



**SELECTED SCALE INSECT GROUPS (HEMIPTERA:  
COCCOIDEA) IN THE SOUTHERN REGION OF THE  
UNITED STATES**

Author: Miller, Douglass R.

Source: Florida Entomologist, 88(4) : 482-501

Published By: Florida Entomological Society

URL: [https://doi.org/10.1653/0015-4040\(2005\)88\[482:SSIGHC\]2.0.CO;2](https://doi.org/10.1653/0015-4040(2005)88[482:SSIGHC]2.0.CO;2)

---

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](http://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

## SELECTED SCALE INSECT GROUPS (HEMIPTERA: COCCOIDEA) IN THE SOUTHERN REGION OF THE UNITED STATES

DOUGLASS R. MILLER

Systematic Entomology Laboratory, PSI, Agricultural Research Service, U.S. Department of Agriculture  
Room 137, Building 005, BARC-West, 10300 Baltimore Avenue, Beltsville, MD 20705

### ABSTRACT

This publication includes general discussions on the Conchaspidae, Diaspididae, Eriococcidae, Ortheziidae, Pseudococcidae, and Putoidae. Keys are presented for genera in the families Eriococcidae, Ortheziidae, and Pseudococcidae. Material for each family include introduction, field appearance, diagnosis, life history, important references, illustration of a slide-mounted adult female, and a checklist of the species occurring in the Southern Region of the United States and their distribution by state.

Key Words: scales, identification, southeastern United States

### RESUMEN

Esta publicación incluye un discusión general de los Conchaspidae, Diaspididae, Eriococcidae, Ortheziidae, Pseudococcidae, y Putoidae. Las secciones para cada familia incluye una introducción, su apariencia en el campo, su diagnóstico, la tabla de vida, referencias importantes, una ilustración de la hembra adulta montada en laminas de microscopio, una lista de las especies que ocurren en la Región sureste de los Estados Unidos y su distribución en cada Estado. Se incluye claves para los Eriococcidae, Ortheziidae, y Pseudococcidae.

Scale insects are phytophagous, feeding by sucking plant juices through a set of stylets. Individual species infest one or more leaves, fruit, branches, main stems, trunks, or roots. They are widely distributed throughout the world with the exception of the cold extremes of the Arctic and Antarctic. They are found on a wide diversity of vascular plants, but only a few species are found on ferns and mosses. There is some debate about their rank in the classification system but they are considered by many authors to be part of the Order Hemiptera, Suborder Sternorrhyncha, Superfamily Coccoidea (Gullan 2001). The group includes about 7,300 species, 1,050 genera (Ben-Dov et al. 2002), and 20 or more families (especially if the margarodoids are divided into separate family units).

Scale insects are generally small, cryptic creatures that cause major problems in agricultural and ornamental ecosystems. They are commonly transported on plant materials and because of their small size and habit of feeding in concealed areas are frequent invasive species (Miller et al. 2005) causing billions of dollars in damage annually (Kosztarab 1990).

Scales are characterized by having a single claw, neotenic adult females, winged but non-feeding adult males, and an unusual form of metamorphosis that normally includes a prepupa and pupa in the adult male (Miller & Kosztarab 1979). Generally there are 3 or 4 instars in the female and 5 instars in the male. Most scale insects produce some kind of wax covering that may entail a

mealy substance over the body or elaborate waxy structures that are attached to the body of the insect or are formed as domicile-like structures.

A list of families that occur in the Southern Region of the United States is given below. This, the splitters view of the Coccoidea, is becoming increasingly accepted in the discipline (Koteja 1974). Distribution records are those listed in ScaleNet (Ben-Dov et al. 2005) and have been supplemented with data from the Florida State Collection of Arthropods, Gainesville, FL and National Museum of Natural History, Beltsville, MD. Distribution records include established outdoor and greenhouse infestations, but do not include records of material taken in quarantine and destroyed.

1. Aclerididae (Flat grass scales)—small-sized family, worldwide 57 species
2. Asterolecaniidae (Pit scales)—moderate-sized family, worldwide 223 species
3. Cerococcidae (Ornate pit scales)—moderate-sized family, worldwide 72 species
4. Coccidae (Soft scales)—large-sized family, worldwide 1,130 species
5. Conchaspidae (False armored scales)—small-sized family, worldwide 29 species
6. Dactylopiidae (Cochineal scales)—small-sized family, native to new world 10 species
7. Diaspididae (Armored scales)—largest-scale family, worldwide 2,300 species

8. Eriococcidae (Felt scales)—large-sized family, rare in the Oriental and Afrotropical areas 556 species
9. Kermesidae (Gall-like scales)—moderate-sized family, primarily from the northern hemisphere 90 species
10. Kerriidae (Lac scales)—moderate-sized family, worldwide 97 species
11. Kuwaniidae—small-sized margarodoid family, occurring under bark of hosts 8 species
12. Lecanodiaspididae (False pit scales)—moderate-sized family, worldwide 78 species
13. Margarodidae (Ground pearls)—moderate-sized margarodoid family, worldwide 108 species
14. Matsucoccidae (Pine bast scales)—small-sized margarodoid family on pines from Australia and the northern hemisphere 46 species
15. Monophlebidae (Giant scales)—moderate-sized margarodoid family, worldwide 255 species
16. Ortheziidae (Ensign scales)—moderate-sized family, worldwide 196 species
17. Pseudococcidae (Mealybugs)—large-sized family, worldwide 1,989 species
18. Putoidae (Giant mealybugs)—small-sized family, in all regions but Australasian and Afrotropical areas 57 species
19. Xylococcidae—small-sized margarodoid family occurring in northern hemisphere and neotropics 11 species

#### Conchaspidae or False Armored Scales (Fig. 1)

False armored scales occur in all zoogeographic regions but probably are introduced in the Australasian and Palearctic regions. Madagascar seems to have the greatest diversity of species. There are 29 species in 4 genera worldwide; in the United States and in the Southern Region there are 3 species in 2 genera (Ben-Dov et al. 2002). *Conchaspis angraeci* Cockerell is widespread and may be introduced into the US, but *Asceloconchaspis milleri* Williams appears to be native to southern Florida.

**Field Characters:** Body hidden under thick wax cover similar to armored scale cover except exuviae not incorporated. Cover not attached to body, often volcano shaped with ridges radiating from scale apex; round or oval in outline. Some covers without conical top, but usually with ridges. Cover of most species white or dirty white. Female body usually white (Mamet 1954) deep red or purple in *Conchaspis cordiae* (F. William Howard, pers. comm., May 2005).

**Diagnosis:** Posterior abdominal segments coalesced into pygidium; legs present in all but 1 species; trochanter and femur fused; tibia and tarsus

fused; antennae 3- to 5-segmented; ocellar spot on head; 2 genera with metathoracic sclerotizations near hind coxae.

**Hosts:** Conchaspids are frequently collected on trees and woody perennials, but they also are found on orchids, euphorbias, and palms.

**Life History:** False armored scales have 4 female instars and 5 in the male (Miller 1991b). First instars settle on the host but do not produce a cover until the first molt. They usually settle on the leaves or branches of the host.

**Important references:** Ben-Dov (1974); Ben-Dov (1981); Mamet (1954); Mamet (1959); Williams (1985a); Williams (1992).

Checklist of false armored scales of the Southern Region (asterisk signifies a commonly collected species)

*Asceloconchaspis milleri* Williams FL  
 \**Conchaspis angraeci* Cockerell FL, PR  
*Conchaspis cordiae* Mamet FL, PR.

Diaspididae or Armored Scale Insects (Figs. 2, 3)

Armored scales are the most speciose family of scale insects including about 2,369 species in 380 genera (Ben-Dov et al. 2002). Although there are several classifications of the Diaspididae, there are two groups that contain a majority of the species and are relatively easy to recognize. They often are used as informal groups and are referred to as diaspidines and aspidiotines; they are based on two of the major subfamilies of armored scales, the Diaspidinae and Aspidiotinae (Ferris 1942). There are no obvious characters that separate these groups all of the time, but most species are consistent with the following combination of characters. Diaspidines produce an elongate scale cover and have two-barred macroducts, more than one seta on each antenna, gland spines between the pygidial lobes, bilobed second lobes, and pores near the spiracles. Aspidiotines produce an oval or round cover and have one-barred macroducts, one seta on each antenna, plates between the pygidial lobes, simple second lobes, and no pores near the spiracles.

**Field Characters:** Wax covering domicile-like, not attached to body; wax covering with exuviae of 1 or 2 immature instars incorporated and usually visible; cover formed of wax manipulated by pygidium, of solid consistency, not filamentous or powdery; often with ventral cover; body elongate or oval; body color white, yellow, purple, red, or orange; occurring on nearly any part of plant, rare on roots and rootlets; some species become buried under plant epidermis.

**Diagnosis:** Posterior abdominal segments coalesced into wax-forming structure called pygidium; generally with lobes and plates or gland spines on pygidium; legs absent or represented by small sclerotized area; antennae represented by unsegmented knob; labium 1-segmented.

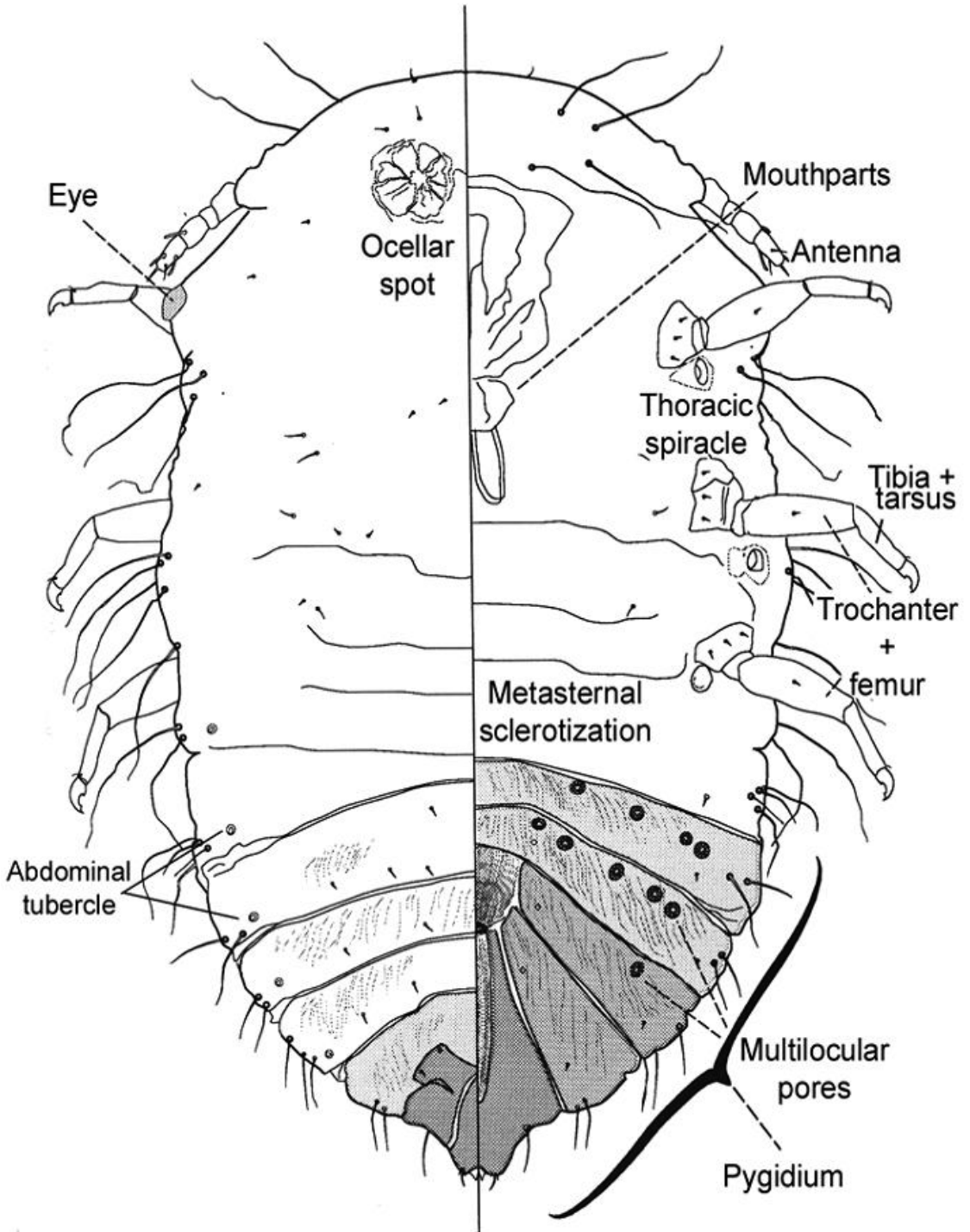


Fig. 1. *Conchaspis angraeci* Cockerell: Illustration from Gill (1993).

Host plants: Armored scales occur on a variety of host plants encompassing more than 1,380 plant genera in 182 plant families (compiled from

Borchsenius 1966). The most prevalent host families are: Fabaceae with about 230 species of armored scales, Poaceae with about 150 species, and

Euphorbiaceae with 145 species. Armored scales usually are pests on plants that survive for more than a single year including fruit and nut crops, forest trees, and ornamentals such as landscape perennials, shrubs, shade trees, and greenhouse plants. Miller and Davidson (1990) compiled a list of 199 species that are considered pests in at least some part of the world. This figure is only about 8% of the total number of described species and their economic impact is quite significant.

Life History: Diaspidids have 3 female instars and 5 male instars (Miller 1991b) Life histories are quite diverse; there can be from 1 to 6 or more generations each year and overwintering can be in any instar except the third, fourth, or adult male. Second instars and mated adult females are probably the most common. In many species, the number of generations and overwintering stages can vary depending on the climate. Eggs or first instars (=crawlers) are laid under the scale cover and a small slit is present at the posterior end of the cover that allows the crawlers egress to the outside. Scale cover formation is an interesting process that usually involves the incorporation of the crawler and second-instar exuviae. Several groups are pupillarial, i.e., the adult female remains inside of the hardened second instar exuviae. Dispersal is undertaken by the first-instar crawler either passively by air movement or actively by crawling. The first instar is the only life stage that has legs with the exception of the third, fourth, and adult male. Males only incorporate the shed skin of the crawler into their cover; the exuviae of the other instars are kicked posteriorly in the cover (Miller & Davidson 2005).

Important references: Balachowsky (1948, 1950, 1951, 1953, 1954); Ben-Dov & German (2003); Borchsenius (1966); Danzig (1993); Ferris (1937, 1938, 1941, 1942); Howard & Oliver (1985); Miller & Davidson (2005); Miller & Gimpel (2005); Tang (1986).

Checklist of Armored Scales of the Southern Region (asterisk signifies a frequently collected species)

- Abgrallaspis colorata* (Cockerell) FL, NC, SC, TX  
 \**Abgrallaspis cyanophylli* (Signoret) FL, GA, LA, MS, PR, TX  
*Abgrallaspis ithacae* (Ferris) GA, TN, VA  
*Abgrallaspis liriiodendri* Miller and Howard LA  
*Abgrallaspis perseae* Davidson GA, TX  
*Acutaspis agavis* (Townsend and Cockerell) FL, TX  
*Acutaspis albopicta* (Cockerell) TX  
*Acutaspis aliena* (Newstead) FL, PR  
 \**Acutaspis morrisonorum* Kosztarab AL, AR, FL, GA, LA, NC, PR, TN, VA  
*Acutaspis perseae* (Comstock) AL, FL, GA, LA, MS, SC, TN, TX  
*Acutaspis scutiformis* (Cockerell) TX  
*Ancepaspsis tridentata* (Ferris) TX  
*Andaspis hawaiiensis* (Maskell) FL  
*Andaspis mackieana* (McKenzie) FL  
*Andaspis punicae* (Laing) FL  
*Annulaspis polygona* Ferris TX  
*Aonidia atlantica* Ferris AL, FL, GA  
*Aonidia shastae* (Coleman) TX  
 \**Aonidiella aurantii* (Maskell) FL, LA, MS, PR, TX  
 \**Aonidiella citrina* (Coquillett) FL, TX  
*Aonidiella comperei* McKenzie PR  
*Aonidiella inornata* McKenzie PR, TX  
*Aonidiella orientalis* (Newstead) FL, PR  
 \**Aonidiella taxus* Leonardi AL, FL, GA, LA  
 \**Aonidomytilus albus* (Cockerell) FL, PR  
*Aonidomytilus concolor* (Cockerell) TX  
*Aonidomytilus crookiae* (Ferris) FL, GA, VA  
 \**Aonidomytilus hyperici* Ferris FL, GA, LA, MS, NC, VA  
*Aonidomytilus peninsularis* (Ferris) TX  
*Aonidomytilus sabatius* Tippins AL, GA  
 \**Aonidomytilus solidaginis* (Hoke) AL, FL, GA, LA, MS, SC, TN, VA  
*Aspidaspis gainesi* McDaniel TX  
*Aspidiella hartii* (Cockerell) PR  
 \**Aspidiella sacchari* (Cockerell) FL, PR, TX  
 \**Aspidiotus destructor* Signoret FL, GA, PR  
*Aspidiotus excisus* Green FL, PR  
*Aspidiotus marisci* AL, FL, GA  
 \**Aspidiotus nerii* Bouché AL, FL, GA, LA, MS, PR, TX  
 \**Aulacaspis rosae* Bouché AL, FL, GA, LA, PR, SC, VA  
 \**Aulacaspis tubercularis* Newstead FL, PR  
 \**Aulacaspis yasumatsui* Takagi FL, PR  
 \**Carulaspis juniperi* Bouché GA, VA  
 \**Carulaspis minima* (Signoret) AL, FL, GA, LA, NC, TN, TX, VA  
*Chionaspis acericola* Hollinger GA, NC, TX  
 \**Chionaspis americana* Johnson FL, GA, LA, MS, TN, TX, VA  
*Chionaspis caryae* Cooley FL, LA, NC, VA  
*Chionaspis corni* Cooley LA, VA  
*Chionaspis etrusca* Leonardi TX  
*Chionaspis floridensis* Takagi FL  
 \**Chionaspis furfura* (Fitch) FL, GA, KY, LA, MS, NC, TN, TX, VA  
 \**Chionaspis gleditsiae* Sanders FL, LA, MS, NC, TN, TX, VA  
*Chionaspis hamoni* Liu and Kosztarab FL  
 \**Chionaspis heterophyllae* Cooley AL, FL, GA, LA, MS, NC, TN  
 \**Chionaspis kosztarabi* Takagi and Kawai FL, GA, MS, NC, SC, TN, VA  
*Chionaspis lintneri* Comstock FL, LA, TX  
*Chionaspis longiloba* Cooley AL, AR, FL, LA, TX  
*Chionaspis nyssae* Comstock AL, FL, GA, LA, MS, NC, SC, TX, VA  
 \**Chionaspis pinifoliae* (Fitch) AL, FL, GA, LA, TN, TX, VA  
*Chionaspis platani* Cooley LA, NC, TX, VA  
 \**Chionaspis salicis* (Linnaeus) AL, AR, FL, LA, MS, NC, TN, TX, VA  
*Chionaspis styracis* Liu and Kosztarab AL, FL, GA, MS  
*Chionaspis trififormis* Tippins and Beshear FL, GA  
*Chortinaspis cottami* McDaniel TX  
*Chortinaspis divaricata* Ferris FL, GA  
*Chortinaspis frankliniana* Ferris TX  
*Chortinaspis graminella* (Cockerell) FL, GA, TX  
*Chortinaspis subchortina* (Laing) FL, MS, TX  
 \**Chrysomphalus aonidum* (Linnaeus) AL, FL, GA, LA, MS, PR, TX  
 \**Chrysomphalus bifasciculatus* Ferris AL, GA, LA, NC, SC, TX, VA  
 \**Chrysomphalus dictyospermi* (Morgan) FL, GA, LA, MS, PR, TX

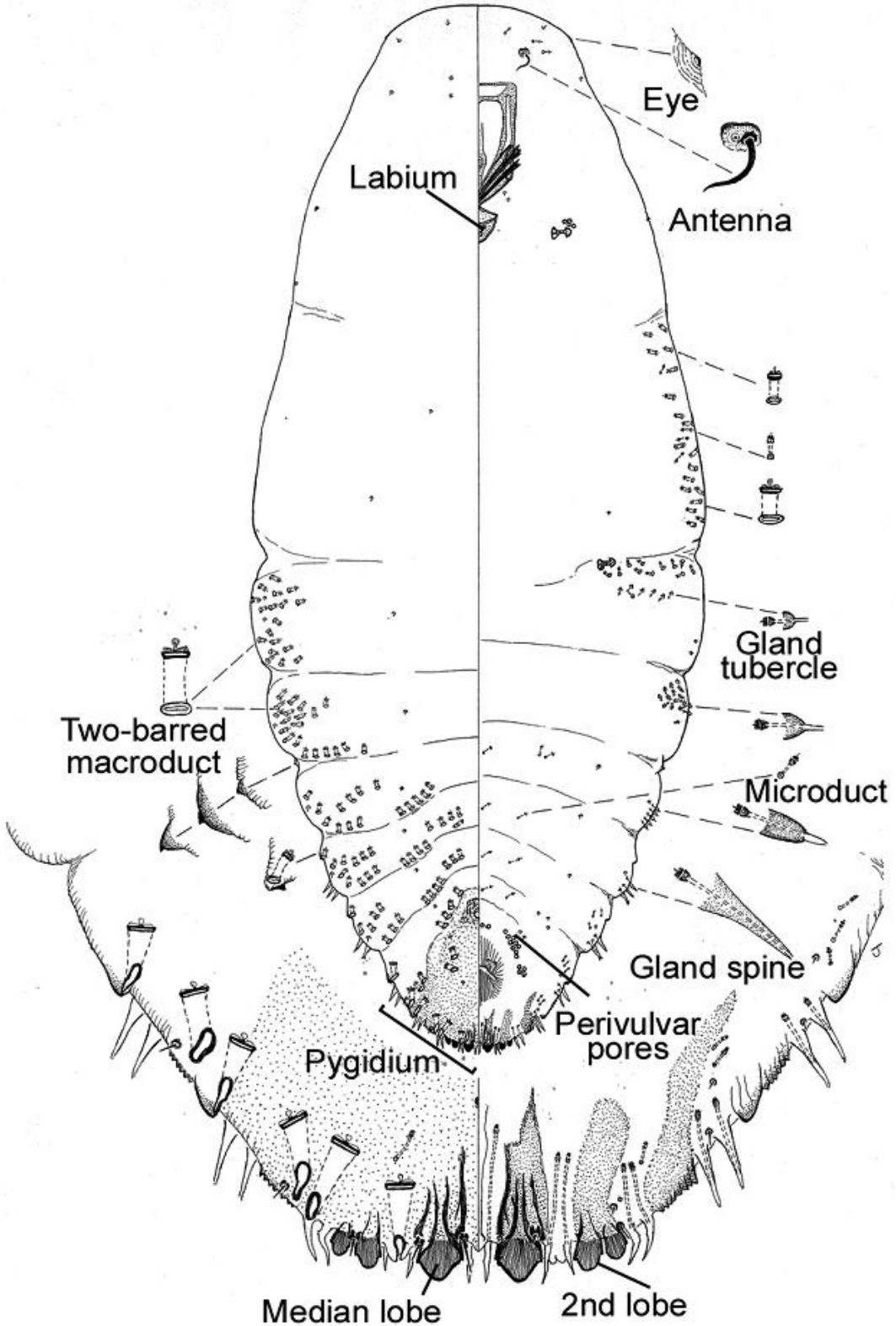


Fig. 2. Diaspidinae—*Lepidosaphes pallida* (Maskell): Unpublished illustration by Davidson.

- Circulaspis fistulata* (Ferris) TX  
*Circulaspis fistulella* Ferris FL, GA, TX  
*Clavaspis barbiger* Ferris FL  
*Clavaspis crypta* Howell and Tippins GA  
*Clavaspis courtsiae* (Marlatt) FL, TX  
*Clavaspis covilleae* (Ferris) TX  
*\*Clavaspis herculeana* (Cockerell and Hadden) FL, PR, TX  
*Clavaspis mori* (Herrick) TX  
*Clavaspis pedilanthi* (Ferris) TX  
*Clavaspis subsimilis* (Cockerell) PR  
*Clavaspis texana* Ferris TX  
*\*Clavaspis ulmi* (Johnson) GA, LA, MS, SC, TX, VA  
*\*Comstockiella sabalis* (Comstock) FL, GA, LA, MS, NC, SC, TX  
*Crenulaspidotus dicentron* Miller and Davidson PR  
*Crenulaspidotus portoricensis* (Lindinger) PR  
*Cupidaspis cupressi* (Coleman) TX  
*Dactylaspis crotonis* (Cockerell) PR  
*Dactylaspis lobata* Ferris TX  
*Diaspidiotus aesculi* (Johnson) TX  
*\*Diaspidiotus ancylus* (Putnam) AL, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*Diaspidiotus bumeliae* Ferris TX  
*Diaspidiotus caryae* Kosztarab GA  
*Diaspidiotus coniferarum* (Cockerell) FL, GA, LA, MS, SC, TX, VA  
*Diaspidiotus crystallinus* Ferris TX  
*Diaspidiotus forbesi* (Johnson) FL, GA, LA, MS, PR, TX  
*Diaspidiotus hunteri* (Newell) GA, TX  
*\*Diaspidiotus juglansregiae* (Comstock) AL, FL, GA, LA, MS, TX, VA  
*\*Diaspidiotus liquidambaris* (Kotinsky) AL, FL, GA, LA, MS, NC, SC, TN, TX, VA  
*\*Diaspidiotus mcombi* McKenzie AL, FL, GA, LA, MS, NC, SC, VA  
*\*Diaspidiotus osborni* (Newell and Cockerell) AL, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*\*Diaspidiotus perniciosus* (Comstock) AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*Diaspidiotus piceus* (Sanders) TN  
*Diaspidiotus socialis* (Hoke) GA, MS, TX  
*Diaspidiotus taxodii* (Ferris) FL, GA, LA, TX  
*\*Diaspidiotus uvae* (Comstock) AL, AR, FL, GA, KY, MS, NC, TN, TX, VA  
*\*Diaspis boisduvalii* (Bouché) FL, GA, LA, PR, TN, TX  
*\*Diaspis bromeliae* (Kerner) FL, LA, PR  
*Diaspis coccois* Lichtenstein FL  
*Diaspis digna* Hoke FL, MS  
*Diaspis diospyri* Ferris TX  
*\*Diaspis echinocacti* (Bouché) FL, GA, LA, PR, TN, TX, VA  
*Diaspis radicolica* Ferris TX  
*Diaspis texensis* (Cockerell) TX  
*Diaspis toumeyii* Cockerell TX  
*Dicirculaspis bibursa* (Ferris) TX  
*Duplachionaspis divergens* (Green) FL  
*Duplaspidotus claviger* (Cockerell) FL  
*Duplaspidotus fossor* (Newstead) PR  
*Duplaspidotus tesseratus* (Grandpre and Charmoy) FL, PR  
*Dynaspidotus abietus* (Schrank) FL, GA, MS  
*Dynaspidotus britannicus* (Newstead) LA  
*Dynaspidotus californicus* (Coleman) GA, LA, TX  
*Epidiaspis tillandsiae* Takagi and Tippins FL, GA  
*Ferrisidea magna* (Ferris) TX  
*Fiorinia externa* Ferris GA, VA  
*\*Fiorinia fioriniae* (Targioni Tozzetti) AL, FL, LA, GA, PR  
*Fiorinia japonica* Kuwana VA  
*Fiorinia pinicola* Maskell GA  
*\*Fiorinia theae* Green AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*Fissuraspis ulmi* (Hoke) AR, FL, GA, MS, TX  
*\*Froggattiella penicillata* (Green) AL, FL, GA, LA, MS, PR, TX  
*Furcaspis biformis* (Cockerell) FL, PR  
*Geodiaspis arundinariae* Tippins and Howell GA  
*Gymnaspis aechmeae* Newstead AL, FL, LA, PR  
*Haliaspis arecibo* Howell PR  
*Haliaspis asymmetrica* (Ferris) FL, GA, NC  
*Haliaspis litoralis* (Ferris) TX  
*Haliaspis mackenziei* (McDaniel) TX  
*Haliaspis nakaharai* Howell PR  
*Haliaspis pennisularis* Howell FL  
*\*Haliaspis spartinae* (Comstock) FL, GA, SC, TX, VA  
*Haliaspis texana* Liu and Howell TX  
*Haliaspis uniolae* Takagi FL, GA, LA, SC  
*\*Hemiberlesia lataniae* (Signoret) AL, FL, GA, LA, MS, PR, TX, VA  
*Hemiberlesia musae* Takagi and Yamamoto PR  
*\*Hemiberlesia neodiffinis* Miller and Davidson AL, AR, FL, GA, LA, MS, NC, SC, TN, TX  
*Hemiberlesia palmae* (Cockerell) FL, PR  
*Hemiberlesia popularum* (Marlatt) TX  
*\*Hemiberlesia rapax* (Comstock) AL, FL, GA, LA, MS, PR, SC, TX, VA  
*Hemigymnaspis eugeniae* (Lindinger) PR  
*Howardia biclavis* (Comstock) LA, PR  
*\*Ischnaspis longirostris* (Signoret) FL, GA, LA, PR  
*Kuwanaspis hikosani* (Kuwana) FL, GA  
*Kuwanaspis howardi* (Cooley) FL, GA, LA  
*Kuwanaspis linearis* (Green) PR  
*\*Kuwanaspis pseudoleucaspis* (Kuwana) AL, FL, GA, LA, SC  
*Kuwanaspis vermiformis* (Takahashi) FL  
*Lapazia obscura* Howell and Beshear TX  
*\*Lepidosaphes beckii* (Newman) FL, GA, LA, MS, PR, TN, TX  
*Lepidosaphes boguschi* McDaniel TX  
*\*Lepidosaphes camelliae* Hoke AL, FL, GA, LA, MS, SC, TX, VA  
*Lepidosaphes conchiformis* (Gmelin) PR  
*\*Lepidosaphes gloverii* (Packard) AL, FL, LA, MS, PR, SC, TX  
*Lepidosaphes lasianthi* (Green) PR  
*Lepidosaphes newsteadi* (Sule) FL, MS  
*\*Lepidosaphes pallida* (Maskell) FL, GA, LA, MS, VA  
*Lepidosaphes pinnaeformis* (Bouché) FL  
*Lepidosaphes rubrovittata* Cockerell PR  
*Lepidosaphes tokionis* (Kuwana) MS, PR  
*\*Lepidosaphes ulmi* (Linnaeus) FL, GA, LA, NC, TN, VA  
*Lepidosaphes vermiculosa* Mamet PR  
*Lepidosaphes yanagicola* Kuwana GA, TN, VA  
*Lopholeucaspis cockerelli* (Grandpre and Charmoy) FL, PRL  
*Lindingaspis floridana* Ferris FL  
*Lopholeucaspis japonica* (Cockerell) VA  
*Melanaspis arundinariae* Deitz and Davidson SC  
*Melanaspis bromiliae* (Leonardi) FL, PR  
*Melanaspis coccolobae* Ferris FL, PR  
*Melanaspis deklei* Deitz and Davidson FL, GA  
*Melanaspis delicata* Ferris TX  
*Melanaspis deliquescens* Ferris TX  
*Melanaspis eleagni* McKenzie LA, TX  
*Melanaspis jamaicensis* Davidson FL  
*Melanaspis latipyga* Ferris TX  
*Melanaspis lilacina* (Cockerell) TX  
*Melanaspis marlatti* (Parrott) FL, GA, TX

- Melanaspis mimosae* (Comstock) FL  
*Melanaspis nigropunctata* (Cockerell) PR, TX, VA  
 \**Melanaspis obscura* (Comstock) AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*Melanaspis odontoglossi* (Cockerell) FL, PR  
*Melanaspis pseudoponderosa* Deitz and Davidson FL  
*Melanaspis smilacis* (Comstock) FL, GA, LA, MS, NC, SC, TX, VA  
*Melanaspis tenax* McKenzie FL, PR  
 \**Melanaspis tenebricosa* (Comstock) AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
 \**Morganella cueroensis* (Cockerell) FL, GA, LA, MS, SC, TX  
*Morganella longispina* (Morgan) FL, PR  
*Mycetaspis apicata* (Newstead) TX  
*Mycetaspis defectopalus* Ferris FL, TX  
*Mycetaspis personata* (Comstock) FL, PR  
*Mycetaspis sphaerioides* (Cockerell) LA  
*Neopinnaspis harperi* McKenzie FL, GA  
*Niveaspis ilicis* (Hoke) GA, MS, TX  
*Oceanaspidiotus araucariae* (Adachi and Fullaway) FL, PR  
 \**Oceanaspidiotus spinosus* (Comstock) AL, FL, GA, LA, MS, PR, TX  
*Odonaspis benardi* Balachowsky TX  
*Odonaspis floridana* Ben-Dov FL  
*Odonaspis litorosa* Ferris TX  
*Odonaspis minima* Howell and Tippins GA  
 \**Odonaspis ruthae* Kotinsky AL, AR, FL, GA, LA, MS, NC, PR, SC, TX  
*Odonaspis saccharicaulis* (Zehntner) AL, FL, PR, TX  
*Odonaspis secreta* (Cockerell) LA  
*Odonaspis texana* Ben-Dov TX  
*Opuntiaspis carinata* (Cockerell) FL  
*Opuntiaspis javanensis* Green FL  
*Palinaspis quohogiformis* (Merrill) FL, PR  
*Parlatoeopsis chinensis* (Marlatt) FL  
 \**Parlatoria camelliae* Comstock AL, FL, GA, LA, MS, NC, SC, TX, VA  
*Parlatoria cinerea* Hadden PR  
*Parlatoria crotonis* Douglas FL, LA, PR  
 \**Parlatoria pergandii* Comstock AL, FL, GA, LA, MS, NC, PR, SC, TX, VA  
 \**Parlatoria proteus* (Curtis) FL, GA, LA, MS, PR, TN, TX  
*Parlatoria pseudaspidiotus* Lindinger FL, PR, TN  
*Parlatoria theae* Cockerell GA, NC, TX, VA  
*Parlatoria ziziphi* (Lucas) FL, PR  
*Pelliculaspis celtis* McDaniel TX  
 \**Pinnaspis aspidistrae* (Signoret) AL, AR, FL, GA, KY, LA, MS, NC, PR, SC, TN, TX, VA  
*Pinnaspis buxi* (Bouché) FL, PR  
 \**Pinnaspis strachani* (Cooley) AL, FL, GA, LA, MS, PR, TX  
*Praecocaspis diversa* Ferris FL  
*Protodiaspis emoryi* Ferris TX  
*Protodiaspis lobata* Ferris TX  
*Protodiaspis vara* Hoke AR, MS, TN, TX  
 \**Pseudaonidia duplex* (Cockerell) AL, FL, GA, LA, MS, TX, VA  
 \**Pseudaonidia paeoniae* (Cockerell) AL, AR, FL, GA, LA, MS, NC, SC, TX, VA  
*Pseudaonidia trilobitiformis* (Green) FL, PR  
 \**Pseudaulacaspis cockerelli* (Cooley) AL, FL, GA, LA, SC, TN, TX, VA  
 \**Pseudaulacaspis pentagona* (Targioni Tozzetti) AL, FL, GA, LA, MS, NC, PR, SC, TN, TX, VA  
 \**Pseudaulacaspis prunicola* (Maskell) AL, FL, LA, MS, NC, VA  
*Pseudischnaspis boweryi* (Cockerell) FL, PR  
*Pseudoparlatoria ostreata* Cockerell FL, PR  
 \**Pseudoparlatoria parlatorioides* (Comstock) AL, FL, GA, PR, SC, TX  
*Pseudoparlatoria tillandsiae* Tippins FL, GA, SC  
*Quernaspis insularis* Howell AR, FL, GA, LA, TX  
*Quernaspis quercicola* Tippins and Beshear GA  
 \**Quernaspis quercus* (Comstock) LA, FL, GA, TX  
*Radionaspis indica* (Marlatt) FL, PR  
 \**Rhizaspidiotus dearnessi* (Cockerell) AL, FL, GA, NC, SC, TX, VA  
*Rutherfordia major* (Cockerell) FL, PR  
*Selenaspis articulatus* (Morgan) FL, PR  
*Situlaspis condaliae* (Ferris) TX  
*Situlaspis yuccae* (Cockerell) FL, TX  
*Stramenaspis kelloggi* (Coleman) TX  
*Tagionia bigeloviae* (Cockerell) TX  
*Tagionia yuccarum* (Cockerell) TX  
*Thysanoflorinia nephelii* (Maskell) FL  
 \**Unaspis citri* (Comstock) FL, GA, LA, MS, PR, VA  
 \**Unaspis euonymi* (Comstock) AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, TX, VA  
*Velataspis anasterias* Ferris TX  
*Velataspis dentata* (Hoke) AL, FL, GA, LA, MS, TN, TX  
*Velataspis mimosarum* (Cockerell) TX  
*Vinculaspis virgata* (Ferris) PR  
*Xerophilaspis prosopidis* (Cockerell) TX

#### Eriococcidae or Felt Scales (Fig. 4)

Felt scales occur in all zoogeographic regions but have very poor representation in the Afrotropical and Oriental regions and are very abundant in New Zealand and Australia. There are 542 species in 69 genera; in the United States there are 80 species in 10 genera; in the Southern Region including Puerto Rico there are 49 species in 7 genera (Ben-Dov et al. 2002). Several species are occasional pests in the Southern Region including *Eriococcus azaleae* on azaleas, *E. coccineus* on cactus especially *Mammillaria*, *E. quercus* on oaks, and *E. spurius* on elms.

Field Characters: Felt scales are very diverse and comprise a number of apparently unrelated groups (Cook et al. 2002). The most common eriococcids in the U.S. are those of the *Eriococcus* type. They produce a white, gray, or yellowish ovisac that encloses the pyriform body of the adult female. Body color varies from pink or red to purple, green, or brown. The posterior end of the sac has a small opening that allows the first instars to escape. Other eriococcids occur under the bark of the host, produce little or no ovisac secretion and often are pink or red. Many species produce galls including one of the most interesting genera *Apiomorpha* which induces very ornate structures on various species of eucalyptus (Cook & Gullan 2002).

Diagnosis: Because of the great diversity and lack of monophyly of this family (Cook et al. 2002) there is no single diagnostic character. Characters that often are present on felt scales include: microtubular ducts; strongly protruding anal lobes; conical setae; cruciform pores; translucent pores on hind legs (Miller & McKenzie 1967).



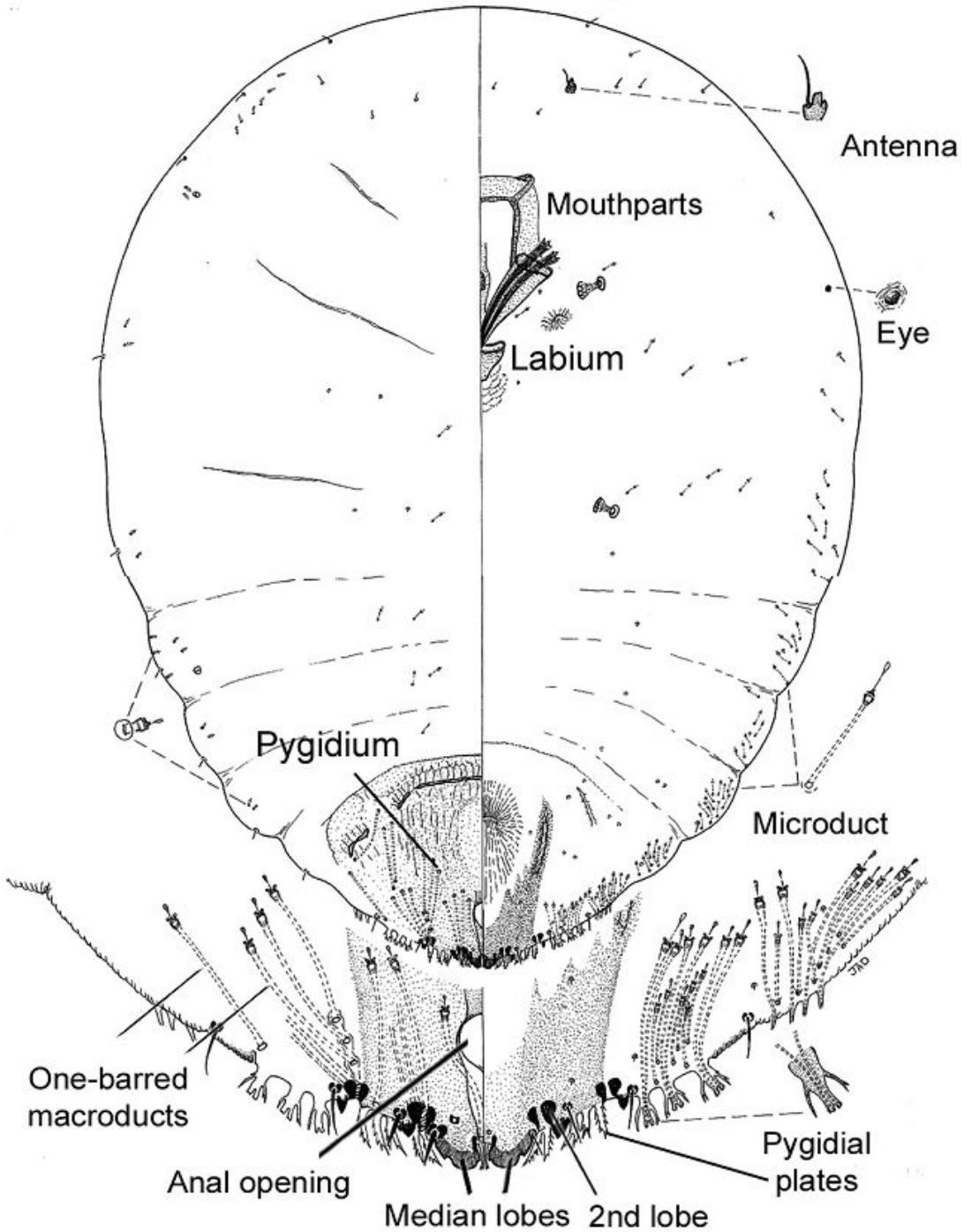


Fig. 3. Aspidiotinae—*Hemiberlesia neodiffinis* Miller and Davidson: Illustration from Miller and Davidson (1998).

Hosts: Eriococcids occur on a wide diversity of hosts including trees, shrubs, and even grasses. They are found on all parts of the host with the

possible exception of small diameter rootlets. The greatest diversity in the southern hemisphere is on older families such as the Myrtaceae whereas

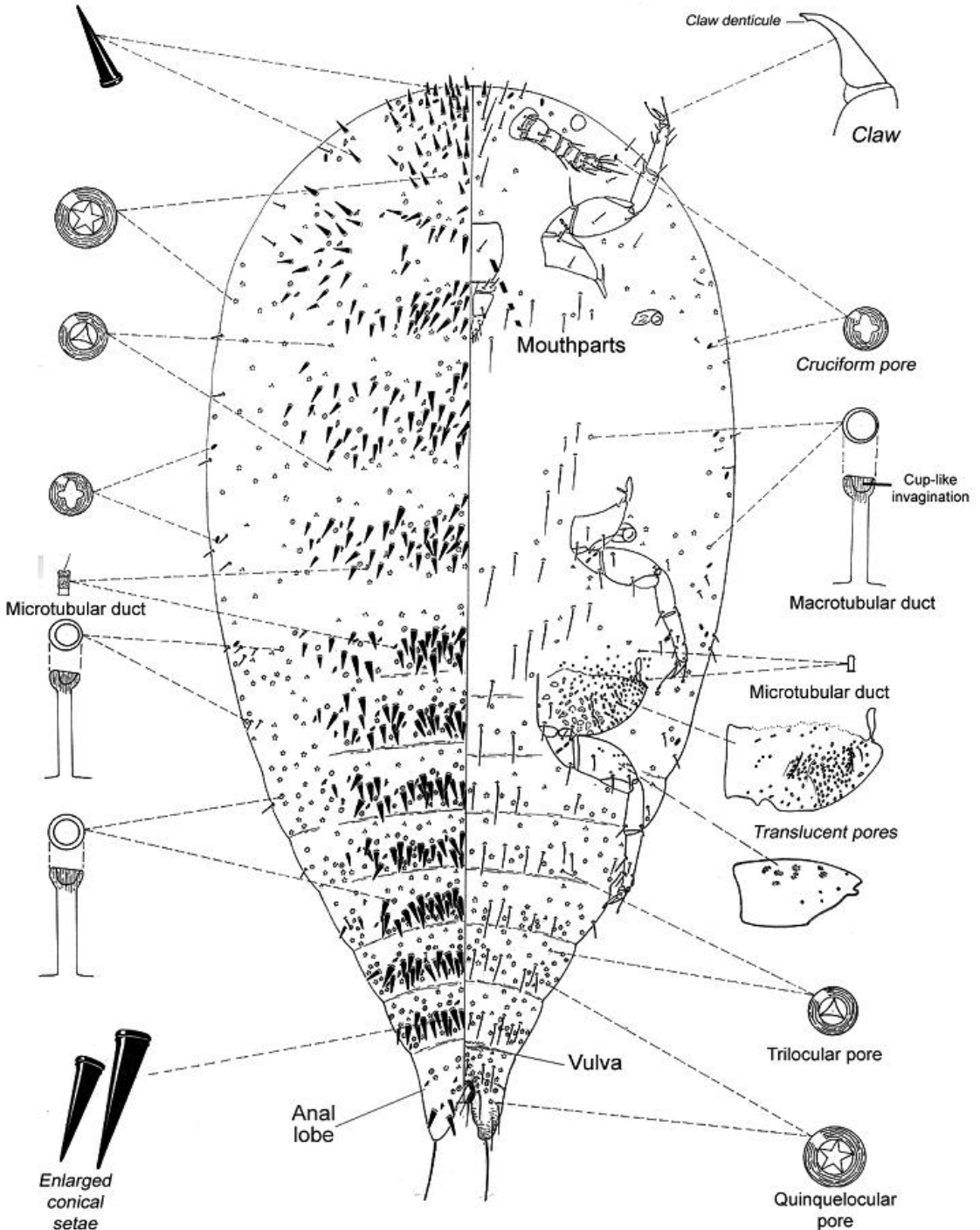


Fig. 4. *Eriococcus* sp.: Unpublished illustration by Miller.

in the northern hemisphere they are most diverse on more advanced plant groups such as the Asteraceae (Hoy 1962; Miller 1969).

Life History: Felt scales have 3 instars in the female and 5 in the male (Miller 1991b). Most eriococcus-type species have 1 or 2 generations each

year. The overwintering stage usually is the adult female or egg in the ovisac. First instars appear in early spring and settling often occurs within hours of emergence from the ovisac. Second-instar males feed for a short period then produce a narrow felt sac that encloses the body. Development of the prepupa, pupa, and adult male occurs within this sac. Soon after molting, the adult female mates and produces the ovisac several days later. Usually

50 to 100 eggs are laid. Some eriococcids have very unusual life histories. One example is the gall-inducing genus *Apiomorpha* which can have females that live for a year or more and produce separate male galls that often are induced on the gall of the female (Cook 2001; Cook & Gullan 2002).

Important references: Cook (2001); Cook et al. (2002); Ferris (1955); Gill (1993); Gullan (1984); Hoy (1962, 1963); Miller & Gimpel (2000).

KEY TO GENERA OF ERIOCOCCIDAE OF THE EASTERN U.S. (ADULT FEMALES)  
(MODIFIED FROM MILLER & MILLER 1993b)

1. Legs present ..... 2  
 Legs absent or represented by vestiges ..... *Cryptococcus* Douglas
- 2(1). Anal lobes present ..... 4  
 Anal lobes absent ..... 3
- 3(2). Macrotubular ducts present; without conspicuous dermal projections along body margin ... *Ovaticoccus* Kloet  
 Macrotubular ducts absent; with conspicuous dermal projections along  
 body margin ..... *Hypericicoccus* Williams
- 4(2). Anal lobes sclerotized, with enlarged setae; anal ring with 4 pairs of setae. .... *Eriococcus* Signoret  
 Anal lobes unsclerotized, without enlarged setae; anal ring with 3 pairs of setae ..... *Oregmopyga* Hoy

Checklist of Felt Scales of the Southern Region  
(asterisk signifies a frequently collected species)

*Apezococcus idiaestes* Ferris TX  
*Cornoculus cornutus* Ferris TX  
*Cryptococcus fagisuga* Lindinger TN, VA  
*Cryptococcus williamsi* Kosztarab VA  
*Eriococcus actius* (Miller and Miller) FL, GA  
 \**Eriococcus araucariae* Maskell FL, TX, PR  
*Eriococcus arenariae* (Miller and Miller) SC  
*Eriococcus arenosus* Cockerell TX  
 \**Eriococcus azaleae* Comstock AL, AR, FL, GA, LA, MS,  
 NC, SC, TN, TX, VA  
*Eriococcus besherae* (Miller and Miller) FL, GA, SC  
*Eriococcus boguschi* McDaniel TX  
*Eriococcus carolinae* Williams NC, VA  
*Eriococcus chilos* (Miller and Miller) VA  
 \**Eriococcus coccineus* Cockerell FL, TX, VA  
*Eriococcus cryptus* Cockerell TX  
*Eriococcus davidsoni* (Miller and Miller) FL  
*Eriococcus dennoi* (Miller and Miller) AL, FL, GA, SC,  
 VA  
*Eriococcus droserae* (Miller, Liu, and Howell) FL, GA  
 \**Eriococcus dubius* Cockerell AL, TX  
*Eriococcus eriogoni* Ehrhorn FL  
*Eriococcus euphoriae* Ferris TX  
*Eriococcus gerbergi* McDaniel TX  
*Eriococcus howelli* (Miller and Miller) FL, GA, SC, VA  
*Eriococcus hoyi* (Miller and Miller) TX  
*Eriococcus kemptoni* Parrott AL, GA, MS, TX, VA  
*Eriococcus larreae* Parrott and Cockerell TX  
*Eriococcus leptoporus* (Miller and Miller) GA  
*Eriococcus megaporus* (Miller and Miller) FL, GA, SC, VA  
*Eriococcus mesotrichus* (Miller and Miller) FL, GA, LA,  
 SC  
*Eriococcus microtrichus* (Miller and Miller) TX  
*Eriococcus missourii* Hollinger GA, LA, MS, VA  
*Eriococcus monotrichus* (Miller and Miller) FL, GA  
*Eriococcus nudulus* (Ferris) TX

*Eriococcus oligotrichus* (Miller and Miller) GA  
*Eriococcus ophius* (Miller and Miller) FL, GA  
 \**Eriococcus quercus* (Comstock) AL, FL, GA, LA, MS,  
 TX, VA  
*Eriococcus smithi* Lobdell FL, GA, LA, MS, SC, TX  
*Eriococcus spurius* (Modeer) AL, AR, LA, TN, TX, VA  
*Eriococcus stellatus* McDaniel TX, VA  
*Eriococcus texanus* King TX  
*Eriococcus tinsleyi* TX  
*Eriococcus tosotrichus* (Miller and Miller) GA  
*Hypericicoccus hyperici* (Ferris) AL, FL, GA, TN  
*Oregmopyga neglecta* (Cockerell) TX  
*Oregmopyga parvispina* (Chaffin) FL, TX  
*Oregmopyga strongyla* Miller and Miller GA  
*Oregmopyga tippinsi* Miller and Miller AL, FL, GA, MS  
*Ovaticoccus adoxus* Miller and Miller TX  
 \**Ovaticoccus agavium* (Douglas) TX

Ortheziidae or Ensign Scales (Fig. 5)

Ensign scales occur in all zoogeographic regions of the world. There are 198 species and 20 genera worldwide; in the United States there are about 30 species in 7 genera; and in the Southern Region there are 17 species in 6 genera (Ben-Dov et al. 2002).

Field Characters: Adult females with a thick wax ovisac that is attached to the abdomen and not the host; body adorned with patches of thick wax giving an ornate, elegant appearance; legs and antennae large and dark (Kozár 2004).

Diagnosis: Anal ring on dermal surface, with pores and setae; apex of antenna with thick terminal seta; abdominal spiracles present; eyes stalked; predominant pore type quadrilocular; usually with ovisac band around perimeter of ventral abdomen (Kozár 2004).

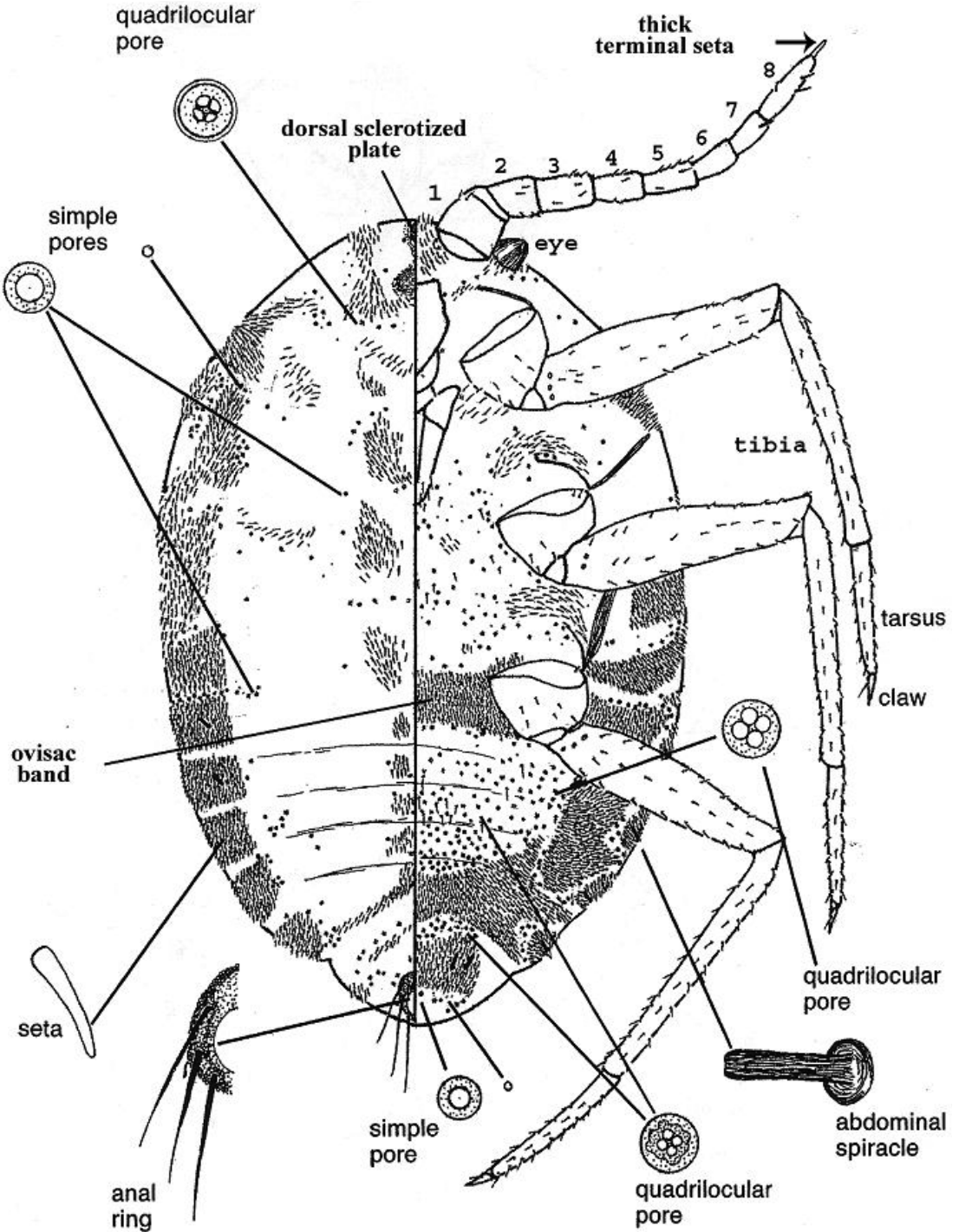


Fig. 5. *Insignorthezia insignis* (Browne): Illustration from Miller (1991a).

Hosts: Ortheziids occur on a broad diversity of host plants ranging from mosses and fungi to grasses and woody shrubs, even on small herbaceous plants (Morrison 1925, 1952).

Life History: Ensign scales have 4 instars in the female and most likely 5 instars in the male (Miller 1991b). It is unknown if the prepupa is mobile like most margarodoid groups or is seden-

tary like other scale insects. The life history of these scales is not well described. In the greenhouse on coleus, *Orthezia insignis* (Browne) could complete a complete life cycle in 30 days and reproduction was strictly parthenogenetic. Offspring were deposited over 24 days and from 80-102 nymphs were produced per female (Shivakumar & Lakshmikantha 2001). Normally feeding on the foliage of the host.

Important References: Kozár (2004); Miller et al. (2005); Morrison (1925, 1952).

Notes: In 2004, a book was completed on the Ortheziidae of the world by Ferenc Kozár. Many new genera and species are included from most areas of the world. The *Orthezia* species groups used by Morrison (1952) are now treated as genera, e.g., the graminis species group is now *Graminorthezia*, so the number of described genera has nearly doubled.

Checklist of Ensign Scales (Ortheziidae) of the Southern Region (asterisk signifies a commonly collected species)

- Graminorthezia pseudograminis* (Morrison) TX
- Graminorthezia tillandsiae* (Morrison) FL, GA, LA, VA
- Insignorthezia cacticola* (Morrison) TX
- \**Insignorthezia insignis* (Browne) FL, PR, TN, VA
- Insignorthezia pseudinsignis* Morrison LA, TX
- Newsteadia americana* Morrison SC, VA
- Newsteadia floridensis* Kozár and Konczne Benedicty FL
- \**Newsteadia minima* Morrison FL, GA, NC, VA
- Newsteadia trisegmentalis* Howell FL, GA
- \**Nipponorthezia obscura* Morrison FL, SC, TX, VA
- Orthezia ambrosicola* Morrison TX
- Orthezia annae* Cockerell TX
- Orthezia graminicola* Morrison GA, MS
- Orthezia solidaginis* Sanders GA, VA
- Praelongorthezia chisosi* Morrison TX
- Praelongorthezia gymnomolomiae* (Morrison) TX
- Praelongorthezia praelonga* Douglas PR

KEY TO ENSIGN SCALE GENERA IN THE SOUTHERN REGION

- 1. Tibiae and tarsi separate ..... 3
  - Tibiae and tarsi fused ..... 2
- 2(1). Antennae 3- or 4-segmented; first 2 segments smaller or equal to other segments ..... *Nipponorthezia*
  - Antennae 6- or 7-segmented; first 2 segments largest ..... *Newsteadia*
- 3(1). With rows of setae inside of ovisac band ..... 4
  - Without rows of setae inside of ovisac band. .... *Insignorthezia*
- 4(3). Head without dorsal sclerotized plates ..... 5
  - Head with dorsal sclerotized plates ..... *Praelongorthezia*
- 5(4). 7 or fewer pairs of abdominal spiracles ..... *Graminorthezia*
  - 8 pairs of abdominal spiracles. .... *Orthezia*

Pseudococcidae or Mealybugs (Fig. 6)

Mealybugs occur in all zoogeographic regions of the world and are abundant in most ecosystems. There are 1,989 species and 271 genera worldwide; in the United States there are 351 species in 48 genera; and in the Southern Region there are 155 species and 37 genera (Ben-Dov et al. 2002).

Field Characters: Adult females are often characterized by a white, mealy or powdery secretion that covers the body. Species that occur in concealed habitats such as grass sheaths either lack this secretion or have only small amounts of it. Frequently marginal areas of the body have a series of protruding lateral wax filaments. These filaments may be absent, confined to the posterior 1 or 2 abdominal segments, or occur around the entire body perimeter. A filamentous secretion often is produced that encloses the eggs and at least part of the body (McKenzie 1967).

Diagnosis: Look for the following combination of characters; none are present in all species. With ostioles; cerarii, when present, usually present at least on anal lobe; 1 or more circuli; swirled-type trilocular pores; translucent pores on hind legs; 2

pores on each surface of trochanter; without basal denticle on claw. Other characters to consider are: trochanter pores parallel to front edge of femur, not oriented transversely; 3 labial segments; usually 3 pairs of anal-ring setae; more than 4 setae on tibia; tubular ducts without invagination (Williams 2004; Miller et al. 2005).

Notes: No single character can be used to determine a specimen as a pseudococcid. Mealybugs are a large and diverse group and exceptions occur for every character. There are species without ostioles, cerarii, circuli, trilocular pores, and translucent pores. Although the family is distinct, the only way that it can be diagnosed is by using a combination of characters (Danzig 1986).

Hosts: Based on an analysis of the host information in the mealybug catalogue by Ben-Dov (1994), mealybugs occur on species in about 250 families of host plants. The most common host family is Poaceae with 585 species. The Asteraceae is a distant second with 250 species. The top ten most common host families are Fabaceae 225; Rosaceae 116; Rubiaceae 101; Euphorbiaceae 97; Myrtaceae 94; Labiatae 85; Moraceae 82; Cyperaceae 75. It is interesting that grasses and composites are such

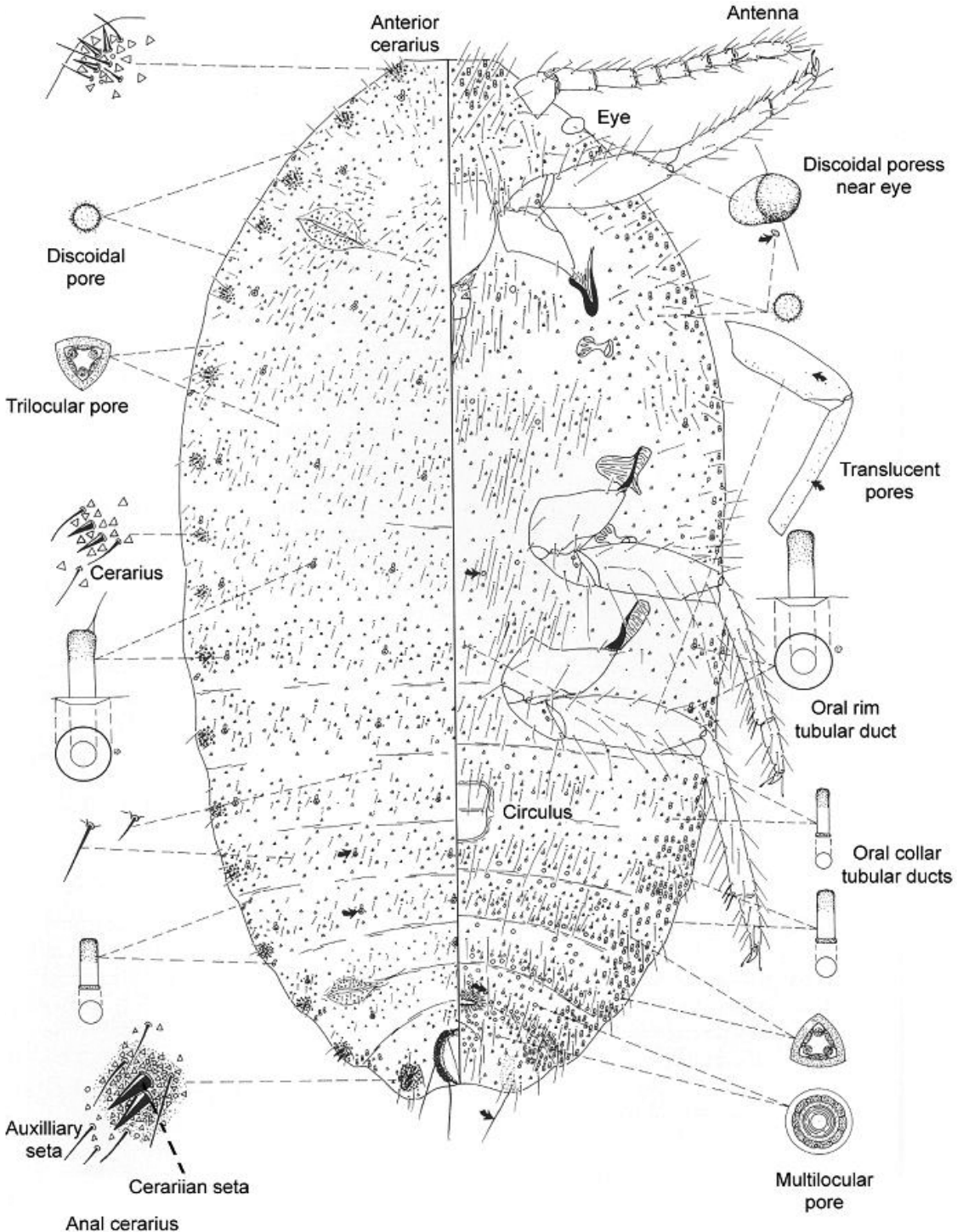


Fig. 6. *Pseudococcus maritimus* (Ehrhorn): Illustration from Miller, Gill, and Williams (1984).

important hosts of mealybugs, but are far less common as hosts of armored scales. This might be explained by the tendency for mealybugs to occur on

herbaceous plants rather than woody plants. There are surprisingly few mealybugs on families such as Salicaceae, Pinaceae, and Betulaceae.

**Life History:** Mealybugs have 4 female instars and 5 instars in the male (Miller 1991b). Mealybugs have a diverse array of life history strategies from occurring in grass blade sheaths, to feeding on rootlets, to occurring exposed on leaves. Thus any generalized life history will have many exceptions. Many mealybugs overwinter as second instars, although adults, first instars, and eggs also can play this role. Eggs or first instars are laid by the adult female. Eggs are normally laid in an ovisac that can enclose all or part of the body of the female. Most species that lay first instars rather than eggs lack any substantial ovisac. Even though the majority of species have legs in

all instars, most mealybugs remain relatively stationary throughout their life; a few species such as members of the genus *Phenacoccus*, move to different areas of the host for overwintering, feeding, oviposition, and molting. Most species have 1 or 2 generations a year, although some are reported to have as many as 8 generations in the greenhouse. Both parthenogenetic and sexual species are common (McKenzie 1967).

Important references: Ben-Dov (1994); Ben-Dov & German (2005); Danzig (1986); Ferris (1950, 1953); Tang (1992); Williams & Watson (1988); Williams & Granara de Willink (1992); Williams (1985b, 2004).

#### KEY TO SLIDE-MOUNTED ADULT FEMALE MEALYBUG GENERA IN THE SOUTHERN REGION

- |   |                        |
|---|------------------------|
| 1. Trilocular pores abundant . . . . .  | 6                      |
| Trilocular pores absent or rare . . . . .   | 2                      |
| 2(1). Quinquelocular pores present . . . . .  | 3                      |
| Quinquelocular pores absent . . . . .   | 4                      |
| 3(2). With a few trilocular pores near spiracles. . . . .   | <i>Brevennia</i>       |
| Without trilocular pores . . . . .  | <i>Heterococcus</i>    |
| 4(2). Posterodorsal setae filamentous, not enlarged . . . . .   | 5                      |
| Some posterodorsal setae enlarged, similar in shape to cerarian setae. . . . .                          | <i>Hypogeoecoccus</i>  |
| 5(4). Pores in spiracular atria. . . . .  | <i>Syrmococcus</i>     |
| Pores absent from spiracular atria. . . . .   | <i>Miscanthicoccus</i> |
| 6(1). Legs present . . . . .  | 9                      |
| Legs absent . . . . .   | 7                      |
| 7(6). Small pores or ducts in cluster posterior of hind spiracle . . . . .                              | 8                      |
| Small pores absent from area posterior of hind spiracle. . . . .  | <i>Antonina</i>        |
| 8(7). Anal ring at end of invaginated tube; anal ring setae longer than diameter of anal ring . . . . . | <i>Chaetococcus</i>    |
| Anal ring on dorsal surface, not in a tube; anal ring setae shorter than diameter of ring. . . . .      | <i>Paludicoccus</i>    |
| 9(6). Antennae not geniculate or elbowed; normally not on rootlets of host . . . . .                    | 11                     |
| Antennae geniculate; usually on rootlets of host. . . . .   | 10                     |
| 10(9). Apex of body with 2 spines; head also with 2 spines . . . . .                                    | <i>Geococcus</i>       |
| Apex of body and head without spines. . . . .   | <i>Rhizoecus</i>       |
| 11(9). Legs well developed, longer than clypeolabral shield plus labium. . . . .                        | 15                     |
| Legs small; front legs about same length or shorter than clypeolabral shield plus labium . . . . .      | 12                     |
| 12(11). Without circuli . . . . .   | 13                     |
| With circuli. . . . .   | <i>Radicoccus</i>      |
| 13(12). Hind coxae not enlarged, without translucent pores . . . . .                                    | 14                     |
| Hind coxae greatly enlarged, with numerous translucent pores . . . . .                                  | <i>Pseudantonina</i>   |
| 14(13). Anal ring without pores . . . . .   | <i>Ehrhornia</i>       |
| Anal ring with many pores . . . . .   | <i>Antoninoides</i>    |
| 15(11). Anal ring with pores . . . . .  | 16                     |
| Anal ring without pores . . . . .   | <i>Humococcus</i>      |
| 16(15). Claw without a denticle . . . . .   | 20                     |
| Claw with a denticle . . . . .  | 17                     |
| 17(16). Dorsal tubular ducts without a sclerotized orifice . . . . .                                    | 18                     |
| Some dorsal tubular ducts protruding and with sclerotized orifices . . . . .                            | <i>Helioecoccus</i>    |
| 18(17). Dorsal setae conical or filamentous . . . . .   | 19                     |
| Some dorsal setae enlarged, often truncate, with cluster of basal trilocular pores . . . . .            | <i>Stemmatomerinx</i>  |

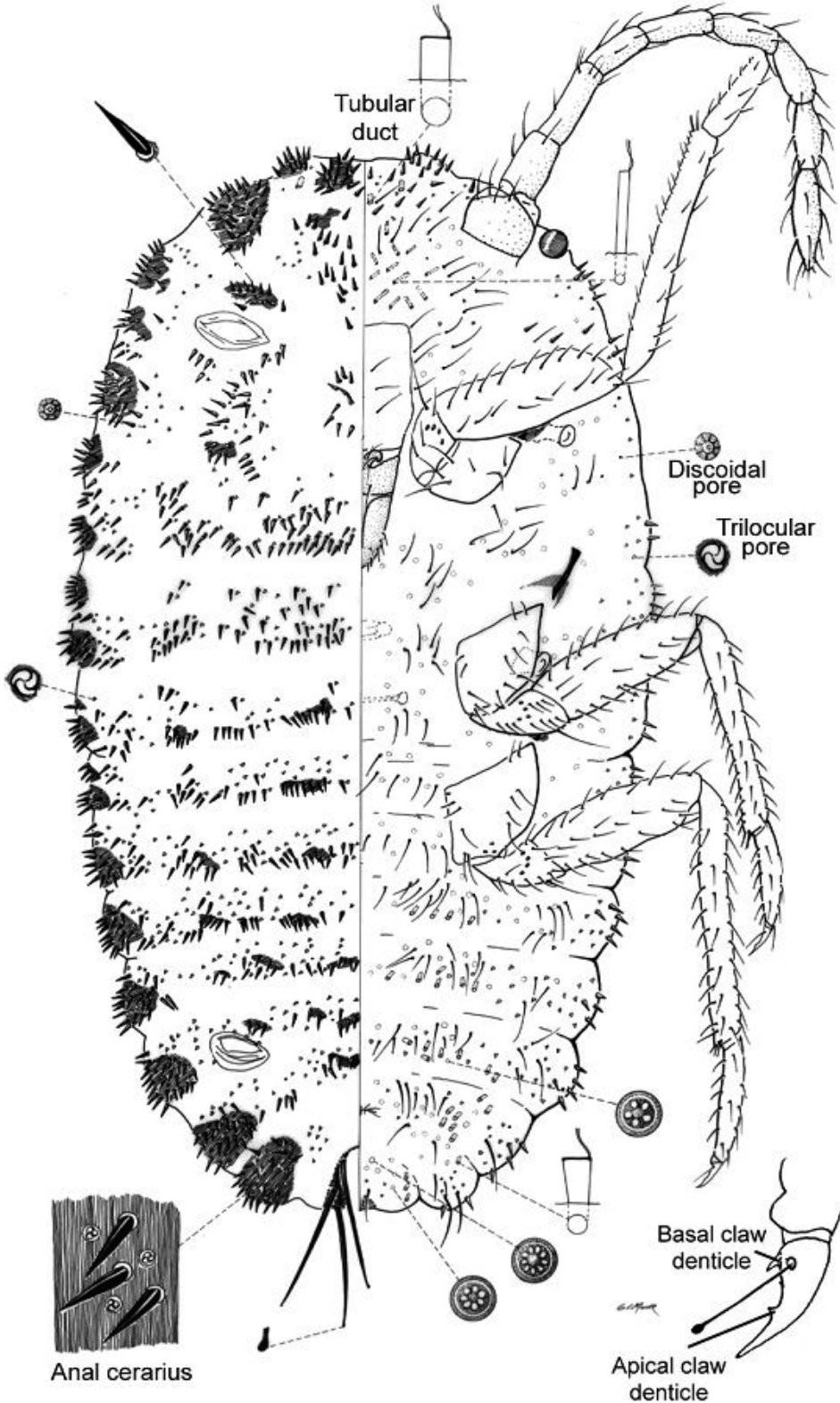


Fig. 7. *Puto kosztarabi* Miller and Miller: Illustration from Miller and Miller (1993).



19(18). Dorsal tubular ducts without clusters of multilocular pores surrounding orifice . . . . .	<i>Phenacoccus</i>
Dorsal tubular ducts with clusters of multilocular pores surrounding orifice . . . . .	<i>Peliococcus</i>
20(16). Without oral-rim tubular ducts . . . . .	28
With oral-rim tubular ducts . . . . .	21
21(20). With multilocular pores at least near vulva . . . . .	22
Without multilocular pores . . . . .	<i>Distichlicoccus</i>
22(21). With more than 6 pairs of cerarii . . . . .	25
With 6 or fewer pairs of cerarii . . . . .	23
23(22). Oral-rim tubular ducts without associated setae, usually without sclerotization around rim . . . . .	24
Oral-rim tubular ducts with associated setae and heavy sclerotization around rim . . . . .	<i>Ferrisia</i> (in part)
24(23). Anal bar present; dorsal setae nearly as long as ventral setae . . . . .	<i>Maconellicoccus</i>
Anal bar absent; dorsal setae conspicuously shorter than ventral setae . . . . .	<i>Chorizococcus</i>
25(22). Anal bar present . . . . .	26
Anal bar absent . . . . .	27
26(25). 18 pairs of cerarii . . . . .	<i>Planococcus</i> (in part)
17 or fewer pairs of cerarii . . . . .	<i>Paracoccus</i>
27(25). Auxiliary setae present in cerarii other than anal-lobe pair . . . . .	<i>Pseudococcus</i>
Auxiliary setae absent from cerarii other than anal-lobe pair . . . . .	<i>Spilococcus</i>
28(20). Small discoidal pores absent from derm near hind coxae . . . . .	30
Small discoidal pores present on derm near hind coxae . . . . .	29
29(28). Anal lobe cerarius with more than 3 conical setae; without unusually long marginal setae on each of posterior 4 abdominal segments . . . . .	<i>Palmicultor</i>
Anal lobe cerarius with 2 conical setae; with unusually long marginal setae on each of posterior 4 abdominal segments . . . . .	<i>Saccharicoccus</i>
30(28). 6 or fewer pairs of cerarii . . . . .	36
More than 6 pairs of cerarii . . . . .	31
31(30). Cerarii anterior of anal lobe pair without auxiliary setae . . . . .	33
Cerarii anterior of anal lobe pair with auxiliary setae . . . . .	32
32(31). Antennae 9-segmented; legs unusually long, extending beyond posterior apex of body . . . . .	<i>Plotococcus</i>
Antennae with fewer than 9 segments; legs not usually extending beyond posterior apex of body . . . . .	<i>Dysmicoccus</i>
33(31). Dorsal setae not conical, differently shaped than cerarian setae . . . . .	34
Some dorsal setae conical, same shape as cerarian setae . . . . .	<i>Nipaeococcus</i>
34(33). Cerarii with 3 or fewer conical setae . . . . .	35
Cerarii with more the 3 conical setae . . . . .	<i>Paraputo</i>
35(34). With more than 10 pairs of cerarii; with an anal bar . . . . .	<i>Planococcus</i> (in part)
With fewer that 10 pairs of cerarii; without an anal bar . . . . .	<i>Oracella</i> (in part)
36(30). Dorsal tubular ducts absent or without associated setae, usually without sclerotization around orifice . . . . .	37
Dorsal tubular ducts with associated setae and sclerotization around rim . . . . .	<i>Ferrisia</i> (in part)
37(36). Multilocular pores present, at least near vulva . . . . .	38
Multilocular pores absent . . . . .	<i>Paradoxococcus</i>
38(37). Without or with 1 circulus . . . . .	39
With more than 1 circulus . . . . .	<i>Tridiscus</i>
39(38). Cerarii numbering more than 1 pair . . . . .	40
Cerarii absent or restricted to anal lobe . . . . .	41
40(39). On pines; body rotund . . . . .	<i>Oracella</i>
On grasses; normally slender, elongate . . . . .	<i>Trionymus</i> (in part)
41(39). Not on grasses; body round or broadly oval . . . . .	42
Occurring on grasses; body often elongate or elongate oval . . . . .	<i>Trionymus</i> (in part)

- 42(41). Anal lobe cerarii with large concentration of basal trilocular pores, 2 conical setae . . . . . *Chnaurococcus*  
 Anal lobe cerarii without a concentration of basal trilocular pores, often without  
 conical setae . . . . . *Eurycoccus*

Checklist of Mealybugs of the Southern Region  
 (asterisk signifies a frequently collected species)

- \**Antonina nakaharai* Williams and Miller (misidentification of *A. crawii*) LA  
 \**Antonina graminis* (Maskell) AL, FL, GA, LA, MS, PR, SC, TX  
 \**Antonina pretiosa* Ferris FL, GA, LA  
*Antoninoides boutelouae* (Parrott) TX  
*Antoninoides nortoni* (Parrott and Cockerell) FL, GA, NC, TX  
*Antoninoides parrotti* (Cockerell) FL, MS, TX  
*Brevennia rehi* (Lindinger) FL, PR, TX  
 \**Chaetococcus bambusae* (Maskell) FL, PR  
*Chnaurococcus trifolii* (Forbes) VA  
*Chorizococcus dentatus* (Lobdell) MS, VA  
*Chorizococcus graysoni* Brachman and Kosztarab VA  
*Chorizococcus nakaharai* Williams and Granara de Willink PR  
*Chorizococcus psoraleae* McKenzie TN  
*Chorizococcus rostellum* (Lobdell) LA, MS, VA  
*Chorizococcus shaferei* (Hollinger) MS  
*Crisicoccus taxodii* Kosztarab FL, GA, VA  
*Distichlicoccus alkalinus* (Cockerell) TX  
*Distichlicoccus digitariae* Williams and Granara de Willink PR  
*Dysmicoccus bispinosus* Beardsey PR  
 \**Dysmicoccus boninsis* (Kuwana) FL, GA, LA, MS, PR  
 \**Dysmicoccus brevipes* (Cockerell) FL, LA, PR  
*Dysmicoccus difficilis* (Lobdell) MS, VA  
*Dysmicoccus diodium* (McConnell) MS, SC, VA  
 \**Dysmicoccus grassii* (Leonardi) PR  
*Dysmicoccus junceus* (McConnell) VA  
*Dysmicoccus lasii* (Cockerell) FL, VA  
*Dysmicoccus merrilli* (Ferris) FL  
*Dysmicoccus milleri* Kosztarab AL, FL, GA, VA  
*Dysmicoccus morrisoni* (Hollinger) AL, GA, LA, MS, VA  
*Dysmicoccus neobrevipes* Beardsey FL, PR  
*Dysmicoccus obesus* (Lobdell) AL, AR, GA, LA, MS, NC, SC, VA  
*Dysmicoccus texensis* (Tinsley) TX  
*Dysmicoccus vaccinii* Miller and Polavarapu NC  
*Dysmicoccus wistariae* (Green) VA  
*Eurycoccus blanchardii* (King and Cockerell) MS, VA  
*Eurycoccus campbelli* Kosztarab VA  
*Eurycoccus copallinae* Ferris FL  
*Eurycoccus yuccae* Ferris TX  
*Ferrisia claviveta* (Lobdell) MS  
*Ferrisia floridana* (Ferris) FL  
*Ferrisia quaintancii* (Tinsley) FL  
 \**Ferrisia malvastra* (McDaniel) TX  
 \**Ferrisia virgata* (Cockerell) FL, LA, PR, TX, VA  
*Geococcus coffeae* Green FL, PR  
*Helioecoccus deserticola* Miller TX  
*Helioecoccus insignis* (Lobdell) LA, MS  
*Helioecoccus osborni* (Sanders) LA, TX, VA  
*Helioecoccus stachyos* (Ehrhorn) VA  
*Helioecoccus wheeleri* (King) TX  
*Heterococcus nudus* (Green) VA  
*Heterococcus rauii* Miller SC  
*Humococcus atriplicis* Ferris TX  
*Humococcus dasychloae* (Ferris) TX  
*Humococcus hilariae* (Ferris) TX  
*Hypogeococcus barbarae* Rau VA  
*Hypogeococcus hamoni* Miller FL  
*Hypogeococcus margaretae* Miller FL  
*Hypogeococcus spinosus* Ferris TX  
 \**Maconellicoccus hirsutus* (Green) FL, PR  
 \**Miscanthococcus miscanthi* (Takahashi) VA  
 \**Nipaeococcus nipae* (Maskell) FL, LA, PR  
 \**Oracella acuta* (Lobdell) FL, GA, KY, LA, MS, NC, SC, TX, VA  
*Palmicultor browni* Williams and Watson FL  
 \**Palmicultor palmarum* (Ehrhorn) FL  
 \**Palmicultor lumpurensis* (Takahashi) FL  
*Paludicoccus distichlium* (Kuwana) TX  
*Paracoccus juniperi* (Ehrhorn) TX  
 \**Paracoccus marginatus* Williams and Granara de Willink FL  
*Paracoccus townsendi* (Cockerell) TX  
*Paradoxococcus mcdanieli* McKenzie AL, FL, GA, MS, SC, TX, VA  
*Paraputo olivaceus* (Cockerell) (=Cataenococcus olivaceus) FL, TX  
*Peliococcus flaveolus* (Cockerell) VA  
*Peliococcus serratus* (Ferris) TN, VA  
*Phenacoccus acericola* King KY, TN, VA  
*Phenacoccus colemani* Ehrhorn FL, PR  
*Phenacoccus dearnessi* King TX, VA  
*Phenacoccus gossypii* Townsend and Cockerell FL  
*Phenacoccus helianthi* (Cockerell) TX  
*Phenacoccus hortorum* Bachman and Kosztarab VA  
*Phenacoccus hurdi* McKenzie TX  
 \**Phenacoccus madeirensis* Green AL, FL, LA, MS, NC, PR, TX, VA  
*Phenacoccus minimus* Tinsley VA  
*Phenacoccus parvus* Morrison FL, PR  
*Phenacoccus rubivorus* Cockerell NC, VA  
 \**Phenacoccus solani* Ferris FL, LA, PR, TX, VA  
 \**Phenacoccus solenopsis* Tinsley FL, MS, TX, VA  
 \**Planococcus citri* (Risso) AL, AR, FL, GA, KY, LA, MS, NC, PR  
 SC, TN, TX, VA  
 \**Planococcus ficus* (Signoret) AL, FL, GA, NC, SC, TX  
*Plotococcus eugeniae* Miller and Denno FL  
*Pseudantonina arundinariae* McConnell SC  
*Pseudantonina giganticoxa* Lobdell FL, GA  
*Pseudantonina nakaharai* Kosztarab VA  
*Pseudantonina wilkeyi* Kosztarab VA  
*Pseudantonina texana* Ferris TX  
*Pseudococcus bryberia* Gimpel and Miller FL, GA, VA  
 \**Pseudococcus comstocki* (Kuwana) GA, LA, SC, VA  
*Pseudococcus dasylliriae* Gimpel and Miller TX  
*Pseudococcus dolichomelos* Gimpel and Miller FL, NC, SC, TX  
*Pseudococcus donrileyi* Gimpel and Miller TX  
 \**Pseudococcus elisae* Borchsenius FL  
*Pseudococcus importatus* McKenzie FL  
 \**Pseudococcus jackbeardsleyi* Gimpel and Miller FL, PR, TX  
 \**Pseudococcus longispinus* (Targioni Tozzetti) AL, FL, NC, PR, TN, TX  
 \**Pseudococcus maritimus* (Ehrhorn) AR, FL, GA, TN, TX, VA  
*Pseudococcus microcirculus* McKenzie FL  
*Pseudococcus nakaharai* Gimpel and Miller FL, TX

*Pseudococcus odermatti* Gimpel and Miller FL  
*Pseudococcus pithecellobii* Gimpel and Miller TX  
*Pseudococcus puertoricensis* Gimpel and Miller PR  
*Pseudococcus sorghiellus* (Forbes) AR, FL, GA, LA, NC, SC, TN, VA  
*Pseudococcus spanocera* Gimpel and Miller AR, FL, GA  
 \**Pseudococcus viburni* (Signoret) AL, FL, GA, NC, SC, VA  
*Rhizoecus americanus* (Hambleton) FL, PR  
*Rhizoecus apizacos* Hambleton TX  
*Rhizoecus cacticans* (Hambleton) FL  
*Rhizoecus dianthi* Green FL  
*Rhizoecus bicirculus* McKenzie TX  
*Rhizoecus brevirostris* Hambleton TX  
*Rhizoecus bituberculatus* McKenzie NC  
*Rhizoecus distinctus* (Hambleton) TN, VA  
*Rhizoecus falcifer* Kunckel d'Herculanis FL  
*Rhizoecus floridanus* Hambleton FL, GA  
*Rhizoecus gracilis* McKenzie TX, VA  
*Rhizoecus hibisci* Kuwana and Takagi FL, PR  
*Rhizoecus kelloggi* (Ehrhorn and Cockerell) FL, TX  
*Rhizoecus keysensis* Hambleton FL  
*Rhizoecus ladoniae* Hambleton FL  
*Rhizoecus leucosomus* (Cockerell) FL, TX, VA  
*Rhizoecus maritimus* (Cockerell) FL  
*Rhizoecus mexicanus* (Hambleton) FL, TX  
*Rhizoecus palestinae* (Hambleton) FL  
*Rhizoecus pseudocacticans* Hambleton FL  
*Rhizoecus simplex* (Hambleton) FL  
*Rhizoecus spicatus* Hambleton FL  
*Rhizoecus solani* (Hambleton) TX  
*Rhizoecus spinipes* (Hambleton) AR, FL, GA  
*Saccharicoccus sacchari* (Cockerell) PR  
*Spilococcus eriogoni* (Ehrhorn) TX  
*Spilococcus gutierreziae* (Cockerell) TX  
*Spilococcus prosopidis* (Cockerell) TX  
*Spilococcus steeli* (Cockerell and Townsend) TX  
*Stemmatomerinx acircula* Howell and Miller FL  
*Stemmatomerinx adenticulata* Howell and Miller GA  
*Stemmatomerinx aristida* Howell and Miller GA  
*Stemmatomerinx beshearae* Howell and Miller GA  
*Stemmatomerinx decorata* Ferris TX  
*Symmococcus spirapuncta* (Lobdell) FL, MS  
*Symmococcus pecosensis* Ferris TX  
*Tridiscus matildae* Kosztarab SC  
*Trionymus americanus* (Cockerell) MS  
*Trionymus caricis* McConnell FL, GA, SC, TN, VA  
*Trionymus clandestinis* McConnell VA  
*Trionymus lowryi* Brachman and Kosztarab VA  
*Trionymus mori* Lobdell MS  
*Trionymus radicolica* (Morrison) PR  
*Trionymus smithii* (Essig) VA

#### Putoidae or giant Mealybugs (Fig. 7)

Giant mealybugs occur in the Nearctic, Neotropical, Oriental, and Palearctic regions. They are absent from the Afrotropical and Australasian regions. There are 57 species and 1 or 2 genera worldwide; in the United States there are 23 species in 1 genus; and in the Southern Region there are 5 species and 1 genus (Ben-Dov et al. 2002).

Diagnosis: Body large and rotund; claw with basal denticle in addition to subapical denticle; cerarii large and conspicuous; trochanter with 3

or 4 pores on each surface; with trilocular pores, ostioles, translucent pores on hind legs, and usually with a circulus (Williams 2004; Miller 1991a).

Notes: Giant mealybugs are quite uniform in their morphological characteristics. The family most likely includes only 1 or 2 genera: *Macrocerococcus* (which often is treated as a synonym of *Puto*) and *Puto*. *Ceroputo* clearly is a pseudococcid and not a putoid. Putoids have only recently been removed from the Pseudococcidae, based primarily on their chromosome system.

Life History: Giant mealybugs have 4 instars in the female and 5 in the male. Most species have a single generation each year, although *Puto sandini* Washburn requires 4 years to complete a generation (Washburn 1965). *Puto antennatus* (Signoret) has a single generation each year and feeds on conifers in the high elevations of the Bavarian Alps. Overwintering occurs in the immature stages under the bark of the host. In early spring the nymphs move to the bases of needles, enlarge, and appear as adults in early May. Adult males are common. Eggs are laid in July (Sampo & Olmi 1979). *Macrocerococcus superbus* Leonardi has essentially the same life history. There is a single generation each year, adults appear in May, and oviposition occurs in July. Mating is necessary for reproduction. First instars are the overwintering stage (Marotta 1992).

Important references: Ben-Dov (1994); Ben-Dov & German (2005); Danzig (1986, 1999); Kosztarab & Kozár (1988); McKenzie (1967); Miller & Miller (1993a); Williams (2004).

Giant Mealybugs (Putoidae) of the Southern Region (asterisk signifies a frequently collected species)

\**Puto barberi* (Cockerell) PR  
*Puto kosztarabi* Miller and Miller VA  
*Puto lasiorum* (Cockerell) TX  
*Puto mexicanus* (Cockerell) TX  
 \**Puto yuccae* (Coquillett) TX

#### ACKNOWLEDGMENTS

I am grateful to following individuals for their comments and criticisms of this manuscript. Chris Thompson and Gary Miller, Systematic Entomology Laboratory, ARS/USDA, Beltsville, MD, Greg Hodges, Florida Department of Agriculture and Consumer Services, Division of Plant Industry, Gainesville, FL and F. William Howard, University of Florida's Ft. Lauderdale Research and Education Center. I am grateful to Ray Gill, California Department of Food and Agriculture, Sacramento and John Davidson, University of Maryland, for use of the conchaspidid and diaspidid illustrations, respectively.

#### REFERENCES CITED

BALACHOWSKY, A. S. 1948. Les cochenilles de France, d'Europe, du nord de l'Afrique et du bassin Méditerranéen. IV. Monographie des Coccoidea, classifica-

- tion—Diaspidinae (Premiere partie) (1er partie). Entomol. Appl. Actual. Sci. Indus. 1054: 243-394.
- BALACHOWSKY, A. S. 1950. Les cochenilles de France, d'Europe, du Nord de l'Afrique et du Bassin Méditerranéen. V. Monographie des Coccoidea; Diaspidinae (deuxième partie) Aspidiotini. Actual. Sci. Indus. 1087: 397-557.
- BALACHOWSKY, A. S. 1951. Les cochenilles de France, d'Europe, du Nord de l'Afrique et du bassin Méditerranéen. VI. Monographie des Coccoidea; Diaspidinae (Troisième partie) Aspidiotini (fin) (3e partie). Entomol. Appl. Actual. Sci. Indus. 1127: 561-720.
- BALACHOWSKY, A. S. 1953. Les cochenilles de France d'Europe, du Nord de l'Afrique, et du bassin Méditerranéen. VII. Monographie des Coccoidea; Diaspidinae-IV, Odonaspidini-Parlatorini. Actual. Sci. Indus. 1202: 725-929.
- BALACHOWSKY, A. S. 1954. Les cochenilles Paléarctiques de la tribu des Diaspidini. Mem. Sci. Inst. Pasteur, Paris. 450 pp.
- BEN-DOV, Y. 1974. On the species of Conchaspidae (Homoptera: Coccoidea) from Africa and Madagascar with description of a new species. Rev. Zool. Africaine 88: 363-373.
- BEN-DOV, Y. 1981. A catalogue of the Conchaspidae (Insecta, Homoptera, Coccoidea) of the world. Ann. Soc. Entomol. France 17: 143-156.
- BEN-DOV, Y. 1994. A Systematic Catalogue of the Mealybugs of the World (Insecta: Homoptera: Coccoidea: Pseudococcidae and Putoidae) with Data on Geographical Distribution, Host plants, Biology and Economic Importance. Intercept Ltd., Andover, UK. 686 pp.
- BEN-DOV, Y., AND V. GERMAN. 2003. A Systematic Catalogue of the Diaspididae (Armoured Scale Insects) of the World, Subfamilies Aspidiotinae, Comstockiellinae and Odonaspidinae. Intercept, Andover, Hants, U.K. 1112 pp.
- BEN-DOV, Y., AND V. GERMAN. 2005. Pseudococcidae and Putoidae. Part of ScaleNet <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>
- BEN-DOV, Y., D. R. MILLER, AND G. A. P. GIBSON. 2002. ScaleNet, Classification. 16 August 2002. <http://www.sel.barc.usda.gov/scalenet/classif.htm>
- BEN-DOV, Y., D. R. MILLER, AND G. A. P. GIBSON. 2002. ScaleNet. 13 January 2005. <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>
- BORCHSENIUS, N. S. 1966. A Catalogue of the Armoured Scale Insects (Diaspidoidea) of the World (In Russian). Nauka, Moscow and Leningrad. 449 pp.
- COOK, L. G. 2001. The biology, evolution and systematics of the gall-inducing scale insect *Apiomorpha*. Ph.D. Dissertation, Austral. Natl. Univ., Canberra 263 pp.
- COOK, L. G., AND P. J. GULLAN. 2002 (2001). Longevity and reproduction in *Apiomorpha* Rubsaamen (Hemiptera: Sternorrhyncha: Coccoidea). Boll. Zool. Agraria Bach. (Milano) 33(3): 259-265.
- COOK, L. G., P. J. GULLAN, AND H. E. TRUEMAN. 2002. A preliminary phylogeny of the scale insects (Hemiptera: Sternorrhyncha: Coccoidea) based on nuclear small-subunit ribosomal DNA. Molec. Phylogenetics Evol. 25(1): 43-52.
- DANZIG, E. M. 1986. Coccids of the Far-Eastern USSR (Homoptera: Coccinea). Phylogenetic Analysis of Coccids in the World Fauna. Amerind Pub. Co., New Delhi, India. 450 pp.
- DANZIG, E. M. 1993. Fauna of Russia and Neighbouring Countries. Rhynchota, Volume X: suborder scale insects (Coccinea): Families Phoenicococcidae and Diaspididae (In Russian). 'Nauka' Pub. House, St. Petersburg. 452 pp.
- DANZIG, E. M. 1999. Mealybugs of the genus *Puto* Signoret (Homoptera, Pseudococcidae) of Russia and neighboring countries (In Russian). Entomol. Oboz. 78: 79-91.
- FERRIS, G. F. 1937. Atlas of the Scale Insects of North America. Stanford Univ. Press, Palo Alto, CA. 136 pp.
- FERRIS, G. F. 1938. Atlas of the Scale Insects of North America. Series 2. Stanford Univ. Press, Palo Alto, CA. 131 pp.
- FERRIS, G. F. 1941. Atlas of the Scale Insects of North America. Series 3. Stanford Univ. Press, Palo Alto, CA. 115 pp.
- FERRIS, G. F. 1942. Atlas of the Scale Insects of North America. Series 4. Stanford Univ. Press, Palo Alto, CA. 253 pp.
- FERRIS, G. F. 1950. Atlas of the Scale Insects of North America (ser. 5) [v. 5]. The Pseudococcidae (Part I). Stanford Univ. Press, Palo Alto, CA. 278 pp.
- FERRIS, G. F. 1953. Atlas of the Scale Insects of North America, v. 6, The Pseudococcidae (Part II). Stanford Univ. Press, Palo Alto, CA. 506 pp.
- FERRIS, G. F. 1955. Atlas of the Scale Insects of North America, v. 7, the Families Aclerididae, Asterolecaniidae, Conchaspidae, Dactylopiidae and Lacciferidae. Stanford Univ. Press, Palo Alto, CA. 233 pp.
- GILL, R. J. 1993. The Scale Insects of California: Part 2. The Minor Families (Homoptera: Coccoidea). Calif. Dept. Food Agric., Sacramento, CA. 241 pp.
- GULLAN, P. J. 1984. A revision of the gall-forming coccoid genus *Apiomorpha* Rübsaamen (Homoptera: Eriococcidae: Apiomorphae). Austral. J. Zool., Suppl. Ser. 97: 1-203.
- GULLAN, P. J. 2001 (1999). Why the taxon Homoptera does not exist. Entomologica 33: 101-104.
- HOWARD, F. W., AND A. D. OLIVER 1985. Armored Scale Insects of Louisiana. Louisiana Agric. Exp. Sta. Bull. No. 767. Sci. Indus. Res. Bull. 146: 1-219.
- HOY, J. M. 1962. Eriococcidae (Homoptera: Coccoidea) of New Zealand. N. Z. Dept.
- HOY, J. M. 1963. A catalogue of the Eriococcidae (Homoptera: Coccoidea) of the world. N. Z. Dept. Sci. Indus. Res. Bull. 150: 1-260.
- KOSZTARAB, M. 1990. 3.1.2 Economic importance, pp. 307-311 In D. Rosen [ed], Armored Scale Insects, Their Biology, Natural Enemies and Control [Series title: World Crop Pests, Vol. 4B]. Elsevier, Amsterdam, the Netherlands. 688 pp.
- KOSZTARAB, M., AND F. KOZÁR. 1988. Scale Insects of Central Europe. Akad. Kiado, Budapest. 456 pp.
- KOTEJA, J. 1974. On the phylogeny and classification of the scale insects (Homoptera, Coccinea). Acta Zool. Cracoviensia 19: 267-325.
- KOZÁR, F. 2004. Ortheziidae of the World. Plant Prot. Inst., Hungar. Acad. Sci., Budapest, Hungary. 525 pp.
- MAMET, J. R. 1954. A monograph of the Conchaspidae Green (Hemiptera: Coccoidea). Trans. R. Entomol. Soc. London 105: 189-239.
- MAMET, J. R. 1959. Notes on the Coccoidea of Madagascar IV. Mem. Inst. Sci. Madagascar (Ser. E) 11: 369-479.
- MAROTTA, S. 1992. Osservazioni bio-etologiche su *Puto superbus* (Leonardi) (Homoptera Coccoidea Pseudococcidae) su *Arrhenatherum elatius* Mert. E. K. in Aruzzo. Redia 75: 485-499.
- MCKENZIE, H. L. 1967. Mealybugs of California with Taxonomy, Biology, and Control of North American

- Species (Homoptera: Coccoidea: Pseudococcidae). Univ. Calif. Press, Berkeley. 526 pp.
- MILLER, D. R. 1969. A systematic revision of *Eriococcus*, with a discussion of the zoogeography of the Eriococcidae. Ph.D. Dissertation, Univ. Calif., Davis 253 pp.
- MILLER, D. R. 1991a. Scale insects (Coccoidea, Homoptera), pp. 421-448 In J. R. Gorham [ed.], Insect and Mite Pests in Food: An Illustrated Key (Volume 2). Agriculture Handbook No. 665. Superintendent of Documents, U.S. Gov. Print. Off., Washington, DC. 767 pp.
- MILLER, D. R. 1991b. The scales, scale insects or coccoids, pp. 90-107 In F. W. Stehr [ed.], Immature Insects, Volume 2. Kendall/Hunt, Dubuque, Iowa. 975 pp.
- MILLER, D. R., AND J. A. DAVIDSON. 1990. 3.1.1 A list of the armored scale insect pests, pp. 299-306 In D. Rosen, D. [ed.], Armored Scale Insects, Their Biology, Natural Enemies and Control [Series title: World Crop Pests, Vol. 4B]. Elsevier, Amsterdam, the Netherlands. 688 pp.
- MILLER, D. R., AND J. A. DAVIDSON. 1998. A new species of armored scale (Hemiptera: Coccoidea: Diaspididae) previously confused with *Hemiberlesia diffinis* (Newstead). Proc. Entomol. Soc. Wash. 100: 193-201.
- MILLER, D. R., AND J. A. DAVIDSON. 2005. Armored Scale Insects of Trees and Shrubs. Cornell Univ. Press, Ithaca, NY. 425 pp.
- MILLER, D. R., R. J. GILL, AND D. J. WILLIAMS. 1984. Taxonomic analysis of *Pseudococcus affinis* (Maskell), a senior synonym of *Pseudococcus obscurus* Essig, and a comparison with *Pseudococcus maritimus* (Ehrhorn) (Homoptera: Coccoidea: Pseudococcidae). Proc. Entomol. Soc. Wash. 86: 703-713.
- MILLER, D. R., AND M. E. GIMPEL. 2000. A Systematic Catalogue of the Eriococcidae (Felt Scales) (Hemiptera: Coccoidea) of the World. Intercept Ltd., Andover, U.K. 589 pp.
- MILLER, D. R., AND M. E. GIMPEL. 2005. Diaspididae: Diaspidinae and Leucaspidae. Part of ScaleNet <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>
- MILLER, D. R., M. E. GIMPEL, AND A. RUNG. 2005. A Systematic Catalogue of the Cerococcidae, Halimococcidae, Kermesidae, Micrococcidae, Ortheziidae, Phenacoleachiidae, Phoenicococcidae, and Stictococcidae (Hemiptera: Coccoidea) of the World. Intercept Ltd., Andover, U.K. 554 pp.
- MILLER, D. R., AND M. KOSZTARAB. 1979. Recent advances in the study of scale insects. Annu. Rev. Entomol. 24: 1-27.
- MILLER, D. R., AND H. L. MCKENZIE. 1967. A systematic study of *Ovaticoccus* Kloet and its relatives, with a key to North American genera of Eriococcidae (Homoptera: Coccoidea: Eriococcidae). Hilgardia 38: 471-539.
- MILLER, D. R., AND G. L. MILLER. 1993a. A new species of *Puto* and a preliminary analysis of the phylogenetic position of the *Puto* group within the Coccoidea (Homoptera: Pseudococcidae). Jeffersoniana: Contr. Virginia Mus. Nat. Hist. 4: 1-35.
- MILLER, D. R., AND G. L. MILLER. 1993b. Eriococcidae of the Eastern United States (Homoptera). Contributions of the American Entomological Institute 27: 1-91.
- MILLER, D. R., G. L. MILLER, G. S. HODGES, AND J. A. DAVIDSON. 2005. Introduced scale insects (Hemiptera: Coccoidea) of the United States and their impact on U.S. agriculture. Proc. Entomol. Soc. Wash. 107: 123-158107.
- MILLER, D. R., A. RUNG, G. VENABLE, AND R. J. GILL. 2005. Scale families. Web page [http://www.sel.barc.usda.gov/scalekeys/all\\_families.htm](http://www.sel.barc.usda.gov/scalekeys/all_families.htm).
- MORRISON, H. 1925. Classification of scale insects of the subfamily Ortheziinae. J. Agric. Res. 30: 97-154.
- MORRISON, H. 1952. Classification of the Ortheziidae. Supplement to "Classification of scale insects of the subfamily Ortheziinae." U.S. Dept. Agric. Tech. Bull. 1052: 1-80.
- SAMPO, A., AND M. OLM. 1979. Biology of *Puto antennatus* (Signoret) on *Pinus cembra* L. and *Picea abies* L. in the Aosta Valley (Italy) (Coccoidea Pseudococcidae). Boll. Lab. Entomol. Agraria 'Filippo Silvestri'. Portici 36: 172-178.
- SHIVAKUMAR, G., AND B. P. LAKSHMIKANTHA. 2001. Biology of *Orthezia insignis* Browne (Ortheziidae: Homoptera) on coleus. Pest Manag. Econ. Zool. 9: 197-200.
- TANG, F. T. 1986. The Scale Insects of Horticulture and Forest of China. Volume III (In Chinese; English Summary). Shanxi Agric. Univ. Press, Taigu, Shanxi. 305 pp.
- TANG, F. T. 1992. The Pseudococcidae of China (In Chinese; English Summary). Shanxi Agricultural University, Taigu, Shanxi, China. 768 pp.
- WASHBURN, R. I. 1965. Description and bionomics of a new species of *Puto* from Utah (Homoptera: Coccoidea: Pseudococcidae). Ann. Entomol. Soc. America 58: 293-297.
- WILLIAMS, D. J. 1985a. Some South American scale insects (Homoptera: Coccoidea) on *Nothofagus*. J. Nat. Hist. 19: 249-258.
- WILLIAMS, D. J. 1985b. Australian Mealybugs (Special Publication No. 953). Brit. Mus. (Nat. Hist.), London. 431 pp.
- WILLIAMS, D. J. 1992. A new genus and species of Conchaspidae (Hemiptera: Coccoidea) from Florida, remarkable in lacking legs. J. Nat. Hist. 26: 1325-1331.
- WILLIAMS, D. J. 2004. Mealybugs of Southern Asia. Nat. Hist. Mus., London. 896 pp.
- WILLIAMS, D. J., AND M. C. GRANARA DE WILLINK. 1992. Mealybugs of Central and South America. CAB Internat., London, England. 635 pp.
- WILLIAMS, D. J., AND G. W. WATSON. 1988. The Scale Insects of the Tropical South Pacific Region. Pt. 2: The Mealybugs (Pseudococcidae). CAB Internat. Inst. Entomol., London. 260 pp.