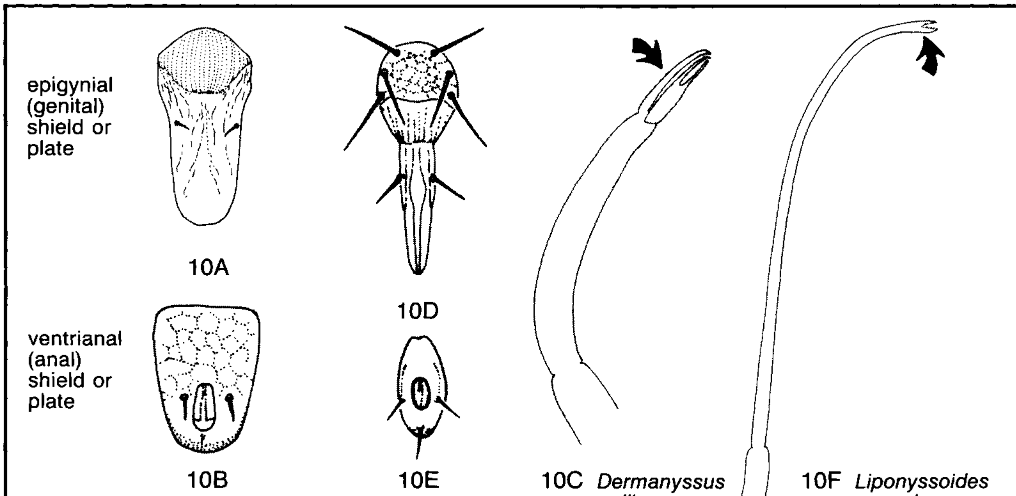
9A *Liponyssoides sanguineus* 9B *Dermanyssus gallinae* 9C *Blattisocius dentriticus*

10 Epigynial shield rounded posteriorly (10A); anal shield subrectangular (10B); chelicera scissorlike (10C), chela movable------------------------**dermanyssid mites,** Dermanyssidae

The **chicken mite,** *Dermanyssus gallinae* (pl. 6), a cosmopolitan species, is representative of this family. Chicken mites live in the nests of their hosts—chickens, pigeons, starlings, and sparrows. The mites sometimes leave the nests and invade buildings through windows and other exterior openings.
10A&B adapted from 3.

Epigynial shield pointed posteriorly (10D); anal shield oval in shape (10E); chelicera not scissorlike (10F), chela fixed. Macronyssidae (**macronyssid mites**)------------ 11

Macronyssid mites parasitize numerous kinds of birds and mammals, including domestic rats and mice.
10D&E adapted from 3.

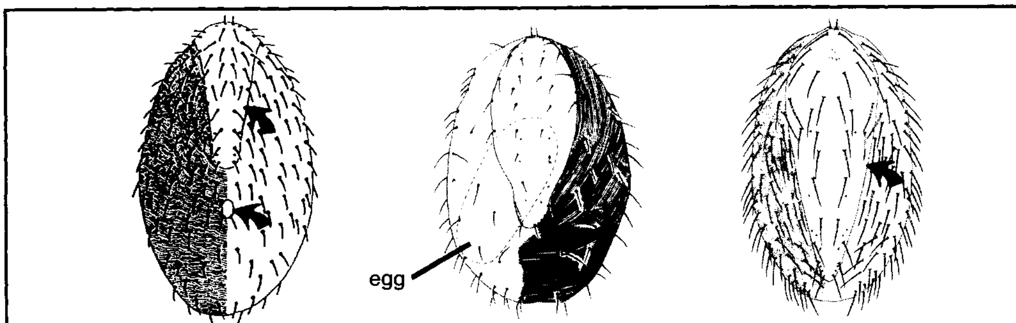


10A 10D 10B *Dermanyssus gallinae* 10E *Liponyssoides sanguineus* 10C *Dermanyssus gallinae* 10F *Liponyssoides sanguineus*

11 Dorsum with 2 shields (11A); pl. 7---------- **house mouse mite,** *Liponyssoides sanguineus*

Distribution: Egypt, United States (New York); probably cosmopolitan.
11A adapted from *3*.

Dorsum with 1 shield (11B, 11C). Genus *Ornithonyssus*------------------------------------ 12



11A *Liponyssoides sanguineus* 11C *Ornithonyssus sylviarum* 11B *Ornithonyssus bacoti*

12 Dorsal shield pointed posteriorly; setae on dorsal shield equal in length to setae on unshielded dorsum (see 11B); pl. 8-------------------- **tropical rat mite,** *Ornithonyssus bacoti*

Distribution: cosmopolitan.

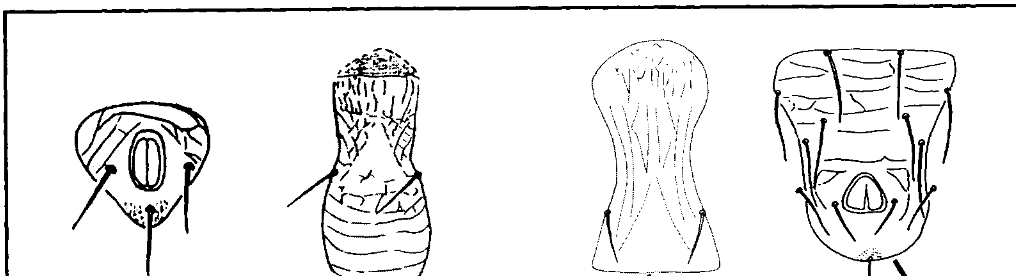
Dorsal shield rounded posteriorly; dorsal shield setae often much shorter than setae on unshielded dorsum (see 11C)------------ **northern fowl mite,** *Ornithonyssus sylviarum*

Distribution: Australia, Europe, Japan, Korea, New Zealand, North America, South Africa, Russia; temperate regions of the world.

13 Epigynial shield rounded posteriorly and at least twice as long as ventrianal shield (13A); fig. 1.2. Laelapidae (laelapid mites)---------------------------------*Androlaelaps casalis*

Distribution: cosmopilitan. Food habits: in stored-food situations, feeds on other arthropods.

Epigynial shield truncate posteriorly and about equal in length to ventrianal shield (13B). Ascidae (ascid mites)-- 14



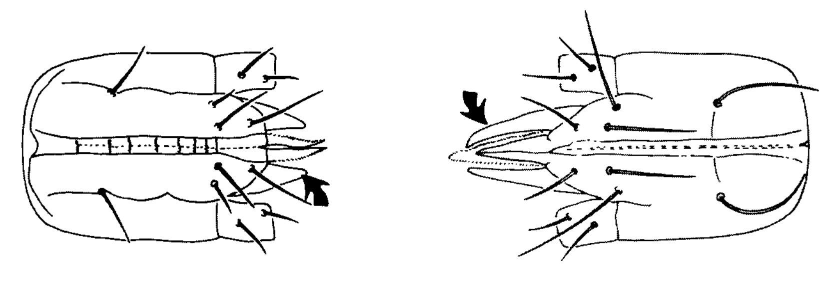
13A *Androlaelaps casalis* 13B *Blattisocius dentriticus*

14 Corniculi relatively short, more or less parallel, and well separated distally (14A) ---------- *Lasioseius*

Distribution: Europe, United States. Food habits: probably mycophagous or predaceous.

Corniculi long, slender, convergent, and close together distally (14B). Genus *Blattisocius* ---------- 15

The 3 species mentioned here are virtually cosmopolitan. They prey on insects and on other mites associated with stored foods.

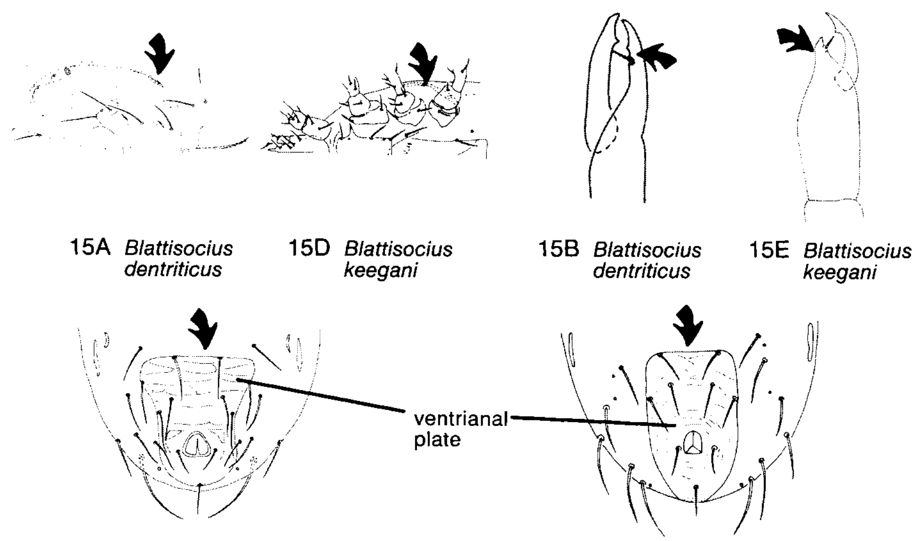


14A *Lasioseius* 14B *Blattisocius dentriticus*

15 Peritreme long, extending forward to coxa II (15A); cheliceral fixed digit with 1 tooth (15B); fixed and movable digits subequal in length (15B); ventrianal plate with 11 setae (15C); pl. 9A ---------- *Blattisocius dentriticus*

See also couplet illustration 8B.

Peritreme short, extending to coxa III (15D); cheliceral fixed digit toothless (15E); fixed digit much shorter than movable digit (15E); ventrianal plate with 9 setae (15F) 16

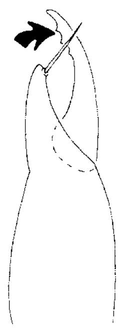


15A *Blattisocius dentriticus* 15D *Blattisocius keegani* 15B *Blattisocius dentriticus* 15E *Blattisocius keegani*

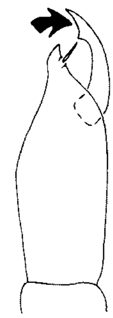
15C *Blattisocius dentriticus* 15F *Blattisocius keegani*

16 Cheliceral movable digit with 3 teeth (16A); pl. 9B ---------------------------- *Blattisocius tarsalis*

Cheliceral movable digit with 1 tooth (16B); pl. 10 ---------------------------- *Blattisocius keegani*



16A *Blattisocius tarsalis*



16B *Blattisocius keegani*

Order Acariformes

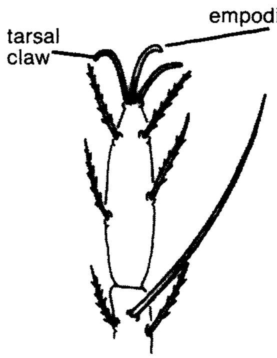
17 Stigmata absent (as in all Astigmata) or present (as in some Cryptostigmata), but if present, never opening between bases of chelicerae or on shoulders of anterior propodosoma -- 18

Since stigmata are always difficult to see in the Cryptostigmata (hence the name of this suborder) and are sometimes difficult to see in the Prostigmata, some additional characters are given here to help the reader sort out the Astigmata, Cryptostigmata, and Prostigmata. Astigs and cryptostigs are characterized by the following: Adults always with 4 pairs of legs; tarsal claw present (17A), without tenent hairs; empodium usually present, often clawlike (17A) (claw may be very small, as in 17B) and sometimes surrounded by a suckerlike pulvillus (17B); empodium never with tenent hairs (17A, 17B); chelicera seldom hooklike or styletiform, usually strong, chelate, and dentate (17C); palpus sometimes with retrorse teeth but never with a thumb-claw complex or strong claw (17D); ventral metapodosoma (opisthogaster) sometimes with claspers or anal plate suckers (17E); hypopodes sometimes present (pl. 17A&C, 18B, 19B, 20A, 23, 25).

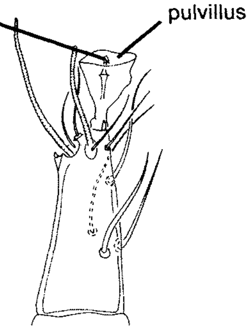
Stigmata present and opening either between bases of chelicerae (17F) or on shoulders of propodosoma (17G). Suborder Prostigmata (prostigmatid mites)---- 47

Adults with 2 to 4 pairs of legs; tarsal claw, if present, sometimes with tenent or rayed hairs (17H); empodium, if present, usually clawlike or padlike (17H), usually with tenent or rayed hairs (17H), and not surrounded by a suckerlike pulvillus (if any structure resembling a suckerlike puvillus is present, then a clawlike empodium is absent); chelicera usually hooklike or styletiform (17I), rarely strong, chelate, and dentate; palpus without retrorse teeth, but sometimes with a strong claw (17F) or thumb-claw complex; ventral metapodosoma without claspers or anal plate suckers (17J); hypopodes absent.

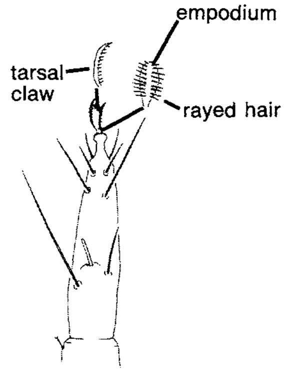
17J adapted from *3*.



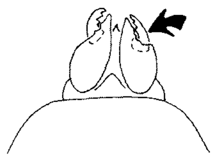
17A *Scheloribates*

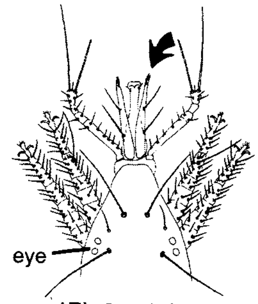


17B *Dermatophagoides pteronyssinus*

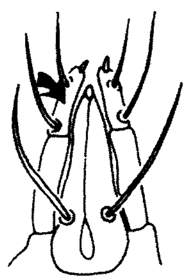


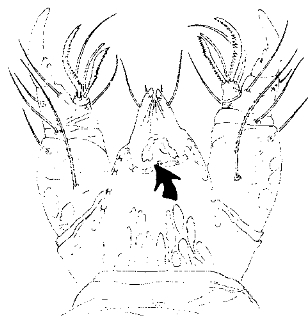
17H *Tydeus*

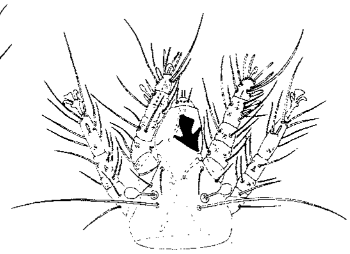

17C *Lepidoglyphus destructor*



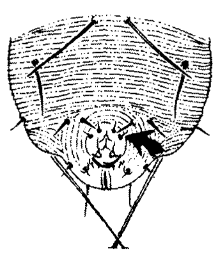
17I *Spinibdella bifurcata*


17D *Carpoglyphus lactis*


17F *Cheyletus eruditus*


17G *Pyemotes tritici*


17E *Suidasia pontifica*

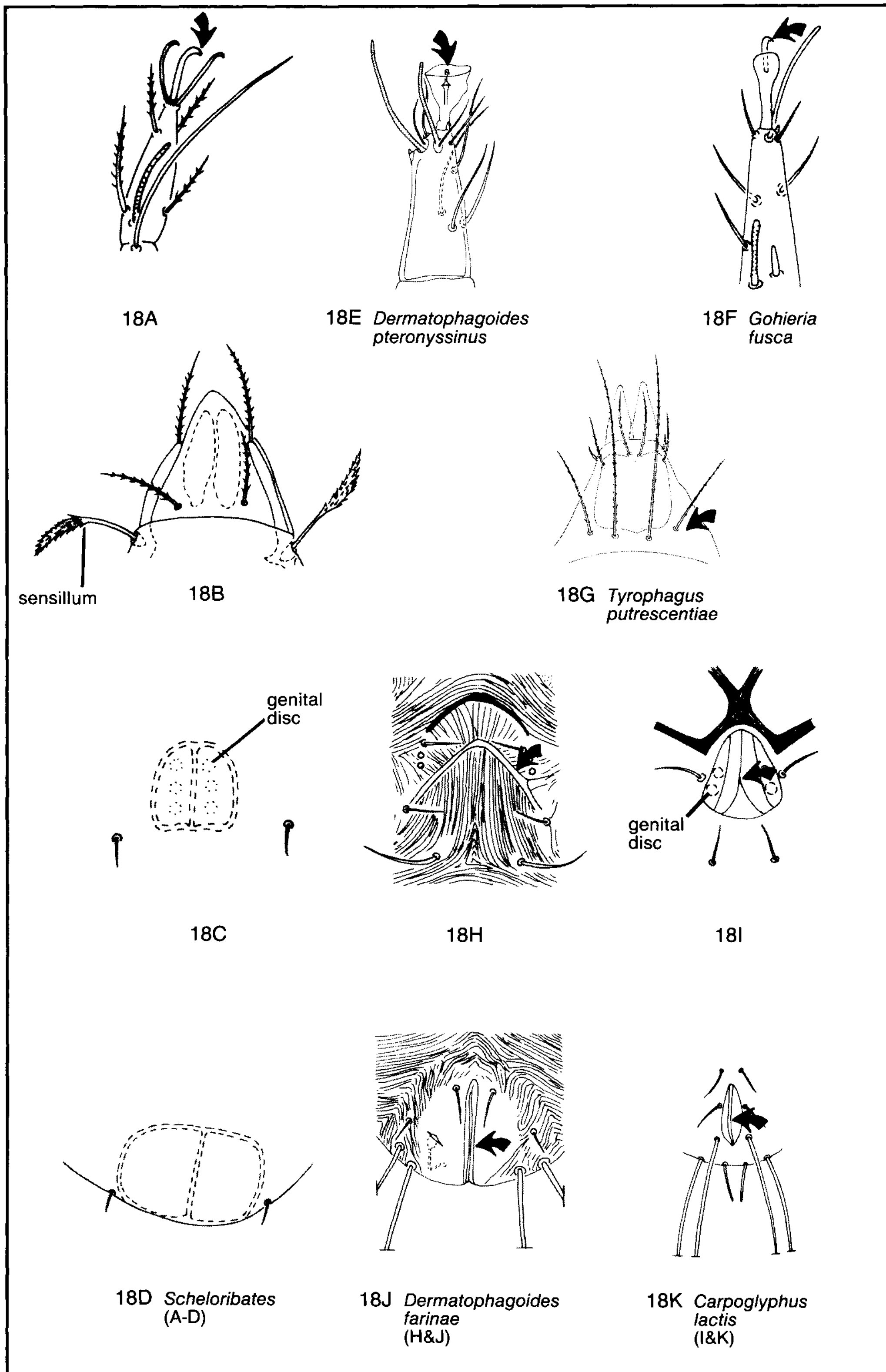

17J *Myobia muscularis*

18 Integument usually strongly sclerotized; empodium, if present, clawlike, not borne on pretarsus (18A); sensory setae (sensilla or prodorsal trichobothria) present on propodosoma (18B); genital opening longitudinal (18C) (not shaped like an inverted U, Y, or V) and usually flanked by 3 pairs of genital discs; genital (18C) and anal (18D) openings similar in shape and covered by trapdoorlike valves; pl. 11A -- beetle mites, oribatid mites, Suborder Cryptostigmata

Sexes usually homomorphic. Oribatid mites are widely distributed in soils around the world. Only a few species have been found (and then only infrequently) in food-storage facilities or in stored or processed foods, notably mushrooms or foods that were moldy or out-of-condition. Among these are *Aphelacarus acarinus, Phauloppia lucorum, Scheloribates laevigatus,* and *Trichoribates novus.*

Integument weakly sclerotized, if at all; empodium clawlike (18E, 18F), often borne on pretarsus; sensory setae absent from propodosoma (18G); genital opening transverse or shaped like an inverted U, V (18H), or Y (18I), and usually flanked by 2 pairs of genital discs; genital (18H, 18I) and anal (18J, 18K) openings not similar in shape. Suborder Astigmata (astigmatid mites) --- 19

Sexes homomorphic or heteromorphic.


18A
18E Dermatophagoides pteronyssinus
18F Gohieria fusca
sensillum
18B
18G Tyrophagus putrescentiae
genital disc
18C
18H
genital disc
18I
18D Scheloribates (A-D)
18J Dermatophagoides farinae (H&J)
18K Carpoglyphus lactis (I&K)

Suborder Astigmata

19 Integumental striae of dorsal hysterosoma broken by spinelike projections (19A); pl. 11B. Sarcoptidae (sarcoptid mites)---------------------------------- **itch mite,** *Sarcoptes scabiei*

Distribution: cosmopolitan. Food habits: skin parasite of mammals.
19A adapted from *3*, 19B from *2*, and 19C from *10*.

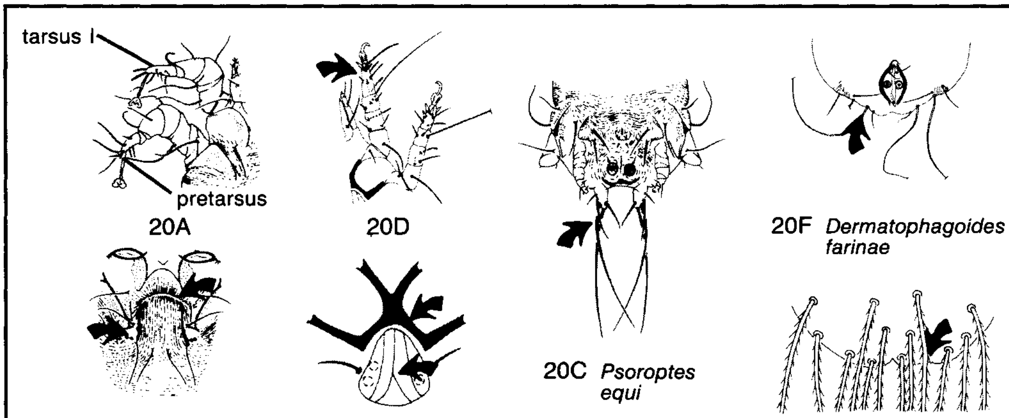
Integumental striae not broken by spinelike projections—surface may be warty (19B), smooth, or granular (19C) -- 20

19A *Sarcoptes scabiei* 19B *Aeroglyphus robustus* 19C *Euroglyphus maynei*

20 Legs I and II clawlike (i.e., the whole leg functions as a claw) and terminating in long pretarsi (20A); tarsi I and II heavily sclerotized (20A); genital opening of female shaped like an inverted U (20B) and flanked by sclerotized genital apodemes; opisthosoma of male bilobed, each lobe bearing 2 long simple setae and 3 short simple setae (20C); pl. 12. Psoroptidae (**scab mites**)
-- **scab mite,** *Psoroptes equi*

Distribution: cosmopolitan. Food habits: skin parasites of mammals.
20A-C adapted from *3*.

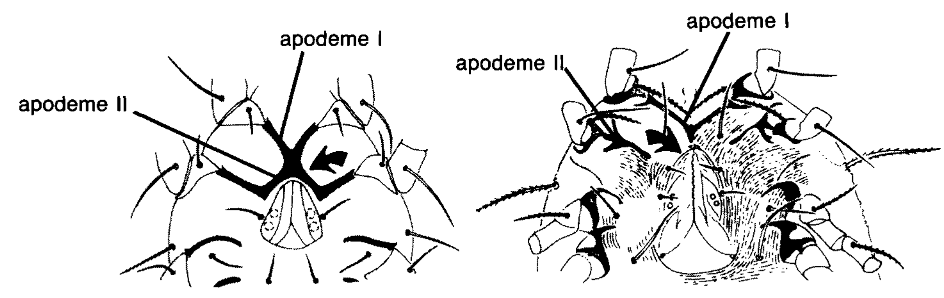
Legs I and II neither clawlike nor terminating in long pretarsi; tarsi I and II lightly sclerotized (20D); genital opening of female not shaped like an inverted U (20E); sclerotized genital apodemes present (20E) or absent; if posterior end of male appears bilobed, the lobes do not each bear 2 long and 3 short simple setae (20F, 20G) 21



20A 20D 20F *Dermatophagoides farinae*

20B *Psoroptes equi* (A&B) 20E *Carpoglyphus lactis* (D&E) 20C *Psoroptes equi* 20G *Glycyphagus domesticus*

21 Apodemes I and II fused with sternum and surrounding anterior end of genital plate (21A) ---------- 22
Apodeme II not fused with sternum and not adjoining anterior end of genital plate (21B) 23



21A *Carpoglyphus lactis*

21B *Aeroglyphus robustus*

22 Genua and tibiae I to IV with sclerotized ridges (22A); epigynial shield subrectangular (22B); pl. 13A. Glycyphagidae (**glycyphagid mites**) (in part)
---------- **brown flour mite,** *Gohieria fusca*

Distribution: cosmopolitan. Food associations: often in flour and in many other kinds of stored food.

Genua and tibiae I to IV without sclerotized ridges (22C); epigynial shield subtriangular (22D); pl. 13B. Carpoglyphidae (**driedfruit mites**)
---------- **driedfruit mite,** *Carpoglyphus lactis*

Distribution: Argentina, Europe, North America; probably cosmopolitan. Food associations: foods containing sugar.

22A *Gohieria fusca*

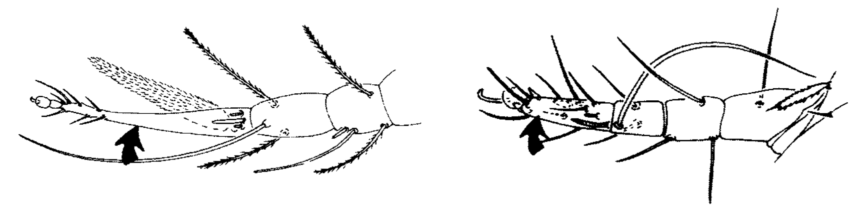
22B *Gohieria fusca*

22C *Carpoglyphus lactis*

22D *Carpoglyphus lactis*

23 Tarsi I to IV slender, and more than twice as long as adjacent tibiae (23A). Glycyphagidae (**glycyphagid mites**) (in part)-- 24

Tarsi I to IV stout, and usually not more than twice as long as adjacent tibiae (23B)------- 26

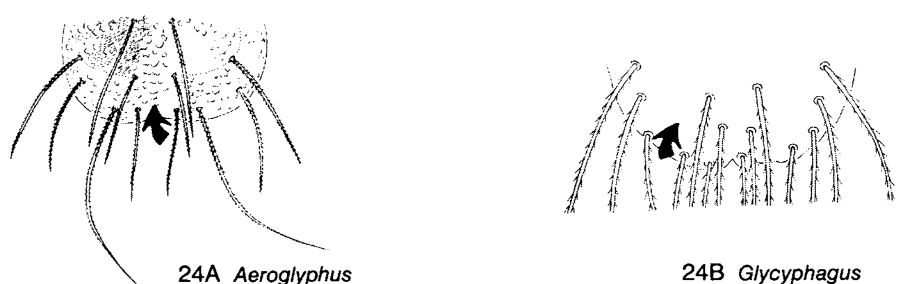


23A *Lepidoglyphus destructor*   23B *Suidasia nesbitti*

24 Dorsal idiosoma with conspicuous wartlike tubercles (24A); cuticle at least partially striate (24A); pl. 14------------------------------------- **warty grain mite,** *Aeroglyphus robustus*

Distribution: North America. Food: stored grains, grain products, and dried fish products. 24A adapted from *2*.

Dorsal idiosoma without wartlike tubercles (24B) (but small triangular spicules may be present); cuticle without striations (24B)-- 25



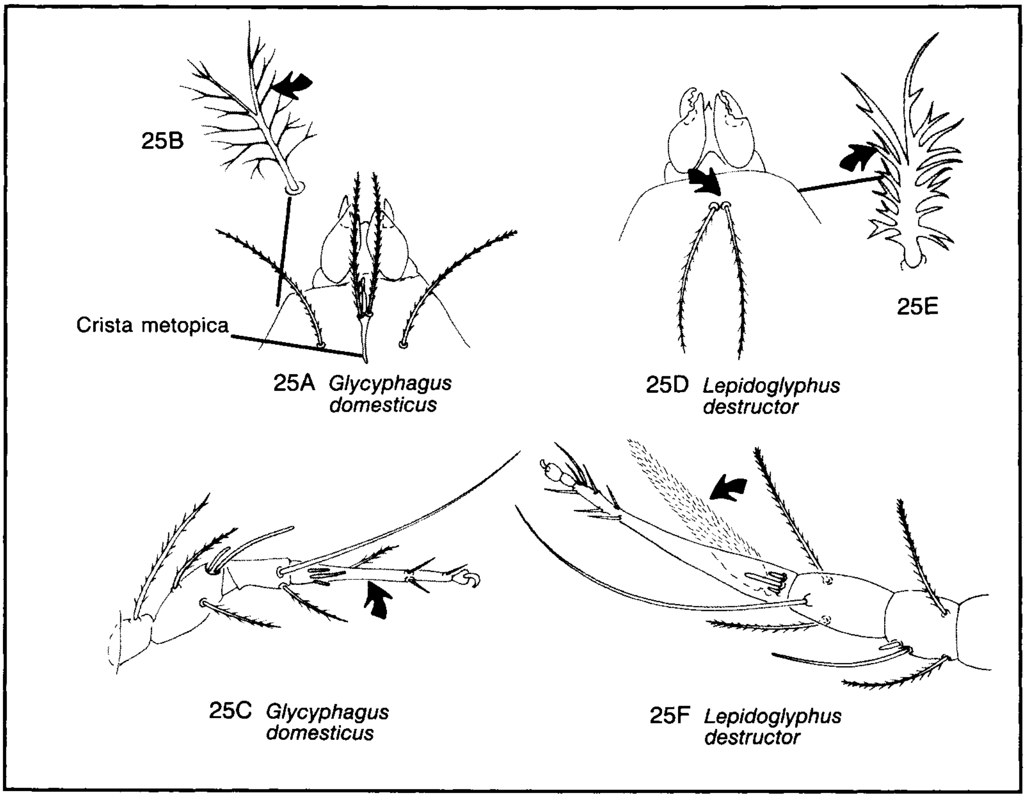
24A *Aeroglyphus robustus*   24B *Glycyphagus domesticus*

25 Crista metopica (prodorsal sclerite) present (25A); supracoxal seta with slender branches (25B); leg I without tarsal scale (25C)-----------------------------------*Glycyphagus*

The **house mite,** *Glycyphagus domesticus* (pl. 15), is representative of this genus. *G. domesticus* is widely distributed around the world and is associated with numerous kinds of stored foods and with fungi.

Crista metopica absent (25D); supracoxal seta with stout branches (25E); leg I with tarsal scale (25F)---*Lepidoglyphus*

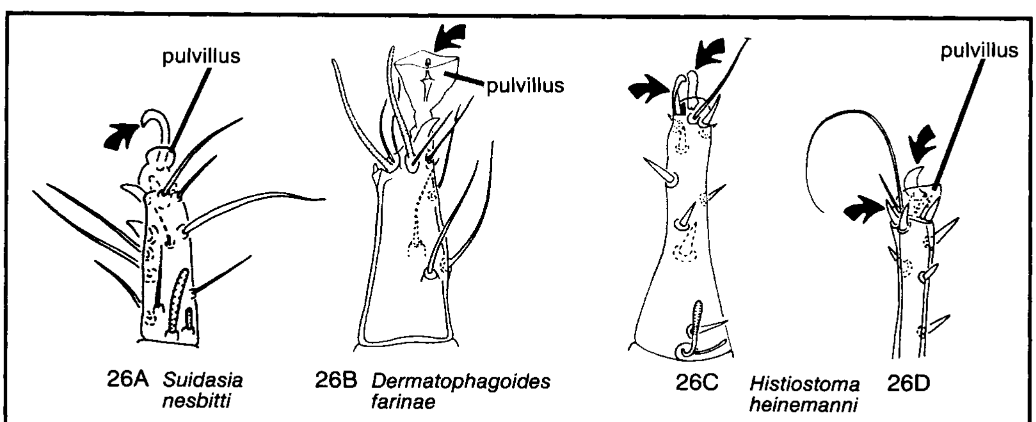
Lepidoglyphus destructor, one of the more common mites associated with stored food, is representative of this genus. This species is cosmopolitan in distribution. It has been found on many kinds of stored foods and on fungi.



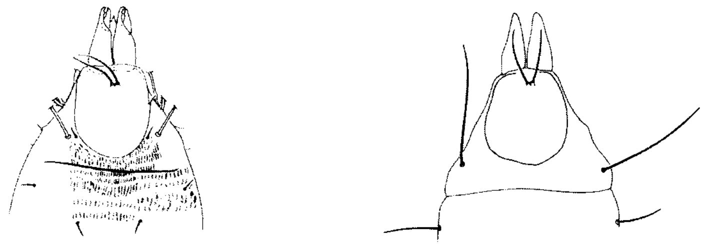
26 Tarsal tip bearing a large and conspicuous clawlike empodium associated with a pulvillus of variable size (26A); metapodosomal venter without prominent, strongly-sclerotized, ringlike structures ---------- 27

Tarsal tip bearing a minute claw surrounded by a conspicuous discoid or bell-shaped pulvillus (26B), and metapodosomal venter without prominent, ringlike structures (as in 42D); or tip of tarsus I bearing a large, clawlike empodium (26C, 26D), and metapodosomal venter with prominent, strongly-sclerotized, ringlike structures (see 42B) ---------- 42

26C&D adapted from *15*.



27 Dorsal idiosoma patterned (27A). Acaridae (**acarid mites**) (in part) ---------- 28
Dorsal idiosoma unpatterned (27B) ---------- 29



27A *Suidasia nesbitti*

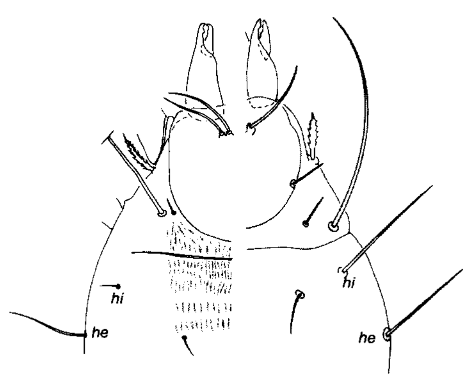
27B *Thyreophagus entomophagus*

28 Female with *hi* (apical dorsolateral seta of hysterosoma) shorter than *he* (humeral seta) (28A) and with anal region subcircular (28B); male without anal suckers (28C); pl. 16 ---------- **scaly grain mite,** *Suidasia nesbitti*

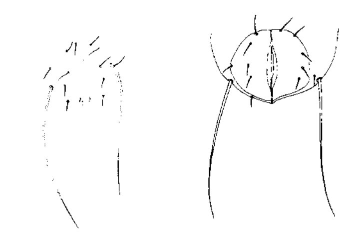
Distribution: Africa, Europe, North America. Foods: wheat bran, rice.

Female with *hi* as long as or longer than *he* (28D) and with anal region circular (28E); male with anal suckers (28F) ---------- *Suidasia pontifica*

Distribution: Africa, Europe, Puerto Rico, Sumatra. Foods: copra, cowpeas, peanuts, rice bran. Synonym: *Suidasia medanensis* Oudemans.



28A *Suidasia nesbitti* 28D *Suidasia pontifica*



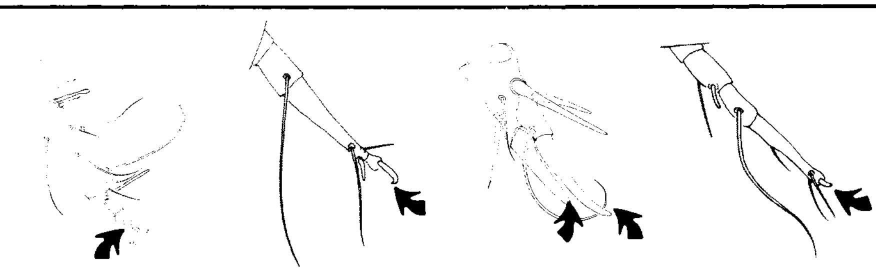
28B 28E

28C *Suidasia nesbitti* (B&C) 28F *Suidasia pontifica* (E&F)

29 Tarsal claws I to IV of female bifurcate (29A); tip of tarsus III of male with 2 large spines (29B). Lardoglyphidae (lardoglyphid mites). Genus *Lardoglyphus*---------- 30

Tarsal claws I and II of male bifurcate. See Olsen (*H001* in chapter 28) on *L. angelinae* for a key to separate this species from *L. konoi* and *L. zacheri*. References: *23, 28.*

Tarsal claws of female simple (29C); tip of tarsus III of male with a simple claw (29D). Acaridae (**acarid mites**) (in part)---------- 31



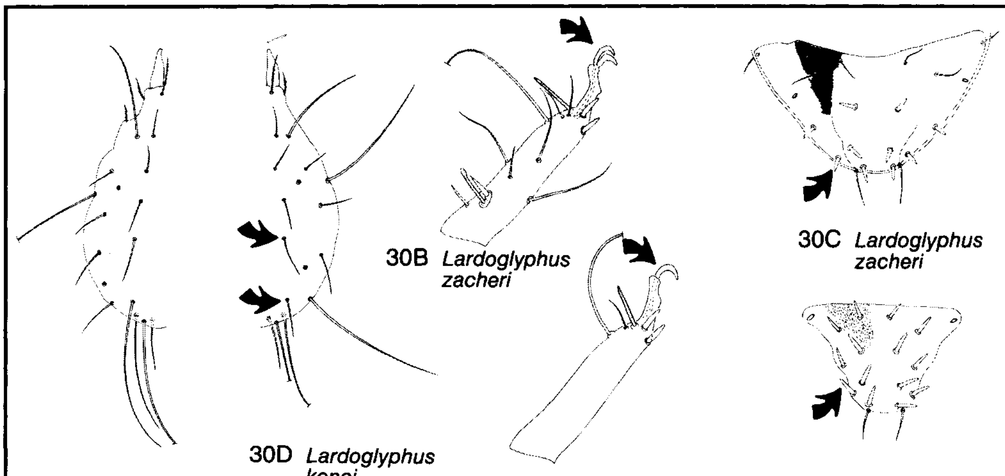
29A *Lardoglyphus zacheri* 29C *Acarus siro* 29B *Lardoglyphus zacheri* 29D *Acarus farris*

30 Seta d_4 more than 3 times as long as d_3 (30A); tarsi I (30B) and II male with bifurcate claws; hysterosomal shield of hypopus with 10 spines (30C); pl. 17A&B ----------*Lardoglyphus zacheri*

Distribution: Australia, Europe, Mexico, South America, United States. Food associations: slaughterhouse by-products and wastes; moldy cheese.

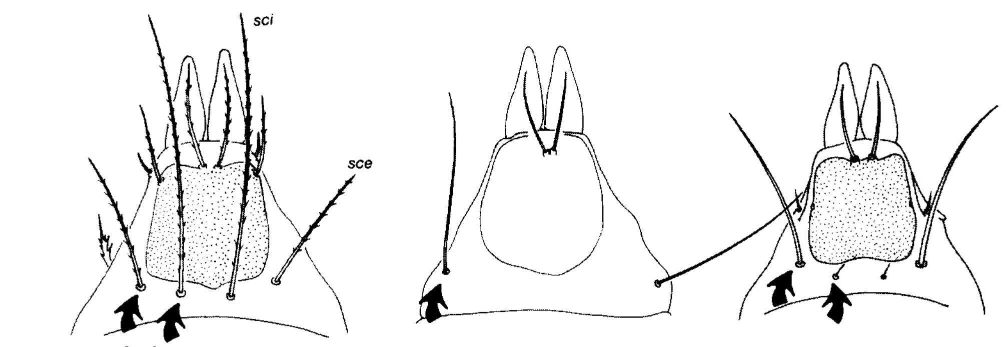
Seta d_4 subequal in length to d_3 (30D); tarsi I (30E) and II of male with simple claws; hysterosomal shield of hypopus with 14 spines (30F); pl. 17C------- *Lardoglyphus konoi*

Distribution: Europe, India, Japan, Kenya, United States. Foods: dried and salted fish, dried meat.



30A *Lardoglyphus zacheri* 30D *Lardoglyphus konoi* 30B *Lardoglyphus zacheri* 30E *Lardoglyphus konoi* 30C *Lardoglyphus zacheri* 30F *Lardoglyphus konoi*

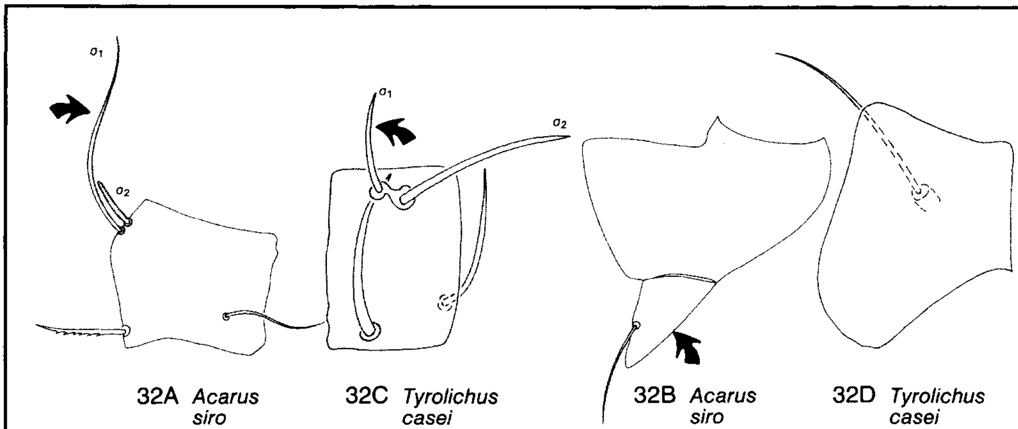
31 Inner proximal seta (*sci*) approximately as long as or longer than outer proximal seta (*sce*) (31A)-- 32
Inner proximal seta absent (31B) or much shorter than outer seta (31C) ------------ 37



31A *Tyrophagus putrescentiae* 31B *Thyreophagus entomophagus* 31C *Rhizoglyphus robini*

32 Solenidion σ_1 on genu I more than 3 times longer than σ_2 (32A); femur I of male enlarged, with a ventral conical process (32B). Genus *Acarus*---------------------------- 33
Solenidion σ_1 on genu I less than 3 times longer than σ_2 (32C); femur I of male not enlarged and not bearing a ventral conical process (32D) ---------------------------- 35

See references *12* and *13* for setal terminology as applied to the Acaridae.

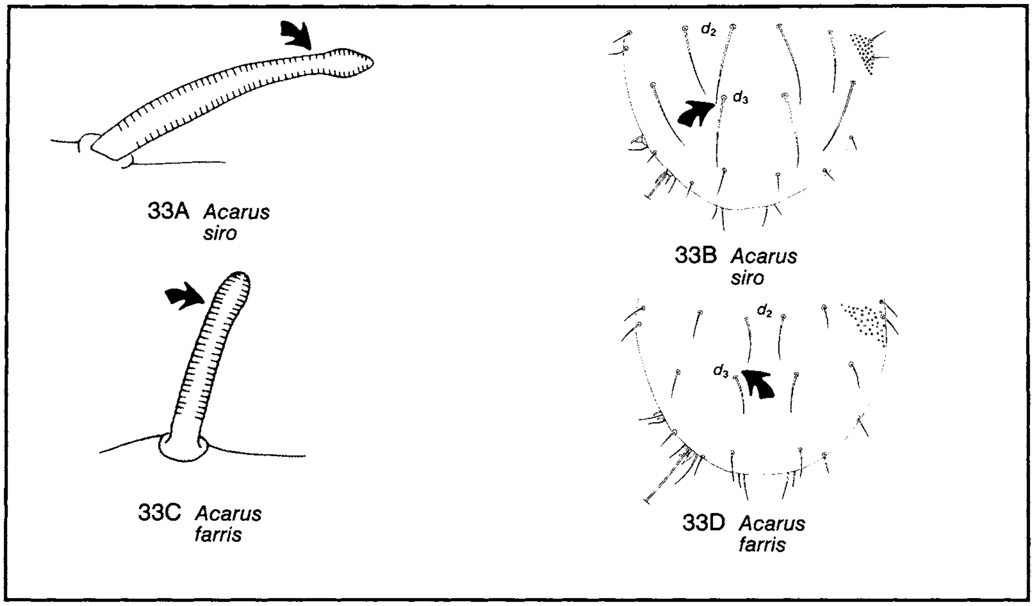


32A *Acarus siro* 32C *Tyrolichus casei* 32B *Acarus siro* 32D *Tyrolichus casei*

33 Solenidion ω_1 of tarsus II recumbent, with a distinct constriction proximal to terminal expansion (33A); seta d_2 of hypopus extending beyond base of d_3 (33B); pl. 18 -- **grain mite,** *Acarus siro*

Distribution: cosmopolitan. Foods: processed grains, fungi.

Solenidion ω_1 of tarsus II not recumbent and without a distinct constriction (33C); seta d_2 of hypopus not extending beyond base of d_3 (33D) ---------------------------- 34



33A *Acarus siro*

33B *Acarus siro*

33C *Acarus farris*

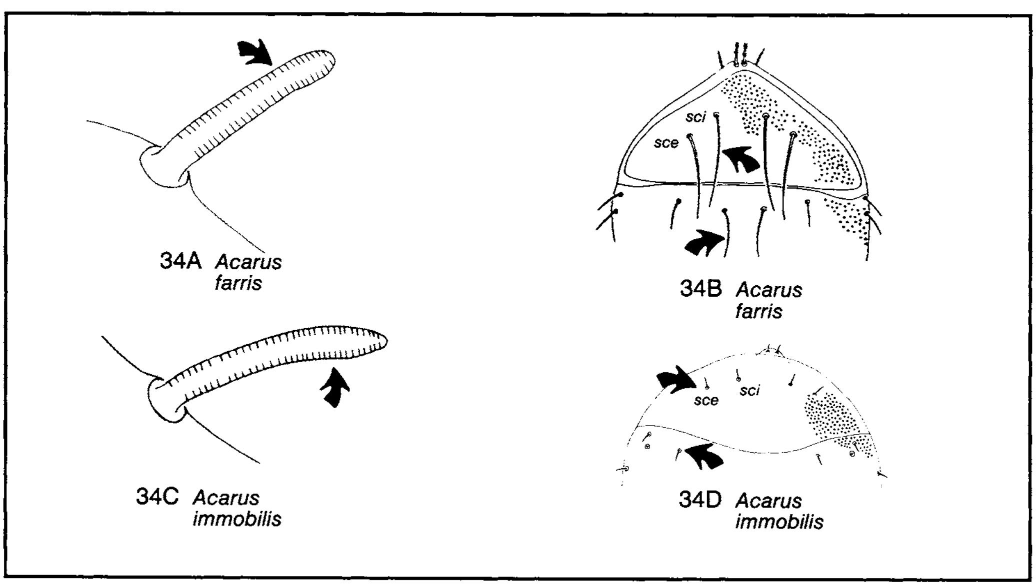
33D *Acarus farris*

34 ω_1 of tarsus II with sides expanding gradually from base, then narrowing to an indistinct neck before expanding into a terminal head; width of widest part of head equal to width of stem (34A); setae *sci* and *sce* of hypopus about 2 times as long as hysterosomal setae (34B); pl. 19--*Acarus farris*

Distribution: East Africa, Europe, United States. Foods: cheese; grains in the field.

ω_1 with sides almost parallel and with a distinct egg-shaped head that is wider at its widest part than any part of the stem (34C); setae *sci* and *sce* of hypopus subequal in length to hysterosomal setae (34D); pl. 20A------------------------*Acarus immobilis*

Distribution: Europe, United States. Foods: farm-stored grains; cheese. Couplets 32-34 adapted from *13, 18.*



34A *Acarus farris*

34B *Acarus farris*

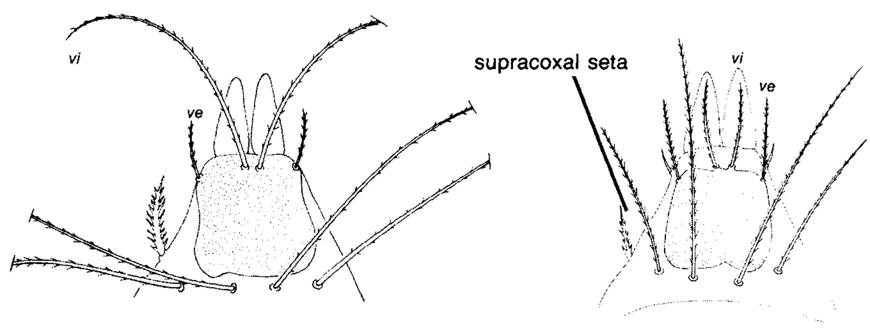
34C *Acarus immobilis*

34D *Acarus immobilis*

35 Seta *vi* more than 4 times longer than seta *ve* (35A); pl. 20B
--**cheese mite,** *Tyrolichus casei*

Distribution: cosmopolitan. Foods: many stored foods, including cheese.

Seta *vi* less than 3 times as long as seta *ve* (35B). Genus *Tyrophagus* -------------- 36



35A *Tyrolichus casei*

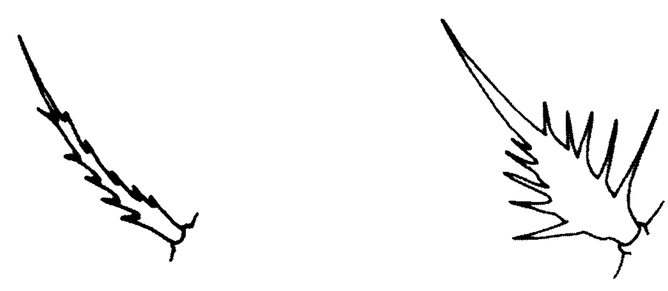
35B *Tyrophagus longior*

36 Supracoxal seta (see 35B) slender, with short, stout spicules (36A); seta d_2 not surpassing base of d_3 (pl. 21A)---*Tyrophagus longior*

Distribution: cosmopolitan. Foods: cheese, grains, and many other stored foods.

Supracoxal seta stout, bulbous, with long, slender spicules (36B); seta d_2 extending well beyond base of d_3 (pl. 21B)----------------------- **mold mite,** *Tyrophagus putrescentiae*

Distribution: cosmopolitan. Foods: fungi; foods with high protein and fat content (dried eggs, cheese, copra, nuts, flour and many other stored foods). Another species, *T. tropicus,* which has been found in copra and rice, would also key out at this point. *T. tropicus* has been collected in Africa, Europe, New Britain, and the United States. According to Hughes (*18*), *T. tropicus* differs from *T. putrescentiae* in having seta *la* almost twice as long as d_1 (*la* and d_1 are subequal in length in *T. putrescentiae*).



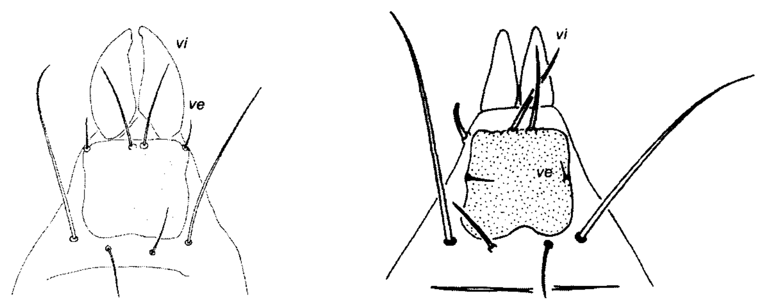
36A *Tyrophagus longior*

36B *Tyrophagus putrescentiae*

37 Seta *ve* nearly level with *vi* (37A)----------**brownlegged grain mite,** *Aleuroglyphus ovatus*

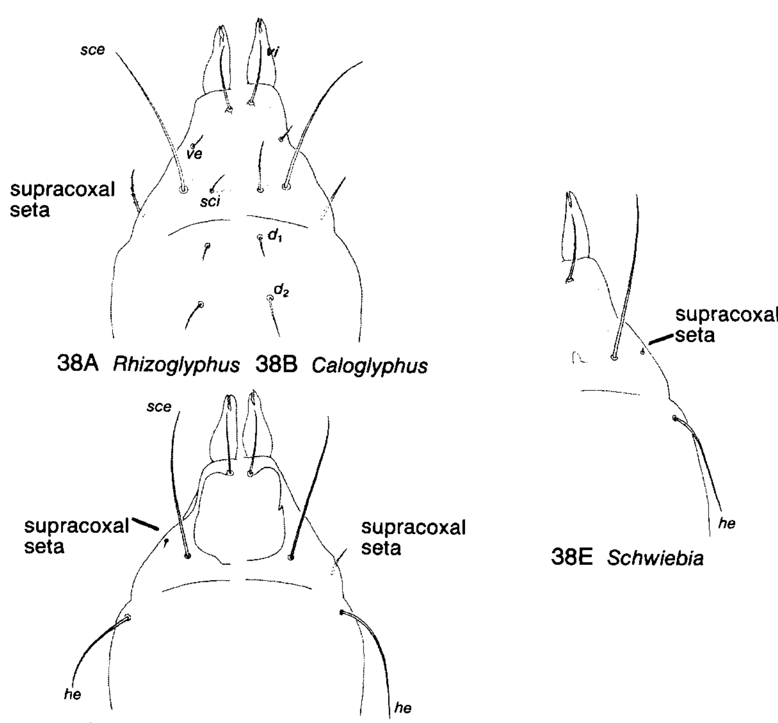
Distribution: Europe, Japan, North America, Russia.
Foods: probably feeds on fungi associated with wheat, bran, flour, chicken meal, and dried fish products.

Seta *ve* absent (see 31B) or, if present, then not on a level with *vi* (37B; see also 31C)--- 38



37A *Aleuroglyphus ovatus* 37B *Caloglyphus*

38 Setae *sci*, d_1-d_5 present (38A, 38B)-- 39
Setae *sci*, d_1, d_2, and d_5 absent (38C, 38D, 38E)-- 40



38A *Rhizoglyphus* 38B *Caloglyphus*

38C *Histiogaster* 38D *Thyreophagus*

38E *Schwiebia*

39 Tarsus I with a large, spinelike seta adjacent to ω_1 and ω_2 (39A)---------------- *Rhizoglyphus*

Members of this genus are sometimes called bulb mites. They are associated with decaying plant and animal matter. Three species, *R. robini* (pl. 22B, 23), *R. echinopus,* and *R. callae,* all widely distributed, have been mentioned in the literature as potential food contaminants. References: *18, 21.*

Tarsus I with a simple seta adjacent to ω_1 and ω_2 (39B)------------------------------ *Caloglyphus*

C. [=*Sancasania*] *berlesei* (pl. 24), a virtually cosmopolitan species, feeds on fungi associated with damp, out-of-condition foods. Reference: *18.*

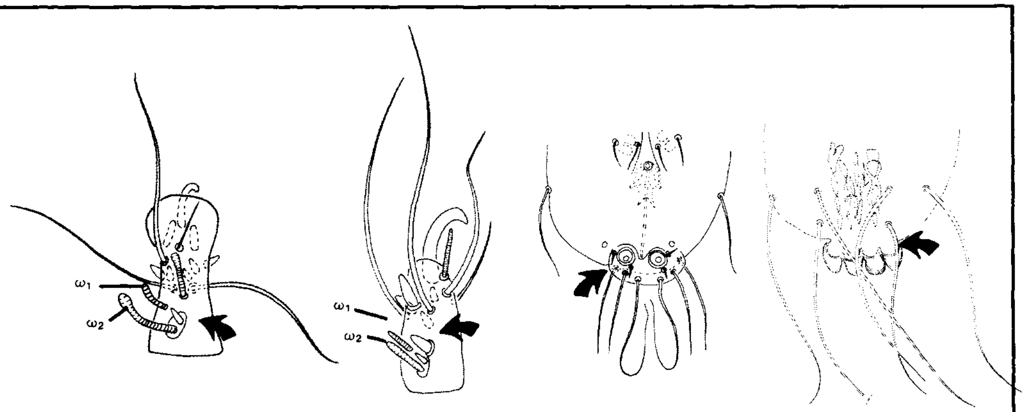
39A *Rhizoglyphus* 39B *Caloglyphus*

40 Tarsus I without spinelike seta in front of ω_1 and ω_2 (40A)
--- *Thyreophagus entomophagus*

Opisthosomal shield of male simple (unlobed) (40B). Distribution: Europe, North America. Foods: flour, dried insects.

Tarsus I with spinelike seta (*ba*) in front of ω_1 and ω_2 (40C)------------------------------ 41

Opisthosomal shield of male, when present, with 4 lobes (40D).



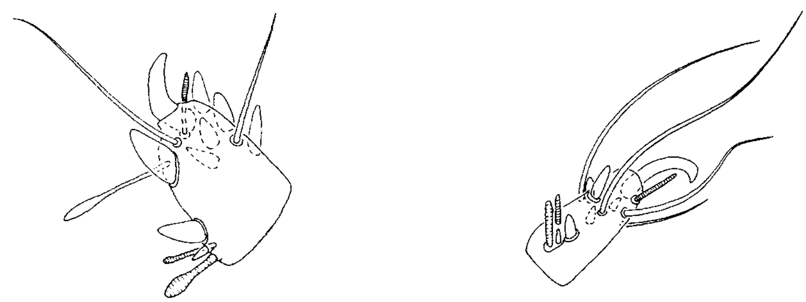
40A *Thyreophagus entomophagus* 40C *Histiogaster* 40B *Thyreophagus entomophagus* 40D *Histiogaster*

41 Tarsus I short and stubby, about as long as wide (41A); opisthosomal shield absent from male-- *Schwiebia*

Distribution: cosmopolitan. Foods: cottonseed meal, ginger (rotting), taro, yams. Reference: see Manson (*C009*) in chapter 28.

Tarsus I elongate, more than twice as long as wide (41B); opisthosomal shield present on male (see 40D)-- *Histiogaster*

Distribution: Europe, Hong Kong, North America. Foods: dried fish, tomatoes; also found in wine. Reference: see Woodring (*C018*) in chapter 28.



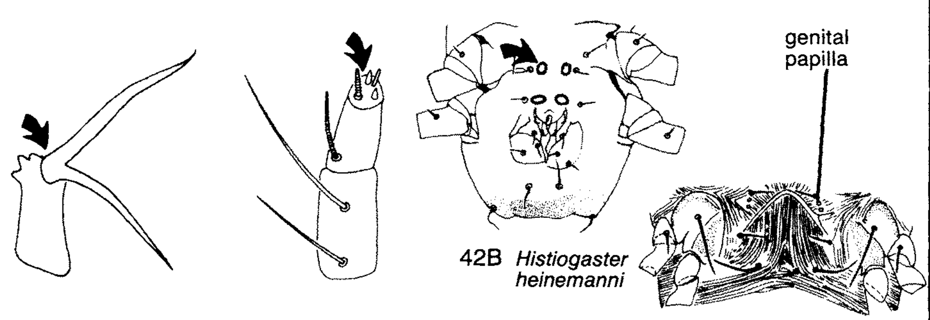
41A *Schwiebia* 41B *Histiogaster*

42 Palpal tarsus with apical sensillae forming a V-shaped process (42A); metapodosomal venter with prominent, strongly-sclerotized, ringlike structures (42B); hypopodial stage present (pl. 25)------------------------ histiostomatid mites, Histiostomatidae

Some members of this family are associated with the production of cultivated mushrooms. *Histiostoma heinemanni* (pl. 25-27) is typical of the family.
42B adapted from *15*.

Palpal tarsus without V-shaped process (42C); metapodosomal venter without ringlike structures (genital papillae may be present, as in 42D, but they are small and weakly sclerotized); hypopodial stage absent. Pyroglyphidae (pyroglyphid mites)--------- 43

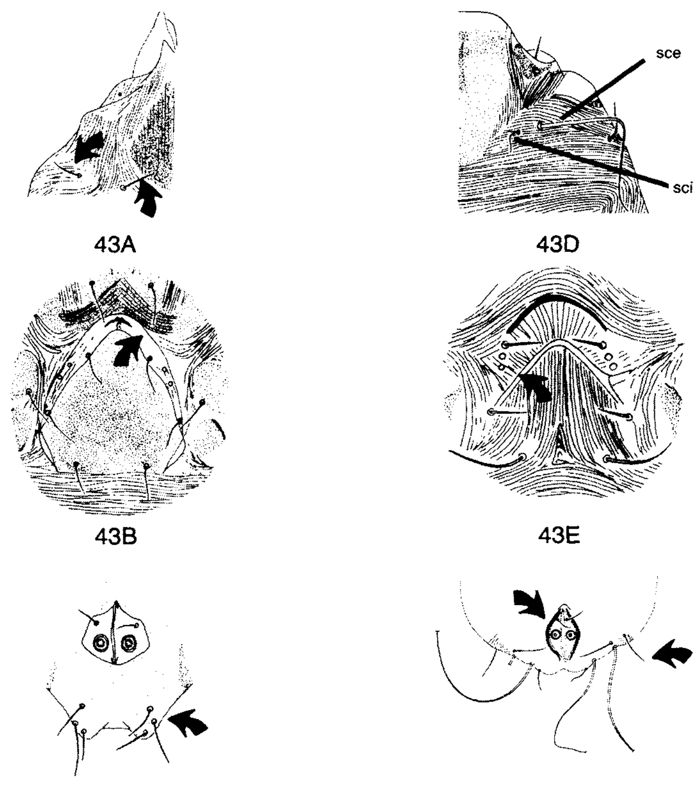
References: *5, 10, 11.*



42A *Histiogaster heinemanni* 42B *Histiogaster heinemanni* 42C *Dermatophagoides farinae* 42D *Dermatophagoides farinae*

43 Seta *sce* as long as *sci* (43A); vulva covered with a membrane (43B); posterior margin of idiosoma of male with 3 to 6 setae (43C); anal sucker plate not surrounded by sclerotized arcs (43C). Genus *Euroglyphus* -- 44
Seta *sce* at least 5 times longer than *sci* (43D); vulva not covered with a membrane (43E); posterior margin of idiosoma of male with 10 setae (43F); anal sucker plate surrounded by sclerotized arcs (43F). Genus *Dermatophagoides* -------------------- 45

The species of *Dermatophagoides* considered here are associated with "house dust."
43A-C adapted from *10*; 43D from *11*.



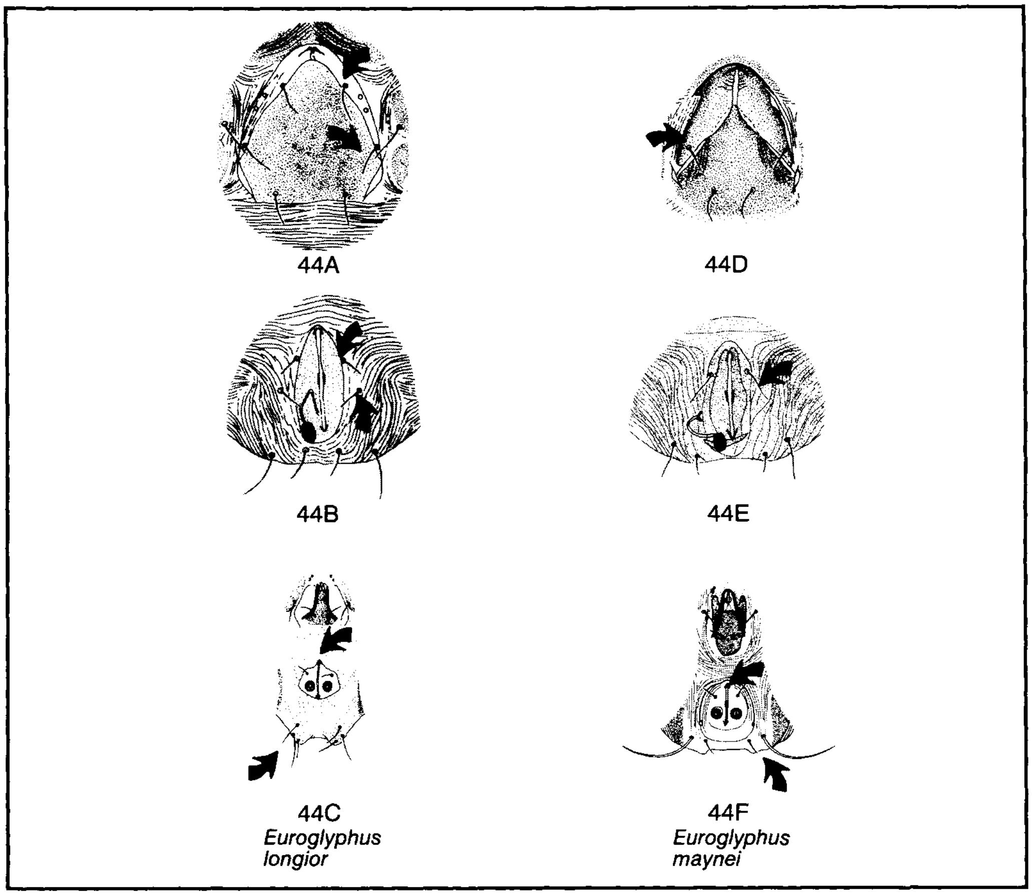
43A
43D
43B
43E
43C *Euroglyphus longior*
43F *Dermatophagoides farinae*

44 Genital sclerite with 2 pairs of setae (44A); with 2 pairs of setae near anal aperture (44B); anal plate of male pointed and located approximately equidistant between genital plate and posterior margin of opisthosoma (44C); ventral opisthosoma of male with 3 pairs of setae near posterior margin (44C); pl. 28, 29
-- *Euroglyphus longior*

Distribution: England, France, Sweden, United States (Ohio). Food: granary debris.

Genital sclerite with 1 pair of setae (44D); with 1 pair of setae near anal aperture (44E); anal plate of male rounded and located closer to the posterior margin of body than to the genital plate (44F); ventral opisthosoma of male with 2 pairs of setae near posterior margin (44F); pl. 30, 31------------------------------*Euroglyphus maynei*

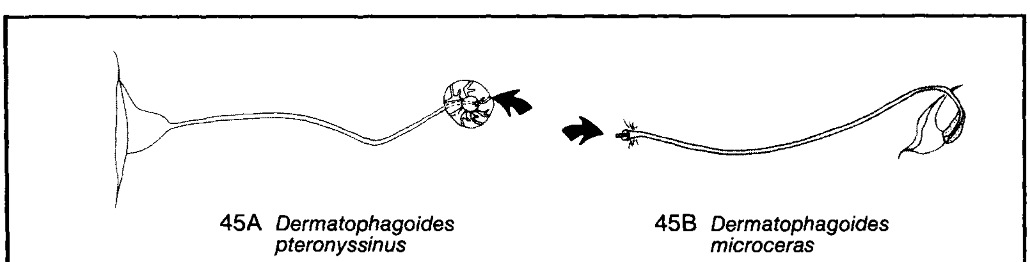
Distribution: Europe, Japan. Substrates: decomposing cottonseed oil; house dust.
44A-F adapted from *10.*



45 Seminal receptacle of bursa copulatrix (see pl. 32) with daisylike sclerotized base (45A) --------------------------------**European house dust mite,** *Dermatophagoides pteronyssinus*

Distribution: essentially cosmopolitan. See also couplet illustration 17B.

Base of seminal receptacle not daisylike in shape (45B)------------------------------------ 46

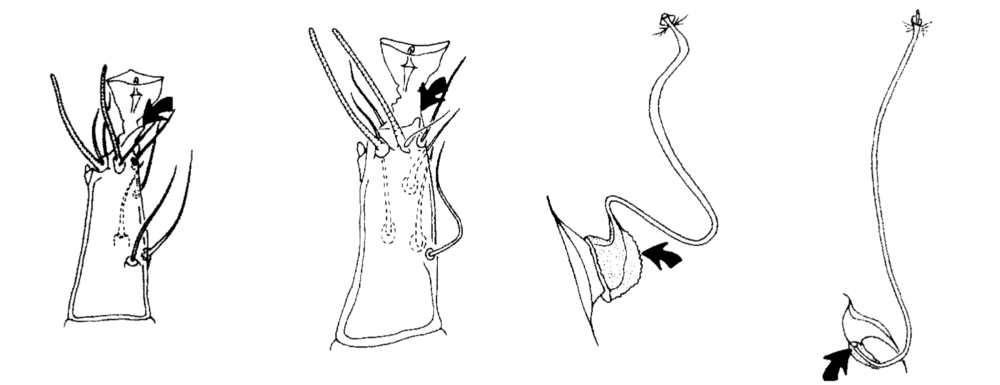


46 Sclerotized process at apex of tarsus I large and sharp (46A); bursa copulatrix heavily sclerotized (46B); pl. 32----------**American house dust mite,** *Dermatophagoides farinae*

Distribution: England, Japan, Netherlands, Russia, Sierra Leone, United States.

Sclerotized process at apex of tarsus I small and blunt (46C); bursa copulatrix lightly sclerotized (46D)--*Dermatophagoides microceras*

Distribution: England, Spain, United States (Louisiana).



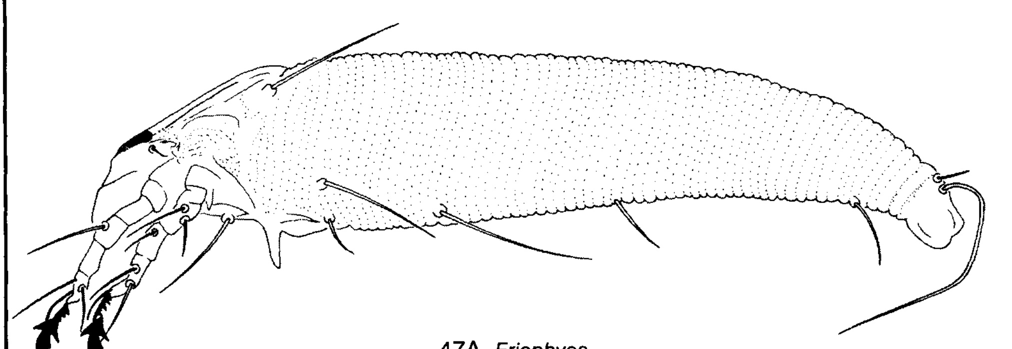
46A *Dermatophagoides farinae* 46C *Dermatophagoides microceras* 46B *Dermatophagoides farinae* 46D *Dermatophagoides microceras*

Suborder Prostigmata

47 With 2 pairs of legs (47A) --eriophyoid mites, Eriophyoidea

The **fig mite,** *Eriophyes ficus* (47A) (Eriophyidae), is representative of this superfamily. Eriophyoids are phytophagous and cosmopolitan. They are variously called bud mites, gall mites, blister mites, or rust mites, depending on where they locate in the host or on the kind of reaction they cause in the host (*20*).

With 3 (pl. 33A) or 4 (pl. 33B) pairs of legs --- 48



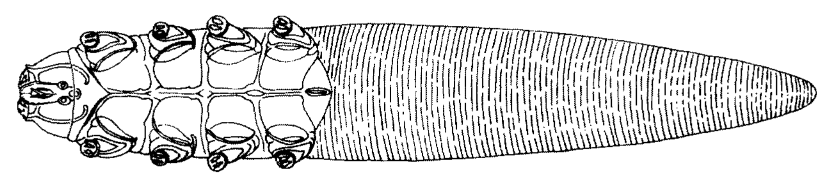
47A *Eriophyes ficus*

48 Body wormlike (48A) ---**follicle mites,** Demodicidae

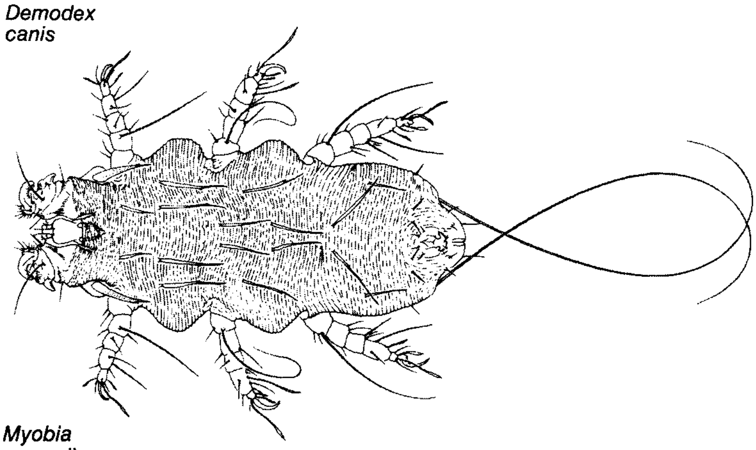
The **dog follicle mite**, *Demodex canis* (48A), is representative of the many host-specific demodicids that parasitize many kinds of mammals. Most follicle mites have all 4 pairs of legs short and stubby. Nematalycid mites (Nematalycidae) are also wormlike in form but they have long legs. They are widely distributed in soils around the world (*20*).

48A&B redrawn by C. Feller from *3* and *1*, respectively.

Body not wormlike (48B) --- 49



48A *Demodex canis*

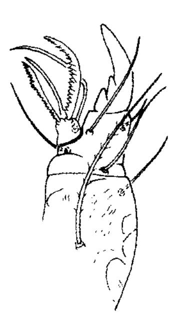


48B *Myobia musculi*

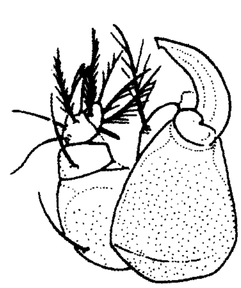
49 Palpal tarsus with thumb-claw complex (49A-C) -- 50

49C adapted from *3*.

Palpal tarsus without thumb-claw complex (49D)-- 54

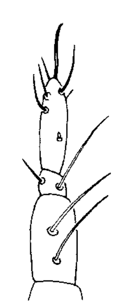


49A *Cheyletus eruditus*



49B *Leptotrombidium akamushi* (larva)

49C *Byrobia praetiosa*



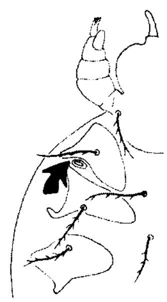
49D *Tydeus*

50 Larva with urstigma (Claparède organ) (50A); adult with crista metopica (50B; see also 50C)--Trombidioidea

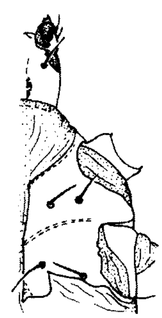
Although it is possible that other members of this superfamily might become associated with food, the form of special interest here is the chigger, the parasitic, six-legged larval stage of the Trombiculidae. Members of the genus *Leptotrombidium* (pl. 33A) are parasitic on vertebrates, including certain birds and mammals that may become pests in warehouses.
50A adapted from *3,* 50B from *1,* 50C from *24,* and 50D from *22.*

Larva without urstigma (50D); adult without crista metopica (50E)------------------------ 51

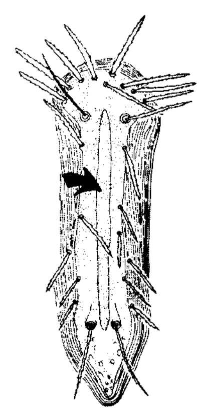
Larvae of the superfamily Erythraeoidea would key out at this point; adults (50C) would key out in the first half of this couplet. Larval erythraeoid mites differ from tetranychids and cheyletids in having a structure resembling a crista metopica. The movable chelae of adult erythraeoids are long and straight and the chelicerae are retractable. Adult trombidioids have nonretractable chelicerae and short, curved, movable chelae. At least one kind of erythraeoid, *Balaustium murorum,* invades buildings in Europe and North America (*20*).



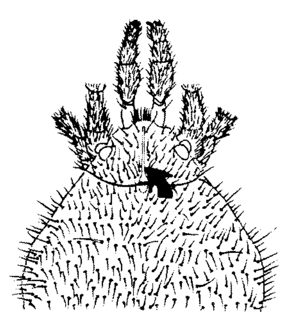
50A *Trombicula microti*



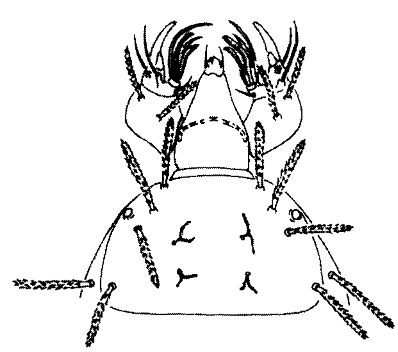
50D *Scutacarus baculitarsus agaricus*



50C *Balaustium putnami*



50B trombidiid mite



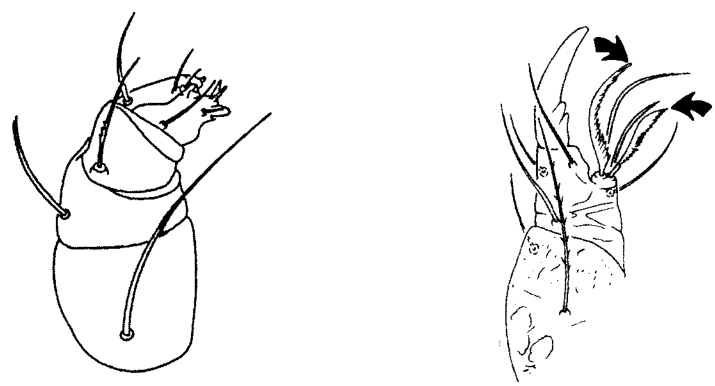
50E *Cheletomorpha lepidopterorum*

51 Palpus without comblike setae (51A)---------------------------------**spider mites,** Tetranychidae

The **clover mite,** *Bryobia praetiosa* (pl. 33B), has the anterior margin of the idiosoma marked by 4 lobes, each bearing a single fringed seta. Note that legs I seem disproportionately long. Clover mites are found in Europe and the United States. They feed on grasses and on other herbaceous plants. They sometimes invade houses and other buildings where they find shelter or lay eggs.

Palpus with comblike setae (51B). Cheyletidae (cheyletid mites)------------------------- 52

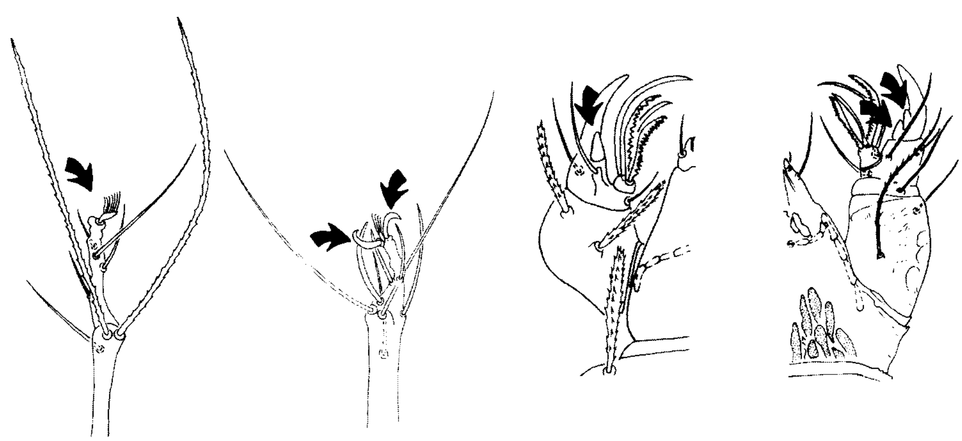
Cheyletid mites prey on small arthropods, especially acarid mites. Their distribution is essentially cosmopolitan. They are often found where foods are stored.



51A *Byrobia praetiosa* 51B *Cheyletus eruditus*

52 Tarsus I without paired claws (52A); palpal claw with 1 basal tooth (52B); pl. 34--*Cheletomorpha lepidopterorum*

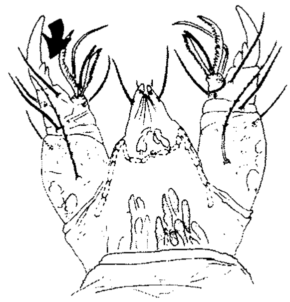
Tarsus I with paired claws (52C); palpal claw with 2 basal teeth (52D) ---------------- 53



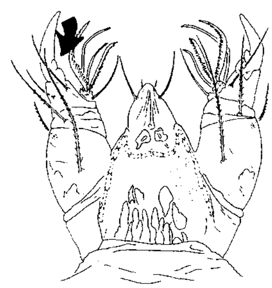
52A *Cheletomorpha lepidopterorum* 52C *Cheyletus malaccensis* 52B *Cheletomorpha lepidopterorum* 52D *Cheyletus eruditus*

53 Basal teeth of palpus similar in form (53A); femur IV with 2 setae (53B) ---------- *Cheyletus eruditus*

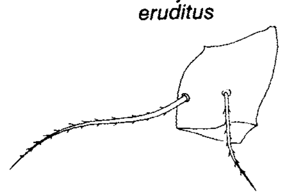
Basal teeth dissimilar (51C); femur IV with 1 seta (53D) ---------- *Cheyletus malaccensis*



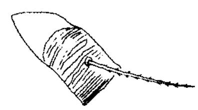
53A *Cheyletus eruditus*



53C *Cheyletus malaccensis*



53B *Cheyletus eruditus*

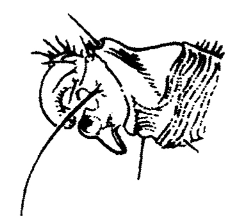


53D *Cheyletus malaccensis*

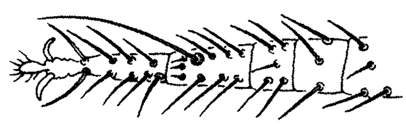
54 Leg I modified for clinging to hairs (54A) ---------- myobiid mites, Myobiidae

Myobia muscularis (see couplet illustration 48B), *Radfordia affinis*, and *R. ensifera* commonly occur as parasites on wild and laboratory rats and mice.

Leg I not modified for clinging to hairs (54B) ---------- 55



54A *Myobia muscularis*

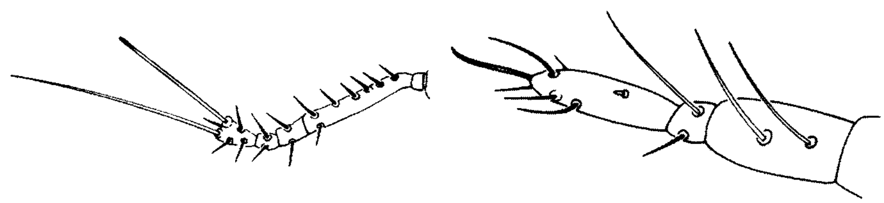


54B *Spinibdella bifurcata*

55 Palpus somewhat elbow-shaped, with 2 long apical setae, the longer being at least 4 times as long as the palpal tarsus (55A) ---------- snout mites, Bdellidae

Spinibdella bifurcata (pl. 35A) is a predator on mites associated with grains and flours in Mexico and the United States (Texas).

Palpus not elbowed; apical setae variable, but none longer than palpal tarsus (55B) 56

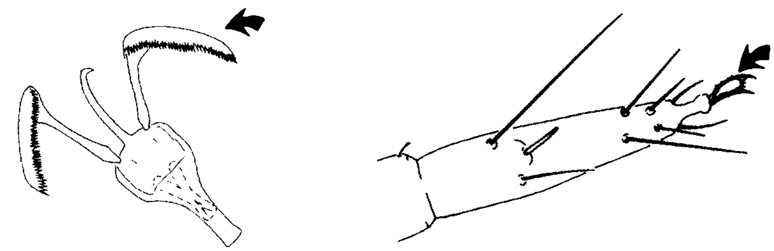


55A *Spinibdella bifurcata* 55B *Tydeus*

56 Tarsal claw both pectinate and scythe-shaped (56A)------------halacarid mites, Halacaridae

Distribution: marine habitats. *Rhombognathides seahami* (pl. 35B) is found on dulse, a coarse red seaweed used as a condiment.

Tarsal claw not pectinate or, if pectinate, then not scythe-shaped (56B)-------------- 57

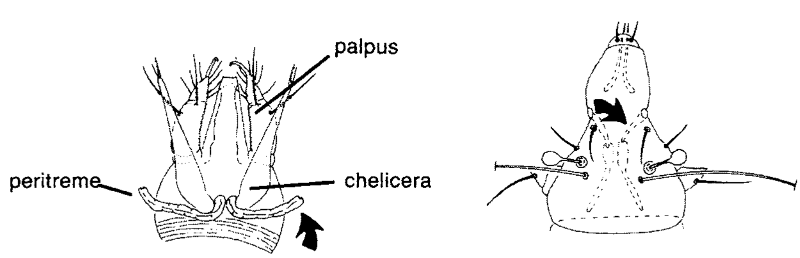


56A *Rhombognathides seahami* 56B *Tydeus*

57 External peritreme present (57A); pl. 36A. Pterygosomatidae (pterygosomatid mites) --cockroach mite, *Pimeliaphilus cunliffei*

These mites, formerly called *P. podapolipophagus* Trägårdh, are ectoparasites of cockroaches. Their distribution coincides with that of their hosts.
Reference: *19*.
57A from *1*, courtesy E. W. Baker.

External peritreme absent (57B)--- 58

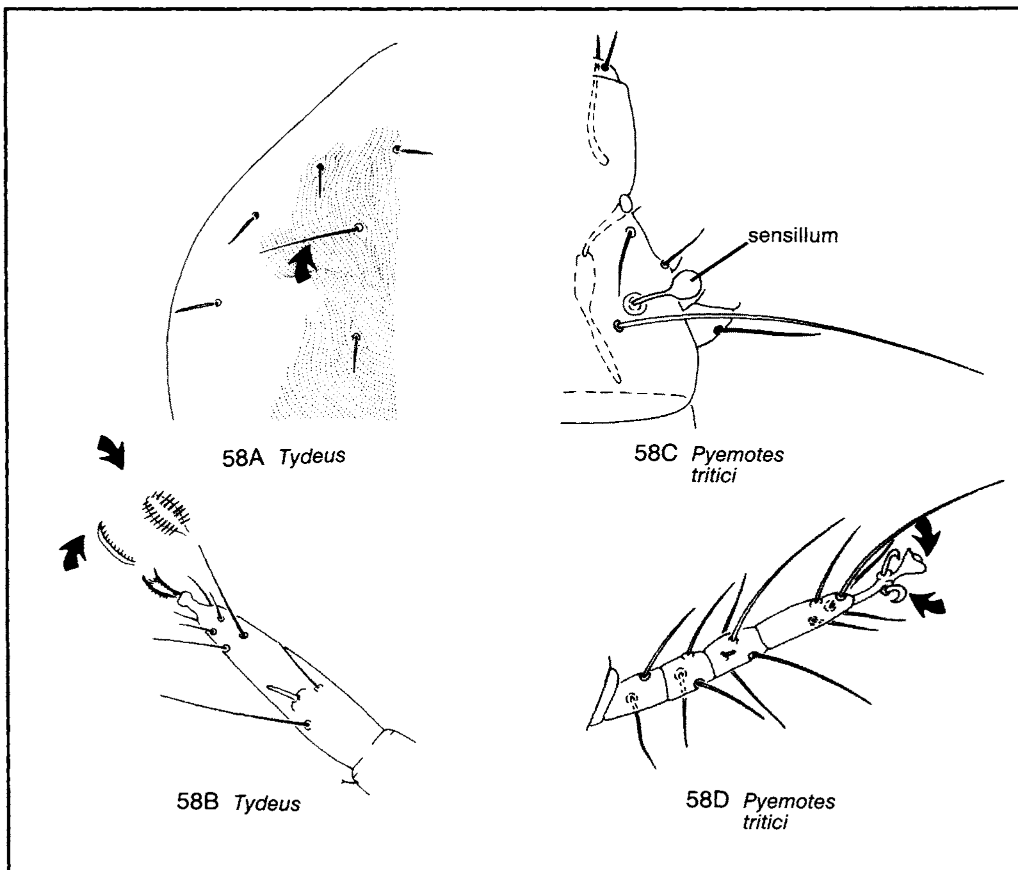


57A *Pimeliaphilus cunliffei* 57B *Pyemotes tritici*

58 Sensillum (prodorsal trichobothrium) of female setaceous (58A); tarsal claw and empodium either smooth or pectinate; rayed hairs present (58B) ---------- **tydeid mites,** Tydeidae

Tydeid mites, especially members of the genus *Tydeus* Koch (pl. 36B), occasionally occur in association with stored foods, but their role there is uncertain; probably they prey on insects and on other mites.

Sensillum of female globular (58C); tarsal claw and pulvillus smooth, without rayed hairs (58D) ---------- 59



58A *Tydeus*

58B *Tydeus*

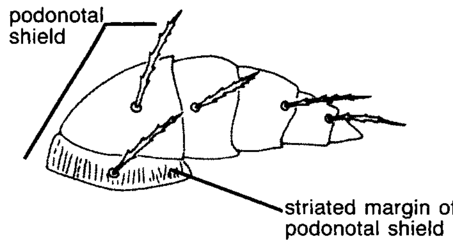
58C *Pyemotes tritici*

58D *Pyemotes tritici*

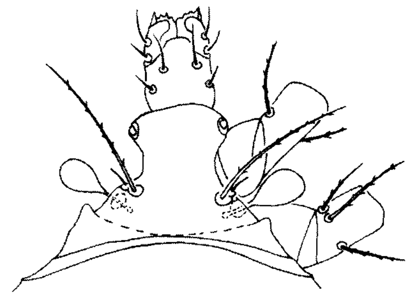
59 Female with hoodlike podonotal shield covering propodosoma and gnathosoma (margin of podonotal shield striated) (59A); trochanter IV of male subtriangular (59B) ---------- scutacarid mites, Scutacaridae

Scutacarus baculitarsus agaricus (22) (pl. 37, 38) is representative of the family. This subspecies has been found in commercial mushroom beds in Pennsylvania and Delaware. The adults are phoretic on phorid flies. The family includes other soil mites that are widely distributed around the world.

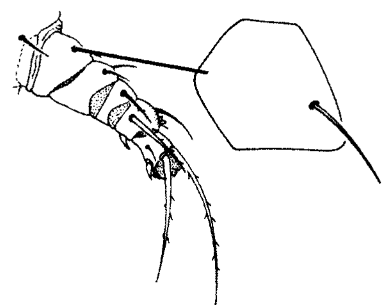
Female without hoodlike podonotal shield (59C); trochanter IV of male subrectangular (59D) ---------- 60



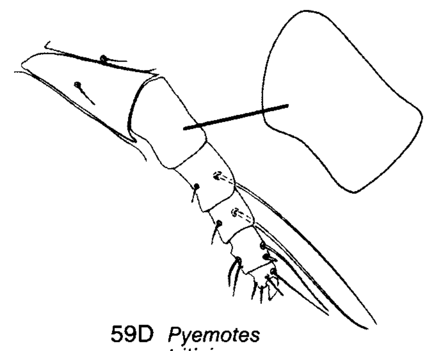
59A *Scutacarus baculitarsus agaricus* (lateral view)



59C *Pseudopygmephorus smileyi*



59B *Scutacarus baculitarsus agaricus*

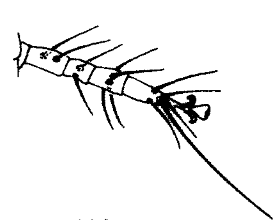


59D *Pyemotes tritici*

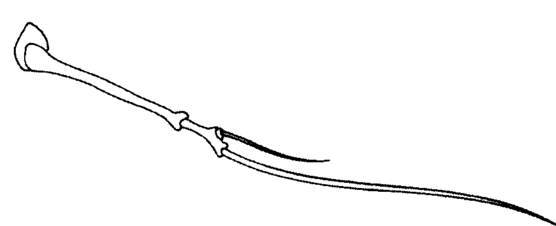
60 Leg IV of female with pretarsus, claw, and pulvillus, but without apical whiplike setae (60A); idiosoma elongate; palpus of male reduced in size or absent, never forming an elongate beak (pl. 39); gravid female with saclike hysterosoma (pl. 40A)------ 61

Leg IV of female without pretarus, claw, and pulvillus, but with apical whiplike setae (60B); idiosoma oval; male palpus always present but variable in shape, sometimes forming an elongate beak; gravid female without saclike hysterosoma (pl. 44). Tarsonemidae (**tarsonemid mites**)-- 62

Certain tarsonemid mites live on fungi, some of which are associated with stored grains. Two species, *Tarsonemus mercedesae* and *T. lukoschusi*, have been associated with commercial mushroom production in Pennsylvania (*16*). Other tarsonemids feed on the eggs of bark beetles and tetranychoid mites (*26*).



60A *Pyemotes tritici*



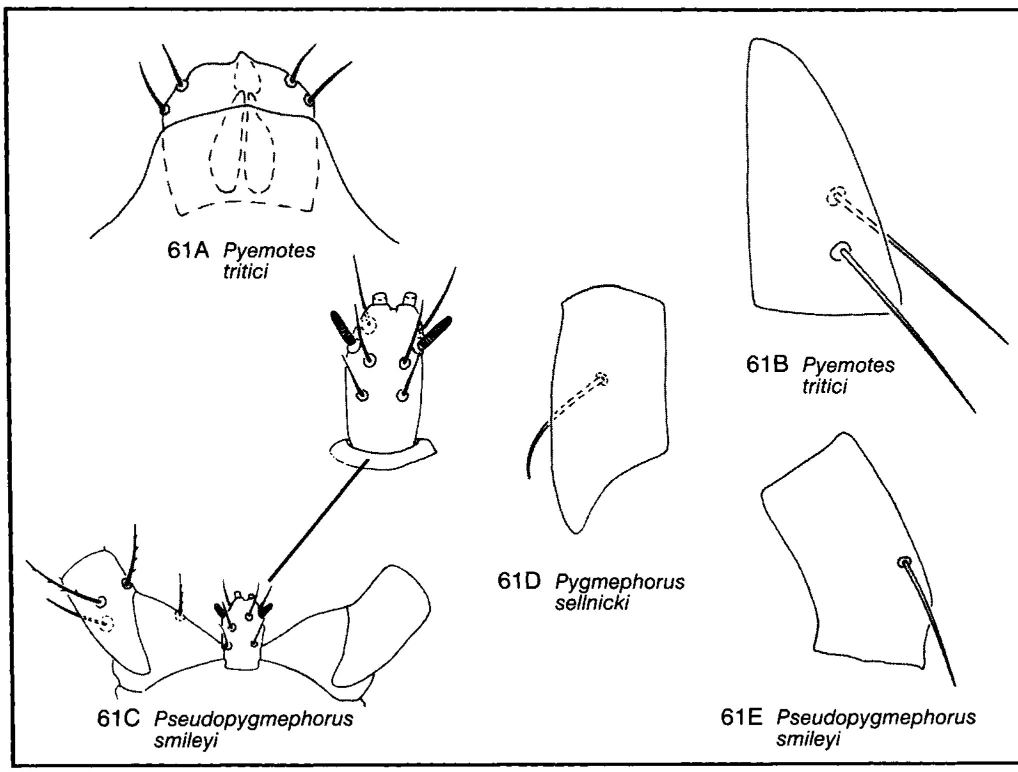
60B *Tarsonemus scaurus*

61 Gnathosoma of male about as wide as long (61A); trochanter IV of female triangular (61B)--**pyemotid mites,** Pyemotidae

The **straw itch mite,** *Pyemotes tritici* (*6*) [= *P. ventricosus* (Newport)] (pl. 39, 40), is a parasite of various insects including *Oryzaephilus surinamensis, Sitophilus oryzae, Callosobruchus maculatus,* and *Sitotroga cerealella.*

Gnathosoma of male longer than wide (61C); trochanter IV of female quadrangular (61D, 61E)--mushroom mites, Pygmephoridae

Pygmephorus sellnicki (pl. 41), a European species introduced into the United States, is common on cultivated mushrooms (*25*). *Pseudopygmephorus smileyi* (pl. 42, 43) is a mushroom pest in Pennsylvania (*17*). 61C&E adapted from *17.*



61A *Pyemotes tritici*

61B *Pyemotes tritici*

61C *Pseudopygmephorus smileyi*

61D *Pygmephorus sellnicki*

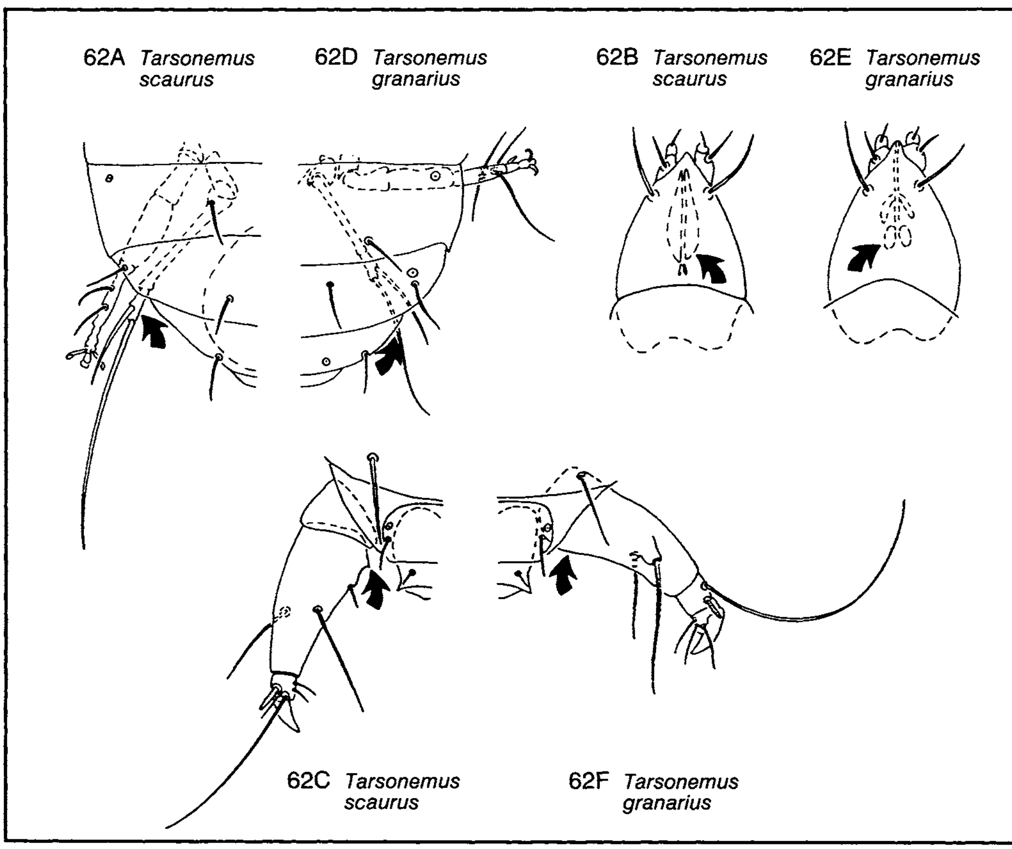
61E *Pseudopygmephorus smileyi*

62 Leg IV of female extending beyond margin of opisthosoma (62A); pharyngeal structure strongly sclerotized, without conspicuous glands at base (62B); femur IV of male with angulation on inner surface near base (62C); pl. 44
---*Tarsonemus scaurus*

Distribution: United States.

Leg IV of female not extending beyond margin of opisthosoma (62D); pharyngeal structure weakly sclerotized, with conspicuous glands at base (62E); femur IV of male without angulation near base (62F); pl. 45
---*Tarsonemus granarius*

Distribution: Canada, England, Japan.



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Notes and Sketches

2 COCKROACHES (BLATTARIA, DICTYOPTERA)

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This key to the adults and egg cases (oothecae) of the species most likely to infest food products is intended primarily for taxa occurring in the United States. It will be helpful for many other countries also because most of the species discussed here are cosmopolitan or nearly so.

The basic classification of cockroaches followed here is that of McKittrick (*31*). Her system, which has been endorsed widely, recognizes five families: Cryptocercidae, Polyphagidae, Blattidae, Blattellidae, and Blaberidae. Some earlier classifications recognized a larger number of families, some of which are still used by a few writers. In an older, traditional sense, a single family, "Blattidae," includes all cockroaches; this usage still appears in some textbooks and general entomological literature.

The species included in this key are listed here according to their family affiliation and in the order in which they appear in the following key to adult cockroaches.

Blattidae: *Periplaneta fuliginosa* (pl. 46D); *P. australasiae* (pl. 47A); *P. americana* (pl. 47B); *P. brunnea* (pl. 47C); *Neostylopyga rhombifolia* (pl. 47D); *Blatta orientalis* (pl. 51A&B); *Eurycotis floridana* (pl. 51C&D); *Blatta lateralis* (pl. 48).

Blattellidae: *Blattella vaga* (pl. 52B); *B. germanica* (pl. 52C-E); *Supella longipalpa* (pl. 54C-E); *Ectobius pallidus* (pl. 55A); *E. sylvestris* (pl. 55D); *Parcoblatta* spp. (pl. 56A-C).

Polyphagidae: Keyed to family level only (pl. 56D&E).

Cryptophagidae: Keyed to family level only (pl. 57A).

Blaberidae: *Panchlora nivea* (pl. 57B); *Pycnoscelus surinamensis* (pl. 57C&D); *Nauphoeta cinerea* (pl. 59); *Blaberus* spp. (pl. 60); *Leucophaea maderae* (pl. 61).

Although any of these species may be important at times, four species are the most serious pest cockroaches in the United States: *Blattella germanica, Periplaneta americana, Blatta orientalis,* and *Supella longipalpa.* In the southern third of the United States, *Periplaneta brunnea* is quite prevalent, sometimes more common than *P. americana.* In foreign countries with tropical or subtropical climates, as well as on board ships carrying fruit or other commercial foodstuffs, several other species often attain considerable stature as pests, notably *P. australasiae* and *Leucophaea maderae.*

The recent—and hopefully ephemeral—appearances of *Blatta lateralis* (*6, 52*), *Blattella asahinai, Ectobius sylvestris* (*26*), and *Epilampra maya* in the United States have prompted us to include in this chapter illustrations of selected species that might become domiciliary in the United States, either by invasion from natural habitats or by importation of cockroaches that are sometimes domestic in their home territories. Those species represented in this chapter only by illustrations are listed here according to their family affiliation.

Blattidae: *Deropeltis erythrocephala* (pl. 50A); *Lamproblatta* spp. (pl. 49A&B); *Methana marginalis* (pl. 49C&D); *Pelmatosilpha* spp. (pl. 50B); *Periplaneta japonica* (pl. 46A&B).

Blattellidae: *Aglaopteryx gemma* (pl. 54A&B); *Blattella lituricollis* (pl. 52A); *Ectobius lapponicus* (pl. 55B&C); *Lupparia* sp. (pl. 53A); *Nyctibora noctivaga* (pl. 53D&E); *Shawella couloniana* (pl. 53B&C).

Polyphagidae: *Arenivaga* spp. (pl. 56D&E).

Cryptocercidae: *Cryptocercus punctulatus* (pl. 57A).

Blaberidae: *Blaberus craniifer* (pl. 60A&B); *B. discoidalis* (pl. 60C); *B. giganteus* (pl. 60D); *Pycnoscelus indicus* (pl. 58).

For readers wishing information on aspects other than those dealt with here, the following publications from among those listed at the end of the chapter are suggested (others are mentioned in the key): Cockroaches in general, *9, 20;* life history information, especially the duration of the stages of the better known species, *14, 47, 53, 54;* applied aspects, *10, 11, 30;* ecology, *48, 51;* identification, *21, 23-25, 29, 32, 34, 38, 42* (see also chapter 28); approved common names, *8.*

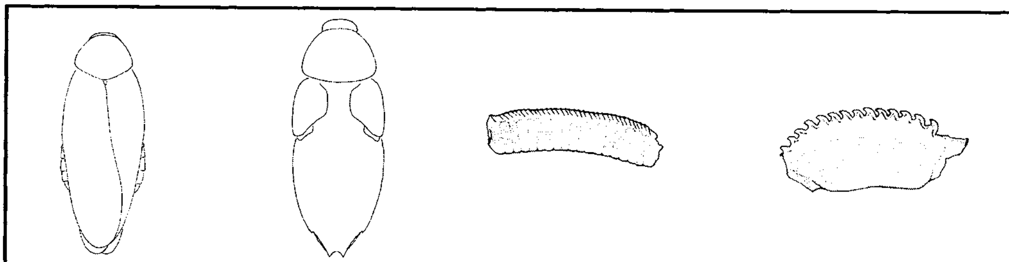
KEY
Drawings by A.D. Cushman unless otherwise noted.

1 Adult cockroach-- 2

This key to adults is adapted from Pratt and Stojanovich (*35*). Adults of all the species (or genera in the case of *Parcoblatta* and *Blaberus*) included in this key bear wings (1A), though some have only very short ones (1B). Younger nymphs show no sign of wings (pl. 52C); wing pads (sheaths) appear as nymphs mature (pl. 52D). Since nymphal and adult cockroaches share many morphological features, it is possible also to identify with this key the nymphal stages of many of the species; care should be taken when the key is applied to nymphs. Some wingless cockroaches of lesser economic importance, e.g., *Lamproblatta* spp. (Blattidae, see couplet 3) of the Neotropics, *Arenivaga* spp. (only males winged; Polyphagidae, see couplet 16) of the southwestern deserts (USA), *Polyphaga* spp. (males winged; Polyphagidae) of southern Asia and North Africa, and *Cryptocercus punctulatus* (Cryptocercidae, see couplet 17) of North America, are not covered here.
Drawings 1A-D by C. Feller.

Ootheca-- 22

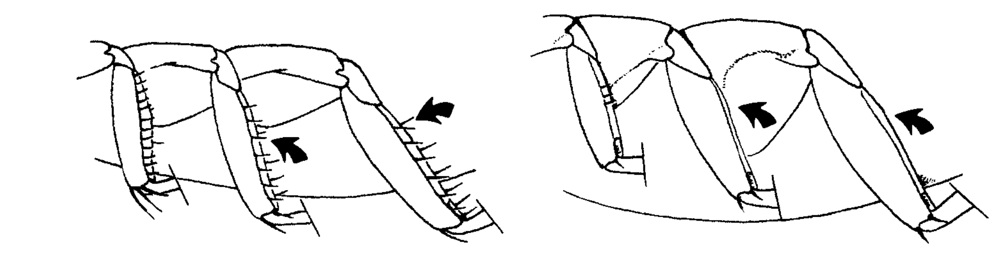
Roth and Willis (*47*) and Roth (*44*) discussed types of reproduction, and Roth (*42, 45*) illustrated the oothecae of many species. Several entomologists (V.E. Adler, H.G. Scott, L.M. Roth, and D.E. Weidhaas) cooperated in this effort by generously loaning us egg cases associated with adults. Dr. Roth also loaned us his notes on identification of egg cases of the common species, and we benefited greatly from his photographs (*42*). We take full responsibility, however, for the distinctions brought out in this key. Although neither polyphagid nor cryptocercid oothecae are likely to be found in domestic or industrial environments, we offer these brief descriptive notes to show that they cannot be easily confused with the egg capsules that are keyed out below. The well-sclerotized ootheca of *Cryptocercus punctulatus* (1C) is elongate, about 8 to 10 mm long by 2.3 mm high, has a well-developed keel with broad dentition, and has about 17 well-defined egg chambers; respiratory pores (one in each denticle) are present but there are no respiratory tubes. Polyphagid oothecae are well-sclerotized. The structure of the keel and the occurrence of respiratory tubules vary among the many species. The end of the ootheca that is held by the female bears a flattened flange (1D), a structure that makes the polyphagid ootheca unique among the Blattaria (*42*). The flange of some species is elongate and beaklike.



1A *Panchlora nivea* | 1B *Blatta lateralis* | 1C *Cryptocercus punctulatus* | 1D *Polyphaga aegyptiaca*

Adults

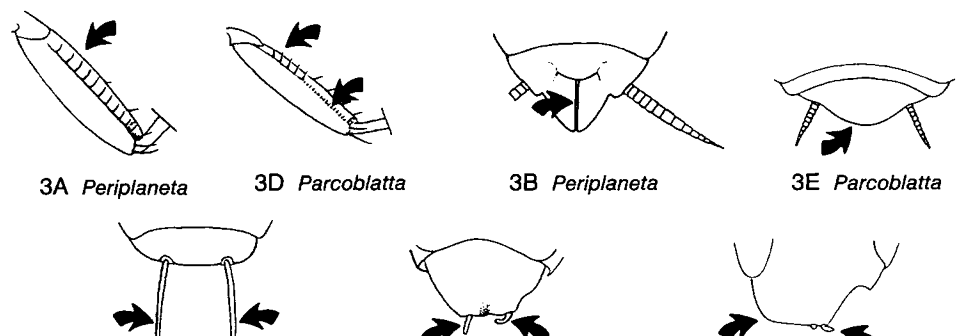
2 Femora II and III with both ventral margins (anterior and posterior) bearing numerous, similarly-arranged, strong spines (2A) ---------- 3
Femora II and III lacking strong spines on ventral margin (2B) ---------- 16



2A *Periplaneta americana* 2B *Blaberus*

3 Large species (pl. 47A), length 18 mm or more (including folded wings); anteroventral margin of femur I always with only large, robust spines (3A); subgenital plate (terminal ventral segment) of female divided longitudinally, appearing valvular (3B); both styli on male subgenital plate similar, symmetrical, elongate, and nearly straight (3C). Blattidae (blattids, blattid cockroaches)---------- 4
Smaller species (pl. 54), usually less than 18 mm long, or, if longer, the anteroventral margin of femur I bears large, robust spines on the basal part, and small, more delicate spines on the distal half (3D); female subgenital plate simple, undivided (3E); styli on male subgenital plate not symmetrical, sometimes unequal in size (3F, 3G). Blattellidae (blattellids, blattellid cockroaches)---------- 12

See pl. 53 and 54A&B for illustrations of *Shawella couloniana, Lupparia* sp., *Nyctibora noctivaga,* and *Aglaopteryx gemma,* all blattellid cockroaches not included in this key. *S. couloniana* (Australia, New Zealand) may occasionally enter human dwellings, but it is essentially an outdoor species (*7*). *L. vilis* (Iwo Jima and other western Pacific islands and adjacent land masses) is probably an arboreal cockroach; it is reported to have invaded houses on Iwo Jima (*7*). *N. noctivaga* (Neotropics) and other species of this genus are sometimes exported on bananas from their native territories. *A. gemma* (Bahama Islands; Florida to Texas) has been found in a house in southern Georgia (*13*); normally it is arboreal, living under bark or under signs nailed to trees (*21*).



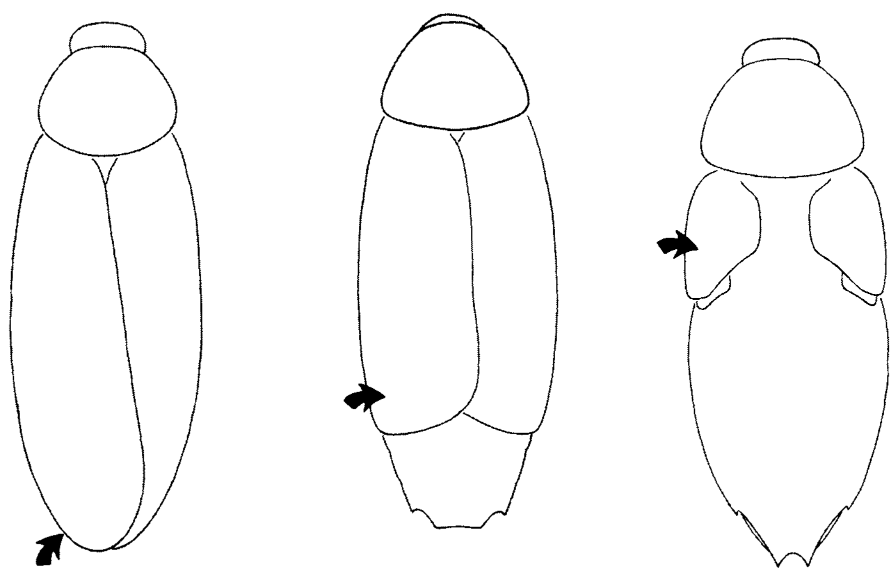
3A *Periplaneta* 3D *Parcoblatta* 3B *Periplaneta* 3E *Parcoblatta*
3C *Periplaneta* 3F *Parcoblatta* 3G *Blattella germanica*

4 Front wings (tegmina), when folded (the position usually seen), extending beyond the tip of abdomen (4A) -- 5

See pl. 46A-C for *Periplaneta japonica,* an exotic species not included in this key. *P. japonica* (China, Japan, USSR) vaguely resembles *Blatta orientalis.* It is an outdoor species, but some populations have become adapted to houses in northern Japan (*7*).
Drawings 4A-C by C. Feller.

Front wings not reaching tip of abdomen (4B), sometimes very short (4C)----------- 9

See pl. 49 and 50 for other blattids, *Lamproblatta* spp., *Methana marginalis, Deropeltis erythrocephala,* and *Pelmatosilpha* sp., not included in this key. *Lamproblatta* spp. (Australia, Neotropics) are outdoor in habit but may become domiciliary on occasion. *M. marginalis* (Australia) lives under the bark of standing or fallen trees. It is an opportunistic invader of human dwellings. *D. erythrocephala* (South Africa) is an outdoor cockroach similar in its house-invading habits to *Parcoblatta* spp. *Pelmatosilpha* spp. (Neotropics, New Zealand) are sometimes shipped with bananas from tropical Latin American countries to many places outside their normal range.

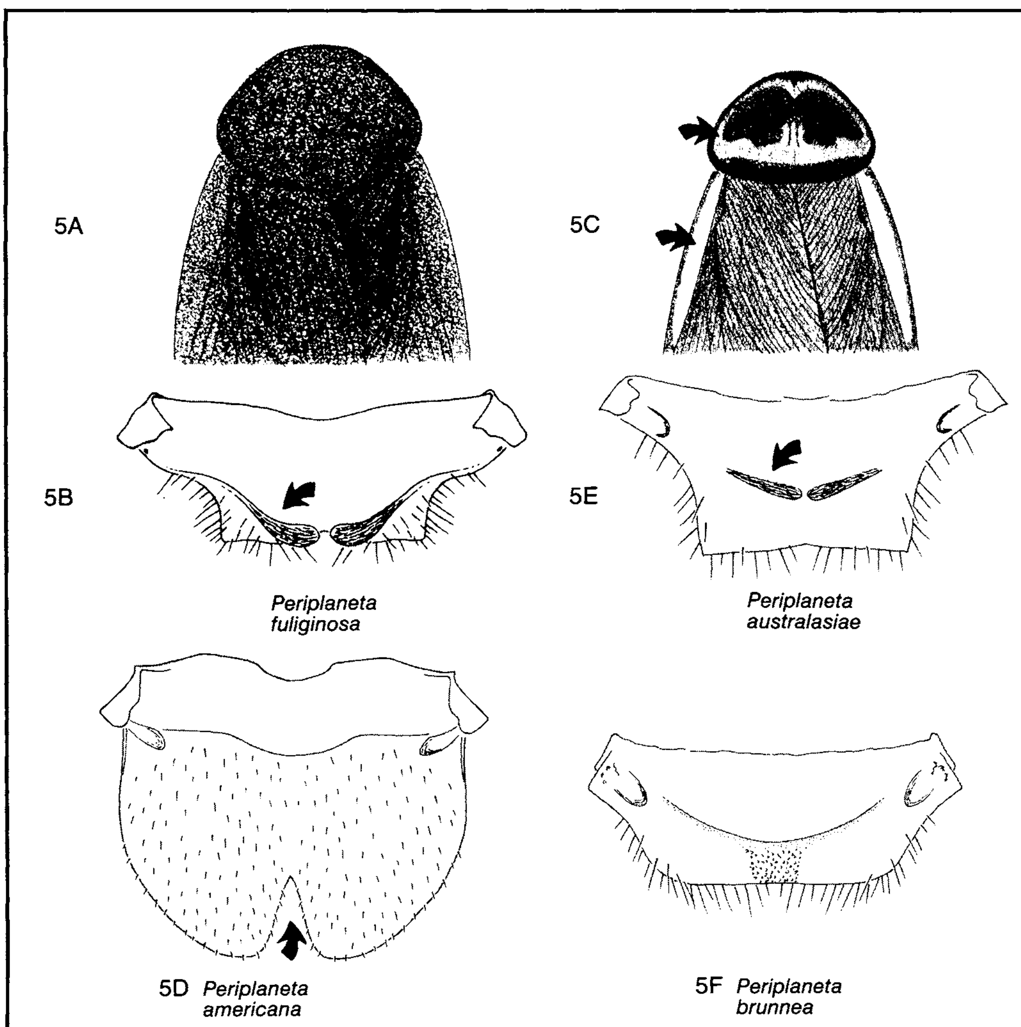


4A *Blatta lateralis*♂ 4B *Blatta orientalis*♂ 4C *Blatta lateralis*♀

5 Color entirely dark, blackish-brown, sometimes shining black (5A); male supraanal plate (terminal abdominal tergite) with thickened structures on ventral surface near apex (5B); pl. 46D ---------------------------- **smokybrown cockroach,** *Periplaneta fuliginosa*

Except for the southern United States, where it is rather common, and California, this species occurs primarily in eastern Asia (*1*); it may have originated there. Although it sometimes is quite important as a pest in buildings, it lives mainly outdoors; sometimes it flies actively. Although smokybrown and American cockroaches sometimes occur together, smokybrowns usually avoid habitats used by *P. americana,* apparently in reaction to pheromones produced by the latter (*33*). Medium- to large-sized nymphs are colored a shining dark chocolate overall, like the adults, but very young nymphs show some white markings.
Drawings 5A&C by C. Feller.

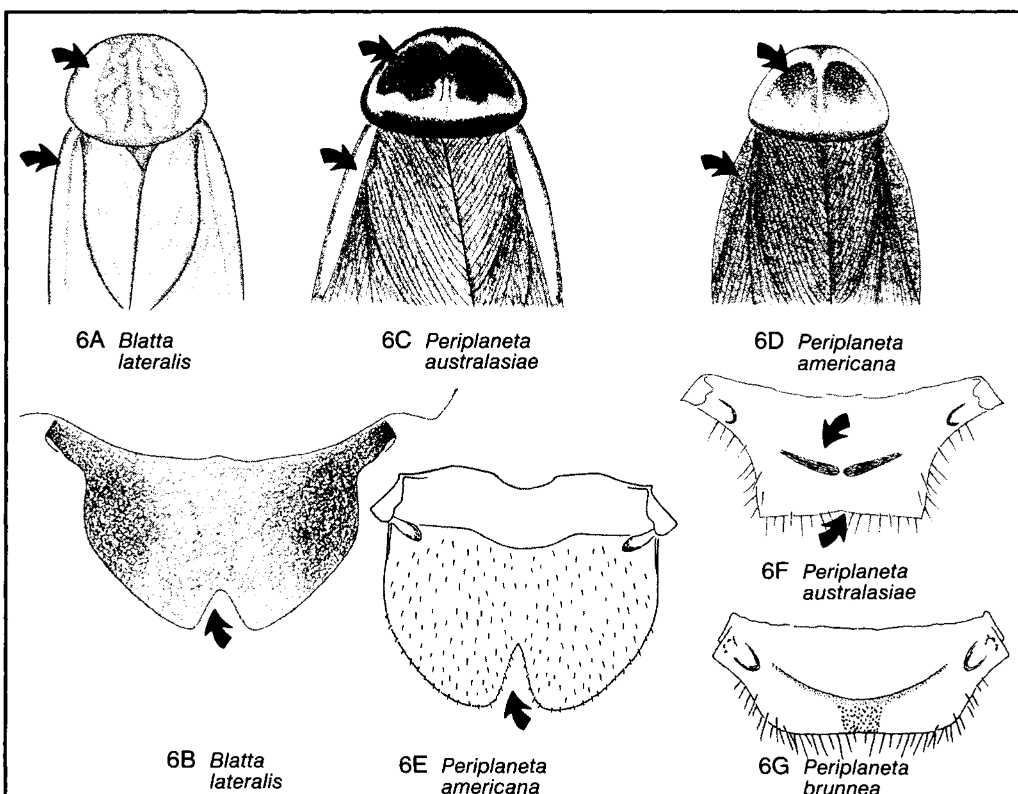
Color not entirely dark, but with some yellowish markings on pronotum or front wings, sometimes on both (5C), or front wings straw-colored (pl. 48♂); male supraanal plate notched (5D), ridged distant from apex (5E), or neither notched nor ridged (5F) 6



6 Front wing brownish-yellow (straw-colored), with a lateral pale stripe; pronotum reddish-brown centrally, with wide margins of transparent yellow (6A); male supra-anal plate with apex broadly notched (6B); pl. 48♂. Genus *Blatta* (in part) -- male, **Turkestan cockroach,** *Blatta lateralis*

Blatta (*Shelfordella*) *lateralis* [*Shelfordella tartara*] is found both outdoors and in buildings in the arid regions of Central Asia, the Near East, and in North Africa as far west as Libya. Infestations have been discovered in Arizona and at military bases in Texas and California (*6, 52*). Although the exact origin of these imported populations is uncertain, it is known that the bases had received shipments from points within the range of this species in the Old World. Nymphs mature in 118-137 days at temperatures of 30-35 C. The adults may live as long as 300 days (*7*). The males have long, fully-functional, brownish-yellow wings. The wings of the nearly black females are represented by short flaps (as they are also in the closely-related *B. orientalis*). Males and females are so dissimilar in appearance that they are treated separately in this key (see couplet 11). The drawings (6A&B, pl. 48) are based on specimens kindly provided by Dr. D.G. Cochran. See also 4A.
Drawings 6A-D by C. Feller.

Front wing chestnut-brown, with (6C) or without (6D) a short yellow stripe near base; pronotum a darker color than brownish-yellow, usually with some yellowish markings (6C&D); male supraanal plate with apex deeply notched (6E), or with transverse ventral ridges (6F), or neither notched nor ridged (6G) ---------------------------------- 7

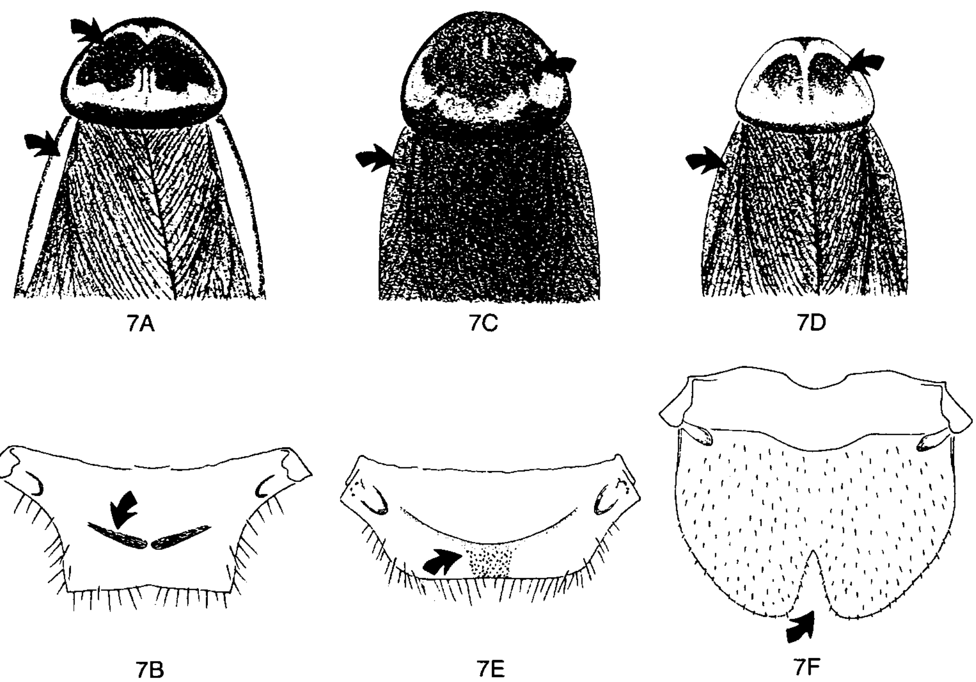


6A *Blatta lateralis* 6C *Periplaneta australasiae* 6D *Periplaneta americana*
6B *Blatta lateralis* 6E *Periplaneta americana* 6F *Periplaneta australasiae* 6G *Periplaneta brunnea*

7 Front wing with a short yellow stripe near base; pronotum with blackish central spot and blackish margins in decided contrast to pale areas (7A); male supraanal plate with thickened transverse ridges on ventral surface distant from posterior margin (7B); pl. 47A---------------------------------------**Australian cockroach,** *Periplaneta australasiae*

This species is apparently native to Africa; now widely distributed, often seen in tropical and subtropical countries. In the United States it is usually restricted to the southern states; it can survive in greenhouses or other favorable situations in colder localities. The nymphs have yellowish spots on the lateral margins of the abdomen and thorax that contrast with the general brown color; the spots on the thorax extend as incomplete stripes toward the middle of the body.
Drawings 7A&C&D by C. Feller.

Front wing entirely chestnut-brown; pronotum with brown markings often not in sharp contrast with pale areas (7C, 7D); male supraanal plate truncate (7E) or deeply notched (7F) but not conspicuously ridged on ventral surface -------------------------- 8



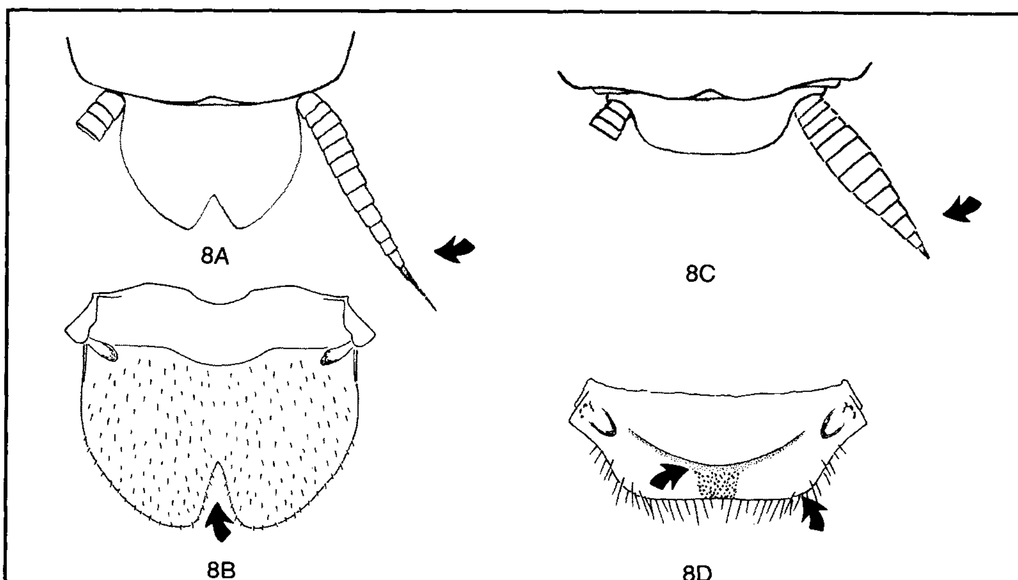
Periplaneta australasiae | *Periplaneta brunnea* | *Periplaneta americana*

8 Cercus very long and slender (especially the apical segments of males) (8A); male supraanal plate long and papery thin near deeply-notched tip, with ventral surface simple, bearing no specialized structures (8B); pl. 47B
-- **American cockroach,** *Periplaneta americana*

This cosmopolitan species, probably native to Africa, is one of the most frequently reported cockroaches in domestic situations. Among the species of *Periplaneta,* this one ranges farthest north in the United States. The nymphs are mostly a uniform chestnut color, though the pronotum of large nymphs has a dark posterior border and two large patches of darker reddish-chestnut toward the front. The duration of the complete life cycle ranges from six months to two years, with one year being the more usual. The nymphal stages usually occupy about six months. Caged adults sometimes live as long as three years. See also 2A, 7D.

Cercus stouter, the segments near apex not so slender (8C); male supraanal plate short, truncate or feebly notched at tip, and only slightly specialized on the ventral surface (8D); pl. 47C---------------------------------------**brown cockroach,** *Periplaneta brunnea*

This species, which is often confused with the American cockroach, is considered to be a native of Africa, but it is widespread in tropical and subtropical countries and is rather abundant in the southern United States. The nymphs have cream-colored spots on the lateral margins of some abdominal segments. Adult size averages less than that of *P. americana,* but the cerci usually permit separation. Unequivocal separation of the two species requires examination of the supra-anal plate of adult males. This is a rather long-lived species. Incubation requires 35 to 59 days at 27 C, and nymphal development, 182 to 192 days. Adult life averages 219 days for females and 244 days for males. A female produces about 30 oothecae (*54*).



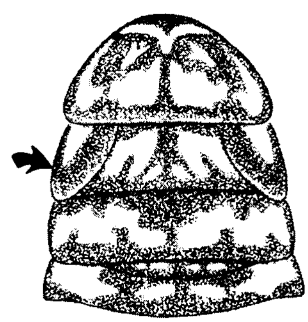
Periplaneta americana

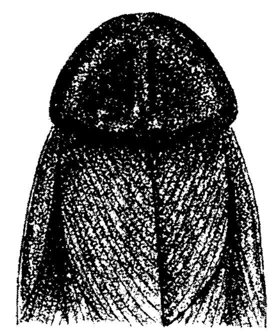
Periplaneta brunnea

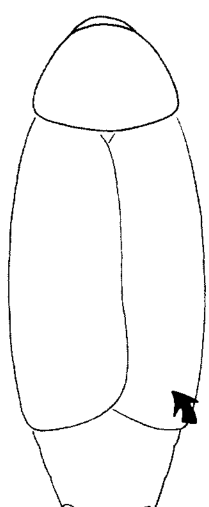
9 Color dark brown, with a conspicuous pattern of yellowish areas (9A); both sexes with vestigial front wings present as small triangular pads separated from each other by a wide mesonotal space (9A); pl. 47D
-- **harlequin cockroach,** *Neostylopyga rhombifolia*

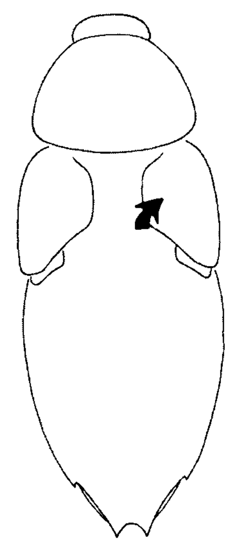
This species, readily recognized by its distinctive color pattern, has apparently not become established in the United States; it is intercepted occasionally along the Mexican border. Rehn (*39*) discussed its probable southeastern Asia origin and its spead to the west coast of Mexico and to certain other tropical areas. Nymphs longer than 10 mm usually have the distinctive markings of the adult, but small ones frequently have only poorly defined markings.
Drawings 9A-D by C. Feller.

Color either uniformly dark or with a few pale marks, but lacking a conspicuous pattern of yellowish areas (9B); front wing either normal (but not reaching tip of abdomen) (9C) or vestigial (9D) -- 10


9A *Neostylopyga rhombifolia*


9B *Blatta orientalis*


9C *Blatta orientalis*

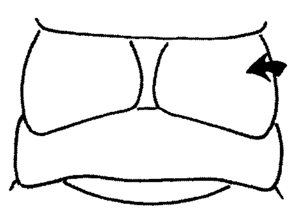

9D *Blatta lateralis*

10 Body length 30 to 40 mm; body color a dark reddish-brown to nearly black (occasionally with a few yellowish areas laterally); front wings same in both sexes, vestigial, and present as short, transverse, subrectangular pads, usually almost touching along midline (10A); segment I of tarsus III shorter than segments II to V combined, with pulvilli (small pads on tarsal segments) of segments II and III large, about as long as their respective tarsal segments (10B); pl. 51C&D -- Florida stinkroach, *Eurycotis floridana*

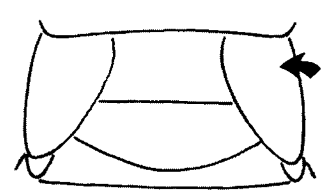
This large, flightless cockroach, native to the United States, occurs only in the Southeast. It usually lives outdoors, but sometimes enters buildings (*19, 30, 51*). When adults are disturbed, they often emit an extremely vile-smelling fluid. The color of very young nymphs is usually a uniform pale brown on the dorsal surface; later they become darker and often have conspicuous pale or yellow lateral markings (pl. 51C). See also 17B.

Drawings 10A&C&D by C. Feller.

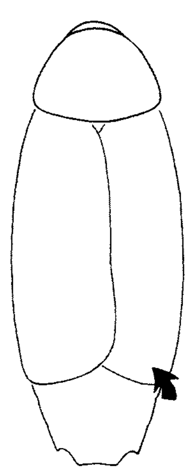
Body length 15 to 27 mm; body color blackish or dark chocolate-brown, either solidly colored or with pale pronotal markings and lateral wing stripes; front wings of females vestigial, present as small, widely separated, triangular pads (10C); front wings of males longer (10D); segment I of tarsus III as long as or slightly longer than segments II to V combined, with pulvilli of segments II and III small, much shorter than their respective tarsal segments (10E). Genus *Blatta* (in part)-------- 11



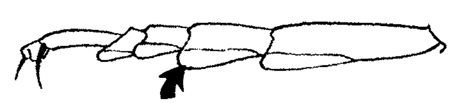
10A *Eurycotis floridana*



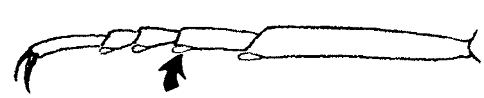
10C *Blatta orientalis*



10D *Blatta orientalis*



10B *Eurycotis floridana*



10E *Blatta orientalis*

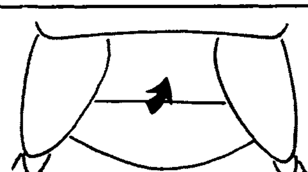
11 Body color of both sexes a solid dark brown to black; front wings of females separated by a distance greater than width (11A); front wings of males overlapping and covering 1/2 to 2/3 of abdomen (11B); pl. 51A&B --------**oriental cockroach,** *Blatta orientalis*

This very well known cockroach occurs mainly in relatively temperate zones (northern United States, England and northern Europe, southern Australia, southern South America), though it appears in port cities throughout the world. Rehn (*39*) thought that north Africa was its most likely original homeland, but Princis (*36*) suggested that southern Russia, in the vicinity of the Black and Caspian Seas, was its center of origin. Oriental cockroaches, which have been spread widely through commerce, are usually limited to the lower levels of dwellings where moisture is readily available and temperatures are not too warm. They are partial to moist or leaky water pipes, floor drains, and sewers. Their ability to withstand temporary submersion in water enables them to pass through water traps. This association with water is responsible for their being called "waterbugs" more than other domestic cockroaches. Like the adults, the nymphs are reddish-brown to black, though young nymphs are often paler. The pad (arolium) between the tarsal claws is small, even in adults. This is especially true of females, but the arolium is of variable size in adult males. Females and some males are unable to climb some vertical walls. Oriental cockroaches are notably less proficient climbers than many other kinds of domestic cockroaches (*46*). Eggs of *B. orientalis* usually hatch in a month or slightly more under warm conditions (much longer when cold). Nymphal growth takes from five to ten months, with nymphal females requiring more time than males to reach maturity. Adults live from one to several months. See also 9B, 10E.

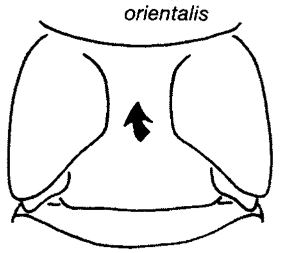
Body of female dark brown to black, with pale lateral wing stripes and scattered pronotal markings; front wings separated by a distance less than width of wing (11C); pl. 48--female, **Turkestan cockroach,** *Blatta lateralis*

See couplet 6. See also 9D.

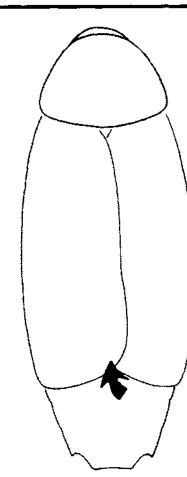
Drawings 11A&C by C. Feller.



11A *Blatta orientalis*



11C *Blatta lateralis*



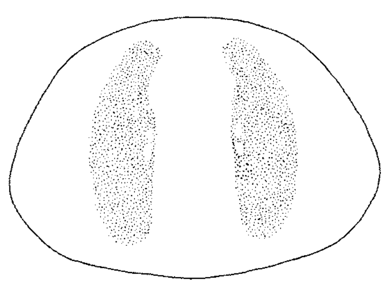
11B *Blatta orientalis*

12 Pronotum with 2 conspicuous longitudinal black bars on a pale background (12A).
Genus *Blattella* ---------- 13

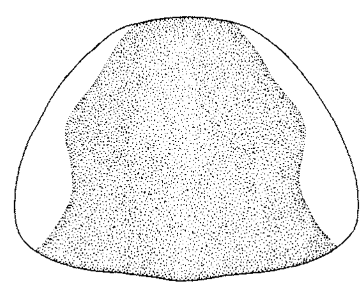
Although only *Blattella germanica* and *B. vaga* are represented in this key, several other members of this genus should be mentioned in passing. In addition to *B. germanica* and *B. vaga,* Princis (*37*) listed 15 species of *Blattella* for the world. Now more than 40 species are recognized worldwide, from southern Asia, Japan, various Indo-Malaysian and Pacific islands, and Africa, including several African species sometimes placed in the genus *Symploce* (L. M. Roth, personal communication). Almost all of them are outdoor species of little economic concern. However, the **false German cockroach,** *B. lituricollis* (pl. 52A), which occurs in Burma, China, the Philippines, and on various islands north to Japan and east to Hawaii, occasionally is a pest, though it too occurs mostly outdoors (*3, 55*). Another outdoor species, *B. nipponica* Asahina (*2*), closely resembles *B. germanica,* except that it flies readily (*B. germanica* does not). Laboratory crosses have not produced offspring. *B. nipponica* occurs in southwestern Japan in grassy areas near the coast, under dead leaves of forest margins, and under decayed vegetation in cultivated areas.

Drawings 12A-C by C. Feller.

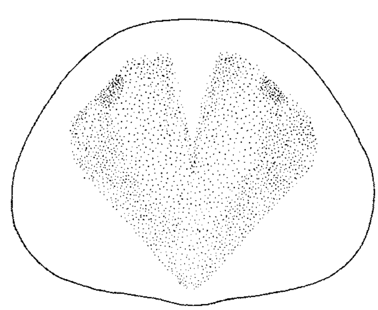
Pronotum without 2 conspicuous longitudinal bars (12B, 12C) ---------- 14



12A *Blattella germanica*



12B *Supella longipalpa*



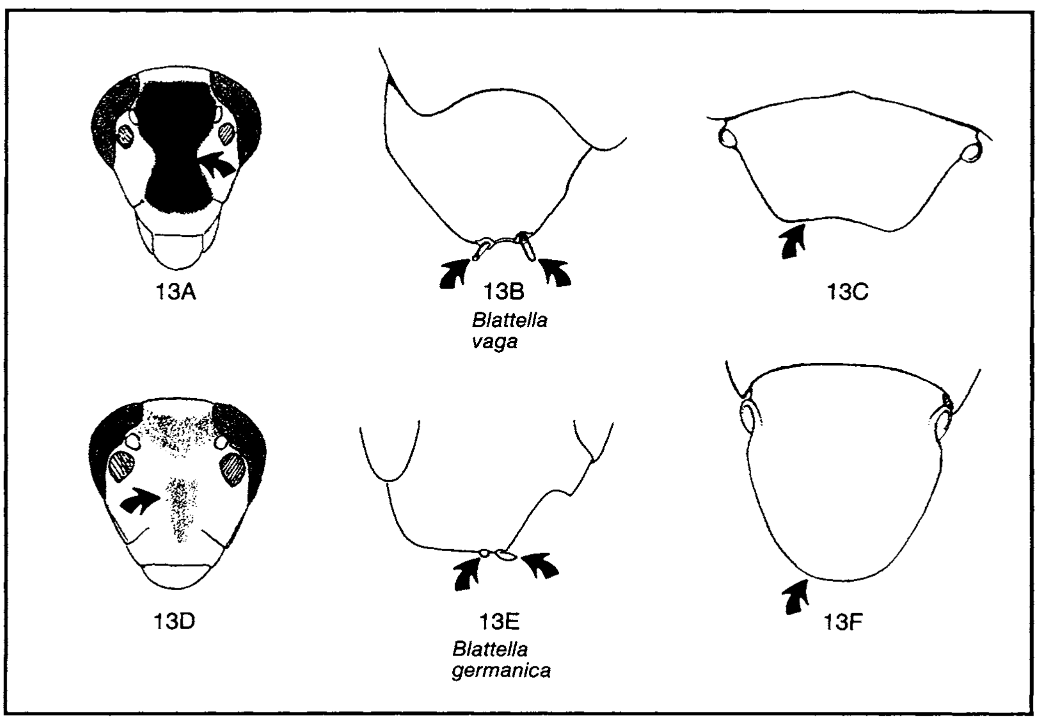
12C *Parcoblatta pennsylvanica*

13 Face with a conspicuous, longitudinal black bar (13A); styli on male subgenital plate elongate, nearly equal in size (13B); male supraanal plate short, broadly emarginate at apex (13C); usually found outdoors, only occasionally in buildings; pl. 52B
--field cockroach, *Blattella vaga*

Although it was found first in Arizona (*22*), *Blattella vaga* (*5, 12, 40, 51*), a primarily outdoor-living relative of the German cockroach, originated in Asia (Afghanistan, India, Sri Lanka). In the United States, it occurs in Arizona, California, New Mexico, Texas, and Utah. During especially dry weather, it sometimes enters houses by way of suitable nearby accumulations of decomposing vegetation, such as leaf mulch.

Face pale or with indefinite brownish areas (13D); styli on male sugenital plate short and rounded, of unequal size (13E); male supraanal plate elongate, rounded at apex (13F); usually found indoors; pl. 52C-E --**German cockroach,** *Blattella germanica*

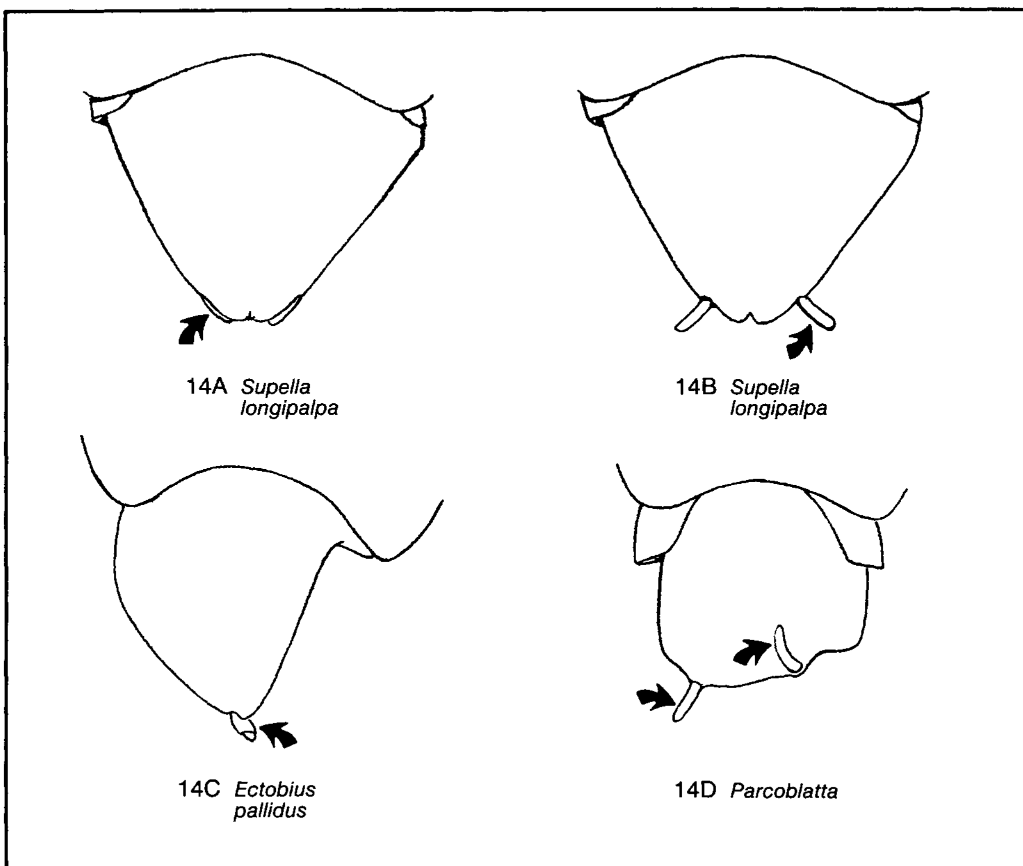
This species, probably the most important pest cockroach, has spread from Africa (*9, 39*) and is now thoroughly cosmopolitan. In medium-sized to nearly mature nymphs the longitudinal pronotal bars are as evident as they are in the adults; the bars are fused in very young numphs (pl. 52C). In these, immediately posterior to the large central black spot on the pronotum, there is a large central pale area that occupies portions of all three thoracic nota. Nymphs molt five to seven times over a period of one or two months if conditions are favorable (longer if unfavorable). Adults live about 100 days usually (less under poor conditions). Caution: *B. asahinai*, the **Asian cockroach**, recently discovered in Florida, is very similar in appearance to *B. germanica*. Consult current literature for comparative descriptions of these two species. See also 12A.



14 Pronotum with uniformly dark central area and pale lateral margins; front wings (in usual folded position) with 2 transverse brownish bars or bands (pl. 54D&E) (inconspicuous on some specimens); width of pronotum usually not more than 4.5 mm; male styli inconspicuous (14A), unless artificially displayed (14B); pl. 54C-E --**brownbanded cockroach,** *Supella longipalpa*

This cockroach, formerly called *S. supellectilium* (*18*), is a native of Africa, but it is now a widely-distributed indoor pest in warm temperate countries. It also occurs outdoors in subtropical areas. Spread through human activities, its distribution has greatly increased in recent decades. It was first reported in the United States at Miami FL in 1902; now it probably occurs in every state. Even so, it is not encountered as frequently as the German cockroach; its rate of infestation in California homes is only 5% of that of the German cockroach (*11*). The color pattern of the nymphs, especially the pale lateral margins of the pronotum and the two separate, irregularly-transverse pale areas of the thoracic notum posterior to the pronotum, is distinctive (pl. 54C). The six to eight nymphal stages occupy about 55 days, and the adults usually live from 90 to 115 days (range is from 67 to 141 days). A complete life cycle takes 100 to 200 days. See also 12B.

If pronotum has paler lateral margins, then its width is more than 4.5 mm; front wings without 2 transverse bands (pl. 55, 56A-C); 1 (14C) or 2 (14D) conspicuous styli present--- 15



14A *Supella longipalpa*

14B *Supella longipalpa*

14C *Ectobius pallidus*

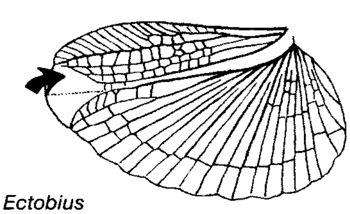
14D *Parcoblatta*

15 A small pale cockroach rarely more than 9 mm long; hind wing with a triangular apical area devoid of veins (15A); subgenital plate narrow at apex, bearing a single stylus (15B); pl. 55A--------------------------**spotted Mediterranean cockroach,** *Ectobius pallidus*

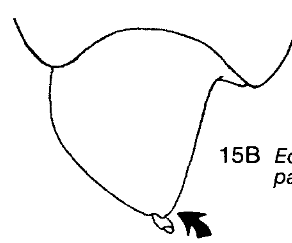
This species, called the tawny cockroach in England, occurs chiefly in southern Europe and parts of North Africa. Recently, it has become established in Massachusetts and Michigan (*15, 17*). It is mainly an outdoor species, but it occasionally invades buildings (*49*) in rural areas. Several other species of *Ectobius*, among which *E. lapponicus* (pl. 55B&C) is the best known and most widely distributed (*37*), occur chiefly outdoors in Europe, but may be found occasionally in domestic situations. *E. sylvestris* (pl. 55D), the forest cockroach, was found in a house in New York state in 1980. See reference *26* for a key to separate *E. sylvestris* from *E. pallidus*.

Specimens almost always more than 9 mm long; hind wing with apex veined (15C); male subgenital plate with broad apex, the 2 styli elongate and well separated (15D); pl. 56A-C--- wood cockroaches, *Parcoblatta*

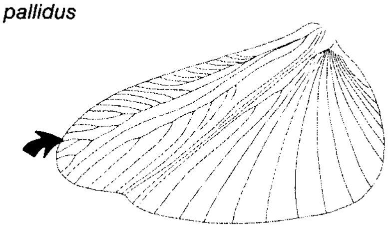
There are 13 species of *Parcoblatta*, 12 of which are outdoor-living, native North American insects (*21*). The species differ in size, body proportions, color pattern of the pronotum and tegmina, and in certain small structural details. They occur most often in or near wooded areas, on the ground in leaf mold, beneath loose bark, in decomposing logs, or in other plant debris (*28*). The males often fly to lights, especially in spring and early summer; thus they are likely to enter buildings adjacent to wooded areas. Nearly all the females are flightless (short wings); they are seen less often indoors. Established breeding colonies are uncommon in houses; occasionally, specimens are brought into homes with firewood. *P. kyotensis*, widespread in and near Japan, and also primarily an outdoor species (although it has been found in buildings), was described recently (*4*). See also 3D&E, 12C, 16E&F.
Drawing 15C by C. Feller.



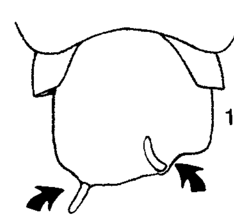
15A *Ectobius pallidus*



15B *Ectobius pallidus*



15C *Parcoblatta*

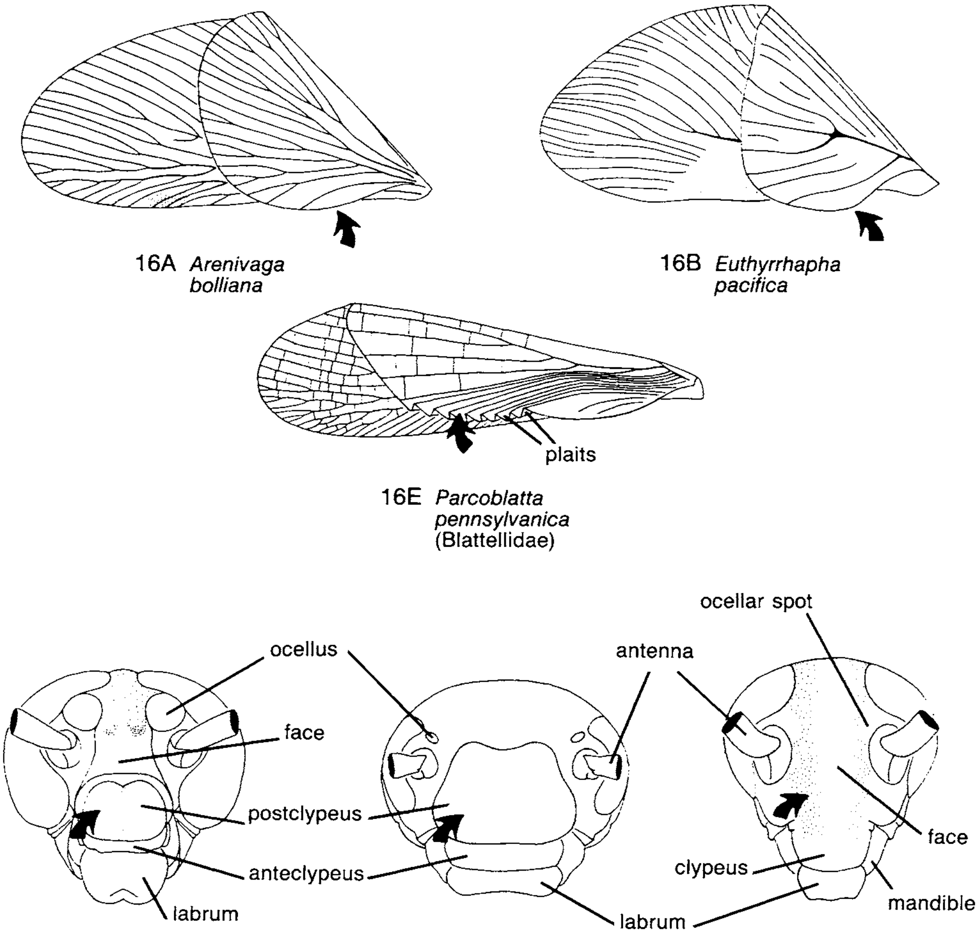


15D *Parcoblatta*

16 With anal area of hind wings (if present) folded in a single flat fold when wings are closed (16A, 16B); postclypeus notably thick and bulging, and often very large (16C, 16D); pl. 56D&E --------------------------polyphagids, polyphagid cockroaches, Polyphagidae

The numerous polyphagid species are distributed nearly worldwide. In the continental United States, polyphagids occur chiefly in the southwestern states and in Florida. None of the United States species (*Arenivaga* spp.) has any economic importance, but in parts of northern Africa and southern Asia, a few species (e.g., *Polyphaga aegyptiaca* and *P. saussurei*) are occasional minor domestic pests (*7*).
Drawings 16A-F by C. Feller.

With anal area of hind wings (if wings are fully developed) folded like a fan when wings are closed (as in 16E); postclypeus not notably large or thick (as in 16F) 17



16A *Arenivaga bolliana*

16B *Euthyrrhapha pacifica*

16E *Parcoblatta pennsylvanica* (Blattellidae)

16C *Arenivaga tonkawa*

16D *Euthyrrhapha pacifica*

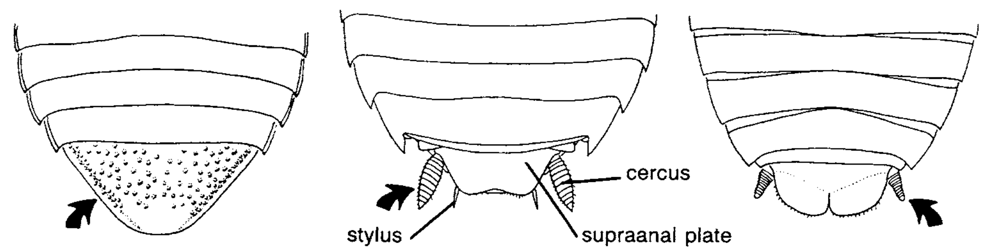
16F *Parcoblatta pennsylvanica* (Blattellidae)

17 Wingless; integument black, strongly sclerotized; cerci concealed by surrounding terminal tergum and sternum (17A); pl. 57A
-- cryptocercids, cryptocercid cockroaches, Cryptocercidae

In contrast to the condition of hidden cerci of cryptocercid adults, the cerci of the whitish or brownish nymphs protrude beyond the margins of the terminal abdominal sclerites. Two species of *Cryptocercus* inhabit China and Manchuria. The third species in this family, the brownhooded cockroach, *C. punctulatus* (pl. 57A), occurs as family groups in rotten logs in the mountains of eastern (Georgia to New York) and western (California to Washington) United States. The three cryptocercid species are of little or no economic importance.

Drawings 17A-C by C. Feller.

Usually with wings, at least in males; cerci visible externally (as in 17B), but may be very small (17C). Blaberidae (blaberids, blaberid cockroaches)-------------------- 18



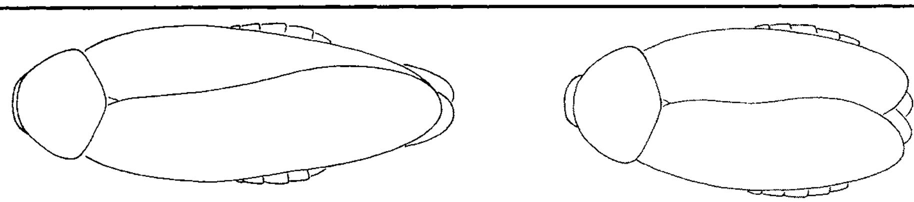
17A *Cryptocercus punctulatus* 17B *Eurycotis floridana* (Blattidae) 17C *Panchlora nivea*

18 Body relatively slender (18A) and colored a nearly uniform pale green; pl. 57B
-- **Cuban cockroach,** *Panchlora nivea*

This cockroach of tropical American origin, the common name of which is based on the type locality of a synonymous species (*16*), is one of several pale green species often carried about on banana ships. Although some outdoor breeding colonies are established in the Gulf states, primarily Texas (*23*), most specimens are adventive, having been recently introduced with fruit (*50*). Unlike the adults, the nymphs are brown. In contrast to the related *Pycnoscelus surinamensis*, the dorsal surfaces of the terminal abdominal segments of nymphs are smooth and shiny.

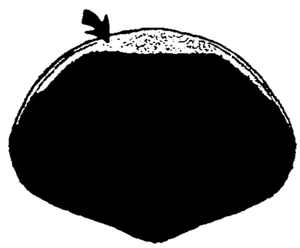
Drawings 18A&B by C. Feller.

Body relatively broad (18B) and not green in color-- 19

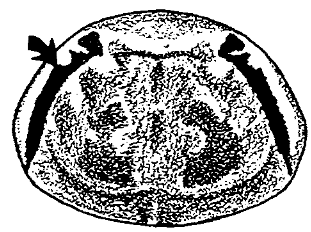


18A *Panchlora nivea* 18B *Pycnoscelus surinamensis*

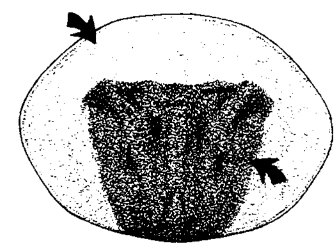
19 Body medium-sized, 30 mm or less in length; pronotum solid black with pale anterior margin (19A) or pronotum with a complex central pattern bordered on each side by a longitudinal black band (19B)--- 20
Body large, 40 mm or more; pronotum pale except for dark design in central area (19C) 21



19A *Pycnoscelus surinamensis*



19B *Nauphoeta cinerea*



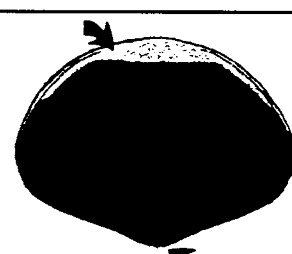
19C *Blaberus discoidalis*

20 Pronotum blackish except for a narrow yellow band of variable width along lateral and anterior margins; posterior margin of pronotum forming a definite obtuse angle (20A); pl. 57C&D ------------------------------**Surinam cockroach,** *Pycnoscelus surinamensis*

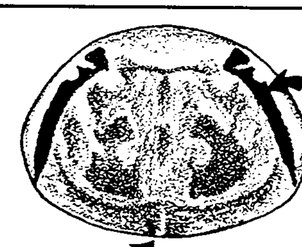
This widespread, parthenogenetic species of warm countries probably originated in the Malayan area. Now it is established outdoors in several Gulf states (USA). It has been found in greenhouses in northern United States and northern Europe (9). The dorsal surface of the last 5 abdominal segments of the nymph is roughened and dull, not glossy like the rest of the body (pl. 57C). In some other species of *Pycnoscelus,* including *P. indicus* (Burma, Hawaii, Indonesia, Malaysia) (*41*; pl. 58), functional males and females occur. See also 18B.

Pronotum pale, with irregular brown blotches in central area, and a submarginal black band on each side; posterior margin of pronotum not angulate, only somewhat broadly protruding (20B); pl. 59. -----------------**cinereous cockroach,** *Nauphoeta cinerea*

This species, evidently originally from tropical Africa, has spread widely through commerce to warm countries around the world. It has become established in a few localities, especially in Florida (*15*), in the continental United States. Food warehouses and grain-milling plants are frequently infested. The name lobster cockroach is based on the pronotal pattern which vaguely resembles a lobster.



20A *Pycnoscelus surinamensis*



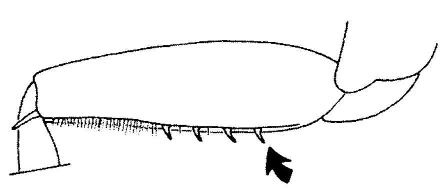
20B *Nauphoeta cinerea*

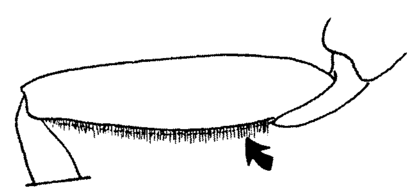
21 Pronotum with sharply-defined, blackish, shieldlike central design, sometimes solidly black, sometimes patterned (pl. 60); femur I with 1 or more short robust spines on ventral margin (21A) -- giant cockroaches, *Blaberus*

Blaberus (*43*), a tropical American genus with about a dozen very large species, is represented in the United States by two species (*B. craniifer,* pl. 60A&B, and *B. discoidalis,* pl. 60C) established in extreme southern Florida. Both of these species and some others (such as *B. giganteus,* pl. 60D) are often maintained in laboratory cultures for scientific and demonstration purposes. In the United States members of this genus are rarely of economic importance, though in some tropical countries they sometimes are pests (*9*). See also 2B, 19C.

Pronotum with brownish central design, darkened in outline only, often not sharply defined (pl. 61); femur I without spines on ventral margin, only a line of stiff fine hairs (21B)
-- **Madeira cockroach,** *Leucophaea maderae*

These large, distinctive cockroaches, apparently native to West Africa (*39*), are now circumtropical in distribution. Madeira cockroaches are especially abundant in those countries south of the United States which border the Caribbean Sea. Fruit stores are especially likely to be infested. Sometimes, as in New York City around 1950, they infest heated buildings in colder areas (*15*).


21A *Blaberus*


21B *Leucophaea maderae*

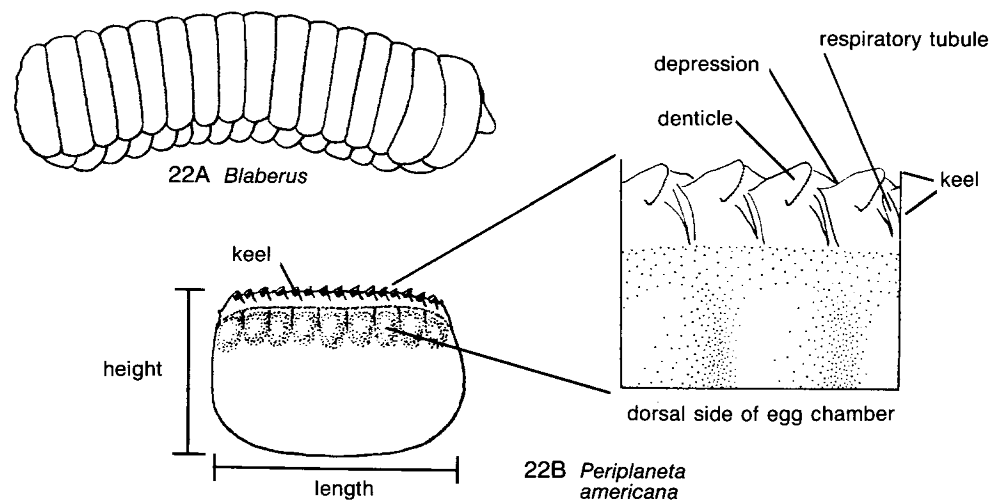
Egg Cases (Oothecae)

22 Ootheca a poorly-sclerotized, whitish or light brown packet, often more than 17 mm long, without a distinct keel (22A) --- blaberids, Blaberidae

Embryonic development in other families of cockroaches (and generally of most other insects) is *oviparous,* i.e., offspring develop in and eventually hatch from eggs that are produced by the mother, charged with nutrients, and deposited (oviposition) somewhere outside the body of the mother. In the Blaberidae the eggs are enclosed in a soft membranous ootheca which protrudes briefly from the mother's body. Then it is retracted and incubated in a special sac until the eggs hatch; the nymphs appear to be "born alive." In the more typical blaberids there is no further access to maternal nutriments after the ootheca is retracted for incubation. This type of development is termed *ovoviviparous.* A more specialized type of blaberid development occurs in the Diplopterinae, a subfamily of about ten Oriental and African species, the best known of which is *Diploptera punctata* (Eschscholtz), the **Pacific beetle cockroach,** a species now widely distributed, especially in the Pacific area. The ootheca of *D. punctata* protrudes for a shorter time than is the case in other blaberids. The ootheca is then withdrawn into the mother's body. This kind of development, termed *viviparous,* is characterized by the continued access of the embryos to nutrients from the mother, a phenomenon superficially similar to the mammalian fetal support system (*44*). We have not attempted to differentiate the egg cases of the various blaberids. Their egg cases are seldom seen by the ordinary observer, and distinctions between species, so far as they are known in regards to egg cases, are less marked than in other families of cockroaches.

Ootheca a well-sclerotized, brown to black packet, not more than 17 mm long, with a distinct keel along the dorsal margin (22B)--- 23

See also couplet 1 for descriptions of the oothecae of Polyphagidae and Cryptocercidae.

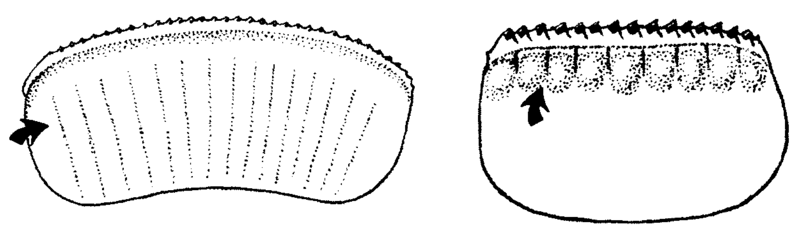


22A *Blaberus*

22B *Periplaneta americana*

23 Egg chambers marked by lines, usually plainly evident, extending completely across ootheca; keel sometimes low, with respiratory tubules usually not evident upon casual inspection (23A); height seldom more than 4 mm. Blattellidae (blattellids) 24

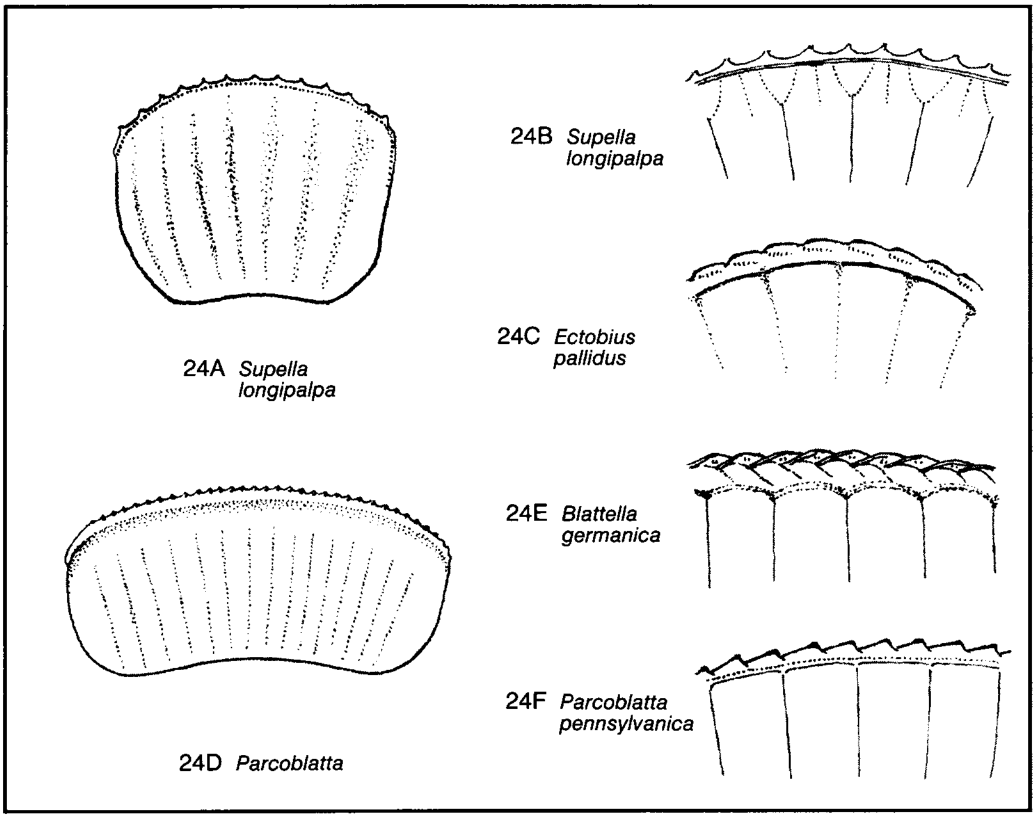
Egg chambers plainly marked only by indentations near the keel, not by definite lines extending completely across the ootheca; keel usually high, with oblique respiratory tubules plainly evident (23B); height usually at least 5 mm. Blattidae (blattids)-- 28


23A *Parcoblatta*

23B *Periplaneta americana*

24 Ootheca short, not more than 4.5 mm long, usually with no more than 10 egg compartments on a side (24A); denticles on keel usually prominent though small (24B), sometimes more rounded (24C) ---------- 25

Ootheca usually more than 4.5 mm long, usually with more than 10 egg compartments on a side (24D); denticles on keel usually not prominent (24E), sometimes distinct (24F) ---------- 26



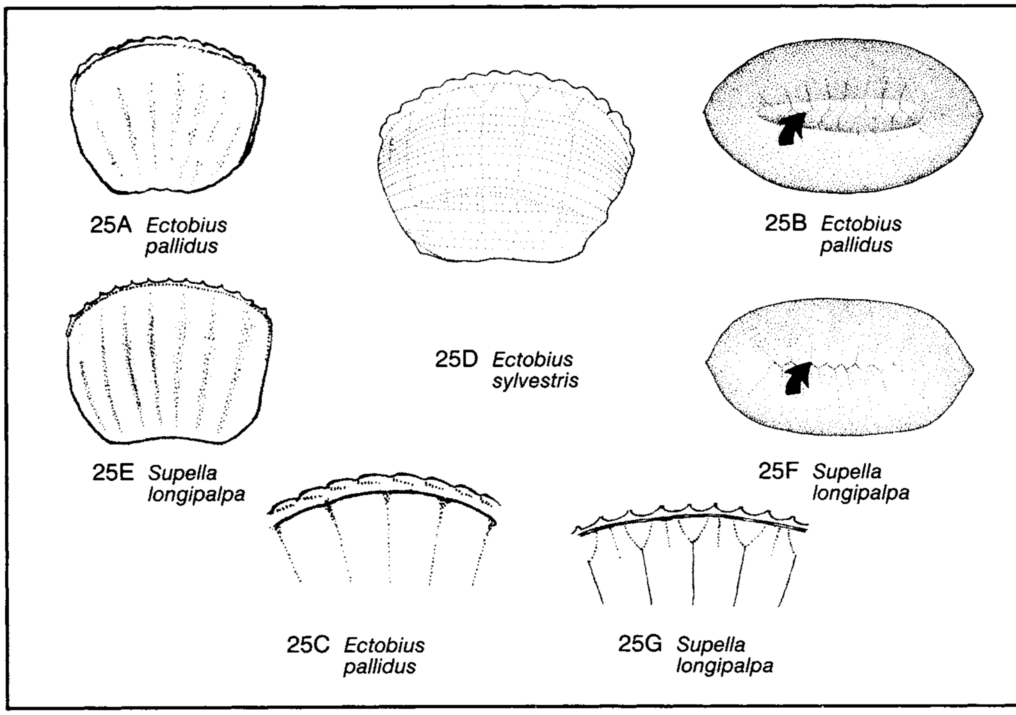
25 Ootheca (25A) 2 to 3 mm long; ventral surface usually with a distinct longitudinal concavity or invagination (most conspicuous in ventral view) where the sides meet (25B); keel serrate with blunt denticles separated by unevenly-rounded depressions (25C) ---------- **spotted Mediterranean cockroach,** *Ectobius pallidus*

The ootheca of *Ectobius sylvestris* is similar to that of *E. pallidus* in size and shape, and it also has a ventral depression. However, the longitudinal grooves of the ootheca of *E. sylvestris* (25D) make it easy to distinguish from that of *E. pallidus*. See also couplet 15.

Drawings 25B&D&F by C. Feller.

Ootheca (25E) at least 4 mm long; ventral surface without distinct concavity (25F); denticles on keel prominent, with the depressions between them evenly rounded (25G) ---------- **brownbanded cockroach,** *Supella longipalpa*

Females often glue the oothecae to surfaces, such as the insides of cabinets or drawers. This habit accounts for much of the distributional spread of this species. Incubation takes 37 days at 30 C (longer if colder). A female usually produces about ten oothecae, but the number ranges from five to twenty.



25A *Ectobius pallidus*

25B *Ectobius pallidus*

25D *Ectobius sylvestris*

25E *Supella longipalpa*

25F *Supella longipalpa*

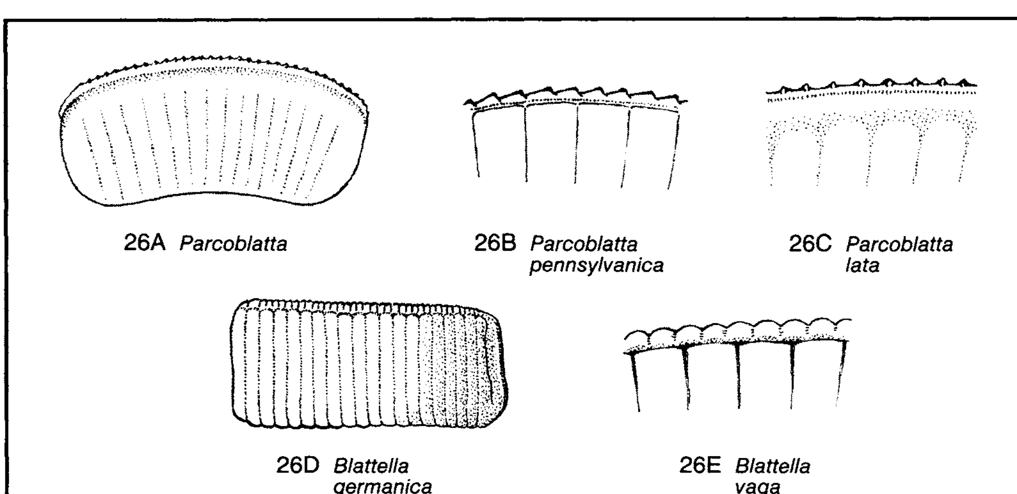
25C *Ectobius pallidus*

25G *Supella longipalpa*

26 Ootheca of uniform color; curvature usually distinct (26A); denticles of keel distinct, usually sharply serrate (26B, 26C)-------------------------- wood cockroaches, *Parcoblatta*

The egg cases of the several species of *Parcoblatta* show considerable differences in size and proportion of length and height (*42*). The ootheca of *P. uhleriana* (Saussure) is unusual in this genus in that it has a deep longitudinal groove on each side of the keel just below the denticles (*27*).

Ootheca not of uniform color, one end (the one that was held by the ovipositor) paler than the other; ootheca straight or slightly curved (26D); denticles on keel low, well-rounded (26E). Genus *Blattella*-- 27



26A *Parcoblatta*

26B *Parcoblatta pennsylvanica*

26C *Parcoblatta lata*

26D *Blattella germanica*

26E *Blattella vaga*

27 Usually about 20 egg compartments on each side; length more than 7 mm; denticles of keel very low and gradually curved (27A); found indoors in most countries ---------- **German cockroach,** *Blattella germanica*

Of the common domestic cockroaches that form well-sclerotized oothecae, this is the only one in which (during a period of 17 to 35 days, depending on the temperature) the female carries the ootheca until, or to within a few hours of, hatching (*53*). A female is likely to produce four to eight egg cases during her life, the later ones usually being smaller. See also 26D.

Usually about 16 egg compartments on each side; length seldom more than 6 mm; denticles slightly higher and curved more abruptly (27B); usually found outdoors ---------- field cockroach, *Blattella vaga*

B. vaga carries the ootheca until (or to just shortly before) hatching (*53*).

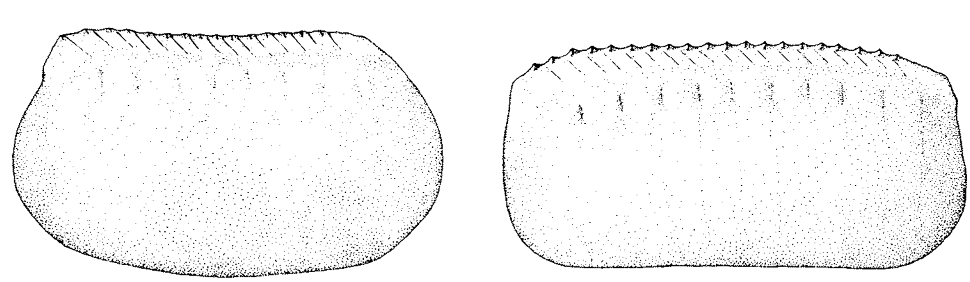
27A *Blattella germanica*

27B *Blattella vaga*

28 Number of denticles in keel seldom more than 17 (28A); ootheca almost always less than 13 mm long ---------- 29

Number of denticles more than 17 (28B); oothecal size variable, sometimes more than 13 mm long ---------- 31

Drawings 28A&B by C. Feller.



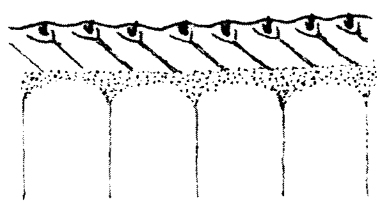
28A *Blatta orientalis*

28B *Periplaneta brunnea*

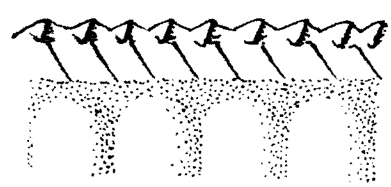
29 Ootheca usually 10 to 12.5 mm long, usually with 14 denticles; depressions between denticles shallow (29A)---------- **oriental cockroach,** *Blatta orientalis*

See also 28A.

Ootheca 8 to 12 mm long, with 14 to 22 denticles; depressions between denticles deep (29B) or shallow---------- 30



29A *Blatta orientalis*

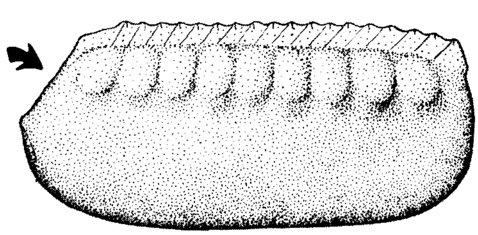


29B *Periplaneta americana*

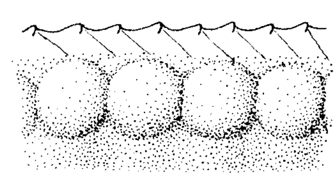
30 Ootheca 9 to 12 mm long, with 14 to 22 denticles; ootheca rounded at one end, truncated dorsally at the other (30A); depressions between denticles shallow (30B) ---------- **Turkestan cockroach,** *Blatta lateralis*

Ootheca 8 to 9 mm long, usually with 16 denticles; ootheca rounded at both ends (30C); depressions between denticles deep (30D) ---------- **American cockroach,** *Periplaneta americana*

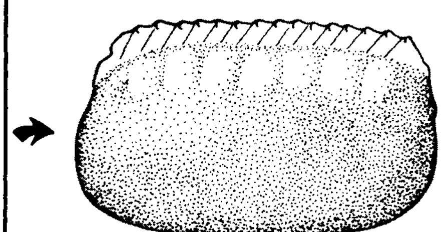
Drawings 30A-C by C. Feller.



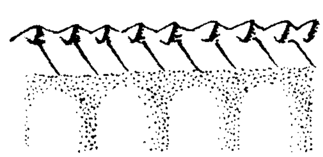
30A *Blatta lateralis*



30B *Blatta lateralis*



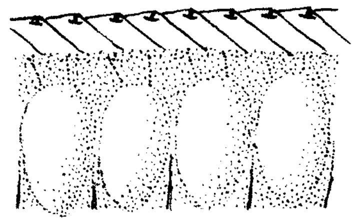
30C *Periplaneta americana*



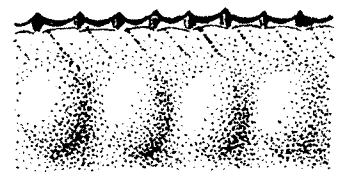
30D *Periplaneta americana*

31 Spaces between denticles almost straight, with depressions so shallow as to not be clearly evident (31A)-------------------------**harlequin cockroach,** *Neostylopyga rhombifolia*

Spaces between denticles with conspicuous depressions (31B)-------------------------- 32



31A *Neostylopyga rhombifolia*



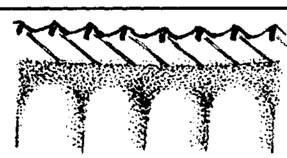
31B *Periplaneta brunnea*

32 Ootheca large, measuring 13.5 to 16 mm long and 6.4 to 7.5 mm high; keel with 18 to 24 denticles (32A)------------------------------------ Florida stinkroach, *Eurycotis floridana*

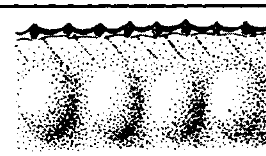
Of the oviparous cockroaches occurring in the United States, this species has the largest ootheca. Larger oothecae are produced by some of the ovoviviparous blaberids (see couplet 22).

Ootheca from 9.5 to 13 mm long; keel (32B-D) with 20 to 26 denticles
--**Australian cockroach,** *Periplaneta australasiae*
brown cockroach, *Periplaneta brunnea*
smokybrown cockroach, *Periplaneta fuliginosa*

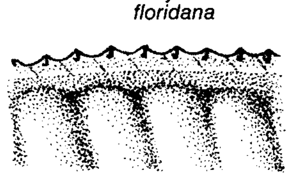
There are some average differences among these species of *Periplaneta* in oothecal size, number of eggs contained, and number and structural details of, and distances between denticles, but these are too variable to be practical in a key. All three species have well-developed denticles (usually at least 20) separated by deep depressions. The oothecae of these species are generally more than 9.5 mm long, in contrast to the shorter oothecae of *Periplaneta americana*. See also 28B.



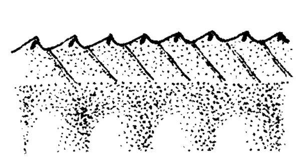
32A *Eurycotis floridana*



32C *Periplaneta brunnea*



32B *Periplaneta australasiae*



32D *Periplaneta fuliginosa*

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3 ADULT BEETLES (COLEOPTERA)

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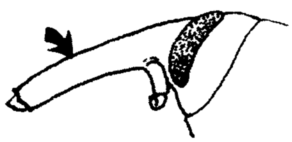
Most of the important species of stored-food beetles (other than those treated elsewhere in this handbook) are included in this key. Adult and larval bruchids, dermestids, and tenebrionids, and adult clerids, cryptophagids, curculionids, lathridiids, and ptinids are treated in subsequent chapters. The general key to the larval beetles is given in Chapter 4.

KEY

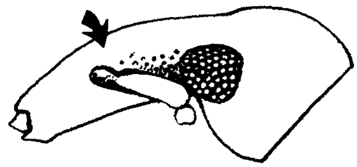
Drawings by A.D. Cushman unless otherwise noted.

1 Head with slender (1A, 1B) or broad beak (1C, 1D); if broad, with transverse carina on basal margin of pronotum extending to side margins (1D) ---------- 2
Head without beak (1E-1H) ---------- 3

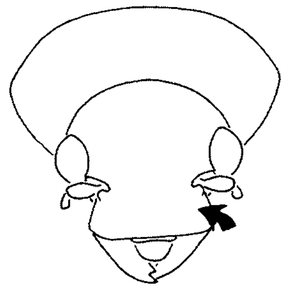
The head in Bruchidae may be interpreted as beaked but the eye is medially emarginate (1E) and the base of the pronotum lacks a carina, features that cannot be used to describe the Anthribidae and Curculionidae. Drawings 1C-F&H by C. Feller.



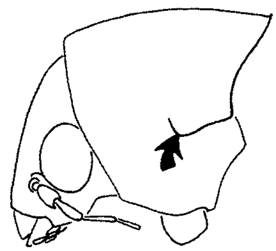
1A *Sitophilus*



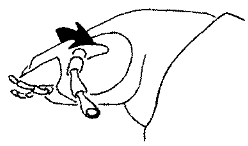
1B *Caulophilus oryzae*



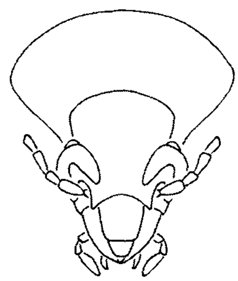
1C *Araecerus fasciculatus*



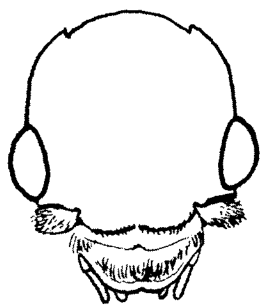
1D *Araecerus fasciculatus*



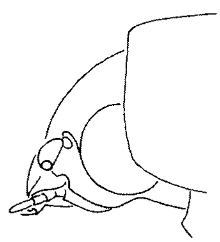
1E *Acanthoscelides obtectus*



1F *Acanthoscelides obtectus*



1G *Dermestes*

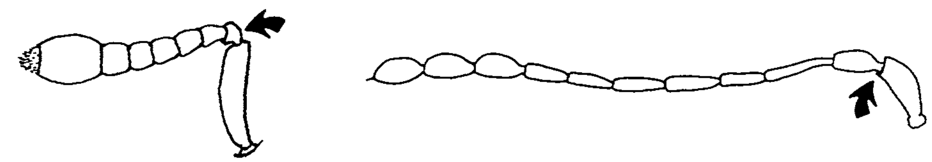


1H *Dermestes*

2 Antenna elbowed (2A); pl. 110B------------------------**snout beetles** or **weevils**, Curculionidae
SEE KEY, CHAPTER 13

Antenna not elbowed (2B); pl. 62B. Anthribidae (**fungus weevils**)
---**coffee bean weevil**, *Araecerus fasciculatus*

Distribution: cosmopolitan; in a wide variety of dry seeds, fruits, stalks, and twigs; especially damaging to coffee beans. See also 1C.
Drawing 2B by J.M. Kingsolver.



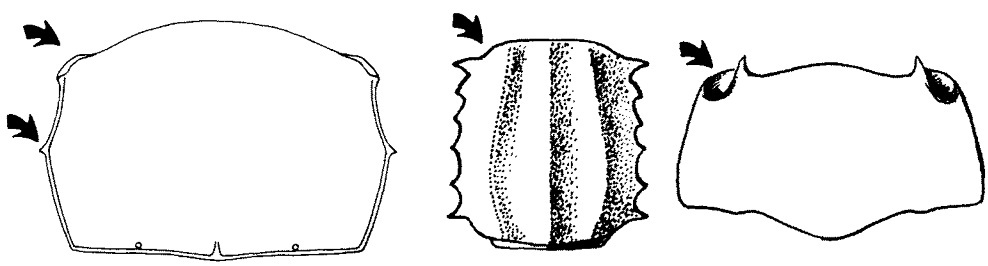
2A *Sitophilus* 2B *Araecerus fasciculatus*

3 Anterior angle of pronotum with thickened callosity, and lateral margin of pronotum with a single tooth (3A); pl. 93B. Cryptophagidae (cryptophagid beetles)
-- *Cryptophagus*
SEE KEY, CHAPTER 9

Body length 1.5 to 3 mm; antenna with a three-segmented club.
Drawing 3A by C. Feller.

Anterior angle of pronotum without thickened callosity, and lateral margin of pronotum either without teeth or with several teeth (3B, 3C) -- 4

Antennal club and body length variable.

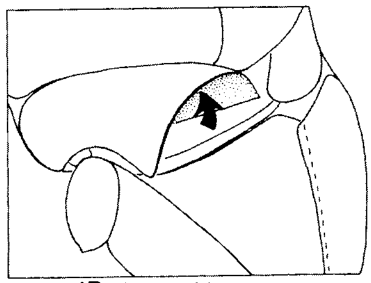


3A *Cryptophagus* 3B *Oryzaephilus* 3C *Murmidius ovalis*

4 Face of coxa III flat or at most with a shallow groove (4A) ---------- 5
Face of coxa III concave (receives femur III) (4B) ---------- 15

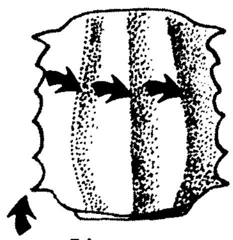
Drawing 4B by C. Feller.

4A *Carpophilus*

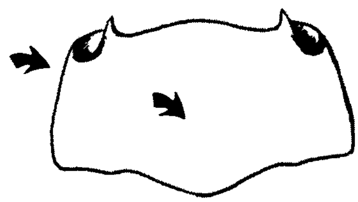


4B dermestid beetle

5 Lateral margin of pronotum with 6 large teeth; dorsal surface of pronotum with 3 longitudinal ridges (5A). Cucujidae (**cucujid beetles**) (in part) ---------- 6
Lateral pronotal margin without prominent teeth (but may be finely serrate) or with only 1 or 2 teeth; no ridges on pronotum (5B) ---------- 7



5A *Oryzaephilus*



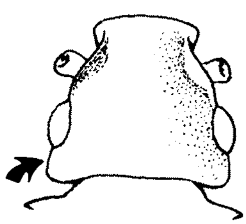
5B *Murmidius ovalis*

6 Length of temple (region directly behind eye) equal to more than one-half vertical diameter of eye (6A); pl. 63C------**sawtoothed grain beetle,** *Oryzaephilus surinamensis*

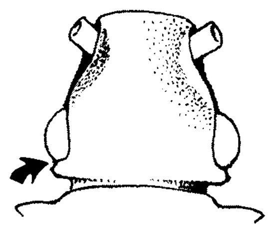
Distribution: cosmopolitan; in a wide variety of grain products and dried fruit. See also 5A.

Length of temple much less than half of vertical diameter of eye (6B); pl. 63D ---------- **merchant grain beetle,** *Oryzaephilus mercator*

Distribution: cosmopolitan; in a wide variety of grain products, dried fruits, and nuts. See also 5A.



6A *Oryzaephilus surinamensis*

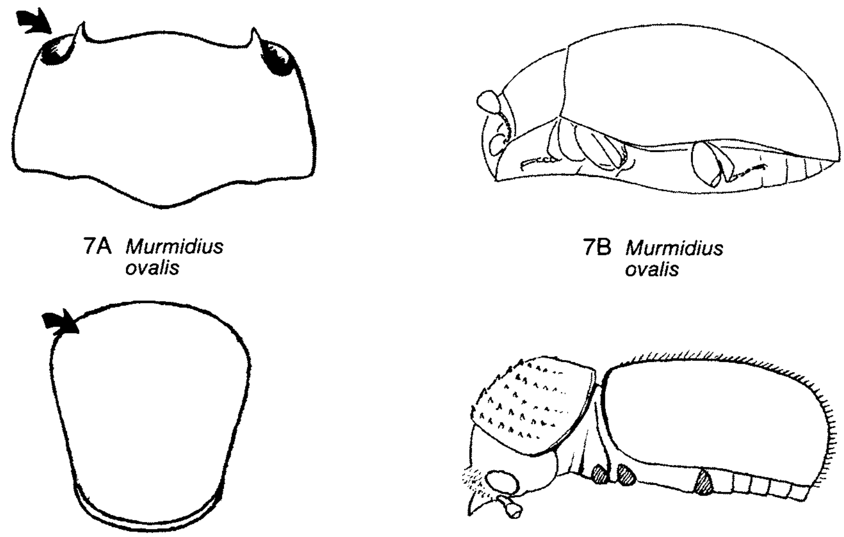


6B *Oryzaephilus mercator*

7 Anterolateral antennal sulcus on pronotum (near eye) (7A); body shape hemispherical, tortoiselike, without spots or stripes (7B); pl. 64B. Cerylonidae (= Murmidiidae) (cerylonid beetles)--oval grain beetle, *Murmidius ovalis*

Body reddish brown; antenna capitate. Distribution: cosmopolitan; in various dry seeds and fruits.
Drawing 7B by C. Feller.

Pronotal sulcus absent (7C); spots and/or stripes may be present if body is not tortoiselike (7D); spots and/or stripes present if body is hemispherical (see pl. 65B) 8



7A *Murmidius ovalis*

7B *Murmidius ovalis*

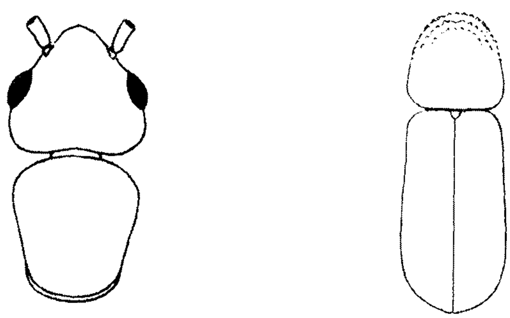
7C *Anthicus floralis*

7D *Dinoderus minutus*

8 Body slender, antlike, with pronotum roughly ovate in dorsal view (8A); pl. 64D. Anthicidae (**antlike flower beetles**) --------**narrownecked grain beetle,** *Anthicus floralis*

Body color reddish brown; head broad; eyes oval (not emarginate); antenna not clubbed. Distribution: cosmopolitan; in grain and dried fruit.

Body not antlike; pronotum not ovate (8B) --- 9



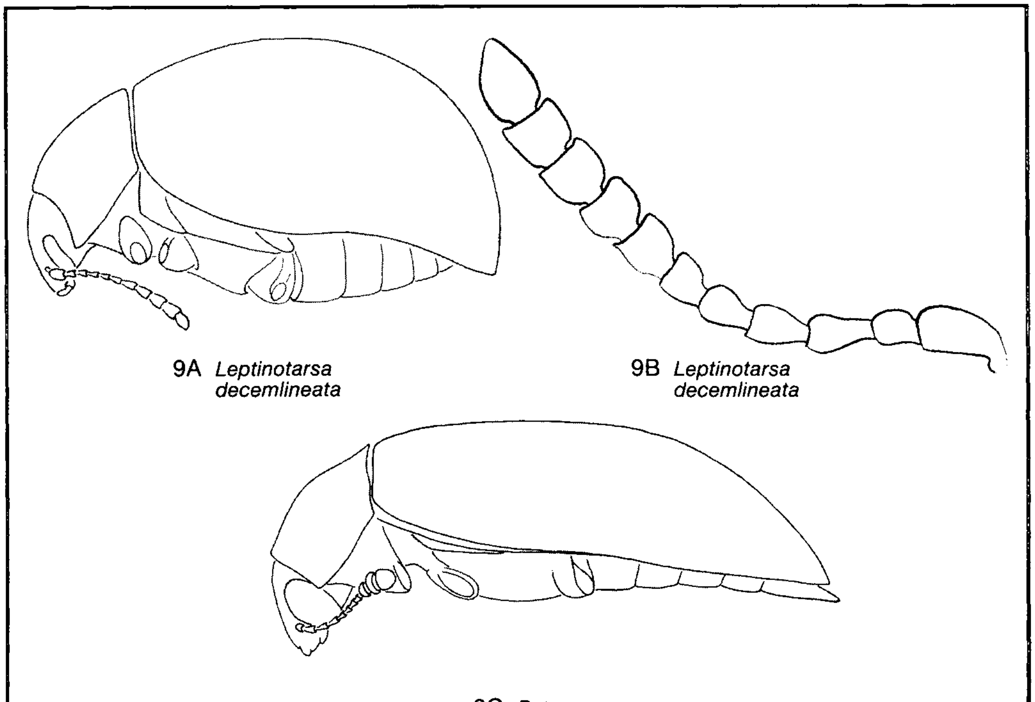
8A *Anthicus floralis*

8B *Rhyzopertha dominica*

9 Body very convex (9A); body pale yellow, with 10 dark brown stripes on elytra and small brown spots on pronotum (pl. 65B). Chrysomelidae (**leaf beetles**) (in part) -- **Colorado potato beetle,** *Leptinotarsa decemlineata*

Antenna gradually clubbed (9B). Distribution: North America and, by introduction, Europe. Hosts: foliage of eggplant, potato, and tomato.
Drawings 9A&C by C. Feller.

Body shape not strongly convex (9C); without or with no more than 2 elytral stripes and pronotal spots (pl. 66B) -- 10



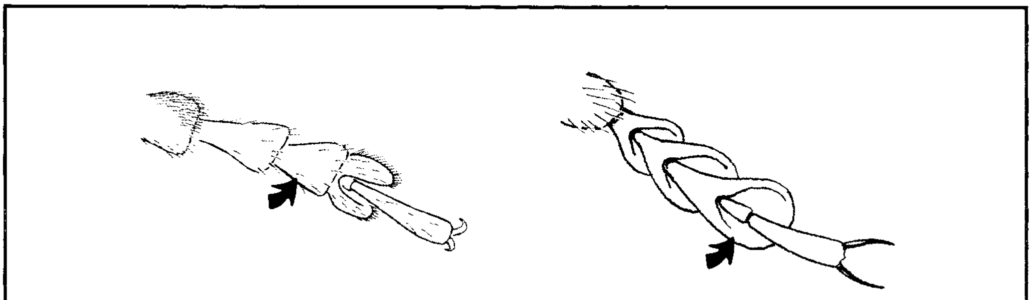
9A *Leptinotarsa decemlineata*

9B *Leptinotarsa decemlineata*

9C *Byturus unicolor*

10 Tarsal segments without flaps (10A) -- 11
Tarsal segments II and III with broad, membranous flaps (10B) -------------------------- 24

Drawing 10A by C. Feller.



10A *Crioceris asparagi*

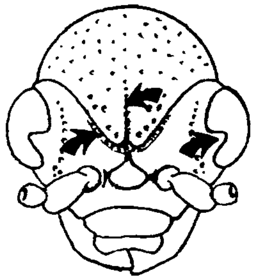
10B *Byturus unicolor*

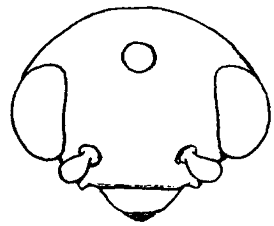
11 Front of head with a medial groove and with a lateral groove over each eye (11A).
Chrysomelidae (**leaf beetles**) (in part) ---------- 12

Antenna not clubbed; eye with mesal emargination (11A).

Front of head without medial and lateral grooves (11B) ---------- 13

Antennal form variable; eye without mesal emargination except in Bruchidae, most Tenebrionidae, some Anobiidae, and some Dermestidae (*Anthrenus scrophulariae*).


11A *Crioceris*


11B *Trogoderma variabile*

12 Body color orange, with 12 black spots on elytra; legs orange, with black knees and tarsi (pl. 1M) ---------- **spotted asparagus beetle,** *Crioceris duodecimpunctata*

Body length: 6-6.5 mm. Distribution: Europe, United States. Host: asparagus. See also 11A.

Body colors reddish orange, dull red, and dark metallic blue; elytra with a broad sutural stripe and 3 transverse bars (sometimes separated from sutural stripe into lateral spots) (pl. 1N) ---------- **asparagus beetle,** *Crioceris asparagi*

Body length: 5.6-6.5 mm. Distribution: Europe, United States. Host: asparagus. See also 11A.

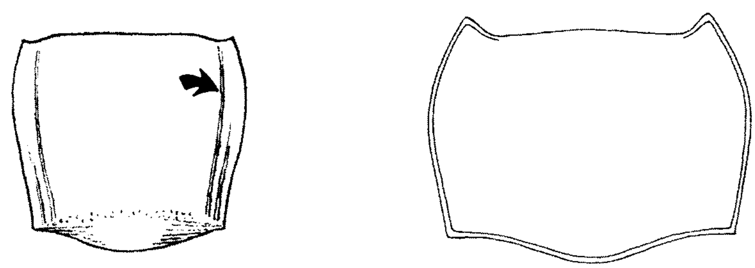
13 Tarsal formula 5-5-4 ---------- 14
Tarsal formula 3-3-3, 4-4-4, or 5-5-5 ---------- 18

14 Pronotum with a raised line parallel to margin (14A); pl. 66B. Cucujidae (**cucujid beetles**) (in part) ---------- males, *Cryptolestes*

Seven species, all with minute, depressed bodies, in grain, grain products, and other stored foods, and all difficult to identify: Cape grain beetle, *Cryptolestes capensis,* in Africa and Europe; **rusty grain beetle,** *C. ferrugineus,* cosmopolitan; *C. klapperichi* in Asia and widely distributed in commerce; *C. pusilloides* in Africa, Australia, North America, South America; **flat grain beetle,** *C. pusillus* (pl. 66D), cosmopolitan; Turkish grain beetle, *C. turcicus,* in the Middle East and Europe; *C. ugandae* in Africa. References: *1, 2.*

Pronotum without raised line parallel to margin (14B); pl. 98 ---------- **darkling beetles,** Tenebrionidae
SEE KEY, CHAPTER 11

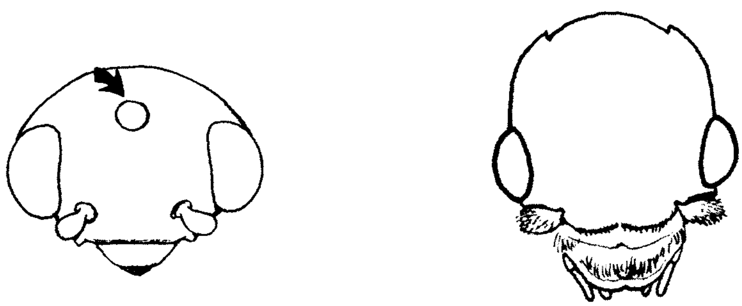
Body form and size variable.
Drawing 14B by C. Feller.



14A *Cryptolestes*   14B *Tribolium brevicorne*

15 Median ocellus present (15A) ---------- **dermestid beetles,** Dermestidae (in part)
SEE KEY, CHAPTER 5

Median ocellus absent (15B) ---------- 16



15A *Trogoderma variabile*   15B *Dermestes*

16 Body length 8 to 10 mm. Dermestidae (**dermestid beetles**) (in part) --------------*Dermestes*
SEE KEY, CHAPTER 5.

Body length 3 to 4 mm. Anobiidae (**deathwatch** and **drugstore beetles**) ----------- 17

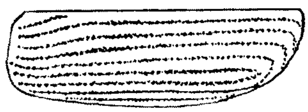
Although *Stegobium paniceum* and *Lasioderma serricorne* (couplet 17) are the anobiids of greatest concern here, 3 other species, all members of the genus *Tricorynus* (= *Catorama*) and all roughly comparable in appearance to *S. paniceum* and *L. serricorne,* should be mentioned in passing: *T. confusus* (eastward from Texas and Kansas in the United States); *T. herbarius,* the Mexican book beetle (Brazil, Fiji, Florida, Hawaii, Mexico); and *T. tabaci* (Belize, Cuba, Dalmatia, Florida, France, Germany, Mexico, Texas). All 3 species have been associated with stored products and all have some potential for spread through commerce. *L. serricorne* differs from all the other anobiids mentioned here in having serrate antennae (the others have a 3-segmented, asymmetrical club). Neither *L. serricorne* nor *T. tabaci* has elytral striations. *T. tabaci* has coarse punctures in front of the eye. *T. confusus* and *T. herbarius* have no punctures in front of the eye and have elytral striations only on the posterolateral portions of the elytra. *T. confusus* is shorter (1.8-2.6 mm) than either *T. herbarius* (2.7-3.5 mm) or *T. tabaci* (3.4-4.6 mm) (3).

17 Elytron distinctly striate (17A); pl. 67B----------------**drugstore beetle,** *Stegobium paniceum*

Distribution: cosmopolitan; in dried plant material, leather, cork, flour, and meal.

Elytron without striae (17B); pl. 67D------------------**cigarette beetle,** *Lasioderma serricorne*

Distribution: cosmopolitan; in tobacco leaves, spices, seeds, and cereal products.



17A *Stegobium paniceum*

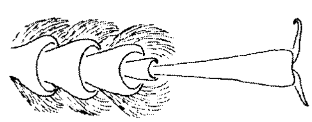
17B *Lasioderma serricorne*

18 Tarsal formula 3-3-3 (18A); pl. 94B---------**minute brown scavenger beetles,** Lathridiidae
SEE KEY, CHAPTER 10

Body length 1 to 2.5 mm; body elongate; antenna clubbed.
Drawing 18B by C. Feller.

Tarsal formula 4-4-4 or 5-5-5 (18B)-- 19

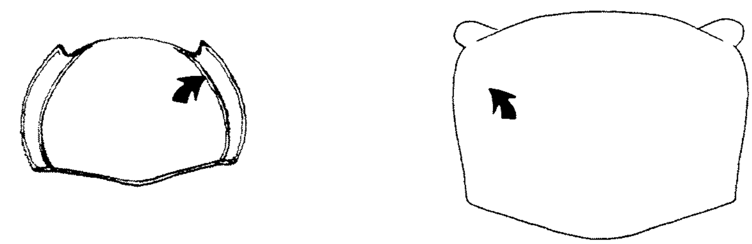
18A lathridiid beetle



18B *Glischrochilus fasciatus*

19 Pronotum with lateral raised line on each side parallel to margin (19A) ---------------- 20
Pronotum without lateral raised lines (19B) -- 21

Drawing 19B by C. Feller.



19A *Mycetaea subterranea*

19B *Ahasverus advena*

20 Tarsal formula 4-4-4; pl. 68B. Endomychidae (= Mycetaeidae) (handsome fungus beetles) --hairy cellar beetle, *Mycetaea subterranea*

Synonym: *M. hirta.* Distribution: Asia, Europe, Hawaiian Islands, North America; in moldy grain.

Tarsal formula 5-5-5. Cucujidae (**cucujid beetles**) (in part)--------------females, *Cryptolestes*

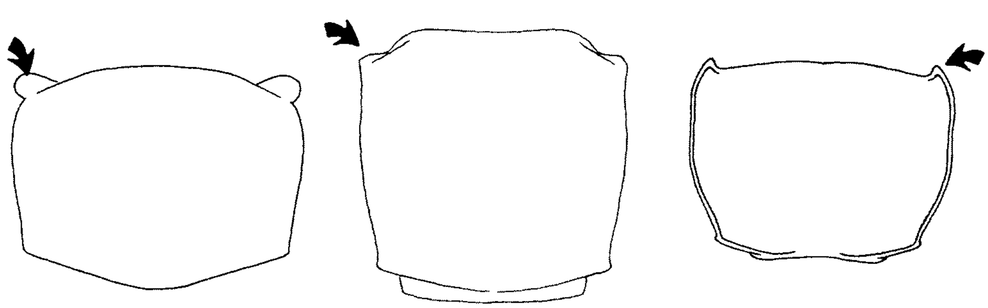
See couplet 14.

21 Pronotum with a small, laterally-directed lobe at each anterior corner (21A, 21B). Cucujidae (**cucujid beetles**) (in part) --- 22

Small, depressed beetles, 2 to 3 mm long.

Pronotum without lobes or with lobes hooklike and directed forward (21C) ---------- 25

Form and size variable.
Drawings 21A-C by C. Feller



21A *Ahasverus advena*

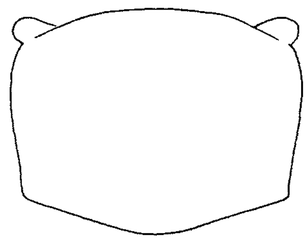
21B *Cathartus quadricollis*

21C *Tenebroides mauritanicus*

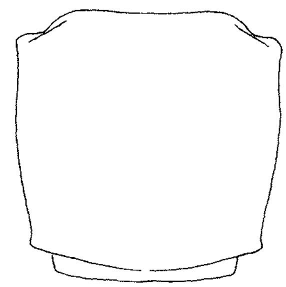
22 Pronotum wider than long (22A); pl. 68C ---------- **foreign grain beetle,** *Ahasverus advena*

Distribution: cosmopolitan; in peanuts and in moldy foods (cocoa, grains, and many others). *Ahasverus rectus* (LeConte) is similar in appearance to *A. advena,* but the lobes at the pronotal angles are rudimentary, and the apical antennal segment is circular in shape (subtriangular in *A. advena*).

Pronotum longer than wide (22B) ---------- 23



22A *Ahasverus advena*



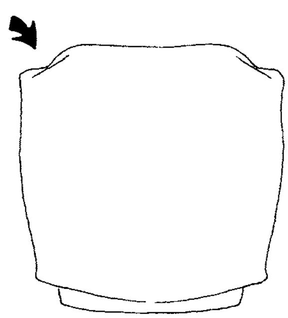
22B *Cathartus quadricollis*

23 Pronotum nearly rectangular, with side margin lacking teeth except for blunt tubercle at anterior corner (23A); pl. 68D ---------- **squarenecked grain beetle,** *Cathartus quadricollis*

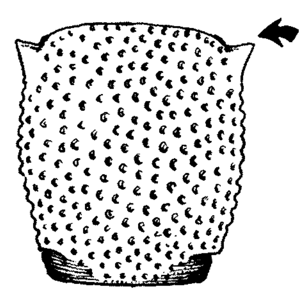
Distribution: cosmopolitan; in corn in field and in seeds.

Pronotum strongly narrowed posteriorly, with side margin serrate, and a sharp, triangular tooth at anterior corner (23B); pl. 68E ---------- *Silvanus planatus*

Pronotum densely punctate. Distribution: Nearctic; in stored corn in California.



23A *Cathartus quadricollis*

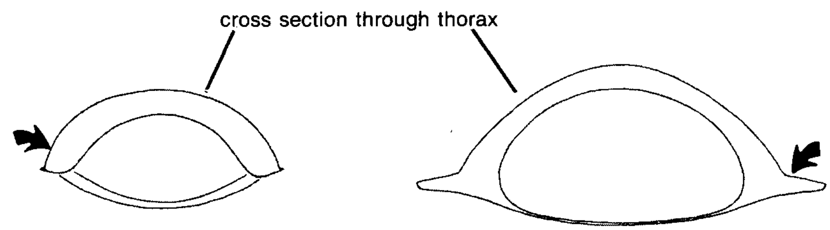


23B *Silvanus planatus*

24 Body color in part metallic blue or green (pl. 1G-I); body with erect setae; pronotum convex but not thin and flattened along lateral margins (24A) ---------- **checkered beetles,** Cleridae
SEE KEY, CHAPTER 7.

Body color not metallic; body setae flat against surface; pronotum convex in middle but flattened along lateral margins (24B); pl. 69B. Byturidae (**fruitworm beetles**) ---------- raspberry fruitworm, *Byturus unicolor*

Antennal club with 3 segments. Distribution: widespread in North America. See also 9C, 10B.



24A *Necrobia rufipes*

24B *Byturus unicolor*

25 Body flattened; elytra often short, exposing pygidium (as in 27A); antennal club composed of 3 symmetrical, closely connected segments (25A); tarsal formula 5-5-5, with segments bristly (25B); pl. 88 ---------- **sap beetles,** Nitidulidae
SEE KEY, CHAPTER 8

Lacking the above combination of characters ---------- 26

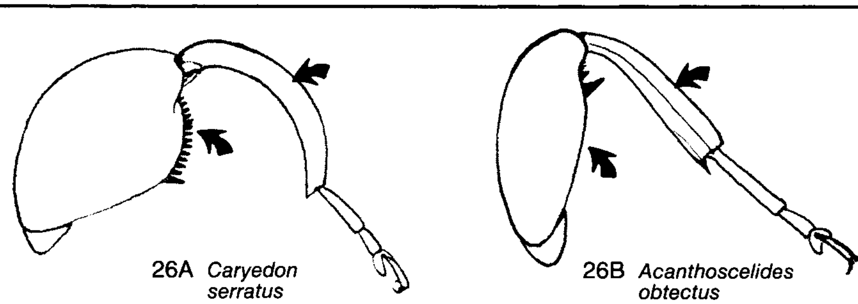
25A *Carpophilus*

25B *Glischrochilus fasciatus*

26 Femur III greatly enlarged and bearing 1 large tooth next to 1 to 12 smaller teeth on the ventral margin; tibia III curved, matching ventral margin of femur (26A); pl. 108B. Bruchidae (**seed beetles**) (in part) ---------- groundnut bruchid, *Caryedon serratus*

This species is also included in the key in Chapter 12.

Femur III only slightly enlarged or not at all; tibia III only slightly curved or not at all (26B) 27



26A *Caryedon serratus*

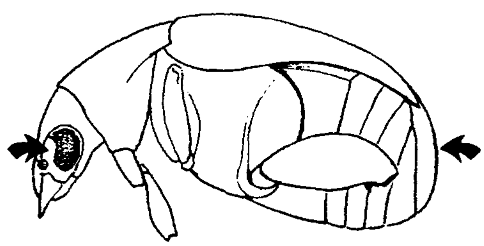
26B *Acanthoscelides obtectus*

27 Pygidium exposed beyond truncate elytra; eye emarginate at antennal insertion (27A); pl. 108C -- **seed beetles,** Bruchidae (in part)
SEE KEY, CHAPTER 12

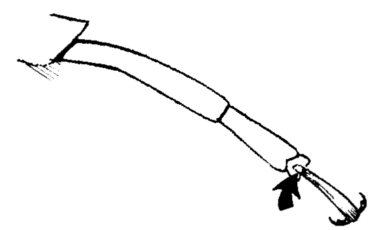
Tarsal formula 5-5-5, with segment IV very small (27B); head vertical (27A).

Pygidium largely or completely concealed by elytra; eye not emarginate at antennal insertion (27C) -- 28

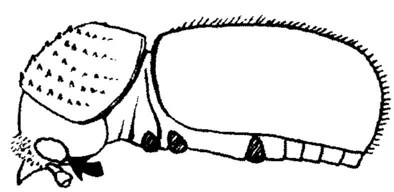
Tarsal formula variable, but segment IV not very small (27D), except in Scolytidae; head vertical (27C) or horizontal (see 28B).
Drawing 27D by C. Feller.



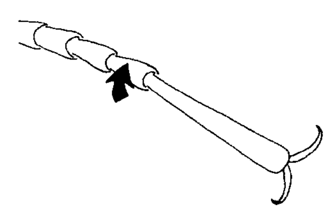
27A *Acanthoscelides obtectus*



27B *Acanthoscelides obtectus*



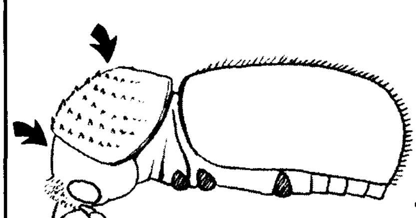
27C *Dinoderus minutus*



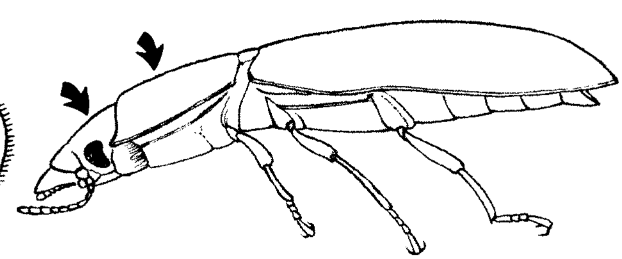
27D *Rhyzopertha dominica*

28 Pronotum hoodlike; head vertical, apparently suspended beneath pronotum, and often not visible in dorsal view (28A) -- 29

Pronotum not hoodlike; head horizontal (28B) -- 34



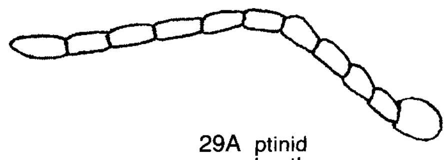
28A *Dinoderus minutus*



28B *Tenebroides mauritanicus*

29 Antenna without club (29A); pl. 82--**spider beetles,** Ptinidae
SEE KEY, CHAPTER 6

Antenna with distinct club of 2 to 4 segments (29B)-- 30


29A ptinid beetle

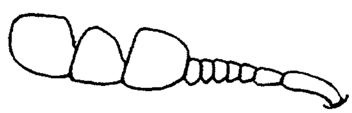

29B *Dinoderus minutus*

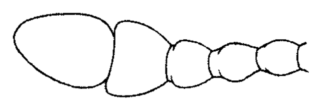
30 Antennal club lopsided (30A); pl. 70B. Bostrichidae (**false powderpost beetles**)-- 31

Antennal club of 3 segments; body cylindrical.

Antennal club symmetrical (30B) -- 33

Antennal club of 2 or 3 segments; body elongate, depressed, or cylindrical.
Drawing 30B by C. Feller.


30A *Dinoderus minutus*

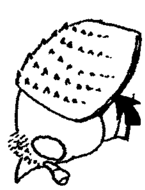

30B *Lyctus brunneus*

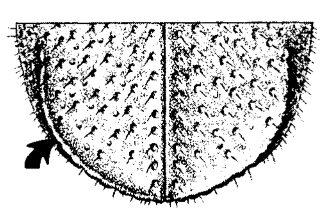
31 Pronotum with a basal row of teeth (31A); pronotum in dorsal view pointed anteriorly; apex of elytron with a strong carina (31B); pl. 70B
-- **larger grain borer,** *Prostephanus truncatus*

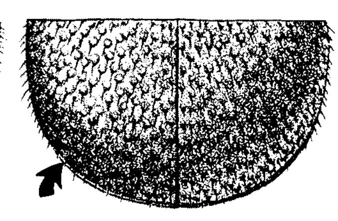
Distribution: Arizona, California, District of Columbia, Missouri, New Jersey, New York, Texas (generally throughout the Southern States, USA), tropical America; tropical Africa; in corn.
Drawings 31B&D by C. Feller.

Pronotum with basal carina (31C); pronotum in dorsal view broadly rounded anteriorly; apex of elytron without carina (31D)--- 32


31A *Prostephanus truncatus*


31C *Dinoderus minutus*


31B *Prostephanus truncatus*

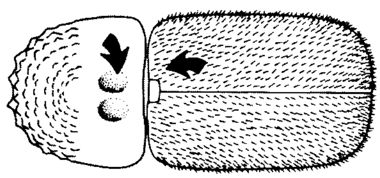

31D *Dinoderus minutus*

32 Pronotum with a pair of shallow depressions; scutellum transversely rectangular; elytral setae straight (32A); pl. 70D----**bamboo powderpost beetle,** *Dinoderus minutus*

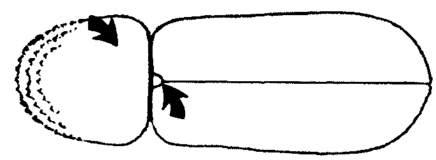
Distribution: cosmopolitan; in dried foods, seeds, and roots, and in corn. See also 28A, 30A.
Drawing 32A by C. Feller.

Pronotum without depressions; scutellum square (32B); elytral setae curved (32C); pl. 71A--**lesser grain borer,** *Rhyzopertha dominica*

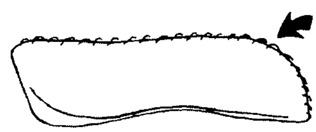
Distribution: cosmopolitan; in a wide variety of stored foods, chiefly cereals, seeds, and dried fruit.



32A *Dinoderus minutus*



32B *Rhyzopertha dominica*



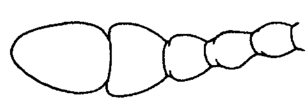
32C *Rhyzopertha dominica*

33 Antennal club of 2 segments (33A); antennal segment I shorter than club; body elongate and depressed; pl. 71D. Lyctidae (**powderpost beetles**)
---brown powderpost beetle, *Lyctus brunneus*

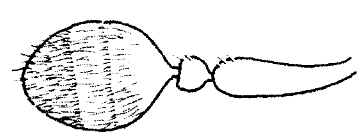
Distribution: cosmopolitan; in vegetable drugs, seeds, and spices.

Antennal club of 3 closely-united segments (33B); antennal segment I longer than club; body cylindrical; pl. 72B. Scolytidae (**bark beetles**)
--- **coffee berry borer,** *Hypothenemus hampei*

Distribution: circumtropical in most coffee-growing areas; in coffee beans.



33A *Lyctus brunneus*

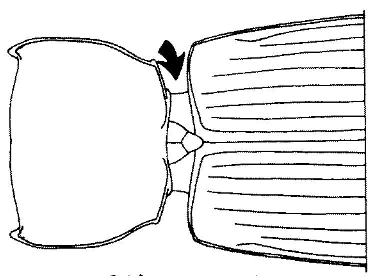


33B *Hypothenemus hampei*

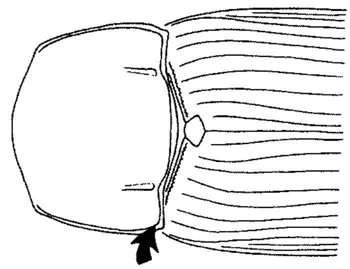
34 Distinct constriction at base of pronotum (34A); pl. 72D. Trogositidae (= Ostomatidae) **(trogositid beetles)** (in part) ---------------------------------- **cadelle,** *Tenebroides mauritanicus*

Distribution: cosmopolitan; in flour, meal, and grains.
See also 28B.
Drawings 34A&B by C. Feller.

Without distinct constriction between pronotum and elytra (34B)-------------------------- 35



34A *Tenebroides mauritanicus*

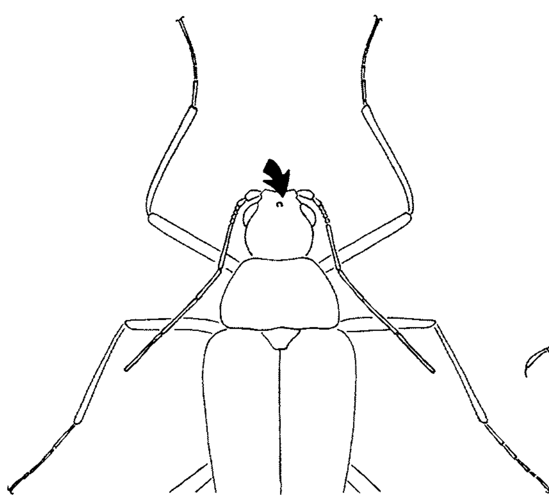


34B *Pharaxonotha kirschi*

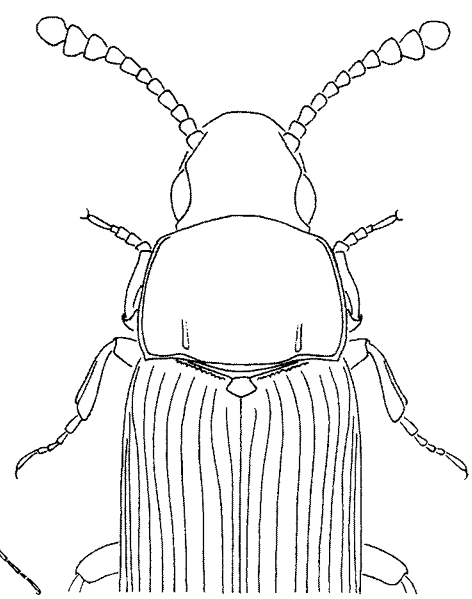
35 Median ocellus present; antenna not clubbed; legs long and slender (35A); Dermestidae **(dermestid beetles)** (in part)---------------- **odd beetle,** *Thylodrias contractus*

Females are wingless. This species is also included in the key to the Dermestidae, Chapter 5.
Drawings 35A&B by C. Feller.

Median ocellus absent; antenna clubbed; legs not unusually long and slender (35B) 36



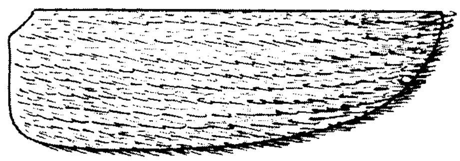
35A *Thylodrias contractus*



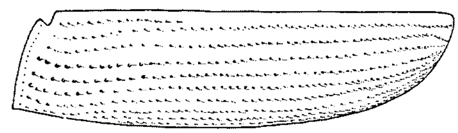
35B *Pharaxonotha kirschi*

36 Elytron with silky hair (36A); tarsal formula 4-4-4. Mycetophagidae (**hairy fungus beetles**) -------------------- 37
Elytron with, at most, short, fine, scarcely visible setae (36B); tarsal formula 5-5-5 38

Drawing 36B by C. Feller.



36A *Typhaea stercorea*



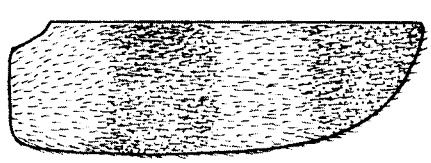
36B *Pharaxonotha kirschi*

37 Elytral pattern of light and dark transverse bands; elytral setae not in rows (37A); pl. 73A --------------------*Litargus balteatus*

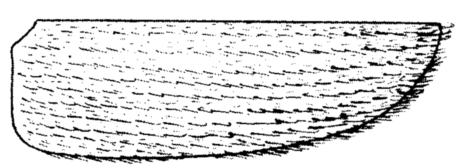
Distribution: Australia, central Europe, Hawaii, North and Central America; in corn and stored grain.

Elytral color a uniform yellowish brown, without pattern; elytral setae in definite rows (37B); pl. 73C --------------------**hairy fungus beetle,** *Typhaea stercorea*

Distribution: cosmopolitan; feeds on mold hyphae in stored grain, seeds, peanuts, and cacao.



37A *Litargus balteatus*



37B *Typhaea stercorea*

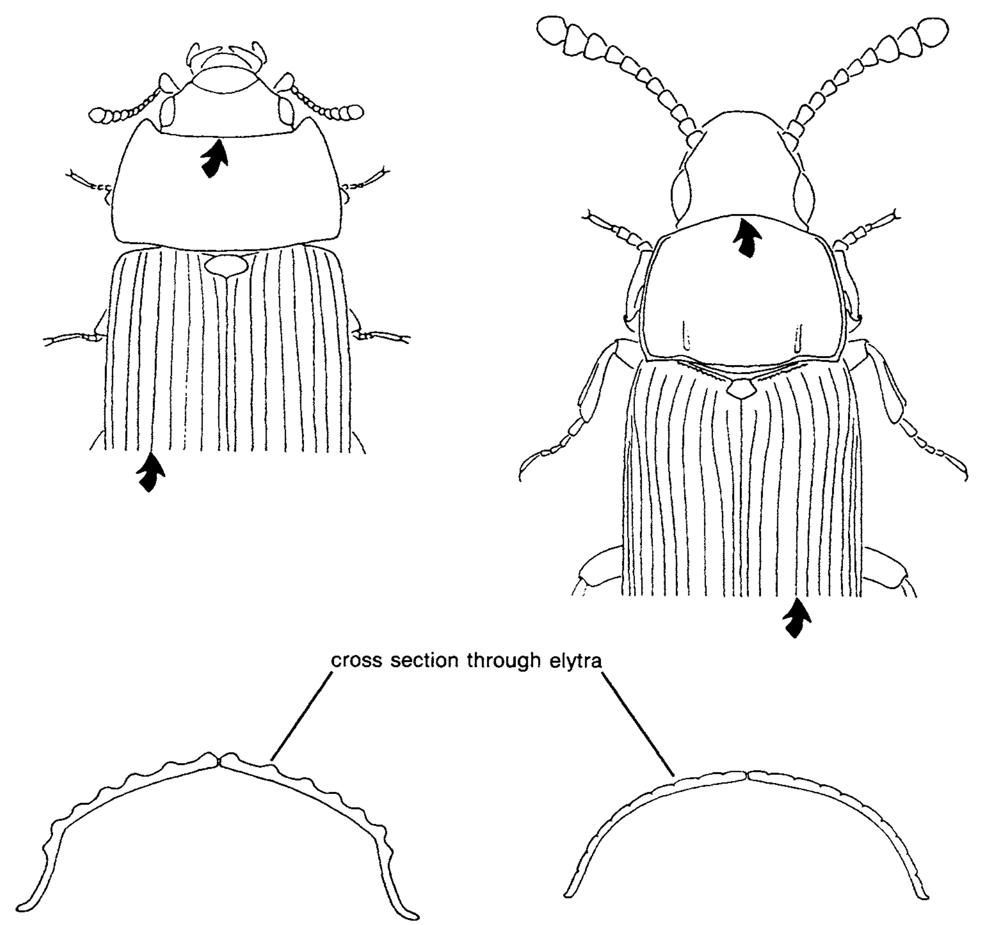
38 Elytron with longitudinal ridges (38A); anterior margin of pronotum broadly emarginate (38A); pl. 74B. Trogositidae (=Ostomatidae) (**trogositid beetles**) (in part) -- Siamese grain beetle, *Lophocateres pusillus*

Distribution: tropicopolitan; in stored grain, flour, seeds, spices, beans, and dried fruit.

Elytron without longitudinal ridges (38B); anterior margin of pronotum somewhat rounded (38B); pl. 74D. Languriidae (languriid beetles) --Mexican grain beetle, *Pharaxonotha kirschi*

Distribution: central Europe, Guatemala, Mexico, United States; in corn and cornmeal.

Drawings 38A-D by C. Feller.



38A *Lophocateres pusillus*

38B *Pharaxonotha kirschi*

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1 Banks, H.J.
1979. Identification of stored product *Cryptolestes* spp. (Coleoptera: Cucujidae): A rapid technique for preparation of suitable mounts. Jour. Australian Ent. Soc. 18(3)217-222.

2 Green, M.
1979. *Cryptolestes klapperichi* Lefkovitch in stored products and its identification (Coleoptera: Cucujidae). Jour. Stored Prod. Res. 15(2)71-72.

3 White, R.E.
1971. *Tricorynus confusus* (Coleoptera: Anobiidae) in tobacco warehouses, with notes on natural hosts. Ann. Ent. Soc. America 64(3)752.

4 LARVAL BEETLES (COLEOPTERA)

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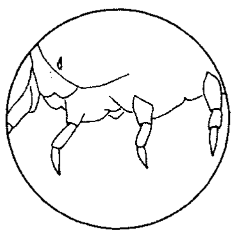
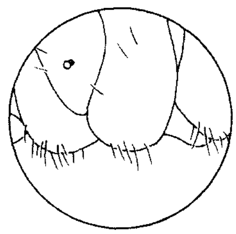
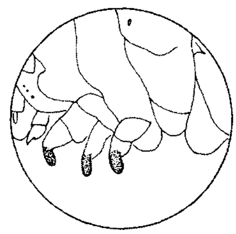
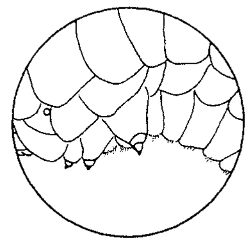
KEY
Drawings by C. Feller unless otherwise noted.

1 With distinct, jointed legs (1A) -- 2
Without legs (1B) or with greatly reduced legs (1C, 1D) -- 11


1A *Ptinus*


1B *Caulophilus oryzae*

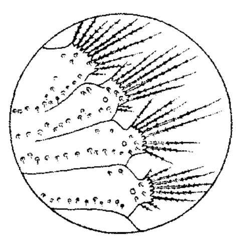

1C *Caryedon serratus*

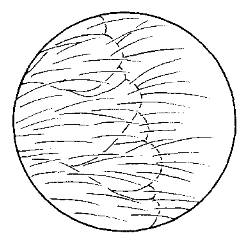

1D *Bruchus pisorum*

2 Body depressed, fringed at sides (2A); head entirely concealed in dorsal view. Cerylonidae (= Murmidiidae) (cerylonid beetles); pl. 64A
-- oval grain beetle, *Murmidius ovalis*

Distribution: cosmopolitan; in stored rice, wheat, and corn, and in other dry plant materials, such as hay and leaves. Reference: *5*.

Body not flattened and fringed (2B); head not entirely concealed from above ----- 3


2A *Murmidius ovalis*

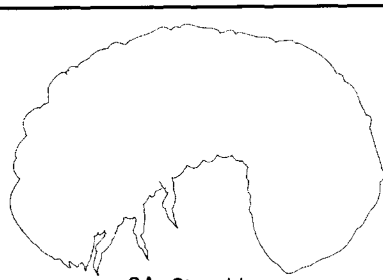

2B *Lasioderma serricorne*

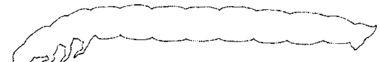
3 Body grublike, distinctly curved (C-shaped) (3A) -- 4

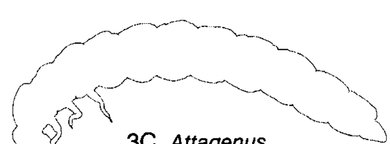
Urogomphi absent.

Body long and slender, nearly straight (3B) (if apparently curved, then not grublike) (3C) -- 13

Urogomphi present or absent.

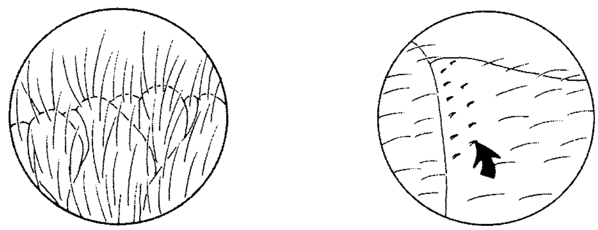

3A *Stegobium paniceum*


3B *Tenebrio molitor*


3C *Attagenus unicolor*

4 Body and head (of dry specimen) with numerous long, soft, hairlike setae (4A)---- 5
Body and head with distinct short and sometimes numerous setae (4B)-------------- 6

Hook-shaped, dorsal asperities sometimes present on thorax and/or abdomen (4B).



4A *Lasioderma serricorne*

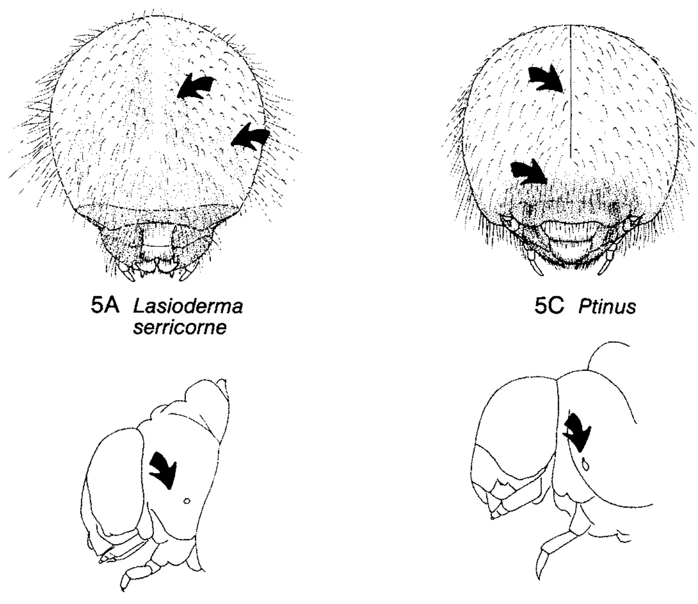
4B *Stegobium paniceum*

5 Color pattern apparent over much of dorsal surface of head (5A); thoracic spiracle distinctly distant from anterior margin of prothorax (5B). Anobiidae **(drugstore beetles)** (in part); pl. 67C------------------------------**cigarette beetle,** *Lasioderma serricorne*

Distribution: cosmopolitan; infests a wide variety of dried plant and animal products, but is best known for its destructiveness to tobacco. References: *2, 10.*

Dorsum of head without color pattern except for a broad pigmented anterior band (5C); thoracic spiracle near anterior margin of prothorax (5D); pl. 85A
---**spider beetles,** Ptinidae

For a key to the larval ptinids attacking stored products, see Hall and Howe *(4)*. For bionomic notes, see key to adult ptinids.



5A *Lasioderma serricorne*

5C *Ptinus*

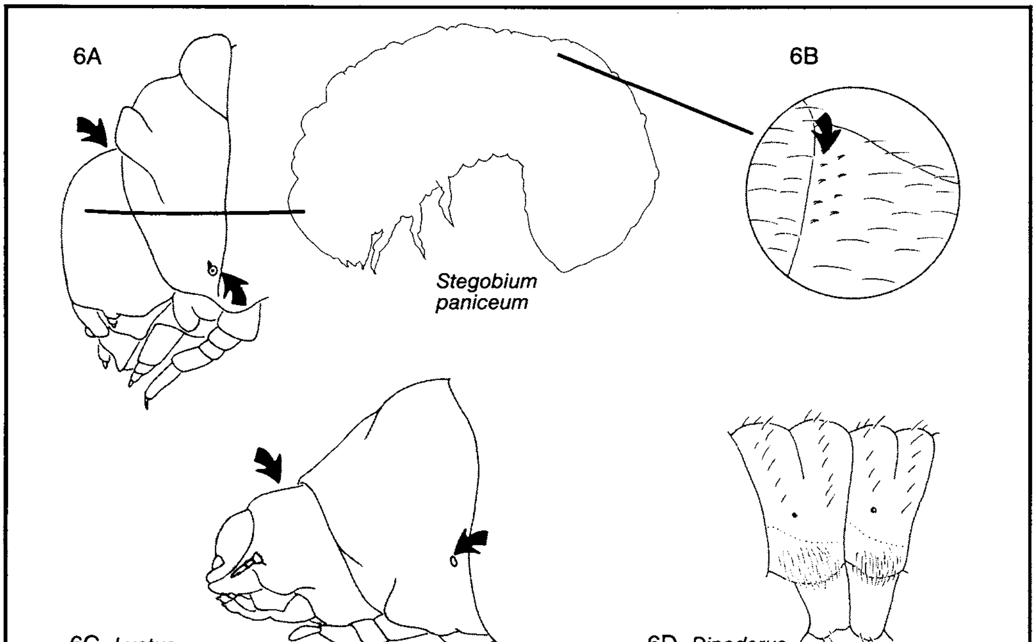
5B *Lasioderma serricorne*

5D *Ptinus*

6 Head not retracted into prothorax; spiracles with a spoutlike process (6A); hook-shaped asperities present (6B). Anobiidae (**drugstore beetles**) (in part); pl. 67A
--**drugstore beetle,** *Stegobium paniceum*

Distribution: cosmopolitan; infests a wide variety of dry plant products. References: *2, 10.*

Head retracted (6C); spiracles oval or round (6C); hooklike asperities absent (6D)-- 7



6C *Lyctus brunneus*

6D *Dinoderus minutus*

7 VIII abdominal spiracle (the most posterior one) about three times bigger than other abdominal spiracles; setae very sparse on most of body surface (7A)
--**powderpost beetles,** Lyctidae

VIII abdominal spiracle subequal in size to other abdominal spiracles; dorsal setae numerous (7B)-- 8

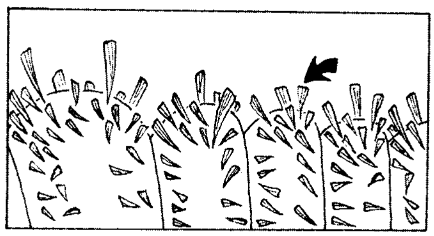
7A *Lyctus brunneus*

7B *Rhyzopertha dominica*

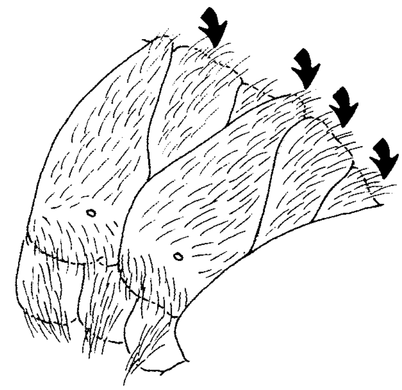
8 Body setae flat, spatulate; segments of thorax and abdomen with dorsal surface undivided (8A). Endomychidae (= Mycetaeidae) (handsome fungus beetles); pl. 68A
--hairy cellar beetle, *Mycetaea subterranea*

Distribution: Europe, Hawaiian Islands, Java, North America, USSR; feeds on molds in warehouses, granaries, and wine cellars. Reference: *5*.

Body setae hairlike, bristly; dorsal surface of meso- and metathorax and abdomen divided into 2 or more folds (8B). Bostrichidae (**false powderpost beetles**)------ 9



8A *Mycetaea subterranea*

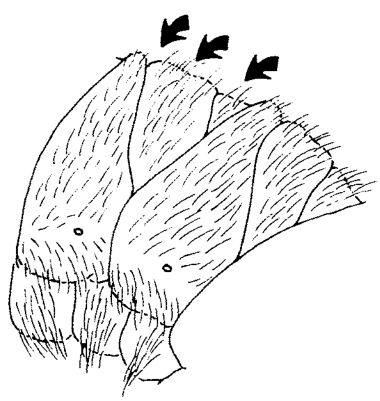


8B *Rhyzopertha dominica*

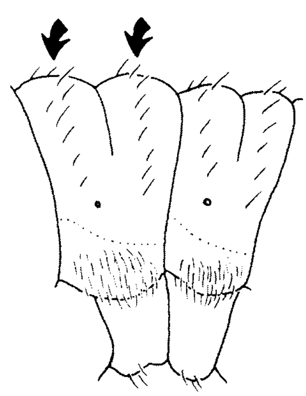
9 Abdominal segments I to V each with 3 dorsal folds; body covered with numerous hairlike setae (9A); pl. 71A------------------------**lesser grain borer,** *Rhyzopertha dominica*

Distribution: cosmopolitan; in a wide variety of stored foods, chiefly cereals, seeds, and dried fruit.

Abdominal segments I to V each with 2 dorsal folds; hairlike setae concentrated on dorsal and lateral areas of body, sparse or absent on other body regions (9B)- 10



9A *Rhyzopertha dominica*



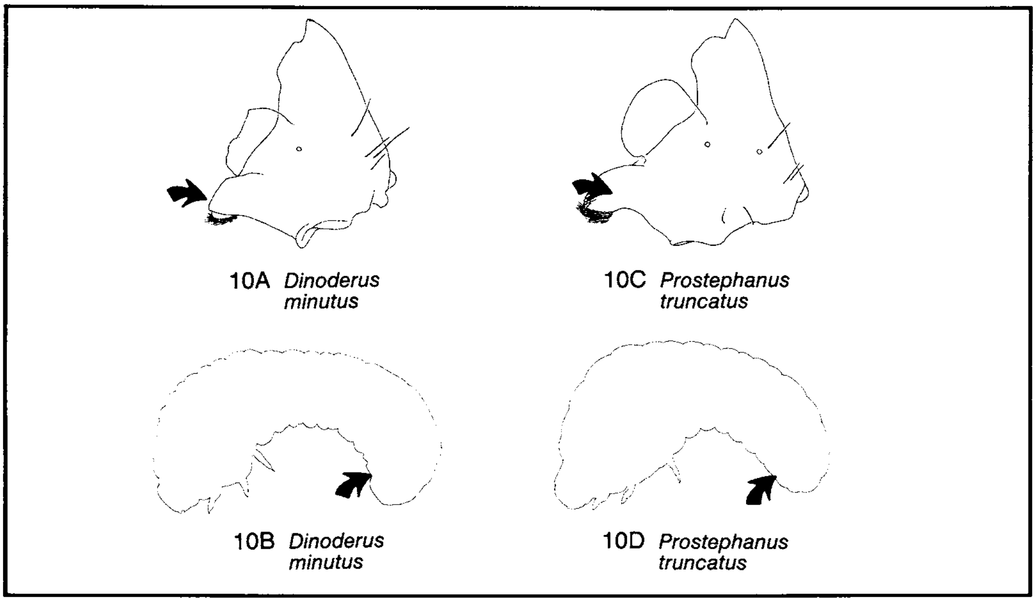
9B *Dinoderus minutus*

10 Mandible with a stubby molar process (10A); posterior end of body strongly curved (10B); pl. 70C----------------------------------**bamboo powderpost beetle,** *Dinoderus minutus*

Distribution: cosmopolitan; although the adults are polyphagic on a wide variety of plant materials, the larvae are strongly stenophagic, thriving only in the stems of various bamboos and canes.

Mandible with an elongate molar process (10C); posterior end of body slightly curved (10D); pl. 70A---**larger grain borer,** *Prostephanus truncatus*

Distribution: cosmopolitan; usually in stored grain.



10A *Dinoderus minutus*

10C *Prostephanus truncatus*

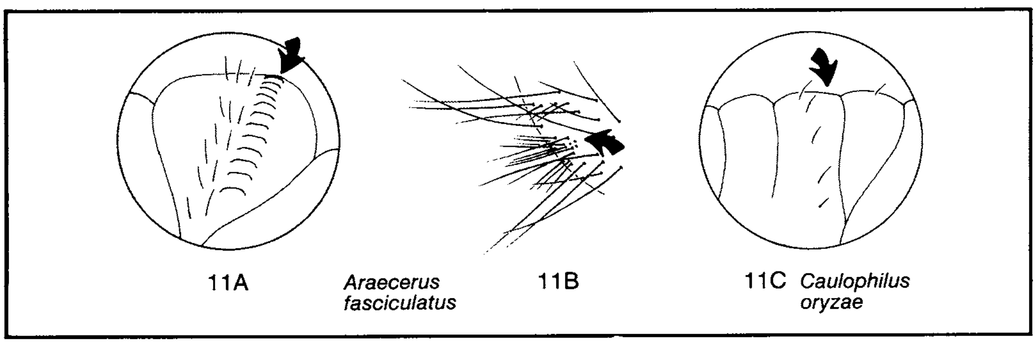
10B *Dinoderus minutus*

10D *Prostephanus truncatus*

11 Body covered with hairlike setae; some dorsal folds of abdomen with transverse rows of longitudinal ridges (11A). Anthribidae (**fungus weevils**); pl. 62A
--**coffee bean weevil,** *Araecerus fasciculatus*

Legs very small (vestigial), barely visible under high magnification (11B). Distribution: cosmopolitan; in a wide variety of dry plant materials. References: *1, 10.*
11B redrawn from *1.*

Body sparsely covered with a few short setae; dorsal folds of abdomen without transverse rows of longitudinal plicae (11C)-- 12



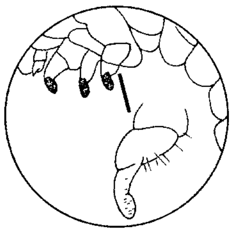
11A *Araecerus fasciculatus* 11B

11C *Caulophilus oryzae*

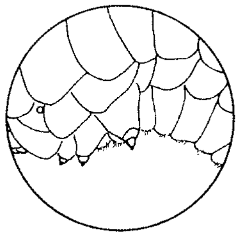
12 Legs present (12A, 12B)--**seed beetles,** Bruchidae (in part)

The larvae of the **pea weevil,** *Bruchus pisorum* (pl. 109A), the groundnut bruchid, *Caryedon serratus* (pl. 108A), and certain other bruchids have 3 pairs of short legs (12A, 12B); other bruchid larvae are legless. References: *8, 10.*

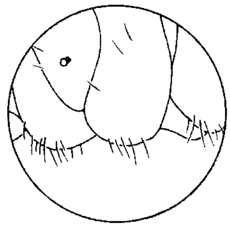
Legs absent (12C)-- 29



12A *Caryedon serratus*



12B *Bruchus pisorum*



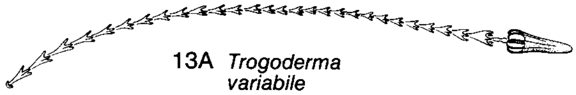
12C *Caulophilus oryzae*

13 Body covered with long, barbed (13A) or flattened (13B, 13C) setae
--**dermestid beetles,** Dermestidae
SEE KEY, CHAPTER 5

Urogomphi often absent (13D). References: *5, 7.*
13B&C redrawn from *5.*

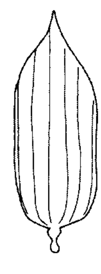
Body setae simple, hairlike (13E)-- 14

Urogomphi often present (13E).

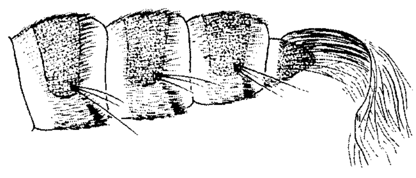


13A *Trogoderma variabile*

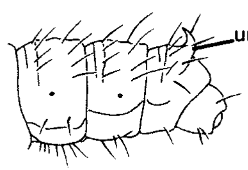
13B *Attagenus*



13C *Attagenus*



13D *Attagenus unicolor*

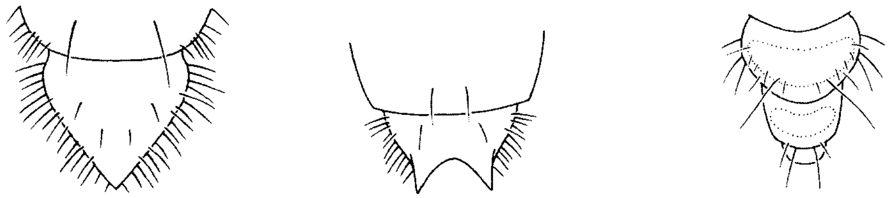


13E *Byturus*

14 Abdominal tip pointed (14A) or bearing urogomphi (14B)------------------------------------ 15

Drawings 14A&B by A.D. Cushman.

Abdominal tip neither pointed nor bearing urogomphi (14C)-------------------------------- 26



14A *Alphitobius laevigatus* 14B *Tribolium audax* 14C *Oryzaephilus surinamensis*

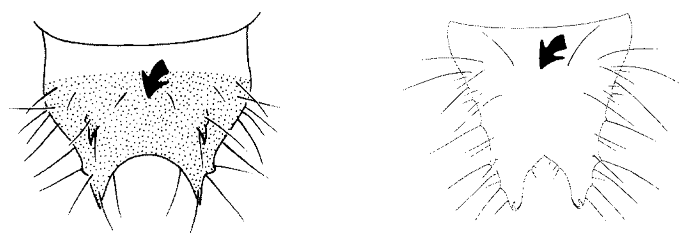
15 Yellowish or brownish body integument largely sclerotized, rigid (but may yield to light pressure), and hard (but may be thin and translucent); pl. 99A, 101A
--**darkling beetles,** Tenebrionidae
SEE KEY, CHAPTER 11

Some have urogomphi; others have a pointed abdomen.

Body integument largely unsclerotized, soft, and flabby; color may be mostly whitish or yellowish, or may be mottled with brown, pink, or lavender on a light background--- 16

Urogomphi present; abdomen not pointed.

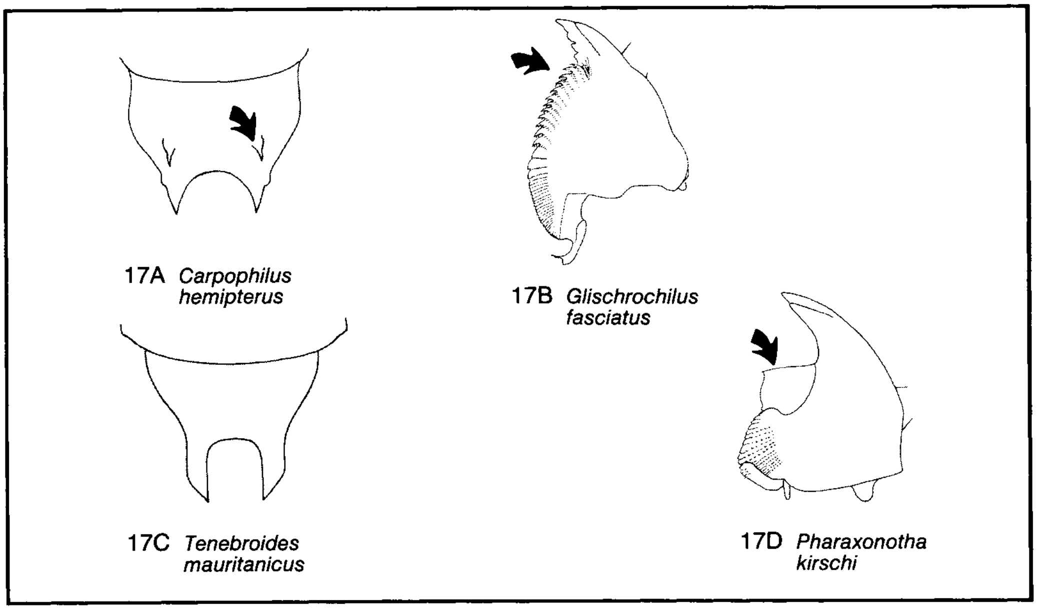
16 Urogomphi arising from a pigmented plate that appears distinct from the rest of the last abdominal segment (16A)--- 17
Last abdominal segment without distinct plate associated with urogomphi (16B)-- 20



16A *Carpophilus hemipterus* 16B *Anthicus*

17 Pregomphus present (17A); mandible with serrate prostheca (17B); pl. 90A
---**sap beetles,** Nitidulidae
SEE KEY, CHAPTER 8

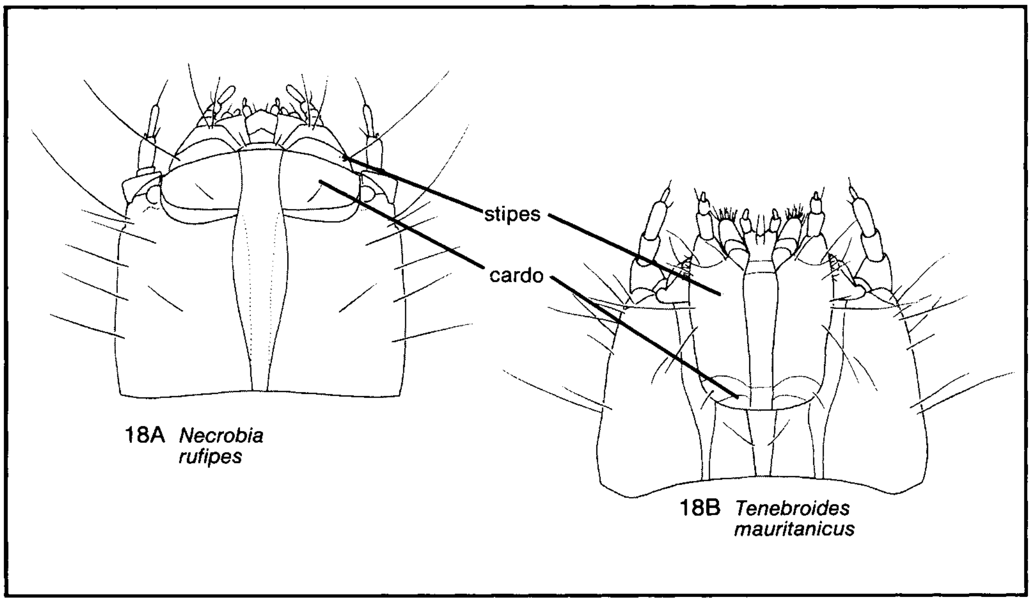
Pregomphus absent (17C); mandible without serrate prostheca (17D)------------------ 18



18 Ventral mouthparts only slightly retracted into underside of head; maxilla with cardo as large as or larger than stipes (18A); body color a mottled pink or lavender or brown on a light background (pl. 87A). Cleridae (**checkered beetles**) --ham beetles, *Necrobia*

Distribution: cosmopolitan; larvae feed on many dried or cured animal products, such as ham, fish, cheese, and egg yolk. References: *10, 11* (includes key to species).

Ventral mouthparts deeply retracted into underside of head; cardo much smaller than stipes (18B); membranous portions of integument uniformly whitish or yellowish. Trogositidae (= Ostomatidae) (**trogositid beetles**)-- 19

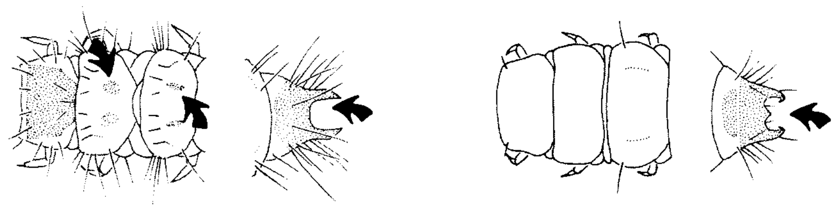


19 Thorax with dorsal dark-colored areas, a large one on the pronotum and 2 each on the meso- and metanota (19A); urogomphi not strongly incurved; space between urogomphi not marked by a tubercle (19B); pl. 72C
---**cadelle,** *Tenebroides mauritanicus*

Distribution: cosmopolitan; in flour, meal, and grains.
See also 18B.

Thoracic dorsum without dark-colored areas (19C); tubercle located between strongly-incurved urogomphi (19D); pl. 74A-----------Siamese grain beetle, *Lophocateres pusillus*

Distribution: tropicopolitan; in stored grain, flour, seeds, spices, beans, and dried fruit.

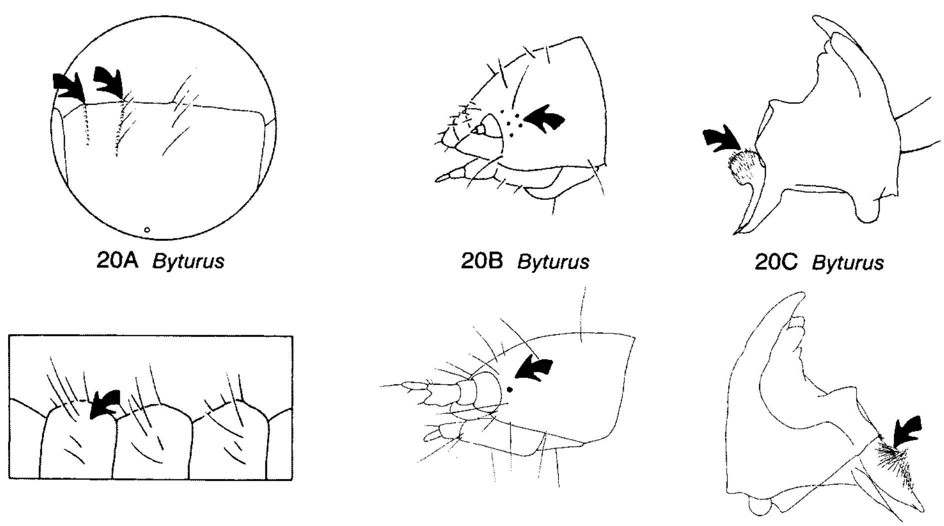


19A *Tenebroides mauritanicus* 19B 19C *Lophocateres pusillus* 19D

20 Abdominal terga with 2 transverse carinae (composed of fused tubercles) (20A); head with 5 ocelli (in a compact group) on each side (20B); mandible with a soft bulbous process covered with short setae (20C). Byturidae (**fruitworm beetles**); pl. 69A
---raspberry fruitworms, *Byturus*

Distribution: Europe, North America; in various berries, especially raspberries and loganberries in northeastern United States. Reference: *10.*

Dorsal carinae absent (20D); head with less than 5 ocelli on each side (20E) (if there are 5 ocelli, they are widely scattered, not compactly grouped); mandible either without a soft, bulbous, seta-covered process or with an elongate process (20F)---- 21



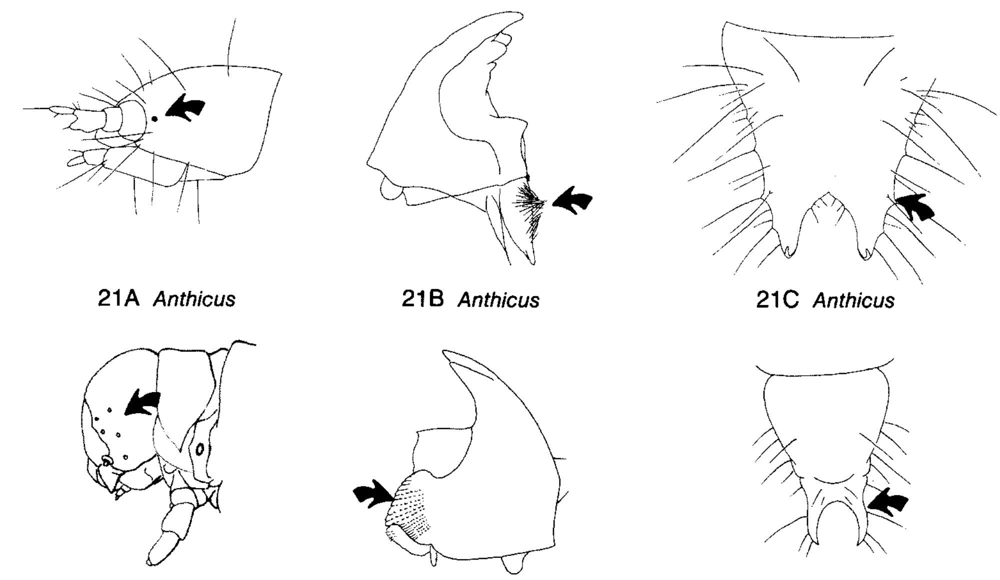
20A *Byturus* 20B *Byturus* 20C *Byturus*

20D *Anthicus* 20E *Anthicus* 20F *Anthicus*

21 1 ocellus on each side of head (21A); molar area of mandible with a soft, elongate process bearing hairs (21B); lateral setae of urogomphi arise from tubercles (21C). Anthicidae (**antlike flower beetles**); pl. 64C--*Anthicus*

Distribution: *Anthicus floralis*, **narrownecked grain beetle,** is cosmopolitan; infests diverse plant materials —haystack refuse, manure piles, stored wheat, and stored cacao; adults and larvae feed on decaying plants and fungi. Reference: *5*.

2 or more ocelli on each side (21D); molar area of mandible without a soft, elongate process (21E); lateral urogomphal setae not arising from tubercles (21F)--------- 22



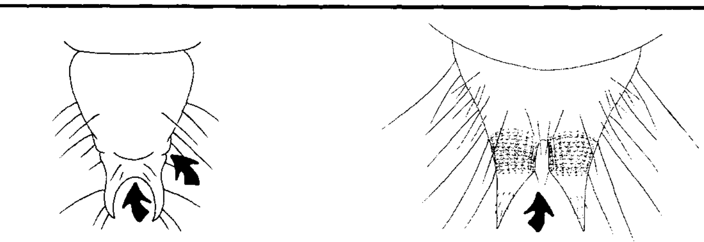
21A *Anthicus* 21B *Anthicus* 21C *Anthicus*

21D *Crioceris asparagi* 21E *Pharaxonotha kirschi* 21F *Cryptolestes*

22 Urogomphi joined at their bases and hinged to the last abdominal segment by a joint on each side (22A). Cucujidae (**cucujid beetles**) (in part); pl. 66A------------*Cryptolestes*

Cucujid species in other genera associated with stored products do not have urogomphi. For bionomic and taxonomic notes, see key to adult beetles (Chapter 3).

Urogomphi distinctly separated at their bases and solidly fused to the VIII abdominal segment (22B)--- 23

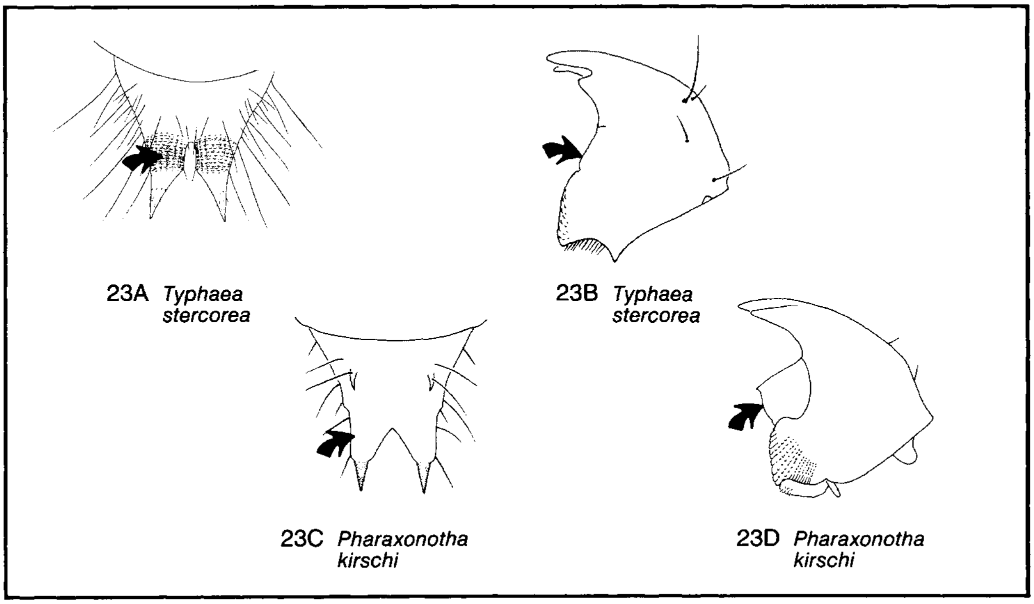


22A *Cryptolestes* 22B *Typhaea stercorea*

23 Urogomphus stout, conical (curved only at the tip if at all), with granular surface often longitudinally ridged (23A); mandible without a retinaculum or prostheca (23B). Mycetophagidae (**hairy fungus beetles**)-- 24

23B redrawn from *5*.

Urogomphus slender, smooth-surfaced, without granulation or ridges (23C); mandible with a distinct retinaculum or prostheca (23D)--- 25

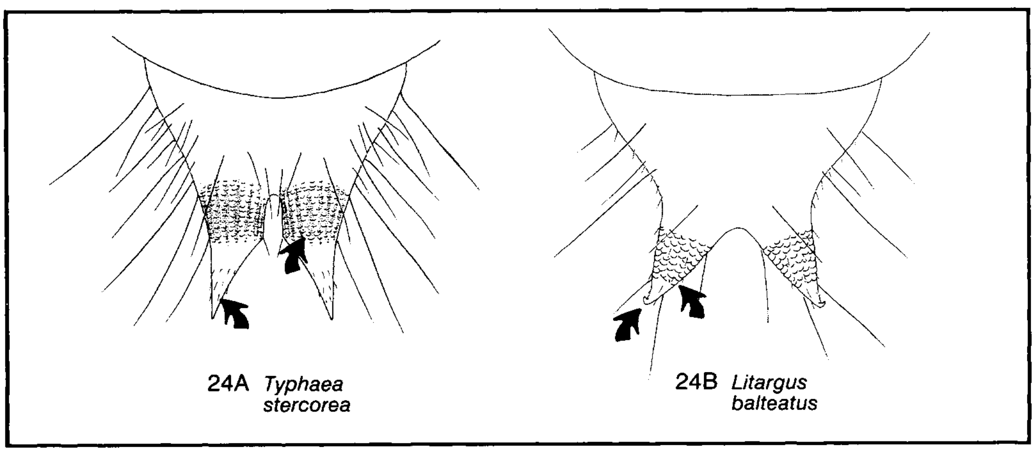


24 Urogomphus tapering to a straight point (not curved), with several longitudinal ridges on basal half (24A); pl. 73B--------------------------**hairy fungus beetle,** *Typhaea stercorea*

Distribution: cosmopolitan; feeds on mold hyphae in stored grain, seeds, peanuts, and cacao.

Urogomphus distinctly curved at tip; longitudinal ridges absent (24B)---*Litargus balteatus*

Distribution: Australia, central Europe, Hawaii, North and Central America; in corn and stored grain.

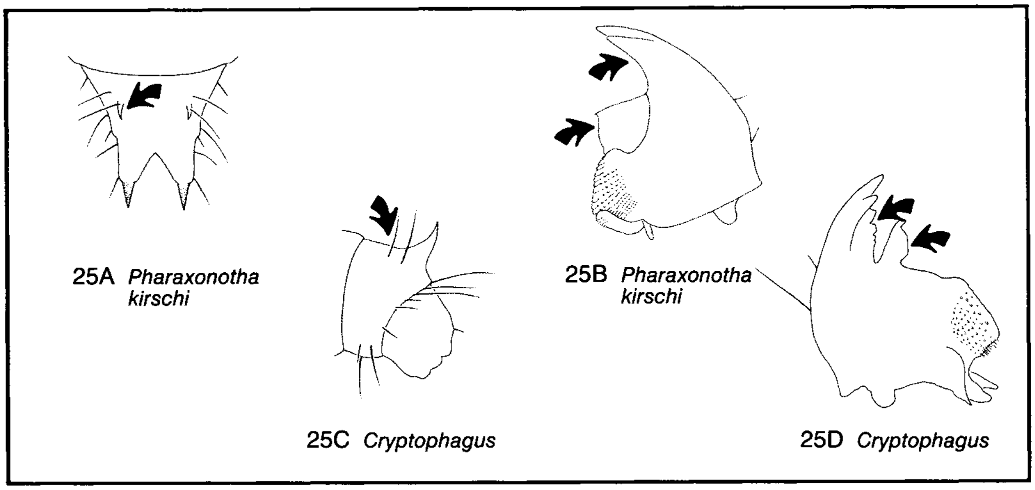


25 Pregomphus present (25A); mandible with no teeth on cutting edge and with a broad, membranous prostheca (25B). Languriidae (languriid beetles); pl. 74C ---Mexican grain beetle, *Pharaxonotha kirschi*

Distribution: Europe, North and South America; in stored plant products, such as corn, wheat, beans, and flour. Reference: *5*.

Pregomphus absent (25C); mandible with a serrate cutting edge, and an elongate, pointed retinaculum (25D). Cryptophagidae (**cryptophagid beetles**); pl. 93A ---*Cryptophagus*

For bionomic information, see key to adult cryptophagids (Chapter 9). Reference: *5*.



25A *Pharaxonotha kirschi*

25B *Pharaxonotha kirschi*

25C *Cryptophagus*

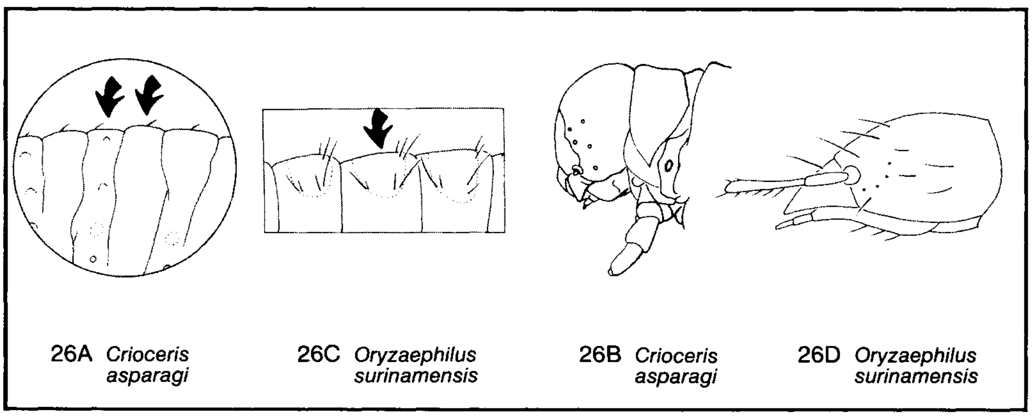
25D *Cryptophagus*

26 Body stout, convex dorsally, with 2 folds visible on most abdominal terga (26A); head hypognathous, vertex rounded (26B). Chrysomelidae **(leaf beetles)**----------------- 27

Head, legs, and other sclerotized body parts often dark-colored.

Body slender and straight with only 1 dorsal fold or plate on each abdominal segment (26C); head prognathous, vertex at most slightly convex (26D)---------------- 28

Head, legs, and other sclerotized body parts light-colored.



26A *Crioceris asparagi*

26C *Oryzaephilus surinamensis*

26B *Crioceris asparagi*

26D *Oryzaephilus surinamensis*

27 Body very stout, strongly convex dorsally; abdomen with 3 parallel rows of darkly-pigmented plates (pl. 65A)-----------**Colorado potato beetle,** *Leptinotarsa decemlineata*

Distribution: North America and, by introduction, Europe; adults and larvae on foliage of eggplant, potato, and tomato.

Body moderately stout, moderately convex dorsally: abdomen without pigmented lateral plates (pl. 65C)--asparagus beetles, *Crioceris*

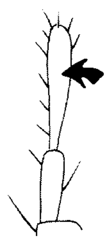
Distribution: Europe, United States; feeding by the larvae of *C. asparagi* causes scarring of growing shoots of asparagus; larvae of *C. duodecimpunctata* develop and feed mainly in the berries of asparagus.

28 Antennal segment II elongate, club-shaped (28A); mandible not partly fleshy nor bearing long setae (28B). Cucujidae **(cucujid beetles)** (in part); pl. 63A&B---------Silvaninae

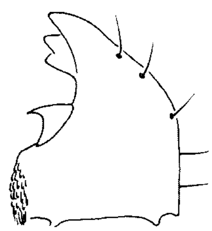
Body setae sparse, straight, sharply-pointed (28C); Reference: 3 (includes key to genera and species).

Antennal segment II short (28D); fleshy portion of mandible bearing 2 long setae (28E); pl. 94A--**minute brown scavenger beetles,** Lathridiidae

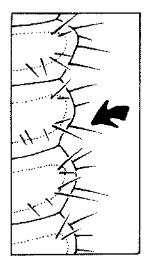
Body setae either short and widened apically (28F) or curved and pointed (28G). Distribution: cosmopolitan (at least the economically-important species); in situations which favor the growth of fungi upon which the adults and larvae feed.
28D-G redrawn from *5*.



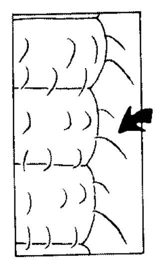
28A *Oryzaephilus surinamensis*



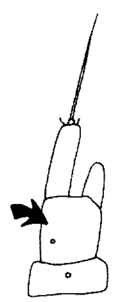
28B *Oryzaephilus surinamensis*



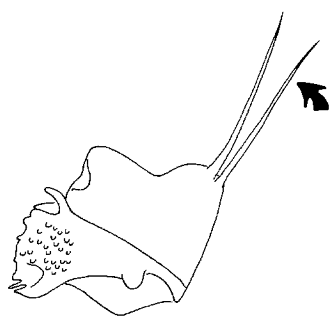
28C *Oryzaephilus surinamensis*



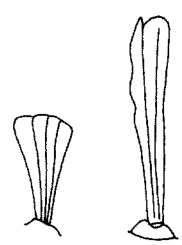
28G *Microgramme filum*



28D *Corticaria fulva*



28E *Corticaria fulva*

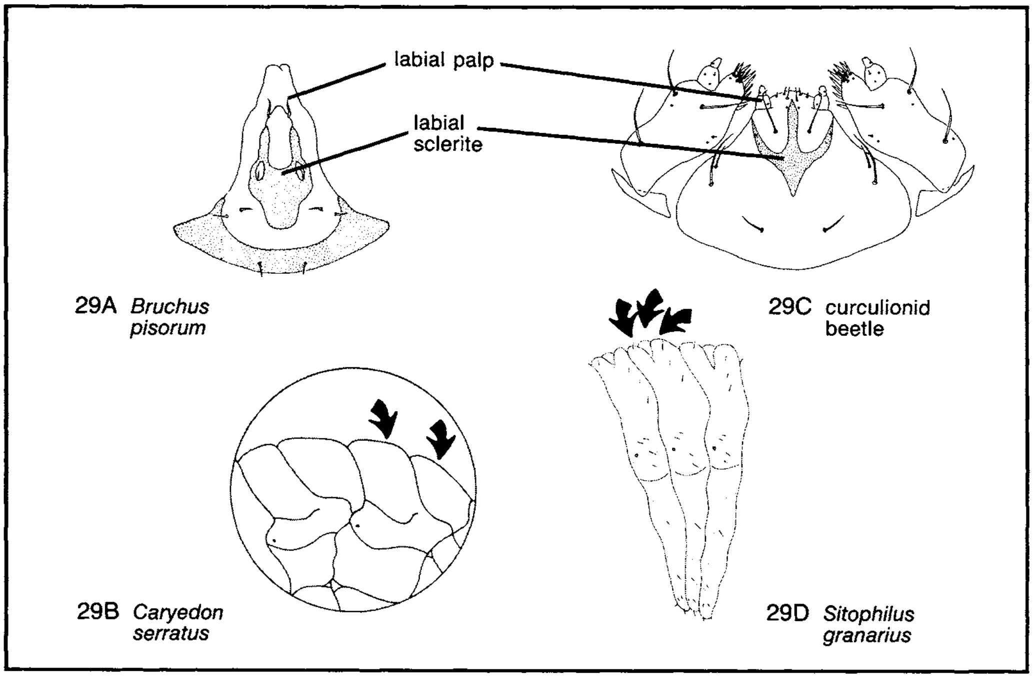


28F *Corticaria fulva*

29 Labial sclerite forked (29A), heart-shaped, or oval; labial palp setalike (29A); most abdominal terga with 2 folds (29B); pl. 107A------------**seed beetles,** Bruchidae (in part)

Labial sclerite trident; labial palp with 1 or 2 segments (29C); most abdominal terga with 3 folds (29D)-- 30

Curculionids cannot be separated from scolytids in the larval stage, and the larvae of both of these families are easily confused with the few species of bruchids with legless larvae.



29A *Bruchus pisorum*

29C curculionid beetle

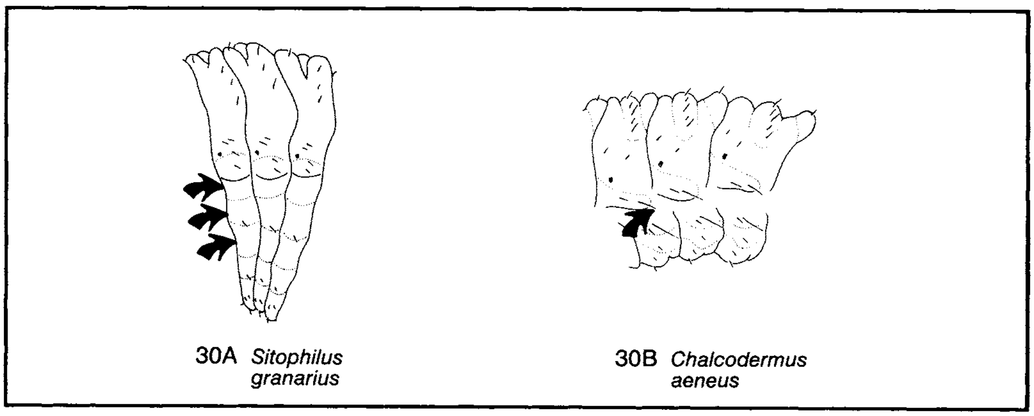
29B *Caryedon serratus*

29D *Sitophilus granarius*

30 Body very stout and very convex dorsally (pl. 113B); abdomen with 3 rows of pleural folds (30A). Curculionidae (**weevils**) (in part). Genus *Sitophilus*---------------------- 31

For bionomic notes, see key to adult weevils.
References: *6*, *8* (includes keys to species).

Body only moderately stout and convex (pl. 110A); abdomen with 1 row of pleural folds (30B)-- 33

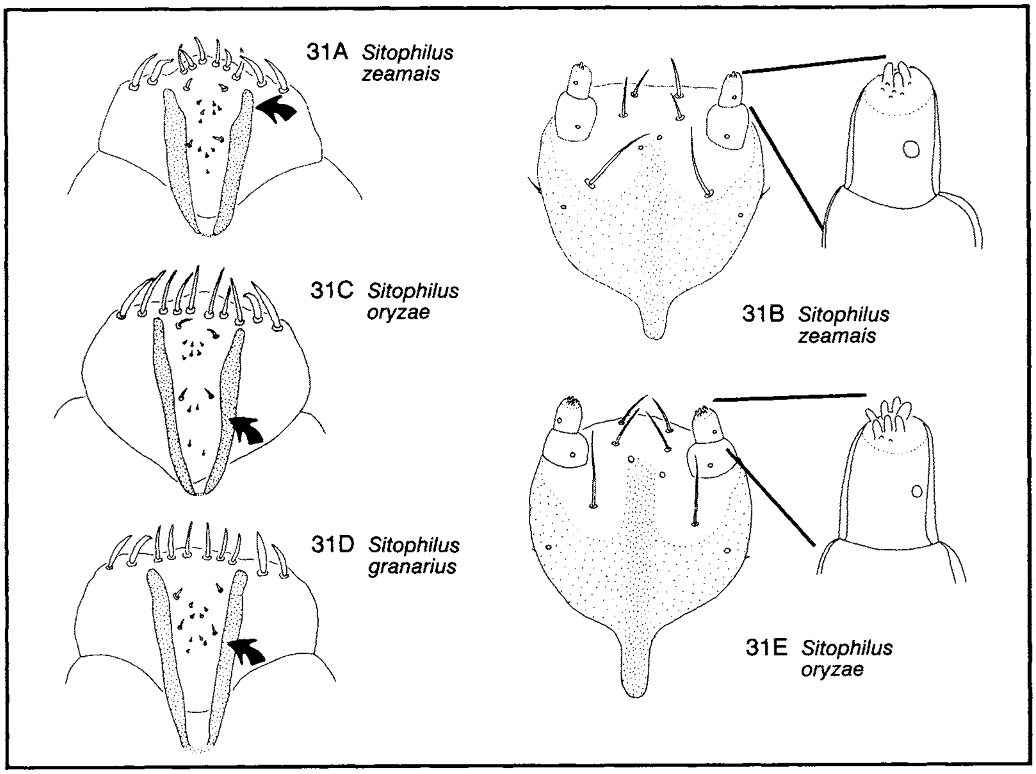


30A *Sitophilus granarius*

30B *Chalcodermus aeneus*

31 Epipharyngeal rod not uniformly wide but with narrower anterior and wider basal regions (31A); labial palp with less than 5 (usually 3) apical sensory papillae (31B) ---**maize weevil,** *Sitophilus zeamais*

Epipharyngeal rod slender, of more or less uniform width throughout its length (31C, 31D); labial palp with at least 5 apical sensory papillae (31E)-------------------------- 32



31A *Sitophilus zeamais*

31B *Sitophilus zeamais*

31C *Sitophilus oryzae*

31D *Sitophilus granarius*

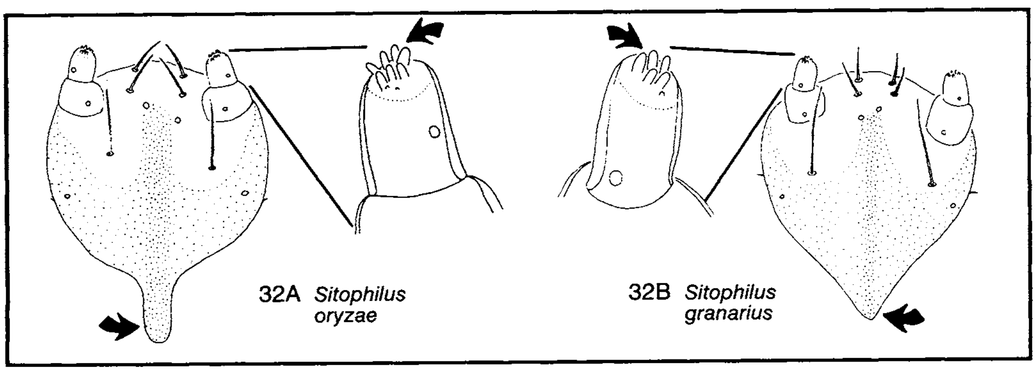
31E *Sitophilus oryzae*

32 Labial palp usually with 7 or 8 apical sensory papillae (32A); premental (labial) sclerite with an elongate posterior process (32A)-----------------------**rice weevil,** *Sitophilus oryzae*

See also 31C.

Labial palp with less than 7 (usually 5) apical sensory papillae (32B); premental sclerite lacking elongate posterior process (32B); pl. 113B------**granary weevil,** *Sitophilus granarius*

See also 31D.



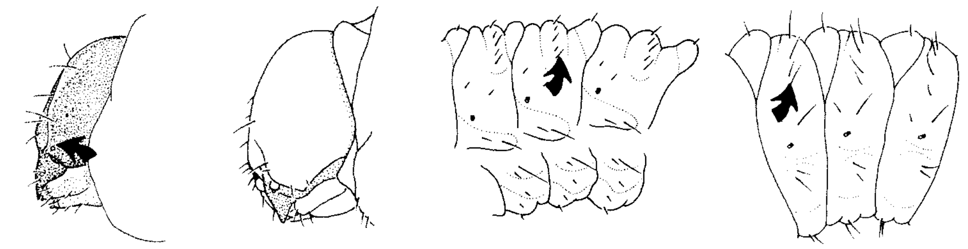
32A *Sitophilus oryzae*

32B *Sitophilus granarius*

33 Ocelli present; head distinctly pigmented on dorsal and lateral surfaces (33A); outer 4 postdorsal setae alternately long and short on abdominal segments I to VII (33B). Curculionidae (**weevils**) (in part)---------- 34

For bionomic notes on the species included here, see key to adult weevils.

Ocelli absent; head pale except for dark anterior margins and mandibles (33C); postdorsal setae subequal in length (33D)---------- 35

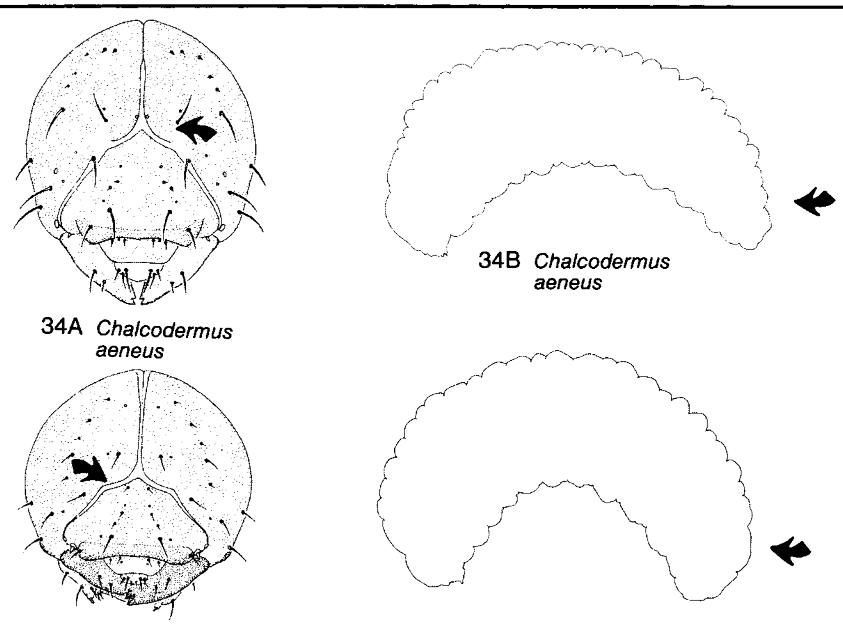


33A *Chalcodermus aeneus* 33C *Caulophilus oryzae* 33B *Chalcodermus aeneus* 33D *Hypothenemus hampei*

34 Head with a pair of white stripes projecting posteriorly from frontal suture; head setae mostly long (about equal to greatest width of labrum) (34A); body distinctly tapered from thorax to abdominal apex (34B); pl. 110A-----**cowpea curculio,** *Chalcodermus aeneus*

Head without white stripes (but may have an unpigmented lobe on angle of frontal suture); head setae mostly short (about equal to greatest width of labrum) (34C); body not tapered posteriorly (34D); pl. 111A----------nut weevils, *Curculio*

Drawings 34A&C by M. Ryan and C. Feller.



34A *Chalcodermus aeneus*

34B *Chalcodermus aeneus*

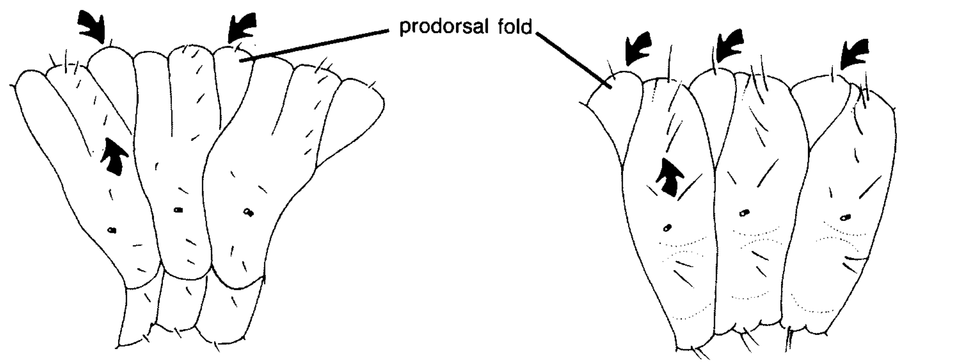
34C *Curculio caryae*

34D *Curculio caryae*

35 Abdominal segments I to VII with 5 postdorsal setae; prodorsal folds on segments I to VI projecting (in profile) about as much as other dorsal folds (35A). Curculionidae (**weevils**) (in part); pl. 112A------------------**broadnosed grain weevil,** *Caulophilus oryzae*

Abdominal segments I to VI with 4 postdorsal setae; prodorsal folds on segments I to VI distinctly more prominent (in profile) than other dorsal folds (35B). Scolytidae (**bark beetles**); pl. 72A------------------------------**coffee berry borer,** *Hypothenemus hampei*

Distribution: Africa, Brazil, Colombia, East Indies, Ecuador, Guatemala, Jamaica, Mexico, Nicaragua, Peru, Micronesia, Sri Lanka; in coffee beans.



35A *Caulophilus oryzae*

35B *Hypothenemus hampei*

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Notes and Sketches

5 DERMESTID BEETLES (DERMESTIDAE, COLEOPTERA)

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KEY

Adults

Drawings by A.D. Cushman unless otherwise noted.

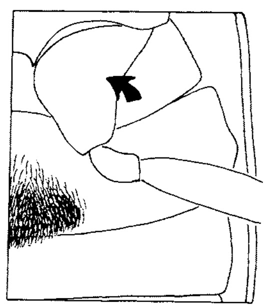
1 Adults ---------- 2
Larvae ---------- 19

2 Face of coxa III not concave; coxa III elongate (2A); antenna long, slender, not clubbed (2B); body slender (pl. 75B&C) ---------- **odd beetle,** *Thylodrias contractus*

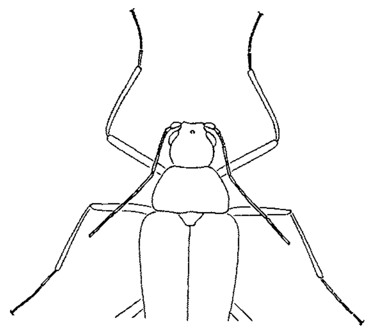
Males winged; females wingless. Distribution: England, North Africa, North America, USSR; in homes (in clothing and bedding) and museums (in dried animal specimens); probably occurs in food only as an accidental contaminant.

Face of coxa III concave (receives femur III); coxa III short (2C); antenna short, thick, and clubbed (2D); body broad (pl. 76A) ---------- 3

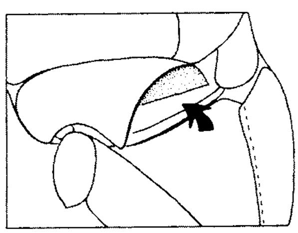
Drawings 2A-D by C. Feller.



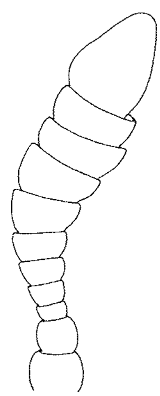
2A *Thylodrias contractus*



2B *Thylodrias contractus*

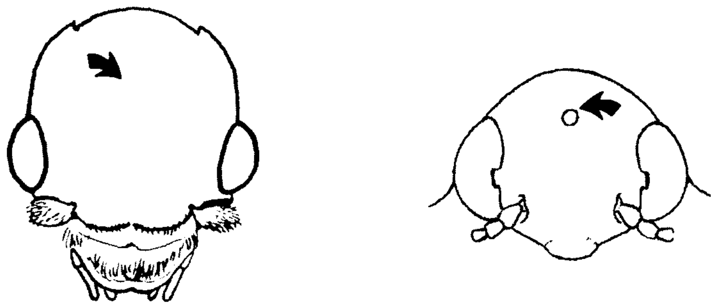


2C dermestid beetle



2D *Trogoderma versicolor*

3 Median ocellus absent (3A). Genus *Dermestes* -- 4
Median ocellus present (3B) -- 9



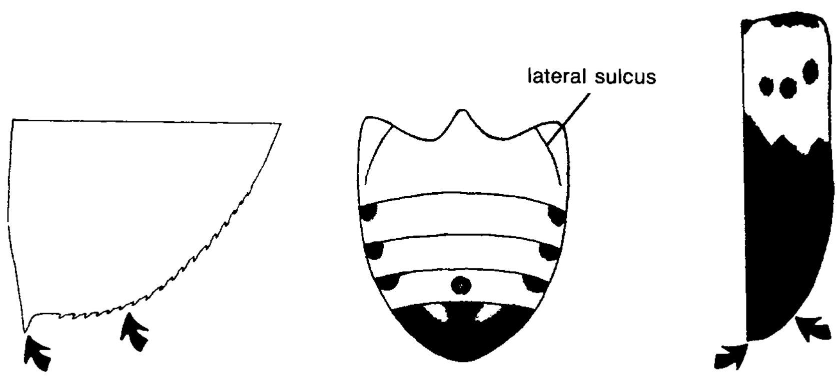
3A *Dermestes*

3B *Trogoderma inclusum*

4 Elytral apex serrate, with a small terminal spine (4A); pl. 76A
-- **hide beetle,** *Dermestes maculatus*

Ventral abdominal color pattern and sulcus shown in 4B. Distribution: cosmopolitan; usually in stored hides and skins, but occasionally in hams.
Drawing 4A by C. Feller.

Elytral apex entire, lacking serrations and spines (4C) -------------------------------- 5



4A *Dermestes maculatus*

4B *Dermestes maculatus*

4C *Dermestes lardarius*

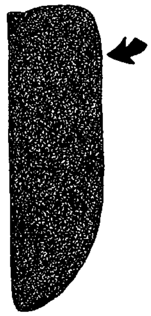
5 Elytron with yellowish basal area bearing 3 dark spots (5A); pl. 76B ---------- **larder beetle,** *Dermestes lardarius*

Abdominal venter uniformly colored, lacking a pattern (5B). Distribution: cosmopolitan; in bacon, ham, sausages, dried fish, and cheese.

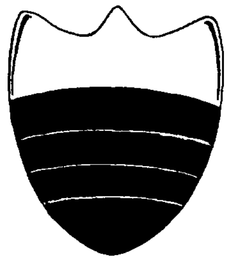
Elytron without a basal band lighter in color than rest of elytron (5C) ---------- 6

Abdomen with (5D) or without (5B) pattern.
Drawing 5C by C. Feller.

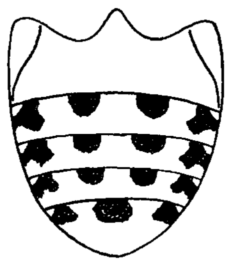
5A *Dermestes lardarius*



5C *Dermestes ater*



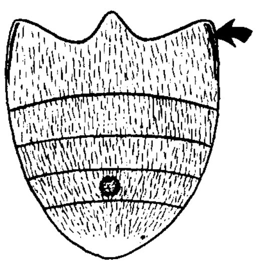
5B *Dermestes lardarius*



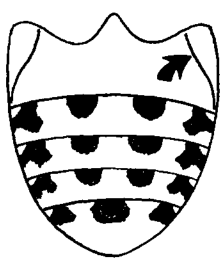
5D *Dermestes ater*

6 Abdominal venter without pattern; lateral sulcus of abdominal sternum I closely parallel to lateral margin (6A) ---------- 7

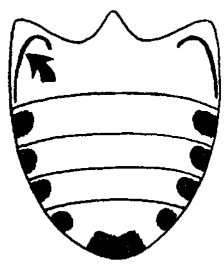
Abdominal venter patterned; lateral sulcus not closely parallel to lateral margin (6B, 6C) 8



6A *Dermestes peruvianus*



6B *Dermestes ater*



6C *Dermestes frischii*

7 Elytral pubescence black, with scattered golden setae; head with rounded medial concavity (7A); pl. 76C---*Dermestes haemorrhoidalis*

Distribution: England, middle and southern Europe; in kitchens, feeding on spillage; probably important only as an occasional accidental contaminant. Reference: *5*.

Elytral pubescence brown or yellowish, with or without scattered golden setae; front convex (not depressed) (7B); pl. 76D
---Peruvian larder beetle, *Dermestes peruvianus*

Distribution: nearly cosmopolitan; in dried meat, hams, and sausage. Reference: *5*.
Drawings 7A&B by C. Feller.

7A *Dermestes haemorrhoidalis*

7B *Dermestes peruvianus*

8 Abdominal venter with medial and lateral brown spots on a yellowish background; anterior end of sinuous lateral sulcus located opposite outer limit of coxa III (8A); pl. 77B --**black larder beetle,** *Dermestes ater*

Distribution: cosmopolitan; in dried fish, cheese, and dried mushrooms; occurs in grains and cereals already infested with insects and rodents.

Abdominal color pattern of lateral dark spots on an ash-gray background; anterior end of lateral sulcus strongly curved toward midline (8B) -----------------*Dermestes frischii*

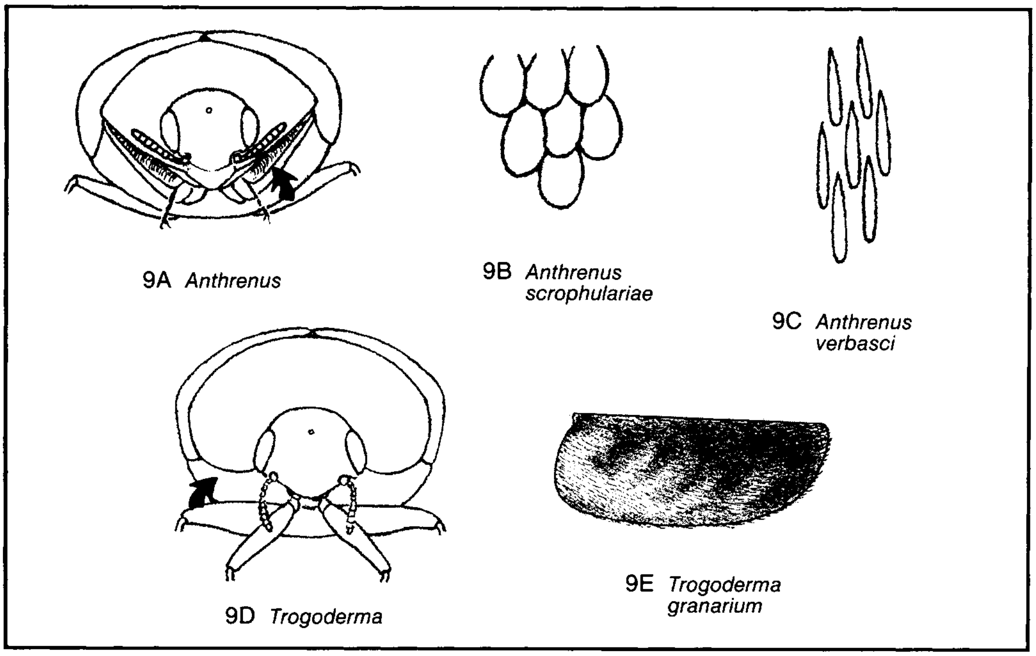
Distribution: cosmopolitan; in dried fish; probably occurs also in other foods as an occasional accidental contaminant.

8A *Dermestes ater*

8B *Dermestes frischii*

9 Antennal cavity of anteroventral surface of prothorax fully visible in anterior view (9A); vestiture of flat scales (9B, 9C). Genus *Anthrenus* -- 10

Antennal cavity not (or only slightly) visible in anterior view (9D); vestiture of hairs (9E) 11



9A *Anthrenus*

9B *Anthrenus scrophulariae*

9C *Anthrenus verbasci*

9D *Trogoderma*

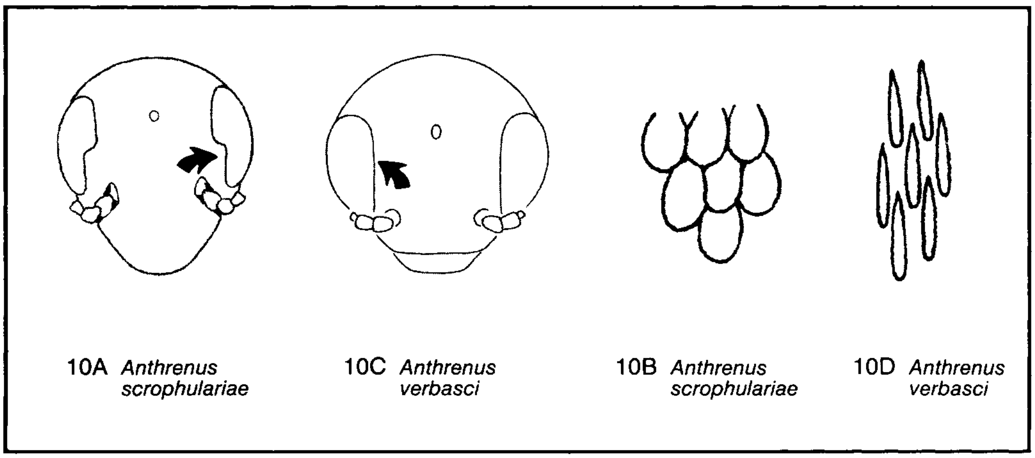
9E *Trogoderma granarium*

10 Eye notched (10A); elytral scales ovate (10B); pl. 1B
---**carpet beetle,** *Anthrenus scrophulariae*

Distribution: cosmopolitan; in dried plants, flour, and wheat; probably important only as an accidental contaminant.

Eye entire (10C); elytral scales elongate, 2 to 3 times as long as wide (10D); pl. 1A
---**varied carpet beetle,** *Anthrenus verbasci*

Distribution: cosmopolitan; in drugs, spices, flour, peanuts, wheat, corn, cereals, and seeds.
Drawing 10C by C. Feller.



10A *Anthrenus scrophulariae*

10C *Anthrenus verbasci*

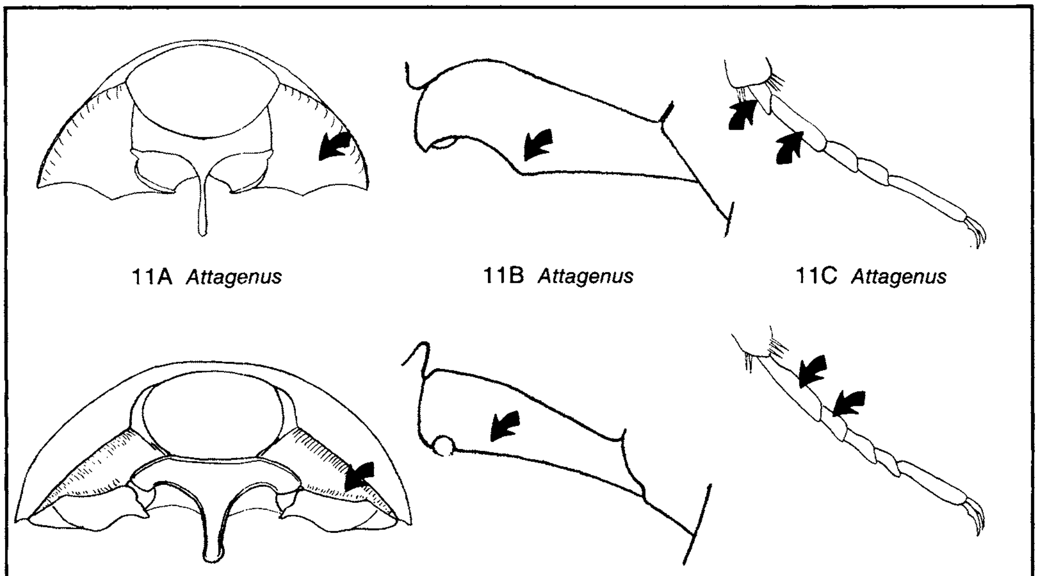
10B *Anthrenus scrophulariae*

10D *Anthrenus verbasci*

11 Antennal cavity not carinate posteriorly (11A); posterior margin of coxal plate III with a blunt, toothlike angulation (11B); segment I of tarsus III shorter than segment II (11C). Genus *Attagenus* ---------- 12

Posterior margin of antennal cavity marked by a fine, transverse carina (11D); posterior margin of coxal plate III curved or sinuate (11E); segment I of tarsus III longer than segment II (11F). Genus *Trogoderma* ---------- 13

The species of *Trogoderma* are difficult to separate because of the color pattern variability of some species. Also, it is especially important to correctly identify the **khapra beetle,** *T. granarium,* and to avoid confusing it with less important species. Specimens of questionable identity, especially those originating in the southwestern United States, should be sent to the Taxonomic Services Unit, PSI, Beltsville Agricultural Research Center-West, Beltsville MD 20705. This key to *Trogoderma* is based on Beal (*1, 2*).



11A *Attagenus* 11B *Attagenus* 11C *Attagenus*

11D *Trogoderma* 11E *Trogoderma* 11F *Trogoderma*

12 Dorsal coloration uniformly brown or brownish-black, except for 2 elytral white spots (pl. 79A) ---------- fur beetle, *Attagenus pellio*

Distribution: Africa, Asia, Europe, North America; in smoked meat, fish, casein, and cereal products.

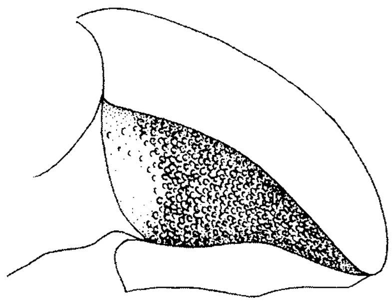
Dorsal coloration uniformly brown or black (pl. 79C) ---------- **black carpet beetle,** *Attagenus unicolor* *Attagenus brunneus*

Distribution: *A. unicolor* (= *A. megatoma*), cosmopolitan in grain, flour, spices, and seeds; *A. brunneus* (= *A. elongatulus*), Afghanistan, Mediterranean Region, Pakistan, USA (in dried milk and peanuts), USSR.

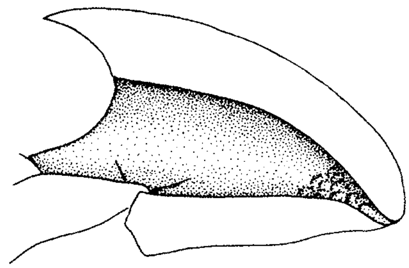
13 Antennal cavity with coarse, confluent punctures, 2 to 3 times larger than eye facet, except for small smooth area near prosternum (13A); pl. 80A-------*Trogoderma simplex*

Distribution: Mexico, western United States; in stored grain.
Drawings 13A-D by C. Feller.

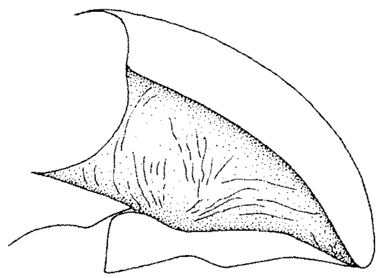
Antennal cavity finely punctate in mesal two-thirds (each puncture about the size of an eye facet) (13B), *or* antennal cavity shining and minutely striate (13C), *or* antennal cavity coarsely punctate or rugose in lateral one-half and striate or finely punctate mesally (13D) -- 14



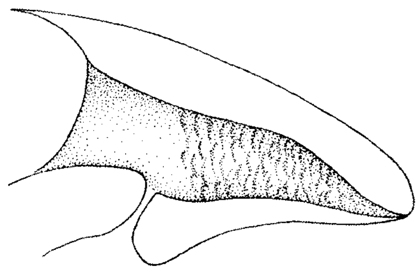
13A *Trogoderma simplex* ♂♀



13B *Trogoderma versicolor* ♂



13C *Trogoderma variabile* ♂♀



13D *Trogoderma versicolor* ♀

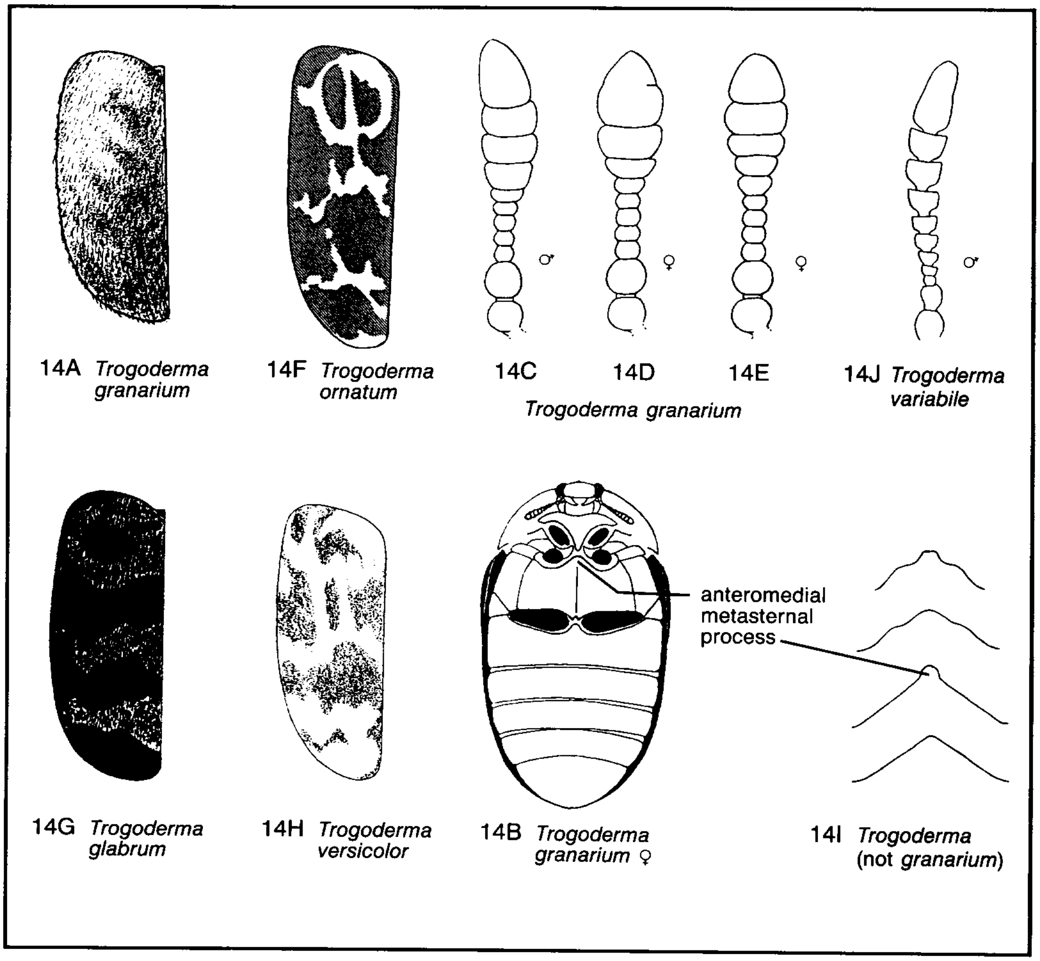
14 Elytron unicolorous or vaguely mottled, but without a clearly defined pattern (14A); anteromedial metasternal margin lacking nipplelike projection (14B); pl. 80B ---------- **khapra beetle,** *Trogoderma granarium*

Number of antennal segments varies from 9 to 11; antennal club of male with at most five segments (14C); antennal club of female with at least 3 segments (14D&E). Distribution: tropicopolitan in hot dry areas; in grain, cereal products, and malt.

Elytron with a definite color pattern (it may be fine and intricate) visible either in maculation or in pubescence or both (14F-H); anteromedial margin of metasternal lobe with a nipplelike projection (14I) ---------- 15

Number of antennal segments always 11; antennal club of male with at least five segments (14I); antennal club of female with at least four segments.

Drawings 14B&I by G.T. Okumura; 14C-E from *2*, 14F from *1*; 14G&H by C. Feller.

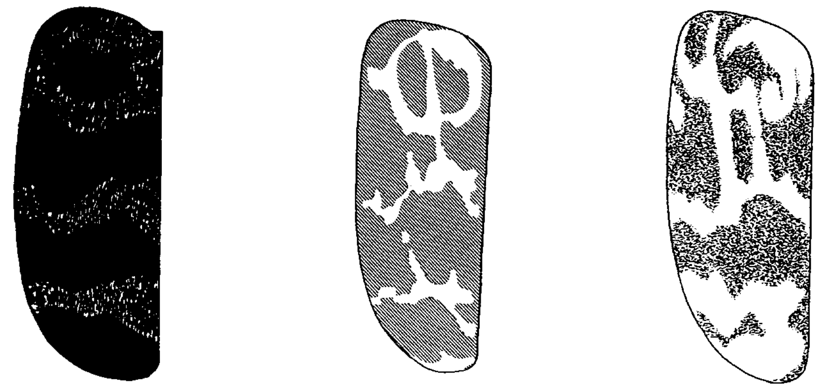


14A *Trogoderma granarium*
14F *Trogoderma ornatum*
14C 14D 14E *Trogoderma granarium*
14J *Trogoderma variabile*
14G *Trogoderma glabrum*
14H *Trogoderma versicolor*
14B *Trogoderma granarium* ♀
14I *Trogoderma* (not *granarium*)

15 Integument unicolorous (black) or black with vague brownish maculations on humeri and apical margins only; never with distinct basal, submedian and subapical bands (if banding is present at all, it is indicated only very vaguely by light-colored pubescence) (15A); pl. 80C--------------------glabrous cabinet beetle, *Trogoderma glabrum*

Elytral pattern highly variable; elytral pubescence easily abraded. Distribution: Holarctic; in grain, cornmeal, cereal products, and dried milk.
Drawings 15A&C by C. Feller.

Integument bicolorous, at least with a pattern of basal, submedian, and subapical bands of lighter maculation on elytra (15B, 15C) -- 16

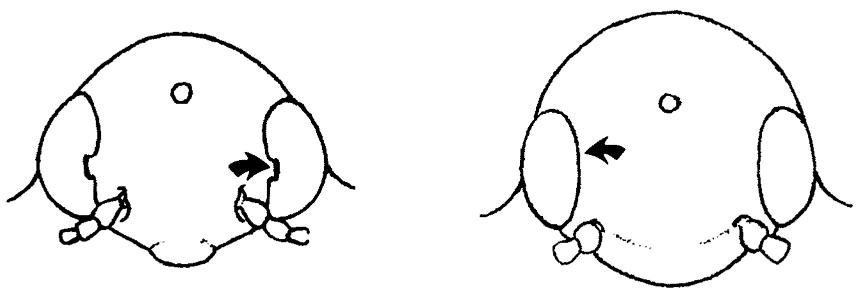


15A *Trogoderma glabrum* 15B *Trogoderma ornatum* 15C *Trogoderma versicolor*

16 Inner margin of eye distinctly notched (16A); pl. 1D
-- larger cabinet beetle, *Trogoderma inclusum*

Distribution: England, United States; in grain, dried milk, and nuts.

Inner margin of eye straight or very slightly sinuate (16B)---------------------------------- 17



16A *Trogoderma inclusum* 16B *Trogoderma variabile*

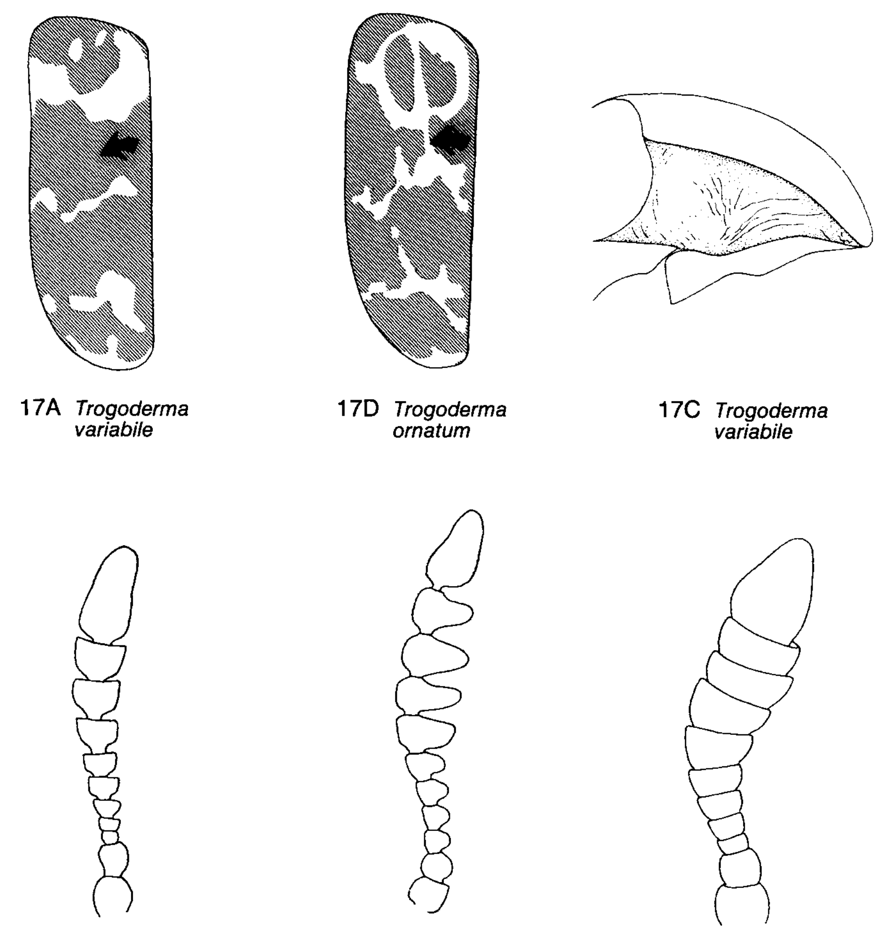
17 Basal band or loop of elytral maculation never connected to submedian band by a longitudinal band or bands (17A); pl. 1C--------**warehouse beetle,** *Trogoderma variabile*

Antennal club of male with segments more or less compactly joined, not serrate (17B); antennal cavity finely striate (17C); basal band or loop, submedian band, and subapical band of elytral maculation always present. Distribution: North America, USSR; in various seeds, cereals (corn, rice, wheat), nuts, dried milk, and fish meal. See also 13C, 14J, 16B.

Basal band or loop of elytral maculation always connected to submedian band by one or more longitudinal bands (17D)-- 18

Antennal club of male with (17E) or without (17F) serrations; antennal cavity finely striate (see 18B), partly punctate (see 18C), or vaguely punctate-striate (see 18E&F).

Drawings 17A&D from *1;* 17C&F by C. Feller



17A *Trogoderma variabile*

17D *Trogoderma ornatum*

17C *Trogoderma variabile*

17B *Trogoderma variabile*

17E *Trogoderma ornatum*

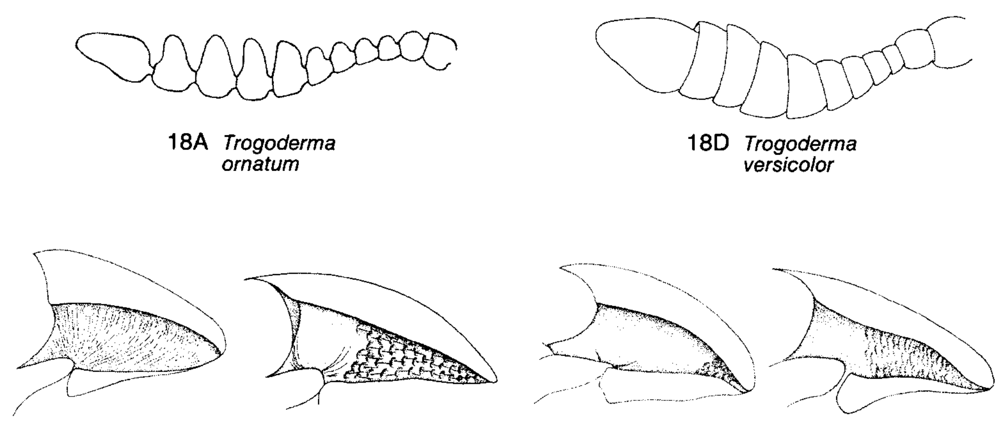
17F *Trogoderma versicolor*

18 Antenna of male serrate (18A); antennal cavity of male polished and finely cross-striate (18B); antennal cavity of female polished and finely striate mesally but punctate in lateral two-thirds (18C); pl. 1E---------ornate cabinet beetle, *Trogoderma ornatum*

Distribution: North America; in cereals, seeds, and fish meal. See also 14F, 17E.

Antenna of male clavate (18D); antennal cavity dull and minutely punctate, but vaguely punctate-striate in lateral one-fifth in male (18E) and in lateral one-half to two-thirds in female (18F); pl. 80D -----------European larger cabinet beetle, *Trogoderma versicolor*

Distribution: Europe; in seeds, grain, rice, wheat, corn, and nuts. See also 13B, 15C.
Drawings 18B-F by C. Feller.



18A *Trogoderma ornatum*

18D *Trogoderma versicolor*

18B *Trogoderma ornatum* ♂

18C *Trogoderma ornatum* ♀

18E *Trogoderma versicolor* ♂

18F *Trogoderma versicolor* ♀

Larvae

Drawings by C. Feller

19 Urogomphi absent (19A)-- 20
Urogomphi present (19B). Genus *Dermestes*-- 23

References: *5, 6.*

19A *Attagenus unicolor*

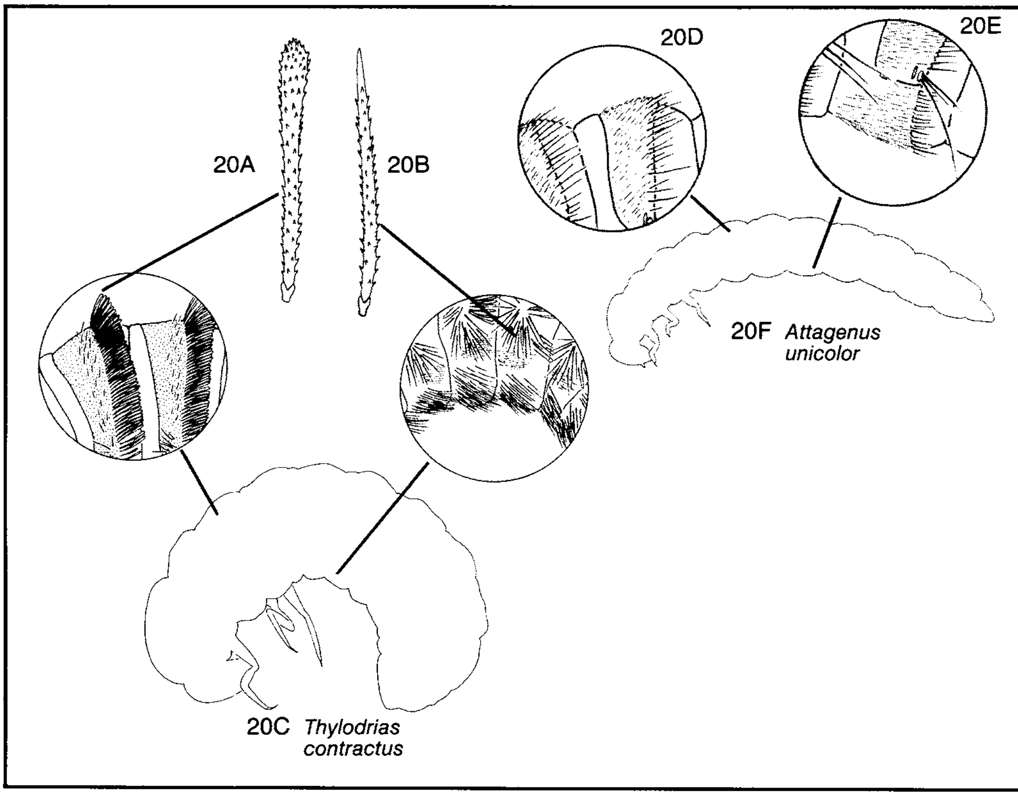
19B *Dermestes maculatus*

20 Each tergum with a row of coarse, spiny, club-shaped setae (20A) along posterior margin and a cluster of spiny, sharp-pointed setae (20B) on each side; pl. 75A ---------- **odd beetle,** *Thylodrias contractus*

Body short, stout, C-shaped (20C).

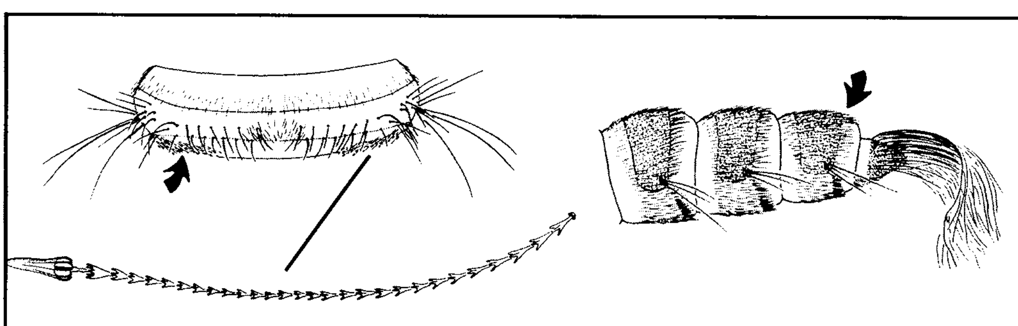
Sharp or club-shaped spiny setae absent (20D, 20E; see also 21A)---------- 21

Body slender (20F) or stout.



21 Hastisetae present (21A) ---------- 22
Hastisetae absent (21B). Genus *Attagenus*---------- 27

Reference: *4.*

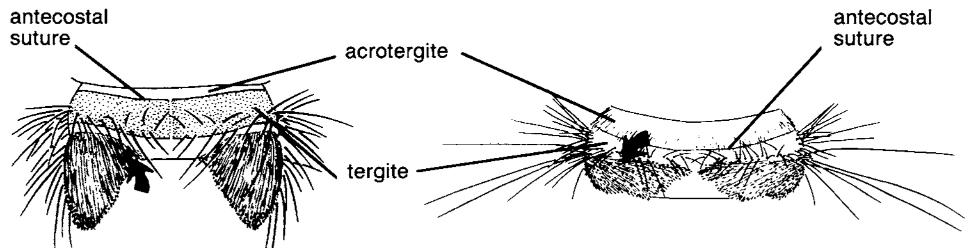


21A *Trogoderma variabile*

21B *Attagenus unicolor*

22 Hastisetal tufts inserted on "islands" in membrane behind strongly curved posterior margins of abdominal segments V, VI, and VII (22A). Genus *Anthrenus* ----------- 29
Hastisetal tufts inserted on tergal plates (22B). Genus *Trogoderma* -------------------- 30

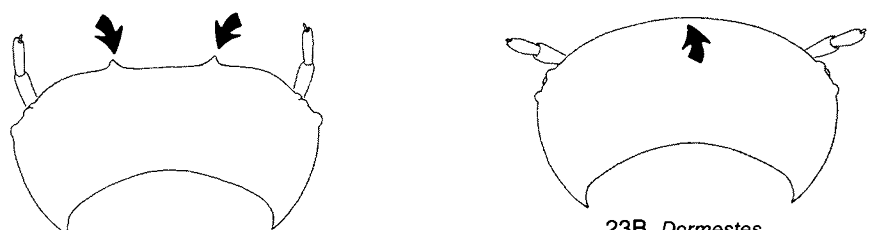
References: *3, 7.*



22A *Anthrenus verbasci*

22B *Trogoderma ornatum*

23 Frontal tubercles present (23A) -- 24
Frontal tubercles absent (23B) --- 26



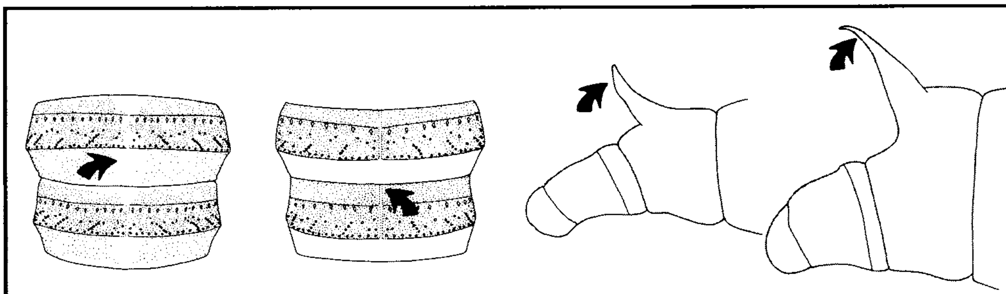
23A *Dermestes maculatus*

23B *Dermestes ater*

24 Dorsal midline marked by a broad, yellow stripe (24A); apex of urogomphus curved anteriorly (24B) ---**hide beetle,** *Dermestes maculatus*
Dermestes frischii

See also 19B, 23A.

Dorsal midline of thorax and abdomen marked only by a thin, unsclerotized line (24C); apex of urogomphus curved posteriorly (24D)-- 25



24A *Dermestes maculatus*

24C *Dermestes lardarius*

24B *Dermestes maculatus*

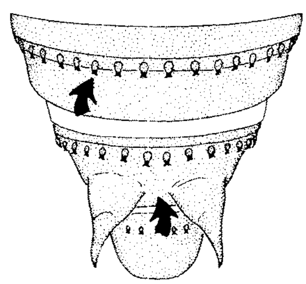
24D *Dermestes haemorrhoidalis*

25 Urogomphi separated by a distance less than width at base of one urogomphus; retrorse tubercles (each bilobed and bearing a medial seta) large and conspicuous on abdominal terga III to X (25A); ventral sclerotized areas well-developed on last 5 abdominal segments (25B)---*Dermestes haemorrhoidalis*

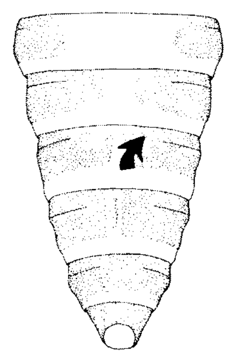
Head tubercles easily seen; urogomphi appear broad at base. See also 24D. Reference: *5*.

Urogomphi separated by a distance equal to width at base of one urogomphus; retrorse tubercles (usually neither bilobed nor setiferous) either absent or small and inconspicuous, especially on terga IX and X (usually absent on X) (25C); ventral sclerotized areas well-developed only on last 4 abdominal segments (25D) ---Peruvian larder beetle, *Dermestes peruvianus*

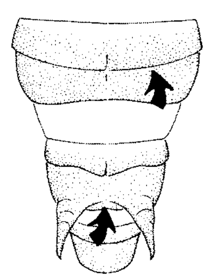
Head tubercles often flattened and inconspicuous; urogomphi appear narrow at base. Reference: *5*.



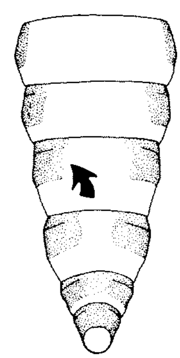
25A *Dermestes haemorrhoidalis*



25B *Dermestes haemorrhoidalis*



25C *Dermestes peruvianus*



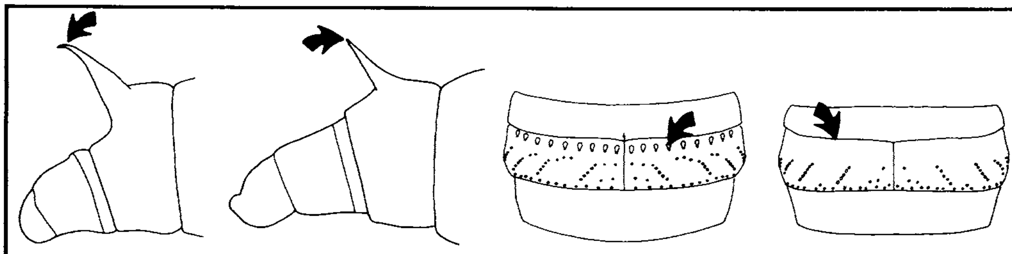
25D *Dermestes peruvianus*

26 Urogomphus curved posteriorly at apex (26A); retrorse tubercles present at least on abdominal tergum VI (26B); ---------------------------------**larder beetle,** *Dermestes lardarius*

See also 24C.

Urogomphus straight (26C); retrorse tubercles absent from all abdominal terga (26D); pl. 77A ---**black larder beetle,** *Dermestes ater*

See also 23B.

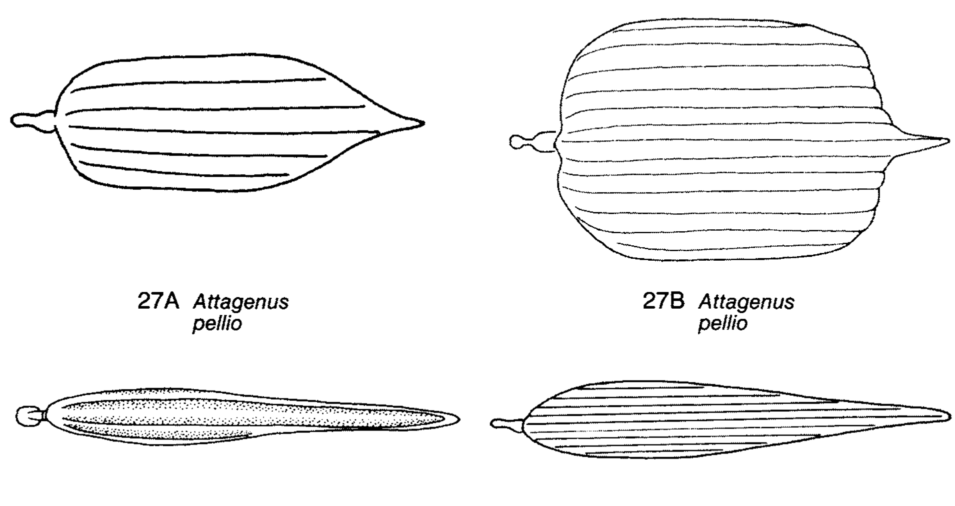


26A *Dermestes lardarius* 26C *Dermestes ater* 26B *Dermestes lardarius* 26D *Dermestes ater*

27 Acrotergites with broad setae (each seta with 5 longitudinal ribs) (27A); abdominal tergite VIII with most setae subrectangular or ovate (27B) ---fur beetle, *Attagenus pellio*

Acrotergites with slender setae only (each seta with no more than 3 longitudinal ribs) (27C); abdominal tergite VIII with either lanceolate or linear setae (27D) ---------- 28

27A-D redrawn from *4*.



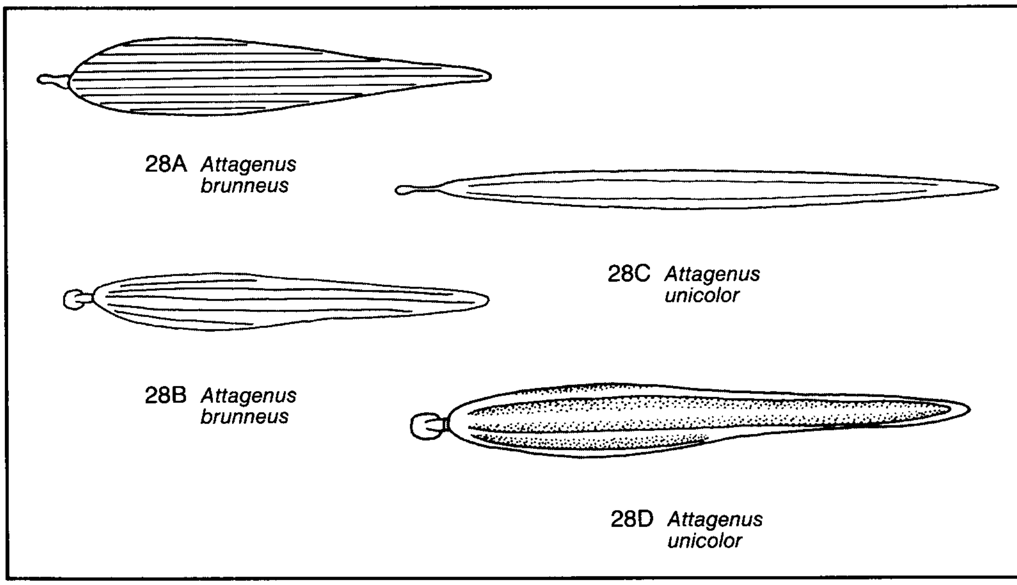
27A *Attagenus pellio* 27B *Attagenus pellio* 27C *Attagenus unicolor* 27D *Attagenus brunneus*

28 Integument of head and dorsum of body light brown; setae of VIII sternite with 8 to 12 ribs (28A)--*Attagenus brunneus*

Tergal setae with up to 5 ribs between margins (28B).

Integument of head and dorsum of body reddish brown; setae of VIII sternite with 2 or 3 ribs (28C)--**black carpet beetle,** *Attagenus unicolor*

Tergal setae with 2 or 3 ribs between margins (28D). Both *A. megatoma* (now *A. unicolor*) and *A. elongatulus* (now *A. brunneus*) have been known previously as *A. piceus*. See also 21B.



28A *Attagenus brunneus*

28C *Attagenus unicolor*

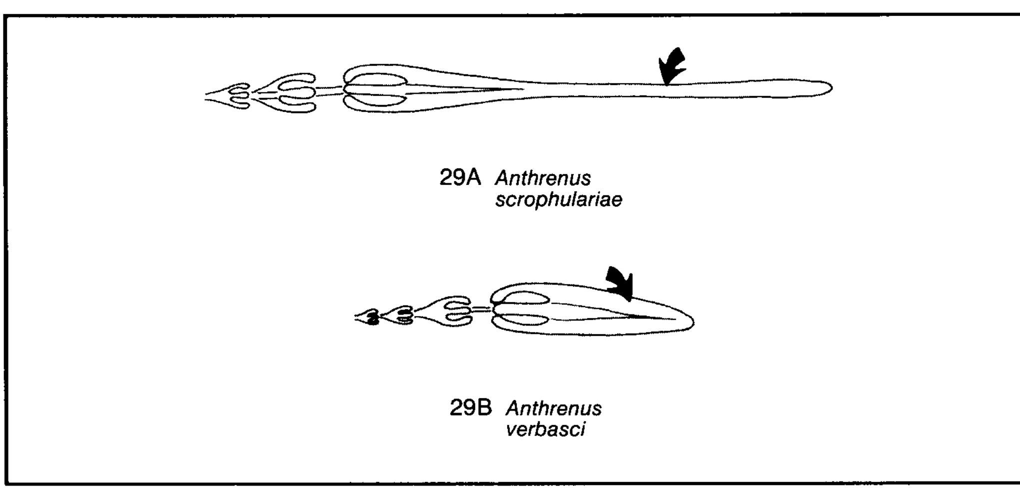
28B *Attagenus brunneus*

28D *Attagenus unicolor*

29 With very long hastisetal heads (29A); abdominal sterna with yellowish sclerotized plates --**carpet beetle,** *Anthrenus scrophulariae*

With short hastisetal heads (29B); abdominal sterna membranous (whitish or transparent); pl. 78 -------------------------------------**varied carpet beetle,** *Anthrenus verbasci*

See also 22A.

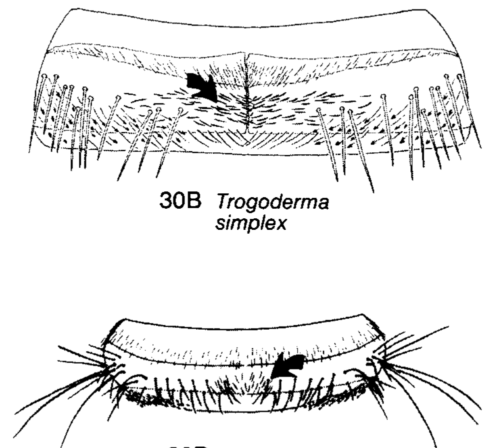


29A *Anthrenus scrophulariae*

29B *Anthrenus verbasci*

30 Setae of basal antennal segment less than half as long as antennal segment II (30A); tergites with short, flat, mesally-directed spicisetae (30B)-------------- *Trogoderma simplex*

Setae of basal antennal segment at least three-fourths as long as antennal segment II (30C); mesally-directed tergal setae absent (30D) -- 31

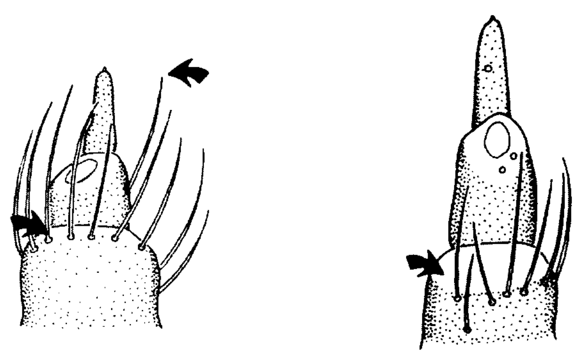


30A *Trogoderma simplex* 30C *Trogoderma variabile* 30B *Trogoderma simplex* 30D *Trogoderma variabile*

31 Setae of basal antennal segment almost completely encircling segment (not bunched on mesal side); setae of antennal segment I reaching or surpassing apex of segment II when antenna is fully extended (31A) -- 32

Single seta (31A) on antennal segment II of *Trogoderma granarium* sometimes absent.

Setae of basal segment bunched on mesal side, leaving one-third or more of lateral surface bare; setae of segment I not reaching apex of segment II of fully-extended antenna (31B) --- 35



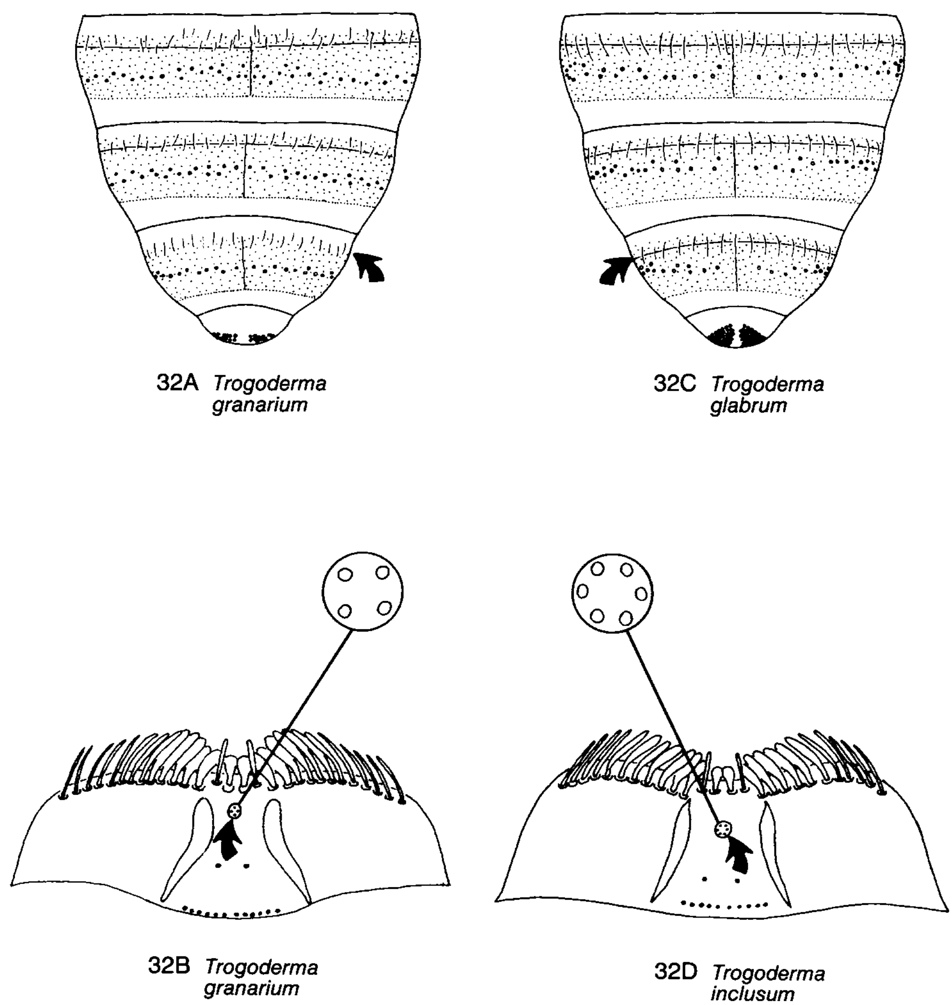
31A *Trogoderma granarium* 31B *Trogoderma variabile*

32 Antecostal suture of abdominal segment VIII usually absent (32A), but in those rare instances when it is present, it is weak and interrupted at several points -- **khapra beetle,** *Trogoderma granarium*

Labium with 4 epipharyngeal papillae in distal sensory cup (32B). See also 31A. See note at couplet 11.

Antecostal suture of abdominal segment VIII present (32C) -------------------------------- 33

Distal sensory cup with 4 (32B) or 6 (32D) epipharyngeal papillae. Antecostal suture visible only if abdomen is distended (as in 32A&C).



32A *Trogoderma granarium*

32C *Trogoderma glabrum*

32B *Trogoderma granarium*

32D *Trogoderma inclusum*

33 Terga medium to dark brown or bluish gray; epipharyngeal papillae 4 (see 32B)
-- glabrous cabinet beetle, *Trogoderma glabrum*

Terga creamy yellow; epipharyngeal papillae 6 (see 32D) ------------------------------------ 34

34 Western Hemisphere ----------------------------------- larger cabinet beetle, *Trogoderma inclusum*

See 32D.

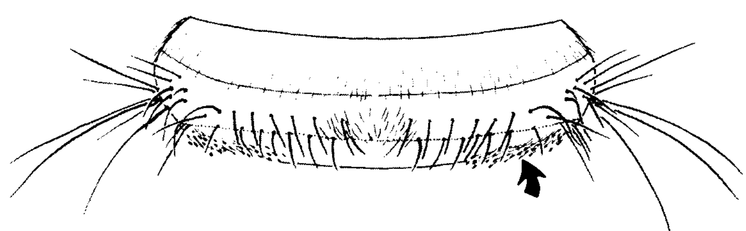
Eastern Hemisphere -------------------- European larger cabinet beetle, *Trogoderma versicolor*

35 Disc of thoracic and anterior abdominal terga usually with very few hastisetae; terga usually with only a single row of large spicisetae (35A); pl. 81
--- **warehouse beetle,** *Trogoderma variabile*

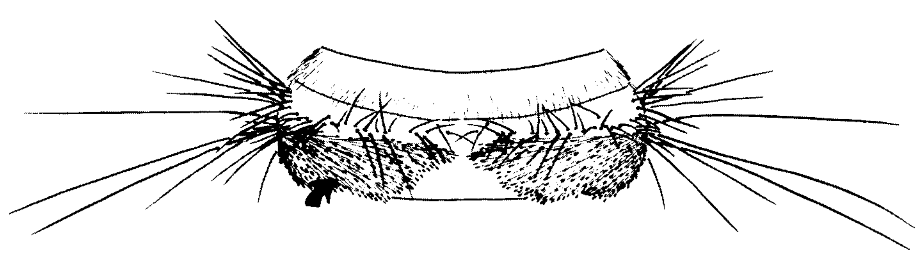
See also 21A, 30C.

Thoracic and anterior abdominal terga usually moderately dense with hastisetae; terga usually with 2 rows of large, erect spicisetae (35B)
-- ornate cabinet beetle, *Trogoderma ornatum*

See also 22B.



35A *Trogoderma variabile*



35B *Trogoderma ornatum*

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Notes and Sketches

6 **SPIDER BEETLES** (PTINIDAE, COLEOPTERA)

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Because of their relatively small, globular, usually hairy bodies and slender legs, the ptinids resemble spiders, hence the common name. The family contains a moderate number of species, approximately 20 of which have been recorded as pests. Not all 20 are included here; those absent are very minor or rare pests that do not occur in North America, the geographic focus of the key presented here. Many of the pest species are widely distributed, even cosmopolitan, and are spread by commerce.

Ptinids often infest foods, but the actual loss of weight due to feeding is small unless the ptinid population is enormous. In addition to damaging food, ptinids indirectly cause spoilage by contaminating food with frass, with fragments of their dead bodies, and with the silk they use to spin cocoons. Ptinids are mainly scavengers, and many readily feed equally on plant or animal materials. Besides being found in human foods, they have been found in the nests of bees, wasps, birds, and mammals, bat caves, warehouses, food-handling businesses, and houses. They are especially attracted to moisture and to bird and mammal excrement. Ptinid infestations, therefore, often follow other kinds of infestations. Excellent accounts of the biology and habits of the species of economic importance were published by R.W. Howe and collaborators from 1949 to 1959 in a series of 17 articles entitled *Studies on Beetles of the Family Ptinidae.* All parts of the series are cited in the final summary article by Howe (*9*).

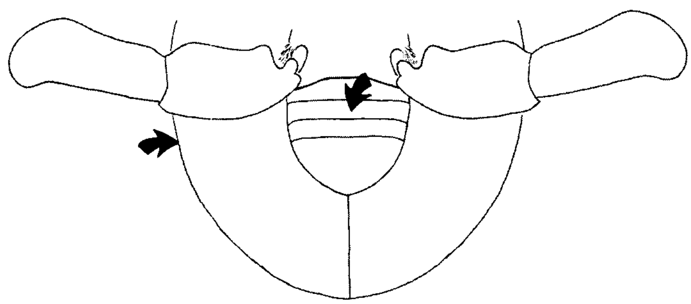
Identification to genus is rather simple, but sexual dimorphism in some species of *Ptinus,* the largest genus, complicates specific identification. The sexes can be so different—slender males (pl. 86A) and stout females (pl. 86B)—as to seem to be separate species. When sexual dimorphism is absent, both males and females are stout. In the past, the presence or absence of sexual dimorphism has been used sometimes as a key character; it was necessary, therefore, to have both sexes of the same species at hand to make the key work. In the following key sexual dimorphism as a character is not used; each sex of the sexually dimorphic species is determined separately. The shape and distribution of patches of white scales on the elytra of many species of *Ptinus* have often been used in keys, but since these scales are easily abraded, minimal use is made of them in this key.

The last complete treatment of the taxonomy and identification of the Ptinidae of North America was published by Fall in 1905 (*4*). The taxonomy of the Ptinidae of economic importance in the world, with keys and illustrations, was presented by Hinton (*7*). Keys and illustrations were published by Papp and Okumura (*10*) for California, by Hatch (*6*) for the Pacific Northwest, by Freude (5) for central Europe, and by Hisamatsu (*8*) for Japan. Several good, short taxonomic articles were published by Brown (*1-3*); one of them (*1*) includes a key to the ptinids that occur in houses and warehouses in Canada.

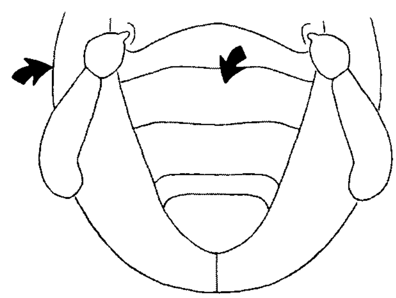
KEY TO ADULTS
Drawings by C. Feller unless otherwise noted.

1 Elytra more than 2 times as wide as abdominal sterna (1A); elytra polished, impunctate, without setae or with only a collar of dense setae at base and a few scattered setae posteriorly, and without striae or longitudinal rows of setae (pl. 82A&B)--- 2

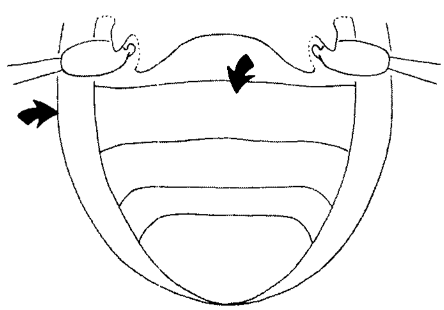
Elytra less than 2 times as wide as abdominal sterna (1B, 1C, 1D); elytra dull or moderately shiny, with appressed scales and/or striae or longitudinal rows of setae (pl. 83A, 85A, 86B)-- 4



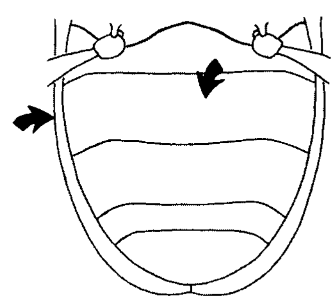
1A *Gibbium psylloides*



1B *Sphaericus gibboides*



1C *Pseudeurostus hilleri*



1D *Ptinus ocellus*

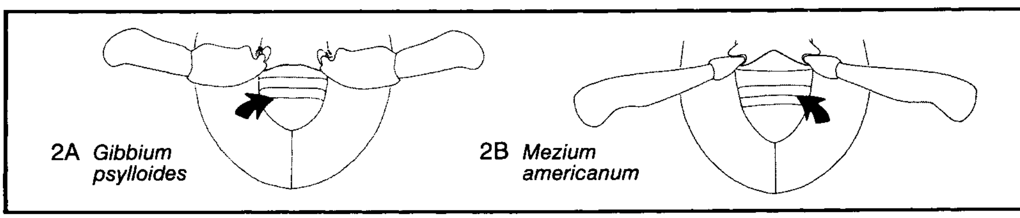
2 Abdomen with 4 visible sterna (2A); trochanter III almost as long as femur III (2A); pronotum and elytra without setae (pl. 82A)-- *Gibbium*

Papers by Hisamatsu (*8*) and Bellés and Halstead (see reference *BW08* in Chapter 28) show that many specimens previously identified as *Gibbium psylloides* are actually *G. aequinoctiale.* This has made interpretation of past literature records of distributions and associations of these two species almost impossible. It now appears that *G. psylloides* is found mainly in Europe, southwest Asia, and North Africa. The distribution of *G. aequinoctiale* is wider and includes the Australian, Ethiopian, Nearctic, Neotropical, Oriental, and Palearctic regions. Both species have been associated with many kinds of stored foods. The two species may be separated as follows:

Median confluence of antennal fossas forming an acute angle; posterior border of antennal fossas strongly produced laterally and sloping on lateral third ------------------------------hump beetle, *Gibbium psylloides*

Median confluence of antennal fossas forming a right angle; posterior border of antennal fossas weakly produced laterally and transverse on lateral third ---*Gibbium aequinoctiale*

Abdomen with 5 visible sterna (2B); trochanter III less than one-third as long as femur III (2B); pronotum and base of elytra densely setose (pl. 82B), their integuments not visible -- 3



2A *Gibbium psylloides*

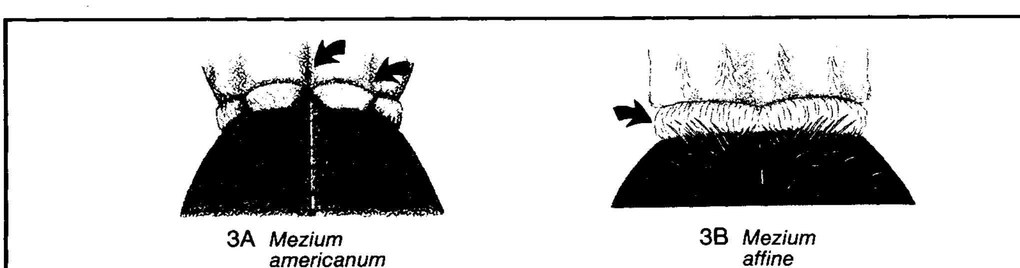
2B *Mezium americanum*

3 Elytra with basal tomentose collar deeply interrupted at middle and on each side of midline (3A); pl. 82B--------------------------**American spider beetle,** *Mezium americanum*

Distribution: cosmopolitan; associated with grains, mixed feeds, cayenne pepper; also reported from melon seeds, tobacco seeds, opium, wool carpet, dried animal products, rat nests. See also 2B.

Elytra with basal tomentose collar entire, not interrupted (3B) --northern spider beetle, *Mezium affine*

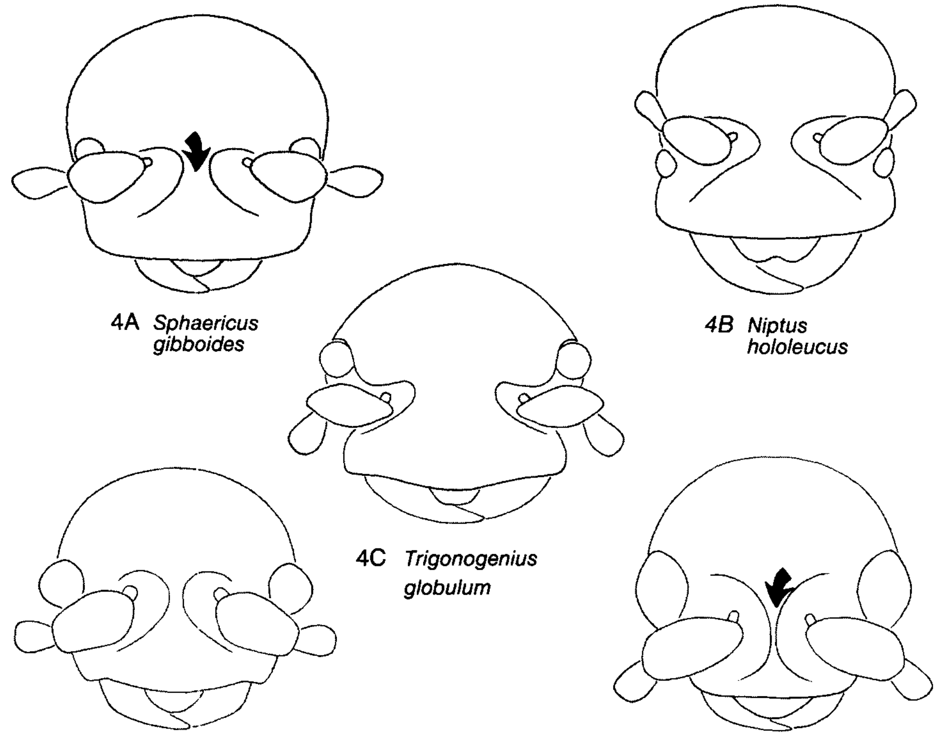
Distribution: Europe, north Africa, North America; associated with seeds, dead insects, decaying plant and animal matter.



3A *Mezium americanum*

3B *Mezium affine*

4 Area between antennal insertions broad and flat (4A, 4B, 4C) ---------------------------- 5
Area between antennal insertions narrow and usually carinate (4D, 4E) -------------- 7

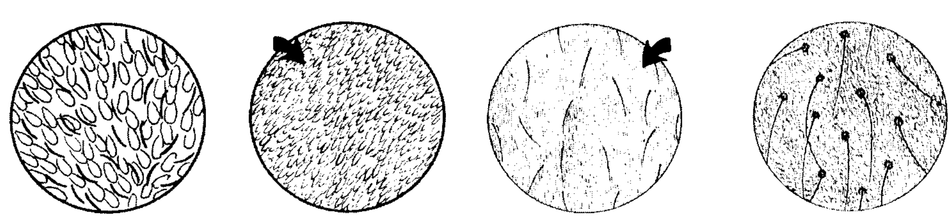


4A *Sphaericus gibboides*
4B *Niptus hololeucus*
4C *Trigonogenius globulum*
4D *Ptinus ocellus*
4E *Ptinus fur*

5 Scales of pronotum (5A) obviously broader than those of elytron (5B); elytra covered with appressed broad scales, without erect setae (pl. 83A) ---------*Sphaericus gibboides*

Distribution: Europe, north Africa, west coast of North America; associated with cumin seeds, red pepper, herbs, dried plants, dried valerian root. See also 1B, 4A.

Scales and setae of pronotum (5C) and elytron (5D) subequal in size; elytra covered with appressed narrow scales or broad setae and with erect setae (pl. 83B&C) 6



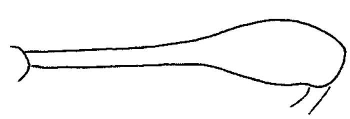
5A *Sphaericus gibboides* 5B
5C *Niptus hololeucus*
5D *Trigonogenius globulum*

6 Femur III slender, but with apical one-third expanded (6A); pronotum evenly convex (pl. 83B), with uniform, appressed setae (6B); antenna long, extending to middle of visible abdominal sternum II; elytra and pronotum covered with golden appressed setae (pl. 1-O, 83B)------------------------------------**golden spider beetle,** *Niptus hololeucus*

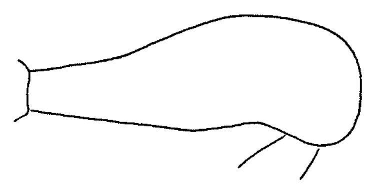
Distribution: cosmopolitan, except for the tropics; associated with wheat, flour, bran, oats, barley, milo, grains, seeds, cacao, spices, tea, bread, casein, belladona roots, rhubarb roots; also reported from wool, cotton, linen, silk, artificial silk, paper, books, cork, bath sponges, brushes, feathers, leather, dead insects, rodent excreta. See also 4B.

Femur III stout, with apical one-half expanded (6C); pronotal surface irregular (pl. 83C), with a mat of confused, appressed setae (6D); antenna shorter, extending to coxa III; elytra and pronotum covered with gray and brown appressed setae (pl. 83C) --**globular spider beetle,** *Trigonogenius globulum*

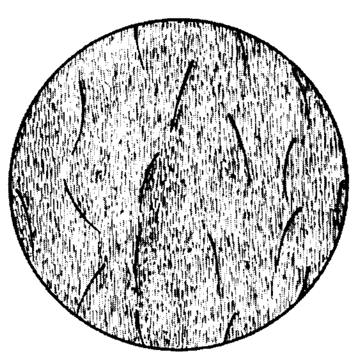
Distribution: Africa, Europe, North America, South America; associated with wheat, flour, corn, oats, beans, barley, raisins, dried pears, dried fruit, caraway seeds, spices, cottonseed meal, copra meal, tartar, argol, sugar, liver meal, botanical drugs; also reported from rice hulls, alfalfa seed, brome seed, cereal dust, cotton, burlap sacks, old clothing, manure piles. See also 4C.



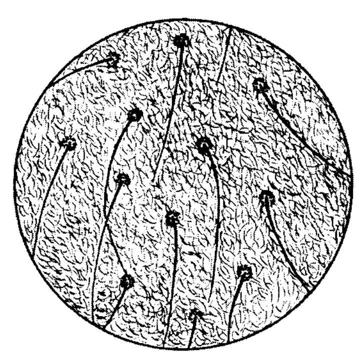
6A *Niptus hololeucus*



6C *Trigonogenius globulum*



6B *Niptus hololeucus*

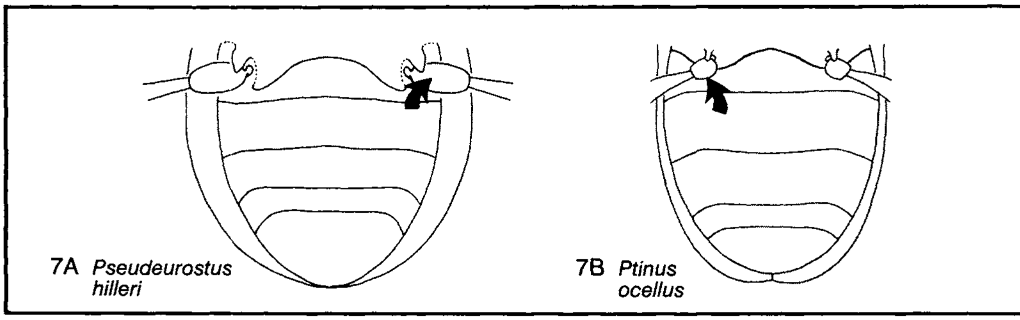


6D *Trigonogenius globulum*

7 Trochanter III long, apex reaching elytral margin (7A); pl. 84------------*Pseudeurostus hilleri*

Distribution: Canada, Europe, Japan; associated with whole wheat flour, oatmeal, animal feeds, brewers yeast, rodent excreta.

Trochanter III short, apex not reaching elytral margin (7B)---------------------------------- 8



7A *Pseudeurostus hilleri*

7B *Ptinus ocellus*

8 Elytral surface completely obscured by vestiture of dark golden appressed setae; longitudinal rows of setae seen only vaguely because of background of appressed setae (pl. 85B)--**Australian spider beetle,** *Ptinus ocellus*

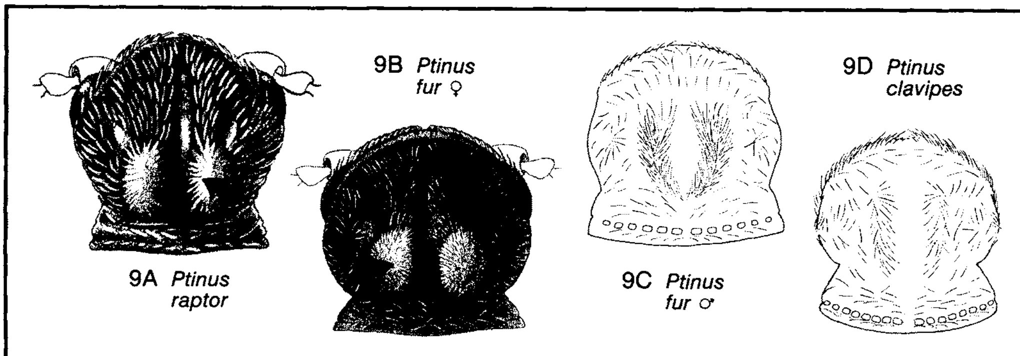
Synonym: *Ptinus tectus.* Distribution: cosmopolitan; associated with wheat, flour, bran, corn, oats, rye, barley, beans, soy grits, hops, nutmegs, cacao, chocolate powder, cayenne pepper, paprika pepper, poultry feed, turkey starter, cereal products, almonds, ginger, raisins, figs, dried apricots and pears, sultanas, calf feed, alfalfa hay, dried soup, fish food, fishmeal, herring meal, crab meat, casein, starch; also reported from flax, beet seeds, nasturtium seeds, sausage rusks, furs, carpets, dead insects, cat feces, dead rats, bird nests. See also 4D, 7B.

Elytral surface mostly visible and longitudinal rows of setae easily seen even though some appressed setae may be present (pl. 86A)-- 9

9 Surface of pronotum partially obscured by 2 dense clumps of erect golden setae (9A, 9B)-- 10

Drawing 9A by A.D. Cushman.

Surface of pronotum visible through vestiture of horizontal, inclined, or erect setae, some of which may form clumps (9C, 9D)--- 11



9A *Ptinus raptor*

9B *Ptinus fur* ♀

9C *Ptinus fur* ♂

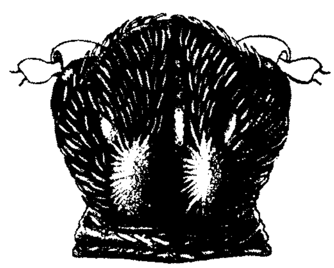
9D *Ptinus clavipes*

10 Pronotal surface between and laterad of dense setal clumps shiny and without punctures or granules (10A)------------------------------------Canadian spider beetle, *Ptinus raptor*

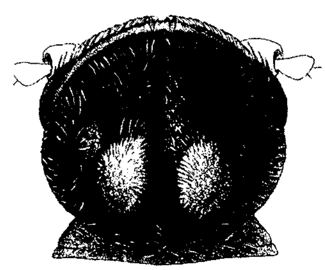
A sexually dimorphic species similar in body form to figures shown in pl. 86. Distribution: eastern USSR, Europe, northeastern North America; associated with flour, grains, pollen in beehives.

Pronotal surface dull, with punctures and/or granules between and laterad of dense setal clumps (10B); pl. 86B -----------------female, **whitemarked spider beetle,** *Ptinus fur*

Distribution: cosmopolitan; associated with flour, whole wheat flour, ground barley, pepper, red pepper, paprika pepper, grains, cereal, ginger, cacao, dates, licorice roots, senna leaves and roots, fresh fruit, brewers yeast, rye bread, cantharides; also reported from henbane seeds, cotton seeds, tobacco seeds, tobacco, straw, pollen in beehives, herbarium specimens, bee pupae, animal skins, leather, furs, stuffed animals, feathers, wasp nests, bird nests, paper, books. See also 4E, 9C.



10A *Ptinus raptor*

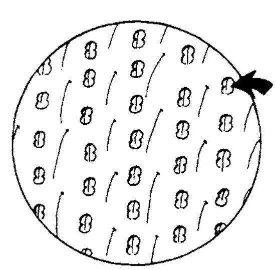


10B *Ptinus fur*

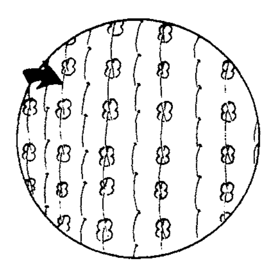
11 Seta of strial puncture of elytron very short, contained within puncture or extending only slightly beyond posterior border of puncture (11A) -------------------*Ptinus gandolphei*

A sexually dimorphic species similar in body form to figures shown in pl. 86. Distribution: California; associated with raisins, mixed feeds, cotton seeds.

Seta of strial puncture longer, extending well beyond posterior border of puncture and reaching at least next puncture (11B) -- 12



11A *Ptinus gandolphei*

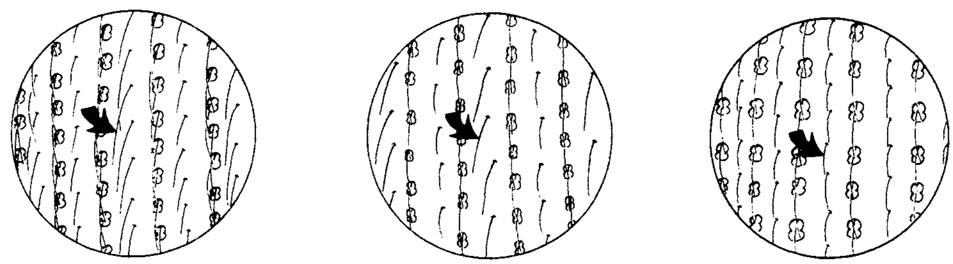


11B *Ptinus fur*

12 Longest erect setae on anterior two-thirds of elytral intervals as long as or longer than last segment of tarsus III (12A) --------------------- **hairy spider beetle,** *Ptinus villiger*

A sexually dimorphic species similar in body form to figures shown in pl. 86. Distribution: Asia, Europe, North America; associated with wheat, flour, farina, cornmeal, rye, mixed feeds, chamomile seeds.

Longest setae on anterior two-thirds of elytral intervals shorter than last segment of tarsus III (12B, 12C) -- 13



12A *Ptinus villiger* 12B *Ptinus clavipes* 12C *Ptinus fur*

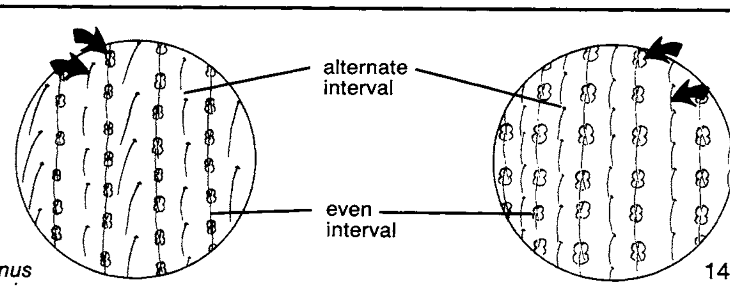
13 Body stout, elytra oval (pl. 86B) -- 14
Body slender, elytra parallel-sided (pl. 86A) -- 15

14 Erect setae of alternate intervals of elytron one-third to one-half as long as (and usually more erect than) setae of even intervals (14A) -- female, **brown spider beetle,** *Ptinus clavipes*

A sexually dimorphic species similar in body form to specimens figured in pl. 86. Synonym: *Ptinus hirtellus*. Distribution: cosmopolitan; associated with wheat flour, oats, milo, barley, corn, cornmeal, beans, rice, soybean meal, cottonseed meal, mixed feeds, cacao, sugar, dried fruit, dried mushrooms, musk root, powdered leaves of senna and jaborandi, cantharides; also reported from seeds of cotton, sunflower, spinach, vetch, alfalfa, and dallisgrass, feathers, skins, books, dead animals, rodent excreta. See also 9D.

Erect setae of alternate and even intervals subequal in length and usually equally slanted (14B); pl. 86B ------------------------ female, **whitemarked spider beetle,** *Ptinus fur*

See couplet 10.



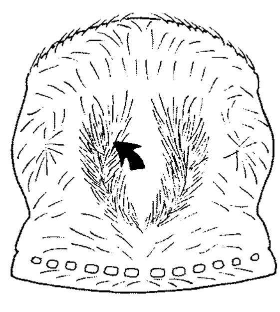
14A *Ptinus clavipes* 14B *Ptinus fur*

15 Pronotum with a slender, dense row of posteriorly-inclined yellowish setae, the 2 rows often joined forming a "U" or "V" (15A); pl. 86A -- male, **whitemarked spider beetle,** *Ptinus fur*

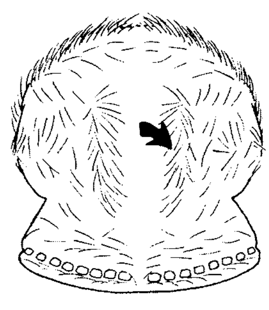
See couplet 10.

Pronotum with erect or anteriorly-directed, golden setae on either side of midline (these setae are not densely spaced and at most form only the vaguest suggestion of rows) (15B)---male, **brown spider beetle,** *Ptinus clavipes*

See couplet 14.



15A *Ptinus fur*



15B *Ptinus clavipes*

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Notes and Sketches

7 CHECKERED BEETLES (CLERIDAE, COLEOPTERA)

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These three species, all cosmopolitan in distribution, are associated with spoiled meat, fish, cheese, and occasionally with cured ham and bacon. Both adults and larvae feed on larvae of other insects and on molds. *Necrobia violacea* is rarely seen in stored foods.

KEY TO ADULTS

1 Color of thorax, legs, and elytral shoulders reddish yellow; color of head and apical three-fourths of elytra metallic blue or green; pl. 1H ---------- **redshouldered ham beetle,** *Necrobia ruficollis*

Color of head, thorax, and abdomen metallic blue or green; color of legs reddish or dark ---------- 2

2 Legs reddish; pl. 1I, 87B ---------- **redlegged ham beetle,** *Necrobia rufipes*

Legs dark; pl. 1G ---------- blacklegged ham beetle, *Necrobia violacea*

8 SAP BEETLES (NITIDULIDAE, COLEOPTERA)

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The adults of those nitidulids that infest stored foods (*2-4*) have five tarsal segments on each leg. Segment IV is unmodified but comparatively small (see couplet illustration 6E); segments I to III have hairy pads on the underside (6E) and are usually dilated. The front coxae are always transverse; the associated trochantins are exposed (10B).

Some genera have truncate elytra that expose one or more segments of the abdomen (2B-D). This is a handy taxonomic feature, but it must be used with caution. Specimens with distended abdomens (from engorgement with food or from having been killed in fluids) generally present more than the normal number of exposed segments behind the elytra (9D). On the dorsum of each normally exposed segment is a large sclerite or tergite. The tergite of the apical segment is termed the pygidium (2B, 2C). The articulating surfaces and the membrane connecting a tergite to an adjoining segment are concealed under normal conditions. These structures become exposed when the abdomen is distended.

A normally concealed segment may have a dorsal sclerite but it consists of only a relatively narrow band at the posterior margin. *Haptoncus luteolus* (6A) is exceptional in that the last two terga are largely sclerotized whether concealed or not. Normally, only the pygidium of *H. luteolus* is exposed, but distended specimens are frequently encountered. The presence of a dorsal membranous area behind the elytra indicates abdominal distention (9D). With this information in mind, the taxonomist must judge how many segments, if any, would be exposed normally.

Male nitidulids have a small, discoidal supplementary segment on the ventral surface of the abdominal apex (11B). In some genera the supplementary segment is also visible on the dorsal side of the abdomen (6A); it does not occur in females (6B).

Hinton (*4*) discussed four species that do not occur in North America and are not included in this key: *Carpophilus flavipes, C. immaculatus, C. sexpustulatus,* and *Haptoncus flavidus.* Hinton also mentioned four other species that occur in North America but not in association with stored foods: *C. pallipennis* (Say), a symbiont of cactus flowers reported from stored foods as a result of misidentification; *Omosita colon* (L.), a carrion feeder not known to invade buildings; *Nitidula rufipes* (L.) and *N. carnaria* (L.). All members of the genus *Nitidula* feed on carrion. There are six species in our North American fauna but only the two recorded from stored foods (dried meats) are included in this key.

The immature stages of six species have not been described: *Carpophilus fumatus, C. maculatus, C. pilosellus, Glischrochilus fasciatus, Nitidula bipunctata,* and *N. ziczac.*

All the other nitidulids associated with stored foods have orthosomatic (or nearly so), prognathous larvae bearing urogomphi (pl. 90A). The urogomphi (22E) are continuous with a sclerite, the anal plate (23B), covering much of the dorsal surface of abdominal segment IX. A pair of pregomphi (23A) protrudes from the anal plate just in front of the urogomphi. Sap beetle larvae, especially those belonging to the genus *Carpophilus*, may often be difficult to identify to species.

KEY

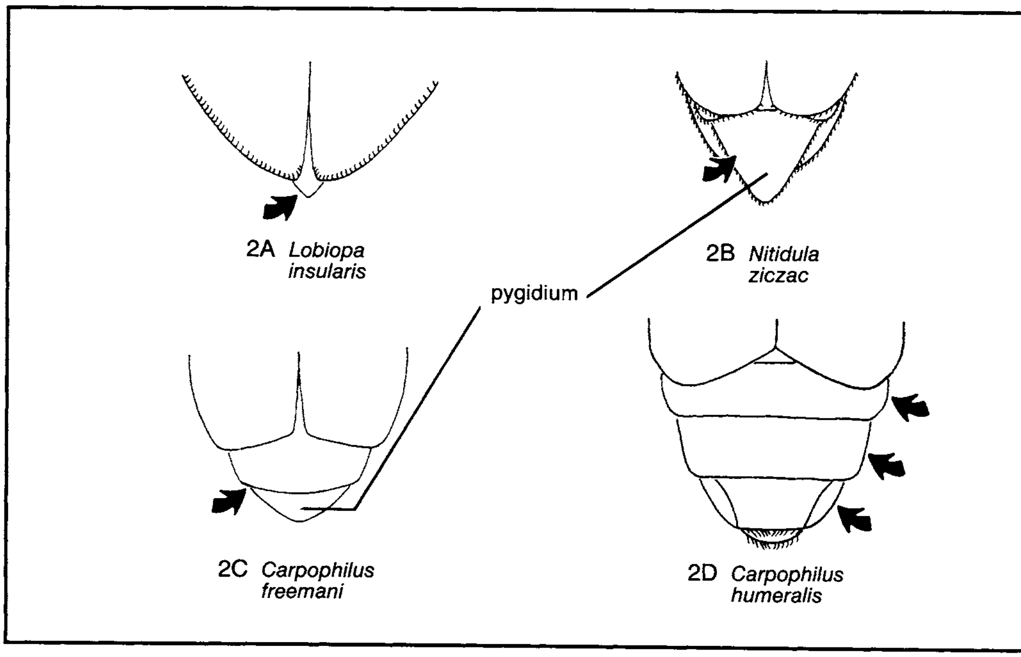
Drawings by W.A. Connell and C. Feller.

1	Adult specimen	2
	Larval specimen	20

Adults

2	Abdomen normally entirely concealed by elytra (2A), or pygidium alone exposed (2B)	3
	Abdomen normally with apical 2 or 3 segments exposed dorsally behind elytra (2C, 2D)	8

See also 9D which illustrates abnormal exposure of a third segment.



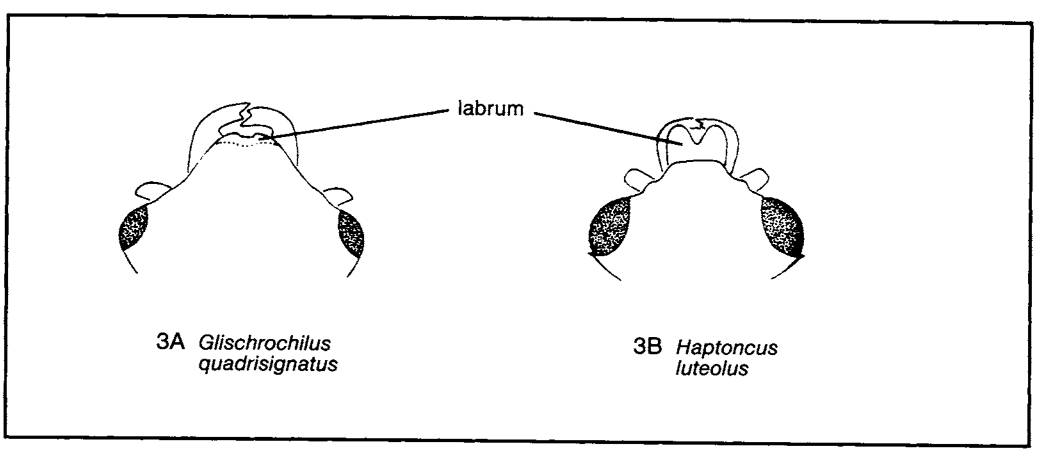
2A *Lobiopa insularis*

2B *Nitidula ziczac*

2C *Carpophilus freemani*

2D *Carpophilus humeralis*

3	Labrum fused to clypeus, the articulation marked by a fine, curved groove (3A)	4
	Labrum free, usually with a median notch on anterior margin (3B)	5



3A *Glischrochilus quadrisignatus*

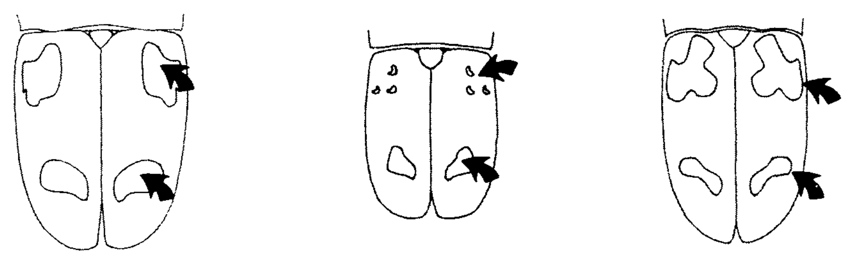
3B *Haptoncus luteolus*

4 Elytron either with 2 conspicuous orange-yellow spots (4A) or with 1 conspicuous spot (posterior) and a group of a few small spots (humeral region) (4B); pl. 88A --*Glischrochilus quadrisignatus*

Body elongate, convex; color light brown to nearly black; integument weakly shiny; vestiture sparse and inconspicuous. Distribution: temperate North America. See also 3A.

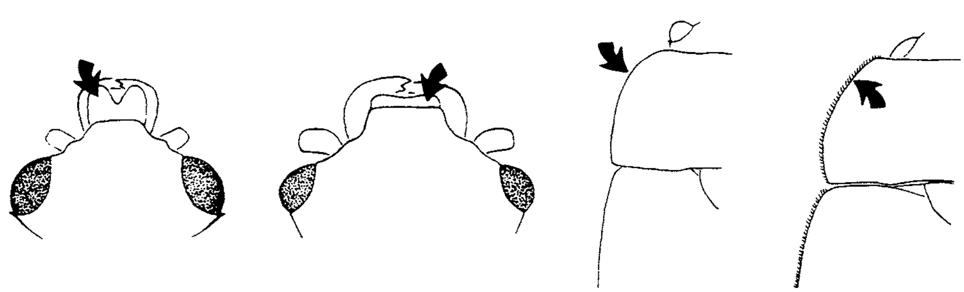
Elytron with 2 conspicuous spots, the humeral one with 3 blunt points (never appearing as a group of small spots) (4C); pl. 88B---------------------------*Glischrochilus fasciatus*

Similar to *G. quadrisignatus* in size, appearance, and geographic distribution (except that there are no California records for *G. fasciatus*).



4A *Glischrochilus quadrisignatus* 4B 4C *Glischrochilus fasciatus*

5 Labrum strongly notched and definitely bilobed (5A); marginal fringe on sides of pronotum narrow and inconspicuous or absent (5B)-- 6
Labrum shallowly emarginate (5C); sides of pronotum and elytra fringed with hairs as long as or longer than the diameter of an eye facet (5D)-------------------------- 7



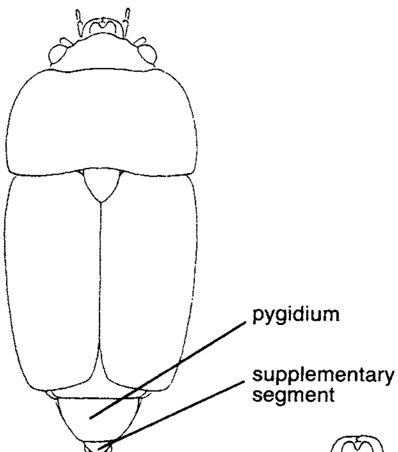
5A *Haptoncus luteolus* 5C *Nitidula ziczac* 5B *Haptoncus luteolus* 5D *Nitidula bipunctata*

6 Body oblong in shape (6A); color a dull yellow to brown; length 1.7 to 2.8 mm; pl. 88C
--yellowbrown sap beetle, *Haptoncus luteolus*

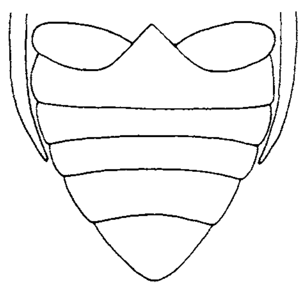
Elytra truncate and free from abdomen at apex; both pygidium and penultimate tergum sclerotized and either both or only pygidium visible from above; male supplementary segment visible from above (6A) (absent in female, 6B); apical two-thirds of male tibia III abruptly dilated (6C); one of several species of *Haptoncus* with small temples behind eyes. Distribution: tropical and subtropical; in North America, north to South Carolina and California (El Dorado County).

Body oval in shape (6D); color dark brown; dorsum with dull yellow margins and many ill-defined light yellow areas; length 4.5 to 8 mm; pl. 88D------------------*Lobiopa insularis*

Pronotal and elytral margins explanate (6D); elytron with 7 rows of short, stout, backward-curving setae; apical two-thirds of tibia not dilated (6E). Distribution: tropics and subtropics of Western Hemisphere; in North America, north to South Carolina and California (El Dorado County).

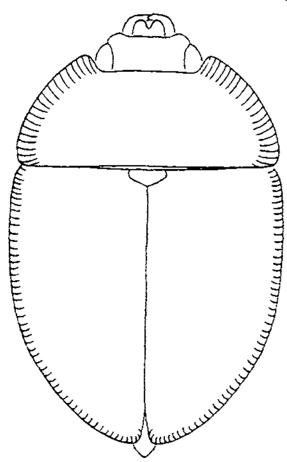


6A *Haptoncus luteolus* ♂

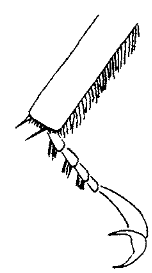


6B *Haptoncus luteolus* ♀

6C *Haptoncus luteolus*



6D *Lobiopa insularis*



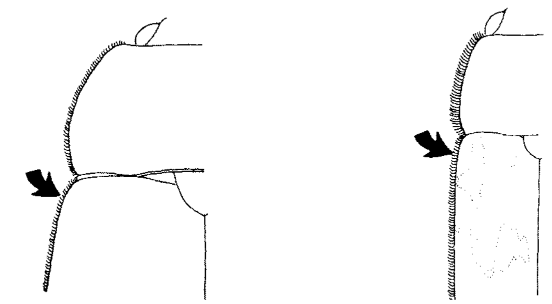
6E *Lobiopa insularis*

7 Elytral fringe narrow (7A); body color a dull brown to nearly black; each elytron with an obscure orange-red spot; pl. 89A---*Nitidula bipunctata*

Distribution: widely occurring in Northern Hemisphere; in North America, from Virginia, Texas, and California to Quebec and Alaska.

Elytral fringe wide (equal to width of reflexed elytral flange) (7B); body color a dull light to dark brown; elytra with obscure, transverse, yellow zigzag bands; pl. 89B --*Nitidula ziczac*

Distribution: Western Hemisphere (Central America to southern Canada). See also 2B, 5C.



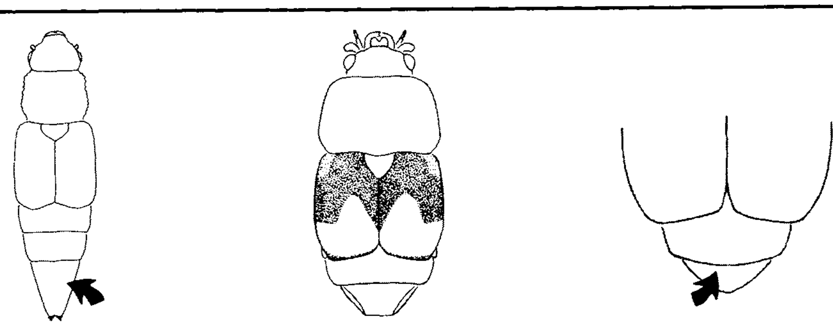
7A *Nitidula bipunctata*

7B *Nitidula ziczac*

8 Body form narrow, elongate; pygidium longer than wide (8A); pl. 89C ---*Conotelus stenoides*

Pronotum nearly square, with narrow, crenulate margin, sinuate in front of acute posterior angles; 3 elongate segments exposed behind truncate elytra; body color a uniform red-brown to nearly black. Distribution: tropics and subtropics of Western Hemisphere; in North America, north to North Carolina and Oklahoma.

Body form broader, less elongate (8B); pygidium transverse (8C). Genus *Carpophilus*-- 9



8A *Conotelus stenoides*

8B *Carpophilus hemipterus*

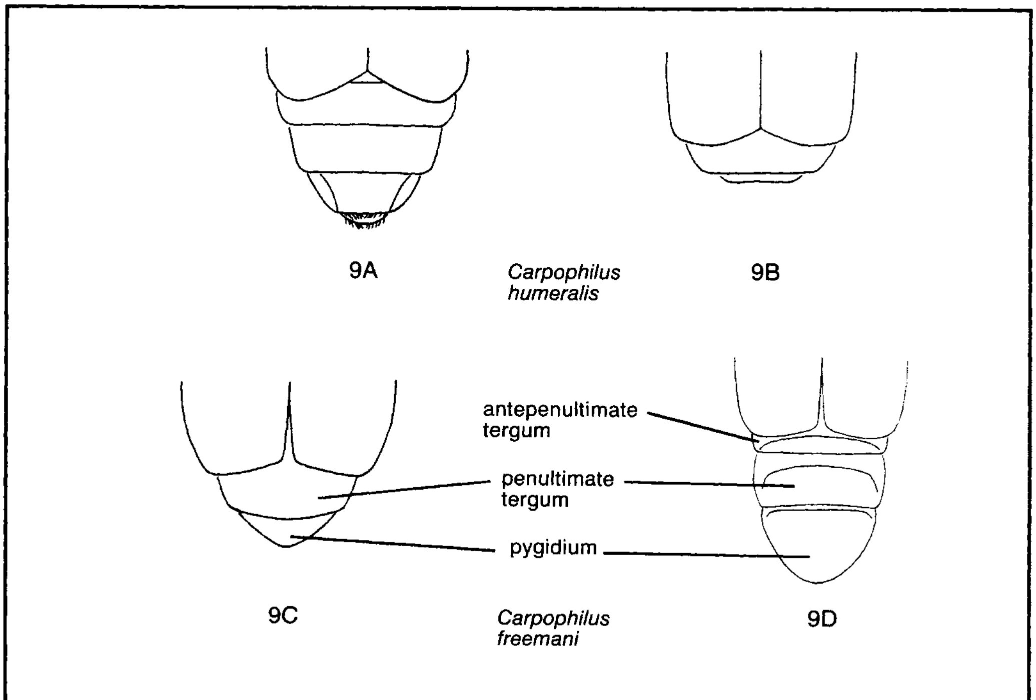
8C *Carpophilus freemani*

9 Normally 3 abdominal terga exposed (9A); dorsum feebly shining, smooth between punctures; body color black, tinged with red, with an obscure orange patch on each shoulder; pl. 89D----------------------------------pineapple sap beetle, *Carpophilus humeralis*

Teneral specimens brown in color; in starved individuals, the last abdominal segment may telescope into the penultimate segment (9B). Distribution: tropics and subtropics; in North America, north to North Carolina and California (Tehama County); first reported from Western Hemisphere (California) by H.C. Fall in 1910.

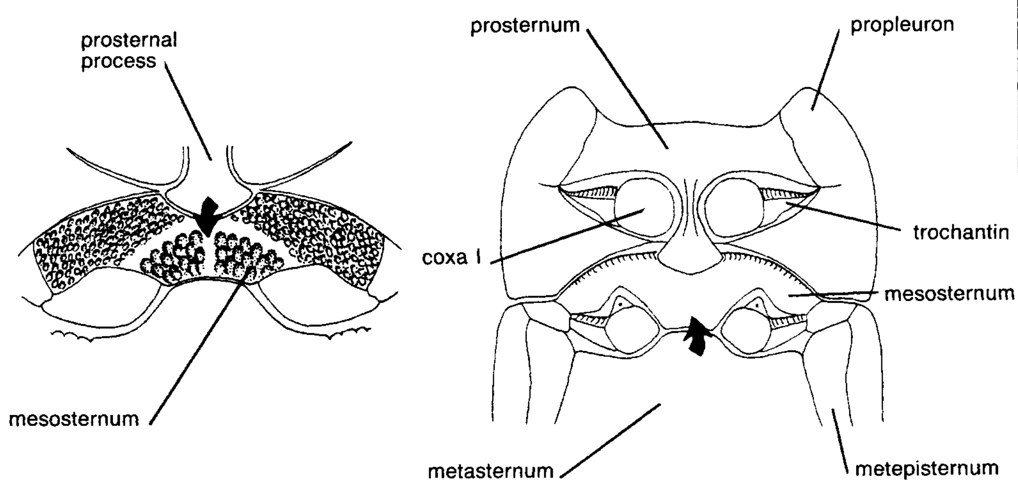
Normally 2 abdominal terga exposed (9C); dorsum dull and finely reticulate between punctures, or, rarely, smooth and shining (if so, then dorsal body color is uniformly dark red-brown)-- 10

Note that the abdomen may be abnormally distended, exposing more than the usual number of terga (9D), or contracted, exposing fewer than the normal number (9B). In all beetles, the 3 most posterior terga, named in sequence starting from the hindmost, are the pygidium, the penultimate tergum, and the antepenultimate tergum. In *Carpophilus* the pygidium and penultimate tergum are completely sclerotized and normally exposed behind the elytra (9C). *C. humeralis* is exceptional among the pest species of this genus in that the antepenultimate tergum is also completely sclerotized and normally exposed. Moreover, its pygidium may sometimes telescope beneath the penultimate tergum (9B). In all other pest carpophilids the antepenultimate tergum is largely membranous, but it may be exposed by abnormal distention (9D). In such a case, the difference in texture, in comparison with the penultimate, should be obvious.



10 Mesosternal disc bisected by an impunctate medial longitudinal ridge or band (10A) ---------- 11
Mesosternal disc undivided down the middle (10B) ---------- 12

Mesosternal disc flat or slightly protuberant, finely or coarsely punctate.



10A *Carpophilus hemipterus*

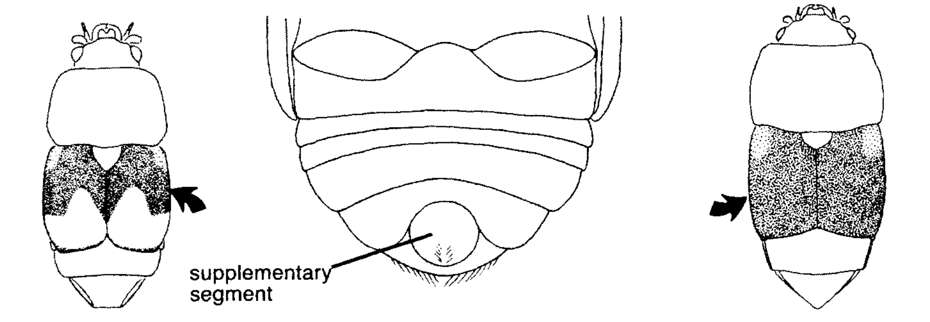
10B *Carpophilus lugubris*

11 Elytra with distinct pattern (11A) of light and dark areas; pl. 90B
--**driedfruit beetle,** *Carpophilus hemipterus*

Dorsal background color brown to brownish black; cuticle dull (not shining) and moderately clothed with inconspicuous dark and light hairs; 11B shows the supplementary segment typical of all male nitidulids. Distribution: cosmopolitan, except for arctic and colder temperate regions; in North America, north to Massachusetts and British Columbia. See also 10A.

Elytra without distinct pattern, but humeral regions or entire elytra may be lighter in color than rest of dorsum (11C); pl. 90C------------------------------*Carpophilus obsoletus*

Dorsal body color rusty brown to black, often black or dark brown, with rusty brown elytra; cuticle sometimes shining; moderate vestiture of inconspicuous pale yellow hairs. Distribution: tropics and subtropics; in North America, Mexico to California (Fresno County) (not established farther east).

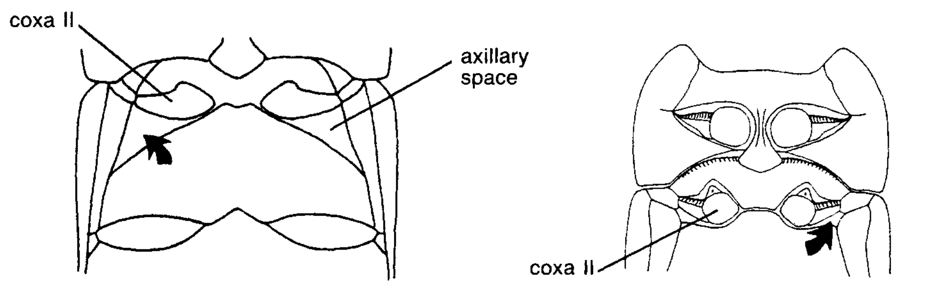


11A *Carpophilus hemipterus*　11B *Carpophilus hemipterus* ♂　11C *Carpophilus obsoletus*

12 Axillary space present (12A)-- 13

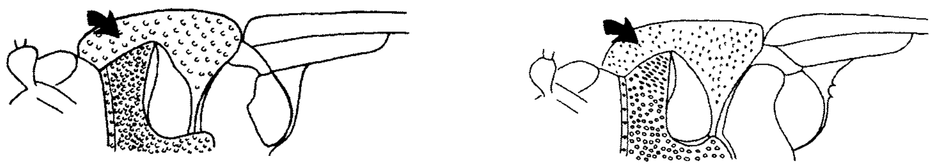
The axillary space, a pseudosclerite located at the anterior angles of the metasternum, is the posterolateral expansion of the posterior lip of each mesocoxal cavity.

Axillary space absent (12B)-- 19



12A *Carpophilus marginellus*　12B *Carpophilus lugubris*

13 Propleuron punctate (punctures may be shallow, with indistinct margins) (13A)---- 14
Propleuron impunctate and either smooth or granulose (13B)---------------------------- 15



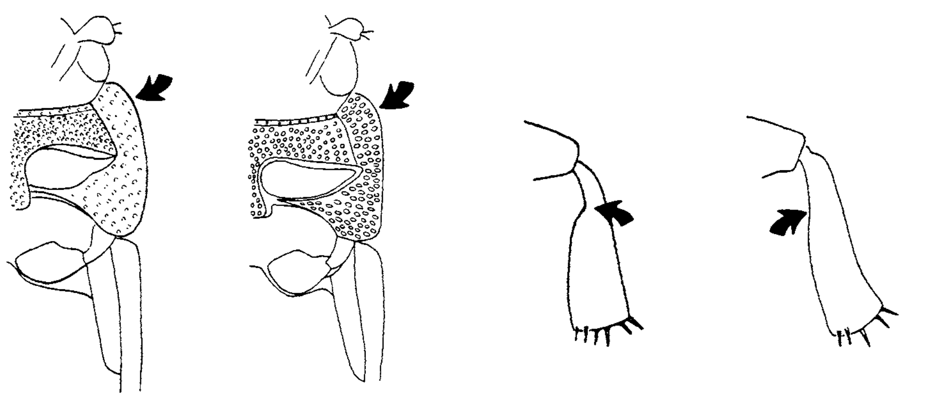
13A *Carpophilus pilosellus* 13B *Carpophilus freemani*

14 Propleural punctures shallow, with obscure margins (14A); tibia III of male abruptly enlarged distally (14B); pl. 91---*Carpophilus pilosellus*

Antennal segment III only slightly longer than II; dorsal body color red-brown to dark brown, with the elytra a shade lighter than pronotum but rarely with a lighter median area on each elytron; cuticle dull and moderately clothed with conspicuous pale yellow hairs. Distribution: tropics and subtropics; in North America, north to South Carolina and California (Yolo County).

Propleural punctures deep, with distinct margins (14C); tibia III of male gradually enlarged distally (14D); pl. 91----------------------**corn sap beetle,** *Carpophilus dimidiatus*

Antennal segment III 25% (or more) longer than II; dorsal body color dark red-brown to nearly black; each elytron usually bears a large central dull orange-yellow spot with indefinite margins; cuticle dull, moderately clothed with conspicuous pale yellow hairs. Distribution: tropics and subtropics; in North America, north to North Carolina and California (Placer County).



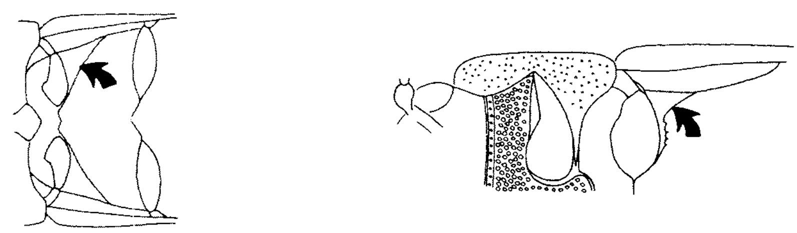
14A *Carpophilus pilosellus* 14C *Carpophilus dimidiatus* 14B *Carpophilus pilosellus* 14D *Carpophilus dimidiatus*

15 Axillary space large (15A); pl. 92A--*Carpophilus marginellus*

The posterior margin of the axillary space extends posterolaterally from a point near the inner side of the coxa to a point beyond the middle of the metepisternum; dorsal body color light brown to dark mahogany; cuticle shiny and scantily clothed with inconspicuous light hairs. Distribution: subtropical and temperate parts of the Northern Hemisphere; in North America, north to New York and Washington.

Axillary space small (15B)--- 16

Even when the axillary space appears relatively large, the extremes of its posterior margin extend on the anterior end no farther than the midpoint on the posterior lip of the mesocoxal cavity, and on the posterior end, no farther than the midpoint on the metepisternal suture.

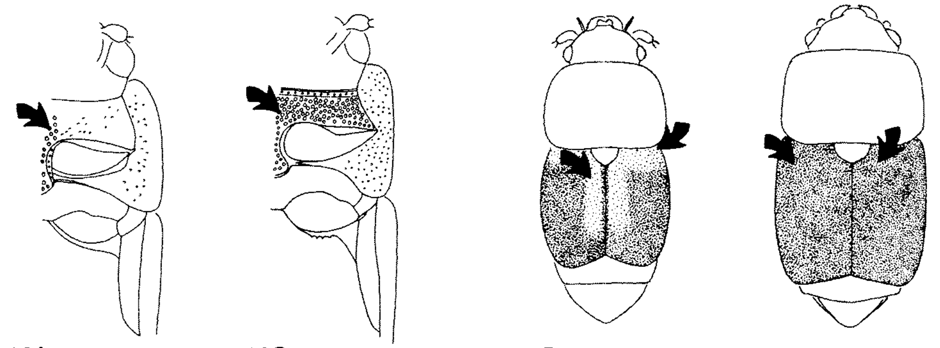


15A *Carpophilus marginellus* 15B *Carpophilus mutilatus*

16 Prosternum punctate only on and immediately in front of the prosternal process (16A); each elytron with 2 light areas (an elongate patch along the suture and a basal patch) usually joined together (16B); pl. 91-----------------------------*Carpophilus maculatus*

Dorsal body color light brown to very dark brown; cuticle dull, moderately clothed with inconspicuous gold and brown hairs. Distribution: many tropical parts of the world; originally described from Hawaii; not recorded from continental USA.

Prosternum entirely or almost entirely punctate (16C); elytral light areas never occurring as an elongate patch near the suture (16D)------------------------------------ 17

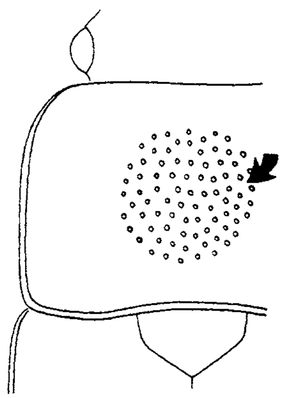


16A *Carpophilus maculatus* 16C *Carpophilus mutilatus* 16B *Carpophilus maculatus* 16D *Carpophilus freemani*

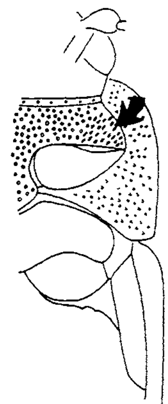
17 Pronotal punctures separated from each other by a distance equal to or greater than twice their diameters (17A); lateral extremities of prosternum weakly punctate or granulose (17B); pl. 91---*Carphophilus freemani*

Dorsal body color red-brown to dark brown; elytra colored a dull yellow except for dark areas next to scutellum, along lateral margin, and at apex; cuticle dull, moderately clothed with inconspicuous yellow and brown hairs. Distribution: cosmopolitan except for arctic and colder temperate regions; in North America, north to New York, North Dakota, and California. See also 9C, 9D.

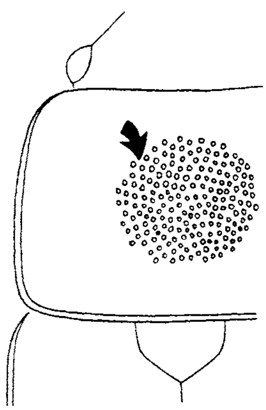
Pronotal punctures separated by a distance equal to or less than their diameters (17C); lateral extremities of prosternum strongly and densely punctate (17D)------------- 18



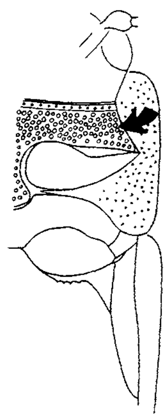
17A *Carpophilus freemani*



17B *Carpophilus freemani*



17C *Carpophilus mutilatus*



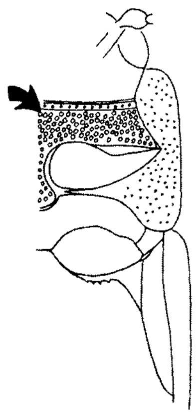
17D *Carpophilus mutilatus*

18 Prosternum entirely punctate (18A); femur III without swelling (18B); pl. 91 -- *Carpophilus mutilatus*

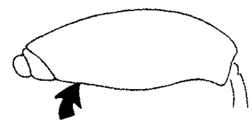
On the pronotum, a narrow impunctate area extends forward on the midline from the posterior margin; dorsal body color of head, elytra, and abdomen red-brown, of pronotum, yellow to orange-yellow; elytral margin and apex and a large median area of the pronotum often as dark as head; elytral disc sometimes with a cloudy discoloration; cuticle dull, moderately clothed with inconspicuous yellow and brown hairs. Distribution: tropical, subtropical, and milder temperate regions; in North America, north to Virginia and California (Tehama County). See also 17C.

Prosternum punctate except for a small area on the midline just behind the anterior margin (18C); femur III with a small, abrupt swelling on the inner margin near the trochanter (swelling usually larger in males; may be inconspicuous or absent) (18D); pl. 91 -- *Carpophilus fumatus*

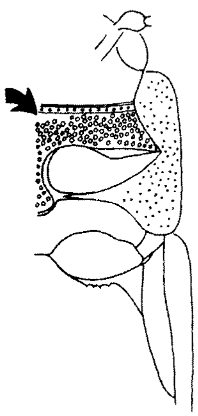
Color, vestiture, and pronotal punctation similar to *C. mutilatus*. Distribution: tropics and subtropics; known only from Florida in USA.



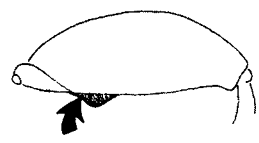
18A *Carpophilus mutilatus*



18B *Carpophilus mutilatus*



18C *Carpophilus fumatus*



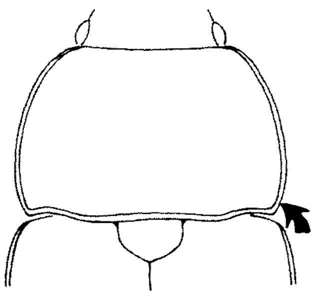
18D *Carpophilus fumatus*

19 Pronotum distinctly narrower anteriorly, with posterior angles obtuse (19A); pronotum moderately convex in lateral view (19B); pl. 92B
--**dusky sap beetle,** *Carpophilus lugubris*

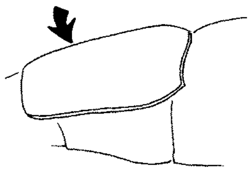
Body color rusty-brown to black (tinged with red); elytron usually with a pale area at shoulder that sometimes extends over base and part of disc; pronotal margins sometimes pale; cuticle dull, moderately clothed with inconspicuous light and dark hairs. Distribution: temperate regions of Western Hemisphere; in North America, from Georgia and Mexico to New Hampshire and Washington. See also 10B.

Pronotum about as wide anteriorly as posteriorly, with a small sinuation before the subacute posterior angles (19C); pronotum slightly depressed (19D); pl. 92C
-- *Carpophilus ligneus*

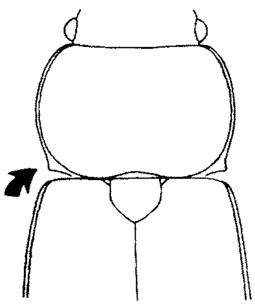
Body color rusty-brown to dark brown (tinged with red); a large, obscurely outlined portion of elytral disc often paler than other dorsal areas; cuticle slightly shining, scantily clothed with inconspicuous light and dark hairs. Distribution: Europe, Central America, North America; in USA, west of Mississippi River and north to Alaska.



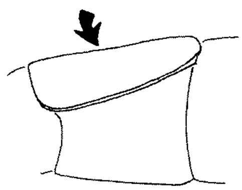
19A *Carpophilus lugubris*



19B *Carpophilus lugubris*



19C *Carpophilus ligneus*

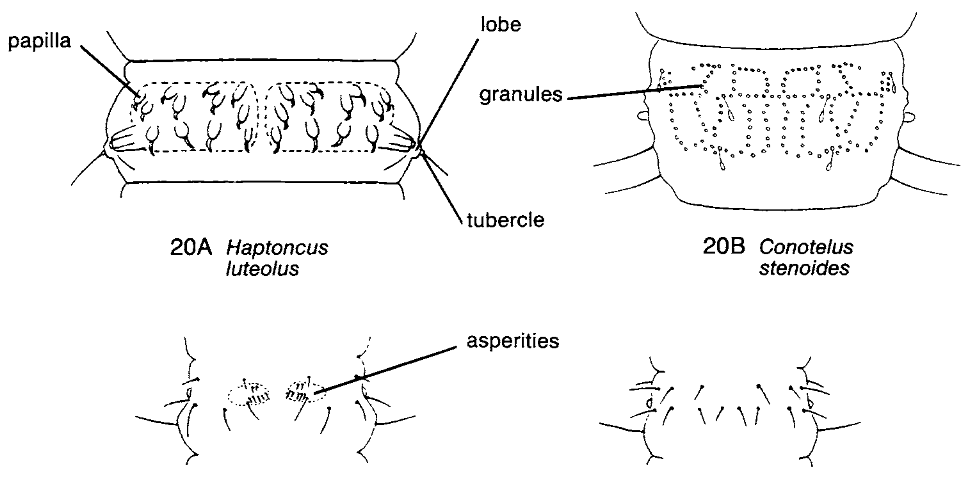


19D *Carpophilus ligneus*

Larvae

20 Abdominal dorsum with sclerites bearing papillae (20A), granules (20B), or asperities (20C) ---------- 21
Abdominal dorsum without ornamentation other than setae (20D) ---------- 24

Although *C. marginellus* does in fact have dorsal asperities, they are so difficult to see that they are considered to be absent for the purposes of this key.
20B redrawn from *1*.



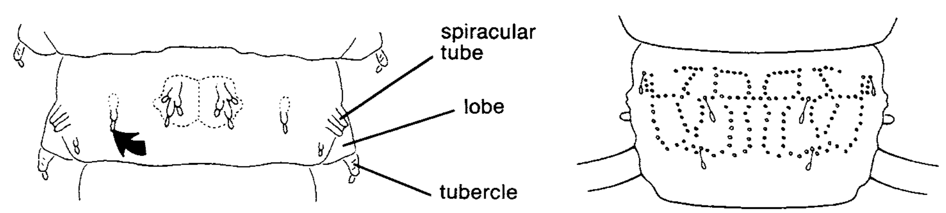
20A *Haptoncus luteolus*
20B *Conotelus stenoides*
20C *Carpophilus humeralis*
20D *Carpophilus hemipterus*

21 Abdomen with lateral tubercles; dorsal papillae prominent, each with an apical spatulate seta (21A) ---------- 22

Two or three ocelli present on each side of head.

Abdomen without lateral tubercles or dorsal papillae (21B) ---------- 23

Two inconspicuous ocelli present on each side of head.
21A&B redrawn from *1*.



21A *Lobiopa insularis*
21B *Conotelus stenoides*

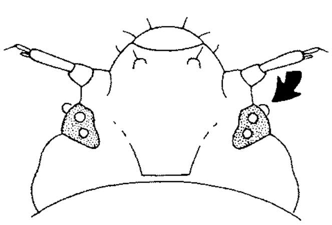
22 Head with 3 large, equal-sized ocelli on each side (22A); each abdominal tergum with a pair of contiguous sclerites (each nearly square in outline) meeting on the midline, with each sclerite bearing 3 papillae, all sharing a common base (22B) --*Lobiopa insularis*

Body length ca 8 mm. Each abdominal tergum also has a small papilla-bearing sclerite on each side (22B). Caution: The characters noted in this couplet may be generic and may not distinguish this species from other *Lobiopa*. However, *L. insularis* is the only known food pest species in this genus.

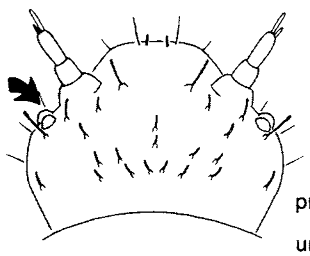
22A&B redrawn from *1*.

Head with 2 small ocelli on each side (22C); each abdominal tergum with 8 short, longitudinal rows of papillae (22D)------------yellowbrown sap beetle, *Haptoncus luteolus*

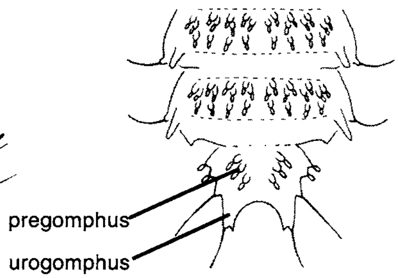
Body length ca 5.5 mm. Each pregomphus appears to be in the form of 3 papillae arising from a common base (22E). Caution: The characters in this couplet do not distinguish *H. luteolus* from some other members of this genus including *H. californicus* Gillogly (found in California).



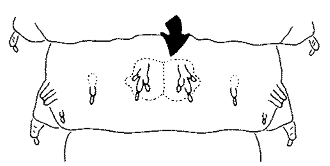
22A *Lobiopa insularis*



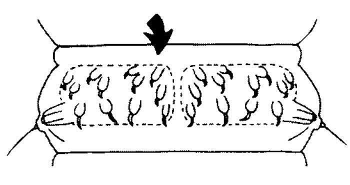
22C *Haptoncus luteolus*



22E *Haptoncus luteolus*



22B *Lobiopa insularis*



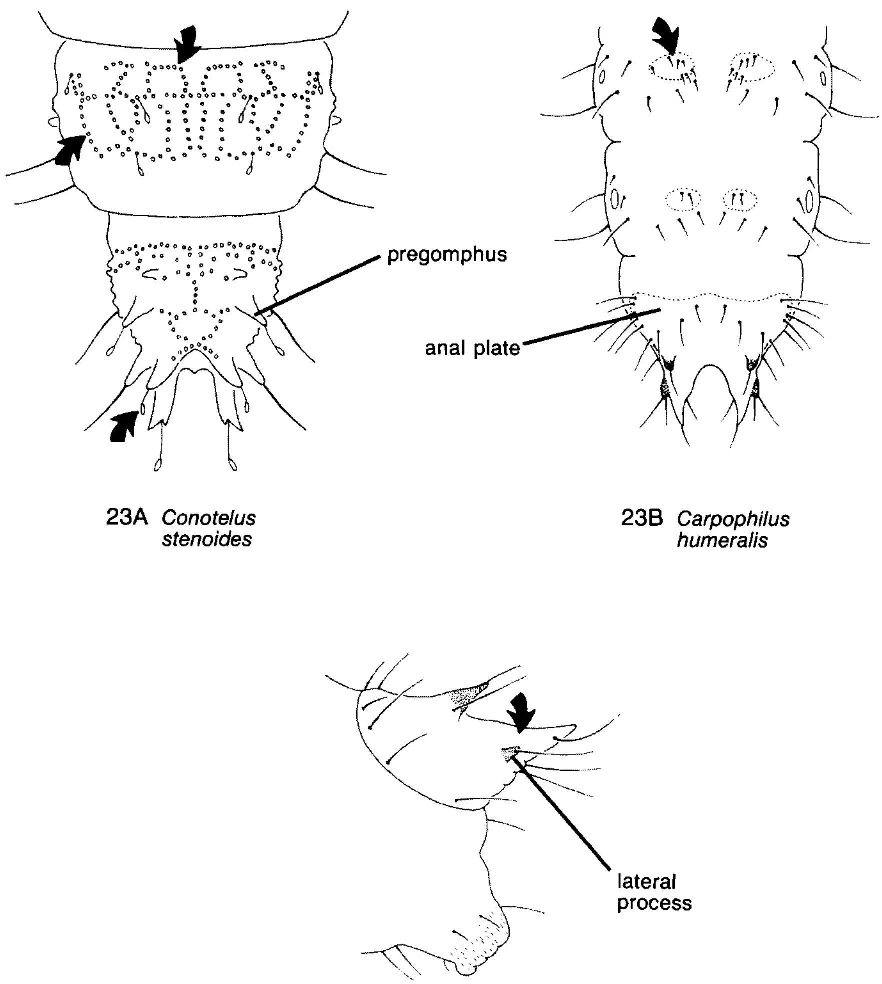
22D *Haptoncus luteolus*

23 Each abdominal tergum with granules arranged in circular and rectangular patterns; urogomphus 2-branched, each branch with a bristle arising at or near the apex (23A)---*Conotelus stenoides*

Body length ca 5 mm.
23A redrawn from *1*.

Each abdominal tergum with paired sclerites bearing 2 to 12 asperities (23B); urogomphus simple (23C)------------------------pineapple sap beetle, *Carpophilus humeralis*

Body length ca 7 mm. See also 20C.



23A *Conotelus stenoides*

23B *Carpophilus humeralis*

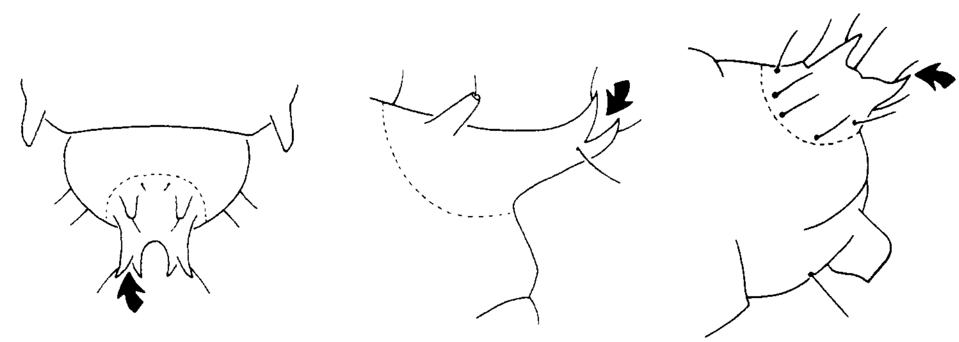
23C *Carpophilus humeralis*

24 Urogomphus branched (24A, 24B)---------------------------------*Glischrochilus quadrisignatus*

Body length ca 9 mm. Each urogomphus divided beyond middle into 2 nearly equal, apically pointed branches, the anterior of which is curved upward, the posterior, inward; pregomphus appears as a truncated cone (24A, 24B); spiracular tubes prominent (longest on segment VIII).

Urogomphus unbranched (24C)-- 25

Each urogomphus may have near its base a small seta-bearing lateral process (note distinction between lateral process, 25C, lateral lobe, 21A, and tubercle, 21A).

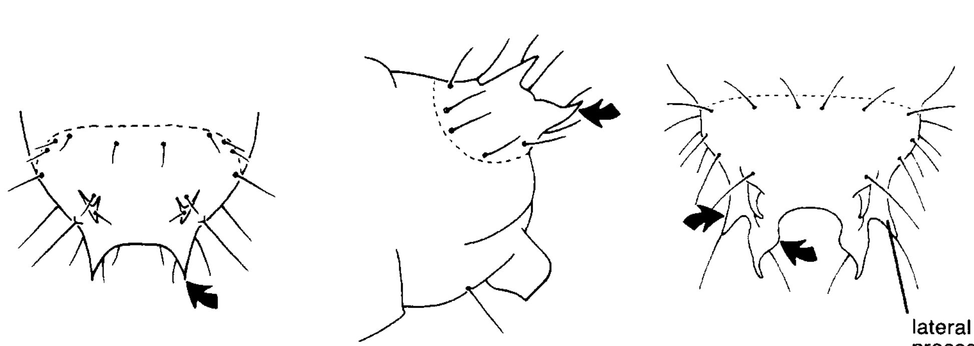


24A *Glischrochilus quadrisignatus* 24B *Glischrochilus quadrisignatus* 24C *Carpophilus ligneus*

25 Urogomphi short, widely separated, and lacking lateral processes (25A, 25B)
--- *Carpophilus ligneus*

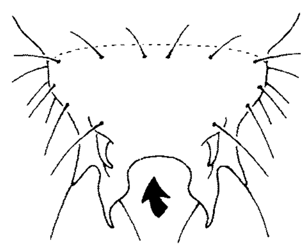
Body length ca 4.5 mm. Pregomphus directed posteriorly but not strongly deflexed (25B). 25A&B based on material provided by Iris Savage; these drawings may not agree entirely with the illustrations in *5*.

Urogomphi longer, each with a lateral process (25C)-- 26

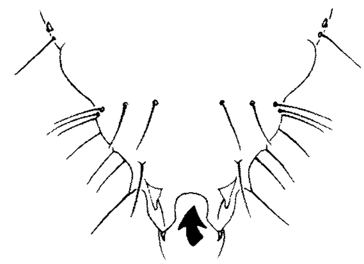


25A *Carpophilus ligneus* 25B *Carpophilus ligneus* 25C *Carpophilus obsoletus*

26 Space between urogomphi wide (26A) ---------- 27
Space between urogomphi narrow (26B) ---------- 30



26A *Carpophilus obsoletus*

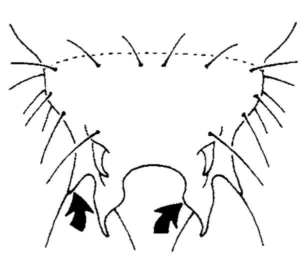


26B *Carpophilus dimidiatus*

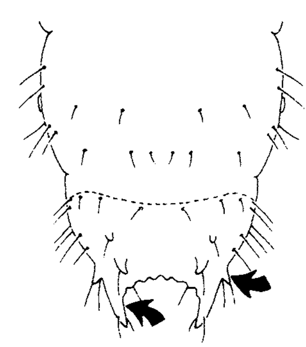
27 Urogomphus dilated on inner surface; lateral process large (27A)--*Carpophilus obsoletus*

Body length ca 6 mm. Pregomphus deflexed and incurved; paired mesonotal and metanotal sclerites weakly developed (may not be visible).

Urogomphus not dilated; lateral process small (27B) ---------- 28



27A *Carpophilus obsoletus*

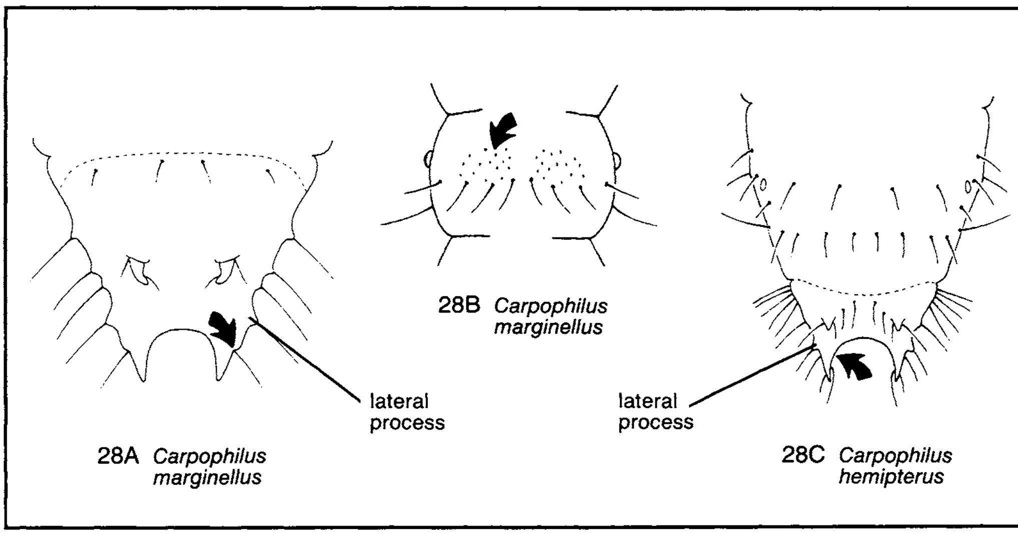


27B *Carpophilus lugubris*

28 Urogomphi abruptly narrowed about midway beyond lateral process, with inner margins subparallel (28A)---*Carpophilus marginellus*

Body length ca 6 mm. Pregomphus deflexed, incurved, and gradually narrowed to a blunt point; mesonotal and metanotal sclerites moderately developed (usually visible in third instar larvae); each abdominal tergum with 2 transversely oval patches of minute asperities that may or may not be visible (28B; see also couplet 20).

Urogomphi gradually narrowed from lateral process to apex (28C) ---------------------- 29



28A *Carpophilus marginellus*

28B *Carpophilus marginellus*

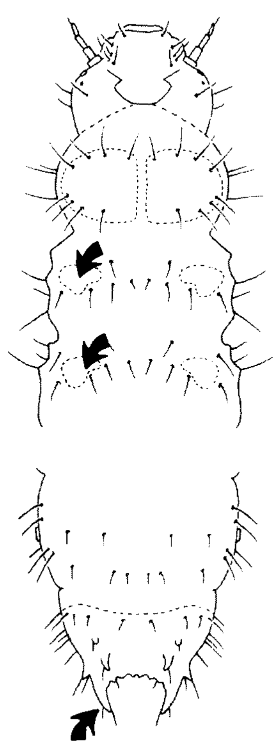
28C *Carpophilus hemipterus*

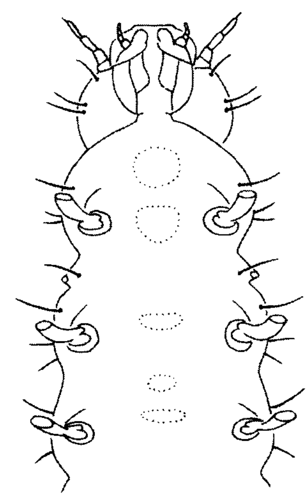
29 Urogomphus incurved (29A); mesonotal and metanotal sclerites strongly developed (29A)--**dusky sap beetle,** *Carpophilus lugubris*

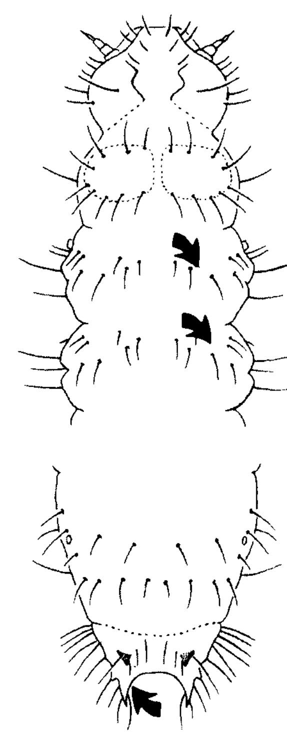
Body length ca 7 mm. Thorax with 5 small sclerites along ventral midline (visible in fresh specimens; may be obscured in preserved specimens) (29B).

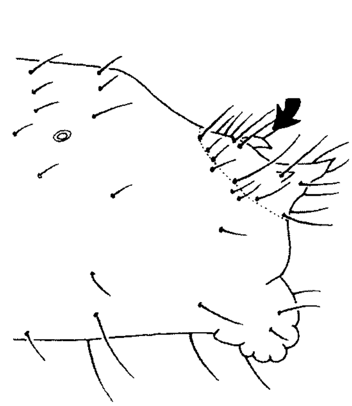
Urogomphus not incurved, the apex spinelike (29C); mesonotal and metanotal sclerites absent (29C); pl. 90A---------------------------------**driedfruit beetle,** *Carpophilus hemipterus*

Body length ca 6 mm. Distal half of pregomphus deflexed and parallel with surface of anal plate (29D). See also 20D and 28C.


29A *Carpophilus lugubris*


29B *Carpophilus lugubris*

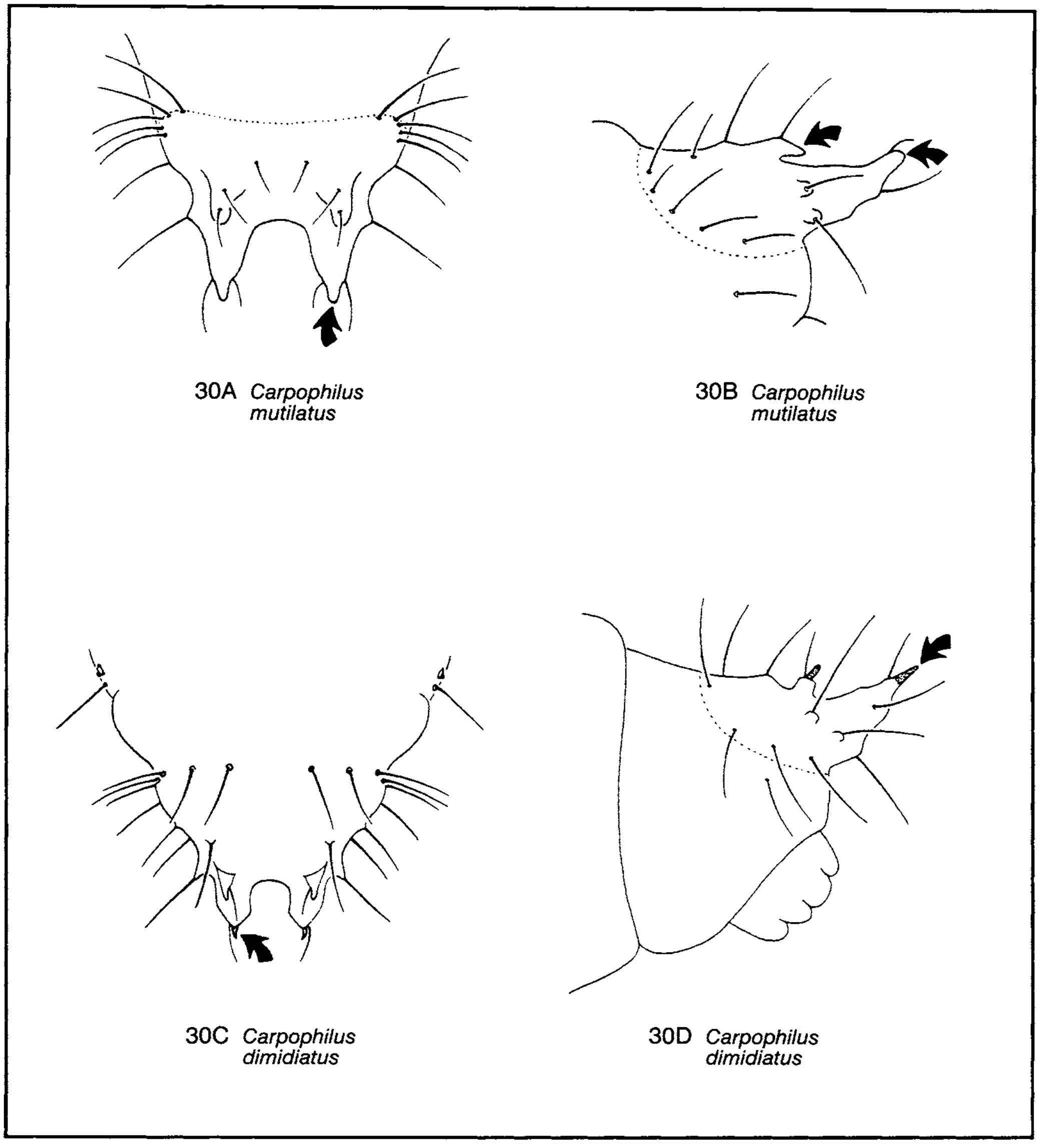

29C *Carpophilus hemipterus*


29D *Carpophilus hemipterus*

30 Inner margins of urogomphi divergent from base to apex; urogomphal apex peglike (30A, 30B)--*Carpophilus mutilatus*
Carpophilus fumatus

Body length ca 6 mm. Pregomphus abruptly deflexed, the distal half parallel to the surface of the anal plate (30B). Larvae of these 2 species are very similar. No reliable characters for separation are known. In the USA, *C. fumatus* occurs only in Florida.

Inner margins of urogomphi generally parallel for most of their length, or inner margins slightly dilated near apex; each urogomphus broadly rounded and bearing a stout spine (30C, 30D)-- 31



30A *Carpophilus mutilatus*

30B *Carpophilus mutilatus*

30C *Carpophilus dimidiatus*

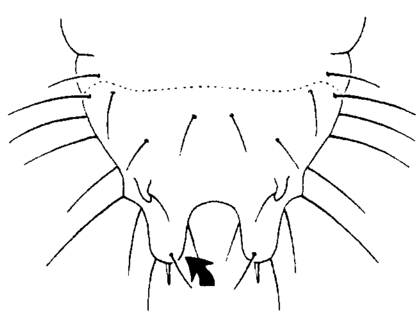
30D *Carpophilus dimidiatus*

31 Urogomphi separated midway along their length by 1.5 times the width of 1 urogomphus; urogomphi never bulging apically (31A)----------------------------*Carpophilus freemani*

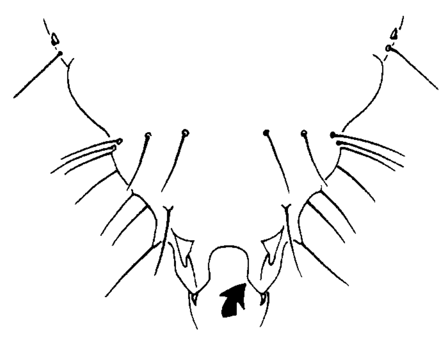
Body length ca 4.5 mm.

Urogomphi separated by less than width of 1 urogomphus; often inner margin of urogomphus appears to have a slight bulge before apex (31B)
---**corn sap beetle,** *Carpophilus dimidiatus*
Carpophilus pilosellus

Larvae of *C. dimidiatus* and *C. pilosellus* are very similar and difficult to separate. Associated adults are helpful, but mixed infestations occur. Last instar larvae of *C. dimidiatus* tend to be larger (length ca 5.5 mm) than those of *C. pilosellus* (length ca 4.0 mm). See also 30D.



31A *Carpophilus freemani*



31B *Carpophilus dimidiatus*

Acknowledgments

Dr. John M. Kingsolver (Agricultural Research Service's Systematic Entomology Laboratory, U.S. Department of Agriculture, Washington DC) and Mrs. Iris Savage (California Department of Food and Agriculture, Sacramento) critically reviewed the manuscript. Dr. Richard S. Zack, Jr. (Department of Entomology, Washington State University, Pullman) and Mrs. Savage provided distribution records for the West Coast. The author gratefully acknowledges the help given to him by all three of these individuals.

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9 CRYPTOPHAGID BEETLES (CRYPTOPHAGIDAE, COLEOPTERA)

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U.S. Department of Agriculture
Beltsville MD 20705

Cryptophagus is the only genus of the family Cryptophagidae associated with stored foods. The species are difficult to identify. Precise identification usually requires removal and observation of the male genitalia. This key to four species is based on the work of Woodroffe and Coombs (*1*), a key to 40 North American species. Members of the genus *Cryptophagus* are associated with molds; their presence in food represents accidental contamination.

KEY TO ADULTS

1 Elytral pubescence of hairs of approximately equal length, entirely decumbent (except, sometimes, laterally) (1A) ---------- 2
Elytral pubescence either of longer, suberect or obliquely-raised hairs or of all hairs obliquely-raised and of uneven length (1B) ---------- 3

Drawings by J.M. Kingsolver.

1A *Cryptophagus acutangulus*

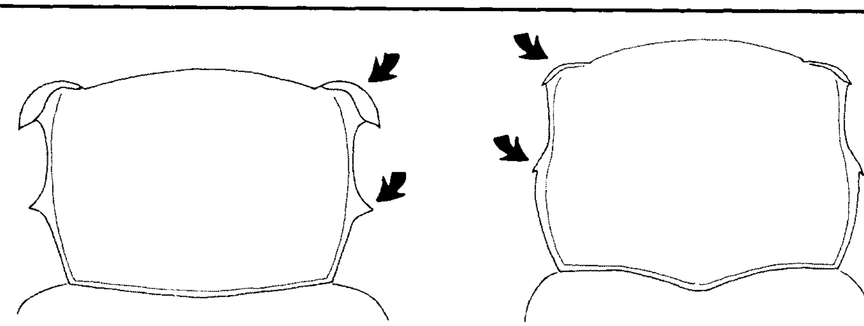
1B *Cryptophagus valens*

2 Width of pronotum greater at level of anterior angles than at level of lateral teeth (2A) ---------- **acute-angled fungus beetle,** *Cryptophagus acutangulus*

Distribution: Holarctic; in various habitats, often including moldy grain.

Width of pronotum no greater across anterior angles than across lateral teeth (2B) ---------- **sigmoid fungus beetle,** *Cryptophagus varus*

Distribution: Canada, northern United States; in stored products and rodent nests.
Drawings adapted from *1* by C. Feller.



2A *Cryptophagus acutangulus*

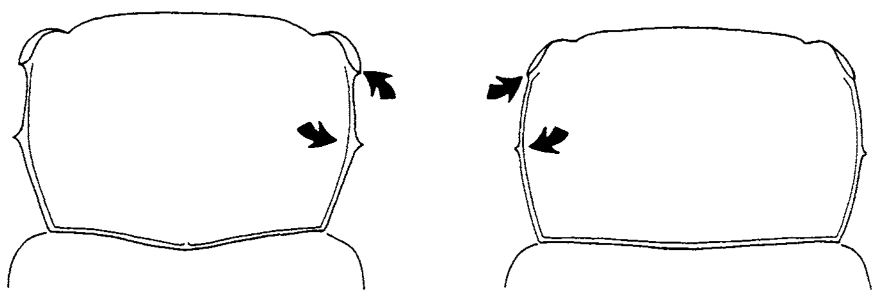
2B *Cryptophagus varus*

3 Margin of pronotum angled at lateral tooth; callosity at anterior angle of pronotum prominent, its posterior corner forming a minute right angle (3A); pl. 93B
---cellar beetle, *Cryptophagus cellaris*

Distribution: cosmopolitan; in stored products.

Margin of pronotum evenly rounded or slightly sinuate, not angled at lateral tooth; callosity present but not prominent and not right-angled posteriorly (3B)
--- *Cryptophagus valens*

Distribution: cosmopolitan; in stored products.
Drawings adapted from *1* by C. Feller.



3A *Cryptophagus cellaris*

3B *Cryptophagus valens*

Reference Cited

1 Woodroffe, G.E., and C.W. Coombs.
1961. A revision of the North American *Cryptophagus* Herbst (Coleoptera: Cryptophagidae). Misc. Pub. Ent. Soc. America 2(2)179-211.

10

MINUTE BROWN SCAVENGER BEETLES (LATHRIDIIDAE, COLEOPTERA)

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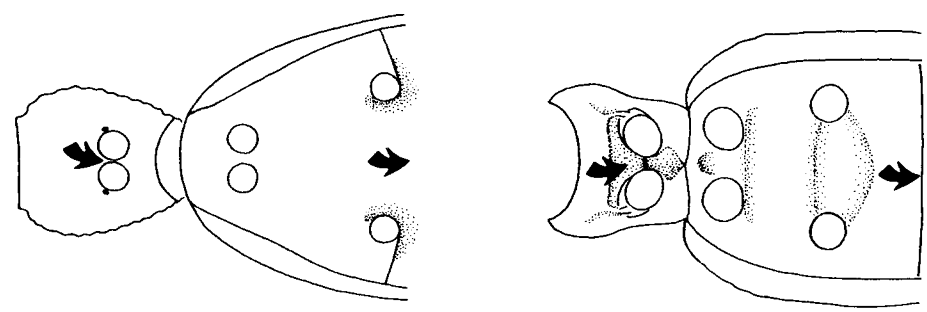
Lathridiids are mycophagous; their presence in stored foods indicates moldy conditions. Since these beetles do not feed directly on stored foods, their occurrence in such commodities may be considered accidental contamination.

KEY TO ADULTS
Drawings by C. Feller unless otherwise noted.

1 Coxae I and II contiguous; abdominal segment I fused to metasternum between legs III (1A); pl. 94B--*Adistemia watsoni*

Distribution: Africa, Canary Islands, Europe, Madeira, North America, South America.

Coxae I and II separated, sometimes narrowly; abdominal segment I separated from metasternum by a suture (1B)-- 2



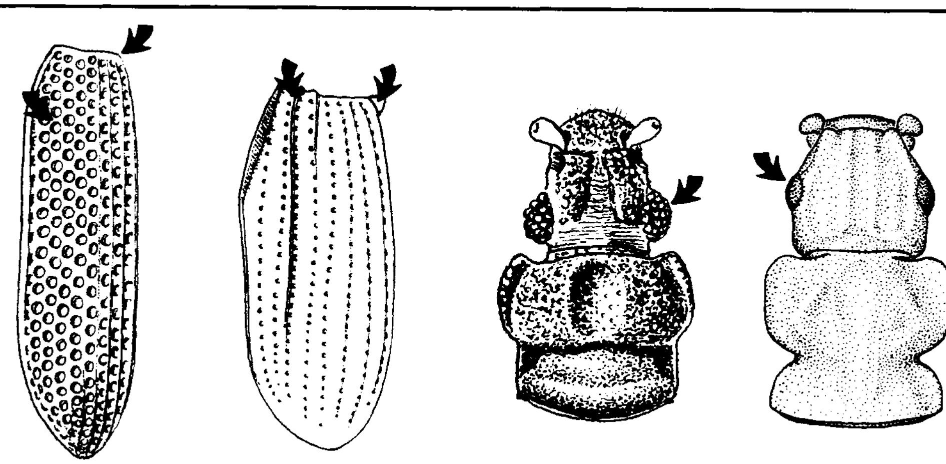
1A *Adistemia watsoni*

1B *Dienerella ruficollis*

2 Seventh interval at elytral shoulder without a prominent carina; scutellum not apparent (2A); eye facets coarse, granular (2B)-- 3

Seventh interval at elytral shoulder with a sharp, prominent carina; scutellum obvious (2C); eye facets fine (2D) -- 7

Drawings 2A-C by A.D. Cushman.



2A *Dienerella*

2C *Lathridius minutus*

2B *Dienerella filum*

2D *Cartodere constricta*

3 Antennal club with 2 segments (3A); anterior half of pronotal disk with broad, moderately deep, oval depression; head with median channel widened posteriorly (3B); pl. 95A---*Dienerella filum*

Distribution: Europe, North Africa, Western Hemisphere.

Antennal club with 3 segments (3C); anterior half of pronotal disk without depression; head without median channel (3D) -- 4

Drawings by A.D. Cushman.

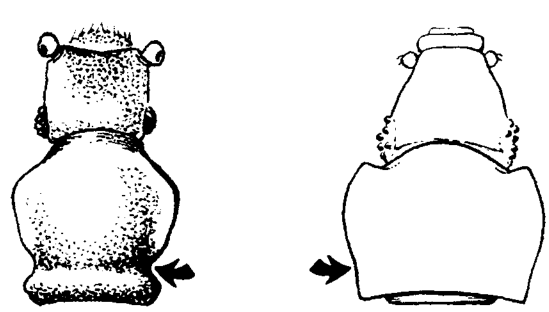
3A *Dienerella filum* 3C *Dienerella ruficollis* 3B *Dienerella filum* 3D *Dienerella ruficollis*

4 Margin of pronotum constricted (4A); pl. 95B-----------------------------*Dienerella ruficollis*

Distribution: Central and North America, Europe, New Zealand, North Africa.

Drawing 4A by A.D. Cushman; 4B by J.M. Kingsolver.

Margin of pronotum not constricted (4B) -- 5

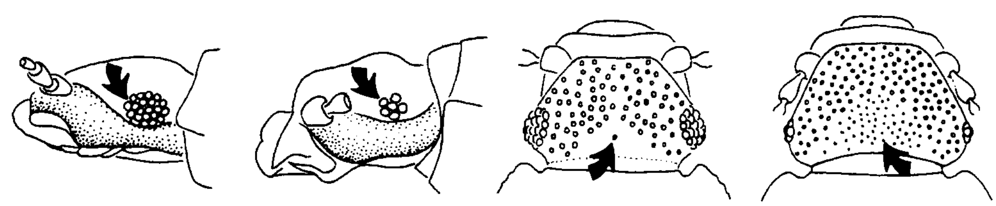


4A *Dienerella ruficollis* 4B *Dienerella filiformis*

5 Eyes normal with 15 to 20 facets (5A); posterodorsal surface of head with triangular depressed area (5B); pl. 95C--*Dienerella arga*

Distribution: Europe, North Africa, North America.

Eyes reduced with 5 or 6 facets (5C); dorsal surface of head without depressed area (5D)-- 6



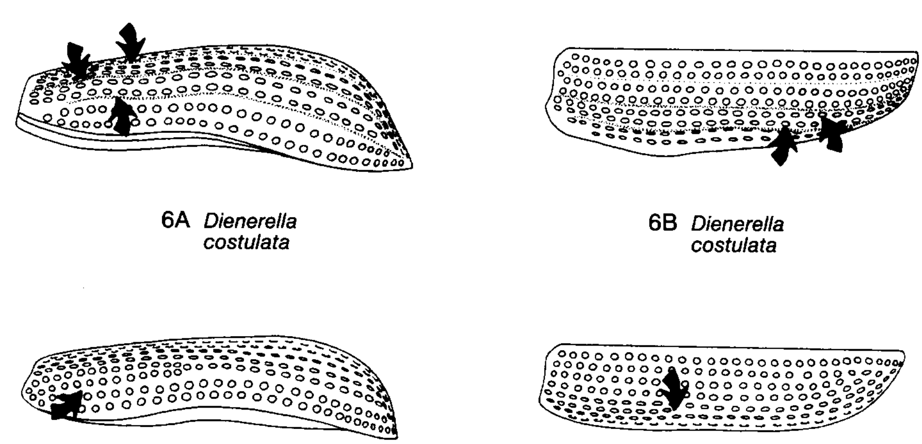
5A *Dienerella arga* 5C *Dienerella costulata* 5B *Dienerella arga* 5D *Dienerella costulata*

6 Elytral intervals 3, 5, and 7 costate (6A); elytral striae 5 and 6 complete, extending from base to apex (6B); pl. 96A---*Dienerella costulata*

Distribution: Europe, Japan, North America.

Elytral intervals not costate (6C); elytral striae 5 and 6 merge forming a single stria posteriorly (6D); pl. 96B---*Dienerella filiformis*

Distribution: Europe, Japan, North America, USSR.



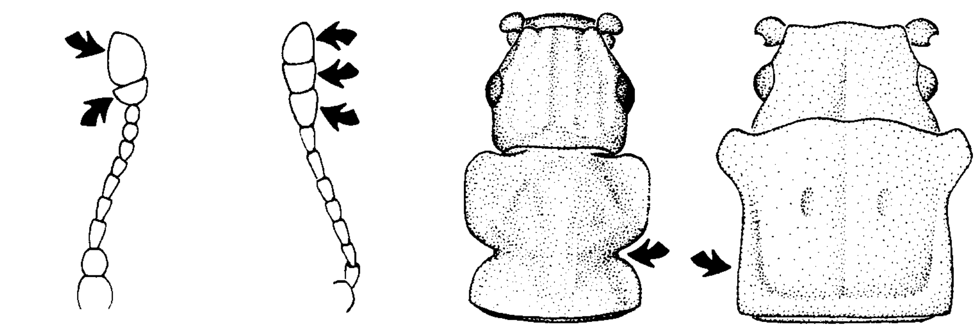
6A *Dienerella costulata* 6B *Dienerella costulata*

6C *Dienerella filiformis* 6D *Dienerella filiformis*

7 Antennal club 2-segmented (7A); pronotum distinctly constricted (7B); pl. 97A
--**plaster beetle,** *Cartodere constricta*

Distribution: cosmopolitan.

Antennal club 3-segmented (7C); pronotum not distinctly constricted (7D)----------- 8



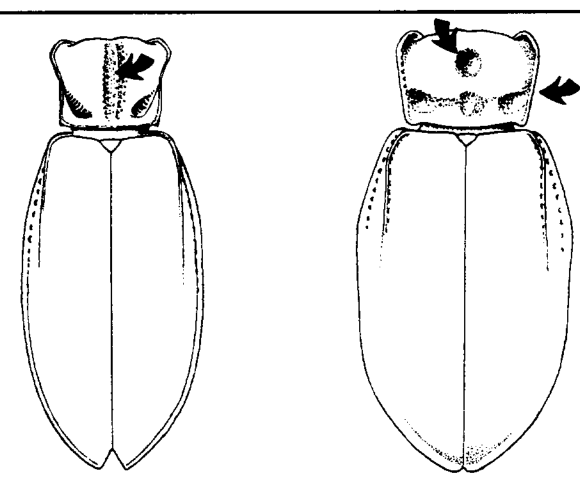
7A *Cartodere constricta* 7C *Lathridius protensicollis* 7B *Cartodere constricta* 7D *Lathridius protensicollis*

8 Pronotal margin sinuate; median depression of pronotal disk shallow and elongate; elytra slightly produced at apex (8A); pl. 97B --------------------------*Lathridius protensicollis*

Distribution: northwestern USA.

Pronotal margin straight; median depression of pronotal disk round and deep; elytra separately rounded at apex (8B); pl. 97C
-- **squarenosed fungus beetle,** *Lathridius minutus*

Pronotum narrowed posteriorly. Distribution: cosmopolitan.
Drawings by A.D. Cushman.



8A *Lathridius protensicollis* 8B *Lathridius minutus*

11 DARKLING BEETLES (TENEBRIONIDAE, COLEOPTERA)

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The Tenebrionidae, commonly called **darkling beetles** or tenebrionids, is a large family of mostly dark species having a 5-5-4 tarsal formula, the forecoxal cavities closed behind, and simple tarsal claws. These beetles usually live in soil in dry areas or under the bark of dead trees. A few species have adapted to and have become pests in stored dry food products. Many such pests have been transported to all parts of the world.

Tenebrionid pests usually infest grains and cereals. Because most of them cannot gnaw through the hard outer covering of whole grains, they usually attack broken or damaged grains. The exact food preferences of most of these beetles in stored foods have not been determined. It has often been said that grain must be moldy or partially spoiled for some species to develop. Perhaps the adults and larvae subsist mainly on mold. This is not an unreasonable hypothesis because some species live in moldy situations in nature. Their presence in bird and mammal nests, in foods stored by small mammals, in caves, and in insect nests probably predisposes some of them to become pests in foods stored by people. Some tenebrionid pests are also scavengers.

The biologies of only a few species are known; literature on the subject is scattered. *Tenebrio molitor, Tribolium castaneum,* and *T. confusum* are rather well known because of their use in physiological, ecological, and genetic experiments. Literature on *Tribolium* is so vast that a serial journal, *Tribolium Information Bulletin,* is needed to coordinate data; this bulletin is an excellent source for biological information on the genus. General discussions on the biology of pest tenebrionids have seldom been collected under a single cover. Two useful references are Lepesme (22) and Cotton (8). References to the biologies of individual genera or species are cited at the appropriate place in the determination key that follows.

Identification of adult darkling beetles associated with the food industry is rather simple because the species are scattered in several tribes and various genera. Because their general appearance is often quite distinct, they can usually be easily recognized by the habitus illustrations in Part 3 of this Handbook. Although some adults are quite small, the specific differences can often be seen with only a hand lens. Keys to adult tenebrionids in stored foods have been provided by Lepesme (22) and Freeman (*10*). Many generalized keys to species of tenebrionids have been published. Some of the more important are those by Blatchley (*1*) for Indiana, Boddy (*2*) for the Pacific Northwest of North America, Kaszab (*19*) for Central Europe, and Brendell (*3*) for the British Isles.

Larval tenebrionids (pl. 99A, 101A) are called false wireworms because of their resemblance to **wireworms**, the larvae of the Elateridae or **click beetles**. Identification of the larvae is not simple. Some larvae are quite small even when mature, and useful characters, such as setae, are occasionally missing. Some structures of the smaller species, such as legs, must be mounted on microscope slides. The most obvious and easily used character is the apex of the abdomen, segment IX. This can often be seen well enough with a strong hand lens. Unfortunately, larval tenebrionids have been only poorly studied. Not all tenebrionids are known in the larval stage and only a few keys to larvae have been published, two of the more important being Van Emden (*31*) for the British Isles and Hayashi (*17*) for Japan.

The key that follows is the first to deal with the larval tenebrionid pests that infest stored foods. Several species are unknown in the larval stage and therefore do not appear in the key to larvae; these are *Alphitobius viator, Apsena rufipes, Coelopalorus carinatus, C. foveicollis, Lepidocnemeplatia sericea, Palorinus humeralis, Palorus cerylonoides, P. ficicola, P. genalis,* and *P. laesicollis.* Information on distribution, food associations, and bibliographic references for each larval pest species may be found under the species name in the key to adults.

KEY

Drawings by C. Feller unless otherwise noted.

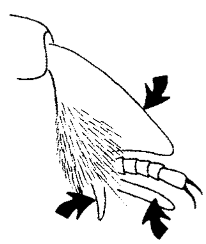
Adults

1 Adult specimens ---------- 2
Larval specimens ---------- 36

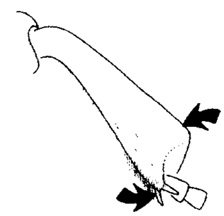
2 Tibia I extremely broad (width at apex almost as great as length); apical spurs of tibia I very long (one spur almost as long as tarsus I) (2A); body completely covered with scales or scalelike setae (so dense as to obscure the epidermis) (pl. 98A) ---------- *Lepidocnemeplatia sericea*

Distribution: western United States; associated with raisins, Mission figs, barley, milo, rice, various grains; also reported from cotton gin trash.

Tibia I narrow or moderately to broadly expanded apically (width at apex no more than ¼ length); spurs of tibia I short, not more than half as long as tarsus I (2B); body not covered with scales (at most covered with setae but epidermis never obscured) (pl. 1F) ---------- 3



2A *Lepidocnemeplatia sericea*



2B *Alphitobius diaperinus*

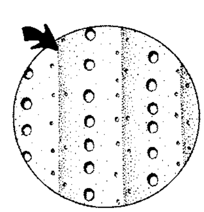
3 Elytra bicolored, yellowish-reddish, with 2 or more broad, transverse bands that are often incomplete (pl. 1F) ---------- **twobanded fungus beetle,** *Alphitophagus bifasciatus*

Distribution: cosmopolitan; associated with barley, beans, chick peas, milo, rice, wheat, mixed feeds, cornmeal (moist), cereals (spoiled), grain products; also reported from fungi, refuse grain, decaying vegetable matter. References: *7, 22*

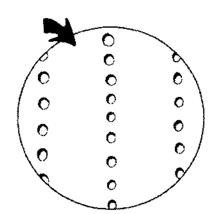
Elytra unicolored (sometimes with setae of different color than epidermis but epidermis of only one color) (pl. 98B) ---------- 4

4 Elytron with a fine (though distinct) longitudinal ridge on each lateral interval (4A) 5
Elytral intervals flat or convex, without ridges (4B), or only interval 7 with a coarse, longitudinal ridge (pl. 104A) ---------- 11

Drawings by A.D. Cushman.



4A *Tribolium audax*



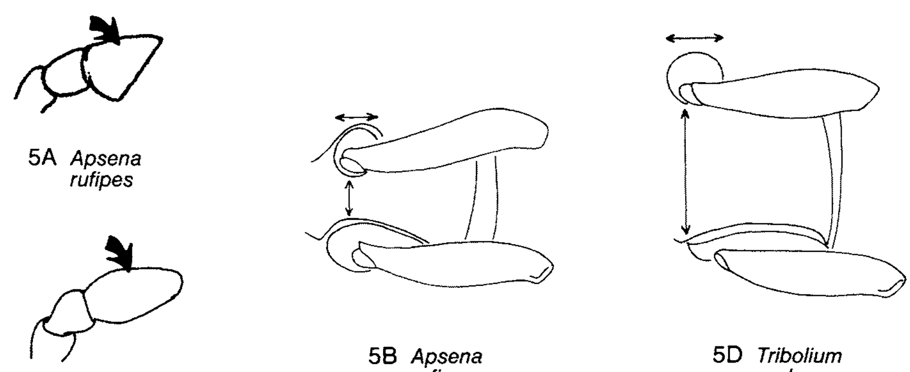
4B *Platydema ruficorne*

5 Maxillary palpus with apical segment broadly triangular (5A); metasternum short (distance between coxa II and coxa III less than diameter of coxa II) (5B); elytra with lateral borders rounded or arcuate (pl. 98B)
-- fig engraver beetle, *Apsena rufipes*

Distribution: California; associated with raisins, figs (in field and storage).

Maxillary palpus with apical segment parallel-sided or narrowed distally (5C); metasternum long (distance between coxa II and coxa III at least twice diameter of coxa II) (5D); elytra with lateral borders parallel or subparallel (pl. 98C). Genus *Tribolium* 6

References: *11, 18, 27.*
Drawings by A.D. Cushman and C. Feller.



5A *Apsena rufipes*

5C *Tribolium audax*

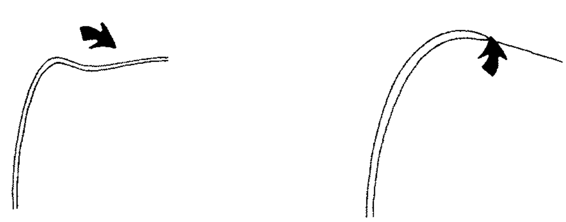
5B *Apsena rufipes*

5D *Tribolium audax*

6 Pronotum with lateral bead continuous with anterior bead (6A); pl. 98C
--- giant flour beetle, *Tribolium brevicorne*

Distribution: western Canada and western United States; associated with oats, chicken feed, mixed feeds, honey comb; also reported from nest of leaf-cutting bees. References: *26, 29.*
Drawings by A.D. Cushman and C. Feller.

Pronotum with lateral bead reaching only to corner, then seeming to disappear under anterior border (6B)-- 7



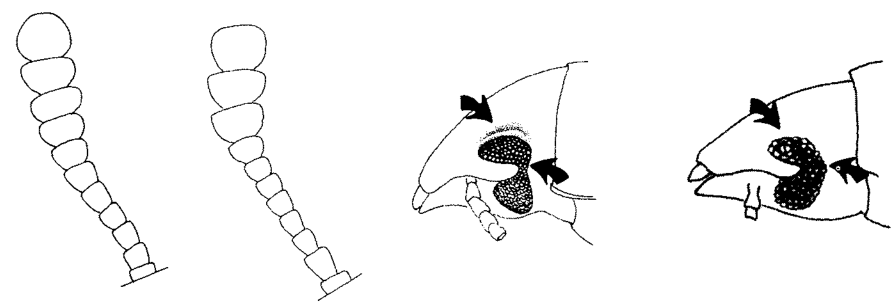
6A *Tribolium brevicorne*

6B *Tribolium audax*

7 Antenna clavate (7A); head with carina over eye; eye divided or deeply constricted (eye at narrowest point without facets or with 1 or 2 facets) (7B)---------------------- 8

Antenna capitate (7C); head without carina over eye; eye with shallow constriction (eye at narrowest with at least 4 facets) (7D)-- 9

Drawing 7D by A.D. Cushman.



7A *Tribolium confusum* 7C *Tribolium audax* 7B *Tribolium confusum* 7D *Tribolium audax*

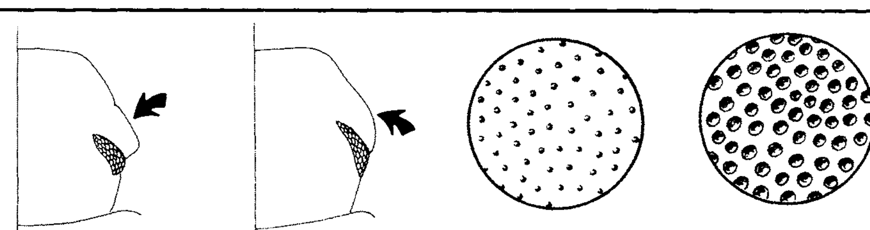
8 Epistoma subangulate at eye (8A); with small punctures centrally on pronotum (8B) and in elytral striae; pronotum widest anterior to half-length (pl. 99B)
-- **confused flour beetle,** *Tribolium confusum*

Distribution: cosmopolitan (but more common in temperate and northern regions); associated with wheat, wheat bran, cracked wheat, flour, graham flour, corn, cornmeal, corn starch, oats, oatmeal, oat flour, beans, rice, broad beans, barley, rye, safflower meal, breakfast cereals, grains, grain products, peanuts, pecans, cashews, almonds, walnuts, orris root, baking powder, cacao, chocolate, powdered milk, ginger, cayenne pepper, raisins, dried fruit, dried vegetables, beet pulp, biscuit; also reported from cottonseed, cottonseed meal, cottonseed hulls, vetch seed, snuff, dried insects. References: *5, 8, 11, 22, 29*. See also 7A&B.

Epistoma rounded at eye (8C); with large punctures centrally on pronotum (8D) and in elytral striae; pronotum widest at half-length (pl. 98D)
--false black flour beetle, *Tribolium destructor*

Distribution: Africa, Europe, North America; associated with flour, bran, groats, rolled oats, semolina, alfalfa meal, sunflower seeds, grains, poultry feed, mixed feeds; also reported from cotton, wool, animal products. References: *11, 29*.

Drawings 8A&C by A.D. Cushman and C. Feller; 8B&D by A.D. Cushman.



8A *Tribolium confusum* 8C *Tribolium destructor* 8B *Tribolium confusum* 8D *Tribolium destructor*

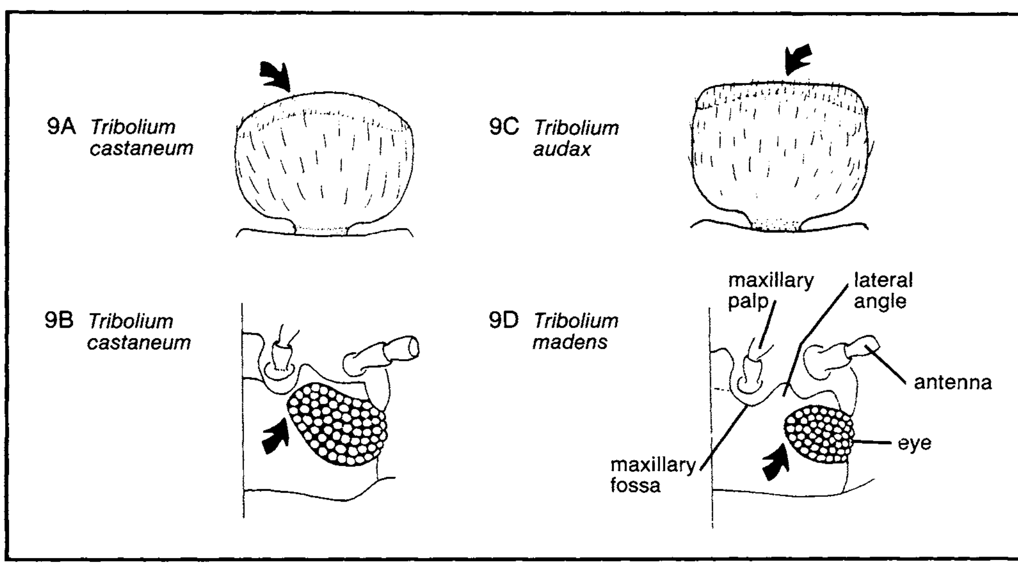
9 Apical antennal segment strongly arcuate (9A); eye large, extending medioventrally nearly to maxillary fossa (9B); pl. 99C -------------- **red flour beetle,** *Tribolium castaneum*

Body color: reddish brown. Distribution: cosmopolitan (in North America more common in southern areas); associated with corn, wheat, wheat bran, flour, rye, oats, milo, millet, barley, rice, grains (broken), grain products, mixed feeds, cereals, beans, peas, lentils, butter beans, peanuts, safflower seed, sunflower seed, ginger, mustard, chillies, cinnamon, nutmeg, cacao, copra, copra meal, yams, raisins, sultanas, dried figs, dried fruit, Brazil nuts, walnuts, almonds, cassava chips, orris root, tapioca, dog and cat food; also reported from flax, flax seed, grain spillage, alfalfa seed, snuff, derris root, oilcake, pineapple plants (decayed), cotton gin trash, lac. References: *8, 11, 22, 29.*

Drawings by A.D. Cushman.

Apical antennal segment subtruncate (9C); eye small, extending medioventrally no farther than to region behind lateral angle of maxillary fossa (9D) ------------------- 10

Body color: black or brownish black.

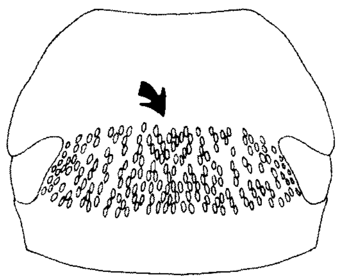


10 Many confluent punctures between eyes (10A); eye not extending medioventrally to region behind lateral angle of maxillary fossa (10B); body slender (pl. 100A) --- **American black flour beetle,** *Tribolium audax*

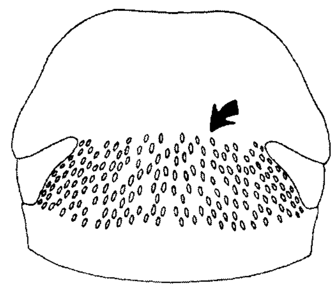
Distribution: North America; associated with wheat, flour, barley, grain, grain products; also reported from bee nests and in logs. References: *11, 15, 29.* See also 4A, 5C&D, 9C.

No confluent punctures between eyes (10C); eye extending medioventrally to region behind lateral angle of maxillary fossa (10D); body robust (pl. 100B) --- black flour beetle, *Tribolium madens*

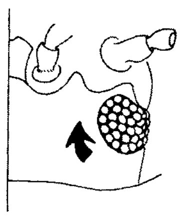
Distribution: Europe, North Africa; recently reported from Canada, USA; associated with flour, cornmeal, grains, seeds. References: *11, 29.*



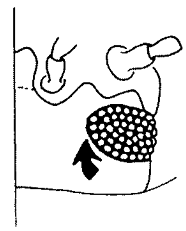
10A *Tribolium audax*



10C *Tribolium madens*



10B *Tribolium audax*



10D *Tribolium madens*

11 Length 10 to 25 mm ---------- 12
Length 3 to 7 mm ---------- 14

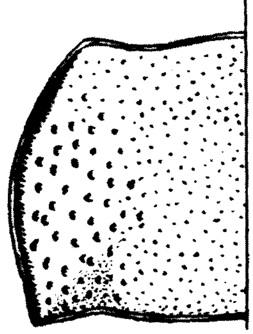
12 Pronotum with very large punctures laterally and small punctures overall (12A); pl. 100C ---------- *Neatus tenebrioides*

Distribution: North America; associated with grain, barley, cereals, cereal products; also reported from under bark of dead trees, squirrel nests, bumblebee nest.

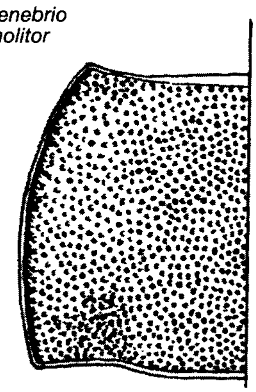
Drawings by A.D. Cushman.

Pronotum with large and small punctures overall (12B) ---------- 13

12A *Neatus tenebrioides*



12B *Tenebrio molitor*



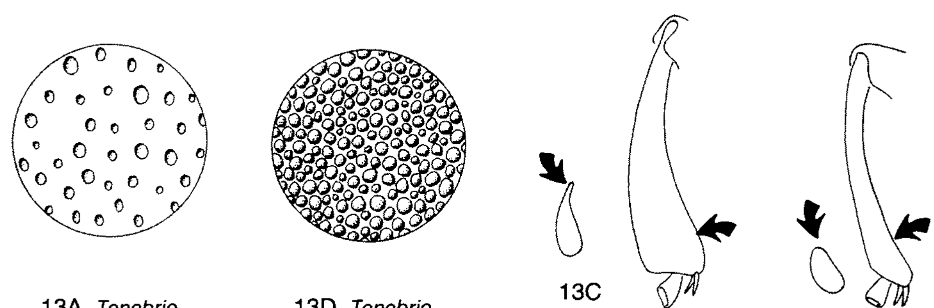
13 Pronotal punctures not contiguous (13A); tibia I moderately expanded apically (13B), with a sharp edge dorsally on apical half (13C); integument weakly shining; pl. 101C -- **yellow mealworm,** *Tenebrio molitor*

The exarate pupa of *T. molitor* is shown in pl. 101B. Distribution: cosmopolitan; associated with corn, cornmeal, oats, wheat bran, grain, mixed feeds, cereal products, bread, crackers, potatoes, dried fruits, meat; also reported from corn cobs, mill sweepings, tobacco, feathers, cotton gin trash. References: *8, 9, 22*. See also 12B.

Many pronotal punctures contiguous (13D); tibia I weakly expanded apically (13E), with blunt or rounded edge dorsally on apical half (13F); integument dull ("matte finish"); pl. 101D -- **dark mealworm,** *Tenebrio obscurus*

Distribution: cosmopolitan; associated with corn, flour, barley, grain, black pepper, mixed feeds, beet pulp; also reported from cottonseed, cottonseed meal, cotton gin trash, soda ash, phosphate fertilizers. References: *8, 9, 22.*

Drawings 13A&D by A.D. Cushman; 13B&C&E&F by A.D. Cushman and C. Feller.



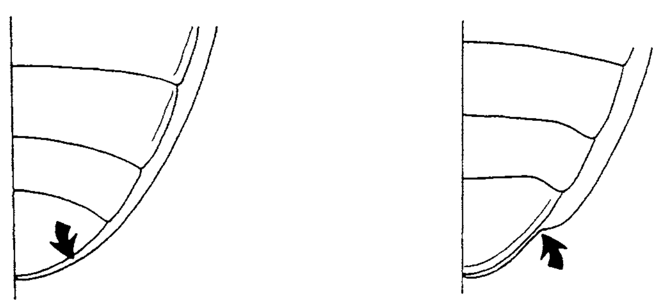
13A *Tenebrio molitor*

13D *Tenebrio obscurus*

13C 13B *Tenebrio molitor*

13F 13E *Tenebrio obscurus*

14 Elytron with pseudopleuron gradually narrowed, sometimes reaching apex (14A) - 15
Elytron with pseudopleuron abruptly abbreviated before apex (14B) -------------------- 30



14A *Platydema ruficorne*

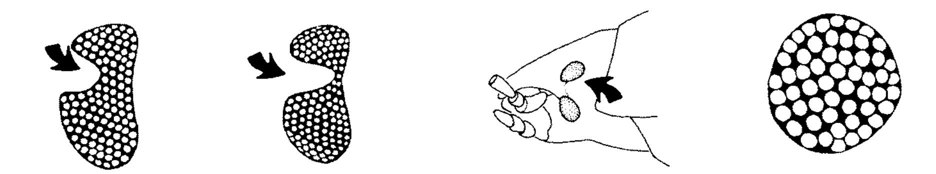
14B *Sitophagus hololeptoides*

15 Body broad and oval (lateral borders strongly curved); dorsal surface satiny black and hairless (pl. 100D) ---------------------------redhorned grain beetle, *Platydema ruficorne*

Distribution: eastern North America; associated with corn, shelled corn, corn shorts, grain (damp, moldy). See also 4B, 14A.

Body elongate (lateral borders almost parallel-sided); dorsal surface shiny, weakly shiny, or hairy (pl. 103A) -- 16

16 Length 5 to 7 mm; eye emarginate (16A, 16B) or divided (16C) -------------------------- 17
Length 3 to 3.5 mm; eye entire (16D) -- 22

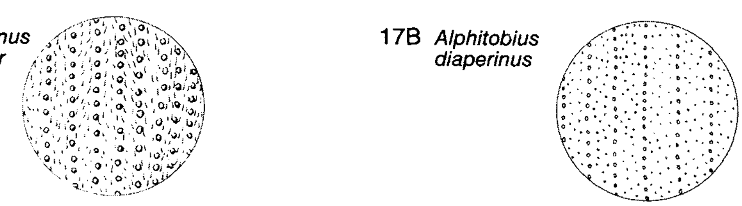


16A *Alphitobius diaperinus* 16B *Alphitobius laevigatus* 16C *Blapstinus discolor* 16D *Palorus subdepressus*

17 Dorsum with dense recumbent setae (17A); pl. 102A
-- fig darkling beetle, *Blapstinus discolor*

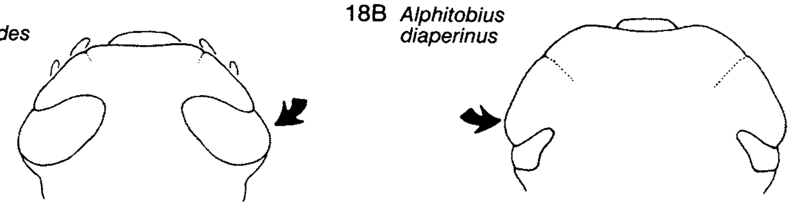
Distribution: western Canada (British Columbia) and USA (California, Idaho, Nevada, Oregon, Utah, Washington); associated with figs, grapes, raisins, peaches, persimmons, strawberries, dried fruits, tomatoes, sugar beets, peppers, beans. See also 16C.

Dorsum without setae (17B) -- 18



17A *Blapstinus discolor* 17B *Alphitobius diaperinus*

18 Head widest at eyes; eyes large, separated by distance subequal to width of eye (18A) 19
Head widest anterior to eyes; eyes small, separated by distance greater than 3 times width of eye (18B) --- 20



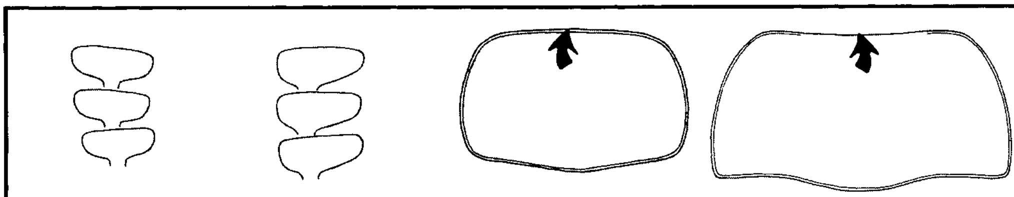
18A *Palembus dermestoides* 18B *Alphitobius diaperinus*

19 Antenna with broad segments symmetrical (19A); pronotum with anteromedial bead (19B); pl. 102B ---------- *Palembus ocularis*

Distribution: pantropical, USA (Florida); associated with corn, oats, wheat, fish meal, yeast; also reported from seed pods of *Tamarindus indicus* and *Cassia* spp., on fruits of wild banana and okra. Reference: *16.*

Antenna with broad segments moderately asymmetrical (19C); pronotum without anteromedial bead (19D); pl. 102C ---------- *Palembus dermestoides*

Distribution: pantropical; associated with corn, cornmeal, wheat flour, oats, rice bran, peanuts, nuts, dried yeast, yeast extract, sucrose, pollen, royal jelly, bread, apples; also reported from lotus and jujube fruits; reared as oriental medicine on herbs. References: *16, 30.* See also 18A.

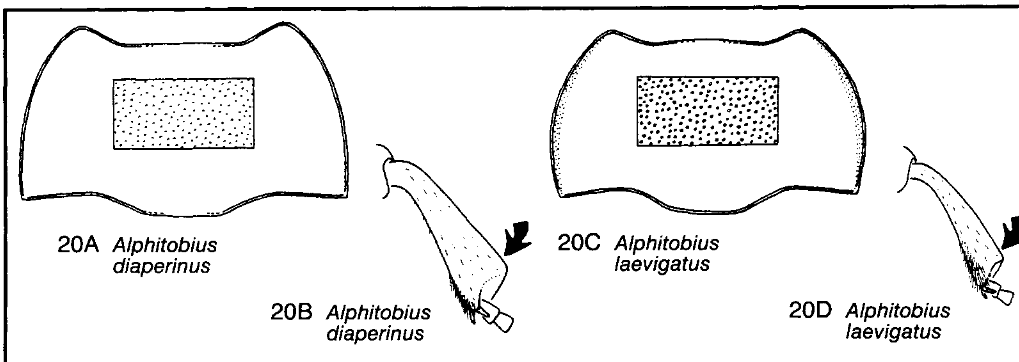


19A *Palembus ocularis* 19C *Palembus dermestoides* 19B *Palembus ocularis* 19D *Palembus dermestoides*

20 Body shiny; pronotum with small punctures separated by a distance much greater than diameter of one puncture (20A); tibia I broadly expanded apically (20B); pl. 103A ---------- **lesser mealworm,** *Alphitobius diaperinus*

Distribution: cosmopolitan; associated with wheat, broken wheat, flour, barley, oatmeal, rice, grain (damp and moldy), cereals, cereal products, mixed feeds, peanuts, soy beans, black gram (urd), cowpeas, copra, cacao, chocolate, sweet potatoes, biscuits, cassava chips, manioc roots; also reported from flax seed, linseed, cottonseed, oilseed products, gum dammar, drugs, tobacco, silkworm cocoons, skins, bones, poultry litter, bat caves. References: *21, 22.* See also 16A, 17B, 18B.

Body dull; pronotum with large punctures usually separated by a distance no greater than diameter of one puncture (20C); tibia I moderately (20D) or weakly expanded apically ---------- 21



20A *Alphitobius diaperinus* 20B *Alphitobius diaperinus* 20C *Alphitobius laevigatus* 20D *Alphitobius laevigatus*

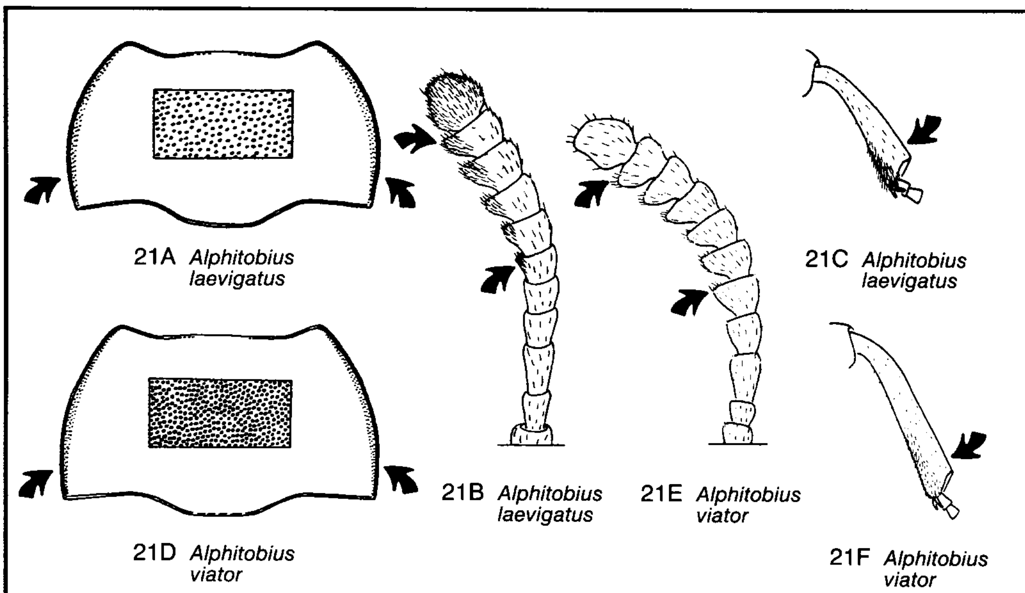
21 Pronotum with lateral borders distinctly narrowed toward posterior angles; pronotal punctures less dense (21A); antenna with segments VI to X asymmetrically expanded apically (21B); tibia I moderately expanded apically (21C); pl. 103B
-- **black fungus beetle,** *Alphitobius laevigatus*

Distribution: cosmopolitan; associated with wheat bran, grain, damp and moldy grain, cereals, cereal products, nuts, dried fruits, legumes, spices, peanuts, mixed feeds, copra, cacao, sugar beets, illupe nuts; also reported from cottonseed, poultry litter, bat caves, animal products, oilseeds and products. Reference: *22*. See also 16B.

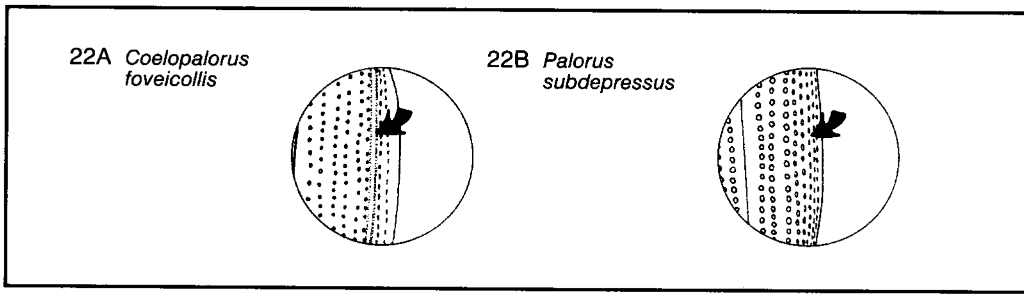
Pronotum with lateral borders subparallel toward posterior angles; pronotal punctures more dense (21D); antenna with segments V to X asymmetrically expanded toward apex (21E); tibia I weakly expanded apically (21F); pl. 103C
-- *Alphitobius viator*

Distribution: tropical Africa; associated with ginger roots, chili peppers, corn; also reported from bones. Reference: *12*.

20A and 21A&D redrawn from *12*.


21A *Alphitobius laevigatus*
21B *Alphitobius laevigatus*
21C *Alphitobius laevigatus*
21D *Alphitobius viator*
21E *Alphitobius viator*
21F *Alphitobius viator*

22 Elytron with interval 7 carinate (22A; pl. 104A&B) -- 23
Elytron with interval 7 rounded or flat (22B; pl. 105A-C)------------------------------------- 24

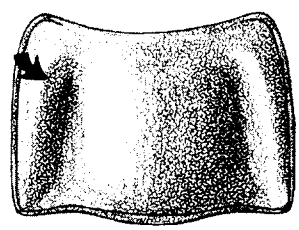

22A *Coelopalorus foveicollis*
22B *Palorus subdepressus*

23 Pronotum with deep lateral depressions (23A); pl. 104A --------------*Coelopalorus foveicollis*

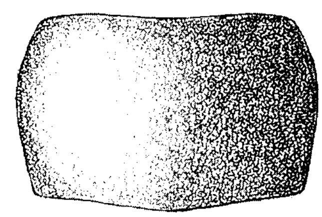
Distribution: Oriental Region; imported into East Africa, Trinidad, USA (Alabama, Hawaii); associated with corn, wheat shorts, copra, grain products, cowpeas, illupe nuts, sago flour, peanut cake, cassava chips; also reported from cattle feed, spillage in rice stores, beetle burrows in logs. References: *13, 14.* See also 22A.

Pronotum without lateral depressions (23B); pl. 104B------------------*Coelopalorus carinatus*

Distribution: Oriental Region; associated with betel nuts, illupe nuts, rice. Reference: *13.*



23A *Coelopalorus foveicollis*

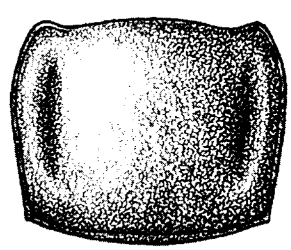


23B *Coelopalorus carinatus*

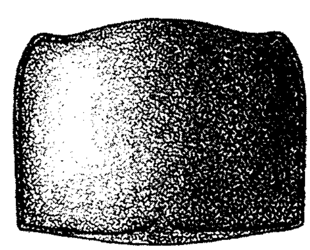
24 Pronotum with deep lateral depressions (24A); pl. 105B----------------------*Palorus laesicollis*

Distribution: Africa; associated with corn (broken kernels), oats; also reported from corn cobs, under bark. References: *13, 14.*

Pronotum without lateral depressions (24B)--- 25



24A *Palorus laesicollis*

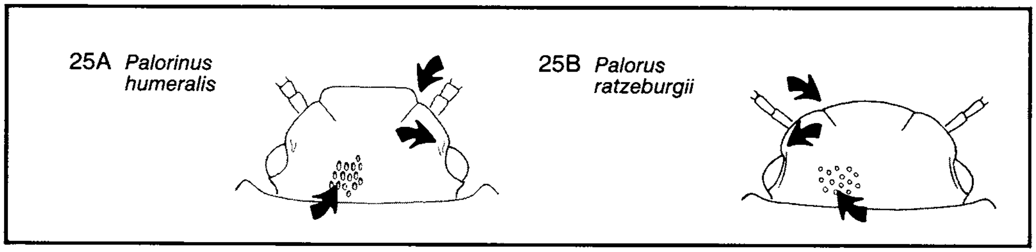


24B *Palorus subdepressus*

25 Head without fine carina (though sometimes with wrinkles) adjacent to top of eye; clypeogenal suture ending posterior to lateral borders; punctures between eyes dense, deep, usually oval (25A)---*Palorinus humeralis*

Distribution: Oriental Region; associated with nutmeg, sago flour. Reference: *13.*

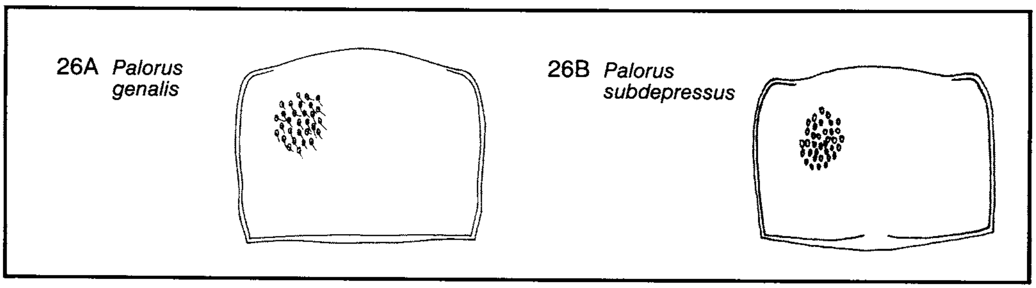
Head with fine carina adjacent to top of eye; clypeogenal suture ending within anterior border or at junction of anterior and lateral borders; punctures between eyes, when dense, are round and not deep (25B) -- 26



26 Pronotal punctures with setae (26A)---*Palorus genalis*

Setae often abraded from medial pronotal punctures. Distribution: Oriental Region; imported into Africa, Central America, West Indies; associated with rice, nutmeg, cassava, illupe nuts, sago flour, tapioca, peanut cake, ginger, beans (cattle feed). Reference: *13.*

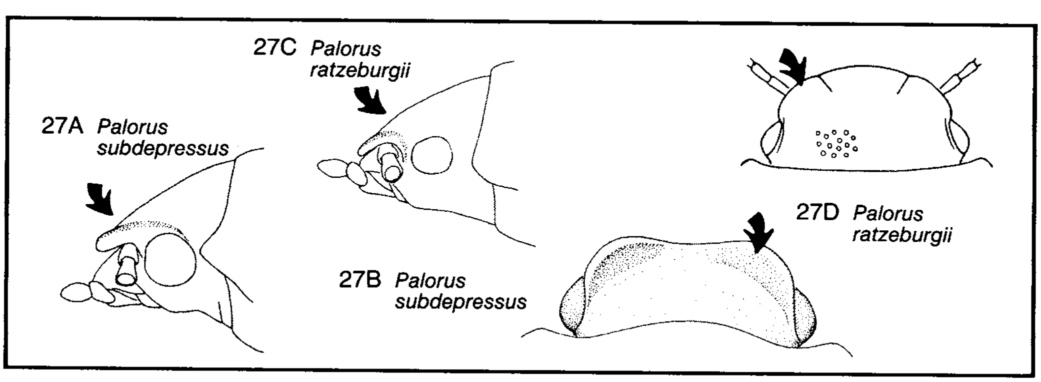
Pronotal punctures without setae (26B)--- 27



27 Clypeus with borders strongly raised laterally and dorsally to antennal insertions, causing a distinct depression posterior to border (27A, 27B); pl. 105A
--- **depressed flour beetle,** *Palorus subdepressus*

Distribution: cosmopolitan; associated with wheat, rice, sorghum, corn, pollards, sago flour, grain, mixed feeds, peanuts, beans (cattle feed), betel nuts, illupe nuts, ginger, pepper, copra, cacao; also reported from flax seed, under bark of logs. References: *13, 22.* See also 16D, 22B, 26B.
27B redrawn from *13.*

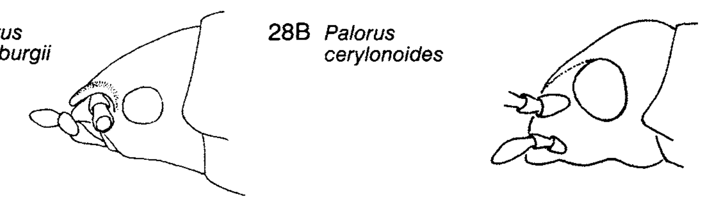
Clypeus with border at most slightly thickened (not strongly raised) laterally and dorsally to antennal insertions, with depression posterior to border vague or shallow (27C, 27D)--- 28



28 Eye small (28A); pl. 105C---------------------------**smalleyed flour beetle,** *Palorus ratzeburgii*

Distribution: cosmopolitan; associated with flour, corn, barley, rice, cereals, cereal products, grain, grain products, bread, peanuts, cassava meal, caraway seeds, macaroni, semolina, rolled oats, split peas, lentils, sago, tapioca, dried milk, almonds, dried apricots, powdered ginger; also reported from linseed seeds and cakes. References: *4, 13, 14, 22.* See also 27D.

Eye large (28B) -- 29


28A *Palorus ratzeburgii* 28B *Palorus cerylonoides*

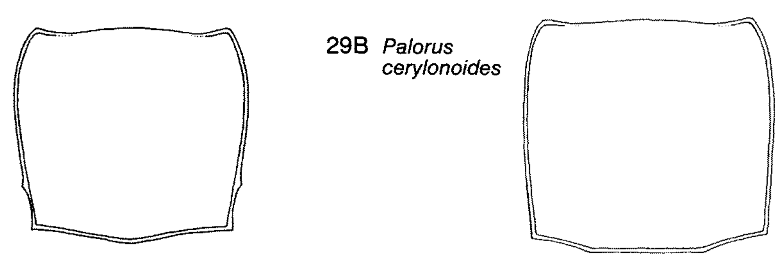
29 Pronotum with lateral borders moderately to strongly convergent to base (29A) -- *Palorus ficicola*

Distribution: Africa; associated with wheat, peanuts, sorghum; also reported from rice store spillage. Reference: *13.*

Pronotum with lateral borders subparallel to weakly convergent to base (29B) --*Palorus cerylonoides*

Distribution: Africa, Oriental Region; associated with illupe nuts, rice, flour mills; also reported from under bark of trees. Reference: *13.* See also 28B.

29A&B redrawn from *13.*


29A *Palorus ficicola* 29B *Palorus cerylonoides*

30 Length at least 6.5 mm; ridge of pseudopleuron easily visible in dorsal view (30A) 31
Length less than 4 mm; ridge of pseudopleuron hidden in dorsal view (30B)------- 32


30A *Cynaeus angustus* 30B *Latheticus oryzae*

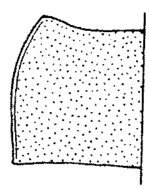
31 Pronotum covered with fine punctures (31A); apex of antenna surpassing base of pronotum by length (or more) of last segment (pl. 106A)--------*Sitophagus hololeptoides*

Surface shiny; males only with epistoma curved dorsally into 2 broad horns (pl. 106A) (epistoma simple in females). Distribution: Central America, Madeira, Mexico, Panama, South America, USA (Arizona, California, Florida, Texas), West Indies; associated with corn, cereals, nutmeg, cacao, copra, avocados, limes, tomatoes, peanuts, yams; also reported from gumbo-limbo and *Pinus ponderosa*. Reference: *22.*. See also 14B.

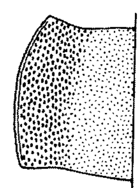
Pronotum with coarse punctures laterally and fine punctures medially (31B); apex of antenna falling short of pronotal base by the length (or more) of last 2 segments (pl. 103D)--**larger black flour beetle,** *Cynaeus angustus*

Both sexes with simple, unarmed epistoma (pl. 103D). Distribution: North America; associated with wheat, flour, corn, oats, rolled oats, barley, sorghum, grain, cereal products, flaked soybeans, dried figs; also reported from corn cobs. Reference: *20.* See also 30A.

31A *Sitophagus hololeptoides*



31B *Cynaeus angustus*



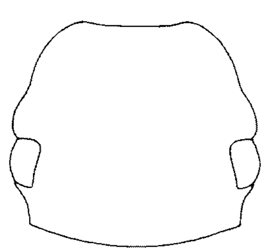
32 Length of head before eyes much greater than ½ distance between eyes (32A); antenna short (length less than distance between eyes) (pl. 104C) ---**longheaded flour beetle,** *Latheticus oryzae*

Mandibles unarmed. Distribution: cosmopolitan; associated with wheat, flour, corn, rye, barley, rolled barley, milo, rice, grain products, cereals, mixed feeds, beans, raisins, cassava chips, oatmeal, bran, tea. References: *6, 22, 24.* See also 30B.

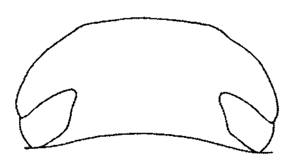
Length of head before eyes not greater than ½ distance between eyes (32B); antenna long (length more than 1.5 times distance between eyes) (pl. 106B). Genus *Gnatocerus*--- 33

Mandibles armed only in males (see 34A&B). Reference: *27.*

32A *Latheticus oryzae*



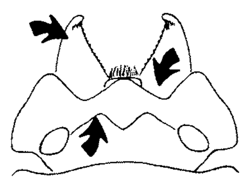
32B *Gnatocerus cornutus*



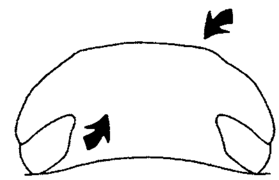
33 Males; mandibles with horns; head with 2 or 4 tubercles between eyes; epistoma incised anteriorly (accommodating dorsally projected mandibular horns) (33A; pl. 106B&C)-- 34

Females; mandibles without horns; head without tubercles between eyes; epistoma not incised (33B)-- 35

33A *Gnatocerus cornutus* ♂



33B *Gnatocerus cornutus* ♀



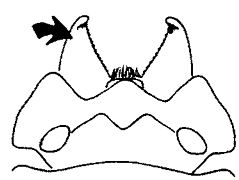
34 Mandibular horns broad and finely serrate (34A); pl. 106B
--**broadhorned flour beetle,** *Gnatocerus cornutus*

Distribution: cosmopolitan; associated with flour, bran, corn, cornmeal, farina, semolina, pancake flour, oatmeal, rolled barley, milo, rice, flaked rice, cereal, cereal products, mixed feeds, cacao, ginger, spices, army biscuit, bread, dog biscuit, yeast cakes; also reported from beet seed, cottonseed meal cake, pyrethrum flowers, rotenone powder, bone meal, animal products, cotton gin trash. References: *22, 23, 25, 28.*

Mandibular horns slender and simple (34B); pl. 106C
---**slenderhorned flour beetle,** *Gnatocerus maxillosus*

Distribution: cosmopolitan; associated with wheat, corn, cornmeal, rice, mixed feeds, peanuts, nutmeg; also reported from tamarind pods, pumpkin seeds. Reference: *22.*

34A *Gnatocerus cornutus* ♂



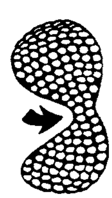
34B *Gnatocerus maxillosus* ♂

35 Eye deeply incised (composed of only 1 or 2 facets at narrowest) (35A)
--**broadhorned flour beetle,** *Gnatocerus cornutus*

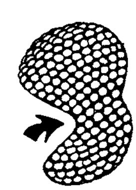
Eye moderately incised (composed of more than 2 facets at narrowest) (35B)
---**slenderhorned flour beetle,** *Gnatocerus maxillosus*

Drawings by A.D. Cushman.

35A *Gnatocerus cornutus* ♀

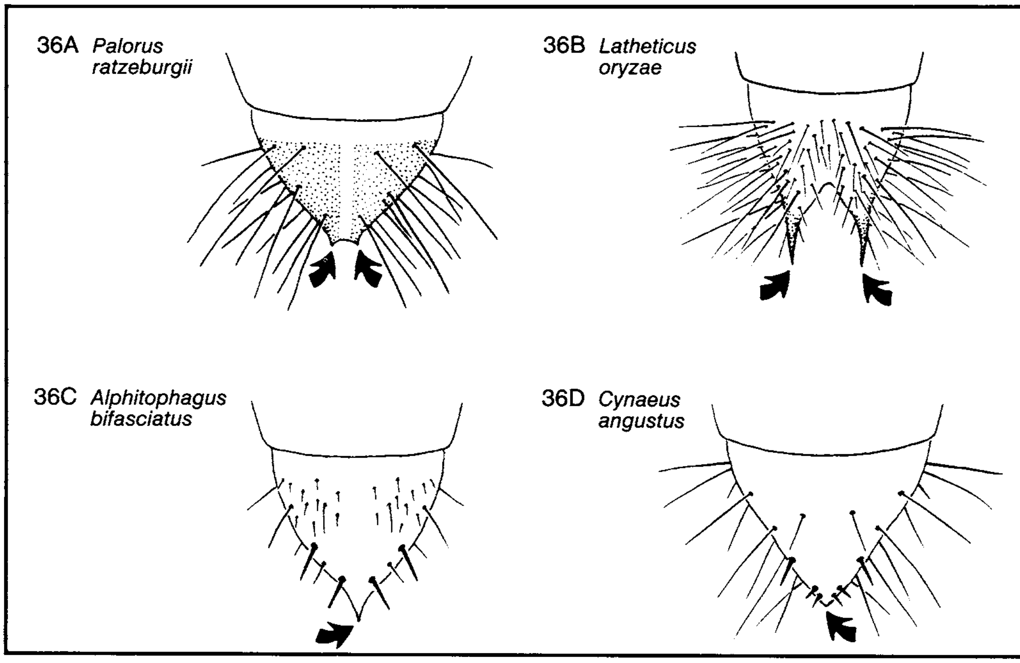


35B *Gnatocerus maxillous* ♀

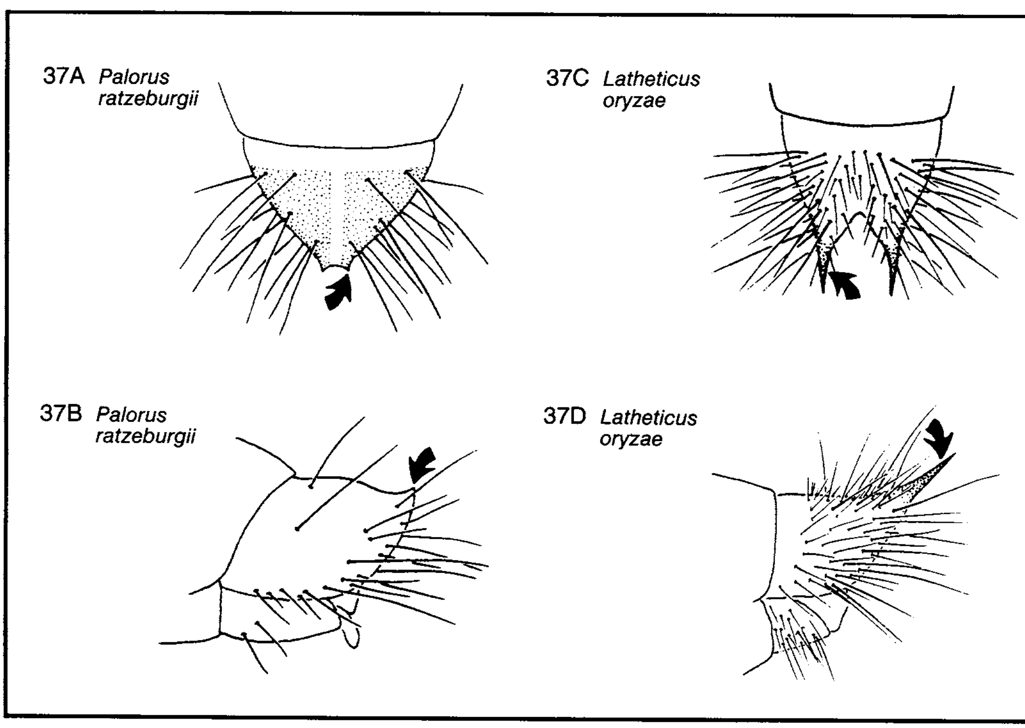


Larvae

36 Last abdominal tergum with 2 acute processes (urogomphi) (36A, 36B)---------------- 37
Last abdominal tergum narrowed to a single acute or blunt process (36C, 36D)--- 47



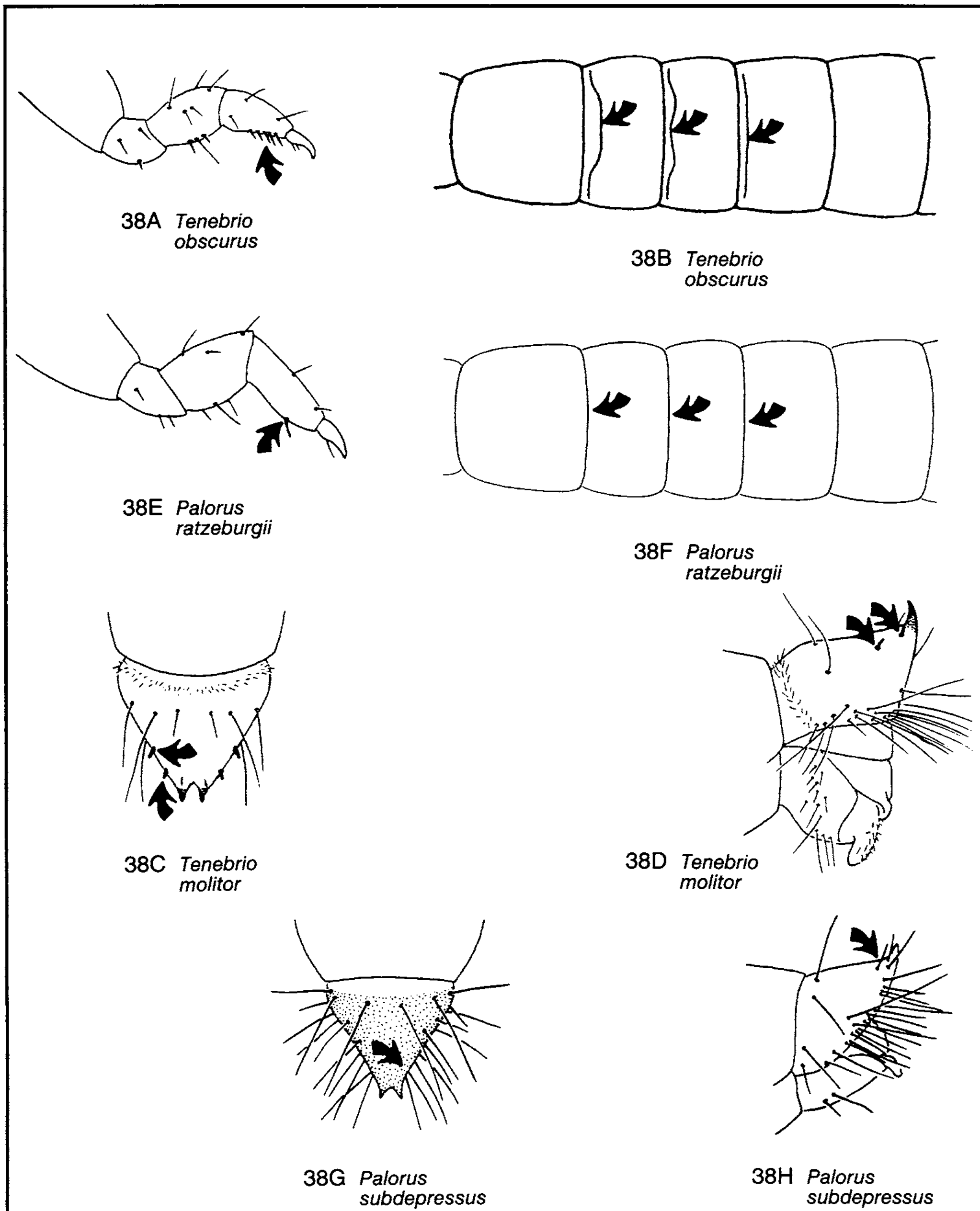
37 Urogomphus short (length approximately 1/5 or less length of last tergum including urogomphi) (37A, 37B)--- 38
Urogomphus long (length 1/3 to 2/3 length of last tergum including urogomphi) (37C, 37D)-- 41



38 Tibiotarsus I with 4 or 5 ventral setae (38A); thoracic terga II and III and abdominal tergum I each with distinct anterior transverse carina or raised line (38B); last abdominal tergum with 2 short stout setae on each side near base of urogomphi (38C, 38D)-- 39

Drawing 38B by A.D. Cushman.

Tibiotarsus I with 1 ventral seta (38E); thoracic terga II and III and abdominal tergum I without anterior transverse carina or raised line (38F); last abdominal tergum without short stout setae on each side (38G, 38H)-- 40

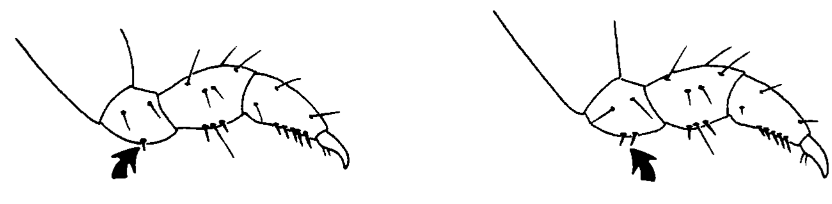


39 Trochanter I with 1 short stout ventral seta (39A)-----**dark mealworm,** *Tenebrio obscurus*

See also 38B.

Trochanter I with 2 short stout ventral setae (39B); pl. 101A
---**yellow mealworm,** *Tenebrio molitor*

See also 38C&D.



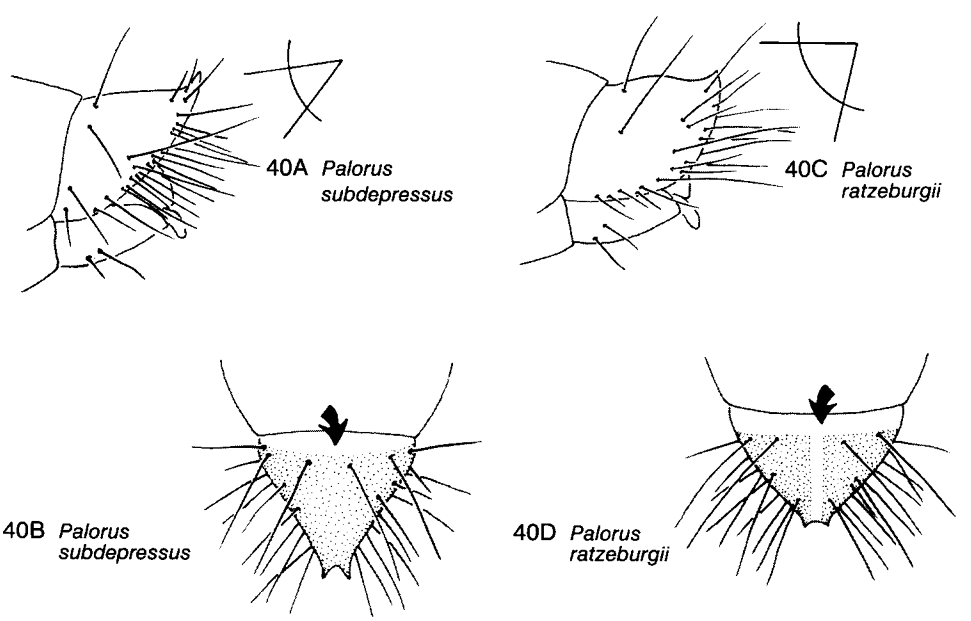
39A *Tenebrio obscurus*

39B *Tenebrio molitor*

40 Last abdominal tergum with area ventral to urogomphus inclined approximately 45° from horizontal (40A), with lateral borders moderately converging posteriorly (40B), and without a colorless longitudinal medial line (40B)
---**depressed flour beetle,** *Palorus subdepressus*

Last abdominal tergum with area ventral to urogomphus inclined approximately 70° from horizontal (40C), with lateral borders strongly converging posteriorly (40D), and with a colorless longitudinal medial line (40D)
---**smalleyed flour beetle,** *Palorus ratzeburgii*

See also 37A, 38E&F.



40A *Palorus subdepressus*

40C *Palorus ratzeburgii*

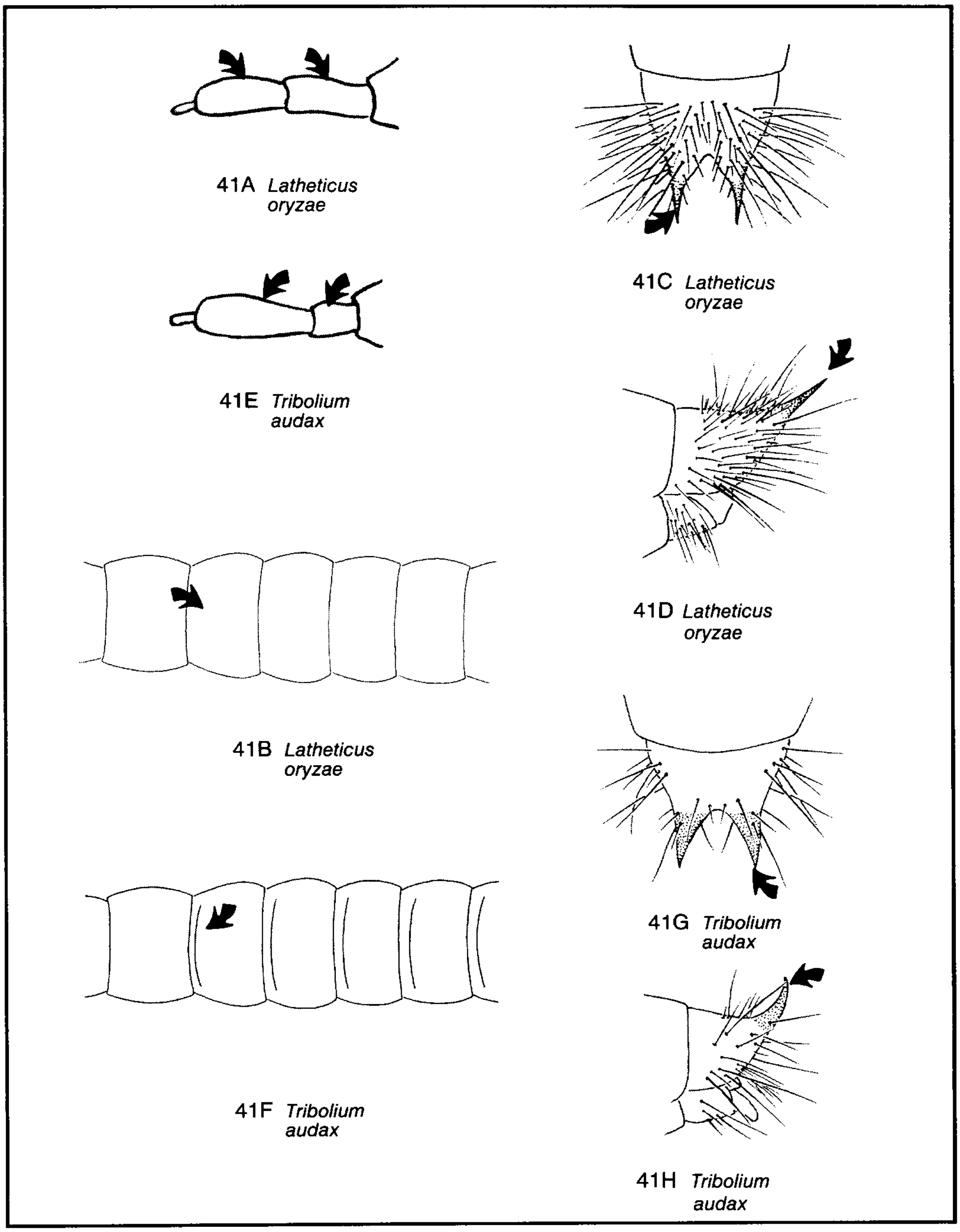
40B *Palorus subdepressus*

40D *Palorus ratzeburgii*

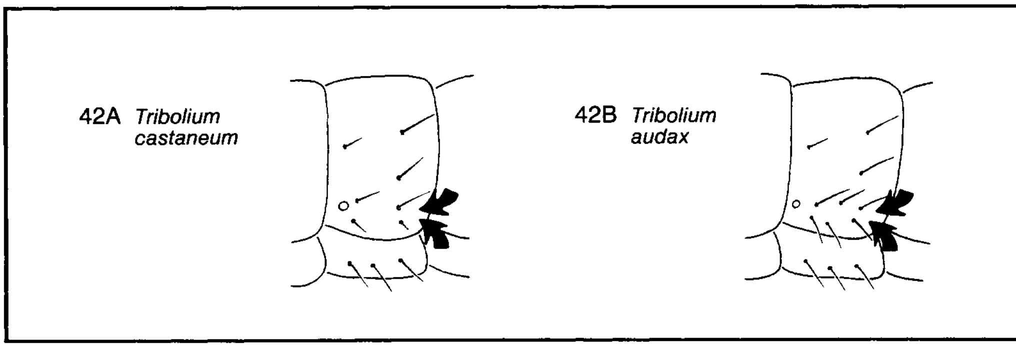
41 Antennal segments I and II subequal in length (41A); thoracic and abdominal terga lacking a distinct anterior transverse carina or raised line (41B); urogomphus light or white basally, dark apically (41C, 41D)----------**longheaded flour beetle,** *Latheticus oryzae*

Drawings 41A&E by A.D. Cushman.

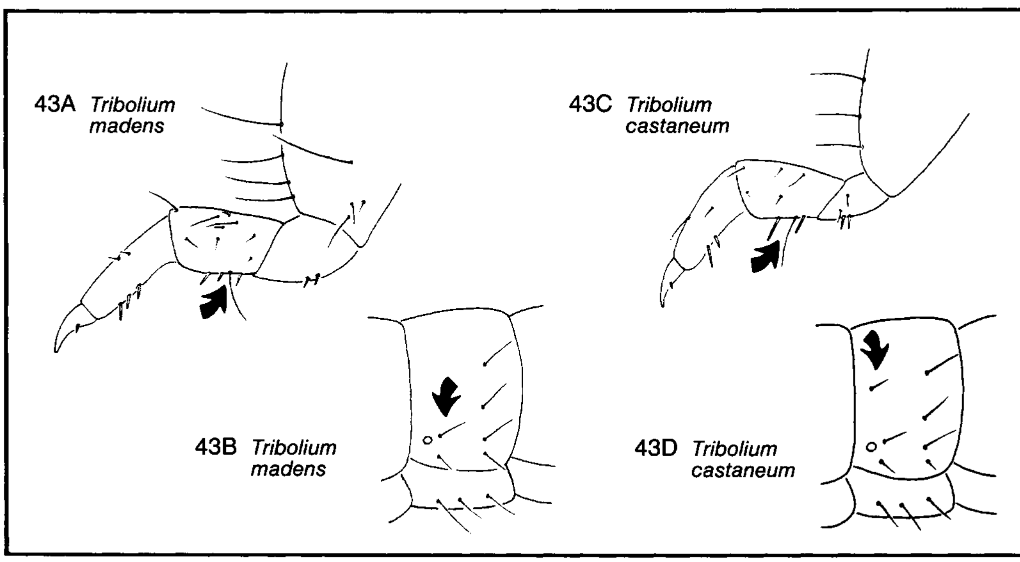
Antennal segment I approximately 1/2 as long as II (41E); thoracic tergum II through abdominal tergum VII each with a distinct anterior transverse carina or raised line (41F); urogomphus uniformly colored (41G, 41H)-- 42



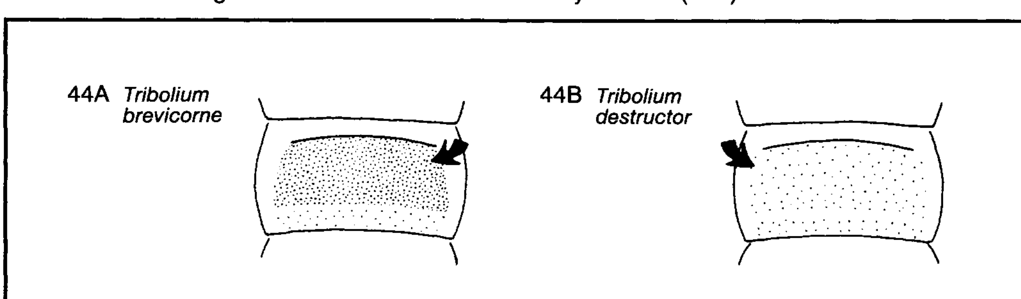
42 Abdominal segments I to IV each with 2 setae above and 2 below an imaginary line drawn posteriorly from spiracle (42A)---------- 43
Abdominal segments I to IV each with 3 setae above and 3 below line drawn posteriorly from spiracle (42B)---------- 44



43 Femur I with 4 ventral setae (43A); abdominal terga I to IV with 2 long setae on each side in anterior row of setae (43B)----------black flour beetle, *Tribolium madens*
Femur I with 3 ventral setae (43C); abdominal terga I to IV with 3 long setae on each side in anterior row of setae (43D)----------**red flour beetle,** *Tribolium castaneum*



44 Abdominal terga I to IV with sclerotized areas dark brown (44A)---------- 45
Abdominal terga I to IV with sclerotized areas yellowish (44B)---------- 46

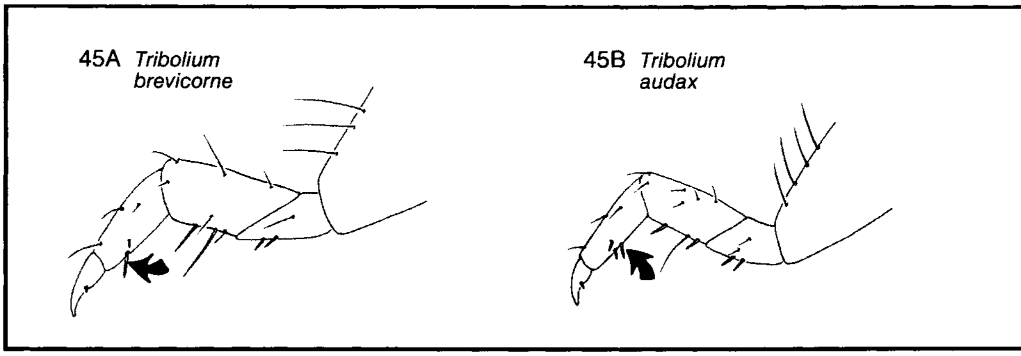


45 Tibiotarsus I with 1 ventral seta (45A)------------------giant flour beetle, *Tribolium brevicorne*

See also 44A.

Tibiotarsus I with 2 ventral setae (45B)-----**American black flour beetle,** *Tribolium audax*

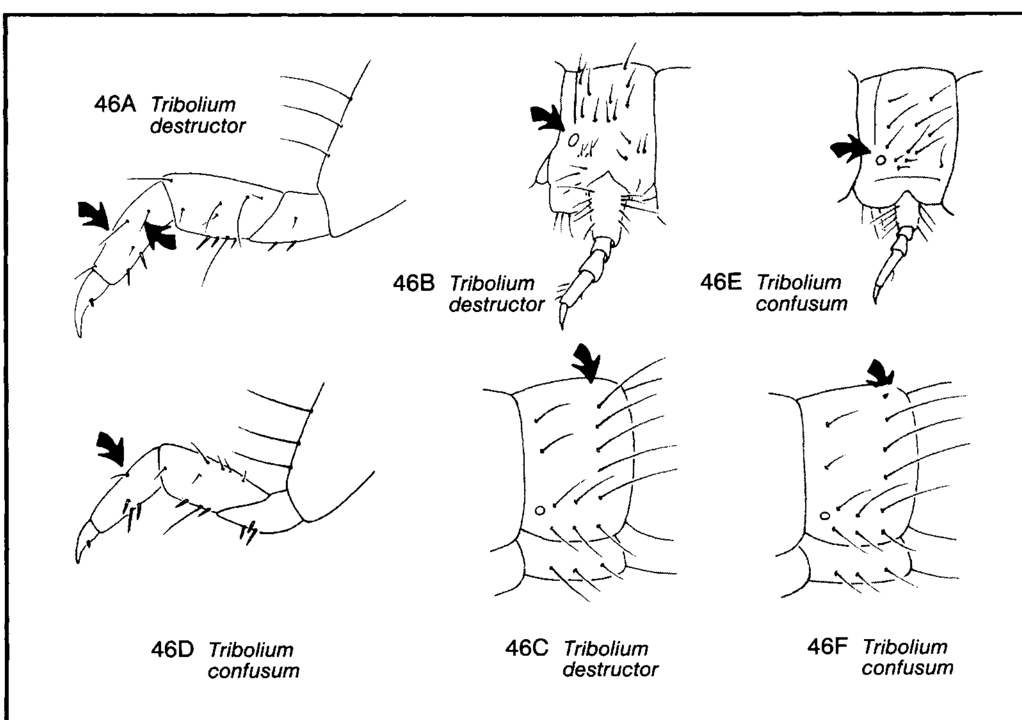
See also 41E-H, 42B.



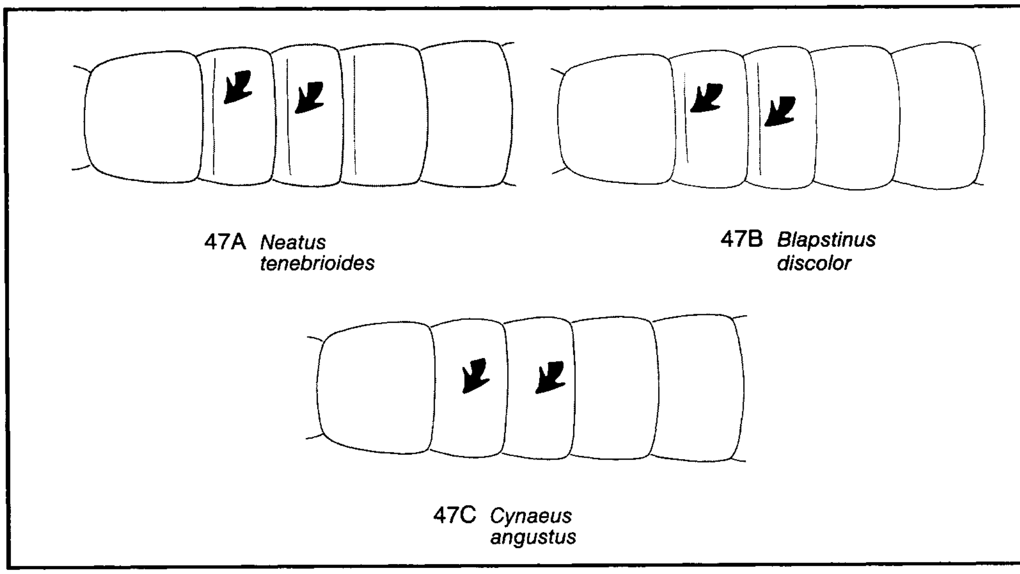
46 Tibiotarsus I with 2 posterodorsal setae (46A); mesothoracic spiracle oval (46B); abdominal terga I to IV with 6 or 7 long setae on each side in posterior row of setae (46C)--false black flour beetle, *Tribolium destructor*

See also 44B.

Tibiotarsus I with 1 posterodorsal seta (46D); mesothoracic spiracle round (46E); abdominal terga I to IV with 4 or 5 long setae on each side in posterior row of setae (46F); pl. 99A---**confused flour beetle,** *Tribolium confusum*



47 Thoracic terga II and III with distinct anterior transverse carina or raised line (47A, 47B)-- 48
Thoracic terga II and III without anterior transverse carina or raised line (47C)----- 51



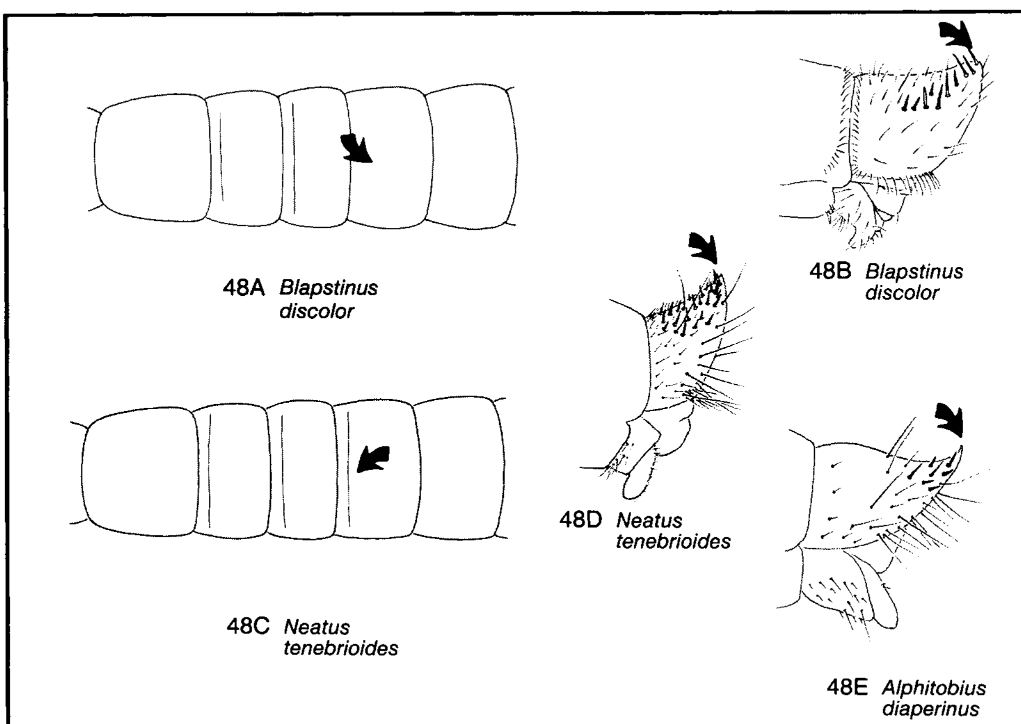
47A *Neatus tenebrioides*

47B *Blapstinus discolor*

47C *Cynaeus angustus*

48 Abdominal tergum I without anterior transverse carina or raised line (48A); tergum of last abdominal segment with blunt apex (48B)
---fig darkling beetle, *Blapstinus discolor*

Abdominal tergum I with a distinct anterior transverse carina or raised line (48C); tergum of last abdominal segment with acute apex (48D, 48E)----------------------- 49



48A *Blapstinus discolor*

48B *Blapstinus discolor*

48C *Neatus tenebrioides*

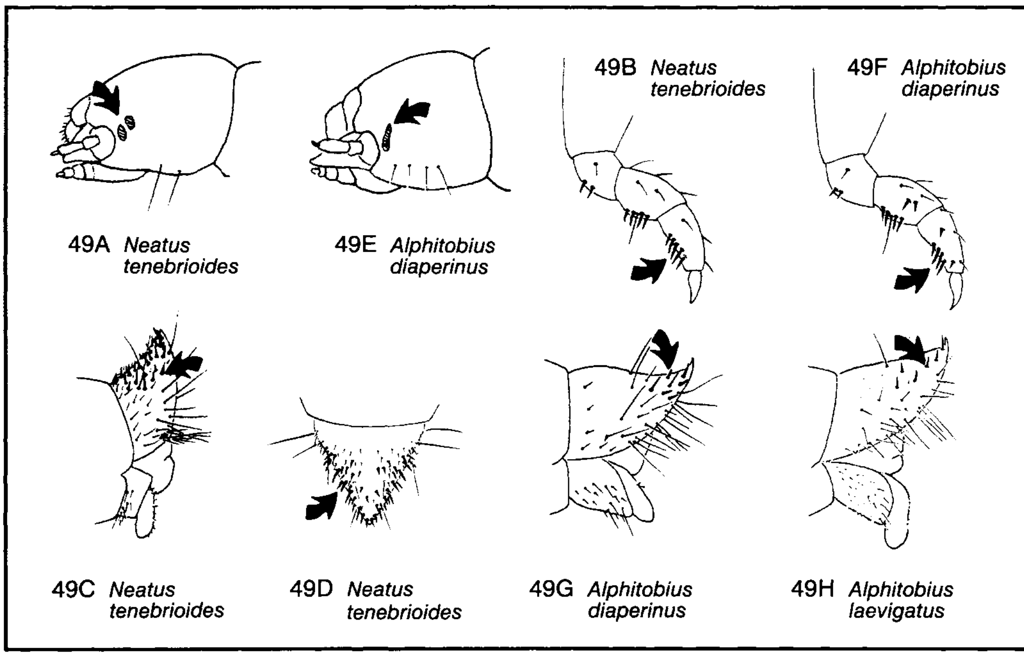
48D *Neatus tenebrioides*

48E *Alphitobius diaperinus*

49 Head with 2 eye spots on each side (49A); tibiotarsus I with 5 or more coarse setae ventrally and only long slender setae posteriorly (49B); last abdominal tergum with numerous short setae (approximately 15) on each side (49C, 49D)
--*Neatus tenebrioides*

See also 48B&C.
Drawings 49A&E by A.D. Cushman.

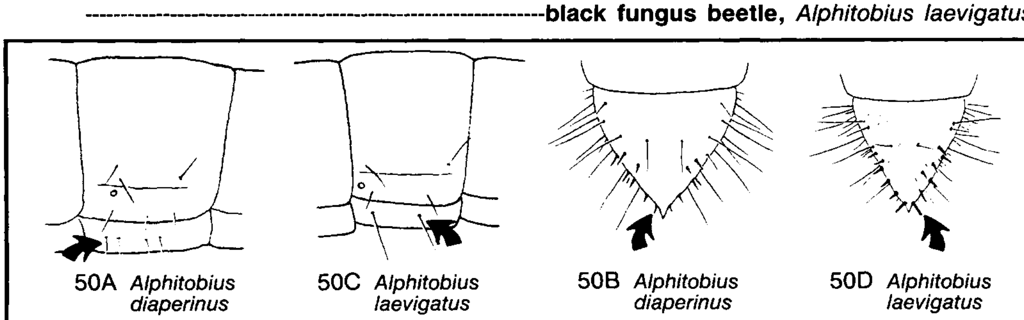
Head with 1 eye spot on each side (49E); tibiotarsus I with 4 or fewer coarse setae ventrally and at least 1 short thick seta in addition to long slender setae posteriorly (49F); last abdominal tergum with longer and fewer setae (approximately 6) on each side (49G, 49H)-- 50



50 Abdominal sterna II to VII with 3 or more setae laterally (50A); last abdominal tergum with seta adjacent to apex not extending to apex (50B; see also 49G)
--**lesser mealworm,** *Alphitobius diaperinus*

See also 49E&F.
Drawings 50A&C by A.D. Cushman.

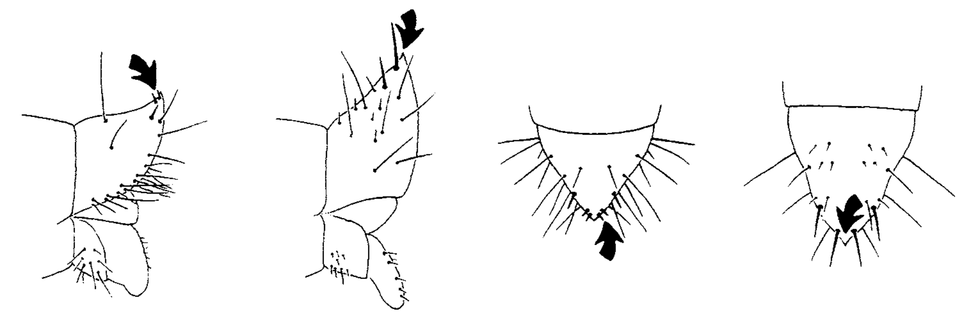
Abdominal sterna II to VII with 2 setae laterally (50C); last abdominal tergum with seta adjacent to apex or beyond (50D; see also 49H)
--**black fungus beetle,** *Alphitobius laevigatus*



51 Last abdominal tergum with a pair of short setae on each side near apex (51A, 51B) -- **larger black flour beetle,** *Cynaeus angustus*

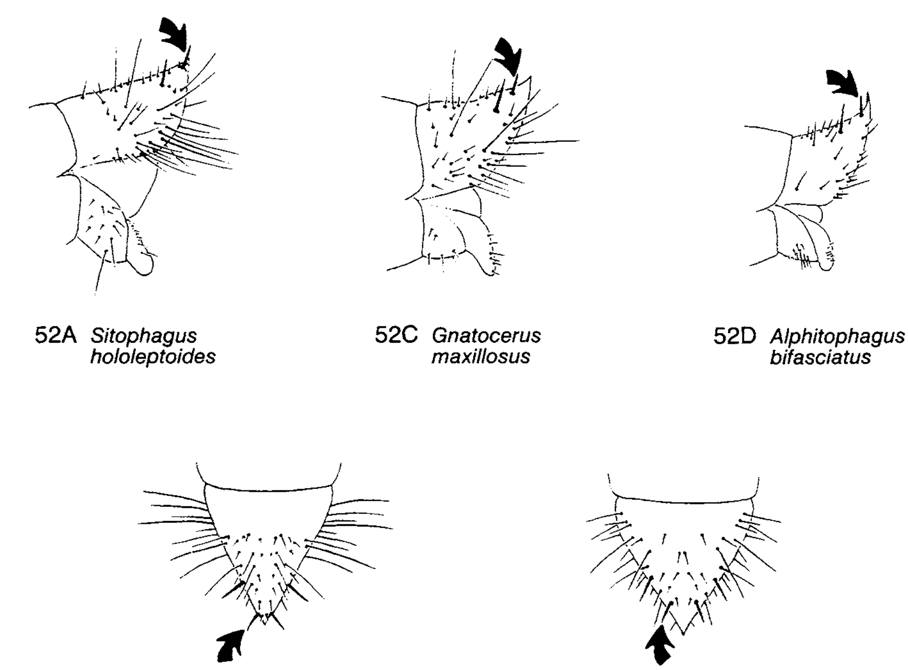
See also 47C.

Last abdominal tergum without a pair of short setae on each side near apex (51C, 51D) -- 52



51A *Cynaeus angustus*
51C *Platydema ruficorne*
51B *Cynaeus angustus*
51D *Platydema ruficorne*

52 Last abdominal tergum with posterolateral seta far surpassing apex (52A, 52B)--- 53
Last abdominal tergum with posterolateral seta not surpassing apex (52C, 52D, 52E) -- 54



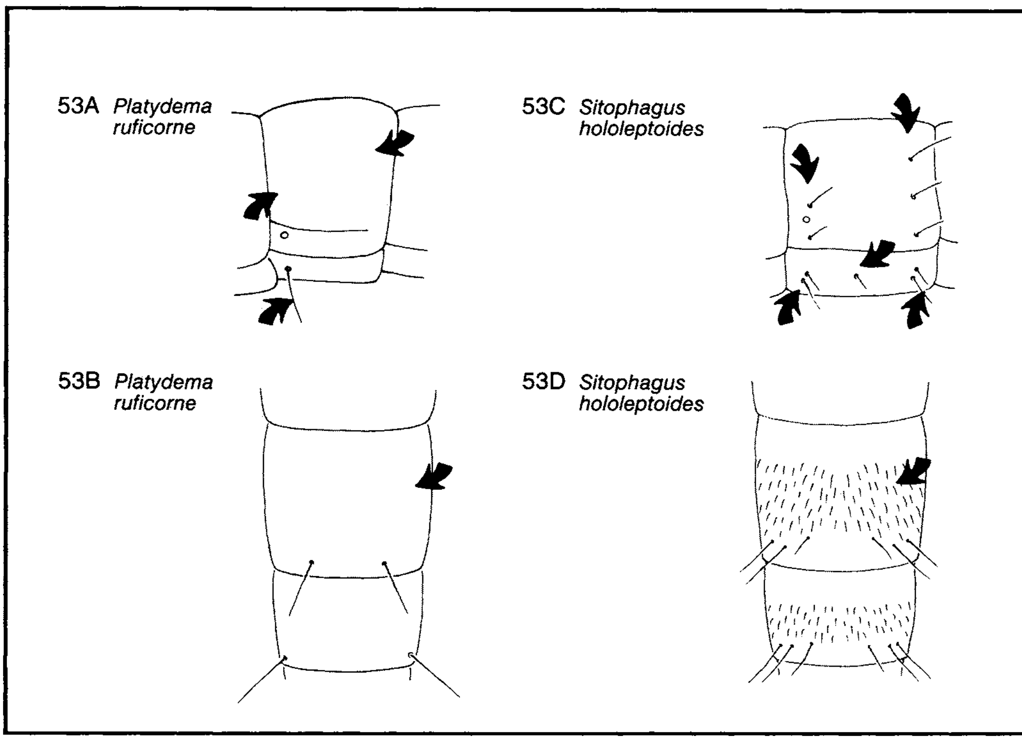
52A *Sitophagus hololeptoides*
52C *Gnatocerus maxillosus*
52D *Alphitophagus bifasciatus*
52B *Sitophagus hololeptoides*
52E *Gnatocerus maxillosus*

53 Abdominal sterna II to IV with 1 long seta in anterior corner (53A); abdominal terga II to IV without setae (53A) and VII and VIII without short setae (53B) ----------redhorned grain beetle, *Platydema ruficorne*

See also 51C&D.

Abdominal sterna II to IV with 2 long setae in anterior corner, 2 in posterior corner, and 1 between the corners (53C); abdominal terga II to IV with 2 setae in anterior row and 3 setae in posterior row (53C), and VII and VIII with numerous short setae (53D)----------*Sitophagus hololeptoides*

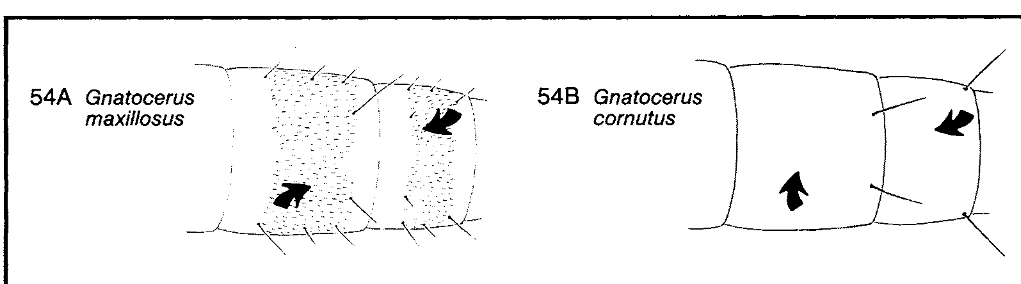
See also 52A&B.



54 Abdominal terga VII and VIII with numerous short setae (54A) ----------**slenderhorned flour beetle,** *Gnatocerus maxillosus*

See also 52C&E.

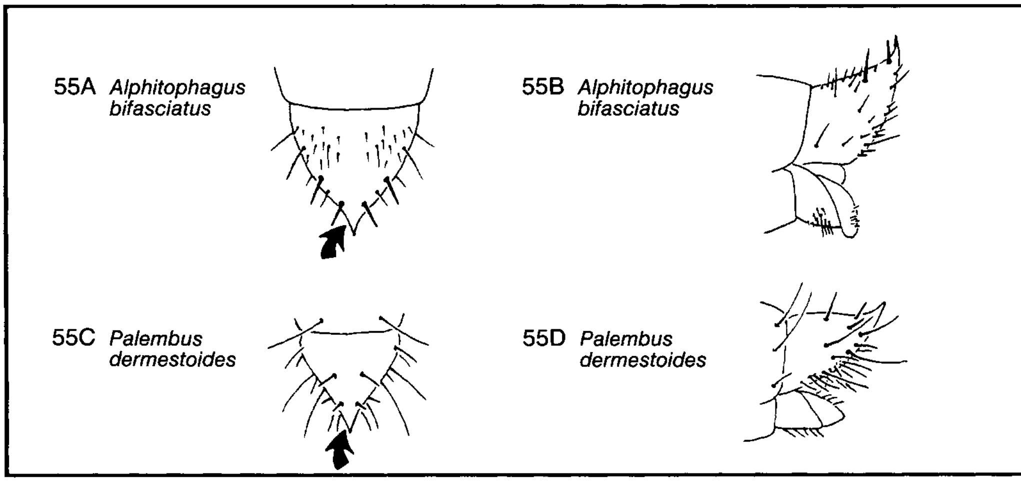
Abdominal terga VII and VIII without short setae (54B)---------- 55



55 Last abdominal tergum with apex suddenly narrowed (55A, 55B)
---**twobanded fungus beetle,** *Alphitophagus bifasciatus*

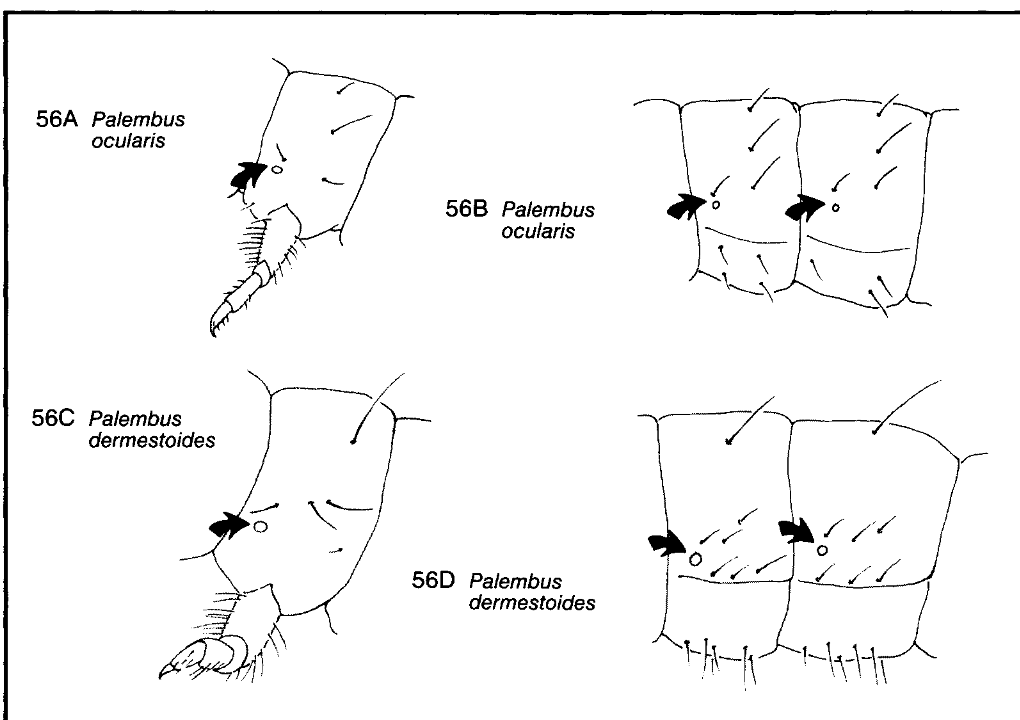
See also 36C, 52D.

Last abdominal tergum with apex gradually narrowed (55C, 55D)------------------------ 56



56 Mesothoracic spiracle oval (56A); spiracle of abdominal segment I subequal in size to spiracle of segment II (56B); abdominal terga VII and VIII obviously darker than terga II to VI---*Palembus ocularis*

Mesothoracic spiracle round (56C); spiracle of abdominal segment I obviously larger than spiracle of segment II (56D); abdominal terga I to VIII light colored---------- 57

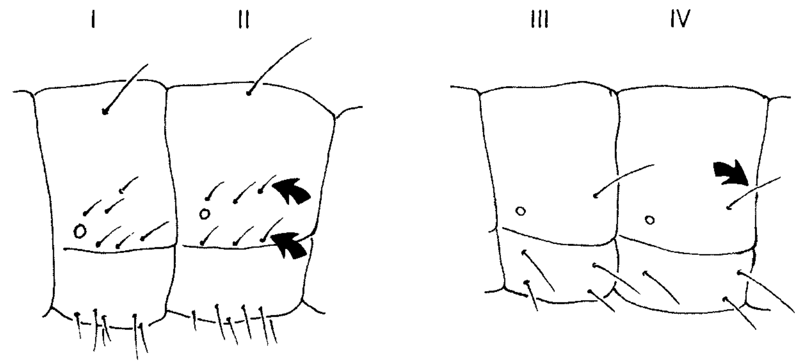


57 Abdominal terga II to IV with 3 setae above and 3 setae below an imaginary line drawn posteriorly from spiracle (57A)---*Palembus dermestoides*

See also 55C&D, 56C.

Abdominal terga II to IV with 1 seta above and no setae below an imaginary line drawn posteriorly from spiracle (57B)------------**broadhorned flour beetle,** *Gnatocerus cornutus*

See also 54B.



57A *Palembus dermestoides*

57B *Gnatocerus cornutus*

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12 SEED BEETLES (BRUCHIDAE, COLEOPTERA)

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Seeds of many food plants, especially those in the bean family (Fabaceae), are often infested by bruchids. Since the larvae feed internally, an infestation may not become apparent until the adults emerge. Adults are easily recognized to species, but the larvae are difficult to determine to genus or species, even with reference specimens available for comparison. Some species are not separable in the larval stage. The larvae are plump, white or yellowish grubs with legs reduced (pl. 108A, 109A) or absent (pl. 107A). The most important taxonomic feature of larvae is the shieldlike labial plate (sclerome) on which the labial palpi are reduced to a pair of setae (see couplet illustration 29A, adapted from *2*, in chapter 4). The mandibles of the larvae are rounded apically and lack teeth (*2*).

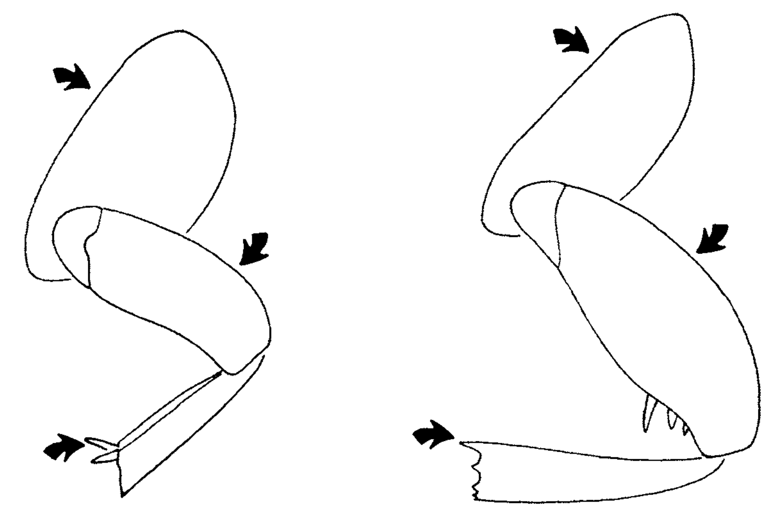
KEY TO ADULTS

Drawings by C. Feller unless otherwise noted.

1 Apex of tibia III with 2 movable spurs; coxa III much wider than femur III (1A); pl. 107B&C
-- **Mexican bean weevil,** *Zabrotes subfasciatus*

Distribution: Africa, India, tropical America; in common bean varieties.

Apex of tibia III without movable spurs (fixed spines may be present); coxa III ranges in width from narrower to scarcely wider than femur III (1B) -------------------------------- 2



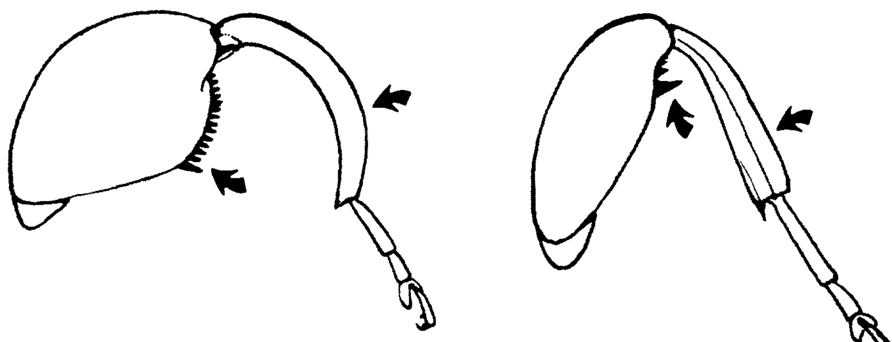
1A *Zabrotes subfasciatus*

1B *Acanthoscelides obtectus*

2 Femur III greatly enlarged, with 1 large tooth and 11 or 12 smaller teeth on ventral margin; tibia III curved, matching curvature of femur III (2A); pl. 108B --groundnut bruchid, *Caryedon serratus*

Distribution: Old World tropics; introduced to New World tropics; in seeds of tamarind (*Tamarindus indica*) in India, Mexico, and Caribbean islands, acacia (*Acacia* spp.), *Cassia* spp., peanuts (*Arachis hypogaea*) in Africa, and other legumes (Fabaceae) (*1*).
Drawings 2A&B by A.D. Cushman.

Femur III not greatly enlarged; no more than 4 teeth on ventral margin of femur III; tibia III nearly straight (2B) --- 3



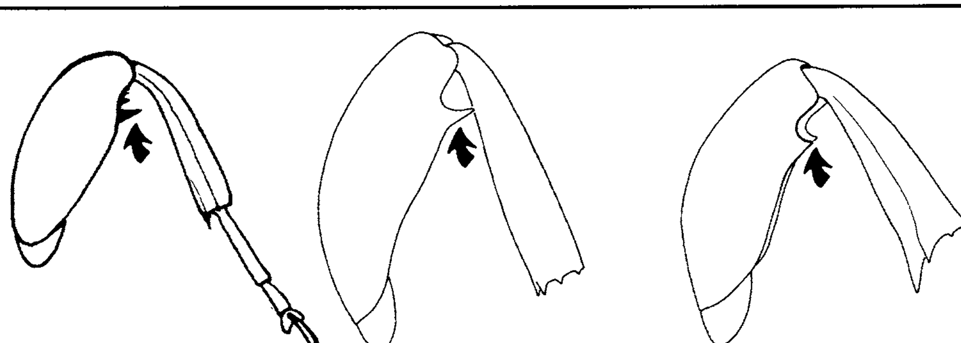
2A *Caryedon serratus*

2B *Acanthoscelides obtectus*

3 With leg III in closed position, ventral margin of femur III with 3 or 4 teeth inside tibia III and no teeth outside tibia III (3A); pl. 108C------**bean weevil,** *Acanthoscelides obtectus*

Distribution: cosmopolitan; in seeds of beans (*Phaseolus* spp.).
Drawing 3A by A.D. Cushman.

With leg III in closed position, ventral margin of femur III with 1 or no internal teeth and 1 external tooth (3B, 3C) --- 4



3A *Acanthoscelides obtectus*

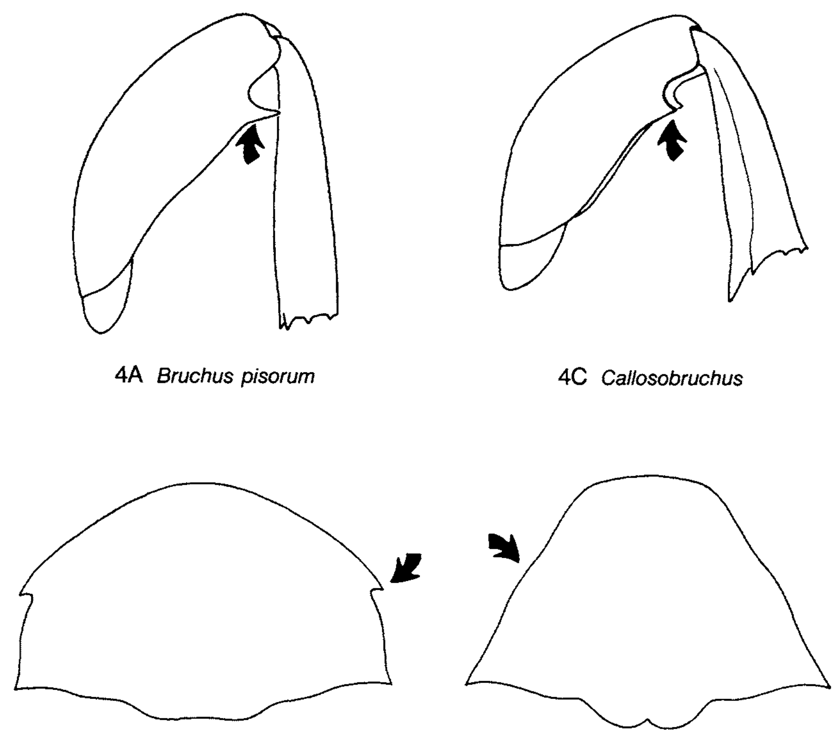
3B *Bruchus pisorum*

3C *Callosobruchus*

4 Femur III with external tooth only (4A); pronotal margin with 1 tooth (4B); pl. 109B
--**pea weevil,** *Bruchus pisorum*

Distribution: cosmopolitan; in seeds of garden pea (*Pisum sativum*).

Femur III with 1 external tooth and 1 internal tooth (4C); pronotal margin with no teeth (4D) 5



4A *Bruchus pisorum*

4C *Callosobruchus*

4B *Bruchus pisorum*

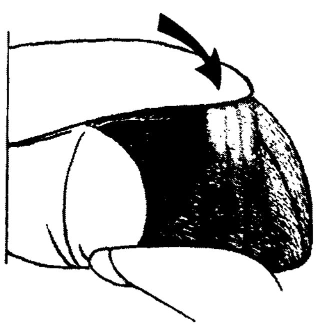
4D *Callosobruchus*

5 Dorsal margin of abdominal segments II to V with a dense, continuous patch of white hair (5A); antenna pectinate (5B, male) or serrate (5C, female); pl. 1K
-- Chinese pea weevil, *Callosobruchus chinensis*

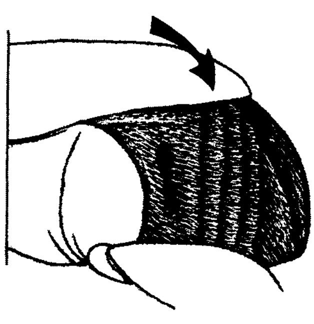
Distribution: cosmopolitan; in various legumes, including pigeon pea (*Cajanus cajan*), hyacinth bean (*Dolichos lablab*), garden bean (*Phaseolus vulgaris*), broadbean (*Vicia faba*), adzuki bean (*Vigna angularis*), mung bean (*V. r. radiata*), cowpea (*V. u. unguiculata*). Other common names: southern cowpea weevil, adzuki bean weevil, mung bean weevil.

Dorsal margin of abdominal segments II to V with diffuse yellowish or whitish hair not in a dense patch (5D); antenna serrate (5E, 5F); pl. 1J
--- **cowpea weevil,** *Callosobruchus maculatus*

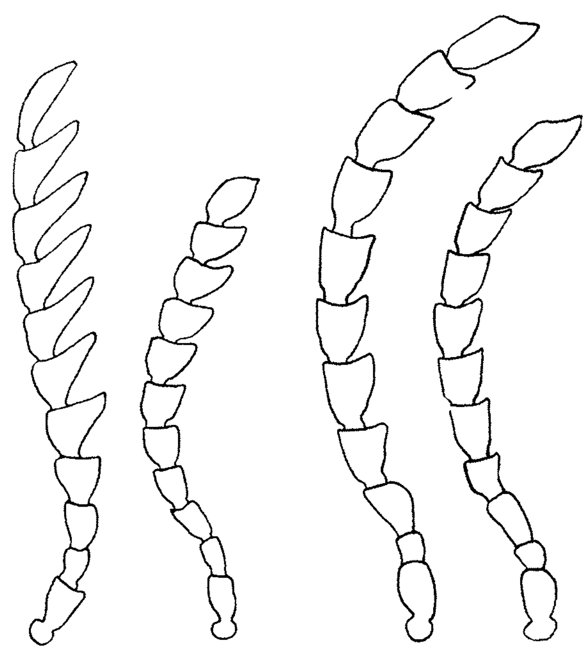
Distribution: cosmopolitan; in seeds of hyacinth bean, cowpea, mung bean, garden bean, and other legumes. Drawings 5A&D by A.D. Cushman; 5B&C&E&F by J.M. Kingsolver.



5A *Callosobruchus chinensis*



5D *Callosobruchus maculatus*



5B 5C 5E 5F

Callosobruchus chinensis *Callosobruchus maculatus*

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Notes and Sketches

13 WEEVILS (CURCULIONIDAE, COLEOPTERA)

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The few kinds of weevils customarily considered as stored product pests are among those keyed and illustrated in this chapter. These are the weevils most likely to cause losses in storage or to be pantry pests. Their foods are subject to postharvest attack and injury.

Most other weevils that are food pests develop along with their hosts and are likely to have left the crop by harvest time or to be nearly ready to do so. Some species leave before pupation; in this case adults are unlikely to be encountered. In other species, pupation occurs in the host, and adults may be found in the market place. A few species, notably the **sweet potato weevil,** may even increase in numbers during storage.

The **cowpea curculio** and the **pecan weevil** are keyed and illustrated as examples of preharvest food pests. The following survey of additional, primarily preharvest, pests lists only some highlights. The emphasis is on North American pests and some possible future immigrants, especially those from tropical America and Eurasia.

Root and Stem Crops

Beets, sugar beets. *Bothynoderes punctiventris* (Germar) is a major pest in central Europe. Other potential immigrants from Eurasia are *Chromoderus fasciatus* (Müller) and *Conorrhynchus mendicus* (Gyllenhal).

Carrots. The **carrot weevil,** *Listronotus oregonensis* (LeConte), is indigenous. *Liparus coronatus* (Goeze) and *Mecaspis alternans* (Herbst) are potential immigrants from Eurasia.

Horseradish. *Baris lepidii* Germar is a destructive, recent immigrant from Eurasia.

Onions. At least four species of *Brachycerus* are potential immigrants from Mediterranean Europe.

Potatoes. The Andean genus *Premnotrypes* includes 12 species, most of which are known pests but of unknown immigration potential.

Sugarcane. In the American tropics, at least two species of *Metamasius* are pests, particularly of injured or overripe sugarcane.

Sweet potatoes. The **sweet potato weevil,** *Cylas formicarius elegantulus* (Summers), is a major pest throughout warm parts of the world except in Africa where sweet potatoes are eaten by several other species of *Cylas.* Several other kinds of weevils infest sweet potato tubers, including two West Indian species, *Euscepes postfasciatus* (Fairmaire), which has spread to Pacific islands, and *Palaeopus costicollis* Marshall, which also infests yams.

Yams. Two potential immigrants are *Palaeopus costicollis* from the West Indies and *Elytroteinus subtruncatus* (Fairmaire) from the Pacific region.

Fruit Crops

Cucurbits. The melon weevil, *Acythopeus curvirostris* (Boheman), is a potential immigrant from Eurasia.

Legumes. Peas and beans are eaten in the field by various species, native and exotic, of *Apion* and *Chalcodermus.*

Nuts. North American nuts are attacked by various indigenous species of *Conotrachelus* and *Curculio.* Other species of *Curculio* from Eurasia are potential immigrants.

Orchard fruits. Fruits of apple, cherry, peach, pear, and plum are eaten by various species of *Coccotorus, Conotrachelus,* and *Tachypterellus* in North America and *Furcipus* in Eurasia.

Peppers. The **pepper weevil,** *Anthonomus eugenii* Cano, is an immigrant from Mexico.

Small fruits. Most berry weevils attack buds rather than fruits, but at least one indigenous species of *Anthonomus* feeds on cranberry fruits. The **grape curculio,** *Craponius inaequalis,* is indigenous.

Tropical fruits. Avocado fruits in tropical America are attacked by various species of *Conotrachelus* and *Heilipus.* Other species of *Conotrachelus* eat guava fruits in tropical America. Pests of cola nuts from Africa include *Balanogastris kolae* and several species of *Sophrorhinus.* Two species of the Oriental genus *Sternochetus* develop in mango seeds, and at least one other develops in fruits; the seed weevil, *S. mangiferae* (Fabricius), has spread to Hawaii and the West Indies.

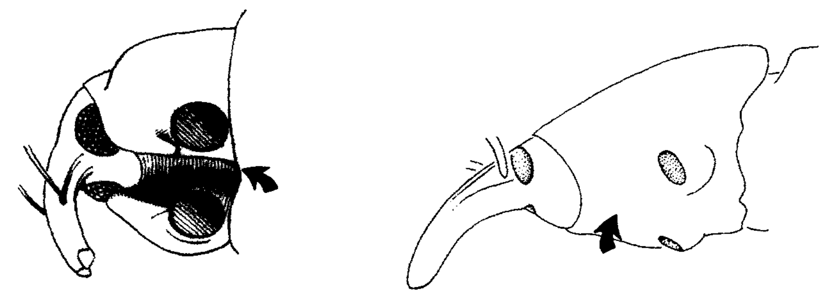
KEY TO ADULTS
Drawings by C. Feller unless otherwise noted.

1 Prosternum with deep groove which receives snout (1A); tarsal claws fused basally; pl. 110B ---------- **cowpea curculio,** *Chalcodermus aeneus*

Body black, deeply punctured dorsally. Distribution: Caribbean region, southeastern USA; in cowpeas and related legumes. Adults oviposit on the developing fruits; at maturity, the larvae emerge from the pods, drop to the ground, and pupate in the soil.
Drawing 1A by A.D. Cushman.

Prosternal groove absent (1B); tarsal claws free basally ---------- 2

Body brown, variously sculptured.



1A *Chalcodermus aeneus*

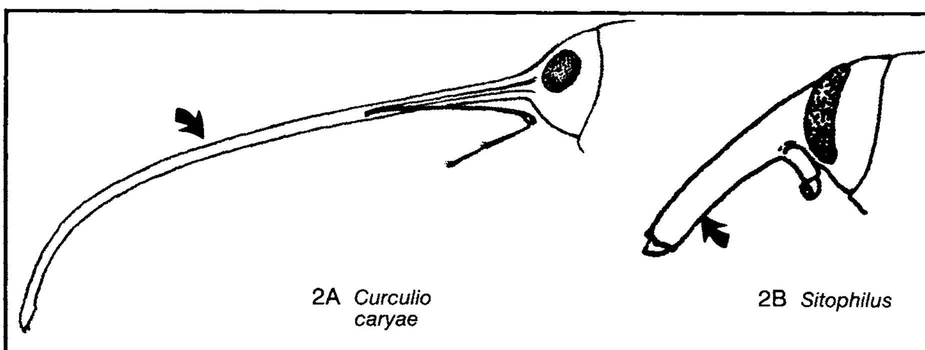
1B *Sitophilus granarius*

2 Snout long (about as long as or longer than body) and very slender (2A); tarsal claws toothed; pl. 111B ---------- **pecan weevil,** *Curculio caryae*

Body yellowish brown, finely punctate and densely squamose dorsally. Distribution: eastern USA; in hickory nuts and pecans. This is one of 27 species of *Curculio* found in America north of Mexico (*1*). Most of the species develop in acorns, but several develop in various commercial nuts. The larvae develop in the growing fruit, drop with the fruit, emerge, burrow into the ground, and pupate. Larvae may be found in harvested nuts.

Snout relatively short (much shorter than body) and stout (2B); tarsal claws not toothed 3

Body color and sculpture various.
Drawings by A.D. Cushman.



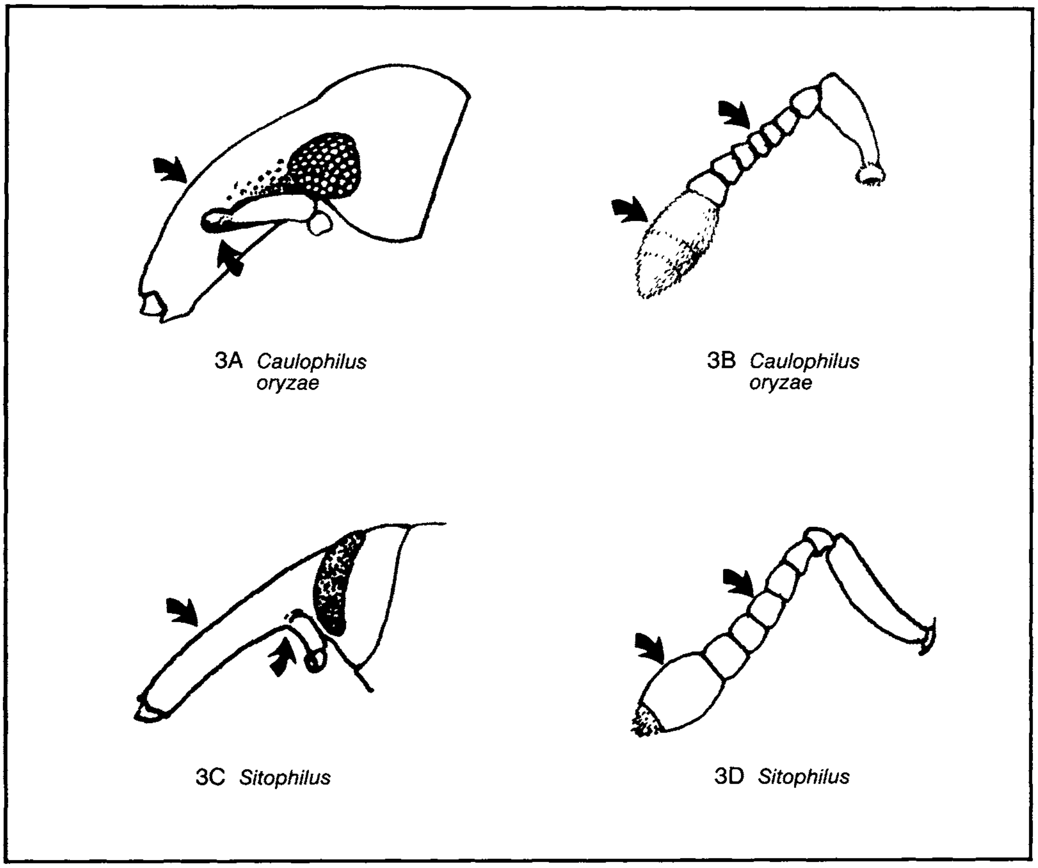
2A *Curculio caryae*

2B *Sitophilus*

3 Snout short and stout, with dorsal margin curved; antenna inserted near middle of snout, far in front of eye (3A); antennal funicle with 7 segments; antennal club with basal segment not shiny (3B); pygidium not exposed; pl. 112B
--**broadnosed grain weevil,** *Caulophilus oryzae*

Distribution: Caribbean region, southeastern USA; occasionally intercepted and perhaps established elsewhere. It appears to be a pest principally of ripening or freshly harvested corn, but specimens may be found in stored seeds or damaged grain. This species also develops in certain fruits, notably in avocado seeds, and in root products (ginger, yams). For further information on the hosts of *C. oryzae,* called *C. latinasus* in the older literature, see *2*.
Drawings by A.D. Cushman.

Snout cylindrical, with dorsal margin straight; antenna inserted near base of snout, just in front of eye (3C); funicle with 6 segments; club with basal segment shiny (3D); pygidium largely exposed. Genus *Sitophilus*-- 4



3A *Caulophilus oryzae*

3B *Caulophilus oryzae*

3C *Sitophilus*

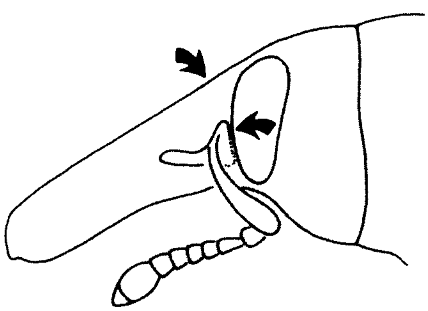
3D *Sitophilus*

4 Snout (in profile) not arched over antennal insertion, its dorsal margin on same plane as frons; antennal insertion nearly contiguous with front of eye (posterior margin of scrobe adjacent to eye) (4A); pl. 113A---------------**tamarind weevil,** *Sitophilus linearis*

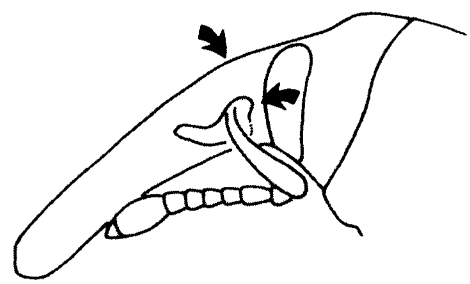
Pronotal punctures small, nearly circular, not interconnected longitudinally; erect setae of elytral intervals 1, 3, 5, 7, and 9 minute, shorter than width of strial punctures; elytral intervals equally raised; alternate intervals not more strongly raised basally than even intervals. Distribution: pantropical. This species develops in fruits of tamarind trees. It is often intercepted at United States ports of entry, but otherwise it is not a stored food pest.

Snout arched over antennal insertion, its dorsal margin not on same plane as frons; antennal insertion separated from eye by a distance subequal to width of scape (posterior margin of scrobe distinct from front margin of eye) (4B) ------------------- 5

Other characters various, not in same combination.



4A *Sitophilus linearis*

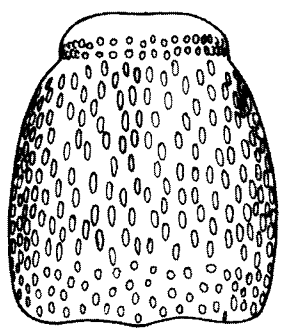


4B *Sitophilus granarius*

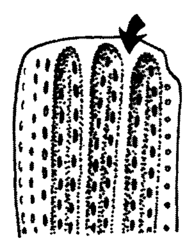
5 Pronotal punctures widely separated, large, elongate (about twice as long as wide), with spaces between punctures generally flat, wide, not forming longitudinal rugae (5A); elytral intervals about as wide as or wider than striae; intervals 3, 5, and 7 strongly raised basally (5B); strial punctures small, not quadrangular, not strongly encroaching upon intervals, not separated from one another by narrow transverse ridges (5B); pl. 113C--**granary weevil,** *Sitophilus granarius*

Distribution: cosmopolitan; in whole grain; a major stored food pest.

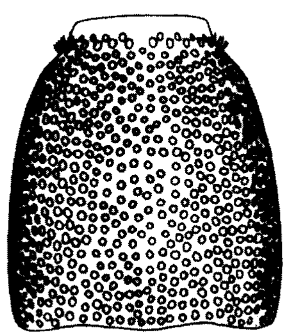
Pronotal punctures closely spaced, small, nearly circular (much less than twice as long as wide), with spaces between punctures generally narrow (5C); elytral intervals much narrower than striae; intervals 3, 5, and 7 not strongly raised basally (5D); strial punctures large, quadrangular, strongly encroaching upon intervals, separated from one another by narrow transverse ridges (5D)------------------------- 6



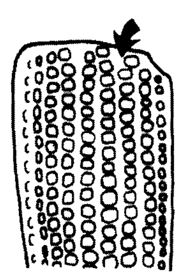
5A *Sitophilus granarius*



5B *Sitophilus granarius*



5C *Sitophilus zeamais*



5D *Sitophilus zeamais*

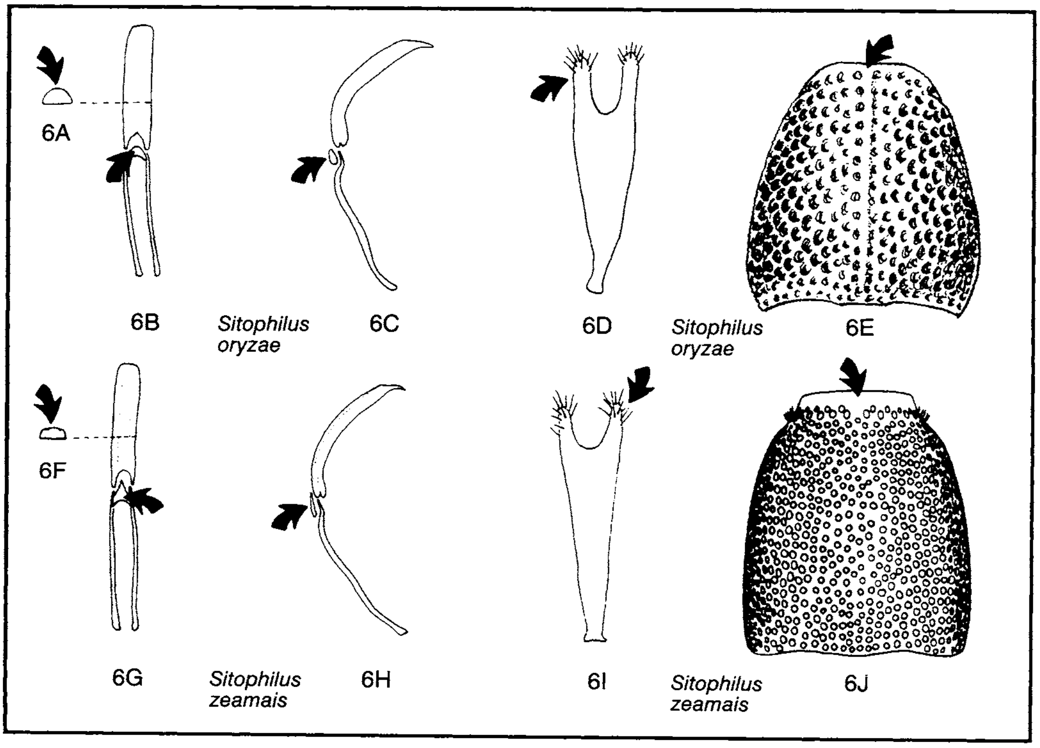
6 Upper surface of median lobe of aedeagus evenly convex (6A); free sclerite at base of median lobe of aedeagus small, with apex rounded (6B, 6C); Y-shaped sternite VIII (spiculum ventrale) of female with lateral lobes parallel-sided and rounded apically (6D); midline of pronotum usually puncture-free (6E); pl. 114A ---------- **rice weevil,** *Sitophilus oryzae*

Punctures on pronotal disc mostly longitudinally elliptical; pronotal and elytral surfaces relatively dull, with moderately strong microsculpture. Distribution: cosmopolitan; in whole grains; a major stored food pest. Of all the characters given in this key, only those of the male genitalia are completely reliable for distinguishing *S. oryzae* from *S. zeamais.* However, when these 2 species occur in mixed infestations, most individuals can be distinguished by the other characters given and by the fact that individuals of *S. oryzae* are often smaller and paler than those of *S. zeamais.* Both species, in addition to infesting stored grains, may infest grain in the field; they also infest other kinds of seeds.

Upper surface of median lobe of aedeagus flattened, with a distinct longitudinal impression on each side of midline (6F); free sclerite of aedeagus large, with apex acute (6G, 6H); lobes of sternite VIII of female gradually and evenly tapered and vaguely acute apically (6I); punctures usually present along midline of pronotum (6J); pl. 114B ---------- **maize weevil,** *Sitophilus zeamais*

Punctures on pronotal disc mostly circular; pronotal and elytral surfaces relatively shiny, with weak microsculpture. Distribution: cosmopolitan; in whole grain; a major stored food pest.

Drawing 6E by A.D. Cushman.



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14 ADULT MOTHS (LEPIDOPTERA)

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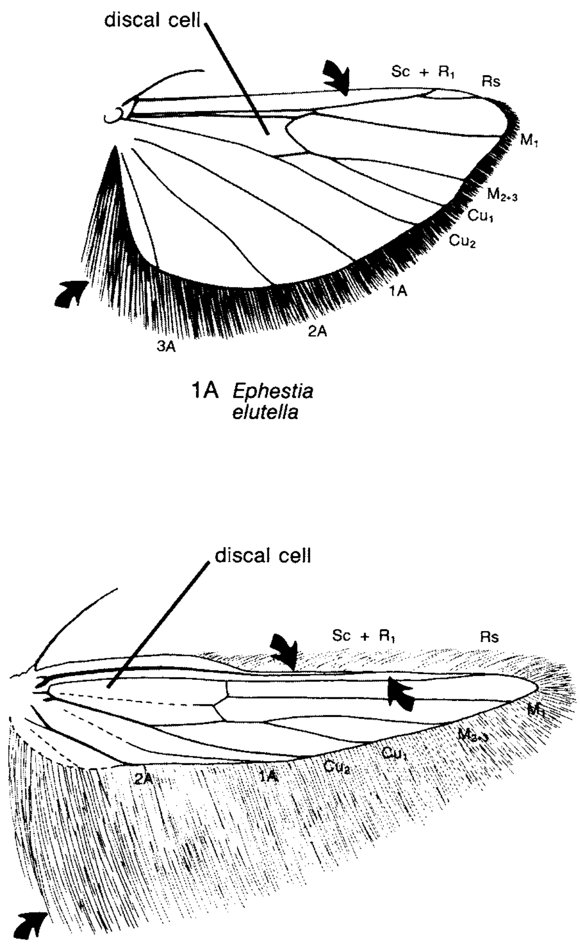
KEY
Drawings by C. Feller unless otherwise noted.

1 Hind wing with a short fringe (fringe hairs less than half as long as the breadth of the wing); Sc and Rs either closely parallel or fused to a point beyond discal cell (1A). Pyralidae (**pyralid moths**) -- 2

Caution: fringe hair length in *Corcyra cephalonica* and *Ephestiodes gilvescentella* may approach wing breadth/2.

Hind wing with a long fringe (fringe hairs at least as long as wing breadth/2); Sc and Rs clearly separate or divergent before and beyond end of discal cell (1B)------- 19



1A *Ephestia elutella*

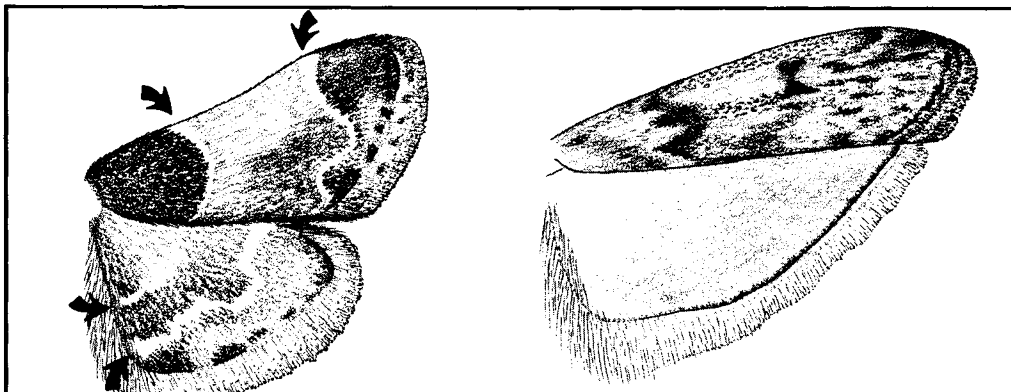
1B *Endrosis sarcitrella*

2 Both front and hind wings crossed by 2 narrow, wavy white lines (2A); pl. 2-O ---------- **meal moth,** *Pyralis farinalis*

The white lines, called the transverse anterior (= antemedial) and transverse posterior (= postmedial) lines, on the forewing bracket a pale brown area and separate it from basal and apical areas that are much darker (chocolate- or purplish-brown); forewing length usually more than 10 mm.

Wavy white lines absent, or present on forewing only (2B) ---------- 3

Hind wing color is a dull gray or white, either without a pattern or with a narrow dark border or diffuse marginal shading; forewing length 6 to 15 mm.

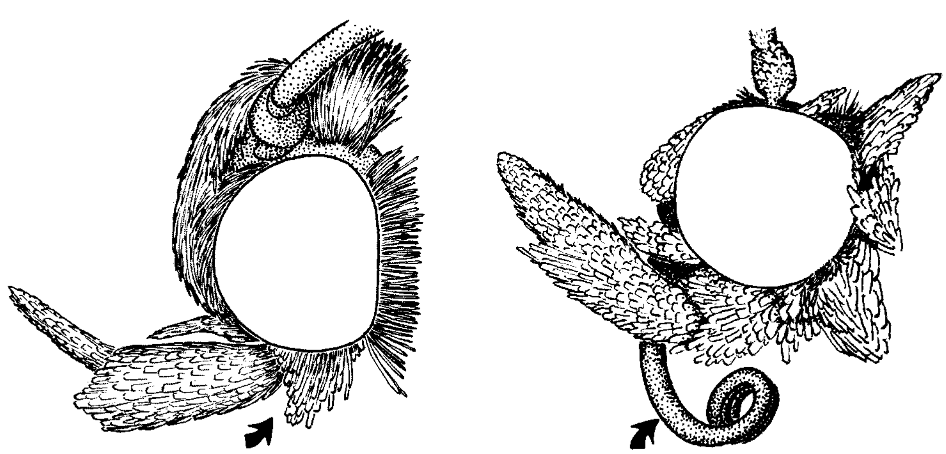


2A *Pyralis farinalis*

2B *Anagasta kuehniella*

3 Tongue absent (3A) or rudimentary (if present, then shorter than twice the diameter of the eye) ---------- 4

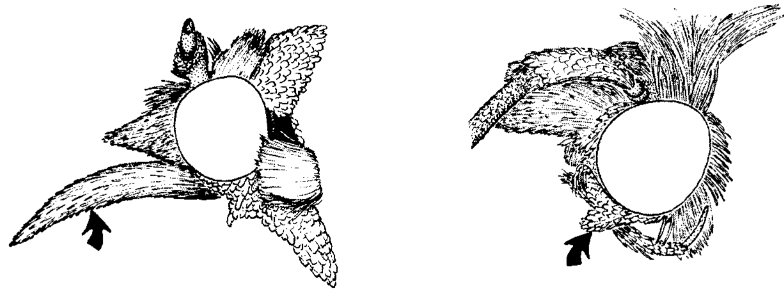
Tongue present and well developed (longer than twice the diameter of the eye) (3B) 11



3A *Aglossa caprealis*

3B *Amyelois transitella*

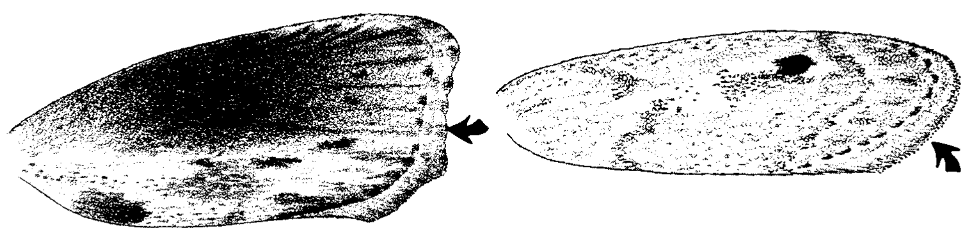
4 Labial palp long (about as long as longest leg spur) and protruding (4A)-------------- 5
Labial palp either distinctly shorter than longest leg spur or if nearly as long, then folded transversely against face (not protruding forward) (4B)-------------------------- 8



4A *Corcyra cephalonica* ♀ 4B *Paralipsa gularis* ♂

5 Outer margin (termen) of forewing concave (5A); pl. 2M
---female, **greater wax moth,** *Galleria mellonella*

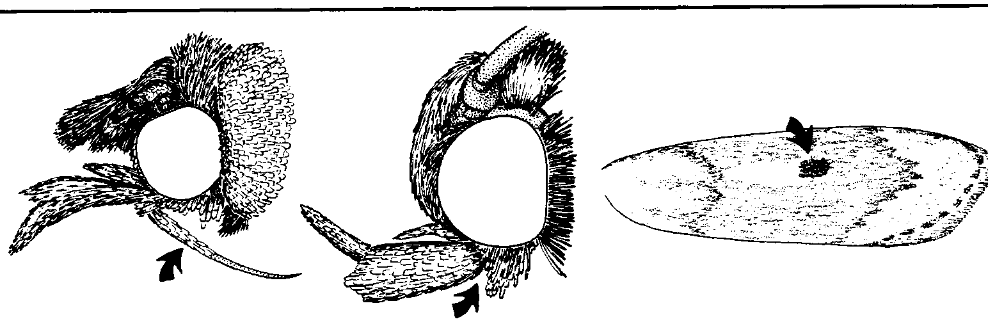
Outer margin of forewing convex (5B)-- 6



5A *Galleria mellonella* ♀ 5B *Paralipsa gularis* ♂

6 Tongue present but reduced (about equal in length to labial palp) (6A); forewing with conspicuous black discal spot (6B); pl. 2L
--female, **stored nut moth,** *Paralipsa gularis*

Tongue absent (6C); discal spot absent (see 7B)-- 7



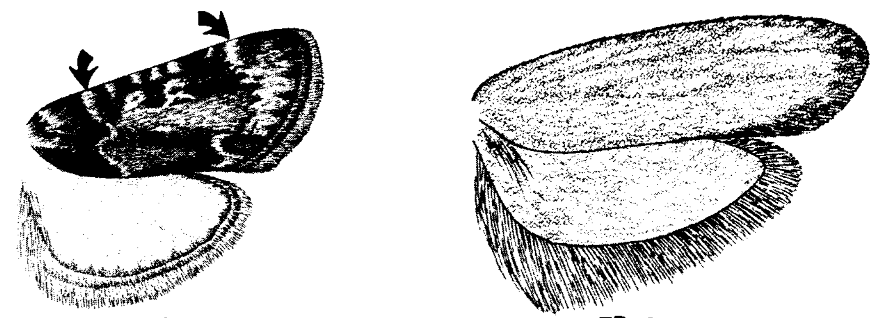
6A *Paralipsa gularis* ♀ 6C *Aglossa caprealis* 6B *Paralipsa gularis* ♀

7 Breadth of forewing greater than 4 mm; forewing with pale antemedial and postmedial lines on a variegated, darker brown background (7A) -- murky meal moth, *Aglossa caprealis*

See also 6C.

Breadth of forewing less than 4 mm; forewing light gray-brown, almost without pattern (7B); pl. 2H--female, **rice moth**, *Corcyra cephalonica*

See also 4A.



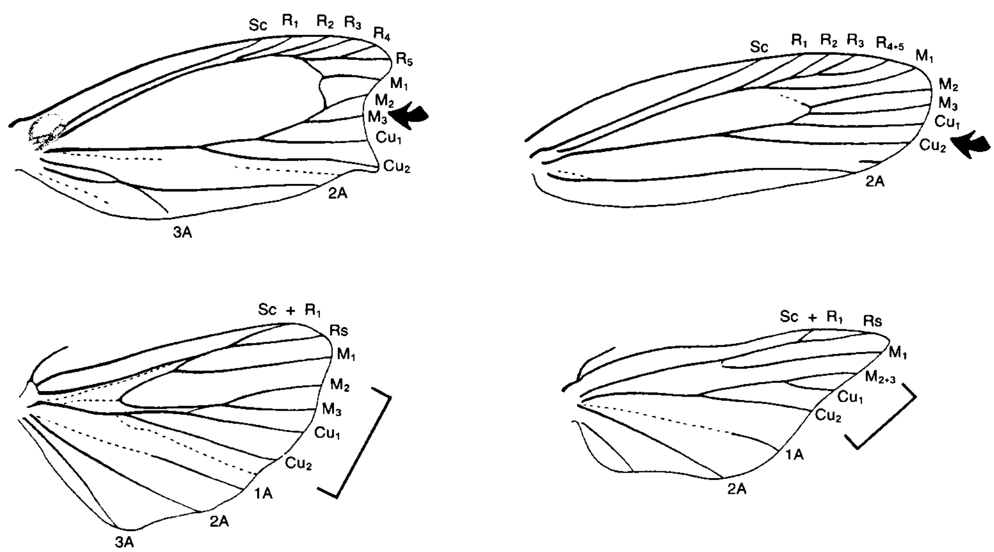
7A *Aglossa caprealis*

7B *Corcyra cephalonica*

8 Forewing breadth 5 to 7 mm; termen of forewing concave; Cu of hind wing apparently 4-branched (8A); pl. 2M------------------ male, **greater wax moth,** *Galleria mellonella*

See also 5A.

Forewing breadth less than 5 mm; termen of forewing convex; Cu of hind wing apparently 3-branched (8B)-- 9



8A *Galleria mellonella*

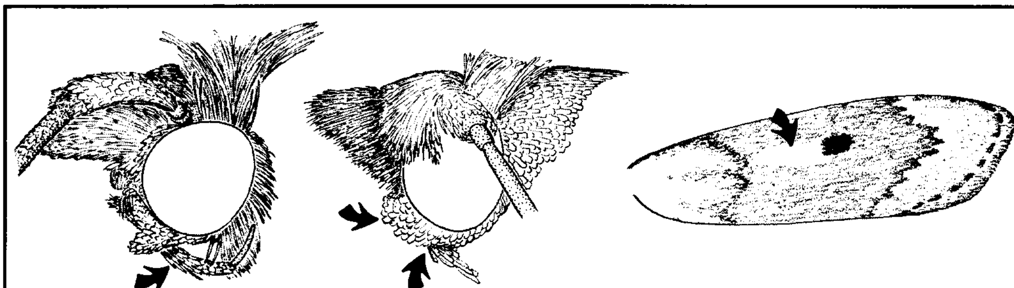
8B *Achroia grisella*

9 Tongue present but very short (9A); forewing with yellowish patch near middle (9B); pl. 2L---male, **stored nut moth,** *Paralipsa gularis*

Labial palps of male inconspicuous; forewing grayish-brown, with (9B) or without discal spot.

Tongue absent (9C); forewing almost without markings (see 7B) ------------------------- 10

Forewing grayish-brown.



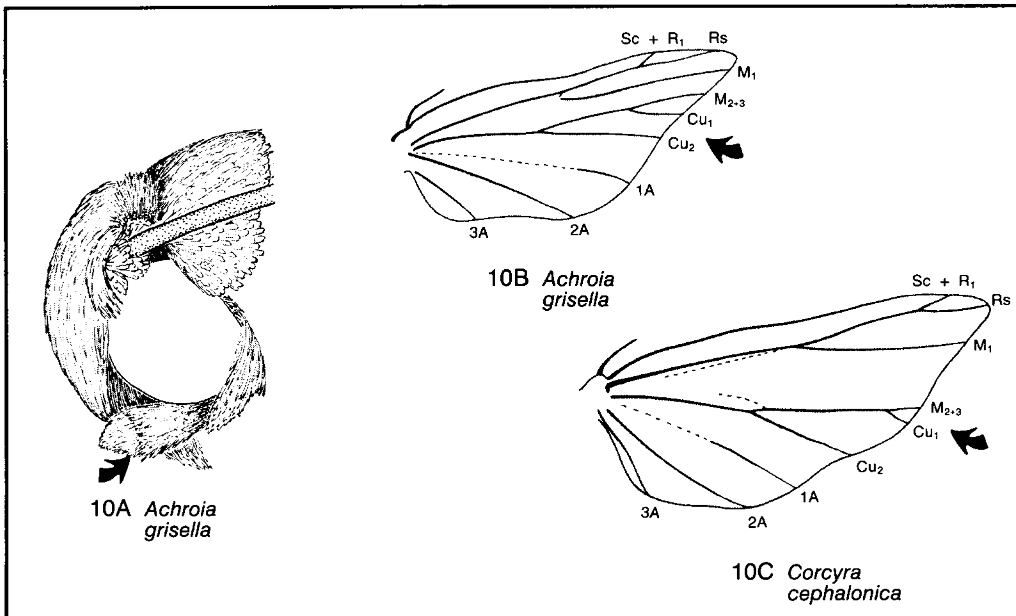
9A *Paralipsa gularis* ♂ 9C *Corcyra cephalonica* ♂ 9B *Paralipsa gularis* ♂

10 Labial palp conspicuous though short (length not exceeding diameter of eye) (10A); labial palps of male transversely incurved, pincerlike; hind wing of male with concave termen (10B); pl. 2C-------------------------------------- **lesser wax moth,** *Achroia grisella*

See also 8B.

Labial palp inconspicuous, very short, upcurved and closely appressed to front of head (tip often concealed in frontal scale tuft) (see 9C); hind wing with convex termen (10C); pl. 2H---male, **rice moth,** *Corcyra cephalonica*

See also 7B.

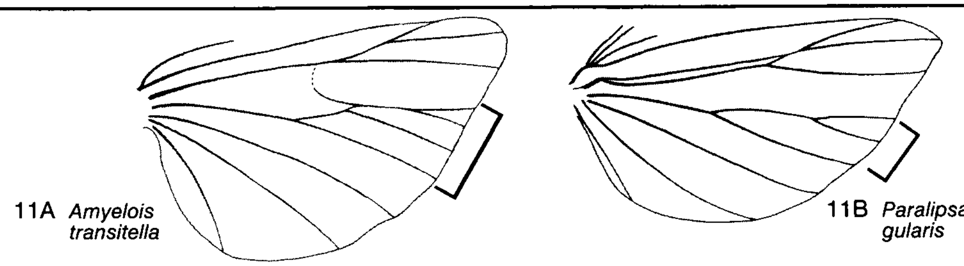


10A *Achroia grisella* 10B *Achroia grisella* 10C *Corcyra cephalonica*

11 Cu of hind wing apparently 4-branched (11A)-----**navel orangeworm,** *Amyelois transitella*

See also 3B.

Cu of hind wing apparently 3-branched (11B)-- 12

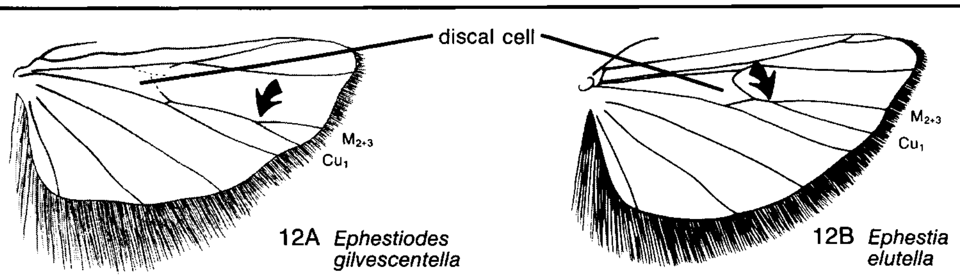


11A *Amyelois transitella*

11B *Paralipsa gularis*

12 M_{2+3} and Cu_1 of hind wing branching nearer to termen than to discal cell; longest fringe hair of hind wing almost equal to wing breadth/2 (12A) --dusky raisin moth, *Ephestiodes gilvescentella*

M_{2+3} and Cu_1 branching closer to discal cell than to termen; longest fringe hair much shorter than wing breadth/2 (12B)--- 13



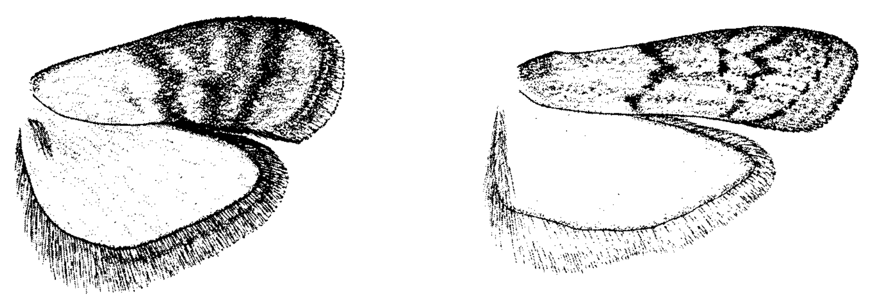
12A *Ephestiodes gilvescentella*

12B *Ephestia elutella*

13 Forewing distinctly bicolored (basal one-third light colored, distal two-thirds dark colored) (13A); pl. 2F, 2G------------------------------ **Indianmeal moth,** *Plodia interpunctella*

The best diagnostic character for this species pertains to the wing scales: Among the stored-food moths, only *Plodia interpunctella* has deep pink or coppery-red scales on the forewing.

Forewing without contrasting basal and distal colors (13B) --------------------------------- 14



13A *Plodia interpunctella*

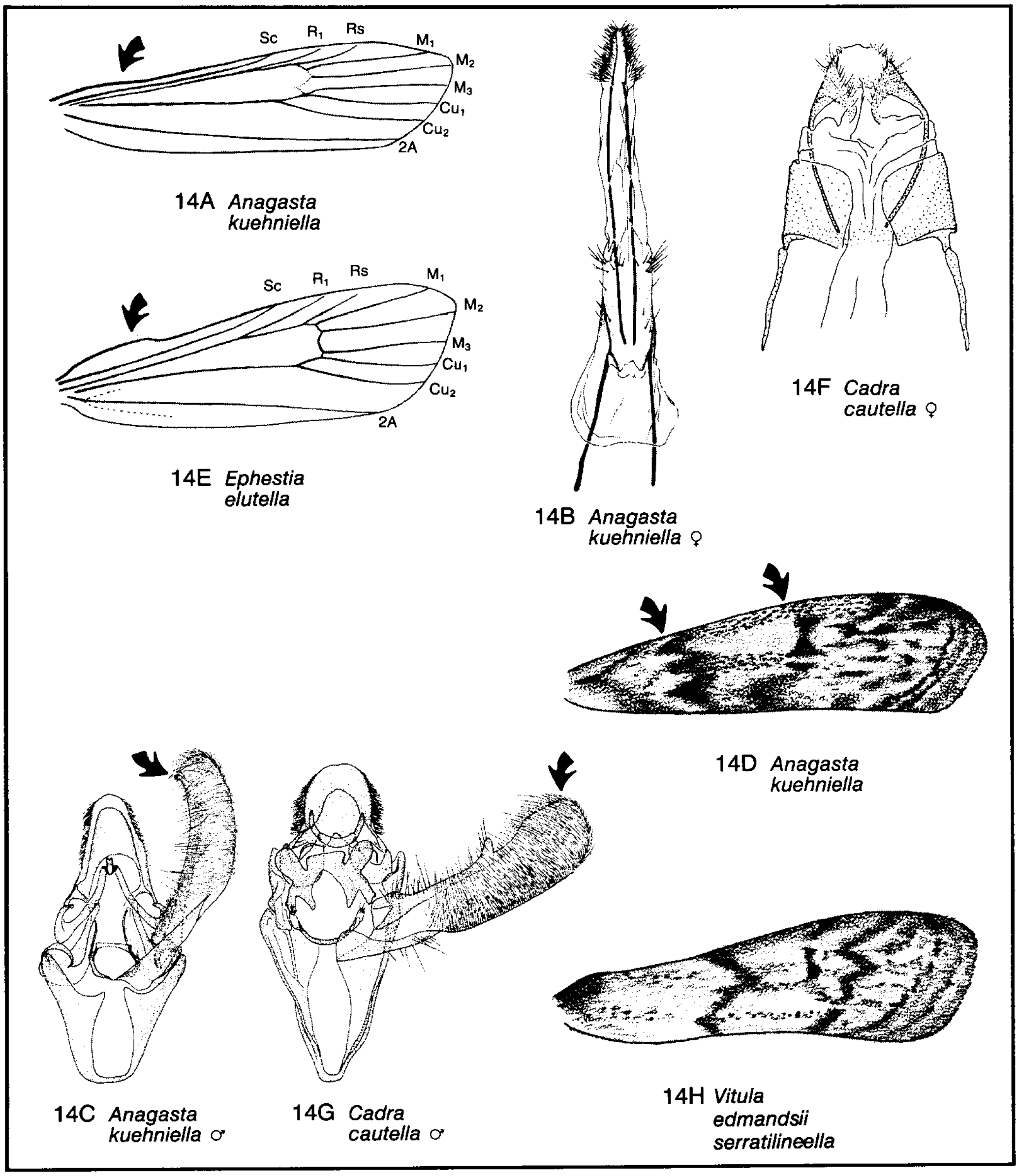
13B *Vitula edmandsii serratilineella*

14 Forewing of male without costal fold (14A); ovipositor much elongated or extensile (14B); costa of valve with only a short terminal process (14C); pl. 2-I
--**Mediterranean flour moth,** *Anagasta kuehniella*

Forewing usually with an obvious pattern of transverse lines and a discal spot (14D). See also 2B.
Drawing 14A by D.C. Ferguson.

Forewing of male with costal fold (usually folded under and appressed against lower wing surface) (14E); ovipositor short (14F); valve either without a terminal costal process (14G; see also 15A, 15C, 17C) or, if a terminal process is present, there is also a prominent process located near the midpoint of the costal margin (see 17A) 15

Forewing with (14H) or without an obvious pattern.



14A *Anagasta kuehniella*

14E *Ephestia elutella*

14B *Anagasta kuehniella* ♀

14F *Cadra cautella* ♀

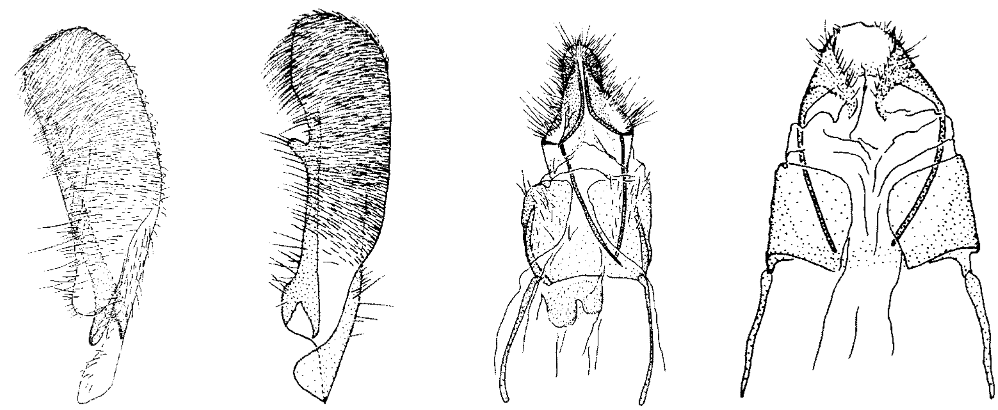
14D *Anagasta kuehniella*

14C *Anagasta kuehniella* ♂

14G *Cadra cautella* ♂

14H *Vitula edmandsii serratilineella*

15 Valve lacking a costal process (15A); ovipositor bluntly attenuated (15B)------------- 16
Valve with a costal process (15C); ovipositor broadly rounded or obtuse (15D).
Genus *Cadra*-- 17



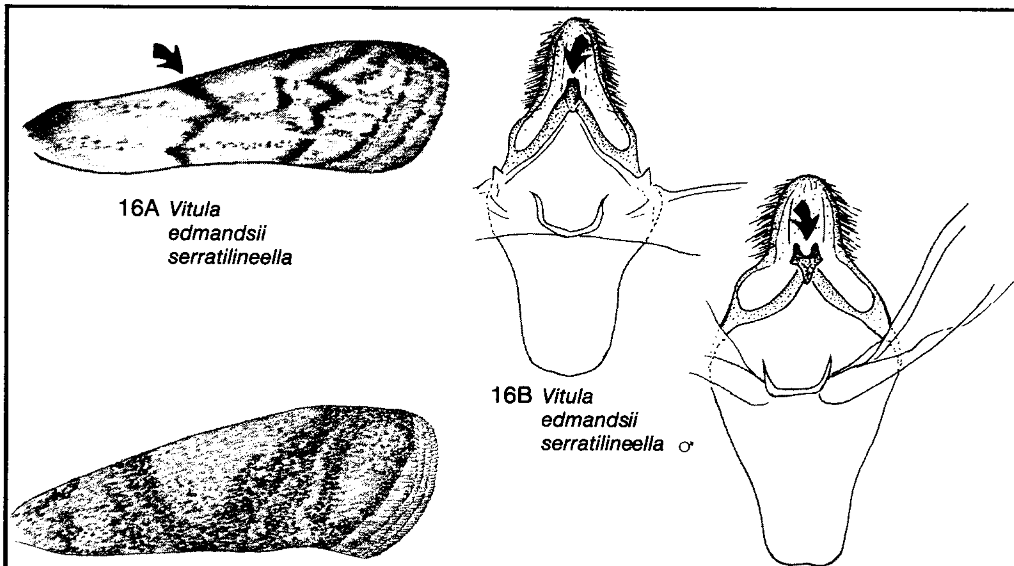
15A *Ephestia elutella* ♂ 15C *Cadra cautella* ♂ 15B *Ephestia elutella* ♀ 15D *Cadra cautella* ♀

16 Forewing nearly always more than 9 mm long, with dentate transverse lines (16A); gnathos not bifurcate apically (16B)
---**driedfruit moth,** *Vitula edmandsii serratilineella*

See also 13B.

Forewing less than 9 mm long, with simple (not dentate) lines (16C); gnathos apically bifurcate (16D); pl. 2J--------------------------------------**tobacco moth,** *Ephestia elutella*

See also 1A, 14E, 15A.
Drawings 16B&D by D.C. Ferguson.



16A *Vitula edmandsii serratilineella*

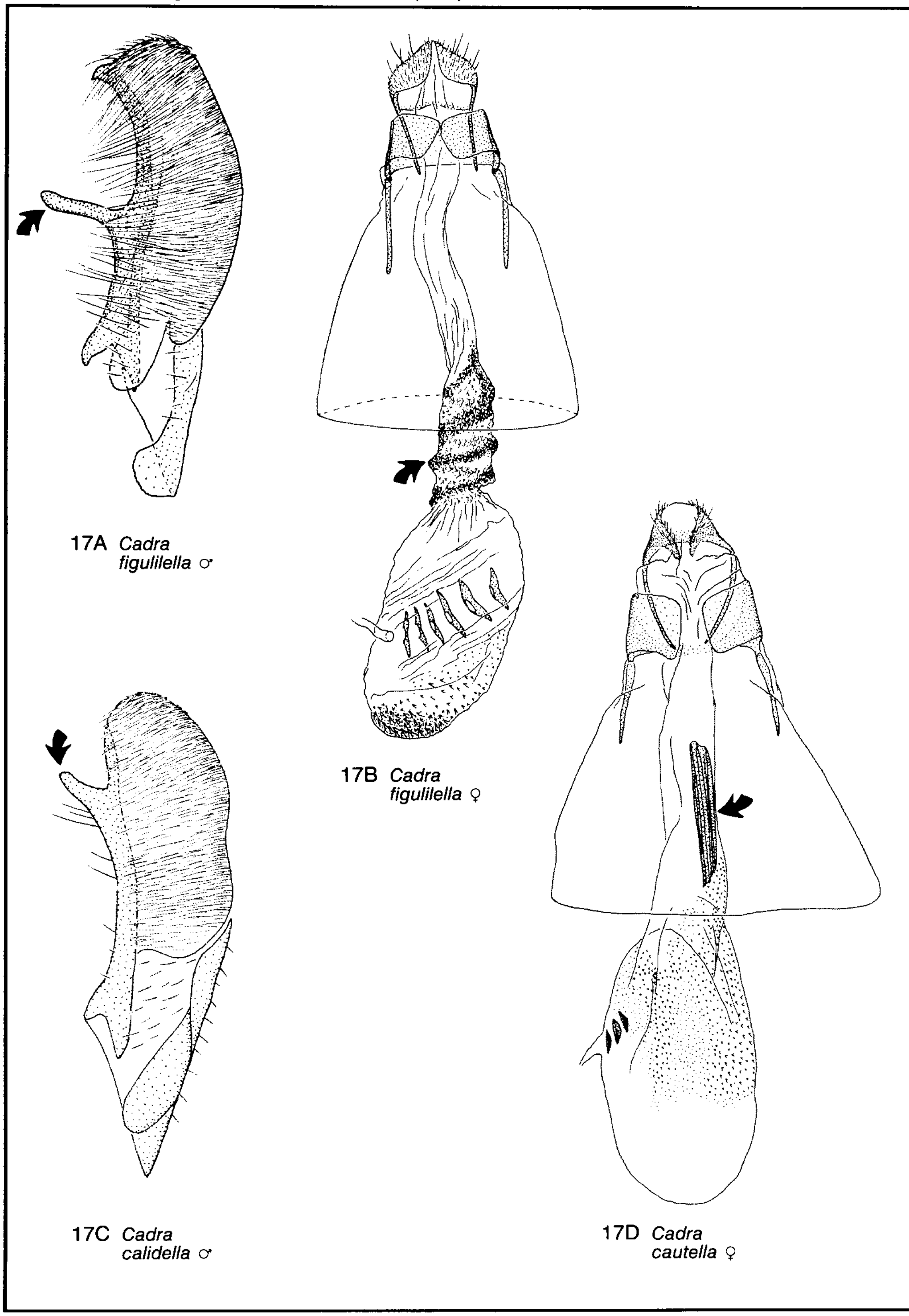
16B *Vitula edmandsii serratilineella* ♂

16C *Ephestia elutella*

16D *Ephestia elutella* ♂

17 Length of costal process of valve subequal to width of valve (17A); ductus bursae with spiral rings of sclerotin (17B)---------------------------------- **raisin moth,** *Cadra figulilella*

Length of costal process of valve much less than width of valve (17C); ductus bursae with a longitudinal sclerotized bar (17D) -- 18



17A *Cadra figulilella* ♂

17B *Cadra figulilella* ♀

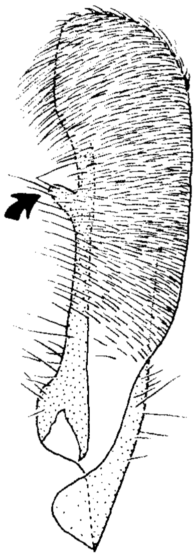
17C *Cadra calidella* ♂

17D *Cadra cautella* ♀

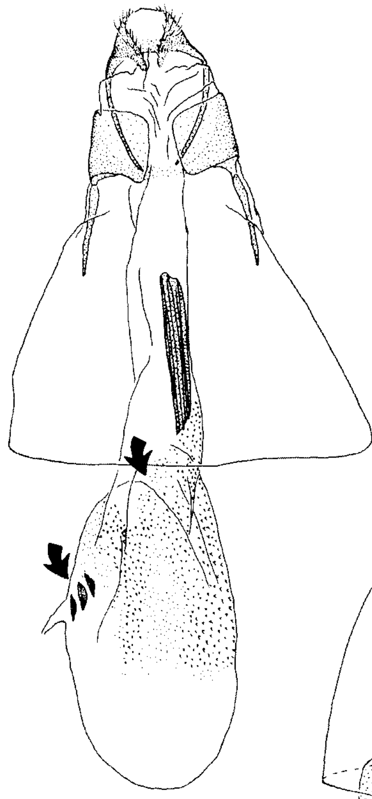
18 Costal process of valve located near middle of costal margin (18A); sclerite of ductus bursae not continuing on to bursa copulatrix; bursa with 2 to 4 (rarely 1 or 5) signa (lamina dentata) (18B)---------------------------------------**almond moth,** *Cadra cautella*

See also 14G.

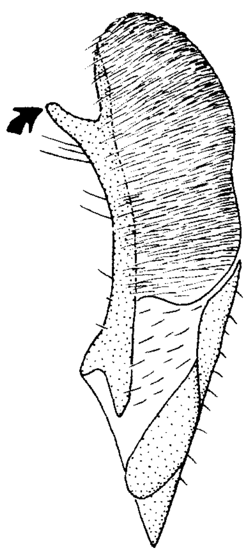
Costal process of valve located beyond middle of costal margin (18C); sclerotized bands extending from sclerite of ductus bursae onto bursa copulatrix; bursa usually with no less than 5 signa (18D)--------------------------------------- carob moth, *Cadra calidella*



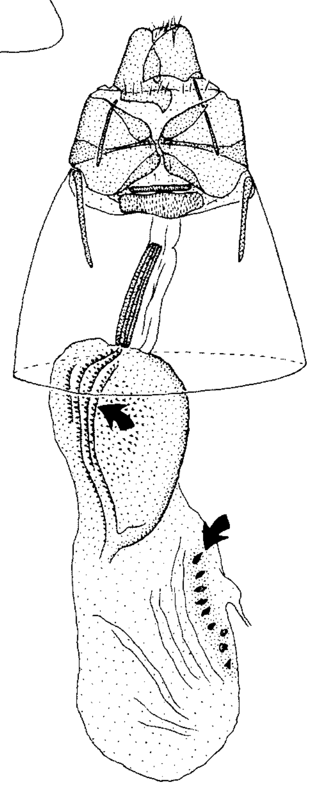
18A *Cadra cautella* ♂



18B *Cadra cautella* ♀

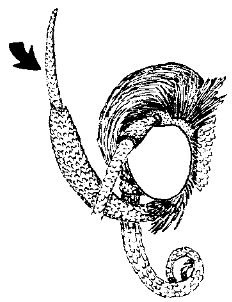


18C *Cadra calidella* ♂

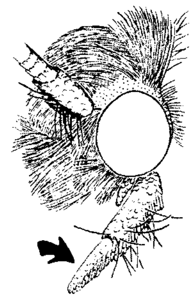


18D *Cadra calidella* ♀

19 Labial palp long, sickle-shaped, sharp-pointed, projecting upward; head smooth-scaled (19A) -- 20
Labial palp short, nearly straight, blunt-pointed, and projecting anteriorly (horizontal or declivent); head rough-haired (19B). Tineidae (tineid moths)------------------------ 22



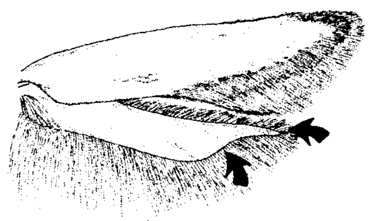
19A *Endrosis sarcitrella*



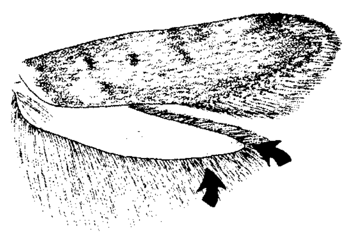
19B *Monopis crocicapitella*

20 Hind wing abruptly attenuated, with sharply-pointed apex; termen concave (20A); forewing pale ochreous brown, often unmarked, but sometimes with a diffuse black spot near distal end of discal cell and (or) another on the apex (pl. 2E). Gelechiidae **(gelechiid moths)**-------------------------------- **Angoumois grain moth,** *Sitotroga cerealella*

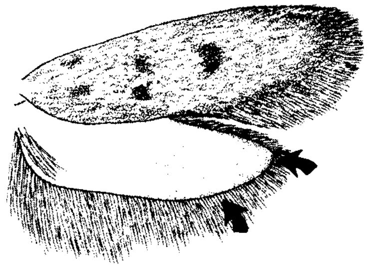
Hind wing regularly tapered, with apex rounded or bluntly pointed (20B, 20C); forewing buff to dark buff-brown, usually with 2 or more dark spots. Oecophoridae **(oecophorid moths)**-- 21



20A *Sitotroga cerealella*



20B *Endrosis sarcitrella*

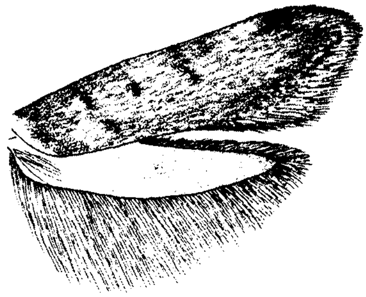


20C *Hofmannophila pseudospretella*

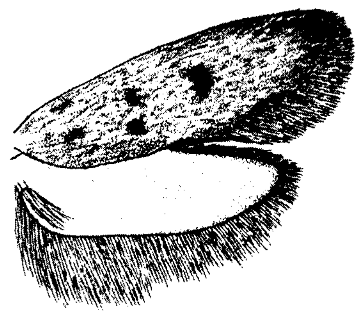
21 Head and pronotum conspicuously white (pl. 2N); labial palp mostly white, with black tip; forewing a shining buff, speckled with dark brown, and usually with 2 or 3 blackish spots (21A); hind wing with 7 veins
--- **whiteshouldered house moth,** *Endrosis sarcitrella*

See also 1B, 19A.

Head, thorax, and labial palp brown; forewing buff-brown to dark buff-brown (pl. 2B); forewing with 3 diffuse or distinct dark brown spots (21B); hind wing with 8 veins
--- **brown house moth,** *Hofmannophila pseudospretella*



21A *Endrosis sarcitrella*

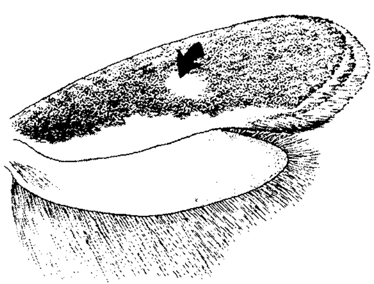


21B *Hofmannophila pseudospretella*

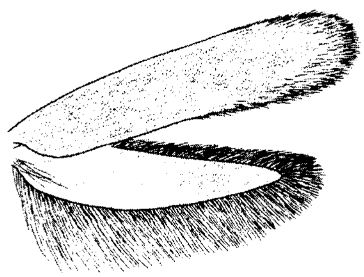
22 Forewing dark brown, with a broad cream-colored inner margin and central spot (22A); pl. 2D-- *Monopis crocicapitella*

See also 19B.

Forewing neither mostly dark brown nor with a definite spot (22B) --------------------- 23



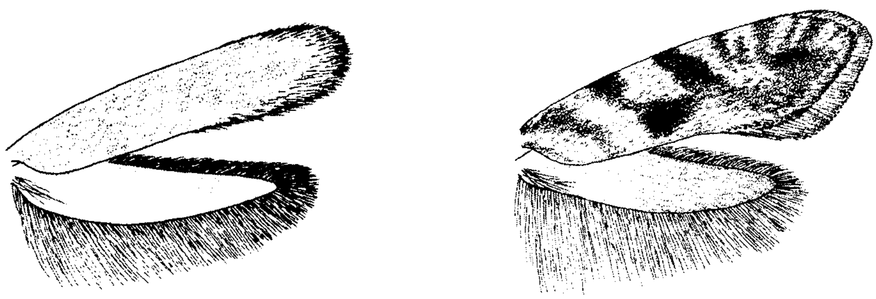
22A *Monopis crocicapitella*



22B *Tineola bisselliella*

23 Forewing a pale ochreous buff, entirely unmarked (23A); pl. 2A
-- **webbing clothes moth,** *Tineola bisselliella*

Forewing buff with dark dusting and irregular brown markings and with about 6 dark reddish-brown or chocolate-brown spots (23B); pl. 2K
--**European grain moth,** *Nemapogon granella*



23A *Tineola bisselliella*

23B *Nemapogon granella*

15 LARVAL MOTHS (LEPIDOPTERA)

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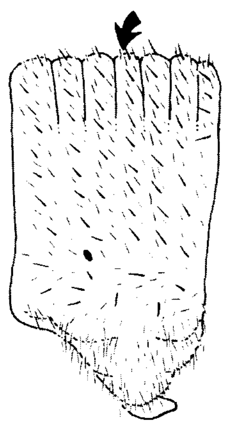
KEY
Drawings by C. Feller unless otherwise noted.

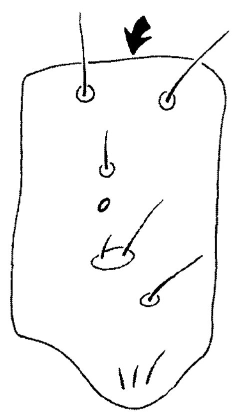
1 Body and head with numerous short secondary setae; abdominal segments divided (at least dorsally) into several annulets (1A); pl. 115A. Pieridae (**whites, sulfur butterflies**)------------------**imported cabbageworm,** *Pieris rapae*

A green larva with a yellowish middorsal stripe and a yellowish broken lateral stripe through the spiracles. Distribution: Europe, North America (imported); hosts: Brassicaceae. This is the only butterfly species included in the key. References: *5, 26, 29.*

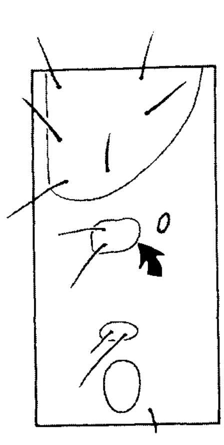
Body and head with primary setae only; abdominal segments not divided into several annulets (1B). Other Lepidoptera ------------------ 2

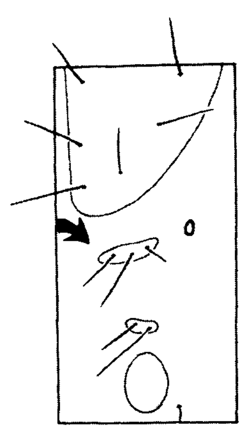
References: *5, 10, 11, 14, 15, 17, 18, 20, 21, 24, 26, 29, 31.*


1A *Pieris rapae*


1B diagrammatic

2 Two setae in prespiracular group of prothorax (2A)------------------ 2
Three setae in prespiracular group of prothorax (2B)------------------ 26


2A diagrammatic

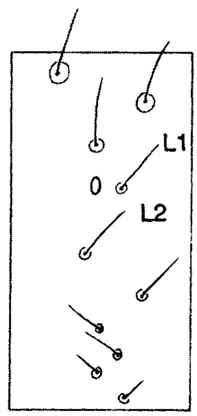

2B diagrammatic

3 Abdominal segments I to VIII with seta L1 behind and L2 below spiracle (3A); crochets in a mesoseries (3B). Noctuidae (**owlet moths** and **underwings**)--------------------- 4

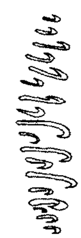
References: *3, 7.*

Abdominal segments I to VIII with setae L1 and L2 close together below spiracle (3C); crochets in a complete circle (3D) or a penellipse (3E). Pyralidae (**pyralid moths**) 7

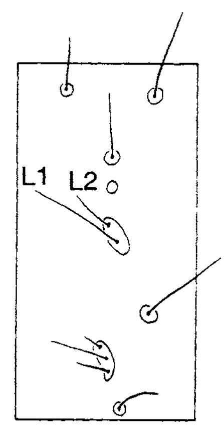
References: *4, 12.*



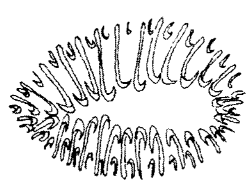
3A noctuid



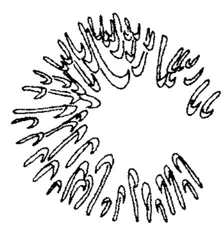
3B noctuid



3C pyralid



3D *Pyralis farinalis*



3E *Ostrinia nubilalis*

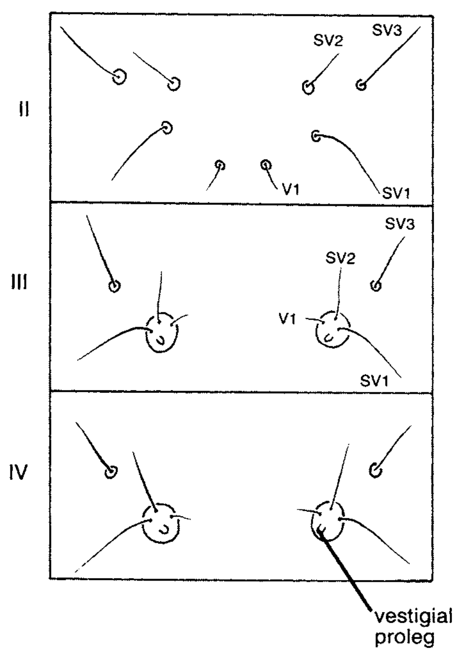
4 Normal prolegs present on abdominal segments V and VI (absent or vestigial on segments III and IV) (pl. 115B)---------- 5
Normal prolegs present on abdominal segments III and VI (pl. 115C)---------- 6

5 Vestigial prolegs present on abdominal segments III and IV; setae SV1, SV2 and V1 grouped closely about proleg on segments III and IV; pinacula of setae SV1 and SV2 well separated on segment II (5A)
----------**cabbage looper,** *Trichoplusia ni*

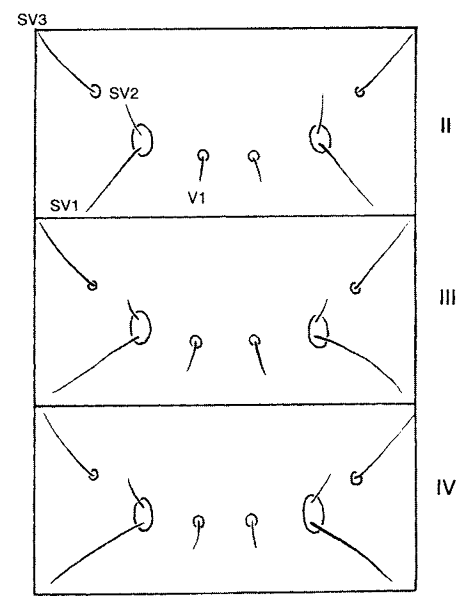
Distribution: the Americas, West Indies; on cabbage and other crucifers. References: *8, 9.*

Vestigial prolegs absent on abdominal segments III and IV; pinacula of SV1 and SV2 fused on segments II tc IV; seta V1 separated from SV1 and SV2 on all segments (5B); pl. 115B----------silver Y moth, *Autographa gamma*

Distribution: Asia, Europe, North Africa; general feeder.



5A *Trichoplusia ni* (ventral view)



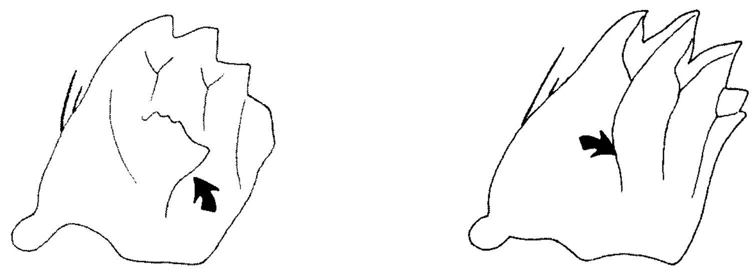
5B *Autographa gamma* (ventral view)

6 Mandible with broad plate on oral surface (6A); integument smooth; pl. 115C ---------- cabbage moth, *Mamestra brassicae*

Distribution: Asia, Europe; on crucifers and other leafy vegetables.

Mandible without broad plate on oral surface (6B); integument with short sharp spines; pl. 116A ---------- **corn earworm, tomato fruitworm,** *Helicoverpa zea*

Distribution: the Americas, West Indies; on beans, corn, cotton, tomatoes, and many other plants. Reference: *6.*



6A *Mamestra brassicae*

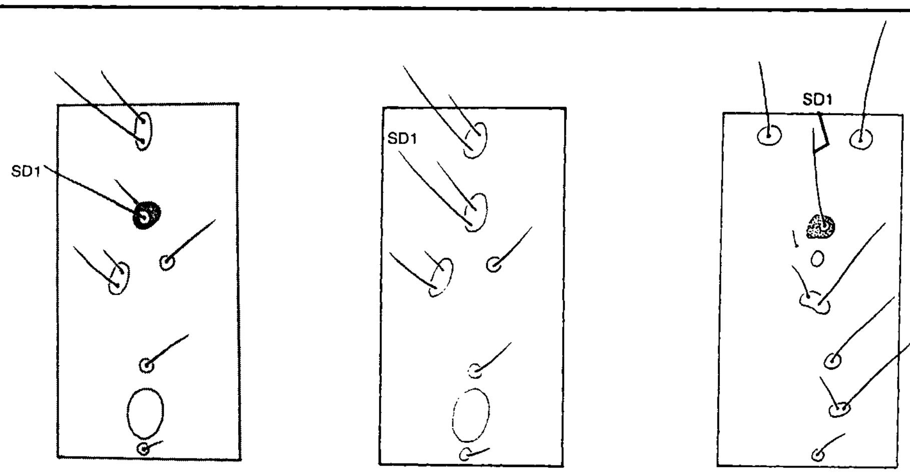
6B *Helicoverpa zea*

7 With sclerotized ring around seta SD1 of mesothorax (7A) Phycitinae (phycitine moths) ---------- 8

Seta SD1 of abdominal segment VIII also surrounded by a sclerotized ring (7B). References: *1, 23, 27.*

Without sclerotized ring around seta SD1 of mesothorax (7C) ---------- 18

Sclerotized ring sometimes present around SD1 on segment VIII.

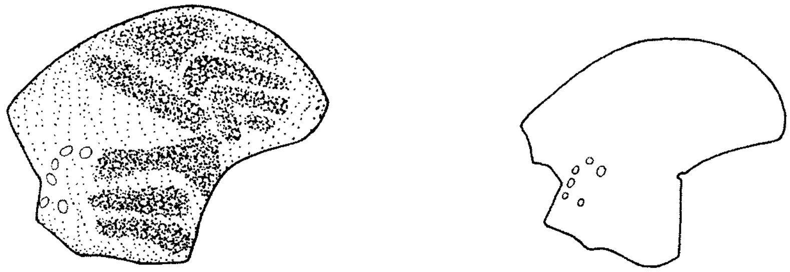


7A diagrammatic

7C diagrammatic

7B diagrammatic

8 Head rugulose, yellow or yellowish-brown, with darker pattern of coalesced spots (8A) 9
Head smooth, uniformly yellow to brown, without darker pattern (8B) ------------------- 10



8A *Acrobasis nuxvorella*

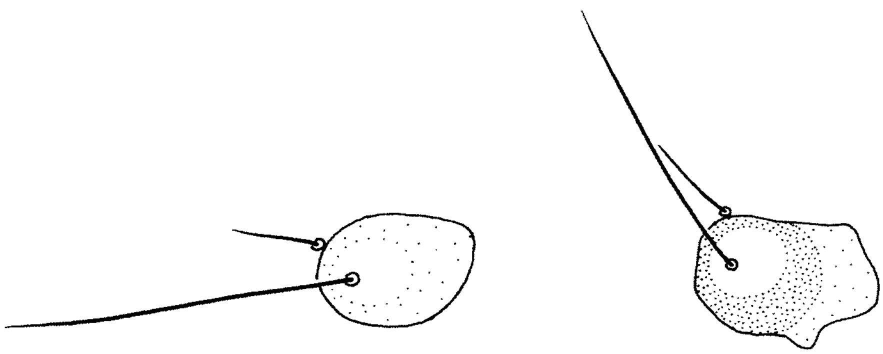
8B *Plodia interpunctella*

9 Head pale yellow with pale brownish pattern; sclerotized ring on mesothorax pale yellow (9A) --- **cranberry fruitworm,** *Acrobasis vaccinii*

Distribution: eastern Canada, eastern USA; on blueberries, cranberries. Reference: *22.*

Head yellowish-brown with brown to dark brown pattern; sclerotized ring on mesothorax dark with pale posterior margin (9B) -- **pecan nut casebearer,** *Acrobasis nuxvorella*

Distribution: eastern USA; on pecans. Reference: *22.*



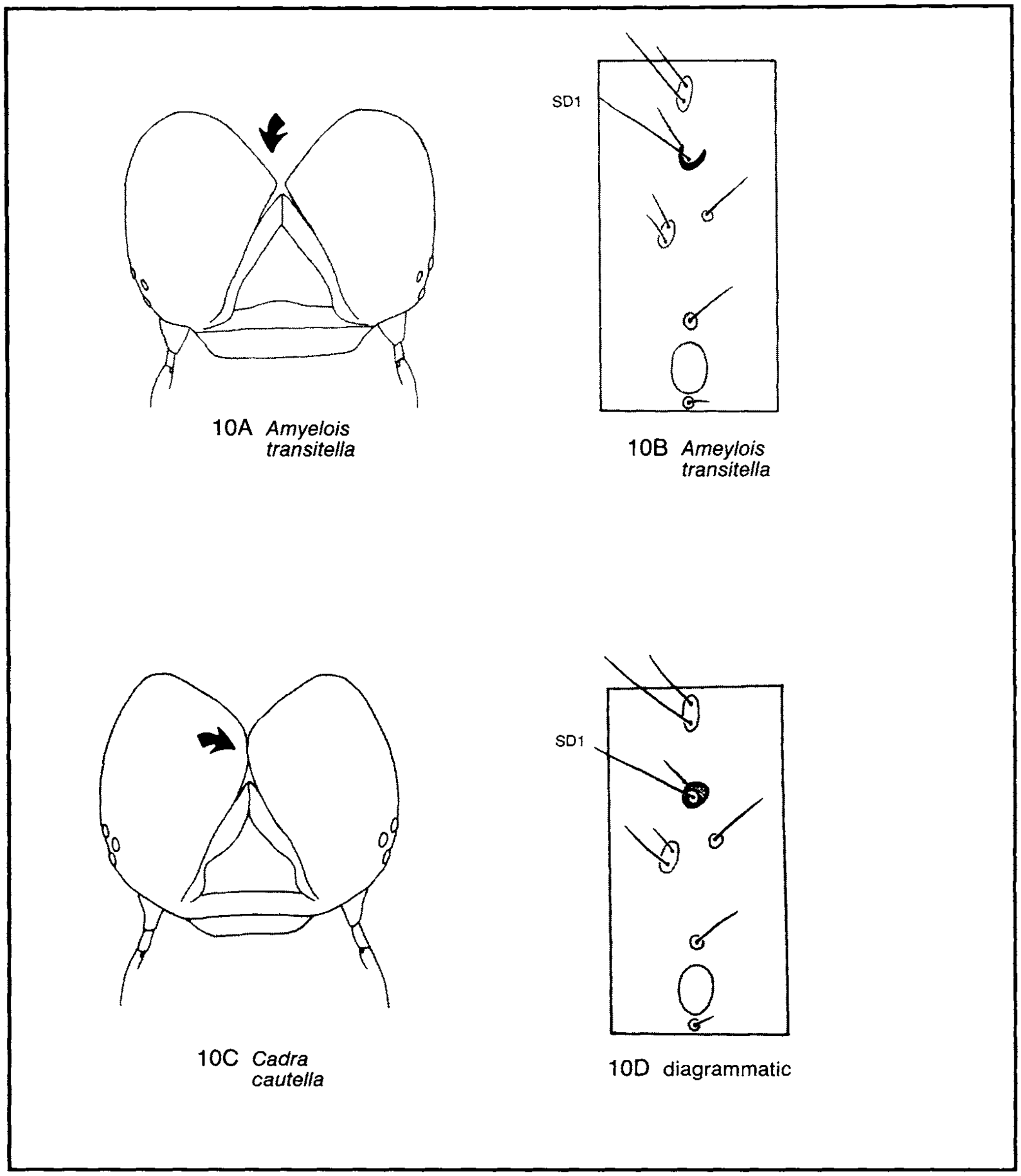
9A *Acrobasis vaccinii*

9B *Acrobasis nuxvorella*

10 Coronal suture absent (10A); sclerotized rings around seta SD1 on mesothorax (10B) and on abdominal segment VIII incomplete
-- **navel orangeworm,** *Amyelois transitella*

Distribution: the Americas, West Indies; on oranges, walnuts, and other fruits and pods.

Coronal suture present (10C); sclerotized rings around seta SD1 on mesothorax (10D) and on abdominal segment VIII complete -- 11



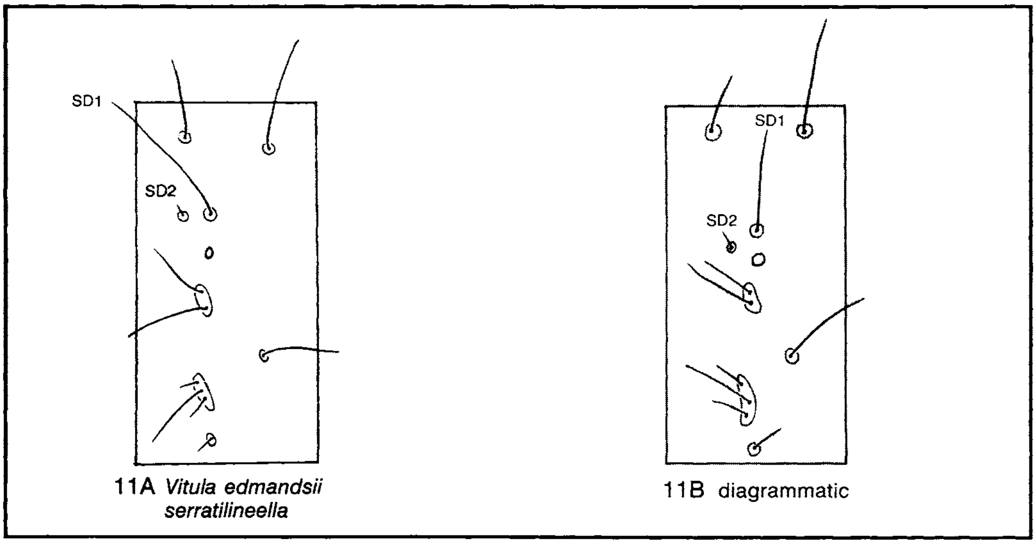
10A *Amyelois transitella*

10B *Ameylois transitella*

10C *Cadra cautella*

10D diagrammatic

11 Seta SD2 level with seta SD1 on most of abdominal segments I to VII (11A) ------ 12
Seta SD2 below seta SD1 on most of abdominal segments I to VII (11B) ------------ 13



11A *Vitula edmandsii serratilineella*

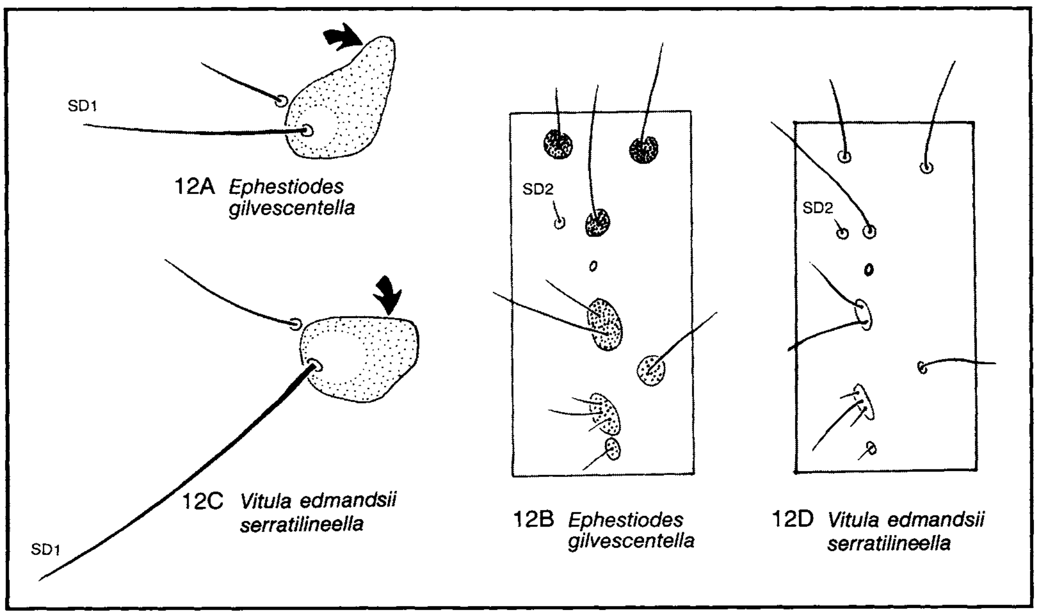
11B diagrammatic

12 Sclerotized ring around seta SD1 on mesothorax elongated dorsoposteriorly (12A); pinacula on abdominal segments I to VIII large and brown (12B)
---dusky raisin moth, *Ephestiodes gilvescentella*

Distribution: Hawaii, western North America; in raisins and stored almonds.

Sclerotized ring around seta SD1 on mesothorax irregularly rounded (12C); pinacula on segments I to VIII small (may or may not be pigmented) (12D)
---**driedfruit moth,** *Vitula edmandsii serratilineella*

Distribution: western Canada, western USA; on dried fruit, honey, and pollen. See also 11A. Reference: *25*.



12A *Ephestiodes gilvescentella*

12C *Vitula edmandsii serratilineella*

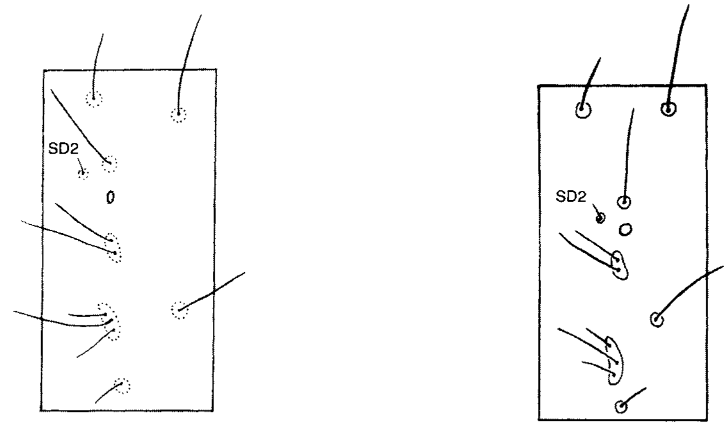
12B *Ephestiodes gilvescentella*

12D *Vitula edmandsii serratilineella*

13 Abdominal segments I to VIII apparently without pinacula (concolorous with body and not evident) (13A); pl. 116B ---------------------------**Indianmeal moth,** *Plodia interpunctella*

Distribution: cosmopolitan; in stored grain and vegetable and fruit products. See also 8B. Reference: *14*.

Abdominal segments I to VIII with small pigmented pinacula (13B). Genera *Cadra* and *Anagasta*-- 14

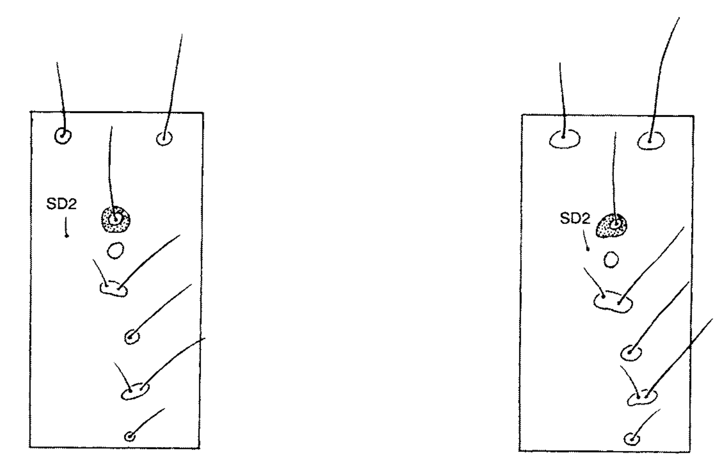


13A *Plodia interpunctella*

13B diagrammatic

14 Abdominal segment VIII with seta SD2 separated from spiracle by 2 to 3 times the horizontal diameter of the spiracle (14A)--- 15

Abdominal segment VIII with seta SD2 separated from spiracle by a distance equal to the horizontal diameter of the spiracle (14B)--- 16



14A diagrammatic

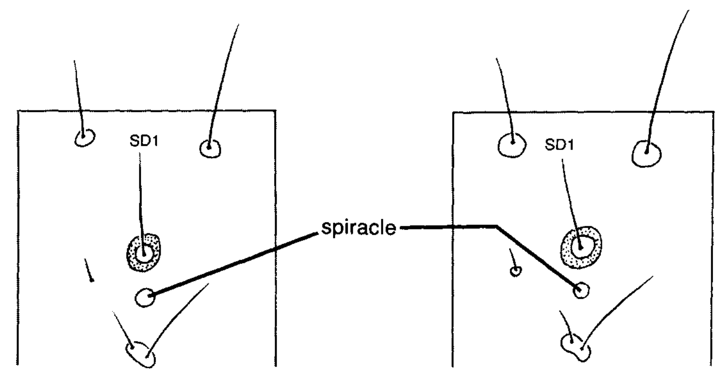
14B diagrammatic

15 Spiracle of abdominal segment VIII as large as the area enclosed by the sclerotized ring around seta SD1 (15A)---------------**Mediterranean flour moth,** *Anagasta kuehniella*

Distribution: nearly cosmopolitan; in grain and other stored and dried vegetable products.

Spiracle of abdominal segment VIII 2/3 or less as broad as the area enclosed by the sclerotized ring around seta SD1 (15B)---------------------**tobacco moth,** *Ephestia elutella*

Distribution: nearly cosmopolitan; in stored and dried vegetable products.



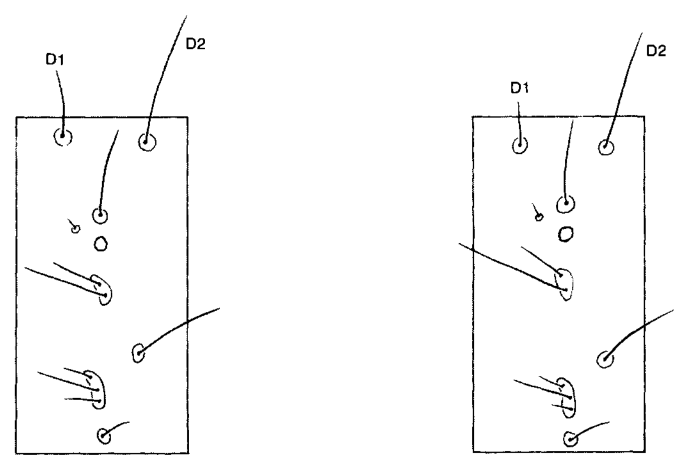
15A *Anagasta kuehniella*

15B *Ephestia elutella*

16 Seta D2 of abdominal segments I to VIII 2 to 2.5 times the length of seta D1 (16A); pl. 116C---**almond moth,** *Cadra cautella*

Distribution: cosmopolitan; in stored and dried vegetable products. See also 10C.

Seta D2 of abdominal segments I to VIII 3 to 5 times the length of seta D1 (16B) 17



16A *Cadra cautella*

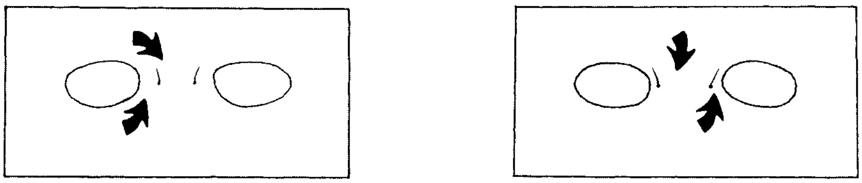
16B *Cadra figulilella*

17 Distance between setae V1 on mesothorax twice or less than the distance between seta V1 and coxa III (17A)---**raisin moth,** *Cadra figulilella*

Distribution: nearly cosmopolitan; in dried fruits, nuts, seeds, and beans. See also 16B.

Distance between setae V1 on mesothorax 3 to 5 times the distance between seta V1 and coxa III (17B)--carob moth, *Cadra calidella*

Distribution: Mediterranean region; in carobs, dried fruits, nuts.



17A *Cadra figulilella*

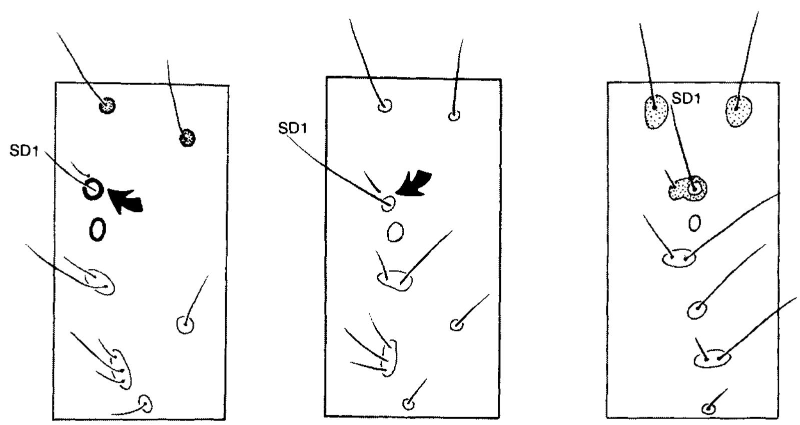
17B *Cadra calidella*

18 Abdominal segment I with sclerotized ring around seta SD1 (18A). Galleriinae (galleriine moths)--- 19

Seta SD1 of abdominal segment VIII also has a sclerotized ring (18B).

Abdominal segment I without sclerotized ring around seta SD1 (18C)------------------ 22

Seta SD1 of abdominal segment VIII may or may not have a sclerotized ring.

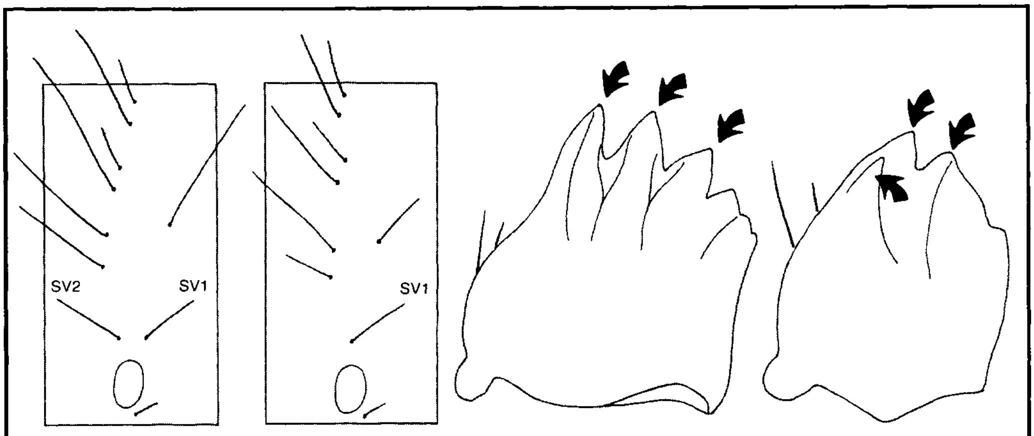


18A *Paralipsa gularis*

18C diagrammatic

18B *Paralipsa gularis*

19 Subventral group bisetose on meso- and metathorax (19A); mandible with 3 apical teeth and no ventral subapical tooth (19B)-- 20
Subventral group unisetose on meso- and metathorax (19C); mandible with 2 apical teeth and 1 ventral subapical tooth (19D) -- 21



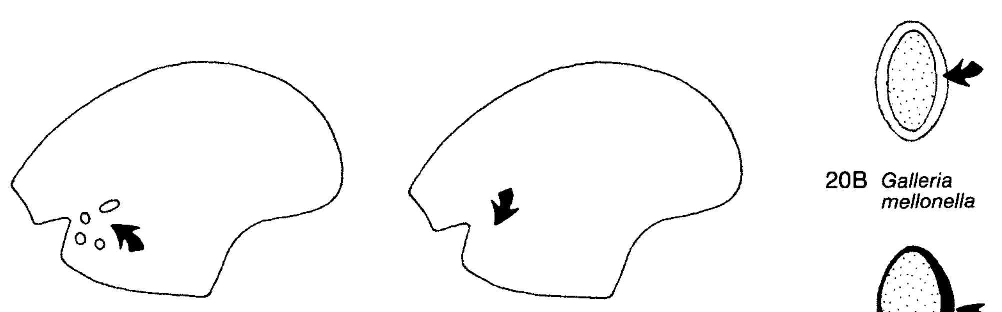
19A *Galleria mellonella* 19C *Corcyra cephalonica* 19B *Galleria mellonella* 19D *Corcyra cephalonica*

20 Head with 4 stemmata on each side (20A); spiracle with yellowish peritreme of uniform thickness (20B); pl. 117A-------------------**greater wax moth,** *Galleria mellonella*

Stemmata I and II are fused; stemma IV is missing. Distribution: cosmopolitan; in honeycombs. See also 19A&B.

Stemmata absent (20C); spiracle with black peritreme, thicker on caudal margin (20D)---**lesser wax moth,** *Achroia grisella*

Distribution: nearly cosmopolitan; in honeycombs and dried fruits.



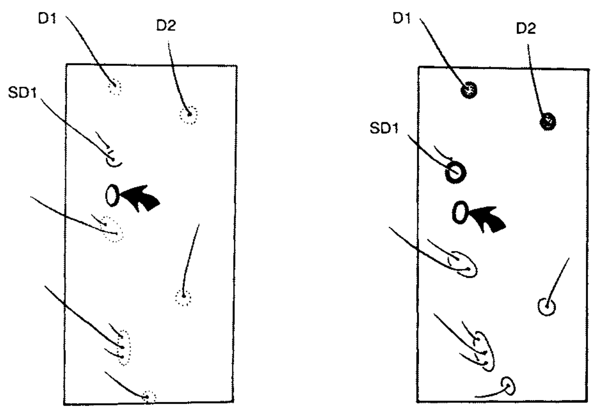
20A *Galleria mellonella* 20C *Achroia grisella* 20B *Galleria mellonella* 20D *Achroia grisella*

21 Sclerotized ring around seta SD1 on abdominal segments I and VIII not complete; spiracular peritremes thicker on caudal margin; pinacula of setae D1 and D2 on abdominal segments not pigmented (21A); pl. 117B ---------- **rice moth,** *Corcyra cephalonica*

Distribution: cosmopolitan; in dried vegetable products. See also 19C&D.

Sclerotized ring around seta SD1 on abdominal segments I and VIII complete; spiracular peritreme of uniform thickness; pinacula of setae D1 and D2 on abdominal segments pigmented (21B)---------- **stored nut moth,** *Paralipsa gularis*

Distribution: nearly cosmopolitan; in stored vegetable products. See also 18B.

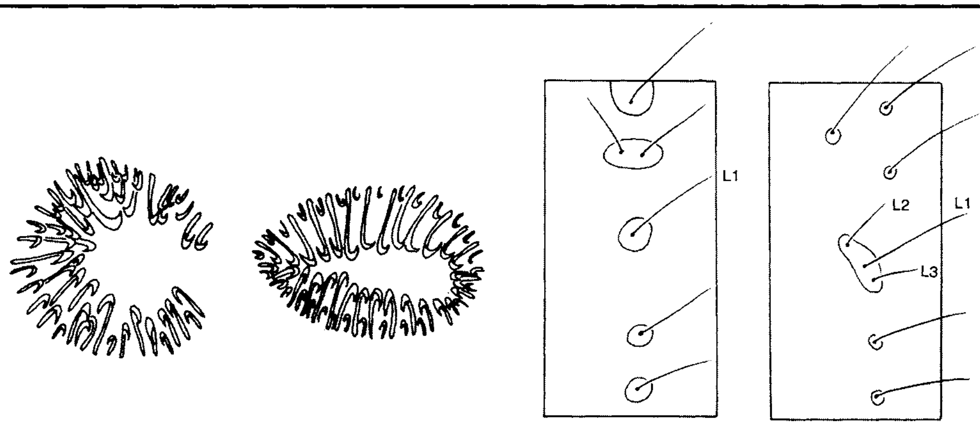


21A *Corcyra cephalonica*

21B *Paralipsa gularis*

22 Ventral prolegs with crochets in a penellipse (22A); abdominal segment IX with 1 seta in lateral group (22B). Pyraustinae (pyraustine moths) ---------- 23

Ventral prolegs with crochets in a complete circle (22C); abdominal segment IX with 3 setae in lateral group (22D). Pyralinae (pyraline moths)---------- 25



22A *Ostrinia nubilalis*

22C *Pyralis farinalis*

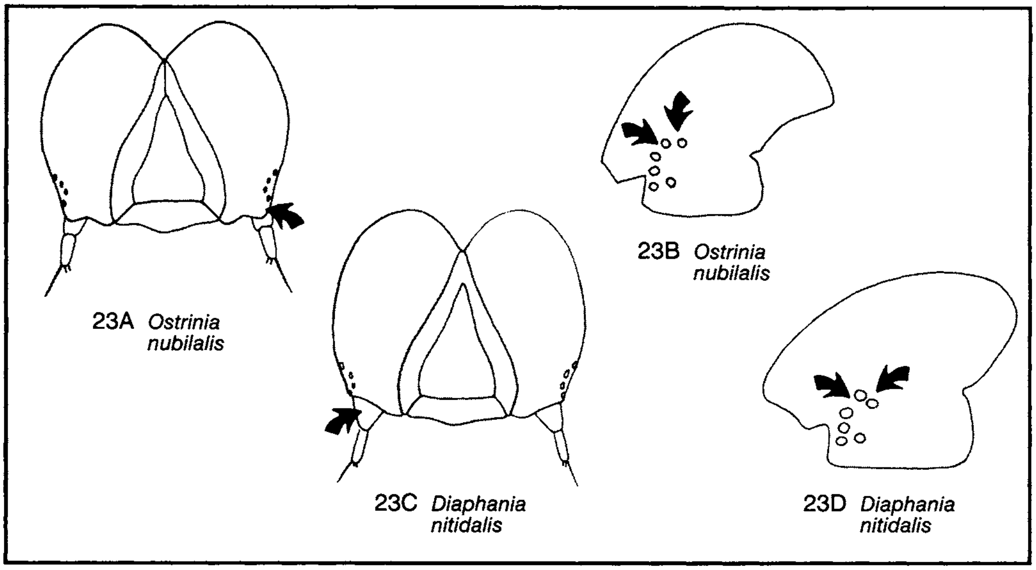
22B diagrammatic

22D diagrammatic

23 Head capsule with a shieldlike extension over base of antenna (23A); stemma II equidistant from stemmata I and III (23B); pl. 117C -- **European corn borer,** *Ostrinia nubilalis*

Distribution: Europe, USA; in beans, corn, peas, and many other plants. See also 3E.

Head capsule without shieldlike extension over base of antenna (23C); stemma II closer to stemma I than to stemma III (23D)-- 24



23A *Ostrinia nubilalis*

23B *Ostrinia nubilalis*

23C *Diaphania nitidalis*

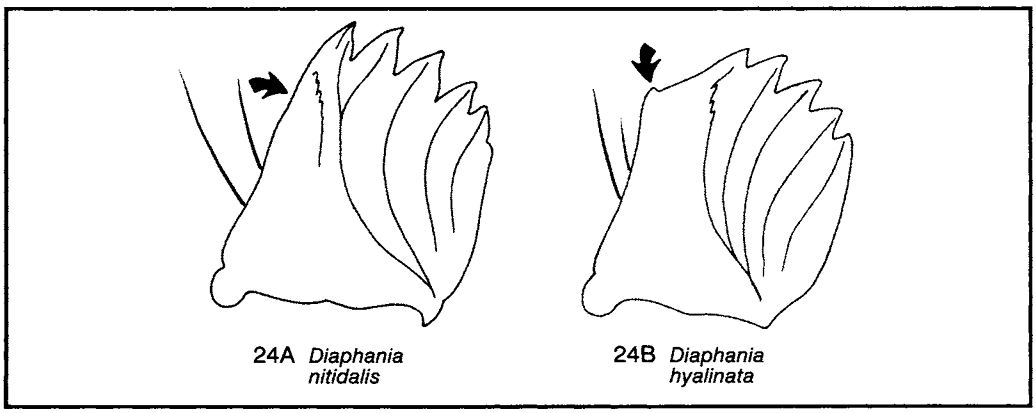
23D *Diaphania nitidalis*

24 Head with a pigmented triangular spot at genal angle; mandible without a projection on lateral margin (24A); pl. 118A-------------------------------**pickleworm,** *Diaphania nitidalis*

Pinacula dark in early instars, pale in late instars. Distribution: the Americas, West Indies; in cantaloupes, cucumbers, gourds, squash. See also 23C, 23D.

Head without a pigmented triangular spot at genal angle; mandible with a projection on the lateral margin (24B) ------------------------------------**melonworm,** *Diaphania hyalinata*

Pinacula pale in all instars. Distribution: eastern USA, Central America, northern South America, West Indies; in cantaloupe, cucumbers, gourds, pumpkins, squash.



24A *Diaphania nitidalis*

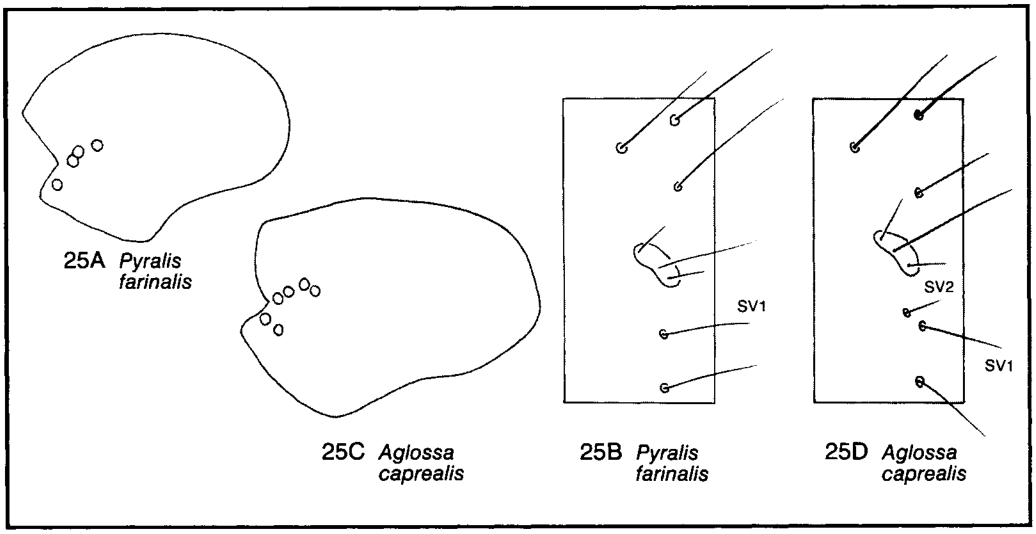
24B *Diaphania hyalinata*

25 Head with 4 pairs of stemmata (25A); abdominal segment IX with 1 subventral seta (25B); pl. 118B---**meal moth,** *Pyralis farinalis*

Stemmata I and II fused; stemma VI usually missing.
Distribution: cosmopolitan; in dried vegetable products.
See also 3D.

Head with 6 pairs of stemmata (25C); abdominal segment IX with 2 subventral setae (25D); pl. 118C---murky meal moth, *Aglossa caprealis*

Distribution: nearly cosmopolitan; in damp grain and rotting vegetable matter.



25A *Pyralis farinalis*

25C *Aglossa caprealis*

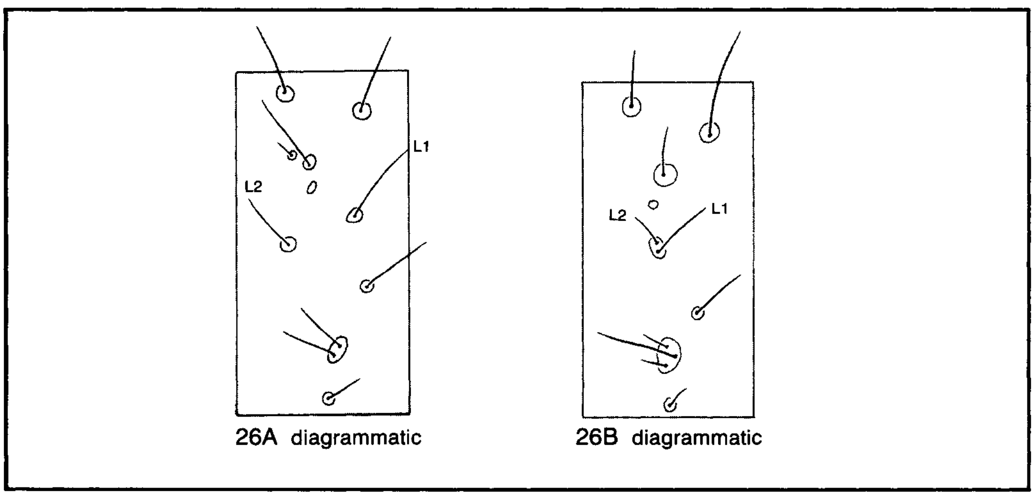
25B *Pyralis farinalis*

25D *Aglossa caprealis*

26 Setae L1 and L 2 on abdominal segments I to VIII distant from each other below spiracle (26A). Tineidae (**clothes moths**)--- 27

L1 may be well above L 2 behind the spiracle.
References: *16, 30.*

Setae L1 and L 2 on segments I to VIII close together below spiracle (26B)-------- 29



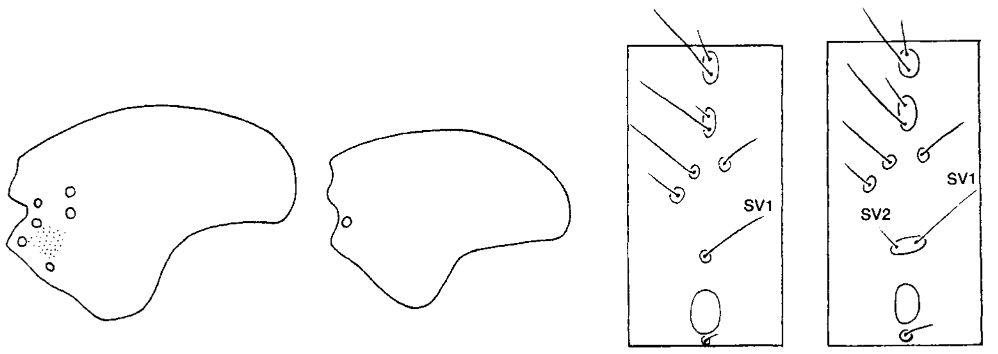
26A diagrammatic

26B diagrammatic

27 Head with 6 pairs of stemmata (27A); meso- and metathorax each with 1 subventral seta (27B)------------------------------**European grain moth**, *Nemapogon granella*

Distribution: nearly cosmopolitan; in mushrooms, stored grain, and dried fruits.

Head with 1 pair of stemmata (27C) or stemmata absent; meso- and metathorax each with 2 subventral setae (27D)------------------------------ 28



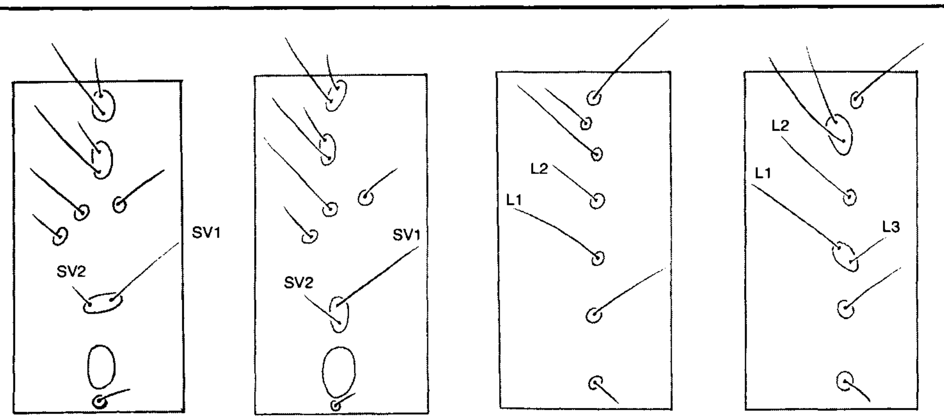
27A *Nemapogon granella* 27C *Monopis crocicapitella* 27B *Nemapogon granella* 27D *Tineola bisselliella*

28 Subventral setae in a nearly horizontal line on meso- and metathorax (28A); abdominal segment IX with 2 lateral setae (28B); stemmata absent; pl. 119A ------------------------------**webbing clothes moth,** *Tineola bisselliella*

Distribution: cosmopolitan; in wool, hair, feathers, and other animal products and occasionally stored cereals.

Subventral setae in nearly a vertical line on meso- and metathorax (28C); abdominal segment IX with 3 lateral setae (28D); head with 1 pair of stemmata ------------------------------*Monopis crocicapitella*

Distribution: Asia, Europe, North Africa, eastern USA; in textiles and dried vegetable matter. See also 27C.

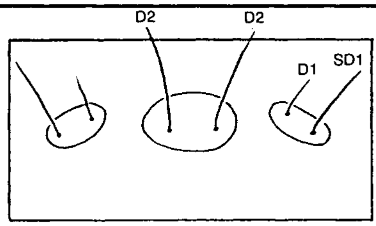


28A *Tineola bisselliella* 28C *Monopis crocicapitella* 28B *Tineola bisselliella* 28D *Monopis crocicapitella*

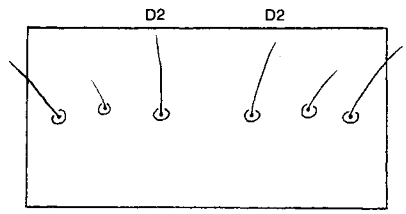
29 Paired setae D2 of abdominal segment IX on a single pinaculum (29A). Tortricidae **(leafroller moths)** ---------- 30

References: *19, 28.*

Paired setae D2 of abdominal segment IX not on a single pinaculum (29B) ---------- 36

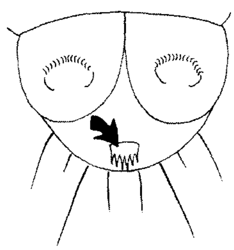


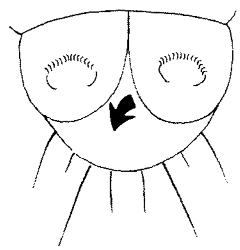
29A diagrammatic (dorsal view)



29B diagrammatic (dorsal view)

30 Anal fork present (30A) ---------- 31
Anal fork absent (30B) ---------- 33


30A diagrammatic

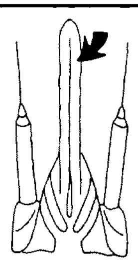

30B diagrammatic

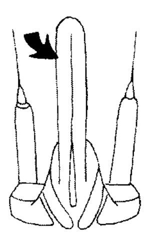
31 Spinneret 7 to 8.5 times as long as wide (31A); 30 to 40 crochets on ventral prolegs (31B) ---------- **oriental fruit moth,** *Grapholita molesta*

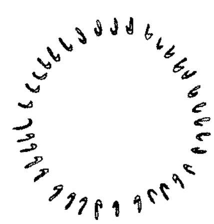
Body length 10 to 12 mm. Distribution: widespread in temperate regions; in apples, apricots, cherries, nectarines, peaches, pears, plums, quinces. Reference: *2.*

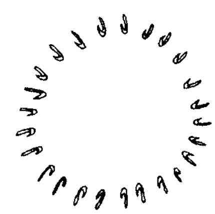
Spinneret 5 to 6 times as long as wide (31C); 25 to 30 crochets on ventral prolegs (31D) 32

Body length 8 to 10 mm.


31A *Grapholita molesta*


31C *Grapholita packardi*


31B *Grapholita molesta*

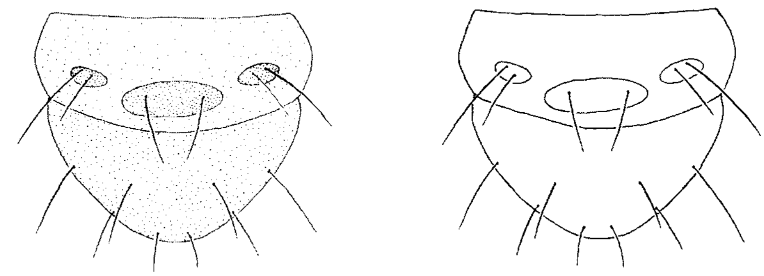

31D *Grapholita packardi*

32 Anal shield brown; pinacula of posterior segments brownish, never suffused with reddish pigment (32A)--**cherry fruitworm,** *Grapholita packardi*

Distribution: eastern Canada and eastern USA; in apples and cherries and in fruits of hawthorn and rose. See also 31C&D.

Anal shield yellowish or pale brown; pinacula of posterior segments never brownish, usually suffused with reddish pigment (32B)---**lesser appleworm,** *Grapholita prunivora*

Distribution: Canada, Europe (introduced), USA; in apples, cherries, pears, and plums.



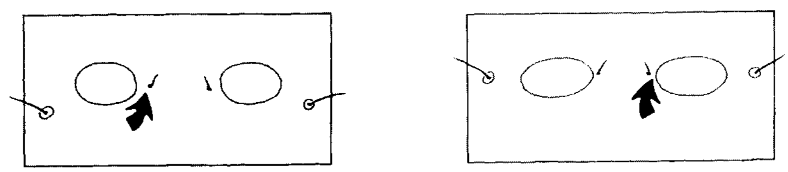
32A *Grapholita packardi*

32B *Grapholita prunivora*

33 Coxae III separated by a distance equal to about 1.5 times their greatest diameter; seta V1 well separated from coxa (33A)----------------------**filbertworm,** *Cydia latiferreana*

Distribution: Canada, Mexico, USA; in acorns and chestnuts.

Coxae III about their own diameter apart; seta V1 very close to coxa (33B) --------- 34



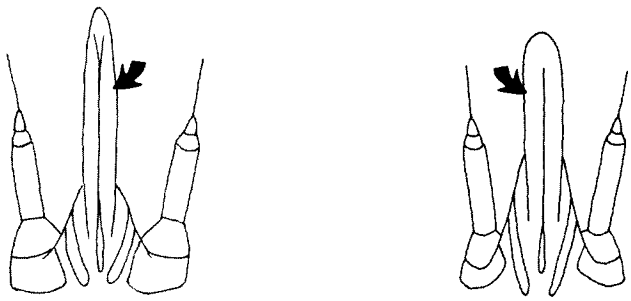
33A *Cydia latiferreana* (ventral view)

33B *Cydia* (ventral view)

34 Spinneret 6 to 6.5 times as long as wide (34A); head yellowish-brown overlaid with darker pattern; pl. 119B-- **codling moth,** *Cydia pomonella*

Distribution: nearly cosmopolitan; in apples, chestnuts, pears, quinces, and walnuts.

Spinneret 5 times as long as wide (34B); head yellow-brown without darker pattern 35



34A *Cydia pomonella*

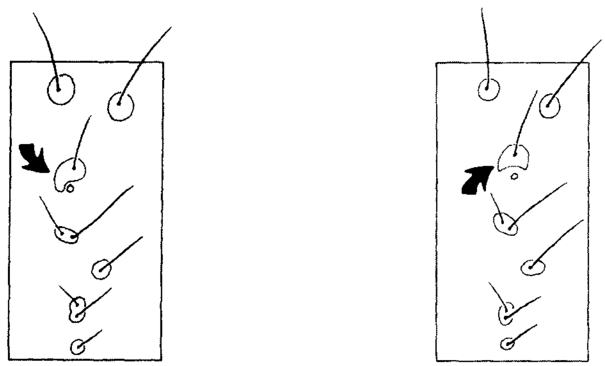
34B *Cydia caryana*

35 Pinaculum of seta SD1 on abdominal segments I to VII usually elongated anterior to spiracle (35A)-- **pea moth,** *Cydia nigricana*

Distribution: Asia Minor, Canada, Europe, USA; in pea pods.

Pinaculum of seta SD1 on abdominal segments I to VII not elongated anterior to spiracle (35B)--- **hickory shuckworm,** *Cydia caryana*

Distribution: eastern Canada, eastern USA; in pecans and hickory nuts. See also 34B.



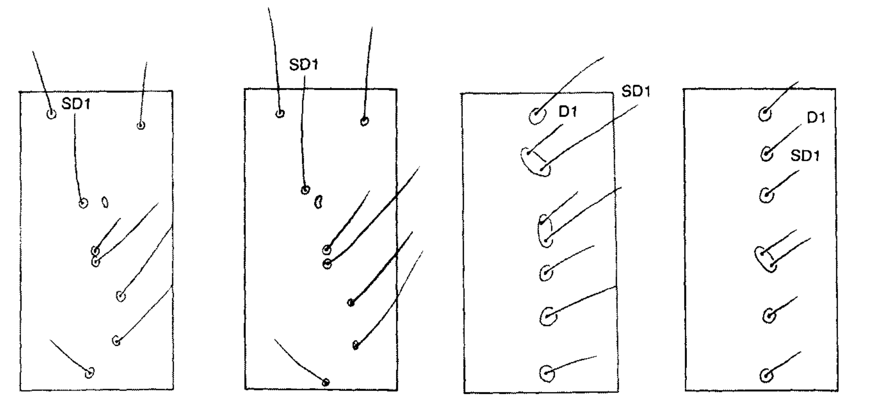
35A *Cydia nigricana*

35B *Cydia caryana*

36 Seta SD1 of abdominal segment VIII directly in front of spiracle (36A); seta SD1 of abdominal segment IX on same pinaculum with D1 (36B); pl. 119C. Cosmopterigidae (cosmopterigid moths) --**pink scavenger caterpillar,** *Pyroderces rileyi*

Distribution: Mexico, USA, West Indies; in corn, cotton, and many rotten or dried fruits.

Seta SD1 of abdominal segment VIII above and in front of spiracle (36C); seta SD1 of abdominal segment IX not on same pinaculum with D1 (36D) --------------------- 37

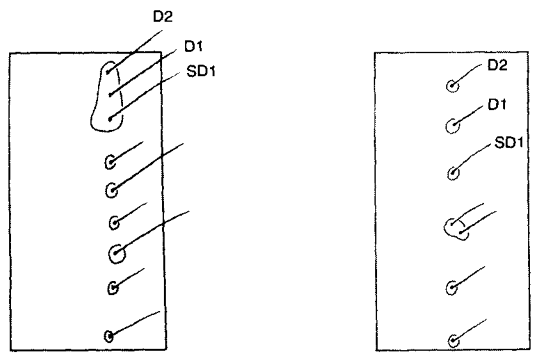


36A *Pyroderces rileyi* 36C diagrammatic 36B *Pyroderces rileyi* 36D diagrammatic

37 Setae D1, D2, and SD1 of abdominal segment IX on a single pinaculum (37A); pl. 120A. Argyresthiidae (argyresthiid moths)------**apple fruit moth,** *Argyresthia conjugella*

Distribution: Europe, Canada (British Columbia), USA (California, Oregon); in apples and *Sorbus* berries.

Setae D1, D2, and SD1 of abdominal segment IX not on a single pinaculum (37B) 38

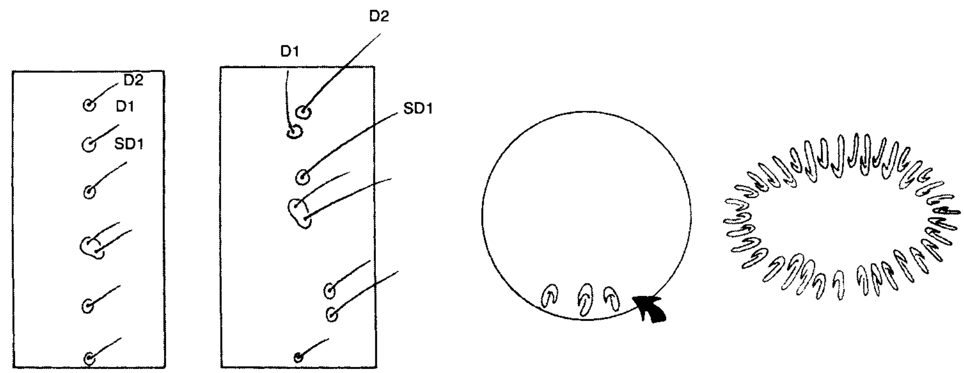


37A *Argyresthia conjugella* 37B *Sitotroga cerealella*

38 Seta D1 equidistant from setae D2 and SD1 on abdominal segment IX (38A); ventral prolegs short, narrow, often indistinct, with only 2 to 4 crochets (38B); pl. 120B. Gelechiidae (**gelechiid moths**)---------------**Angoumois grain moth,** *Sitotroga cerealella*

Distribution: nearly cosmpolitan; larvae live inside kernels of stored grain.

Seta D1 closely associated with and anterior to D2 on abdominal segment IX (38C); prolegs distinct, well developed, with many crochets (38D). Oecophoridae (**oecophorid moths**)---------- 39



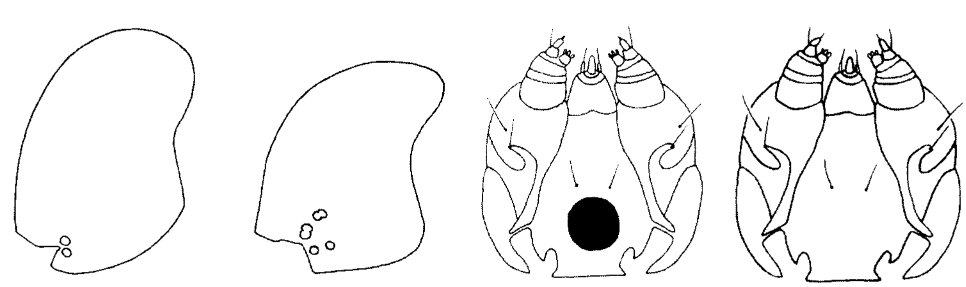
38A *Sitotroga cerealella* 38C *Hofmannophila pseudospretella* 38B *Sitotroga cerealella* 38D *Hofmannophila pseudospretella*

39 Head with 2 pairs of stemmata (39A); submentum with large oval pit (39B) ----------**whiteshouldered moth,** *Endrosis sarcitrella*

Distribution: nearly cosmopolitan; in bulbs and decaying fruit.

Head with 4 pairs of stemmata (39C); submentum without large oval pit (39D); pl. 120C ----------**brown house moth,** *Hofmannophila pseudospretella*

Stemmata I and II fused and stemmata III and IV fused, giving the appearance of 4 stemmata. Distribution: nearly cosmopolitan; in bulbs, stored vegetable products, and many other substrates. See also 38C.



39A *Endrosis sarcitrella* 39C *Hofmannophila pseudospretella* 39B *Endrosis sarcitrella* 39D *Hofmannophila pseudospretella*

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Notes and Sketches

16 FLIES (DIPTERA)

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Many kinds of flies are attracted to perishable foods on which they feed and deposit their eggs or larvae (maggots). Feeding by the larvae often hastens further decay by fostering growth of secondary decomposers such as bacteria and fungi. Larvae may develop rapidly in some media. For example, blow fly larvae (Calliphoridae) may reach full growth in three days under optimal conditions. Some larvae feed inside plant tissues and therefore often go unnoticed when the plants are bought for food or prepared for storage.

The keys given here to some common flies or groups of flies often associated with food are designed to separate taxa at least to family level and in some cases to generic or specific level. Most of the structures referred to in the keys are visible to the unaided eye or require no more than a hand lens; others require the use of a dissecting microscope. The key characters and the descriptive notes used to separate larvae pertain to full-grown larvae.

This key is compiled from several sources (*1, 2, 4, 5*). More complete, technical keys to family and generic levels for adult flies (and, in many cases, larvae) may be found in McAlpine *et al.* (*3*).

KEY

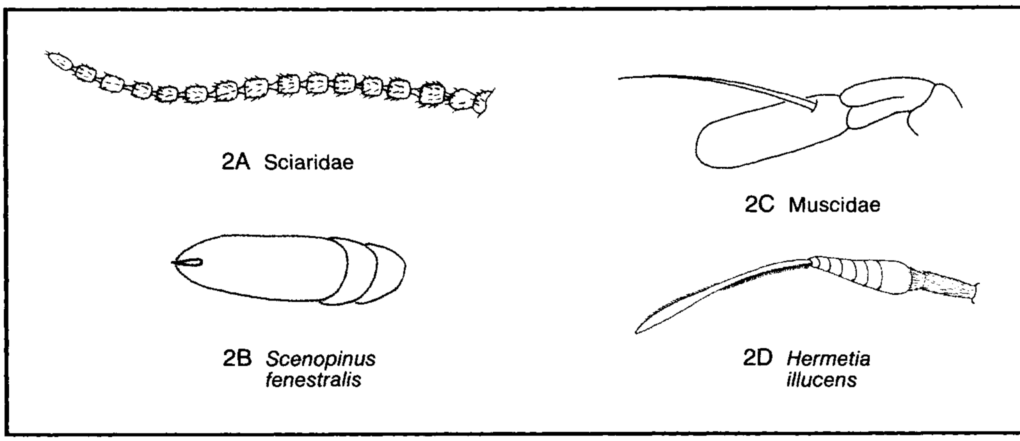
Drawings by C. Feller unless otherwise noted.

Adults

1 Adult specimen ---------- 2
Larval specimen ---------- 32

2 Antenna with 7 to 16 segments, each segment discrete, more or less similar, and freely articulated (2A) ---------- 3
Antenna with 3, often dissimilar, segments (2B, 2C) ---------- 5

The third segment may be annulate (2D) or aristate (2B, 2C).



2A Sciaridae

2C Muscidae

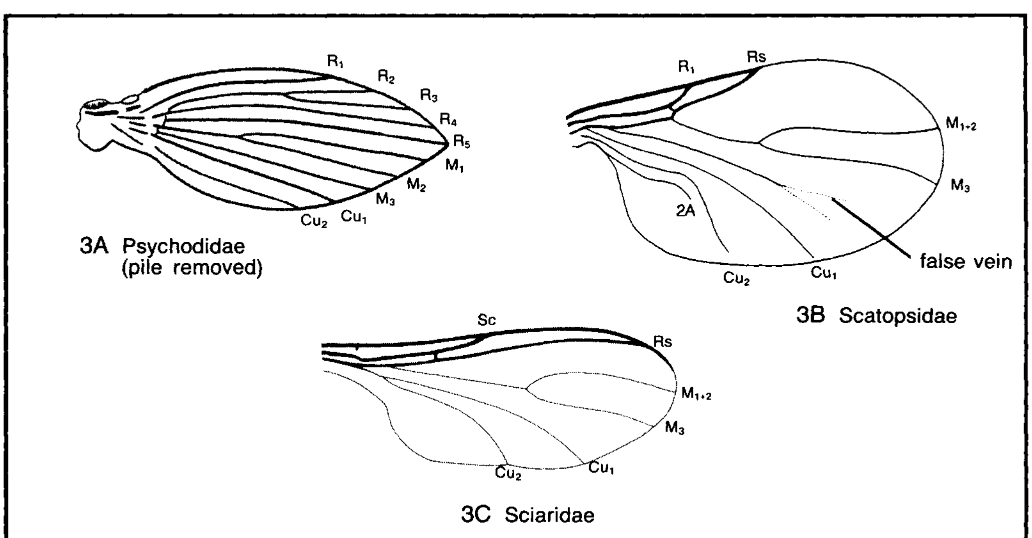
2B *Scenopinus fenestralis*

2D *Hermetia illucens*

3 Mothlike; body and wings densely haired, with wings held rooflike over body (pl. 121C); wing veins evenly distributed, not stronger anteriorly than elsewhere (3A) ---------- **moth flies,** Psychodidae

Drawing 3A from 2.

Not mothlike; much of the body smooth and shining; wings held flat or erect over body (see 4A, 4B); wing veins stronger and concentrated in anterior part of wing (3B, 3C) ---------- 4



3A Psychodidae (pile removed)

3B Scatopsidae

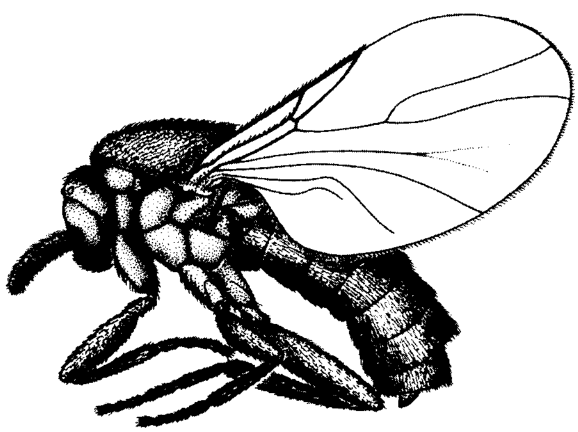
3C Sciaridae

4 Antenna clublike, with 7 to 12 segments; antennal length much shorter than thorax (4A) -- minute black scavenger flies, Scatopsidae

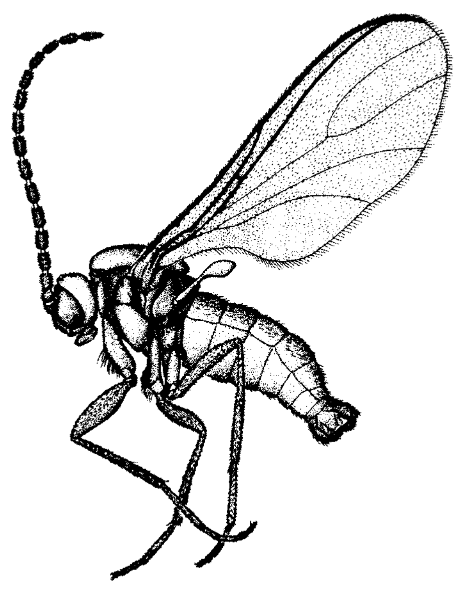
Species of the cecidomyiid genera *Heteropeza, Henria,* and *Mycophila* infesting cultivated mushrooms would also key out at this point (the adults of these genera have 10 or fewer antennal segments). In Sciaridae, the costal vein ends just beyond the last branch of R; in Cecidomyiidae, the costal vein continues beyond the wing tip. It would be unusual to find the adults of these mushroom pests anywhere but in mushroom houses. Even there cecids would be associated with the edible portions of mushrooms only as accidental contaminants. See also 3B.

Antenna elongate and flexible, with 16 segments; antennal length longer than thorax (4B)-- **darkwinged fungus gnats,** Sciaridae

See also 2A, 3C.



4A Scatopsidae

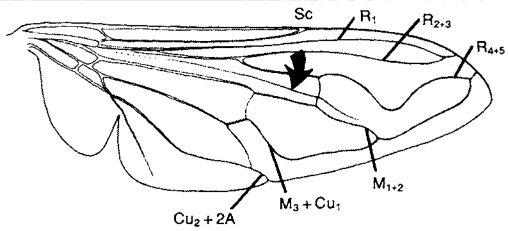


4B Sciaridae

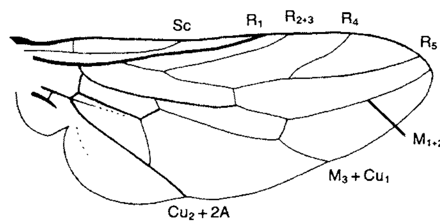
5 Wing with spurious vein (5A); body beelike; pl. 122A. Syrphidae (**flower flies**)
-- **drone fly,** *Eristalis tenax*

This is one of several similar species likely to be found.

Wing without spurious vein (5B); body not beelike -- 6

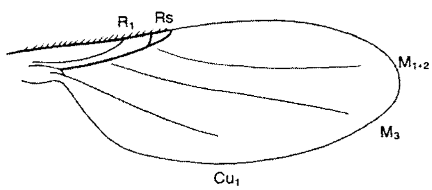


5A *Eristalis tenax*

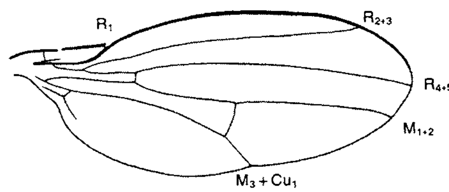


5B *Scenopinus*

6 Wing with strong veins anteriorly and weak, oblique veins posteriorly (6A); pl. 123C&D
-- **humpbacked flies,** Phoridae
Wing veins not appreciably stronger anteriorly than elsewhere (6B)-------------------- 7

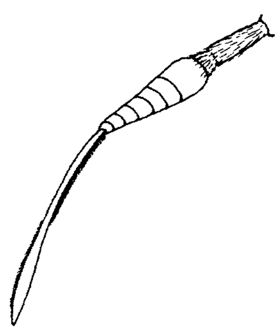


6A *Megaselia*

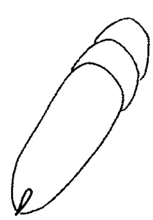


6B *Drosophila*

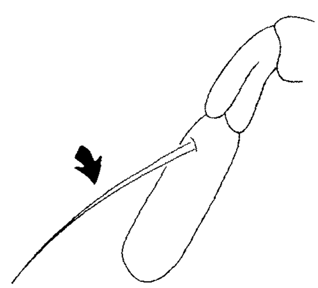
7 Antenna without a long, dorsal arista (7A, 7B) --- 8
Antenna with a long, dorsal arista (7C) --- 9



7A *Hermetia illucens*



7B *Scenopinus fenestralis*



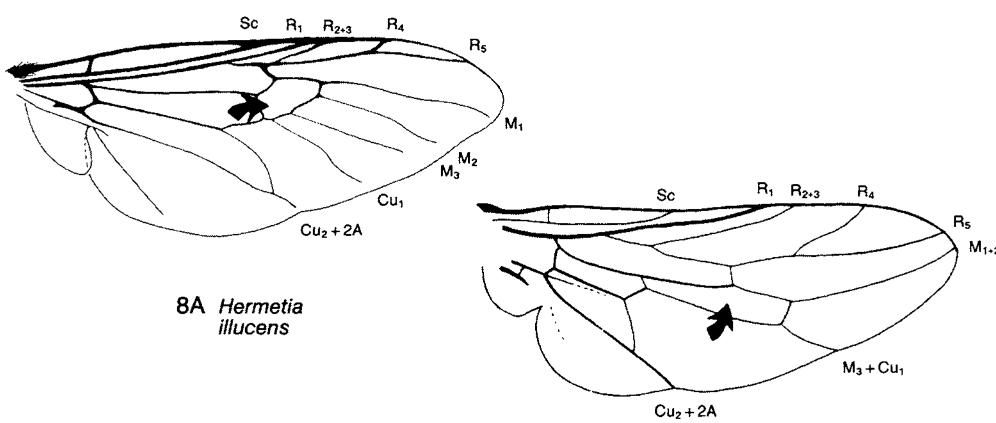
7C Muscidae

8 Discal (central) cell rounded with several veins issuing from it (8A); pl. 124B&C. Stratiomyidae (**soldier flies**) --------------------------------**black soldier fly,** *Hermetia illucens*

This is one of several similar species likely to be found.
See also 7A.

Discal cell long, with only 2 veins issuing from it (8B); pl. 125A. Scenopinidae (window flies) --*Scenopinus* spp.

See also 7B.



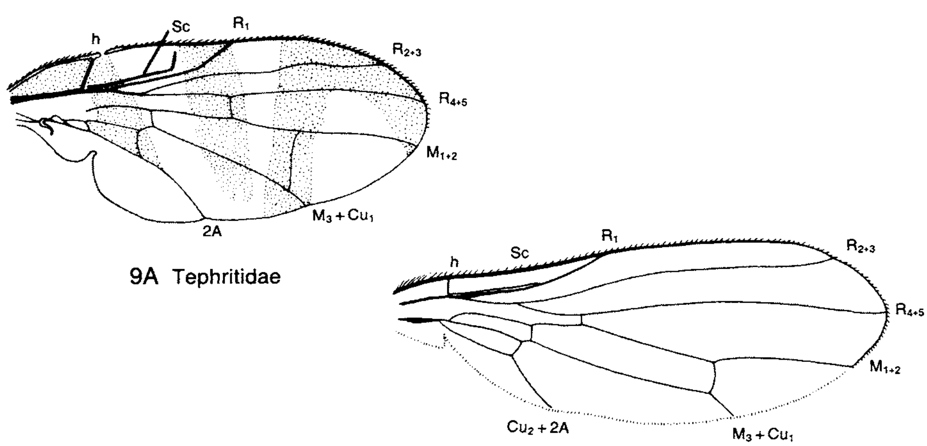
8A *Hermetia illucens*

8B *Scenopinus*

9 Thorax, abdomen, and wing (9A) patterned --------------------------------**fruit flies,** Tephritidae

Tephritids likely to occur in fruit products include *Anastrepha* spp., *Rhagoletis* spp., and *Ceratitis capitata.*

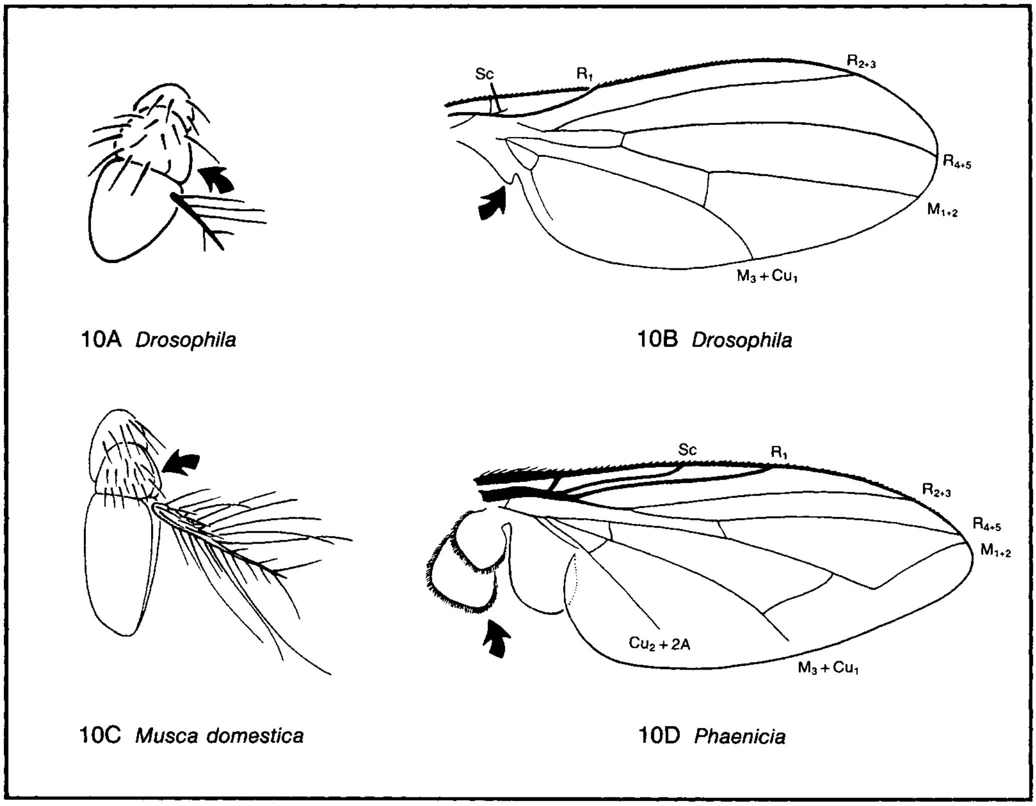
Thorax and abdomen usually brown to black; wing not patterned (9B) (may be a spot near apex of R_{2+3}) -- 10



9A Tephritidae

9B *Psila rosae*

10 Antennal segment II without longitudinal suture (10A); calypteres of wing absent or inconspicuous (10B) ---------- 11
Antennal segment II with longitudinal suture (10C); wing with large calypteres (10D) 15



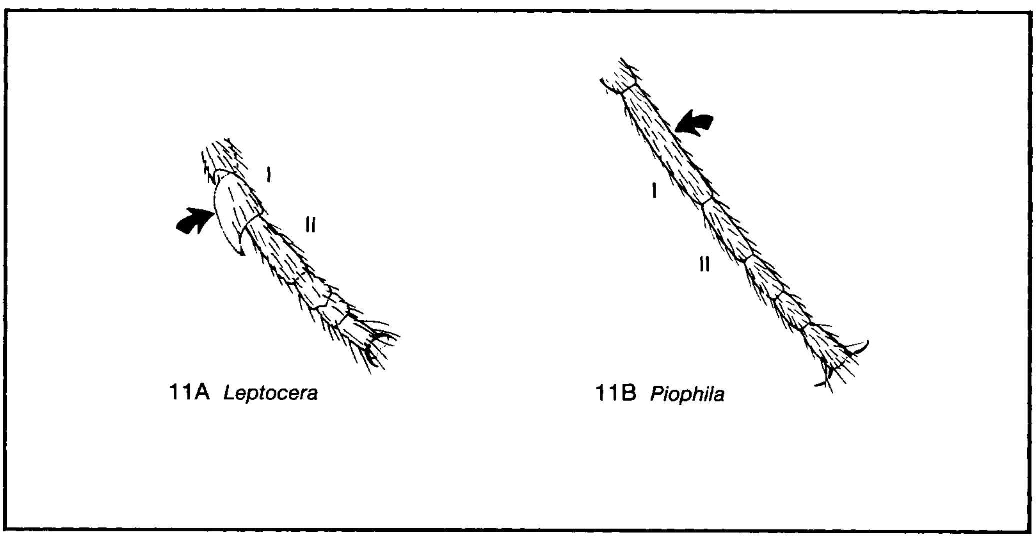
10A *Drosophila*

10B *Drosophila*

10C *Musca domestica*

10D *Phaenicia*

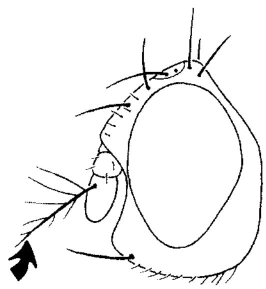
11 First segment of tarsus III wider and shorter than segment II (11A); pl. 125B.
Sphaeroceridae (small dung flies) ---------- *Leptocera* spp.
First segment of tarsus III longer but not wider than segment II (11B) ---------- 12



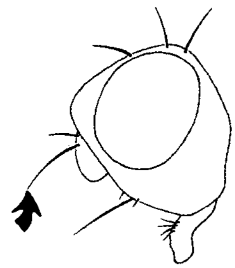
11A *Leptocera*

11B *Piophila*

12 Arista plumose (12A) -- 13
Arista simple or with inconspicuous hairs (12B) -- 14



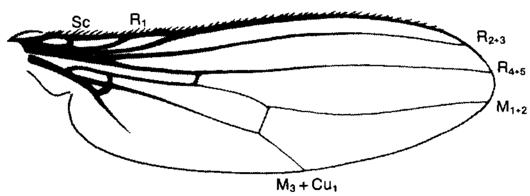
12A *Drosophila*



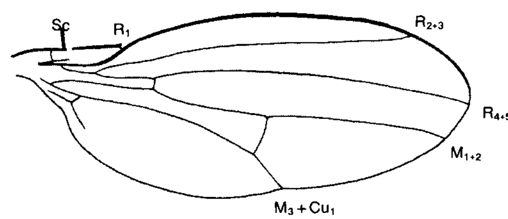
12B *Piophila casei*

13 Abdomen conspicuously narrowed at base (pl. 126A&B); subcostal vein complete (13A)
--- black scavenger flies, Sepsidae
Abdomen not conspicuously narrowed at base (pl. 126C); subcostal vein incomplete
(13B). Drosophilidae **(small fruit flies)**--*Drosophila*

See also 10A, 12A.



13A *Sepsis*



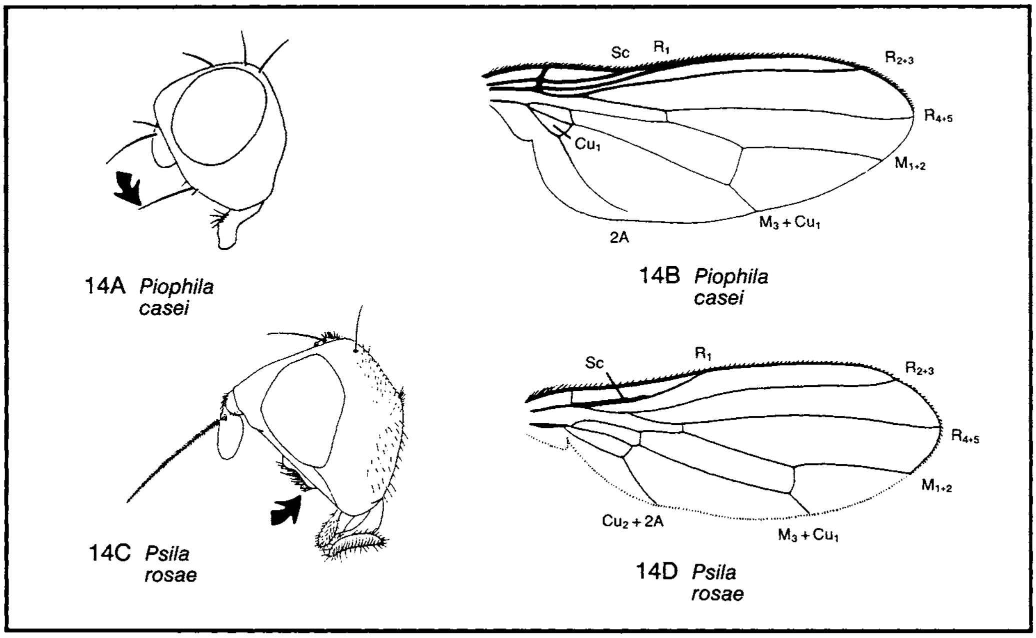
13B *Drosophila*

14 Strong oral bristle present (14A); subcostal vein ending in costa (14B); pl. 127A.
Piophilidae (**skipper flies**)---**cheese skipper,** *Piophila casei*

See also 11B.

Strong oral bristle absent (14C); subcostal vein ending in radius (14D); pl. 127B.
Psilidae (**rust flies**)--**carrot rust fly,** *Psila rosae*

This is one of several similar species likely to be found.



14A *Piophila casei*

14B *Piophila casei*

14C *Psila rosae*

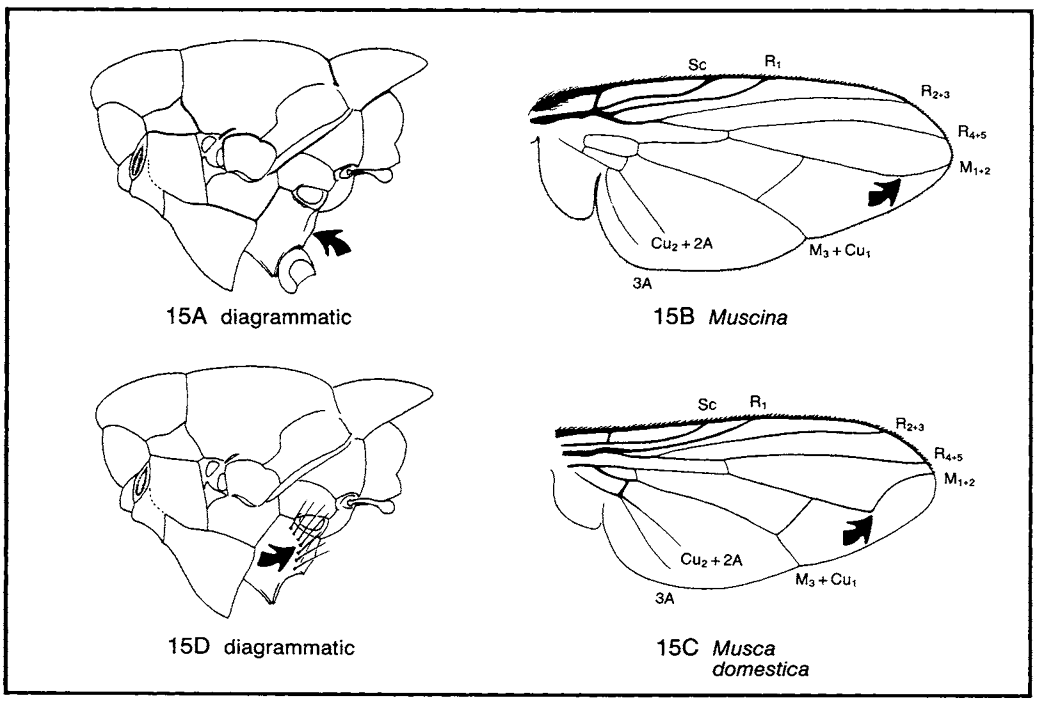
14D *Psila rosae*

15 Hypopleuron bare (15A). Muscidae (muscid flies) -- 16

Median vein (M_{1+2}) straight or gently curved forward (15B), except in *Musca* spp. (15C).

Hypopleuron with a row of strong setae (15D) -- 21

Median vein (M_{1+2}) strongly bent forward near apex (as in 15C).



15A diagrammatic

15B *Muscina*

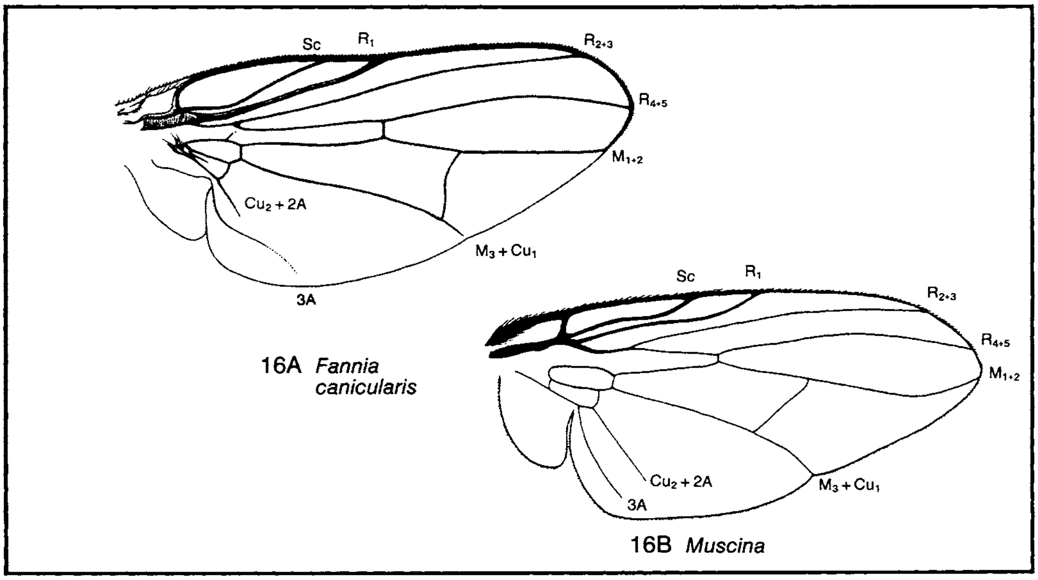
15D diagrammatic

15C *Musca domestica*

16 Vein 3A so strongly curved forward that it would intersect with a hypothetical extension of $Cu_2 + 2A$ well before wing margin (16A); pl. 128B
---**little house fly,** *Fannia canicularis*

This is one of several species likely to be found.

Vein 3A straight or only weakly curved (16B) -- 17



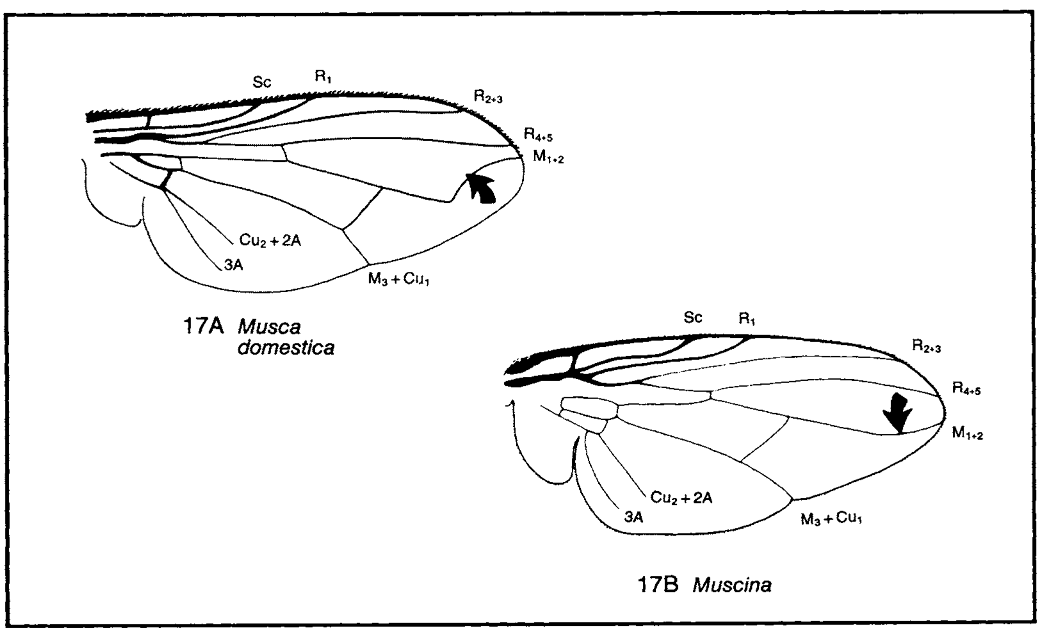
16A *Fannia canicularis*

16B *Muscina*

17 Vein M_{1+2} strongly bent forward apically (17A); pl. 129B------**house fly,** *Musca domestica*

See also 10C.

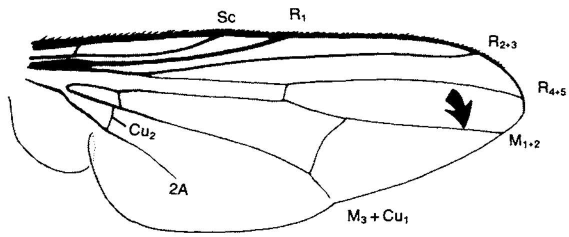
Vein M_{1+2} straight or weakly curved apically (17B) --- 18



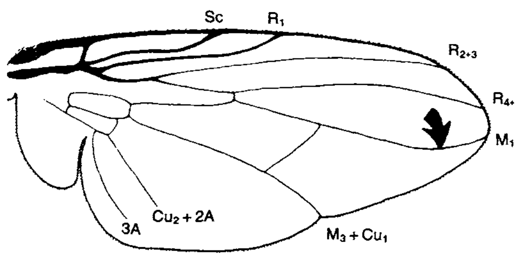
17A *Musca domestica*

17B *Muscina*

18 Median vein straight (18A); body shining, black. Genus *Ophyra* ---------- 19
Median vein curved apically (18B); body dull, grayish-black, with tip of scutellum reddish. Genus *Muscina* ---------- 20



18A *Ophyra*



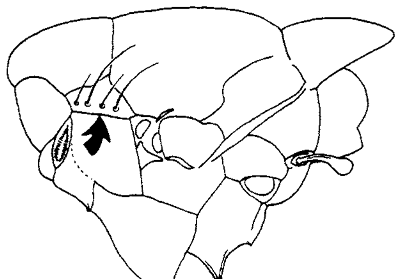
18B *Muscina*

19 Palpus yellow; pl. 130A ---------- bronze dump fly, *Ophyra aenescens*
Palpus black ---------- dump fly, *Ophyra leucostoma*

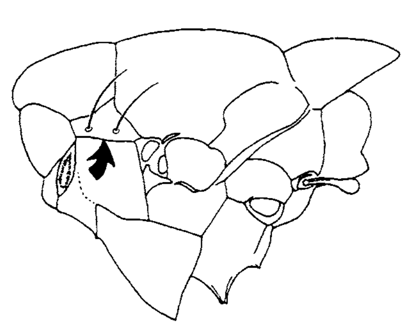
20 Legs predominantly red; pl. 130B ---------- **false stable fly,** *Muscina stabulans*
Legs black ---------- *Muscina assimilis*

21 Notopleuron with 3 or 4 setae (21A); body dull colored, the abdomen with checkered pattern; pl. 131B. Sarcophagidae (**flesh flies**) ---------- *Sarcophaga* spp.

Notopleuron with 2 setae (21B); body shining green, bronze, or blue. Calliphoridae (**blow flies**) ---------- 22

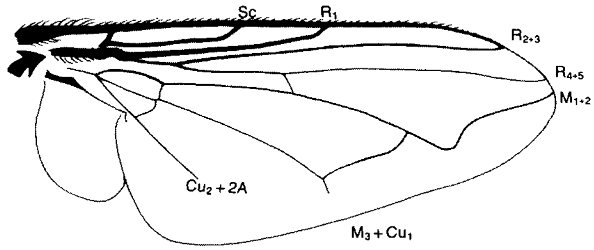


21A diagrammatic

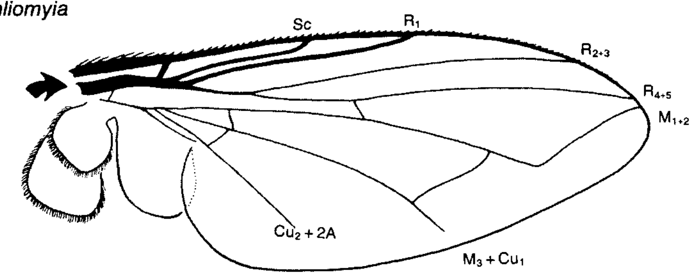


21B diagrammatic

22 Base of stem vein (R) ciliate (22A) ---------- 23
Base of stem vein (R) bare (22B) ---------- 26

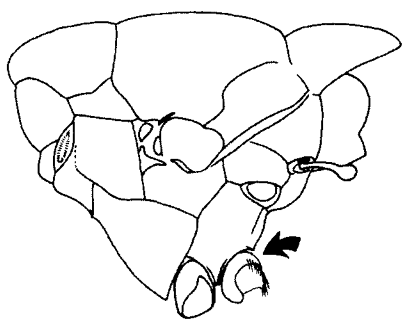


22A *Cochliomyia*

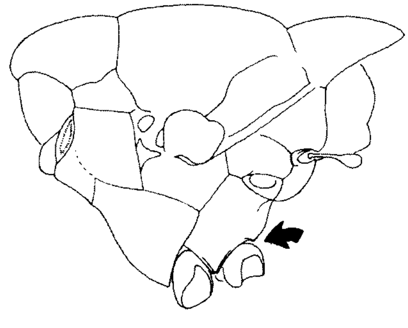


22B *Phaenicia*

23 Coxa III pilose posteriorly (23A) ---------- 24
Coxa III bare posteriorly (23B) ---------- 25



23A diagrammatic



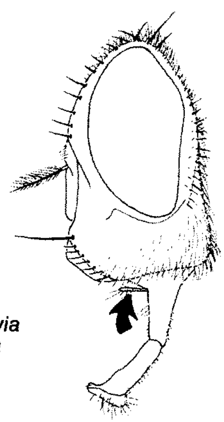
23B diagrammatic

24 Palpus short, filiform (24A); pl. 132B------**secondary screwworm,** *Cochliomyia macellaria*

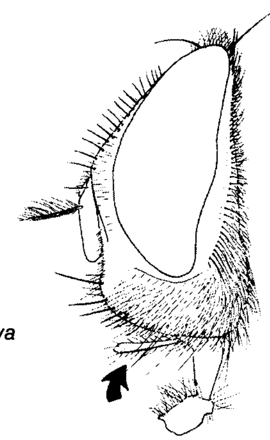
See also 22A.

Palpus long, clavate (24B); pl. 133E&F--------Old World screwworm flies, *Chrysomya* spp.

Body length: 8-12 mm. Members of the genus *Chrysomya,* widely distributed in the Old World, commonly lay eggs on meat and fish (2). Four species are now established in the New World. The **hairy maggot blow fly,** *C. rufifacies,* appeared in Costa Rica shortly before 1978 and has since spread through Mexico to Texas and Oklahoma. *C. albiceps, C. megacephala,* and *C. chloropyga* have been collected in South America (Brazil, Peru) since 1975.



24A *Cochliomyia macellaria*



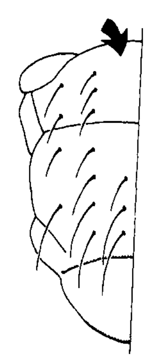
24B *Chrysomya rufifacies*

25 Mesothoracic spiracle (25A) with orange hair; presutural acrostical bristles well developed (25B)--**black blow fly,** *Phormia regina*

Mesothoracic spiracle (25A) with black hair; presutural acrostical bristles vestigial, not differentiated from surrounding hairs (25C)
--- Holarctic blow fly, *Protophormia terraenovae*

25A diagrammatic

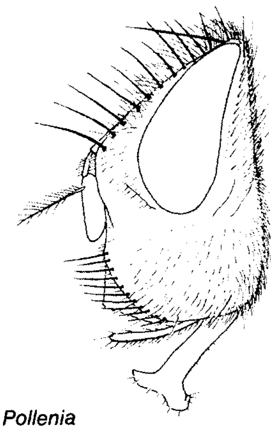
25B *Phormia regina*



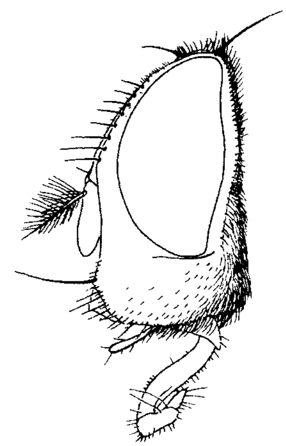
25C *Protophormia terraenovae*

26 Eye comparatively small in relation to head (26A); thorax with crinkly yellow hair among the bristles ---------- **cluster fly,** *Pollenia rudis*

Eye comparatively large in relation to head (26B); thorax without crinkly hair ------ 27

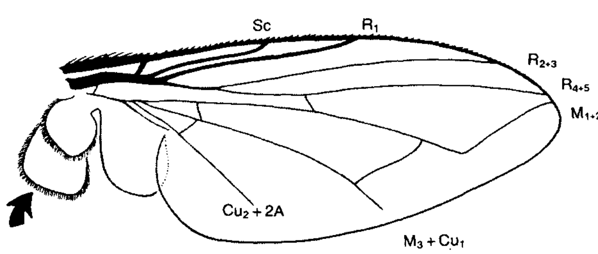


26A *Pollenia rudis*

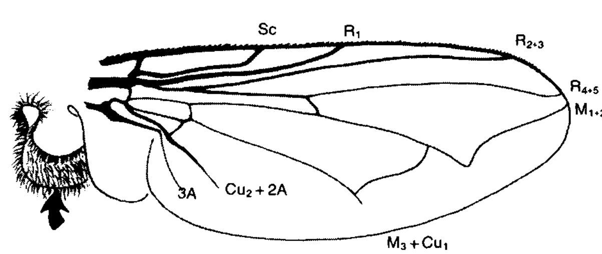


26B *Phaenicia sericata*

27 Lower (proximal) calypter bare (27A). Genus *Phaenicia* ---------- 28
Lower calypter with long, dark pile (27B) ---------- 29



27A *Phaenicia*



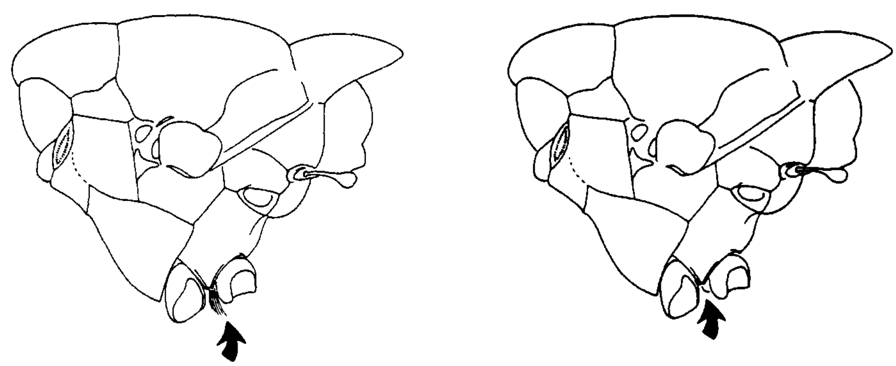
27B *Calliphora*

28 Metasternum setose (28A)---------------------------------------green bottle fly, *Phaenicia sericata*

Body length: 6-9.5 mm. See also 26B.

Metasternum bare (28B)---------------------------------------bronze bottle fly, *Phaenicia cuprina*

Body length: 5-8.5 mm.



28A *Phaenicia sericata*

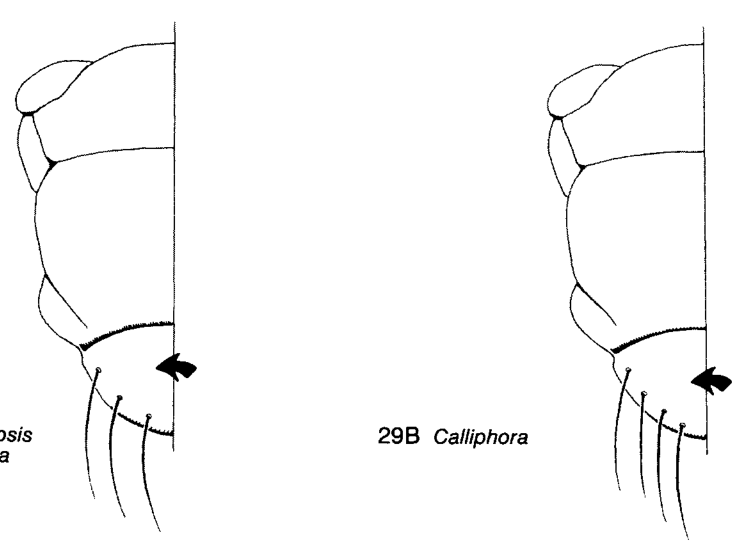
28B *Phaenicia cuprina*

29 Scutellum with 3 strong lateral bristles on each side (29A)
---blue bottle fly, *Cynomyopsis cadaverina*

Body length: 9-14 mm.

Scutellum with 4 strong lateral bristles on each side (29B). Genus *Calliphora*------- 30

See also 27B.



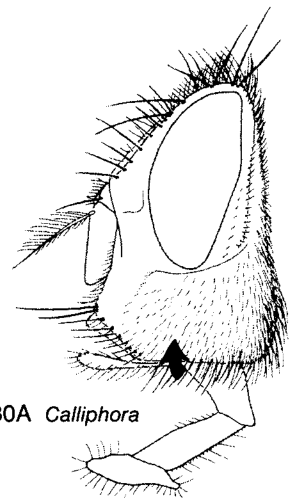
29A *Cynomyopsis cadaverina*

29B *Calliphora*

30 Integument of bucca (30A) reddish on anterior half; basicosta (30B) yellow to orange
-- cosmopolitan blue bottle fly, *Calliphora vicina*

Body length: 6-12 mm.

Buccal integument (30A) black; basicosta (30B) black-- 31



30A *Calliphora*

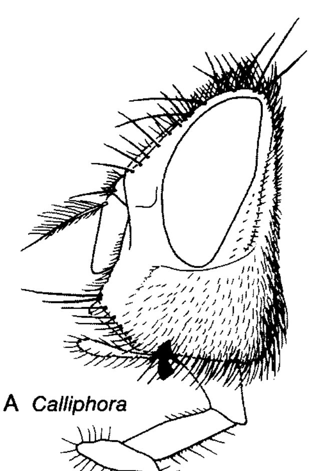
30B *Calliphora*

31 Buccal hairs (31A) mostly black; tibia II with 2 posterior bristles (31B)
-- Nearctic blow fly, *Calliphora terraenovae*

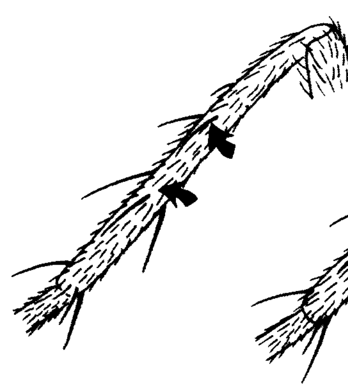
Body length: 9-13 mm.

Buccal hairs (31A) mostly reddish orange; tibia II with 3 posterior bristles (31C)
--- Holarctic blue bottle fly, *Calliphora vomitoria*

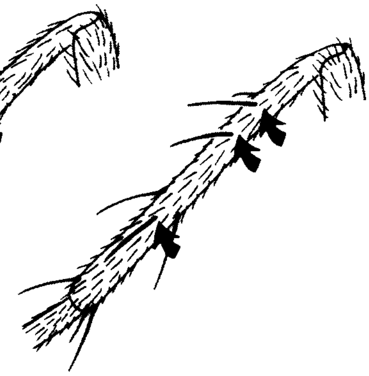
Body length: 10-14 mm.



31A *Calliphora*



31B *Calliphora terraenovae* (posterior view of left tarsus II)



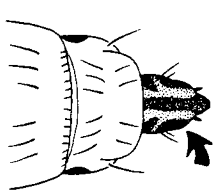
31C *Calliphora vomitoria* (posterior view of left tarsus II)

Larvae

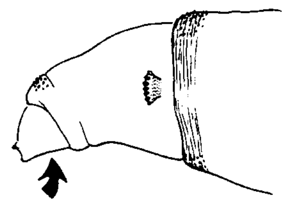
32 Larva with a definite, sclerotized head capsule (32A) ---------- 33

Cecid larvae (Cecidomyiidae) would key out at this point. These larvae are less than 5 mm long and have a tiny, lightly-sclerotized head capsule. The most distinctive character is the sternal spatula, a clove-shaped "breast bone" located ventrally on the pro-thorax. Most of the mushroom-infesting species have minute, whitish larvae that are inconspicuous against the white color of their hosts, but if members of the genus *Mycophila* are present, their bright orange color renders the mushrooms unmarketable.

Larva without a definite, sclerotized head capsule (mouth hooks may or may not be visible) (32B) ---------- 37



32A *Hermetia illucens*



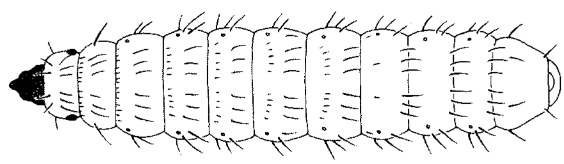
32B *Musca domestica*

33 Large larva (15 to 20 mm) with long, conspicuous setae on all body segments (33A). Stratiomyidae (**soldier flies**); pl. 124A ---------- **black soldier fly,** *Hermetia illucens*

This is one of several similar species likely to be found. See also 32A.

Small larva (less than 8 mm), either mostly glabrous or pubescent (31B) ---------- 34

Drawing 33B by A.D. Cushman.

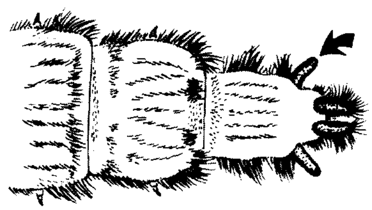


33A *Hermetia illucens*

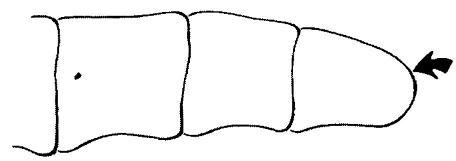
33B *Scenopinus*

34 Body fuzzy; posterior spiracles at tips of long, membranous processes (34A) or at tip of a sclerotized tube (34B) ---------- 35
Body smooth; posterior spiracles flush with body wall (34C) ---------- 36

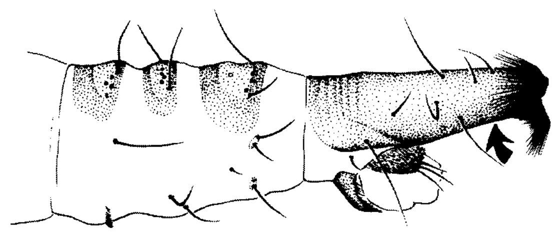
Larval chironomid midges (Chironomidae [Tendipedidae]) would key out at this point. Midge larvae have a complete head capsule, usually have prominent anterior and posterior prolegs, and have no functional spiracles. Midge larvae occasionally appear in foods that have been washed with unfiltered water from storage tanks or ponds.



34A Scatopsidae



34C Sciaridae



34B Psychodidae

35 Posterior spiracles at ends of long, dorsolateral tubes (35A)
---------- minute black scavenger flies, Scatopsidae

Body length: 3-5 mm.

Posterior spiracles at end of long median tube (see 34B); pl. 121A&B
---------- **moth flies,** Psychodidae

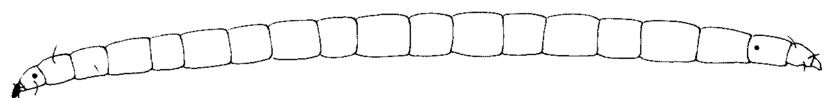
35A Scatopsidae

36 Larva eellike, with diminutive, conelike, brown head capsule (36A); short but conspicuous setae present on first 3 segments and on last segment. Scenopinidae (window flies) ---------- *Scenopinus* spp.

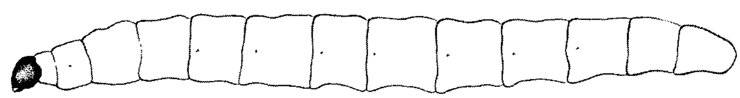
Body length: about 22 mm.

Larva more robust, with a large black head capsule (36B); conspicuous setae absent ---------- **darkwinged fungus gnats,** Sciaridae

Body length: 6-11 mm.



36A *Scenopinus*

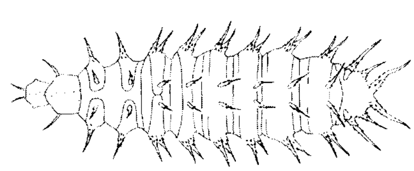


36B Sciaridae

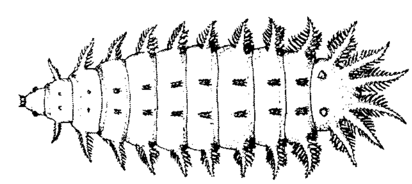
37 Body more or less depressed, with long, often feathery lobes on most segments (37A, 37B, 37C) ---------- 38

Body cylindrical, without conspicuous lobes on each segment (37D) ---------- 39

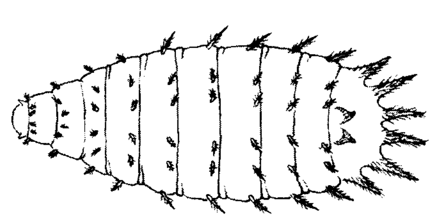
Drawing 37B from 2; 37C by A.D. Cushman.



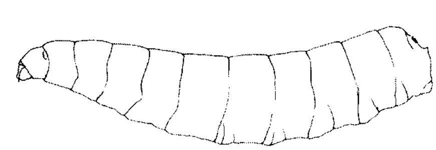
37A *Fannia canicularis*



37B *Fannia scalaris*



37C *Megaselia*



37D *Anastrepha*

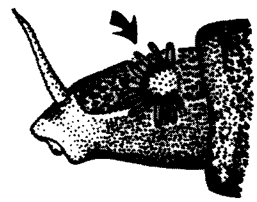
38 Body about 5 mm long; anterior spiracle simple (38A); pl. 123A&B
---------- **humpbacked flies,** Phoridae (in part)

See also 37C, 45A.

Body about 10 mm long; anterior spiracle branched (38B); pl. 128A. Muscidae (muscid flies) (in part) ---------- *Fannia* spp.

See also 37A&B.

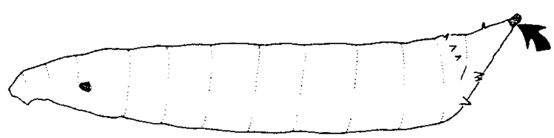
38A *Megaselia*



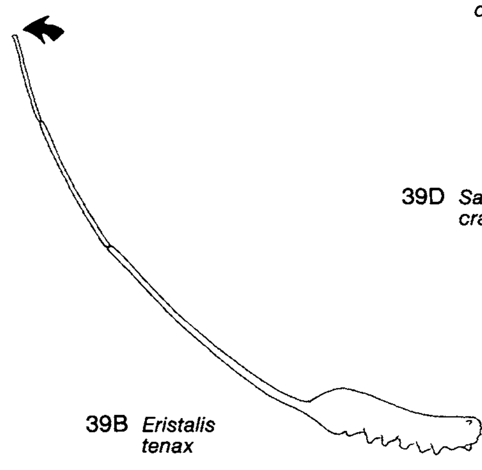
38B *Fannia*

39 Posterior spiracles small, located either on peglike tubercles or cones (39A) or at the end of a long tail (39B) ---------- 40
Posterior spiracles large, more or less flush with body surface (39C, 39D) ---------- 46

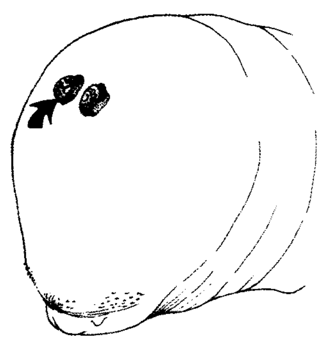
Drawing 39D by A.D. Cushman.



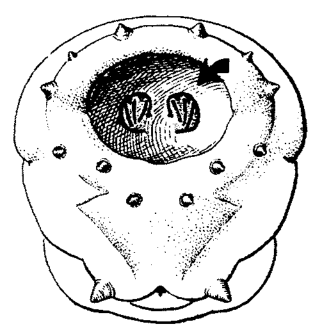
39A *Drosophila*



39B *Eristalis tenax*



39C *Musca domestica*

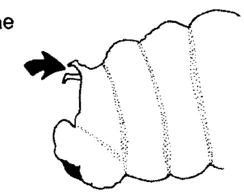


39D *Sarcophaga crassipalpis*

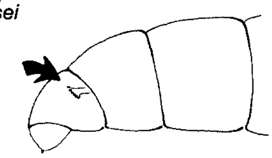
40 Anterior spiracles located on dorsal surface of body (40A) -**leafminer flies,** Agromyzidae

Body length: 5 mm.

Anterior spiracles located on sides of body (40B)-- 41



40A Agromyzidae

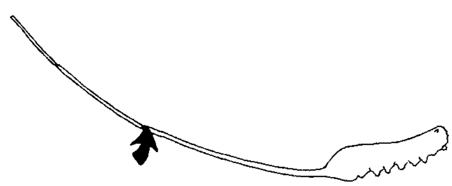


40B *Piophila casei*

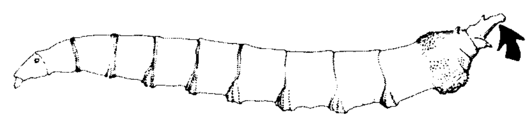
41 Posterior end of body extended as a long, telescoping tail (41A); pl. 122B. Syrphidae **(flower flies)**--**drone fly,** *Eristalis tenax*

This is one of several similar species likely to be found.

Posterior end of body never more than slightly extended (41B) -------------------------- 42



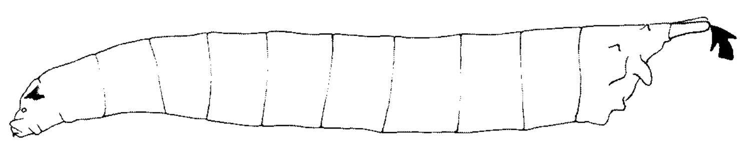
41A *Eristalis tenax*



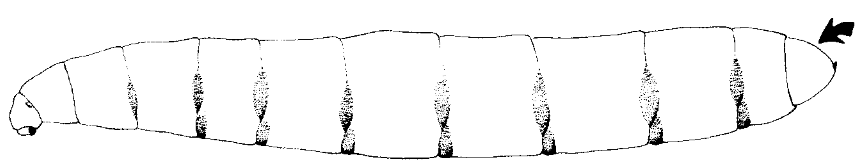
41B Sepsidae

42 Posterior spiracles located at apex of long tubercles (42A) -------------------------------- 43

Posterior spiracles located at apex of short cones (42B)------------------------------------ 44



42A *Drosophila*



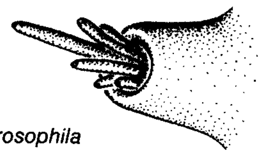
42B *Psila rosae*

43 Anterior spiracle a tube with many retractable branches protruding from tip (43A) ---------- **small fruit flies**, Drosophilidae

Body length: 5 mm. See also 42A.

Anterior spiracle branched from base (43B)---------- black scavenger flies, Sepsidae

Body length: 5-6 mm. See also 41B.



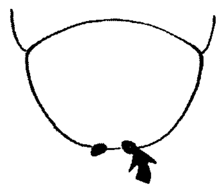
43A *Drosophila*

43B Sepsidae

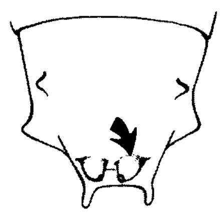
44 Posterior spiracles located on sclerotized, pigmented cones; last abdominal segment without lobes (44A). Psilidae (rust flies)---------- **carrot rust fly,** *Psila rosae*

Body length: 8 mm. This is one of several similar species likely to be found. See also 42B.

Posterior spiracles located on membranous cones; last abdominal segment with lobes (44B) ---------- 45



44A *Psila rosae*



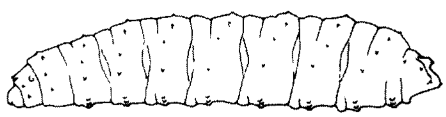
44B *Piophila casei*

45 Larva with lobes on most segments (45A); pl. 123A&B ---------- **humpbacked flies,** Phoridae (in part)

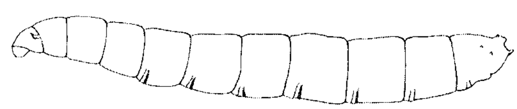
See also 37C, 38A.

Larva with lobes only on last segment (45B). Piophilidae (**skipper flies**) ---------- **cheese skipper,** *Piophila casei*

Body length: 6-9 mm. See also 40B, 44B



45A *Megaselia*



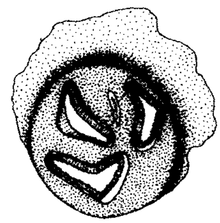
45B *Piophila casei*

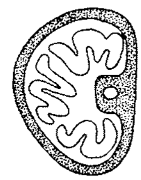
46 Posterior spiracular plate completely pigmented (except for openings and button, when present) (46A). Muscidae (muscid flies) (in part) ---------------------------------*Muscina* spp.

Body length: 10-12 mm.

Posterior spiracular plate unpigmented (except for peritreme, if present) (46B)----- 47

46A *Muscina stabulans*





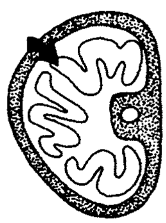
46B *Musca domestica*

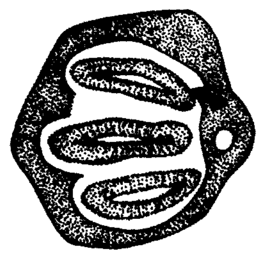
47 Posterior spiracles with sinuous slits (47A); pl. 129A. Muscidae (muscid flies) (in part) --**house fly,** *Musca domestica*

See also 32B, 39C.

Posterior spiracles with straight slits (47B) -- 48

47A *Musca domestica*



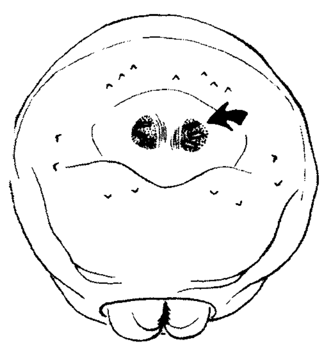


47B *Calliphora*

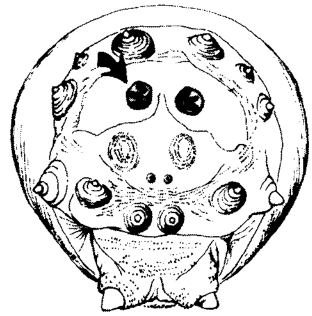
48 Peritreme absent from posterior spiracular plate (48A)-----------------**fruit flies,** Tephritidae

Body length: 9-10 mm. See also 37D.

Peritreme present around posterior spiracular plate (48B)-------------------------------- 49



48A *Anastrepha*



48B *Calliphora*

49 Posterior spiracles with 3 short slits positioned almost perpendicular to one another (49A); pl. 134E. Anthomyiidae **(anthomyiid flies)**------------------------------------*Hylemya* spp.

Spiracular button, if present, located near the upper medial margin of spiracular plate.

Posterior spiracles with slits approximately parallel (49B)------------------------------------ 50

Spiracular button located near the medial or lower medial edge of spiracular plate.

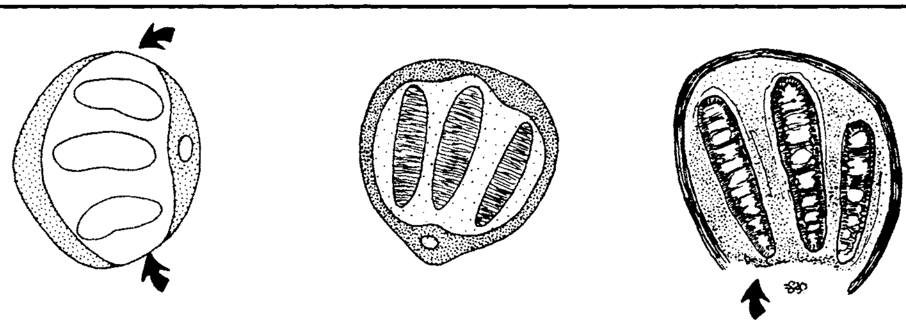
49A *Hylemya* 49B *Calliphora*

50 Peritreme of posterior spiracle with 2 unsclerotized areas (50A). Muscidae (muscid flies) (in part)------------------------------------*Ophyra* spp.

Body length: 9-10 mm.

Peritreme of posterior spiracle complete (50B) or with only 1 weakly sclerotized area (50C)------------------------------------ 51

Drawing 50C from 2.

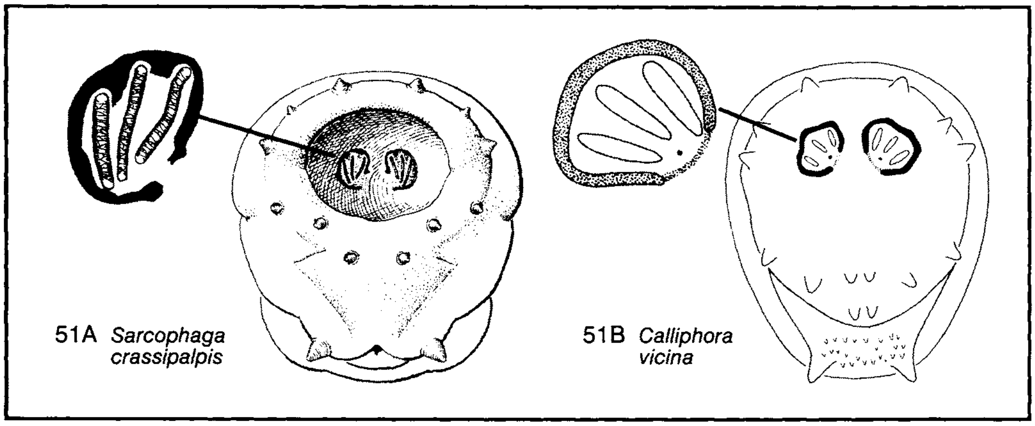


50A *Ophyra* 50B Calliphoridae 50C Sarcophagidae

51 Posterior spiracular plates set in a cavity; spiracular slits essentially vertical in orientation (51A); pl. 131A------------------------------------**flesh flies,** Sarcophagidae

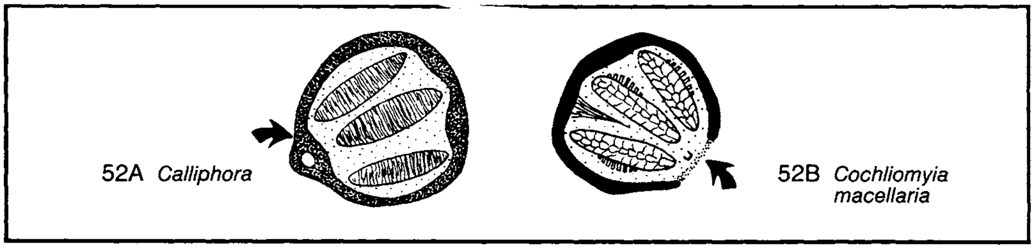
See also 50C.
Drawing 51A from 2.

Posterior spiracles not set in a cavity; spiracular slits directed towards midventral line (51B). Calliphoridae **(blow flies)**------------------------------------ 52



51A *Sarcophaga crassipalpis* 51B *Calliphora vicina*

52 Posterior spiracles with complete peritreme (52A) ---------- 53
Posterior spiracles with incomplete peritreme (52B) ---------- 54

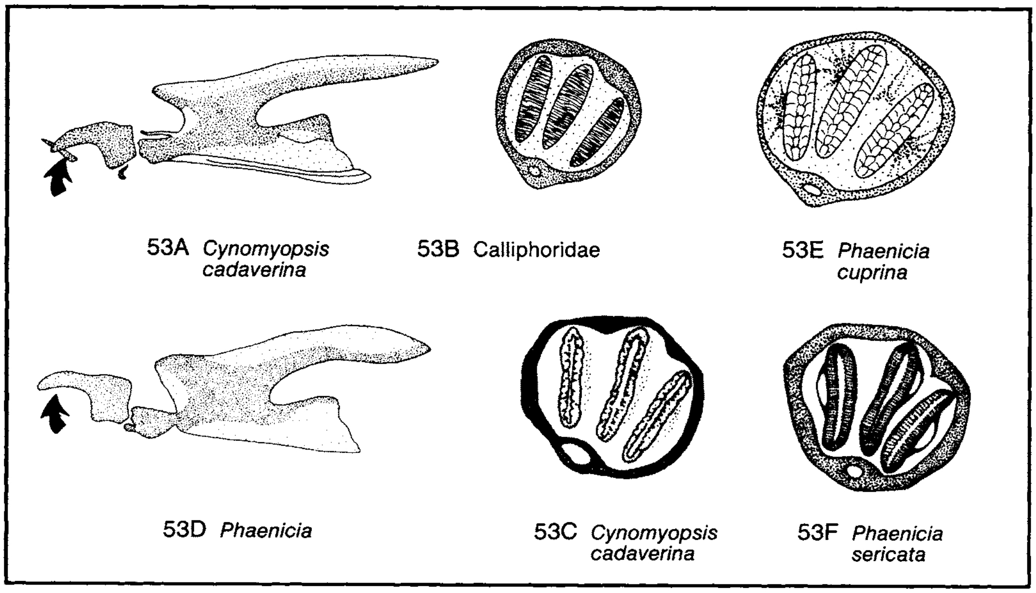


52A *Calliphora* 52B *Cochliomyia macellaria*

53 Accessory sclerite of cephalopharyngeal skeleton present (53A); peritreme of posterior spiracles strongly sclerotized (53B, 53C) ---------- *Calliphora* spp.
---------- blue bottle fly, *Cynomyopsis cadaverina*

Body length of *Calliphora* spp.: 6.8-18 mm.; of *C. cadaverina*: 18-22 mm. See also 47B, 48B, 51B.

Accessory sclerite absent (53D); peritreme less strongly sclerotized (53E, 53F); pl. 134A-D ---------- *Phaenicia* spp.



53A *Cynomyopsis cadaverina* 53B Calliphoridae 53E *Phaenicia cuprina*

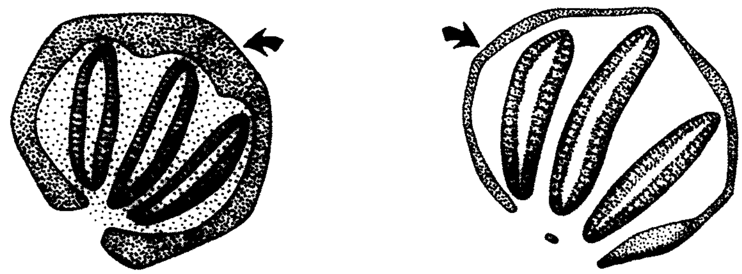
53D *Phaenicia* 53C *Cynomyopsis cadaverina* 53F *Phaenicia sericata*

54 Peritreme of posterior spiracle very thick (54A); pl. 133A-D
---Old World screwworm flies, *Chrysomya* spp.

Body length: 12-18 mm. Body segments sometimes with dorsal lobes.

Peritreme of posterior spiracle only moderately thick (54B)------------------------------- 55

Body segments without dorsal lobes.



54A *Chrysomya*　　54B *Phormia regina*

55 Button absent or indistinct on posterior spiracles; walls of posterior spiracular slits with lateral swellings (55A); pl. 132A---**secondary screwworm,** *Cochliomyia macellaria*

Button distinct on posterior spiracles; spiracular slits without lateral swellings (55B)
---**black blow fly,** *Phormia regina*

55A *Cochliomyia macellaria*　　55B *Phormia regina*

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Notes and Sketches

17 ANTS (FORMICIDAE, HYMENOPTERA)

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Ants are recognized by the constriction at the base of the abdomen and by the presence of one or two nodes in the constricted area that are distinctly differentiated from the rest of the abdomen. Also, the antennae are elbowed, with the first segment (scape) unusually long. Three castes are usually present: workers, females (queens), and males; these are described below.

Workers (fig. 17.1, pl. 135-150). Wings and wing scars absent; ocelli lacking or very small. Those species with workers all about the same size are termed monomorphic; in polymorphic species there is a considerable size range in the worker caste. The largest forms are called soldiers, the smaller forms, minors or minor workers. When soldiers are present they are commonly structurally different from the minors. Workers are most commonly encountered, and they are the most abundant of the three castes. They construct the nest, defend the colony, take care of the colony, and forage for food. It is the worker caste that may be observed foraging for food in food storage areas.

Females (fig. 17.2). Morphologically similar to workers but usually larger, with the thorax enlarged by the wing musculature; with wings or wing scars and with three distinct ocelli.

About 580 species and/or subspecies of Formicidae occur in North America north of Mexico (*1, 2*). About 50 of these have a reputation for being household or food-industry pests (*3*). Ants may nest in or near buildings, in wood or soil, or under objects. They often forage for food in food storage areas. Some ants prefer sweet substances, but many are general feeders taking whatever they find during foraging trips.

The key given here is limited to the subfamilies and to some of the more common genera and species of household pests occurring in North America. Illustrations of these as well as some of the less common taxa (all from *3*) are given in chapter 27. Additional taxonomic and biological information may be found in the references at the end of this key (see also ch. 28).

Males (fig. 17.3). Wings present; head usually reduced in size and bearing disproportionately large eyes and large ocelli; mouthparts reduced; antennae elbowed but scape sometimes rather short; genital appendages usually protruding. The sexual castes (males and females) may be very abundant at the time of swarming (they are normally seen outside the nest only at swarming time). They are often attracted to lights in buildings, but they do not forage for food as do the workers.

Larvae (fig. 17.4). Thoracic legs lacking; without horny projection at apex of abdomen; commonly gourd-shaped, with a slender neck and small head capsule; hairs of various sizes and shapes usually abundant on body. Larvae of some species spin cocoons in which the pupal stage is passed; others do not. Ant larvae are not easily differentiated from those of other Hymenoptera.

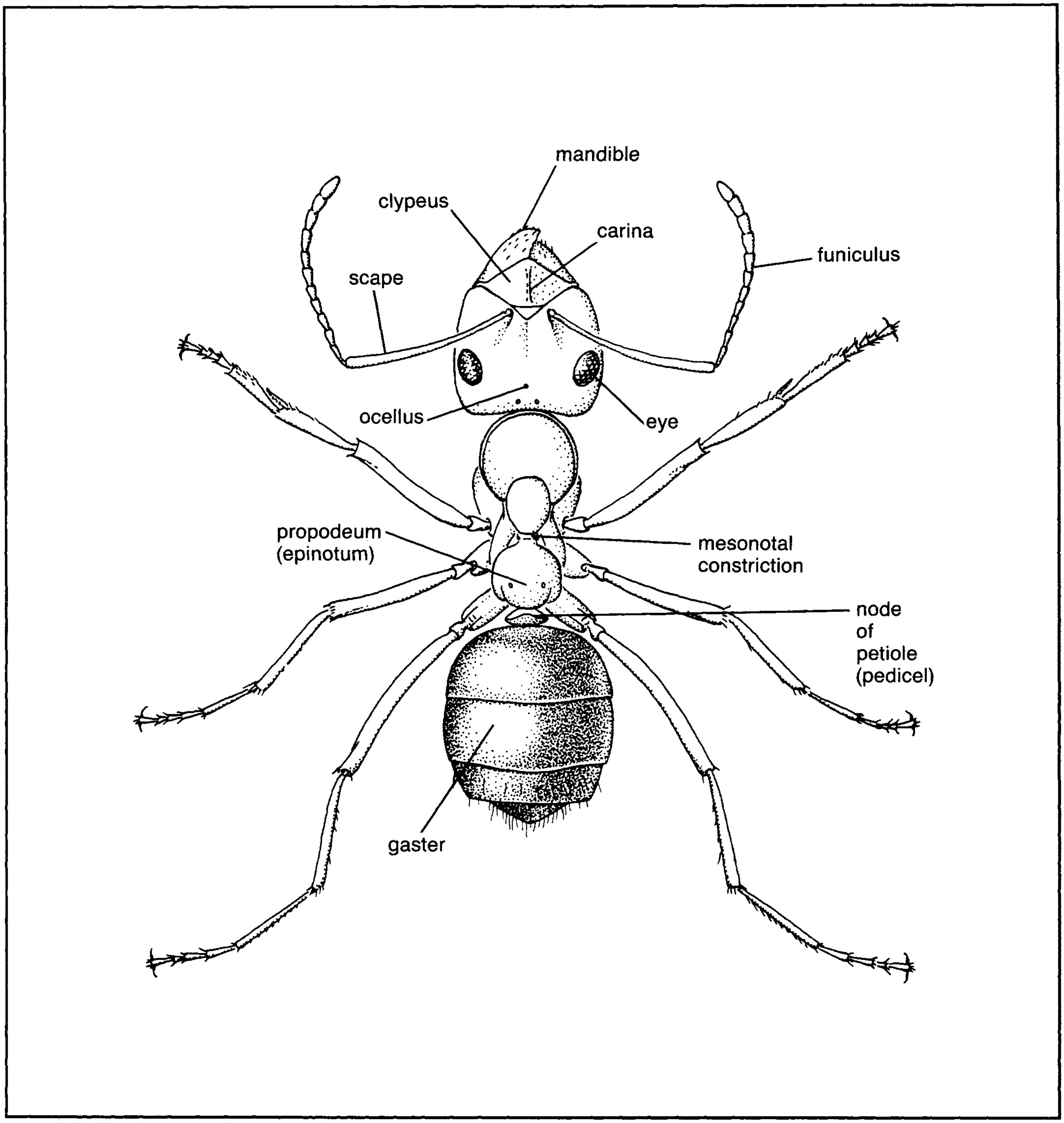


Figure 17.1. Worker, **Allegheny mound ant,**
Formica exsectoides Forel, dorsal view.
(Redrawn from *3* by C. Feller.)

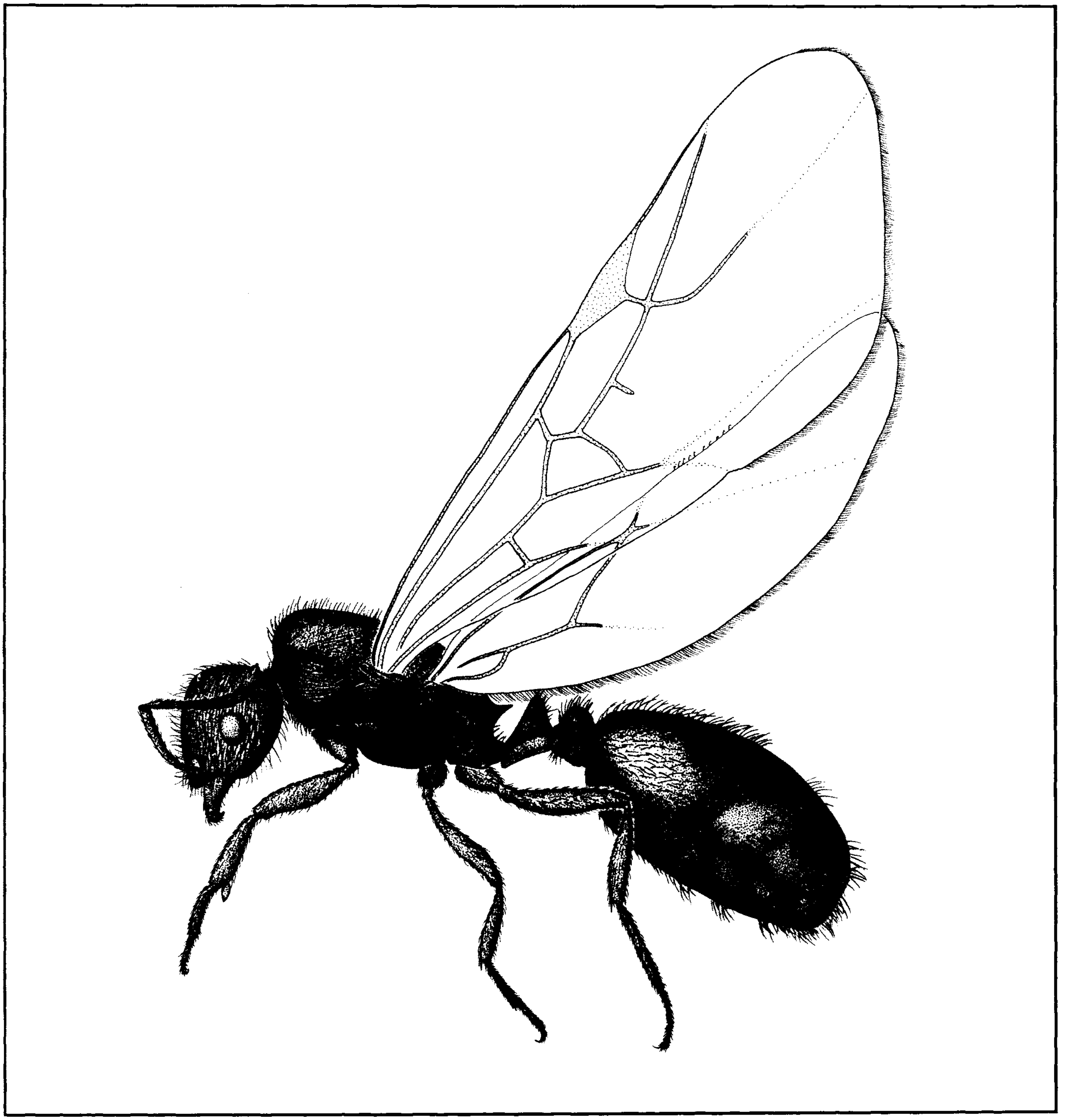


Figure 17.2. Female, **pavement ant,**
Tetramorium caespitum, lateral view. (Drawing
by C. Feller.)

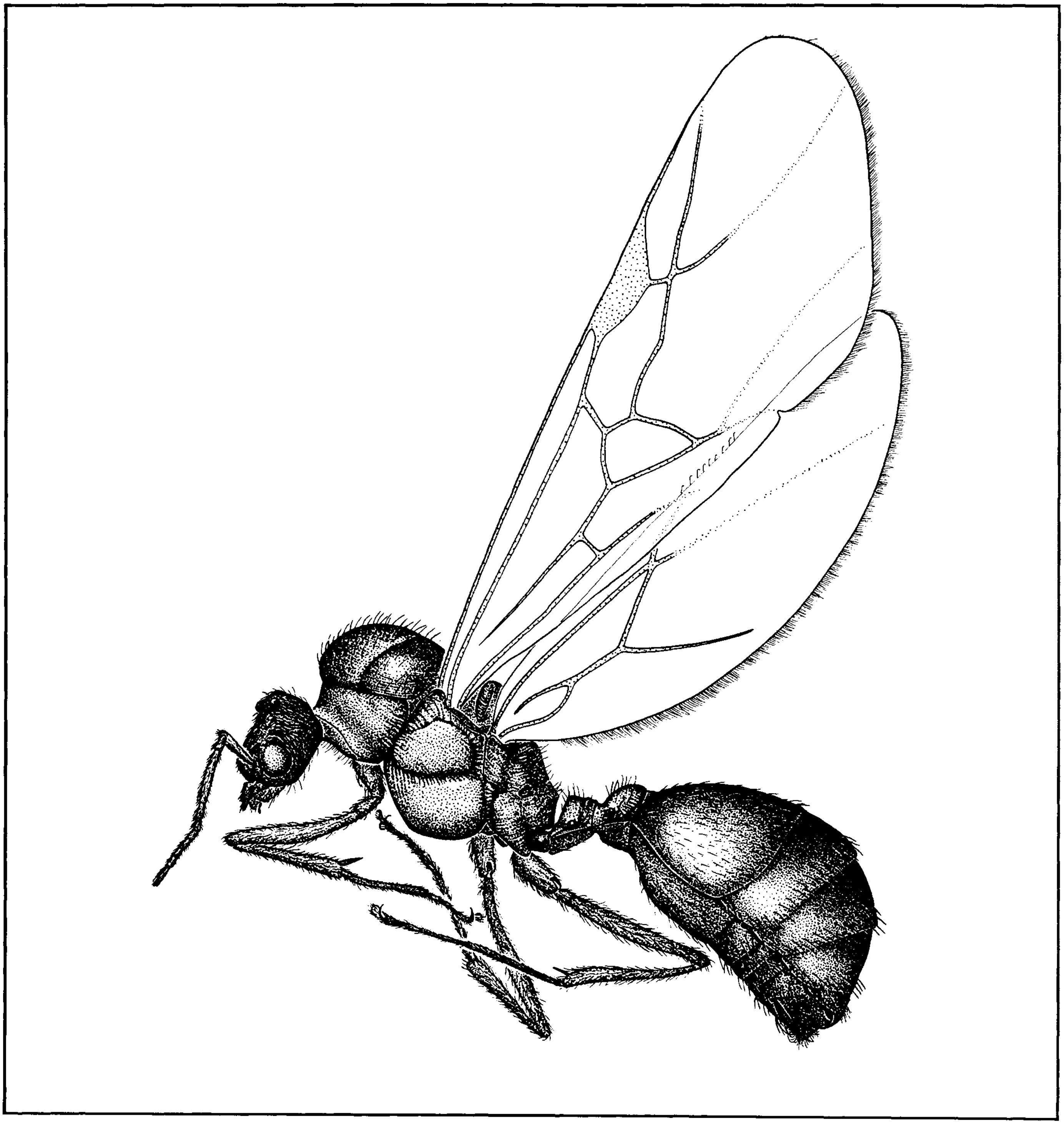


Figure 17.3. Male, **pavement ant,** *Tetramorium caespitum,* lateral view. (Drawing by C. Feller.)

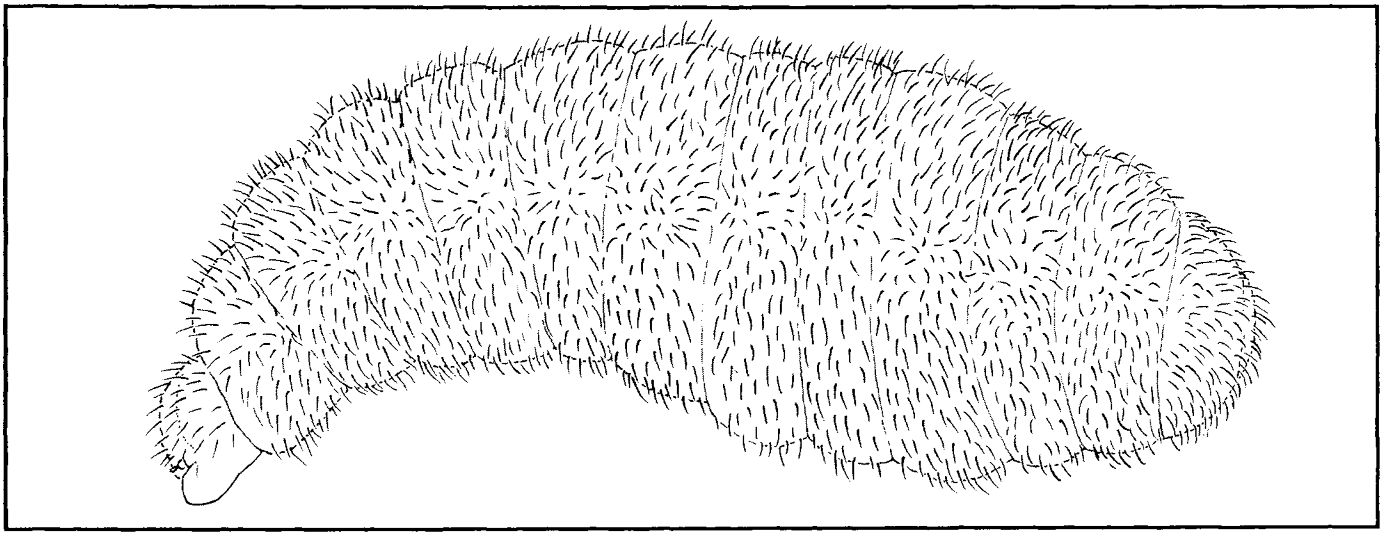


Figure 17.4 Larva, **larger yellow ant,** *Acanthomyops interjectus.* (Drawing by C. Feller.)

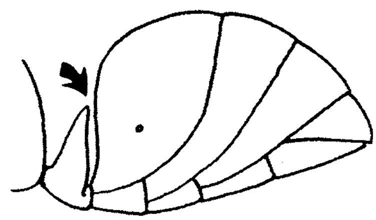
KEY TO WORKERS

Drawings by A.D. Cushman unless otherwise noted.

1 Pedicel with 2 segments (1A) ---------- 2

Pedicel with 1 segment (1B) ---------- 9

1A myrmicine ant



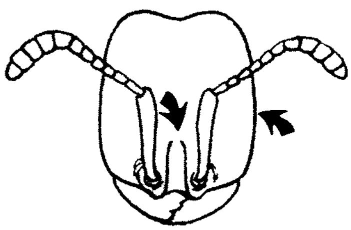
1B *Iridomyrmex humilis*

2 Frontal carinae close together, not covering antennal insertions; antennae inserted very close to mouth; eyes absent or very small and ocellus-like (2A); pl. 135A-C ---------- army ants, Dorylinae

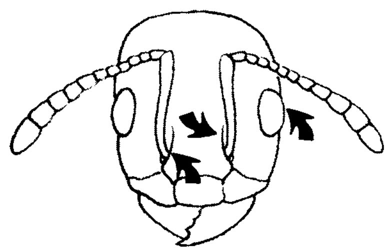
Propodeum usually unarmed (2B).

Frontal carinae widely separated, each with a lobe that partially covers antennal insertions; antennae inserted away from mouth; eyes usually large and multifaceted (2C); pl. 136-142, 143A&B. Myrmicinae (myrmicine ants) ---------- 3

Propodeal spines present (2D) or absent.



2A army ant



2C myrmicine ant

2B diagrammatic

2D myrmicine ant

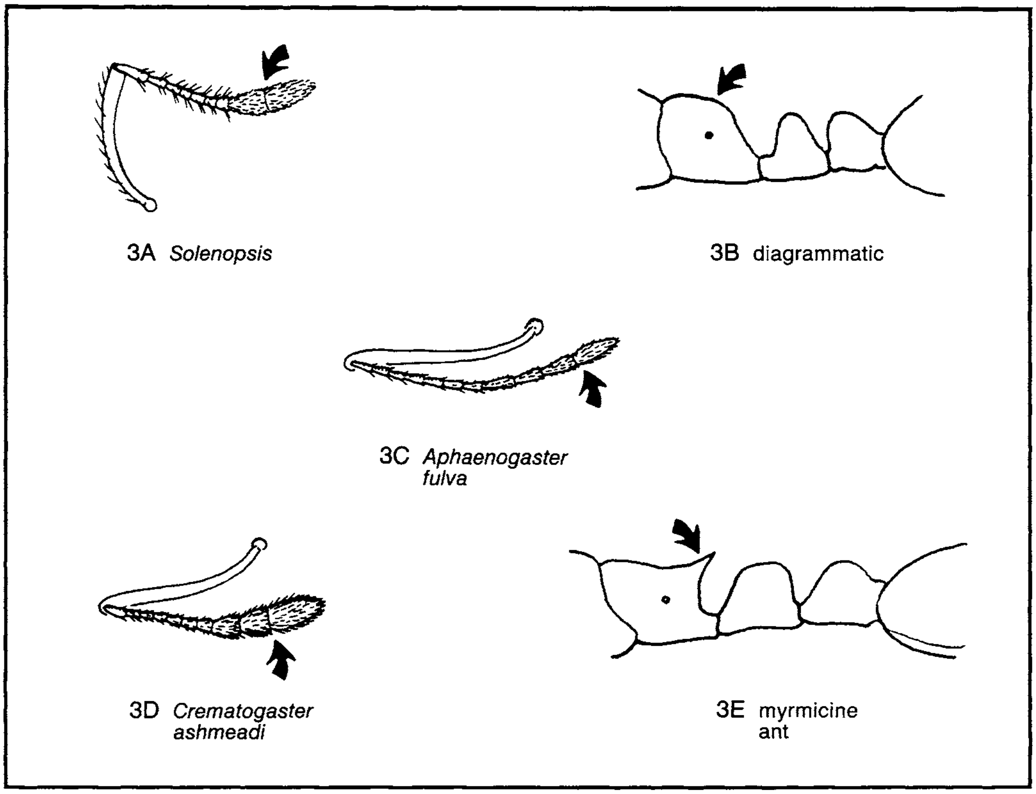
Myrmicinae

3 Antenna with 10 segments, the last 2 segments forming a distinct club (3A)-------- 4

Propodeum unarmed (3B).
Drawings 3A&C&D by C. Feller.

Antenna with more than 10 segments, either without a distinct club (3C) or with 3 or 4 segments forming a club (3D)-- 5

Propodeal spines present (3E) or absent.



4 Eye small, usually with 4 to 6 facets (pl. 136A); workers monomorphic---------- *Solenopsis*

The **thief ant,** *Solenopsis molesta* (pl. 136A), occurs throughout most of the United States. The workers are minute (1.3 to 1.8 mm long) and yellowish in color. They are omnivorous, feeding on many household foods. They apparently prefer foods of high protein content. They may nest in buildings, invading cabinets, shelves, and containers.

Eye large, multifaceted (pl. 136B&C); workers polymorphic; pl. 136B&C, 137A
--- fire ants, *Solenopsis*

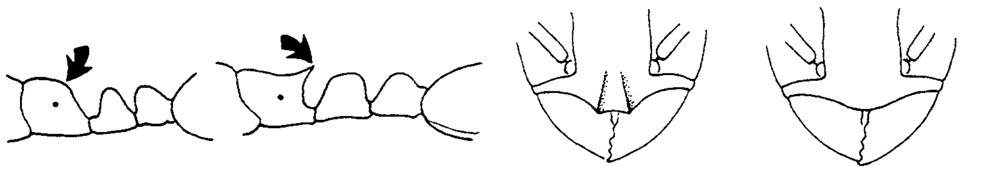
Body 1.6 to 6 mm long and usually reddish brown or blackish. These species usually nest in mounds in the soil but foraging workers may enter buildings; includes the fire ants of southern United States, 2 species of which have been introduced from South America.

5 Propodeum without spines or teeth (5A)--- 6

Clypeus usually bicarinate (5B).

Propodeum with spines (5C)-- 7

Clypeus not bicarinate (5D).



5A diagrammatic 5C myrmicine ant 5B *Monomorium pharaonis* 5D myrmicine ant

6 Integument (except for abdomen) uniformly finely punctate and subopaque (pl. 137B) --- **pharaoh ant,** *Monomorium pharaonis*

Body color light brown to yellowish. Distribution: widely distributed around the world by commerce; found in most cities and towns in the United States where it infests hotels, apartment buildings, groceries, and other places where food is handled commercially; nests in buildings and feeds on a wide variety of foods.

Integument shining, impunctate, sometimes with some transverse striations on posterior margin of head and epinotum (pl. 137C, 138A&B) --other species of *Monomorium*

Most species have habits similar to those of *M. pharaonis*.

7 Clypeus without a sharp, raised margin in front of antennal insertion (7A) --other species of Myrmicinae

Body length and antennal form variable. See pl. 138-142 for selected representatives of the genera *Aphaenogaster, Atta, Crematogaster, Pheidole,* and *Ochetomyrmex;* each has representatives that may be found in buildings and food storage areas.

Posterior border of clypeus forming a sharp, raised margin in front of antennal insertion (7B). Genus *Tetramorium*--- 8

Antenna with a 3-segmented club (see 3D); body length: 2.5-4 mm.

7A myrmicine ant 7B *Tetramorium*

8 Head without an antennal sulcus (pl. 143A); head and thorax with longitudinal striations; body color brownish to black------------------**pavement ant,** *Tetramorium caespitum*

Distribution: a common species throughout most of Europe and the United States; largely confined to metropolitan areas; nests in soil, under objects, in rotting wood, and sometimes in wood of homes; omnivorous; may feed on household foods, preferring meats or grease.

Head with antennal sulcus (pl. 143B); head and thorax usually rugulose; color yellowish or brownish--other North American species of *Tetramorium*

A few species of *Tetramorium* are found in southern United States; they may infest buildings, as does *T. caespitum,* but they are not as common as the pavement ant.

9 Gaster with a distinct constriction between the first and second gastric segments (9A) --- ponerine ants, Ponerinae

Species of this subfamily are not known to be associated with the food industry.

Gaster entire (9B)-- 10

9A ponerine ant

9B *Iridomyrmex humilis*

10 Acidopore absent (anal slit is transverse, subapical, and ventral) (10A). Dolichoderinae (dolichoderine ants); pl. 143C, 144-- 11

Acidopore present (terminal, circular, and usually surrounded by a fringe of hairs) (10B). Formicinae (formicine ants); pl. 145-150 -- 14

10A dolichoderine ant

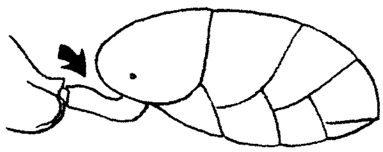
10B formicine ant

Dolichoderinae

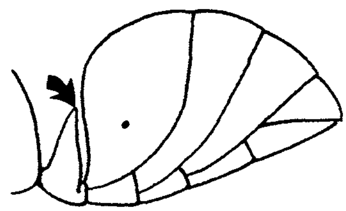
11 Petiolar node vestigial (11A). Genus *Tapinoma*-- 12

Petiole in lateral view slender and attached to ventral side of gaster (11A).

Petiolar node suberect to erect, usually easily seen in profile (11B)-------------------- 13



11A *Tapinoma sessile*



11B *Iridomyrmex humilis*

12 Body a uniform light brown to black, 2.4 to 3.3 mm long; pl. 143C
--**odorous house ant,** *Tapinoma sessile*

Distribution: northern Mexico, United States, southern Canada; nests in soil, under objects, under bark, in stumps, in plant cavities, and in a wide variety of other sites; omnivorous, feeding on a wide variety of household foods but preferring sweets.

Head and thorax brownish or black; antennae, legs, and gaster whitish to yellowish; length 1.3 to 1.5 mm; pl. 144A--*Tapinoma melanocephalum*

Distribution: widely distributed by commerce in the warmer regions of the world; in higher latitudes, may be found in heated buildings; nests in a wide variety of habitats; omnivorous but prefers sweet substances.

13 Propodeum in profile short (about twice as high as long) (pl. 144B)
--- **Argentine ant,** *Iridomyrmex humilis*

Thorax usually without erect hairs; propodeum without a conical posterior elevation. Distribution: widely distributed by commerce; in the United States it is found mostly in the Southern States and in California; nests in a wide variety of habitats, such as soil, rotten wood, bird nests, bee hives and under objects on the ground; feeds on almost any kind of food but is especially attracted to sweets; it is a persistent household pest wherever it is found.

Propodeum not twice as high as long (pl. 144C&D)-------- other species of Dolichoderinae

Thorax usually with some erect hairs; propodeum with (pl. 144D) or without (pl. 144C) a posterior conical elevation.

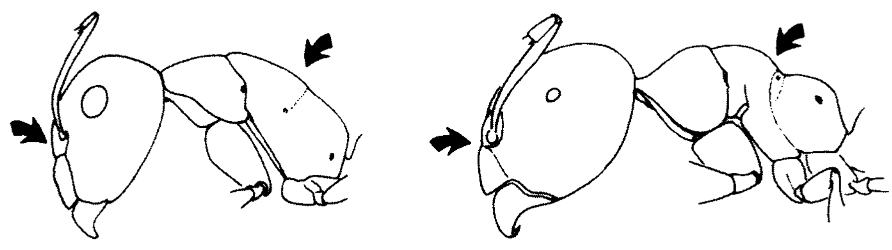
Formicinae

14 Antenna inserted far from posterior margin of clypeus; thorax in profile usually evenly curved (14A); pl. 145, 146, 147A&B---------------------------------carpenter ants, *Camponotus*

Mostly larger species ranging in length from 4 to 12 mm. Distribution: throughout the United States; commonly nest in wood; nest in wooden buildings usually only when wood is moist or has begun to rot, but can enlarge nests into adjacent sound wood; omnivorous, taking virtually all kinds of food in households.

Drawings 14A&B by C. Feller.

Antenna inserted at or very near posterior margin of clypeus; thorax irregularly curved in profile (14B) -- 15



14A *Camponotus*

14B formicine ant

15 Eye closer to posterior margin of head than to base of mandible (15A); pl. 147C, 148, 149, 150A--- other species of Formicinae

Antennal scape and thoracic dorsum usually without stiff setae. This is a large subfamily with representatives found throughout the United States. Some, such as *Lasius* spp., nest in lawns and open fields; the yellowish *Acanthomyops* spp. often nest next to foundation walls; species of other genera nest under objects or construct large mounds; some commonly enter buildings in search of food; most feed on virtually any food but many prefer sweets.

Eye closer to base of mandible than to posterior margin of head (15B). Genus *Paratrechina* -- 16

Antennal scape and thoracic dorsum usually with stiff hairs.

15A formicine ant

15B *Paratrechina*

16 Antennae and legs disproportionately long; body slender (pl. 150B) -- **crazy ant,** *Paratrechina longicornis*

Suberect to erect hairs usually absent from antennal scape. Distribution: widely distributed by commerce throughout the warmer regions of the world; established in southern United States, but found only in buildings farther north; nests in a wide variety of habitats—in trash, refuse piles, soil, in various locations in buildings, and under objects on the ground; omnivorous but preferring sweets.

Antennae and legs not disproportionately long; body robust (pl. 150C) -- other species of *Paratrechina*

Stiff suberect to erect hairs always present on thorax and tibiae and sometimes present on scape. Several species key out here; they are found mostly in eastern and southern United States; some are occasional household pests and may often be found where food is stored.

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Notes and Sketches