

To the Graduate Council:

We are submitting herewith a dissertation written by Christof Friedrich Stumpf entitled "**A Revision of the Pit Scale Species in the Subfamily Asterolecaniinae (Hemiptera: Coccoidea) in North and South America**". We have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Ecology and Evolutionary Biology.



Paris L. Lambdin, Major Professor

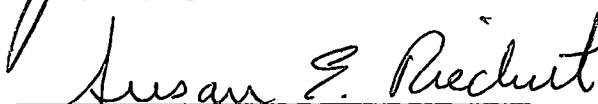


Thomas G. Hallam, Department Head

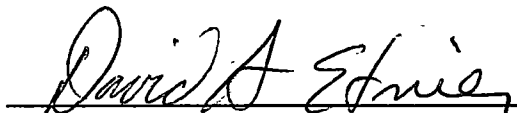
We have read this dissertation
and recommend its acceptance:



Jerome F. Grant



Susan E. Riechert



David A. Etnier

Accepted for the Council:



Associate Vice Chancellor and
Dean of the Graduate School

**A Revision of the Pit Scale Species in the
Subfamily Asterolecaniinae (Hemiptera: Coccoidea)
in North and South America**

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Christof Friedrich Stumpf
May 2000

Copyright @ 2000 by Christof Friedrich Stumpf

All rights reserved

ACKNOWLEDGMENTS

There are a number of people and institutions I would like to thank. I am very grateful to my parents, Horst and Ingrid Stumpf, that have supported me all the way during my studies in Austria and in the United States. My grandmother, Lotte Spinka, has helped me financially for all six years that I have spent persuing my doctoral degree.

My special thanks go to the Austrian-American Educational Commission, which decided to support me with a Fulbright grant. Without this grant, I would not have been able to study in the United States.

Paris Lambdin, my major professor, has given me his help and advice throughout my studies. I would like to thank him and my committee members, David Etnier, Jerome Grant, and Susan Riechert.

I was very fortunate to find many good friends at the University of Tennessee, whom I cannot name all. My sincere thanks for countless discussions and philosophical insights go to my friends, Mladen Matev and Greg Schmidt, and to the Rationalists of East Tennessee, which provided a forum for open thought and sharpening my scholarly wits.

ABSTRACT

The pit scales or Asterolecaniidae represent a diverse group found in all major biogeographical regions of the world on a variety of host plants. Specimens representing both known and unknown species were obtained from institutions in North and South America for study. Species were described and illustrated based on morphological characters of the adult females. Computer-generated illustrations for each species were developed and stored in electronic files.

A key was developed to include the 64 species of pit scales found in North and South America representing 12 genera (*Asterodiaspis*, *Asterolecanium*, *Bambusaspis*, *Grammococcus*, *Mycetococcus*, *Mycococcus*, *Neoasterodiaspis*, *Palmaspis*, *Planchonia*, *Pollinia*, *Russellaspis*, and *Sclerosococcus*). The subfamily Asterolecaniinae contains 56 different species in eight genera (*Asterodiaspis*, *Asterolecanium*, *Bambusaspis*, *Grammococcus*, *Neoasterodiaspis*, *Palmaspis*, *Planchonia*, and *Russellaspis*). From these, 48 species in the genera *Asterodiaspis*, *Asterolecanium*, *Bambusaspis*, *Neoasterodiaspis*, *Palmaspis*, *Planchonia*, and *Russellaspis* were described and illustrated. Because of the presence of recent descriptions, eight species of *Grammococcus* and *Palmaspis* were not described, but were included in the key. From the 48 species included in this study, 11 new species (two species of *Asterolecanium*, five species of *Bambusaspis*, and four species of *Palmaspis*) were described and illustrated. Also, three species in the genus *Bambusaspis* were synonymized and the genus *Grammococcus* was included in the subfamily Asterolecaniinae.

In the U.S., 17 species of the subfamily Asterolecaniinae occur in seven genera (three in *Asterodiaspis*, four in *Asterolecanium*, five in *Bambusaspis*, one in *Neoasterodiaspis*, one in *Palmaspis*, two in *Planchonia*, and one in *Russellaspis*). From these, 13 species in the genera *Asterodiaspis* (three species), *Bambusaspis* (six species), *Neoasterodiaspis* (one species), *Planchonia* (two species), and *Russellaspis* (one species) have been introduced in the U.S. Only *Asterolecanium agavis*, *Al. grandicolum*, *Al. puteanum*, and *Palmaspis inlabefacta* are considered native to the U.S.

The introduced genus *Asterodiaspis* consists of three species in North and South America feeding exclusively on oaks. The genus *Asterolecanium* contains 12 species in the New World, including two newly discovered species. Eleven species of the bamboo-feeding genus *Bambusaspis* are found in the New World including five new species. The two species of the palm-infesting genus *Grammococcus* are exclusively found in the Neotropics, while the two oak-infesting species of *Mycetococcus* are restricted to the Western U.S. and Mexico, and *Mycococcus coperniciae* is known only from palms in Cuba. *Neoasterodiaspis adjuncta* is an oak-infesting species recorded from New York, which was introduced from Southeast Asia. Some 24 species of the exclusively palm feeding genus *Palmaspis* have been recorded from the New World including four new species. The introduced genus *Planchonia* is represented by two species in North and South America. *Pollinia pollini* is an introduced pest in olive growing areas (e.g., California and Argentina) of both continents. In addition, the four species of *Sclerosococcus* occur on bromeliads in North and South America, and *Russellaspis pustulans* occurs on over 46 plant families.

Computer-generated phylogenetic trees were developed and tested for robustness. The phylogenetic relationships of 38 species in the subfamily Asterolecaniinae were evaluated based on 43 morphological characters of the adult females. A complete consensus tree of the 40 most parsimonious trees was developed. This study suggests that most genera may be monophyletic, while the genera *Asterolecanium* and *Palmaspis* appear to be paraphyletic. Pit scale biodiversity has not been adequately investigated, and many additional discoveries of new species are expected from tropical regions.

TABLE OF CONTENTS

CHAPTER		PAGE
I	INTRODUCTION	1
II	MATERIALS AND METHODS	9
	Materials	9
	Mounting Method	9
	Measurements	13
	Illustrations	13
	Species Descriptions	14
	Phylogenetic Analysis	15
III	FAMILY ASTEROLECANIIDAE (COCKERELL 1897) AND ITS AFFINITIES	16
	Phylogenetic Analysis	17
	Biology	18
	Distribution	19
	Economic Importance	20
IV	PIT SCALE MORPHOLOGY	23
	Adult Female Tests	23
	General Morphology of the Adult Females	23
	Body Shape	23
	Derm	25
	Segmentation	25
	Slide-Mounted Females	26
	Dorsal Surface	27
	The 8-shaped pores	27
	Multilocular pores	28
	Simple disk pores	28
	Tubular ducts	28
	Caudal tubes	29
	Anal lobes	29
	The arched plate	30
	Anal plates	31
	The anal ring	31
	Ventral Surface	32
	The clypeolabral shield	32
	The labium	33
	Antennae	34
	Legs	34

	Spiracles	34
	The 8-shaped pores	35
	Quinquelocular pores	35
	Multilocular pores	36
	Simple disk pores	36
	Setae	37
	Key to the Adult Females of the Family Asterolecaniidae in North and South America	37
V	SPECIES DESCRIPTIONS	45
	Genus <i>Asterodiaspis</i> Signoret, 1876	45
	<i>Asterodiaspis luteola</i> (Russell), 1941.	46
	<i>Asterodiaspis variabilis</i> (Russell), 1941.	50
	<i>Asterodiaspis variolosa</i> (Ratzeburg), 1870.	54
	Genus <i>Asterolecanium</i> Targioni-Tozzetti, 1868	66
	<i>Asterolecanium agavis</i> Russell, 1941.	68
	<i>Asterolecanium cristatum</i> Ferris, 1921.	72
	<i>Asterolecanium dorsisetosum</i> , n.sp.	77
	<i>Asterolecanium epidendri</i> (Bouché), 1844.	81
	<i>Asterolecanium grandiculum</i> Russell, 1941.	91
	<i>Asterolecanium ingae</i> Russell, 1941.	95
	<i>Asterolecanium multioctoporosum</i> , n.sp.	100
	<i>Asterolecanium puteanum</i> Russell, 1941.	105
	<i>Asterolecanium quaesitum</i> Russell, 1941.	110
	<i>Asterolecanium sanbernardense</i> Hempel, 1937.	114
	<i>Asterolecanium townsendi</i> Cockerell, 1902.	119
	<i>Asterolecanium viridulum</i> Cockerell, 1902.	123
	Genus <i>Bambusaspis</i> Cockerell, 1902	128
	<i>Bambusaspis bambusae</i> (Boisduval), 1869.	129
	<i>Bambusaspis bambusicola</i> (Kuwana), 1916.	138
	<i>Bambusaspis brasiliensis</i> , n.sp.	142
	<i>Bambusaspis caudata</i> (Green), 1930.	146
	<i>Bambusaspis hemisphaerica</i> (Kuwana), 1916.	152
	<i>Bambusaspis magna</i> , n.sp.	157
	<i>Bambusaspis mexicana</i> , n.sp.	162
	<i>Bambusaspis miliaris</i> (Boisduval), 1869.	166
	<i>Bambusaspis octocircularis</i> , n.sp.	176
	<i>Bambusaspis scirrosis</i> (Russell, 1941).	180
	<i>Bambusaspis tetrasetosa</i> , n.sp.	185
	Genus <i>Grammococcus</i> Miller & Lambdin, 1978	189
	<i>Grammococcus adetocorymbus</i> Miller & Lambdin, 1978	190

	<i>Grammococcus corymbus</i> Miller & Lambdin, 1978	191
Genus	<i>Neoasterodiaspis</i> Borchsenius, 1960	191
	<i>Neoasterodiaspis adjuncta</i> (Russell), 1941.	192
Genus	<i>Palmaspis</i> Bodenheimer, 1951	196
	<i>Palmaspis asetosa</i> , n.sp.	197
	<i>Palmaspis bicircularis</i> , n.sp.	201
	<i>Palmaspis boliviae</i> (Russell), 1941.	205
	<i>Palmaspis bondari</i> (Lepage), 1940.	210
	<i>Palmaspis degenerata</i> (Russell), 1941.	214
	<i>Palmaspis difficilis</i> (Russell), 1941.	219
	<i>Palmaspis distincta</i> (Russell), 1941.	223
	<i>Palmaspis gilva</i> (Russell), 1941.	228
	<i>Palmaspis inlabefacta</i> (Russell), 1941.	231
	<i>Palmaspis inusitata</i> (Russell), 1941.	236
	<i>Palmaspis jubae</i> , n.sp.	240
	<i>Palmaspis pallida</i> (Russell), 1941.	244
	<i>Palmaspis palmae</i> (Cockerell), 1893.	248
	<i>Palmaspis sabalis</i> (Russell), 1941.	253
	<i>Palmaspis similis</i> (Russell), 1941.	257
	<i>Palmaspis trisetosa</i> , n.sp.	262
	<i>Palmaspis truncata</i> (Russell), 1941.	265
	<i>Palmaspis urichi</i> (Cockerell), 1894.	270
	<i>Palmaspis elvae</i> Matile-Ferrero, 1996	275
	<i>Palmaspis jesseniae</i> Matile-Ferrero, 1996	275
	<i>Palmaspis longifila</i> (Borchsenius), 1950.	275
	<i>Palmaspis loretoensis</i> Matile-Ferrero, 1996	277
	<i>Palmaspis marfil</i> Matile-Ferrero, 1996	277
	<i>Palmaspis ucayali</i> Matile-Ferrero, 1996	278
Genus	<i>Planchonia</i> Signoret, 1870	278
	<i>Planchonia arabis</i> Signoret, 1876.	279
	<i>Planchonia stentae</i> (Brain), 1920.	287
	<i>Planchonia fimbriata</i> (Fonscolombe), 1834	293
Genus	<i>Russellaspis</i> Bodenheimer, 1951	294
	<i>Russellaspis pustulans</i> (Cockerell), 1892.	294
VI	PHYLOGENETIC ANALYSIS OF ADULT FEMALES OF THE SUBFAMILY ASTEROLECANIIDAE	307
VII	CONCLUSIONS	320
	LIST OF REFERENCES	327

CHAPTER	PAGE
VITA	356

LIST OF FIGURES

FIGURE	PAGE
1. Adult ♀♀ of <i>Asterodiaspis variolosa</i> producing pits.	11
2. Morphological characters of a generalized pit scale.	24
3. Schematic diagram of pit scale mouthparts.	33
4. <i>Asterodiaspis luteola</i> (Russell), 1941.	47
5. <i>Asterodiaspis variabilis</i> (Russell), 1941.	51
6. <i>Asterodiaspis variolosa</i> (Ratzeburg), 1870.	55
7. <i>Asterolecanium agavis</i> Russell, 1941.	69
8. <i>Asterolecanium cristatum</i> Ferris, 1921.	73
9. <i>Asterolecanium dorsisetosum</i> , n.sp.	78
10. <i>Asterolecanium epidendri</i> (Bouché), 1844.	82
11. <i>Asterolecanium grandiculus</i> Russell, 1941.	92
12. <i>Asterolecanium ingae</i> Russell, 1941.	96
13. <i>Asterolecanium multioctoporosum</i> , n.sp.	101
14. <i>Asterolecanium puteanum</i> Russell, 1941.	106
15. <i>Asterolecanium quaesitum</i> Russell, 1941.	111
16. <i>Asterolecanium sanbernardense</i> Hempel, 1937.	115
17. <i>Asterolecanium townsendi</i> Cockerell, 1902.	120
18. <i>Asterolecanium viridulum</i> Cockerell, 1902.	124
19. <i>Bambusaspis bambusae</i> (Boisduval), 1869.	130
20. <i>Bambusaspis bambusicola</i> (Kuwana), 1916.	139
21. <i>Bambusaspis brasiliensis</i> , n.sp.	143
22. <i>Bambusaspis caudata</i> (Green), 1930.	147
23. <i>Bambusaspis hemisphaerica</i> (Kuwana), 1916.	153
24. <i>Bambusaspis magna</i> , n.sp.	158
25. <i>Bambusaspis mexicana</i> , n.sp.	163
26. <i>Bambusaspis miliaris</i> (Boisduval), 1869.	167
27. <i>Bambusaspis octocircularis</i> , n.sp.	177
28. <i>Bambusaspis scirrosis</i> (Russell, 1941).	181
29. <i>Bambusaspis tetrasetosa</i> , n.sp.	186
30. <i>Neoasterodiaspis adjuncta</i> (Russell), 1941.	193
31. <i>Palmaspis asetosa</i> , n.sp.	198
32. <i>Palmaspis bicircularis</i> , n.sp.	202
33. <i>Palmaspis boliviae</i> (Russell), 1941.	206
34. <i>Palmaspis bondari</i> (Lepage), 1940.	211
35. <i>Palmaspis degenerata</i> (Russell), 1941.	215
36. <i>Palmaspis difficilis</i> (Russell), 1941.	220
37. <i>Palmaspis distincta</i> (Russell), 1941.	224
38. <i>Palmaspis gilva</i> (Russell), 1941.	229
39. <i>Palmaspis inlabefacta</i> (Russell), 1941.	232

FIGURE		PAGE
40.	<i>Palmaspis inusitata</i> (Russell), 1941.	237
41.	<i>Palmaspis jubae</i> , n.sp.	241
42.	<i>Palmaspis pallida</i> (Russell), 1941.	245
43.	<i>Palmaspis palmae</i> (Cockerell), 1893.	249
44.	<i>Palmaspis sabalis</i> (Russell), 1941.	254
45.	<i>Palmaspis similis</i> (Russell), 1941.	258
46.	<i>Palmaspis trisetosa</i> , n.sp.	263
47.	<i>Palmaspis truncata</i> (Russell), 1941.	266
48.	<i>Palmaspis urichi</i> (Cockerell), 1894.	271
49.	<i>Planchonia arabis</i> Signoret, 1876.	280
50.	<i>Planchonia stentae</i> (Brain), 1920.	288
51.	<i>Russellaspis pustulans</i> (Cockerell), 1892.	295
52.	Tree 1 of 40 most parsimonious trees.	313
53.	Strict consensus tree of 40 most parsimonious trees (cladogram).	315
54.	Strict consensus tree of 40 most parsimonious trees (phylogram).	317

LIST OF ABBREVIATIONS FOR COLLECTIONS

AUEM	Auburn University Entomological Museum, Auburn, AL.
CDFA	California Department of Food and Agriculture, Sacramento, CA.
FSCA	Florida State Collection of Arthropods, Gainesville, FL.
INSUE	Instituto Superior de Entomologia, Tucumán, Argentina.
MNC	Museo de Historia Natural de la Ciudad de Mexico, Mexico City, Mexico.
MNHN	Museum National d'Histoire Naturelle, Paris, France.
NHM	The Natural History Museum, London; formerly British Museum of Natural History (BM), London, England.
SA	South African National Collection of Insects, Pretoria, South Africa.
UCD	The University of California, Davis, CA.
USNM	U.S. National Museum of Natural History, Washington D.C.
UT	The University of Tennessee, Knoxville, TN.
VPI	The Virginia Polytechnic Institute and State University, Blacksburg, VA.
ZI	Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia.

GENERIC ABBREVIATIONS

<i>Asterodiaspis</i>	<i>As.</i>
<i>Asterolecanium</i>	<i>Al.</i>
<i>Bambusaspis</i>	<i>Ba.</i>
<i>Grammococcus</i>	<i>Gr.</i>
<i>Neoasterodiaspis</i>	<i>Ne.</i>
<i>Palmaspis</i>	<i>Pa.</i>
<i>Planchonia</i>	<i>Pl.</i>
<i>Russellaspis</i>	<i>Ru.</i>

CHAPTER I

INTRODUCTION

The family Asterolecaniidae is a large group of scale insects with a worldwide distribution in all major zoogeographic regions. However, most species are found in the tropical and subtropical regions of the world. The taxon includes an estimated 400 species (Scalenet - <http://www.sel.barc.usda.gov/scalenet/scalenet.htm>) in 22 genera. This number elevates the Asterolecaniidae to the fifth largest family of Coccoidea, after the Diaspididae, Pseudococcidae, Coccidae, and Eriococcidae. As in other scale insect taxa, additional discoveries of new species are expected in the future, as more material from tropical regions becomes accessible to taxonomists. Russell (1941), in her foundational revision of the genus *Asterolecanium*, described 83 new species worldwide, some of which were combined later (Podsiadlo 1990a, b; Stumpf & Lambdin 2000a). The objectives of the present study were to revise the subfamily Asterolecaniinae in North and South America, present new keys for all species, and elucidate the species affinities. This research concentrated on the pit scales of the New World, but nevertheless yielded 11 species new to science from material stored in U.S. and international research collections.

A few species of pit scales can cause severe economic damage to a variety of host plants by sap-sucking, twig-girdling, or loss of aesthetic value. The more significant damage usually occurs from species introduced in a new environment without their complement of predators or parasitoids. Many pit scale species are oligotrophic, feeding on a particular host plant taxon. The generic taxonomy has often been influenced in part

by the host plant associations, e.g., the genera *Bambusaspis*, *Asterodiaspis*, and *Palmaspis* feed on bamboo, oaks, and palms, respectively. Pit scale taxonomy is based on female morphology using Russell's (1941) criteria, distinctive autapomorphies such as dorsal multilocular pores for the genera *Grammococcus* and *Polea*, and reduction of characters. The resulting groups cluster similar species together, but do not take into account problems with paraphyly, e.g., a new genus may arise from inside an existing genus. The short life span of adult males makes their inclusion into taxonomy very difficult. For some genera, only females are known to exist (e.g., *Asterodiaspis* and *Neoasterodiaspis*).

The following 22 genera are recognized in the family Asterolecaniidae:

Abditicoccus Lambdin & Kosztarab, *Amorphococcus* Green, *Asterodiaspis* Signoret, *Asterolecanium* Targioni-Tozzetti, *Bambusaspis* Cockerell, *Callococcus* Ferris, *Endernia* Danzig, *Frenchia* Maskell, *Grammococcus* Miller & Lambdin, *Hsuia* Ferris, *Hyalococcus* Borchsenius, *Liuaspsis* Borchsenius, *Mycetococcus* Ferris, *Mycococcus* Ferris, *Neoasterodiaspis* Borchsenius, *Palmaspis* Bodenheimer, *Planchonia* Signoret, *Polea* Green, *Pollinia* Targioni-Tozzetti, *Russellaspis* Bodenheimer, *Sclerosococcus* McKenzie, and *Trachycoccus* Borchsenius. Genera that occur in North and South America include: *Asterodiaspis*, *Asterolecanium*, *Bambusaspis*, *Grammococcus*, *Mycetococcus*, *Mycococcus*, *Neoasterodiaspis*, *Palmaspis*, *Planchonia*, *Pollinia*, *Russellaspis*, and *Sclerosococcus*. From these, all genera except *Mycetococcus*, *Mycococcus*, *Pollinia*, and *Sclerosococcus* are included in the subfamily Asterolecaniinae based on the presence of a translucent, hard scale cover and the arrangement of the marginal 8-shaped pores and

multilocular pores. Little is known about the systematic relationship of the Asterolecaniinae to the outside taxa. Borchsenius (1960) concluded that *Pollinia* belonged to the subfamily Cerococcinae, and Brown & McKenzie (1962) considered *Mycetococcus* to be closely related to *Cerococcus* because of the presence of sclerotized anal lobes. However, based on anal area characteristics, *Mycetococcus*, *Pollinia*, or *Sclerosococcus* may not be part of either of the three pit scale families. This view is supported by Miller (1990), who concluded that *Mycetococcus* was closely related to *Phoenicoccus*, and did not belong in the Asterolecaniidae. Miller & Williams (1993) reported the genus *Pollinia* as a sister group to the three pit scale families Asterolecaniidae, Cerococcidae, and Lecanodiaspididae, using morphological characters of adult females, males, and first instars.

In 1844, *Lecanium epidendri* was described by Bouché on *Epidendrum cuspidatum* G. Lodd. from greenhouses in Berlin. Boisduval (1868a) named this species *Chermes epidendri*. He then described a new species, *Coccus aureus*, on *Calathea* (*Maranta*) *vittata* hort. ex Körn. from greenhouses in Paris (Boisduval 1868c). The genus *Asterolecanium* was erected by Targioni-Tozzetti (1868) with *Asterolecanium aureum* as the type species. Signoret (1869, 1870, 1876b) recognized *Asterolecanium* as a valid genus. In 1895, Maskell transferred all pit scales into the genus *Planchonia* (Maskell 1895b, c). However, Cockerell (1896, 1897a, 1902b) and Fernald (1903) listed all known species of pit scales under the genus *Asterolecanium*. This view was supported by Newstead (1903), Sanders (1906), Leonardi (1908, 1920), Green (1909), Lindinger (1912, 1937), Brain (1920), MacGillivray (1921), Morrison & Morrison (1928), Takahashi

(1928, 1930, 1933, 1936, 1941, 1942, 1956), Balachowsky (1932), Wolcott (1936, 1941), Archangelskaya (1937), Borchsenius (1937a, b, 1950b), Gomez-Menor (1940), Russell (1941), Zimmerman (1948), Schmutterer (1952b, 1972), Ferris (1955), Kosztarab (1959), Beardsley (1966), Tranfaglia (1974), and Miller (1985, 1996). In a revision of the genus, Russell (1941) synonymized *Al. aureum* with *Al. epidendri*, therefore, making *Al. epidendri* the types species of the genus. The species included in *Asterolecanium* were subsequently divided by Borchsenius (1950c, 1960, 1961) and Bodenheimer (1951, 1953) into the genera *Asterodiaspis*, *Asterolecanium*, *Bambusaspis*, *Hyalococcus*, *Neoasterodiaspis*, *Palmaspis*, *Planchonia*, *Russellaspis*, and *Trachycoccus*. The two authors reintroduced previously used names, such as *Asterodiaspis*, *Bambusaspis*, and *Planchonia*, that had been abandoned in favor of a single genus, *Asterolecanium*. Support of the view of multiple genera based on Russell's (1941) categories was later advanced by Morrison & Morrison (1966), Danzig (1967), Tereznikova (1981), Kozar & Walter (1985), Williams & Watson (1990), Longo et al. (1995), and Stumpf & Lambdin (2000b). However, Gill (1993) only recognized the two genera *Asterolecanium* and *Bambusaspis*, while Kosztarab (1996) placed all species of *Asterolecanium* into the genus *Asterodiaspis*.

The genus *Asterodiaspis* was erected by Signoret in 1876, with *As. quercicola* as the type species (Signoret 1876a). This view was accepted by Comstock (1881). Targioni-Tozzetti (1892) believed Signoret's species to be *Asterolecanium ilicicola* (Targioni-Tozzetti 1888). Cockerell (1893a) synonymized *Asterodiaspis* with *Planchonia*. Maskell (1895b, c) placed all pit scales into the genus *Planchonia*.

Asterodiaspis was considered a junior synonym of *Asterolecanium* by Cockerell (1895c, 1897a), Fernald (1903), Newstead (1903), Sanders (1909), Lindinger (1937, 1943), Gomez-Menor (1940), Russell (1941), Ferris (1955), Boratynski (1961), Schmutterer (1972), Bogner & Vinis (1979), Miller (1985), and Gill (1993). Borchsenius (1950c, 1960, 1961) and Bodenheimer (1951) reestablished the genus *Asterodiaspis* and named *Asterodiaspis ilicicola* the type species. Morrison & Morrison (1966), Danzig (1967, 1986), Podsiadlo (1972, 1974a, 1974b, 1976b, 1990a, b), Kosztarab & Kozar (1978, 1988), Schmutterer (1980), Tereznikova (1981), C.I.E. (1983), Martin Mateo (1984), Kozar & Walter (1985), Pellizzari (1994), Longo et al. (1994, 1995), Kosztarab (1996), and Stumpf & Lambdin (2000b) recognized *Asterodiaspis* as a valid genus. Species from different genera have been placed into *Asterodiaspis* several times in the history of this genus. Koteja (1976) treated *Bambusaspis bambusae* as *Asterodiaspis*, while Kosztarab (1996) transferred all species of *Asterolecanium*, *Planchonia*, and *Russellaspis* in the northeastern U.S. into *Asterodiaspis*.

Cockerell (1902c) established *Bambusaspis* as a new section of *Asterolecanium* to include species on bamboo and palms, but did not designate it as a new genus. This section was accepted by Sanders (1906) who named *miliaris* its type. Fernald (1903), Takahashi (1928, 1930, 1933, 1936, 1941, 1942, 1956), Wolcott (1936, 1941), Russell (1941), Zimmerman (1948), and Ferris (1955) did not recognize the generic status of *Bambusaspis*. However, Borchsenius (1950c, 1960, 1961) and Bodenheimer (1951) introduced *Bambusaspis* as a valid genus. Morrison & Morrison (1966), Kozar & Walter (1985), Williams & Butcher (1987), Williams & Watson (1990), Gill (1993), Longo et al.

(1994, 1995), and Stumpf & Lambdin (2000b) followed this taxonomic view, while Beardsley (1966), Lambdin (1977a), Bennett & Alam (1985), and Miller (1985) did not, acknowledging Russell's (1941) and Ferris' (1955) concept of a single genus *Asterolecanium*.

The genus *Grammococcus* was erected by Miller & Lambdin in 1978 with *Gr. adetocorymbus* as its type. Species of this genus are closely related to the oriental genus *Polea* Green (Miller & Lambdin 1978). Both genera are without marginal 8-shaped pores and marginal multilocular pores, and possess clusters of dorsal multilocular pores. Kosztarab et al. (1986) accepted the genus *Grammococcus* in their listing of new generic names of the Coccoidea. Matile-Ferrero (1996) discovered the presence of translucent green tests in species of *Grammococcus*, which was acknowledged by Stumpf & Lambdin (2000b). This character along with those of the anal area clearly infer that the genus *Grammococcus* belongs in the Asterolecaniinae.

Borchsenius (1960) established the genus *Neoasterodiaspis* with *Ne. pasaniae* (Kuwana & Cockerell) as its type (Kuwana 1909), based on the presence of a large dorsal spike on the marginal 8-shaped pores (Borchsenius 1961). Also, Morrison & Morrison (1966), Kozar & Walter (1985), and Stumpf & Lambdin (2000b) included the genus in their listings. Liu & Shi (1990, 1993) found that some species may or may not have these spikes, depending on the position of the insect on the host plant. These findings challenge the validity of the genus.

In 1951, Bodenheimer erected the genus *Palmaspis* based on Russell's (1941) morphological and host plant criteria, and designated *Pa. phoenicis* (Ramachandra Rao

1922) as its type. Borchsenius (1960) only accepted it as a monotypic genus. Morrison & Morrison (1966), Kozar & Walter (1985), and Stumpf & Lambdin (2000b) recognized it as a valid genus, while Ferris (1955) and Miller (1996) did not, accepting Russell's (1941) view of a single genus *Asterolecanium*. Matile-Ferrero (1996) listed 29 species belonging to *Palmaspis*.

The genus *Planchonia* has a long history as a synonym for *Asterolecanium*. It was proposed by Signoret (1870), with *Pl. fimbriata* (Boyer de Fonscolombe) as the type species. *Planchonia fimbriata* was initially described as *Coccus fimbriatus* by Boyer de Fonscolombe (1834). Signoret (1876b) considered *Planchonia* distinct from *Asterolecanium*, as did Maskell (1882, 1884) and Cockerell (1893a, c). However, in 1893, Cockerell synonymized *Planchonia* with *Asterolecanium* (Cockerell 1893d). In 1887 and later in 1894, Maskell voiced doubt about the validity of genus *Asterolecanium*. Maskell (1895b, c) replaced *Asterolecanium* with *Planchonia*, but Cockerell (1897a) and Fernald (1903) dismissed the genus *Planchonia* in favor of *Asterolecanium* for inclusion of all pit scales. This position was supported by Lindinger (1937), Gomez-Menor (1940), and Russell (1941). The genus *Planchonia* was reestablished by Bodenheimer (1951) based on Russell's (1941) categories, which was accepted by Borchsenius (1960, 1961), Morrison & Morrison (1966), Danzig (1967), Komosinska & Podsiadlo (1967), Kosztarab & Kozar (1978, 1988), Bognar & Vinis (1979), Schmutterer (1980), Tereznikova (1981), Martin Mateo (1984), Kozar & Walter (1985), Pellizzari (1994), Longo et al. (1995), and Stumpf & Lambdin (2000b). Ferris (1955), Tranfaglia (1974),

Miller (1985), Gill (1993), and Kosztarab (1996) did not recognize *Planchonia*.

Kosztarab (1996) placed species of this genus into *Asterodiaspis*.

Bodenheimer (1951) erected the genus *Russellaspis* in honor of Louise Russell and her morphological categories (Russell 1941) with the type species *Ru. pustulans*. This species was earlier described by Cockerell as *Asterodiaspis pustulans* (Cockerell 1892c), and had subsequently been treated as *Planchonia pustulans* (Cockerell 1893a) and *Asterolecanium pustulans* (Cockerell 1894a, 1897a). Cockerell (1897a) and Fernald (1903) placed every pit scale species into *Asterolecanium*, which was accepted by Wolcott (1936, 1941), Russell (1941), Zimmerman (1948), and Ferris (1955). Borchsenius (1960, 1961), Morrison & Morrison (1966), Kozar & Walter (1985), and Stumpf & Lambdin (2000b) accepted Bodenheimer's (1951) generic evaluation. Beardsley (1966), Castel-Branco (1971), C.I.E. (1984), Bennett & Alam (1985), Miller (1985, 1996), and Kosztarab (1996) did not recognize the genus *Russellaspis*. Kosztarab (1996) placed *Ru. pustulans* back into *Asterodiaspis*.

In the present study, 37 species were redescribed and illustrated, three species were merged into one species, and 11 species new to science were described and illustrated. Eight species of *Grammococcus* and *Palmaspis* were not described or illustrated, but included in the key, because recent descriptions were available. Although no specimens of *Palmaspis longifila* (Borchsenius 1950) were available for study, a translation of the description from Russian is provided. *Planchonia fimbriata* (Fonscolombe, 1834) was not included in the study, because its occurrence in the New World is interpreted as a misidentification.

CHAPTER II

MATERIALS AND METHODS

Materials

Specimens were borrowed from several institutions and government agencies as slide mounted specimens, in alcohol, or as dry material. Names for institutions are provided in "List of Abbreviations for Collections" (p. xiii). No live material was available for this study. Dry material and alcohol preserved specimens were mounted following the procedure below. Generally, pit scales are placed in cellophane bags or similar containers, and allowed to dry. With this procedure, emerging first instars (crawlers), adult males, or parasitoids can be easily collected. Alcohol preserved specimens (70%) were processed similarly as dry material. Other preservatives such as Mark André II or Carnoy II can also be used.

Mounting Method

Microscopic examination of specimens is necessary for a correct identification because of their small size and the presence or absence of characteristic minute pores and ducts. Scale insect taxonomy depends on morphological characters of adult females, because these are larger and more frequently visible on the host plant and exhibit more characters than the larval stages. Adult males are only available for a short period in their life cycle, and some species are parthenogenetic, e.g., *Asterodiaspis variolosa*, *Asterolecanium epidendri*, and *Bambusaspis bambusae*. For most species, only adult females are available for study. Young adult females that have not yet laid eggs and are not parasitized are the best candidates for mounting. Females die soon after egg

deposition, shrivel up, and occupy about one third of the tests (Fig. 1). These specimens are difficult to mount. Many of these females will have eggs remaining inside their body that must be removed to observe the characters on the derm.

Pit scales do not produce an excessive amount of wax compared with other species groups. Some will have long filaments extending from the margin under the tests. These are produced by the marginal 8-shape pores (Foldi & Lambdin 1995), but are easily removed in clearing fluids prior to initiating the mounting procedure. Therefore, a brief version of the original method by Wilkey (1962) and Lambdin & Kosztarab (1973, 1977) was used with promising results:

1. Specimens were placed into Essig's Aphid Fluid (EAF, formula given below) until they were soft enough for the removal of the tests. Tests are hard and sclerotized, and enclose the dorsal aspect of the insect. There is no set time limit for specimens to remain in EAF. Best results are obtained by soaking the insects in the liquid for several hours. This process can be speeded up by gently heating the specimens on a heating plate (lowest possible setting) for several minutes.
2. A small incision was made, preferentially laterad between the two spiracular furrows to avoid damaging important morphological characters, and the body contents were gently teased out with a microspatula. To remove all body contents, the specimen dish was transferred onto the heating plate for 1-2 minutes. If necessary, this process was repeated until the specimen was completely translucent.
3. A drop of staining solution (formula given below) was placed into the solution. Specimens were usually left to stain overnight, but could also be stained in several minutes by heating them on the heating plate. There is no danger of over-staining specimens.
4. Specimens were placed into 95% ethyl alcohol for 2 minutes to remove possible excess stain and any traces of water. It is important not to keep them in alcohol for too long to avoid excessive shriveling.
5. Specimens were transferred into clove oil for about 5 minutes. They can be left in the fluid for a longer time, if necessary.
6. Insect were mounted in Canada Balsam on a microscope slide. After application of the cover slip, the slides were placed onto the heating plate for a few seconds to achieve an equal distribution of the Canada Balsam under the cover slip.
7. Slides were marked with a diamond-point pencil.

Fig. 1. Adult ♀♀ of *Asterodiaspis variolosa* producing pits.



8. Slides took about a month to cure under room temperatures. During this time, the slides may be viewed carefully under the compound microscope, if lower magnifications are chosen and the cover slip does not come into contact with the objective.

9. Labels were printed with a computer and fixed onto the slides.

Formula for Essig's Aphid Fluid (Wilkey 1962, Lambdin & Kosztarab 1973):

Lactic acid (reagent grade 85%)	20 parts
Phenol (sat. H ₂ O)	2 parts
Glacial acetic acid	4 parts
Distilled water	1 part

Formula for Staining solution: (Lambdin & Kosztarab 1973, modified from Wilkey 1962):

Essig's Aphid Fluid	15 ml
Acid fuchsin (2% aqueous solution)	20 drops
Lignin pink (2% aqueous solution)	20 drops
Erythrosin (2% aqueous solution)	20 drops

Measurements

Measurements in microns were obtained with a Wild phase contrast microscope at magnifications of 60X to 1000X. Numbers given are the average rounded to the nearest one-tenth of a micron followed by the range in parentheses. Numbers and measurements were taken from 10 specimens, when available. In those instances where several species have recently been synonymized (e.g., *Asterodiaspis variolosa*, *Bambusaspis miliaris*), more than 10 specimens were measured per species. Structures were measured for length and width at their longest or widest points, respectively.

Illustrations

Illustrations were produced and printed onto 24-lb. high resolution paper. One half of a species outline was drawn onto paper with the aid of a bendable ruler and scanned into a computer with a resolution of 600 dpi. The other half of the outline was duplicated with the computer program Adobe Photoshop™, and the complete outline was

then printed onto paper. Morphological characters were drawn into the outline, where the left side depicted the dorsal aspect of the species, and the right side depicted the ventral aspect. The illustration was again scanned into the computer, and all hand-drawn pores were replaced by computer-generated pores. Enlargements of the various morphological structures were scanned and pasted around the illustration. The final product was saved onto electronic files, reduced in size electronically to fit letter-sized paper, and printed onto the high resolution paper.

Structures depicted in the illustrations were reduced to different sizes and placed around the species drawings. Therefore, different structures do not conform to the same magnification. The reader is urged to compare actual sizes given in the species descriptions. A concerted effort was made to draw structures in the species outline to scale and place them in the correct locations.

Species Descriptions

Data on microscopic slides were recorded and included in the descriptions. The number of specimens examined is presented followed by the number of slides in parentheses. Descriptions and keys include only morphological characters of adult females. A separation of dorsal and ventral aspects was followed in the descriptions with the exception of the anal lobes. There it was considered impractical, because the anal lobes contain structures on dorsum and venter. A comprehensive literature review, host and other biological data, predators and parasitoids, economic importance, and distribution records were provided for each species, if available from the literature. A two-letter abbreviation system was used for generic abbreviations ("Generic

Abbreviations", p. xiii). The two-letter abbreviation system of the U.S. postal service was used for states within the U.S.

Phylogenetic Analysis

A cladistic analysis was performed on morphological characters of adult females to test the monophyly of the New World pit scale genera. The lack of good characters due to the general tendency of character reduction in the pit scales limited the analysis to 38 species and the two outgroups, *Cerococcus* and *Lecanodiaspis*. The outgroups were scored by comparing several species of these two genera from the literature (Howell & Kosztarab 1972; Lambdin & Kosztarab 1973, 1977) and from specimens available at the UT museum, and creating a generalized type for both genera. A parsimony analysis was performed with the computer program, PAUP (Swofford 1993), the resulting complete consensus tree was analyzed with MacClade (Maddison & Maddison 1992).

CHAPTER III

FAMILY ASTEROLECANIIDAE (COCKERELL 1897) AND ITS AFFINITIES

Cockerell (1897a) erected the subfamily Asterolecaniinae as a part of the Coccidae. The year commonly accepted for the erection of the subfamily Asterolecaniinae is 1896. However, this interpretation is inconsistent with the actual publication date 1897. Therefore, the subfamily Asterolecaniinae and the family Asterolecaniidae are here considered to be validly published in 1897. Berlese & Leonardi (1898) accepted Cockerell's classification. Fernald (1903) placed the pit scales in the subfamily Dactylopiinae. Enderlein (1914) first elevated the Asterolecaniinae to the family level.

Asterolecaniinae Cockerell, 1897a:327; Berlese & Leonardi, 1898:129; Green, 1909:293; Lindinger, 1912:11; Leonardi, 1920:238; MacGillivray, 1921:183; Russell 1941:3; Zimmerman, 1948:277; Schmutterer, 1952b:562; Habib, 1957:371; Borchsenius, 1960:131, 1961:63; Tereznikova, 1981:79; Danzig, 1986:277. Asterolecaninae Berlese & Leonardi, 1898:127. Dactylopiinae Fernald, 1903:39; Leonardi, 1908:154. Asterolecaninos Gomez-Menor, 1940:231.

Asterolecaniidae Enderlein, 1914:369; Russell 1941:3; Zimmerman, 1948:277; Bodenheimer, 1951:328, 1952:317, 1953:134; Schmutterer, 1972:420, 1980:51; Ferris 1955:8; Habib, 1957:371; Borchsenius 1959:840, 1960:101, 1961:63; Kosztarab, 1959:404, 1996:287; Kosztarab & Kozar 1988:312; Beardsley, 1966:497; Danzig, 1967:824, 1986:277; Koteja, 1974a:59, 1974b:310, 1976:278; Koteja & Liniowska, 1976:675; Howell & Williams, 1976:187; Tereznikova, 1981:77; Miller, 1985:105,

1996:69; Kozar & Walter, 1985:80; Williams & Watson, 1990:191; Gill, 1993:96; Longo et al., 1995:124; Hodgson, 1997:167. Coccidae Cockerell, 1897a:322; Fernald, 1903:15; Berlese & Leonardi, 1898:127; Green, 1909:293; Lindinger, 1912:1; Leonardi, 1920:23; MacGillivray, 1921:1. Lecaniidae Schmutterer, 1952b:544. Asterolecanidae Longo et al., 1994:22.

Phylogenetic Analysis

Based on cytological evidence, Brown & McKenzie (1962) concluded that the Diaspididae had evolved from the Asterolecaniidae. However, in a morphological study of adult males, Giliomee (1968) found a close relationship between Asterolecaniidae, Coccidae, Lecanodiaspididae, and Kermococcidae. Koteja (1947a, 1974b, 1976) and Koteja & Liniowska (1976) placed the Asterolecaniidae closer to the Beesoniidae, Halimococcidae, Phoenicoccidae, and Diaspididae than to other Coccoidea using characters of the mouthparts. Lambdin & Kosztarab (1977) concluded from their phenetic analysis that Asterolecaniidae, Cerococcidae, and Lecanodiaspididae were more closely related to each other than to the Eriococcidae. Danzig (1986) placed the Stictococcidae as the closest relatives of the Asterolecaniidae. Ben-Dov (1990) agreed with Lambdin & Kosztarab's (1977) findings. Miller (1990) found the three pit scale families to be related to the diaspidoids plus *Mycetococcus* and *Beesonina*. In a cladistic analysis of morphological characters of several instars, Foldi (1995) established a sister group relationship of the Asterolecaniidae to the Diaspididae, Halimococcidae, Phoenicoccidae, and Beesoniidae, confirming Koteja's (1974a, 1974b, 1976) and Koteja & Liniowska's (1976) hypotheses. Miller & Williams (1993), Miller & Hodgson (1997),

and Hodgson (1997) concluded from phylogenetic analyses of adult females, adult males, and first instars that the three pit scale families were a discrete group, and were most closely related to the Coccidae, Acleridae, Micrococcidae, and Tachardiidae. They listed the clade Cerococcidae-Lecanodiaspididae as a sister taxon to the Asterolecaniidae. Kosztarab (1996) grouped Asterolecaniidae, Cerococcidae, and Lecanodiaspididae together as a separate evolutionary line. In a cladistic analysis of morphological characters of first instars, adult females, and adult males of 21 scale insect families, Foldi (1997a) found a sister group relationship between Asterolecaniidae and Lecanodiaspididae, with the Cerococcidae as the most closely related sister taxon. The nearest relatives to the three pit scale families appeared to be three separate clades including the Coccidae, the Acleridae and Tachardiidae, and the Micrococcidae, Stictococcidae, Phoenicococcidae, Halimococcidae, Beesoniidae, and Diaspididae. Unfortunately, "no paleontological data are available on the origin and evolution of the Asterolecaniidae family group" (Koteja 1990).

Biology

Life history information, if available in the literature, is provided in the species descriptions. The biology is only known for species of economic importance, such as *Asterodiaspis variolosa*, *Asterolecanium epidendri*, and *Bambusaspis bambusae*. Interestingly enough, these species are all parthenogenetic. Like scale insects in general, most species of pit scales occur in subtropical and tropical latitudes, exhibiting several generations per year. All females have three instars (first instar [crawler], second instar, and adult). The males have five instars (first instar, second instar, prepupa, pupa, and

adult). The only mobile instars are the crawlers and the adult males. Development is characterized by a complete loss of legs and eyes, and a reduction of the antennae to one-segment in the adult females. Preadult males produce a cocoon-like protective cover that protects them during the prepupal and pupal stages. During these two stages, legs and antennae are reformed, and wings develop. Adult males live for only one or two days. Descriptions and illustrations of first, second, prepupal, and pupal instars of pit scales are presented in Boratynski (1961), Giliomee & Munting (1968), Habib (1943), and Podsiadlo (1974a, 1976b, 1989).

Distribution

Fifty-six species of pit scales in eight genera occur in the subfamily Asterolecaniinae in the New World. The existence of *Planchonia fimbriata* (Fonscolombe) in the New World is questionable, and this species is not included in the key. The genera *Asterodiaspis*, *Neoasterodiaspis*, *Planchonia*, and most species of *Bambusaspis* are believed to have been introduced into the New World by shipping infested plant stock or by other human activities. *Russellaspis pustulans* may have originated in the Neotropics. All species of the genus *Asterolecanium* in the New World are native to this region. However, species of *Asterolecanium* are also present in almost all other faunal regions worldwide (Russell 1941). Some of Russell's (1941) species were transferred to different genera by Borchsenius (1950c, 1960) and Bodenheimer (1951). The genus *Palmaspis* is found around the world where palms grow. A biogeographic origin cannot be determined with certainty, but most of the known species occur in the Neotropical region, therefore, suggesting a Neotropical origin (Russell 1941,

Matile-Ferrero 1996). The genus *Grammococcus* was described from Trinidad, Colombia, and Peru (Matile-Ferrero 1996, Miller & Lambdin 1978). The distribution of each species is given in the species description. Several species are distributed in all or most major zoogeographical regions (e.g., *Asterodiaspis variolosa*, *Asterolecanium epidendri*, *Bambusaspis miliaris*, *Ba. bambusae*, *Russellaspis pustulans*). These species have been introduced by humans with agricultural trade, and are also the economically most important species.

Economic Importance

Some species of pit scales may cause serious economic damage, depending on the host plant and its geographic location. These problems are enhanced with modern agricultural trade distributing pest species all over the globe. Economic damage is caused by direct damage to marketable fruits, premature leaf drop, loss of plant vigor, die-back, loss of aesthetic value due to the unsightly appearance of infested plants, twig-girdling, and death of the host due to sap-sucking. No literature citations are known for production of honeydew and ensuing reduction in plant photosynthesis by sooty molds like in other scale insects. Pit scales injecting saliva into the plant tissue induce the host to produce an open gall around the insect. These galls are visible on the plant long after the insect dies, and are recognized as the typical pits of the Asterolecaniidae. The production and appearance of galls depends on both the pit scale and the host plant species. Parr (1940) investigated the salivary enzymes of *Asterodiaspis variolosa* involved in sap sucking and the chemical effects on the tissues of the host plant. Habib (1943) described the lignification of plant tissue probed with the mouthparts by *Russellaspis pustulans* and the

formation of the gall. The most damaging species in the Asterolecaniinae are *Asterodiaspis variolosa*, *Asterolecanium epidendri*, *Bambusaspis bambusae*, *Ba. miliaris*, *Planchonia arabis*, *Pl. stentae*, and *Russellaspis pustulans*. Parthenogenesis may play an important role, because it enables populations to quickly establish themselves after an initial infestation. Several species that are confirmed to be parthenogenetic are *As. variolosa*, *Al. epidendri*, *Ba. bambusae*, and *Ba. miliaris*. Most parthenogenetic species occur in the oak-infesting genera *Asterodiaspis* and *Neoasterodiaspis*, and the bamboo-infesting genus *Bambusaspis*. Unfortunately, little is known about the biology of most species of pit scales. The golden oak scale, *As. variolosa*, is well known from oaks in Europe, where it does not cause any serious problems. Transferred into different continents, it has become an important pest on oaks in several parts of the world including California and New Zealand. Many species became pests in horticultural or greenhouse environments. The orchid pit scale, *Al. epidendri*, was first described by Bouché in 1844, and has been known as a serious problem in greenhouses ever since. Pit scale species, such as *Ba. bambusae*, *Ba. bambusicola*, and *Ba. miliaris*, can cause serious damage to bamboo plants in places like Florida where bamboo serves mainly horticultural purposes (A. Hamon 1999, personal comm.). The pittosporum pit scale, *Pl. arabis*, originates in Europe where it infests english ivy, *Hedera helix*, and a variety of other host plants. It is a serious pest on *Pittosporum tobira* in California (Gill 1993) and on *Panax* sp. in Canada (E. Maw 1996, pers. comm.). The South African pit scale, *Pl. stentae*, has been introduced into the New World with infested plant material, and has become a threat to a variety of ornamental host plants (Stumpf & Lambdin 2000c). The pit scale with the

most impressive array of host plants is the oleander pit scale, *Ru. pustulans*. Russell (1941) recorded it from more than 150 plant species in more than 46 host plant families. It is most damaging on oleander, *Nerium oleander*, but may cause serious damage on other hosts (Devnath 1986, Habib 1943, Wolcott 1953).

CHAPTER IV

PIT SCALE MORPHOLOGY

Adult Female Tests

All members of the subfamily Asterolecaniinae exhibit hard, greenish, translucent tests (Fig. 1) that are produced by secretions of the tubular ducts (Foldi & Lambdin 1995). These tests cover the whole dorsum and a small part of the venter. Although the adult female fills the test, it is not attached to it. The test is always convex, although the shape is variable depending on the species. In the genera *Bambusaspis* and *Palmaspis*, it is usually much longer than wide, while in *Asterodiaspis* or *Asterolecanium* it may be subcircular, round, or 2/3 as wide as long. Unfortunately, most species are only known from slide-mounted specimens. In addition, the marginal 8-shaped pores may produce long waxy filaments that protrude to the side of the insect. These filaments are produced continuously, and are not separated from the insect.

General Morphology of the Adult Females

Fig. 2 depicts the morphological characters of a generalized pit scale including different types of pores and ducts.

Body Shape

The body may be circular, semicircular, pyriform, or elongate oval. The venter is flat, the dorsum is convex, following the test. The degree of convexity differs among genera. *Bambusaspis* and *Palmaspis* are relatively flat, while *Asterodiaspis*, *Asterolecanium*, and *Planchonia* are strongly convex.

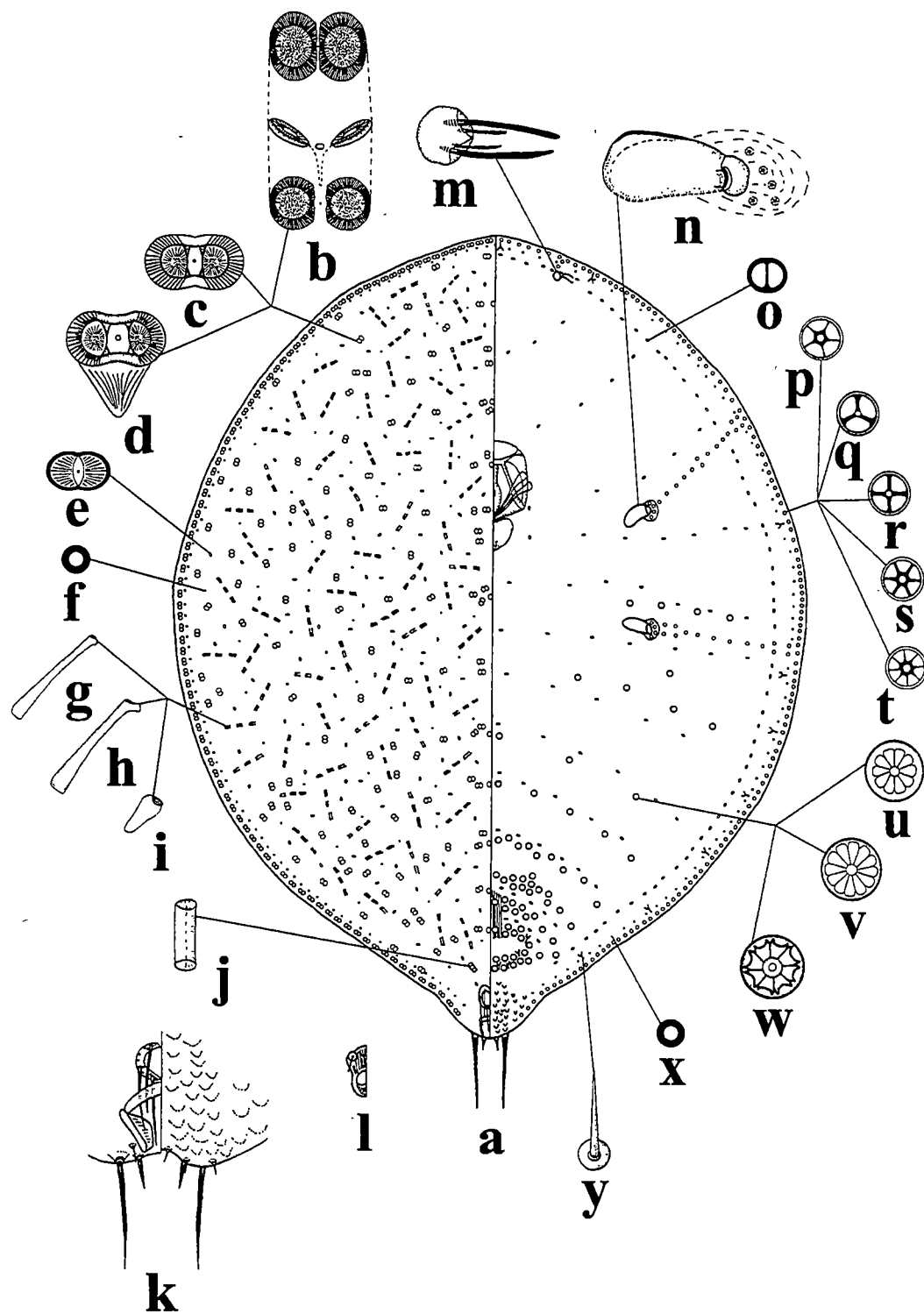


Fig. 2. Morphological characters of a generalized pit scale.

Derm

The derm is membranous on both dorsum and venter. Because of the hard tests, no further sclerotization of the derm is required for survival. However, the ventral anal area often retains some of the heavier sclerotization of the past and may be rugose, or slightly or strongly sclerotized. In one species, *Bambusaspis scirrosis*, the anal area is sclerotized both dorsally and ventrally; thus, creating the appearance of a diaspidid-like pygidium. Microspines on the venter are present in few species.

Segmentation

The segmentation in pit scales is more difficult to establish than in related taxa such as Cerococcidae (Lambdin & Kosztarab 1977) or Lecanodiaspididae (Howell & Kosztarab 1972). In general, segmental lines cannot be distinguished on the dorsum. Easy recognition characters such as setae are missing on the dorsum of Asterolecaniinae species with the exception of one pair of anal setae in some species, and the apical and subapical setae. Large dorsal 8-shaped pores are often arranged in a strong lace or swirl-like pattern in the genera *Asterolecanium*, *Planchonia*, and *Russellaspis*. However, this pattern is not sufficient to discern segmental borders. In the genus *Planchonia*, the large number of small dorsal 8-shaped pores occasionally may be used to distinguish between segmental lines.

As in all scale insects, the head and thorax are fused into a cephalothorax. However, the distribution of ventral 8-shaped pores and the position of antennae and spiracles distinguish between the two tagmata. Besides the distribution of ventral 8-shaped pores, only the position of a small cluster of quinquelocular pores between the

marginal row of quinquelocular pores and each antenna demark the segmental lines on the head. The thorax is clearly indicated ventrally by the spiracles, the spiracular furrows, and 8-shaped pore rows. Legs are not present in adult females. Only a few oriental species exhibit "claws" as vestiges of legs (Russell 1941).

Indications for ventral abdominal segmentation can be obtained from the rows of transverse 8-shaped pores, multilocular pores, and segmental setae (Fig. 2a). The first and second segment are considered fused, the eighth segment is indicated by the vulva. No anal cleft is present as in the Cerococcidae and Lecanodiaspididae, but the anal lobes are often indented. The anal lobes are considered to be part of the ninth segment. However, the anal lobes in the Asterolecaniinae are fused with the surrounding derm. If multilocular pores are present, they are expressed on the ninth segment posteriad of the vulva and on several anterior segments. The tenth segment can be recognized dorsally by an area usually devoid of ducts and pores. It also contains the anal ring, the arched plate, and the pair of anal plates, if present. The anal opening is considered to lie on the eleventh segment.

Slide-Mounted Females

Foldi (1991, 1997c), Foldi & Cassier (1985), and Foldi & Pearce (1985) give a general introduction into the types of pores and ducts found in Coccoidea. Many of these structures are also present in the Asterolecaniinae. Foldi & Lambdin (1995) discuss 8-shaped pore glands, tubular ducts, multilocular pores, and quinquelocular pores as found in the Asterolecaniidae, Cerococcidae, and Lecanodiaspididae. Foldi (1990, 1997b), Koteja (1974a, b, 1976), Koteja & Liniowska (1976), Parr (1940), and Pesson (1944)

describe the coccoid digestive system and its associated morphological structures, such as the mouthparts. Foldi (1990, 1997b) and Parr (1940) describe the respiratory system and the spiracular structures of *As. variolosa* and other coccoids such as Coccidae and Diaspididae.

Dorsal Surface

The 8-shaped pores

occur in several distinct forms. The large 8-shaped pores are either bent (Fig. 2b) or flat (Fig. 2c). The pores on the dorsum are generally of the same type in the same species. Dorsal pores may occur in medial, submarginal, or transverse bands or swirls, and can vary tremendously even among members of the same species. In several species large dorsal 8-shaped pores may or may not be present (Stumpf & Lambdin 2000a). Therefore, these pores should only be used cautiously as species specific characteristics. The marginal 8-shaped pores may be of the same type as the dorsal pores, slightly longer in appearance, but still bent (Fig. 2b), or flat (Fig. 2c). They are completely missing in the genus *Grammococcus*. In the genus *Neoasterodiaspis*, these pores exhibit a characteristic dorsal spike (Fig. 2d). Foldi & Lambdin (1995) described the large 8-shaped pores and investigated their ultrastructure. The pores are formed by a central cell surrounded by four lateral cells and an intermediate cell. The lateral cells open in a common reservoir, from which a ductule leads to the outside, and produce wax that is often visible as large lateral filaments. All species have small 8-shaped pores (Fig. 2e). These are usually arranged in transverse rows or bands, or swirls following the pattern of the large 8-shaped pores. In most cases, not enough pores are present to distinguish segmental borders.

Multilocular pores

are only present in the genus *Grammococcus*. They are found in submarginal clusters as described by Miller & Lambdin (1978).

Simple disk pores

(Fig. 2f) are found either irregularly distributed over the dorsum or associated with the large dorsal 8-shaped pores in all species. Few species possess disk pores on the venter. In addition, a dorsal submarginal row of disk pores is exhibited in many species. In some species, this row is missing, while it is found on the ventral submargin in others. In the genus *Planchonia*, a submarginal row is present on both the dorsum and the venter.

Simple pores typically appear circular and consist of one duct. According to Kawai & Tamaki (1967), Lambdin & Kosztarab (1977), Tamaki (1970), and Tamaki et al. (1969), simple pores secrete a wet wax composed of hydrocarbons.

Tubular ducts

(Fig. 2g) occur in all species. In the Asterolecaniinae, they are only found on the dorsum. In most cases, no particular pattern can be discerned. However, in some species on palm and bamboo, the tubular ducts are arranged into 4-6 longitudinal bands.

Secretions of the tubular ducts form the protective test (Foldi & Lambdin 1995). The associated gland cells consist of a large central cell and four lateral cells. The central cell is attached to the end of the inner ductule, while the lateral cells are attached to the inner end of the outer ductule (Foldi & Lambdin 1995). From a common reservoir, glucoproteins and other secretions are guided to the outside through the outer ductule. In their analysis, Foldi & Lambdin (1995) found the pit scale *Asterodiaspis variolosa* to be

different from the ornate pit scale, *Cerococcus quercus* (Cerococcidae), and the false pit scale, *Lecanodiaspis sardoa* (Lecanodiaspididae). In *As. variolosa*, the inner ductule is reduced in length and the outer ductule becomes larger in diameter toward the outer end. The dense area visible in the illustrations of tubular ducts of all species corresponds to the attachment site of the lateral cells, and demarcates the border between inner and outer ductule. In some pit scale species (Fig. 2h), the inner ductule is either longer or stronger modified than in the more advanced *As. variolosa*. Some species possess strongly reduced tubular ducts without visible inner ductules (Fig. 2i).

Caudal tubes

(Fig. 2j) are restricted to the genus *Bambusaspis*. They are always found as a single pair of tubes, one tube on either side of apparently the ninth abdominal segment antero-laterad of the anal ring and, at least on the mounted specimen, posteriad of the ventrally located vulva. These structures usually appear as simple tubes with a weak longitudinal division. In *Ba. scirrosis*, a sclerotized plate is associated with each tube. The function of the caudal tubes is unknown.

Anal lobes

(Fig. 2k) are not prominent in the Asterolecaniinae. Usually, only a slight indentation is present. Most species possess a pair of apical and a pair of subapical setae. These setae may be exactly at the apex, on the dorsal, or the ventral side of the anal lobe. In addition, one to three pairs of ventral setae, and one pair of dorsal setae may be present. The size of the different setae can vary considerably. The apical setae are usually large and prominent, the other setae small and slender. The dorsal area of the anal lobe is generally

membranous, while the ventral area is either membranous, wrinkled, rugose, or slightly or strongly sclerotized. Microsclerotizations of the ventral area posteriad of the vulva are rare. Some species have a strong, almost plate-like sclerotization on the venter. In *Ba. scirrosis*, both venter and dorsum are strongly sclerotized, resulting in a pygidium-like appearance similar to diaspidids.

The arched plate

(Fig. 2k) is present in all species of *Asterolecanium* and *Planchonia*, in *Russellaspis*, and in most species of *Bambusaspis*; sometimes the arched plate is fused with the anal plates. The genera *Asterodiaspis*, *Grammococcus*, *Neoasterodiaspis*, and *Palmaspis* do not possess apical plates. No setae are found on either arched plates or anal plates, but several seta-like spines may occur. If present, the arched plates form a ring-like structure together with the anal plates, through which the setae of the anal ring project. These characters closely link the Asterolecaniinae with the family Lecanodiaspididae. The disappearance of apical sclerotizations is believed to be an advanced character, as other characters such as the number of dorsal and marginal 8-shaped pores or the number of ventral and marginal multilocular pores are also reduced in these taxa. Hodgson (1995b) homologizes the arched plates of the Asterolecaniidae and Lecanodiaspididae with the single triangular anal plate of the Cerococcidae. He considers it to be a posterior extension of the dorsum and not to derive from the anal lobe in contrast to the anal plates of the Coccidae.

Anal plates

(Fig. 2k) occur in the same pit scale taxa that also possess arched plates. The two anal plates may be separate or fused. They are believed to be homologous to the fused "bow-tie" shaped anal plates of the Lecanodiaspididae (Hodgson 1995b). Hodgson (1995b) found developmental differences and differences in the position of the anal plates in relation to the anal ring between the Lecanodiaspididae and the Coccidae, and concluded that they are not homologous structures.

The anal ring

(Fig. 2k) is visible in most species; it is hard to detect or not visible in some species of *Palmaspis*, e.g., *Pa. gilva*. The genera believed to be at the base of the Asterolecaniinae (*Asterolecanium*, *Planchonia*, *Russellaspis*) possess a well-developed anal ring with two halves connected to each other by sclerotizations. The anal rings of these closely related genera are always found with three pairs of slender setae and 2-3 rows of pores. The related families Cerococcidae and Lecanodiaspididae also possess well-developed anal rings with 3 or 4 pairs of setae (Howell & Kosztarab 1972, Lambdin & Kosztarab 1973, 1977). In most species of *Bambusaspis*, anal rings are similar to those found in the previously mentioned three genera. In *Ba. tetrasetosa* and *Ba. scirrosis*, the anal rings are plate-like with only one pair of setae. The same trend can be observed in the more advanced pit scale genera (*Asterodiaspis*, *Grammococcus*, *Neoasterodiaspis*, and *Palmaspis*). In these genera, the two anal ring halves are fused and plate-like (Fig. 2l). In the Coccoidea, the function of the anal ring setae is believed to help guide the ejection of liquid excrements or honeydew away from the body to avoid contamination (Foldi &

Pearce 1985, Matile-Ferrero 1997, Williams & Williams 1980). However, in the Diaspididae which also possess tests that are separated from the derm, no honeydew is produced (Williams & Williams 1980, Banks 1990). Instead, anal fluids appear to be used in the scale cover formation. Excess nutrients may also be retained in the stomach epithelium or even reinjected into the plant tissue (Banks 1990). There are no references in the literature for production of honeydew in the Asterolecaniinae including extensively studied pest species with a typical anal ring with six setae (e.g., *Ru. pustulans*) and those with a reduced, plate-like anal ring (e.g., *As. variolosa*). The reduction of the anal ring in the more advanced pit scale taxa seems to support these findings. However, no studies have been conducted regarding the occurrence of excess nutrients in pit scales.

Ventral Surface

The mouthparts (Fig. 3) lie mesad at about the end of the anterior third of the body (Fig. 2a).

The clypeolabral shield

(Fig. 3) includes the clypeus, labrum, and tentorial branches that function as muscle attachments for the pharyngeal pumping system. Morphology and physiology of the digestive system of the Coccoidea were discussed by Foldi (1990, 1997b), Koteja (1974a, b, 1976), Koteja & Liniowska (1976), Parr (1940), and Pesson (1944). The ends of the four stylets reside in maxillary and mandibular levers, from where they pass the hypopharyngeal plate. The pharynx is in contact with the stylets posteriad, and surrounded by the hypopharyngeal wings dorsad and the lateral clypeal sulci ventrad.

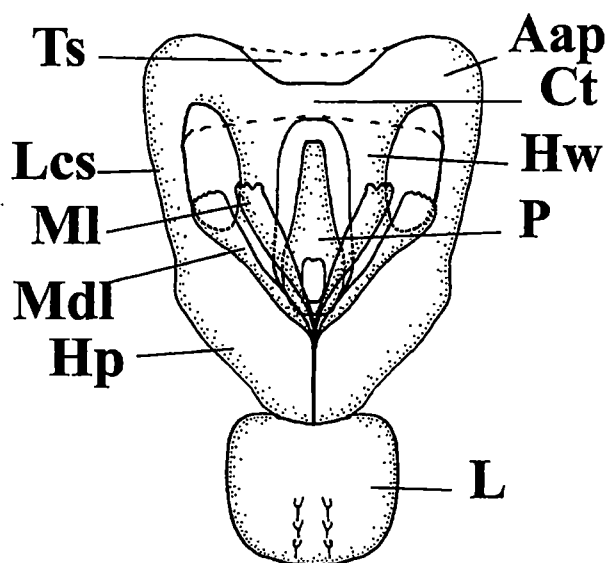


Fig. 3. Schematic diagram of pit scale mouthparts.

Aap: Anterior arm of the pretentorium
 Ct: Corpotentorium
 Hp: Hypopharyngeal plate
 Hw: Hypopharyngeal wing
 L: Labium
 Lcs: Lateral clypeal sulcus
 Mdl: Mandibular lever
 Ml: Maxillary lever
 P: Pharynx
 Ts: Tentorial sclerotization

Both structures attach to the hypopharyngeal plate anteriorly and are connected to each other through the anterior arm of the pretentorium. The corpotentorium connects the two sides antero-dorsad. This arrangement is present in the more advanced genera *Asterodiaspis*, *Grammococcus*, *Neoasterodiaspis*, and *Palmaspis*, and also in two species of *Asterolecanium*. In *Neoasterodiaspis*, the corpotentorium is not visible. In the genera *Bambusaspis*, *Planchonia*, and *Russellaspis*, and most species of *Asterolecanium*, the two anterior arms of the pretentorium are connected to each other ventrally through a sclerotized membrane or branch of the tentorium (Fig. 2a). In most species of *Bambusaspis*, this sclerotization is responsible for the typical bent shape of the clypeolabral shield.

The labium

(Fig. 3) is one-segmented and typically heart-shaped with 0-3 setae in the adult female.

Koteja (1974a) provided a detailed discussion of the labium and its implication in familial relationships.

Antennae

(Fig. 2m) are one-segmented with several (usually two) fleshy and several slender setae. The antennae may be further reduced to a stump, as in many species of *Palmaspis*. The apex of the antennae is generally concave, with setae often originating deep inside the antennae. A few quinquelocular pores may be present between the margin and each antenna.

Legs

are not present in adult females of New World Asterolecaniinae. In some oriental species, "claws" remain as leg vestiges (Russell 1941). Gall formation and the production of the test has made legs redundant in evolutionary history. Leg reduction is known for many scale insect taxa. In another advanced sessile group with tests, the Diaspididae, the legs have also been lost completely.

Spiracles

(Fig. 2n) are present either submarginally or medially on the prothorax and metathorax. Both spiracles are usually about the same size. The spiracular morphology of the families Coccidae and Diaspididae was discussed by Foldi (1990, 1997b) and Hodgson (1995a). The tracheal system opens into the atrium which is protected by valves. A sclerotized cavity called the peritreme lies at the lateral end of the atrium. In pit scales, the peritreme is often surrounded by derm folds in which the spiracular furrow extends its quinquelocular pores. The spiracular arm, sometimes also called muscle plate, is attached

to the peritreme and provides muscle attachments for the spiracular valves. From each spiracle, a spiracular furrow of multilocular pores extends to the margin. The furrows in the Asterolecaniinae are always single and never bifurcate as in many Cerococcidae and Lecanodiaspididae. The spiracular pores may vary in number of loculi from three to six locular, but most are quinquelocular. In some species of *Palmaspis*, these pores are trilocular. No setae are associated with the spiracular furrows. The wax produced by the pores is hydrophobic and therefore prevents water penetration and facilitates air circulation (Foldi 1997c).

The 8-shaped pores

(Fig. 2o) on the venter are also referred to as the bilocular pores. These pores are usually oval, and consist of a sclerotized outer margin with a central bar and two loculi. Two types of pores are found. The first type with a slight sclerotization of the outer margin is restricted to a submarginal row. The second type are the dark-rimmed pores (Foldi & Lambdin 1995, Russell 1941) which are strongly sclerotized and cover the whole venter in transverse rows. They also form clusters on each side of the mouthparts. The ultrastructure is similar to the dorsal 8-shaped pores producing white filaments (Foldi & Lambdin 1995). In a few cases, the dorsal 8-shaped pore type can also be found in submarginal bands on the venter.

Quinquelocular pores

(Fig. 2p) are found in the spiracular furrows and the marginal row. Some of these pores may also be trilocular (Fig. 2q), quatrolocular (Fig. 2r), 6-locular (Fig. 2s), or 8-locular (Fig. 2t). In the genera *Grammococcus* and *Palmaspis*, the trilocular pores may become

the dominant pore type. The genus *Grammococcus* does not possess a marginal row of quinquelocular pores.

Multilocular pores

(Fig. 2u, v, w) are similar in all scale insects and were extensively studied by Foldi (1981, 1990, 1991, 1997c), Foldi & Cassier (1985), Foldi & Lambdin (1995), Kawai & Tamaki (1967), Tamaki (1970), and Tamaki et al. (1969). The multilocular pores can be separated into several groups with identical cytological characteristics depending on the number of loculi (Foldi & Lambdin 1995). They consist of 8-12 glandular cells that open into a common reservoir covered by a loculate plate with 3-12 micro-orifices or loculi. An internal cuticular structure operates as a molding apparatus to secrete curved wax threads.

Pores with usually 10-12 loculi are found in almost all species. These pores occur in transverse rows or bands around and posteriad of the vulva. Depending on the species, several rows may also be present on the abdomen antieriad of the vulva; sometimes incomplete rows extend to the thoracic region with pores antieriad of metathoracic and prothoracic spiracles. In some species in the genera *Asterodiaspis*, *Palmaspis*, and *Planchonia*, the pores in these rows may be 5-9 locular.

Simple disk pores

(Fig. 2x) are similar to those present on the dorsum. They occur in the genera *Planchonia* and *Russellaspis*, and in several species of *Asterolecanium*.

Setae

(Fig. 2y) are so sparse as to be unimportant taxonomically. Besides those on the anal lobes, several transverse rows of slender setae are usually present on the posterior part of the abdomen, corresponding to the perivulvar rows of multilocular pores. A submarginal row corresponding to the ventral submarginal row of 8-shaped pores can be found in most species. This row is always incomplete in the genus *Bambusaspis*.

Key to the Adult Females of the Family Asterolecaniidae

in North and South America

This key was developed from the material at hand. The parts of the key dealing with the genus *Asterolecanium* were modified from Russell's (1941) key. The key for *Sclerosococcus* was adapted from Lambdin (1980), and the key for *Grammococcus* was adapted from Miller & Lambdin (1978).

1. Dorsum with oval, sclerotized plate, no other structures visible; with circle of quinquelocular pores around mouthparts *Mycococcus coperniciae* Ferris
- Dorsum without oval, sclerotized plate, with various ducts and pores; without circle of quinquelocular pores around mouthparts 2
- 2(1). With strongly sclerotized anal lobes and deep anal cleft *Mycetococcus* Ferris 3
- Without strongly sclerotized anal lobes and deep anal cleft 4
- 3(2). Each anal lobe with more than 20 setae; without additional rows of setae on dorsum *Mycetococcus corticis* (Townsend & Cockerell)
- Each anal lobe with less than 20 setae; with additional rows of setae on dorsum *Mycetococcus ehrhorni* (Cockerell)
- 4(2). With 5 setae on each of two protruding anal lobes *Pollinia pollini* (Costa)
- Without protruding anal lobes 5
- 5(4). Without translucent green test; with transverse rows of setae on dorsum *Sclerosococcus* McKenzie 6
- With translucent green test; without transverse rows of setae on dorsum; dorsal setae only on anal lobes *Asterolecaniinae* 9

- 6(5). With clusters of 7-locular pores in marginal band on cephalothorax; without groups of tack-like setae on submargin between antenna and prothoracic spiracle 7
 Without clusters of 7-locular pores in marginal band on cephalothorax; with 2 groups of 3-6 tack-like setae on submargin between antenna and prothoracic spiracle *Sclerosococcus bromeliae* McKenzie
- 7(6). Apical abdominal segments heavily sclerotized; quinquelocular pores in 2 transverse abdominal rows on dorsum and venter *Sclerosococcus ferrisi* McKenzie
 Apical abdominal segments not sclerotized; quinquelocular pores in 4-5 transverse abdominal rows on dorsum and venter 8
- 8(7). With complete marginal band of 7-locular pores; apical setae longer than 120μ *Sclerosococcus chilensis* Lambdin
 With marginal band of 7-locular pores restricted to cephalothorax; apical setae less than 120μ *Sclerosococcus tillandsiae* Lambdin
- 9(5). With complete or incomplete row or band of marginal 8-shaped pores; without dorsal clusters of multilocular pores 11
 Without row or band of marginal 8-shaped pores; with dorsal clusters of multilocular pores *Grammococcus* Miller & Lambdin 10
- 10(9). Lateral areas of anal ring connected antieriad by thin, sclerotized bar; dorsal clusters of quinquelocular pores frequently with spaces between the pores; with row of 37-62 submarginal 8-shaped pores on venter. *Grammococcus adetocorymbus* Miller & Lambdin p.190
 Lateral areas of anal ring separate, not connected by sclerotized bar; dorsal clusters of quinquelocular pores with pores closely appressed, without spaces between pores; with row of 24-36 submarginal 8-shaped pores on venter *Grammococcus corymbus* Miller & Lambdin p.191
- 11(9). With one pair of caudal tubes; in many species tentorial sclerotization arch-like *Bambusaspis* Cockerell 12
 Without caudal tubes; without arch-like tentorial sclerotization 22
- 12(11). Anal ring with 6 setae 16
 Anal ring with less than 6 setae 13
- 13(12). Anal area sclerotized dorsally and ventrally, pygidium-like; marginal rows of 8-shaped pores and quinquelocular pores incomplete, interrupted in cephalic area *Bambusaspis scirrosis* (Russell) p.180
 Anal area not sclerotized dorsally and ventrally; marginal rows of 8-shaped pores and quinquelocular pores not interrupted in cephalic area 14
- 14(13). Without transverse abdominal rows of multilocular pores on venter; with less than 100 marginal 8-shaped pores *Bambusaspis tetrasetosa*, n.sp. p.185
 With transverse abdominal rows of multilocular pores on venter; with more than 100 marginal 8-shaped pores 15

- 15(14). With complete submarginal band of large dorsal 8-shaped pores; row of marginal 8-shaped pores terminating anterior of anal lobes; with multilocular pores in transverse abdominal rows on venter *Bambusaspis octocircularis*, n.sp. p.176
 With a few submarginal large dorsal 8-shaped pores, but not in a complete band; row of marginal 8-shaped pores does not terminate before anal lobes, but encircles it completely; with quinquelocular pores in transverse abdominal rows on venter *Bambusaspis brasiliensis*, n.sp. p.142
- 16(12). Marginal 8-shaped pores arranged in a row; tentorial sclerotization arch-like; tubular ducts either longer than 17μ or shorter than 10μ 17
 Marginal 8-shaped pores arranged in a band; tentorial sclerotization not arch-like; tubular ducts $12-14\mu$ long *Bambusaspis hemisphaerica* (Kuwana) p.152
- 17(16). Tubular ducts less than 10μ *Bambusaspis bambusicola* (Kuwana) p.138
 Tubular ducts more than 17μ 18
- 18(17). With multilocular pores in transverse bands on venter 19
 Without multilocular pores in transverse bands on venter 20
- 19(18). Length of body $1300-1900\mu$; length of apical setae $69-85\mu$ *Bambusaspis bambusae* (Boisduval) p.129
 Length of body $2300-3600\mu$; length of apical setae $8-11\mu$ *Bambusaspis magna*, n.sp. p.157
- 20(18). Marginal row of quinquelocular pores ends together with marginal 8-shaped pores ca. two 8-shaped pore lengths before apex of abdomen; large dorsal 8-shaped pores always present, in medial band *Bambusaspis mexicana*, n.sp. p.162
 Marginal row of quinquelocular pores variable, never ends together with marginal 8-shaped pores before apex of abdomen, row may be interrupted between spiracular furrows or completely missing; if large 8-shaped pores present, then in submarginal row 21
- 21(20). Marginal row of 8-shaped pores sporadic, interrupted in several places; marginal row of quinquelocular pores absent *Bambusaspis caudata* (Green) p.146
 Marginal row of 8-shaped pores complete, not interrupted in several places; marginal row of quinquelocular pores present, but incomplete *Bambusaspis miliaris* (Boisduval) p.166
- 22(11). Anal ring with 6 setae; with submarginal row of simple disk pores 23
 Anal ring with 0-4 setae; without submarginal row of simple disk pores 37
- 23(22). Marginal or submarginal rows of simple disk pores on dorsum and venter; apical plates fused, anvil-shaped; large 8-shaped pores never present on venter *Planchonia* Signoret 24
 Marginal or submarginal row of simple disk pores either on dorsum or on venter; apical plates usually not fused and anvil-shaped, if apical plates anvil-like, then large marginal or submarginal 8-shaped pores present on dorsum and venter 25

- 24(23). With three transverse abdominal bands of multilocular pores on venter around vulva, occasionally with additional 4th row, edges of locular plates in pores fringed; simple disk pores on venter only in submarginal row, not in transverse rows *Planchonia stentae* (Brain) p.287
 With at least five transverse abdominal bands of multilocular pores on venter around vulva, edges of locular plates in pores not fringed; simple disk pores on venter in submarginal row and in transverse rows
 *Planchonia arabis* Signoret p.279
- 25(23). If 6 pairs of apical setae present, then always with marginal band of 8-shaped pores; most species without simple disk pores on venter, if disk pores present on venter, then specimen either with bands of marginal or submarginal 8-shaped pores on dorsum and venter, or clypeolabral shield without tentorial sclerotization *Asterolecanium* Targioni-Tozzetti 26
 With 6 pairs of apical setae and single row of marginal 8-shaped pores; with submarginal row of simple disk pores on venter (this character not easy to recognize); with tentorial sclerotization on clypeolabral shield.
 *Russellaspis pustulans* (Cockerell) p.294
- 26(25). Without tentorial sclerotization on clypeolabral shield. 27
 With tentorial sclerotization on clypeolabral shield. 28
- 27(26). With simple disk pores in submarginal row on venter; large dorsal 8-shaped pores larger than marginal 8-shaped pores . *Asterolecanium ingae* Russell p.95
 Without simple disk pores in submarginal row on venter; usually without large dorsal 8-shaped pores, if pores present, than not larger than marginal 8-shaped pores *Asterolecanium sanbernardense* Hempel p.114
- 28(26). With marginal band of 8-shaped pores 29
 With marginal row of 8-shaped pores 32
- 29(28). With marginal or submarginal band of 8-shaped pores on dorsum and venter; with submarginal row of simple disk pores on venter 30
 With marginal band of 8-shaped pores only on dorsum; without submarginal row of simple disk pores on venter 31
- 30(29). Large 8-shaped pores on dorsum and venter flat or only slightly bent, pores in a marginal band on both dorsum and venter; apical setae 63-71 μ long
 *Asterolecanium multioctoporosum*, n.sp. p.100
 Large 8-shaped pores on dorsum and venter bent; pores in a marginal band on dorsum, similar smaller pores in a submarginal band on venter; apical setae 25-35 μ long *Asterolecanium quaesitum* Russell p.110
- 31(29). Marginal row of quinquelocular pores short, interrupted between spiracular furrows; apical plates triangular; large dorsal 8-shaped pores larger than marginal 8-shaped pores *Asterolecanium grandiculum* Russell p.91
 Marginal row of quinquelocular pores not interrupted between spiracular furrows; apical plates square; large dorsal 8-shaped pores same size as marginal 8-shaped pores *Asterolecanium viridulum* Cockerell p.123

- 32(28). Apical setae longer than 40μ ; apical plates not forming a ring together with arched plate; clypeolabral shield without spur on tentorial sclerotization 33
 Apical setae $5-13\mu$ long; apical plates fused and connected to arched plate, forming a ring through which anal ring setae project; clypeolabral shield with small spur on tentorial sclerotization
 *Asterolecanium dorsisetosum*, n.sp. p.77
- 33(32). Large dorsal 8-shaped pores at least 4μ larger than marginal 8-shaped pores . 35
 Large dorsal 8-shaped pores not more than $1.5-2\mu$ larger than marginal 8-shaped pores 34
- 34(33). Marginal row of quinquelocular pores complete, not interrupted antieriad; submarginal row of simple disk pores incomplete, pores associated with transverse bands of large dorsal 8-shaped pores; large dorsal 8-shaped pores same size as marginal 8-shaped pores
 *Asterolecanium puteanum* Russell p.105
 Marginal row of quinquelocular pores incomplete, interrupted antieriad, and often also interrupted between spiracular furrows; submarginal row of simple disk pores complete; large dorsal 8-shaped pores slightly (about 1.5μ) larger than marginal 8-shaped pores *Asterolecanium agavis* Russell p.68
- 35(33). Large dorsal 8-shaped pores usually in transverse bands with median, submedian, and submarginal clusters, and a submarginal row, sometimes only with submarginal row; anal lobes either smoothly indented or in sclerotized steps; often with pear-shaped ventral sclerotization on anal lobes
 *Asterolecanium epidendri* (Bouché) p.81
 Large dorsal 8-shaped pores arranged in swirls; anal lobes not as described above; without pear-shaped ventral sclerotization on anal lobes 36
- 36(35). Marginal row of quinquelocular pores incomplete; anal plates trapezoid-shaped *Asterolecanium cristatum* Ferris p.72
 Marginal row of quinquelocular pores complete; anal plates long and thin, not trapezoid-shaped *Asterolecanium townsendi* Cockerell p.119
- 37(22). Anal ring fused, heart-shaped or triangular, with 2 setae; large dorsal and marginal 8-shaped pores *Asterodiaspis*-type (Fig. 2c or d), flat or only slightly bent 38
 Anal ring fused, but never heart-shaped or triangular, with 0-4 setae; large dorsal and marginal 8-shaped pores typical (Fig. 2b), bent in most species
 *Palmaspis* Bodenheimer 41
- 38(37). Marginal 8-shaped pores with distinct dorsal spike.
 *Neoasterodiaspis adjuncta* (Russell) p.192
 Marginal 8-shaped pores without dorsal spike *Asterodiaspis* Signoret 39
- 39(38). Apical setae on separate lobes, $40-43\mu$ long; with less than 32 quinquelocular pores in each spiracular furrow; only multilocular pores in transverse abdominal rows on venter 40

- Apical setae not on separate lobes, 23-37 μ long; with 32-80 quinquelocular pores in each spiracular furrow; pores in transverse abdominal rows on venter quinquelocular or multilocular *Asterodiaspis variolosa* (Ratzeburg) p.54
- 40(39). With 9-16 quinquelocular pores in each spiracular furrow; with several sizes of dorsal 8-shaped pores, largest 4.0-4.6 μ long.
. *Asterodiaspis luteola* (Russell) p.46
- With 21-31 quinquelocular pores in each spiracular furrow; with one size of dorsal 8-shaped pores, about 2.3 μ long *Asterodiaspis variabilis* (Russell) p.50
- 41(37). Without apical setae *Palmaspis asetosa*, n.sp. p.197
- With apical setae 42
- 42(41). Tubular ducts not more than 2.5 times longer than wide 43
- Tubular ducts much more than 2.5 times longer than wide 44
- 43(42). Tubular ducts atypical, about as long as wide; anal ring without setae, but with four seta-like sclerotizations *Palmaspis distincta* (Russell) p.223
- Tubular ducts 2-2.5 times longer than wide; anal ring with 4 setae
. *Palmaspis loretoensis* Matile-Ferrero p.277
- 44(42). Without marginal row of trilocular or quinquelocular pores, or with very short incomplete row where spiracular furrows meet margin; apex of abdomen not sclerotized; marginal row of 8-shaped pores complete, not interrupted posteriad, with some apical 8-shaped pores oriented in right angle to margin.
. *Palmaspis jubae*, n.sp. p.240
- With marginal row of trilocular or quinquelocular pores; if row very short, then either marginal row of 8-shaped pores incomplete or apex of abdomen sclerotized ventrad; if marginal row of 8-shaped pores complete, never with apical 8-shaped pores oriented in right angle to margin. 45
- 45(44). Without anal ring or anal ring without setae 46
- Anal ring with setae 50
- 46(45). Without large dorsal 8-shaped pores 47
- With large dorsal 8-shaped pores 48
- 47(46). Without transverse rows of ventral multilocular pores on abdomen around vulva; clypeolabral shield with lateral clypeal sulcus.
. *Palmaspis gilva* (Russell) p.228
- With transverse rows of ventral multilocular pores on abdomen around vulva; clypeolabral shield without lateral clypeal sulcus
. *Palmaspis sabalis* (Russell) p.253
- 48(46). Large dorsal 8-shaped pores in two distinct anterior swirls; apical setae on ventral lobes *Palmaspis inlabefacta* (Russell) p.231
- Large dorsal 8-shaped pores not in two distinct anterior swirls; apical setae not on ventral lobes 49
- 49(48). Anal lobes with two apical, two subapical, two dorsal, and four ventral setae, respectively; marginal row with quinquelocular pores
. *Palmaspis inusitata* (Russell) p.236

	Anal lobes with two apical setae; marginal row with trilocular pores	<i>Palmaspis elvae</i> Matile-Ferrero p.275
50(45).	Anal ring with 2 setae	51
	Anal ring with 4 setae	61
51(50).	Without transverse rows of ventral multilocular or quinquelocular pores around vulva	52
	With transverse rows of ventral multilocular or quinquelocular pores around vulva	55
52(51).	Marginal row with trilocular pores, row may be very brief and interrupted anteriorly or long and complete; with 2 subapical setae	53
	Marginal row with quinquelocular pores, interrupted anteriorly; without subapical setae <i>Palmaspis trisetosa</i> , n.sp. p.262	
53(52).	Marginal row of trilocular pores extends over whole margin, row sometimes interrupted anteriorly, but never just brief extension of spiracular furrows for a few pores	54
	Marginal row of trilocular pores not extending over whole margin, row just brief extension of spiracular furrows for a few pores	
	 <i>Palmaspis ucayali</i> Matile-Ferrero p.278	
54(53).	Anal lobes sclerotized ventrally; apical setae longer than anal ring setae	
	 <i>Palmaspis urichi</i> (Cockerell) p.270	
	Anal lobes not sclerotized ventrally; apical setae shorter than anal ring setae	
	 <i>Palmaspis marfil</i> Matile-Ferrero p.277	
55(51).	With large dorsal 8-shaped pores	58
	Without large dorsal 8-shaped pores	56
56(55).	With quinquelocular pores in transverse abdominal rows around vulva; anal ring setae same size or slightly shorter than apical setae	
	 <i>Palmaspis degenerata</i> (Russell) p.214	
	With multilocular pores in transverse abdominal rows around vulva; anal ring setae longer than apical setae	57
57(56).	Anal ring in two parts, with lateral areas connected mesad and several strong spikes antero-dorsad; marginal row of trilocular, quatuorocular, and quinquelocular pores not interrupted posteriorly; anal lobes distinct, with ventral sclerotization <i>Palmaspis similis</i> (Russell) p.257	
	Anal ring in one part, with sclerotized tubes leading to the anus through which anal ring setae project; marginal row of trilocular pores interrupted posteriorly; anal lobes indistinct, without ventral sclerotization	
	 <i>Palmaspis jesseniae</i> Matile-Ferrero p.275	
58(55).	Large dorsal 8-shaped pores in two anterior swirls; anal ring forms two plates, connected by a bar posteriad; anal lobes with distinct bar-like sclerotization ventrad <i>Palmaspis bicircularis</i> , n.sp. p.201	
	Large dorsal 8-shaped pores not in two anterior swirls; anal ring not as described above; anal lobes rugose or sclerotized ventrad, but never with distinct bar-like sclerotization	59

- 59(58). Transverse abdominal rows on venter with quinquelocular pores; with marginal band of trilocular pores; lateral clypeal sulcus usually missing *Palmaspis difficilis* (Russell) p.219
Transverse abdominal rows on venter with multilocular pores; with marginal row of trilocular pores; lateral clypeal sulcus always present 60
- 60(59). Anal ring a single plate with two setae, without pores; apical setae much longer than anal ring setae; anal tube visible; large dorsal 8-shaped pores in two submedial rows with varying pore sizes, smaller pores in adjoining circles *Palmaspis boliviae* (Russell) p.205
Anal ring with two lateral plates carrying setae and 3-4 minute pores; apical setae about same size or slightly longer than anal ring setae; anal tube not visible; large dorsal 8-shaped pores in medial band and loose submarginal row with varying pore sizes *Palmaspis palmae* (Cockerell) p.248
- 61(50). Bands of marginal 8-shaped pores and quinquelocular pores not interrupted posteriad; without transverse abdominal rows of multilocular pores on venter; anal ring setae slightly longer than apical setae *Palmaspis longifila* (Borchsenius) p.275
Rows of marginal 8-shaped pores and trilocular or quinquelocular pores interrupted posteriad; with transverse abdominal rows of multilocular pores on venter; anal ring setae shorter than apical setae 62
- 62(61). Lateral clypeal sulcus missing; with 15-21 trilocular or quinquelocular pores in spiracular furrows, never extending to proximal end of spiracular arm; with pores in folds around atria 63
Lateral clypeal sulcus present; with 6-15 quinquelocular pores in spiracular furrows, sometimes extending to proximal end of spiracular arm; without pores in folds around atria *Palmaspis bondari* (Lepage) p.210
- 63(62). With 2 apical, 2 subapical, and 4 ventral setae on anal lobes; anal ring not on small separate lobe; labium rectangular; spiracles submarg

CHAPTER V

SPECIES DESCRIPTIONS

Genus *Asterodiaspis* Signoret, 1876

Asterodiaspis Signoret, 1876a:209, 1876b:606, 642; Comstock, 1881:329; Borchsenius, 1950c:781, 1960:174, 1961:65; Bodenheimer, 1951:328, 1960:174; Morrison & Morrison, 1966:19; Danzig, 1967:825, 1986:280; Podsiadlo, 1972:389, 1974a:75, 1974b:487, 1976b:401, 1990a:363, 1990b:90; Kosztarab & Kozar, 1978:136, 1988:313; Schmutterer, 1980:51; Tereznikova, 1981:83; C.I.E., 1983:1; Martin Mateo, 1984:63; Kozar & Walter, 1985:80; Pellizzari, 1994:31; Longo et al., 1994:18, 1995:124; Kosztarab, 1996:287; Stumpf & Lambdin, 1998:35.

Type species: *Aonidia ilicicola* Targioni-Tozzetti, 1888:423, by subsequent designation of Borchsenius (1950c:781).

Asterolecanium Targioni-Tozzetti, 1892:285; Cockerell, 1895c:513, 1897a:327; Fernald, 1903:49; Newstead, 1903:150; Sanders, 1909:431; Leonardi, 1920:238; Lindinger, 1937:180, 1943:207; Gomez-Menor, 1940:232; Russell, 1941:4; Ferris, 1955:15; Boratynski, 1961:4; Schmutterer, 1972:420; Bognar & Vinis, 1979:16; Miller, 1985:105; Gill, 1993:98. *Planchonia* Cockerell, 1893a:76; Maskell, 1895b:61, 1895c:134.

Generic description:

Dorsum: With marginal row of large 8-shaped pores, flat or only slightly bent; minute 8-shaped pores, simple pores, and tubular ducts present; anal ring heart-shaped, fused, and with one pair of setae; anal lobes only weakly developed, without anal indentation.

Venter: With one-segmented antennae, 8-shaped pores near mouthparts, in submarginal

row, and in transverse rows, primarily on abdomen; legs absent, quinquelocular pores in spiracular furrows and marginal row, multilocular pores in abdominal rows anterior of genital opening; in *As. variolosa*, these pores may have 3-10 loculi.

Diagnosis: Marginal 8-shaped pores flat, *Asterodiaspis*-type (Fig. 2c). On oaks.

Hosts: Members of this genus are found only on oaks. The three species in the New World were introduced with infested plant stock from Europe and Asia.

***Asterodiaspis luteola* (Russell), 1941**

Proposed Common Name: Yellow Oak Scale

Fig. 4

Asterolecanium luteolum Russell, 1941:124. *Asterodiaspis luteola* Borchsenius, 1960:177; Kozar & Walter, 1985:80; Kosztarab, 1996:292.

Type material: On *Quercus* sp., 7(1), paratypes, all adult ♀♀, Chestnut Hill, Phila., PA, coll., R.G. Pierce, XI 1915 (USNM); *Quercus serrata*, 9(2), paratypes, all adult ♀♀, Japan, 1893 (USNM), no. 20 5697, bag no. 45 766, mounted from dry material.

Description:

Body (Fig. a) subcircular, widest in spiracular area, with anal setae on ventral lobe; 570 (520-640) long, 483 (440-540) wide. Derm membranous with 3 different sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a single row that terminates ca. 3 pore lengths before apex of abdomen, with pores in anal area slightly less dense, row with 128 (108-148) pores, each 7.4 (6.9-8.0) long, 4.3 (4.0-4.6) wide.

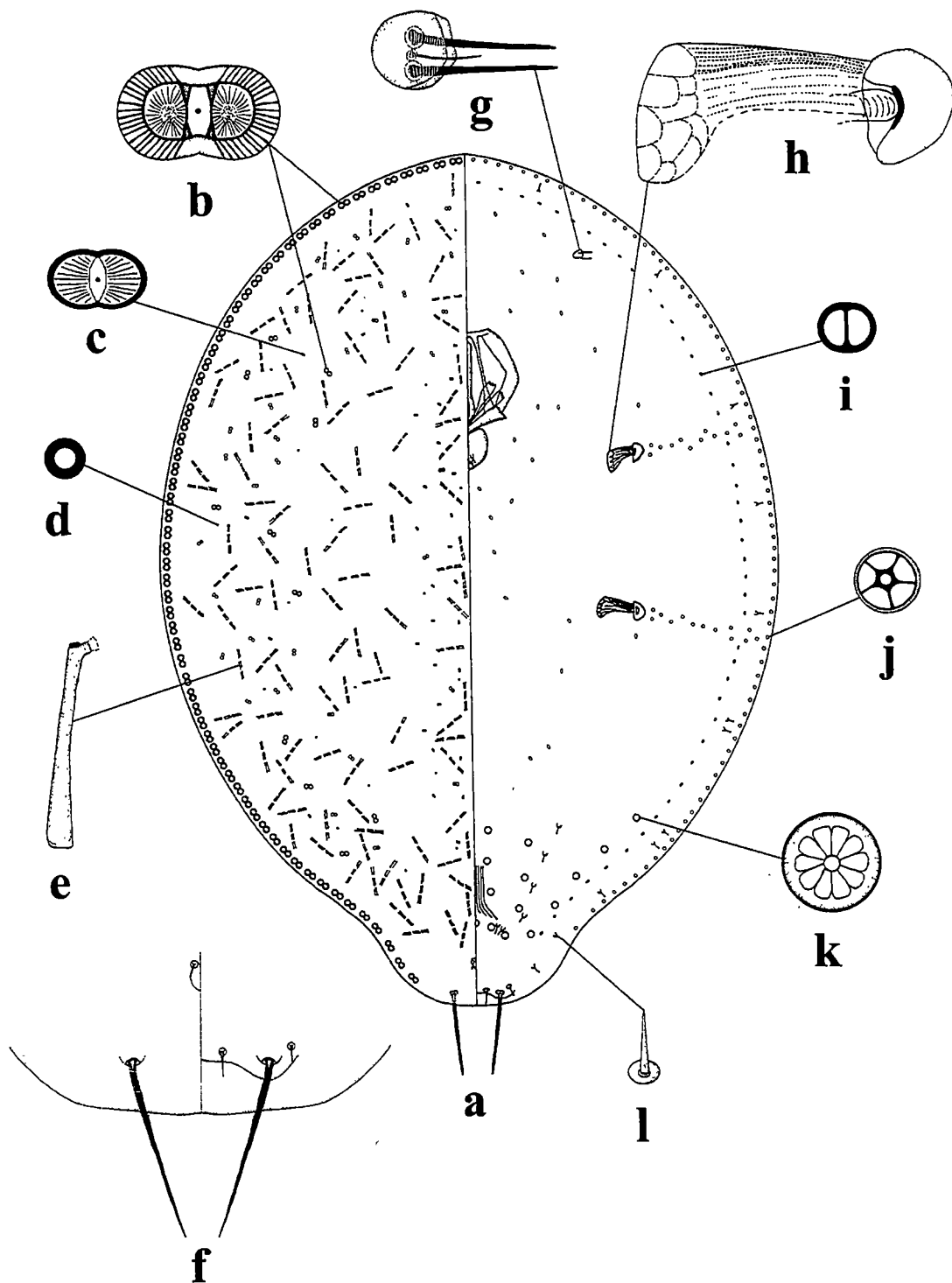


Fig. 4. *Asterodiaspis luteola* (Russell), 1941.

Other pores (Fig. c) in 3 sizes, pores arranged in medial and submarginal swirls; largest pores 4.4 (4.0-4.6) long, 2.6 (2.3-2.9) wide; medial pores 3.5 (2.9-4.0) long, 2.0 (1.7-2.3) wide; and smallest pores 2.3 (2.3-2.3) long, 1.5 (1.1-1.7) wide.

Simple disk pores (Fig. d) arranged within the 8-shaped pore swirls, consisting of 35 (26-42) pores, each pore 1.3 (1.1-1.7) in diam.

Tubular ducts (Fig. e) in irregular medial, submedial, and submarginal bands, each 18.4 (17.2-19.5) long, 2.4 (2.3-2.9) wide.

Anal lobes (Fig. f) with all setae on venter, without anal plates; each lobe with one apical seta 45.8 (40.2-52.9) long, one subapical seta 6.9 (5.7-8.6) long, and one ventral seta 5.2 (4.0-6.3) long.

Anal ring (Fig. f) heart-shaped, fused, without pores, 7.0 (5.7-9.8) long, 6.4 (5.7-7.5) wide; with one pair of slender setae, each 4.2 (3.4-5.2) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 88.0 (79.3-94.3), width 76.0 (69.0-83.9).

Labium (Fig. a) heart-shaped, 36.8 (33.3-41.4) long, 40.4 (36.8-46.0) wide; with 2 (1-2) pairs of setae, each 6.0 (4.6-6.9) long.

Antennae (Fig. g) one-segmented, cylindrical, 6.3 (4.6-7.5) long, 7.6 (6.3-9.2) wide at base; with 2 (1-2) fleshy setae, 10.1 (6.9-12.6) long, and 1 (0-2) slender setae, 3.4 long.

Spiracles (Fig. h) located in submarginal area; anterior 27.7 (24.1-29.9) long, 12.3 (11.5-13.8) wide, atrium 6.0 (4.6-6.9) in diam.; posterior 28.4 (26.4-29.9) long, 11.6 (10.9-12.6) wide, atrium 6.1 (5.2-7.5) in diam.; anterior spiracular furrows with a band of

12 (9-14) quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a band of 13 (9-16) pores, 1 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 91 (74-110) pores, each 2.1 (1.7-2.3) long, 1.3 (1.1-1.7) wide; dark-rimmed pores with 49 (26-70) pores in transverse rows primarily on cephalothorax, and with 4 (0-7) pores irregularly arranged on each side of mouthparts; some pores appear less sclerotized than others; each 2.3 long and 1.8 (1.7-2.3) wide.

Quinquelocular pores (Fig. j) in spiracular furrows and in a marginal row consisting of 163 (100-222) pores, row ends 6 (3-17) 8-shaped pore lengths before apex of abdomen; each 2.6 (2.3-2.9) in diam.

Multilocular pores (Fig. k) with 2, occasionally 3, incomplete rows consisting of 2 (0-2) and 2 (1-3) pores, respectively; and 4 complete rows anterior to genital opening, each row with 6 (5-7), 6 (6-8), 6 (5-8), and 5 (4-6) pores, respectively; each 10 (8-10) loculi and 4.8 (4.6-5.2) in diam.

Setae (Fig. l) with 5 segmental rows around genital opening corresponding to 2-3 incomplete and 4 complete rows of multilocular pores, each with 2 setae, posterior row with 4 setae each 4.4 (3.4-5.7) long; also submarginal row with 24 (18-28) setae, row less dense in cephalothoracic region, some setae in pairs; each 3.6 (3.4-4.6) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: PA; Japan.

Economic importance: This species is of no economic importance.

Diagnosis: With 9-16 quinquelocular pores in each spiracular furrow; with several sizes of dorsal 8-shaped pores, largest 4.0-4.6 long.

Affinities: Closely related to the other species of *Asterodiaspis*, especially to *As. variabilis*.

Notes: This species is probably native to the Far East (Japan), and was introduced into the U.S. from infested host plants.

***Asterodiaspis variabilis* (Russell), 1941**

Proposed Common Name: Variable Oak Scale

Fig. 5

Asterolecanium variabile Russell, 1941:217.; Ferris, 1955:26. *Asterodiaspis variabile* Kozar & Walter, 1985:80.

Type material: On *Quercus variabilis*, 3(1), paratypes, 2 adult ♀♀, 1 second instar ♀, Tsingtao, Shantung Prov., China, coll., C.Y. Chiao, 17 VI 1930 (USNM), H.N.Y.B.G., no. 45 2201.

Additional material studied: On *Castanea sequinii*, 3(1), all adult ♀♀, near Hong Chow, China, at Wash., D.C., coll., W.B. Wood, 1 II 1935 (USNM), B.P.Q. no. 034077, no. 38-1917.

Additional host: *Quercus acuta* (Russell 1941).

Description:

Body (Fig. a) subcircular, widest in spiracular area, without anal indentation; anal setae on venter; 685 (560-860) long, 630 (540-780) wide. Derm membranous with small 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

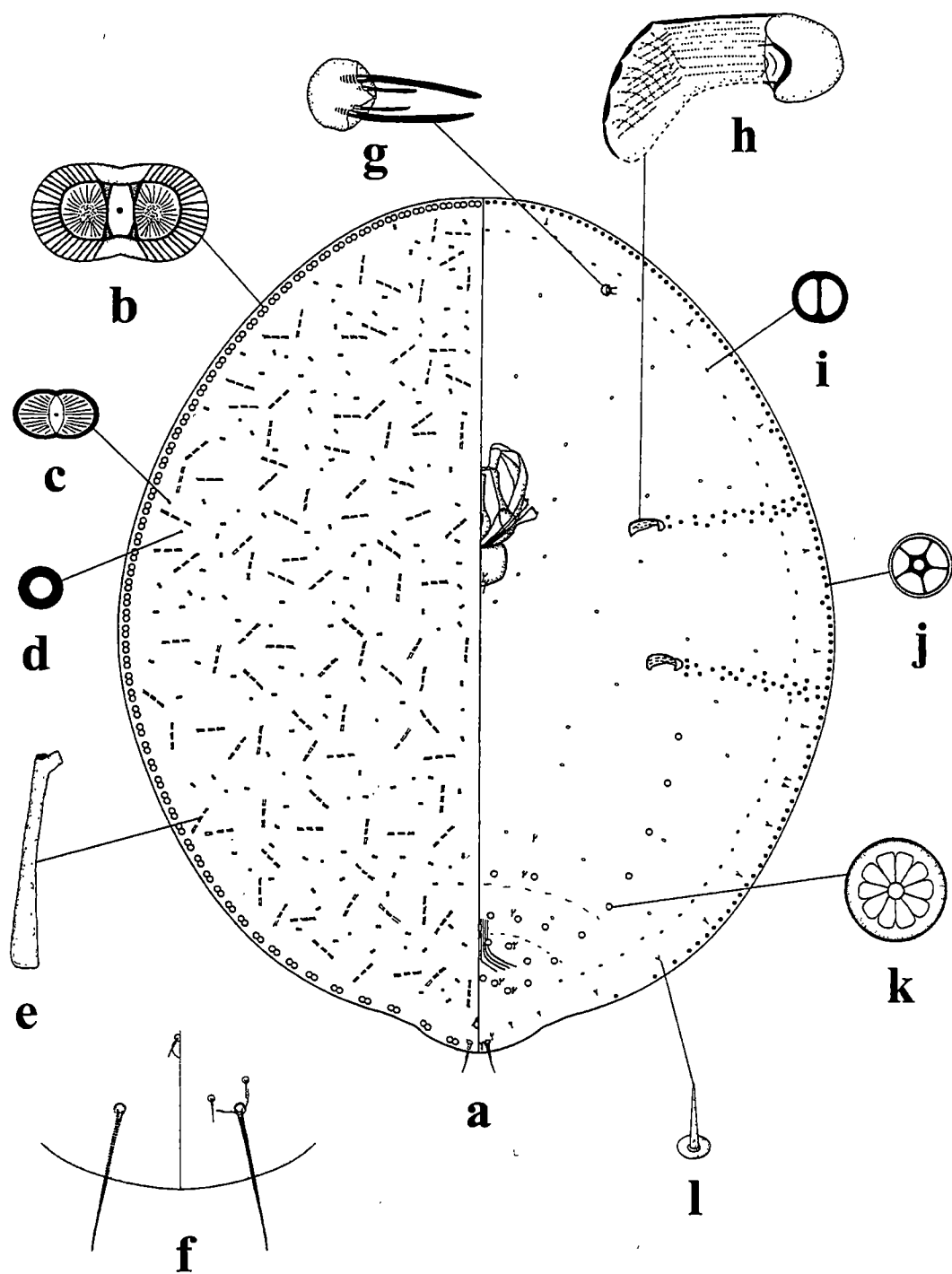


Fig. 5. *Asterodiaspis variabilis* (Russell), 1941.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a single row with 138 (128-150) pores that terminates ca. 1-2 pore lengths before apex of abdomen, pores less dense in anal area; each pore 8.8 (8.0-9.2) long, 5.5 (4.6-5.7) wide. Other pores (Fig. c) form transverse bands with 277 (214-340) pores together with disk pores; only small pores present, each 2.3 (2.3-2.3) long, 1.2 (1.1-1.7) wide.

Simple disk pores (Fig. d) form transverse bands with 48 (42-54) pores associated with 8-shaped pores, each 1.3 (1.1-1.7) in diam.

Tubular ducts (Fig. e) distributed throughout derm, each 21.1 (19.5-23.0) long, 2.3 (1.7-2.9) wide.

Anal lobes (Fig. f) with all setae on venter, without anal indentation or anal plates; each lobe with one apical seta 48.3 (46.0-51.7) long, one subapical seta 6.6 (5.7-8.0) long, and one ventral seta 6.2 (5.2-8.0) long.

Anal ring (Fig. f) heart-shaped, fused, with one pair of slender setae, without pores; anal ring 6.2 (5.7-6.9) long, 6.5 (5.7-6.9) wide, each seta 5.0 (4.0-6.9) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 98.9 (97.7-101.1), width 85.7 (80.5-97.7).

Labium (Fig. a) heart-shaped, 36.8 (34.5-39.1) long, 50.0 (46.0-54.0) wide; with 2 (1-2) pairs of setae, each 6.1 (5.7-6.9) long.

Antennae (Fig. g) one-segmented, cylindrical, 6.8 (5.2-9.2) long, 9.1 (8.6-9.2) wide at base; with 2 fleshy setae 8.7 (6.9-10.3) long, and 2 slender setae 4.0 (3.4-4.6) long.

Spiracles (Fig. h) located between median and margin; anterior 30.8 (28.7-33.3) long, 12.5 (12.1-13.8) wide, atrium 5.5 (4.0-7.5) in diam.; posterior 32.4 (31.0-34.5) long, 13.0 (11.5-14.4) wide, atrium 6.3 (5.2-8.0) in diam; anterior spiracular furrows with a band of 25 (21-31) quinquelocular pores, 2 (1-4) pores wide; posterior furrows with a band of 28 (24-33) quinquelocular pores, 2 (1-4) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 87 (72-100) pores; each pore 1.9 (1.7-2.3) long, 1.5 (1.1-1.7) wide; dark-rimmed 8-shaped pores with about 40 pores in transverse rows and 6 (4-8) pores on each side of mouthparts, pores 1.9 (1.7-2.3) long and wide.

Quinquelocular pores (Fig. j) in spiracular furrows and in marginal row consisting of 212 (180-246) pores, row ends 6 (5-9) 8-shaped pore lengths before apex of abdomen; row less dense apicad, each pore 2.3 (2.3-2.3) in diam.

Multilocular pores (Fig. k) with 4, occasionally 5, incomplete rows consisting of 2 (0-2) pores in each row; and 4 complete rows anterior to genital opening, each row with 6 (5-7), 8 (8-9), 9 (8-10), and 8 (7-10) pores, respectively; each pore 10 loculi and 4.6 (4.6-4.6) in diam.

Setae (Fig. l) with 5 segmental rows around genital opening corresponding to 4 complete and 1 incomplete rows of multilocular pores, each with 2 setae, posterior row with 4 setae; each 5.5 (4.6-6.3) long; also submarginal row with 28 (22-34) setae, row less dense in cephalothoracic area, some setae in pairs, each 4.6 (3.4-5.7) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: NY; China.

Economic importance: The variable oak scale is of no economic importance.

Diagnosis: With 21-31 quinquelocular pores in each spiracular furrow; with one size of dorsal 8-shaped pores, about 2.3 long.

Affinities: Closely related to the other species of *Asterodiaspis*, especially to *As. luteola*.

Notes: *Asterodiaspis variabilis* is probably native to the Far East (China), and was brought into the U.S. with infested host plants. With the generic name change from *Asterolecanium* to *Asterodiaspis*, the grammatic gender also changed from neuter to feminine. Therefore, a name emendation is proposed for this species.

***Asterodiaspis variolosa* (Ratzeburg), 1870**

Common Name: Golden Oak Scale

Fig. 6

Coccus variolosus Ratzeburg, 1870:188. *Asterodiaspis variolosus* Boas, 1898:395.

Asterolecanium variolosum Cockerell, 1899:269, 1927:836; King, 1901:193, 1902:404; Newstead, 1903:156; Fernald, 1903:53; Leonardi, 1908:155, 1920:250; Sanders, 1909:431; Green, 1910:5, 1922b:19, 1928:8; Lindinger, 1912:13, 280, 360; 1935:130; Porter & Vayssière, 1914:49; Brain, 1920:110; Ferris, 1920:6, 13, 1955:26; Hollister, 1920:144; MacGillivray, 1921:189; Bodenheimer, 1924:75; Britton, 1924:170, 1926:228, 1928:206, 1938:141; Richter, 1928:189; Friend, 1930:617; Balachowsky, 1932:XXV; Gourlay, 1935:216; Sweetman, 1935:376; Herbert, 1936:38; Borchsenius, 1937a:68, 1937b:172, 179, 180, 183, 185, 1950b:136; Archangelskaya, 1937:59;

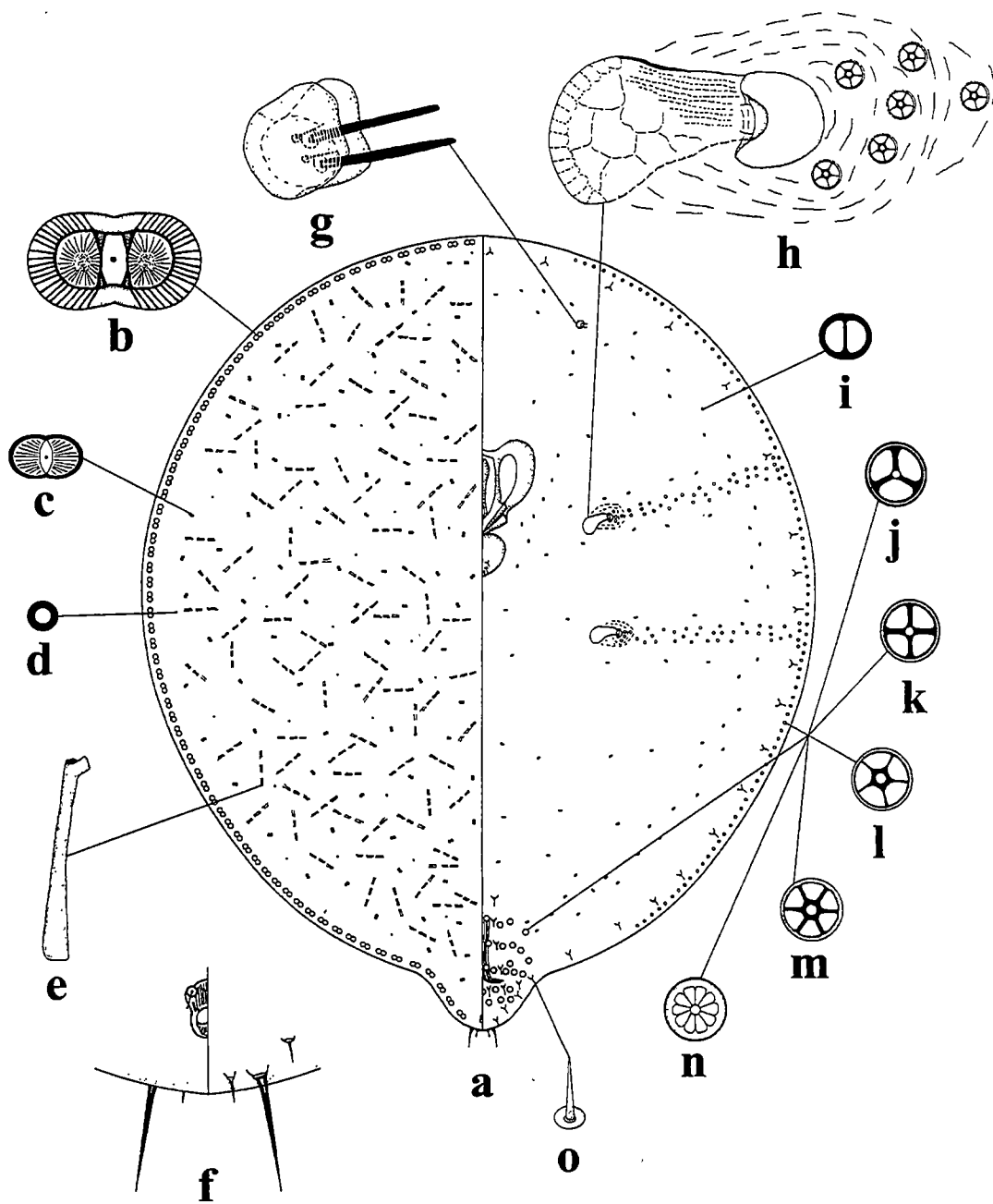


Fig. 6. *Asterodiaspis variolosa* (Ratzeburg), 1870.

Silvestri, 1939:687; Gomez-Menor, 1940:235; Parr, 1940:1; Russell, 1941:218; Kloet & Hincks, 1945:77; Pritchard & Beer, 1950a:494, 1950b:9; Schmutterer, 1952a:378, 1952b:563, 1952c:73, 75, 79, 80, 84, 93, 1953:65, 1972:421; Betts, 1955:295, 1956:69; Essig, 1958:301; Zak-Ogaza, 1958:146; Kosztarab, 1959:404; Wilson, 1960:39; Boratynski, 1961:4; Tshumakova, 1961:337; Della Beffa, 1961:262; DeBach, 1962:70; Brown & Eads, 1965:11; Gonzales & Rojas, 1966:138; D'Araujo e Silva et al., 1968:134; Herting, 1972:136; Okiwelu, 1977:615; Bartlett, 1978:47; Bognar & Vinis, 1979:16; Miller, 1985:105; Baxendale & Johnson, 1990:90; Gill, 1993:101. *Asterolecanium variolosum* var. *japonicum* Cockerell, 1900:71. *Asterodiaspis variolosum* Morley, 1910:94; Podsiadlo, 1972:389, 1974a:75, 1974b:487. *Asterolecanium variolosum* var. *minor* Sassi, 1911:63. *Asterilecanium variolosum* Lindinger, 1923:146. *Asterolecanium minus* Russell, 1941:132; Pritchard & Beer, 1950a:494, 1950b:9; Borchsenius, 1950b:136; Ferris, 1955:25; Kosztarab, 1959:404, 1977:184; Boratynski, 1961:4; Koehler & Tamaki, 1964:146; Brown & Eads, 1965:11; Herting, 1972:136; Schmutterer, 1972:420; Okiwelu, 1977:615; Bognar & Vinis, 1979:16; Miller, 1985:105; Hecht-Poinar et al., 1989:15; Gill, 1993:100; Watson et al., 1994:227. *Asterodiaspis minus* Bodenheimer, 1953:135; Borchsenius, 1960:178; Danzig, 1967:825; Podsiadlo, 1972:389, 1974a:75; Kosztarab & Kozar, 1978:138; Schmutterer, 1980:51. *Asterodiaspis variolosa* Borchsenius, 1960:178; Danzig, 1967:825; Podsiadlo, 1975a:347, 1975b:211, 1976a:69, 1976b:401, 1986a:255, 1986b:185, 1989:3, 1990a:363, 1990b:90, 1991:177; Koteja, 1974a:83; 1976:278; Koteja & Liniowska, 1976:675; Kosztarab & Kozar, 1978:139, 1988:317; Schmutterer, 1980:51; Tereznikova, 1981:89; C.I.E., 1983:1; Martin

Mateo, 1984:64; Kozar & Walter, 1985:80; Kozar et al., 1994:155; Pellizzari, 1994:32; Longo et al., 1995:124; Foldi & Lambdin, 1995:35; Foldi, 1995:266, 1997a:203; Kosztarab, 1996:297; Lagowska & Koteja, 1996:35. *Asterodiaspis variolosus* Andrianova, 1960:17. *Lecanium quercicola* incertae sedis Bouché, 1851:112; Lindinger, 1934:167. *Lecanide quercicola* Signoret, 1868:868. *Asterolecanium quercicola* Signoret, 1870:279; Douglas, 1885:160; Hagen, 1887:60; Maskell, 1887:92, 1894:95; Targioni-Tozzetti, 1892:299, 300; Green, 1895:231; Saccardo, 1895:49; Cockerell, 1895c:513, 1897a:327, 1899:269; King, 1899:112; Rübsaamen, 1902:316; Fernald, 1903:52; Leonardi, 1920:253; MacGillivray, 1921:189; Russell, 1941:173; Lindinger, 1943:207; Pritchard & Beer, 1950a:494, 1950b:9; Borchsenius, 1950b:136; Ferris, 1955:25; Sugonjaev, 1958:311, 313; Kosztarab, 1959:404; Boratynski, 1961:4; Della Beffa, 1961:263; Brown & Eads, 1965:11; Herting, 1972:136; Schmutterer, 1972:421, 1980:51; Miller, 1985:105; Kosztarab & Kozar, 1988; Gill, 1993:101; Van Rensburg et al., 1997:25. *Asterodiaspis quercicola* Comstock, 1881:330; Douglas, 1886:250; Packard, 1890:102; Sturgis, 1895:193; Newstead, 1895:85, 1897a:81, 1900:238, 1901:1; Lowe, 1897:586; Marlatt, 1899:75; Borchsenius, 1950c:781, 1960:174; Bodenheimer, 1953:135; Danzig, 1967:825; Podsiadlo, 1972:389, 1974a:75, 1974b:487, 1975a:347, 1975b:211, 1976b:401, 1986a:255, 1986b:185, 1989:3; Kosztarab & Kozar, 1978:139, 1988:314; Tereznikova, 1981:86; Kozar & Walter, 1985:80; Kozar et al., 1994:155. *Lecanium quercus* Altum, 1882:365. *Planchonia quercicola* Cockerell, 1893a:79; Maskell, 1895c:135, 1896:396; Craw, 1896:43. *Coccus quercicola* Judeich & Nitsche, 1895:1252.

Type material: No type material available.

Additional material studied: On *Quercus palustris*, 7(1), 6 adult ♀♀, 1 first instar, TN, Knox Co., coll., P. Lambdin, 27 V 1975 (UT); 10(3), 2 adult ♀♀, 8 first instars, New Zealand, 30 VI 1932 (UT); *Quercus palustris*, 43(4), 1 adult ♀, 6 second instar ♀♀, 36 first instars, TN: Knox Co., coll., P. Lambdin, 19 VI 1975 (UT); *Quercus alba*, 3(1), all adult ♀♀, TN: Sevier Co., coll., M. & M. Kosztarab, 6 VI 1976 (UT); *Quercus prinus*, 6(1), 5 adult ♀♀, 1 first instar, parasite, TN: Blount Co., coll., K. Watson, 17 VIII 1976 (UT); *Quercus prinus*, 5(1), all adult ♀♀, TN: Blount Co., coll., K. Watson, P. Lambdin, 9 IX 1976 (UT); *Quercus palustris*, 5(1), 3 adult ♀♀, 2 second instar ♀♀, TN: Knox Co., coll., K. Watson, 19 VIII 1977 (UT); *Quercus palustris*, 7(2), 4 adult ♀♀, 3 second instar ♀♀, TN, Knox Co., coll., K. Watson, 23 VII 1977 (UT); *Quercus palustris*, 3(1), 2 adult ♀♀, 1 second instar ♀, TN, Knox Co., coll., K. Watson, 30 VII 1977 (UT); *Quercus palustris*, 2(1), 1 adult ♀, 1 second instar ♀, TN, Knox Co., coll., K. Watson, 2 IX 1977 (UT); *Quercus palustris*, 5(2), all adult ♀♀, TN, Knox Co., coll., K. Watson, 15 IX 1977 (UT); *Quercus palustris*, 15(3), 14 adult ♀♀, 1 second instar ♀, TN, Knox Co., coll., K. Watson, 23 IX 1977 (UT); *Quercus palustris*, 13(2), 5 adult ♀♀, 8 second instar ♀♀, TN, Knox Co., coll., K. Watson, 26 X 1977 (UT); *Quercus palustris*, 2(1), 2 adult ♀♀, TN, Knox Co., coll., K. Watson, 24 IV 1978 (UT); *Quercus palustris*, 15(1), 3 adult ♀♀, 10 second instar ♀♀, 2 first instars, TN, Knox Co., coll., K. Watson, 6 VII 1978 (UT); *Quercus palustris*, 14(1), 5 adult ♀♀, 8 second instar ♀♀, 1 first instar, TN, Knox Co., coll., K. Watson, 3 VIII 1978 (UT); *Quercus palustris*, 9(1), 4 adult ♀♀, 5 second instar ♀♀, TN, Knox Co., coll., K. Watson, 21 VII 1978 (UT);

Quercus palustris, 19(1), 7 adult ♀♀, 11 second instar ♀♀, 1 first instar, TN, Knox Co., coll., K. Watson, 28 VII 1978 (UT); *Quercus palustris*, 9(1), 7 adult ♀♀, 2 second instar ♀♀, TN, Knox Co., coll., K. Watson, 31 VII 1978 (UT); *Quercus rubra*, 2(2), all adult ♀♀, VA, Augusta Co., Waynesboro Nursery, coll., A.B. Hamon, det., P.L. Lambdin, 5 IV 1973 (UT); 4(2), all adult ♀♀, VA, Blacksburg, V.P.I. golf course, coll., M. Kosztarab, 7 I 1972 (UT); *Quercus robur*, 37(8), 16 adult ♀♀, 21 first instars, Argentina, San Salvador de Jujuy, coll., E. Agostini, det., C. Stumpf, 9 XII 1994 (UT); *Encissa* sp., 19(6), 17 adult ♀♀, 2 first instars, Chile, Region, Cord., Coelemu, VIII, coll., J. Salgado, det., J. Artigas, 30 III 1956 (UT); *Quercus* sp., 1(1), adult ♀, CA, San Josa, Sta. Clara Co., coll., M. Lottle, 24 III 1967, calif. dept. agr. no. 67C28-10 (FSCA); *Quercus alba*, 1(1), adult ♀, NH, Plymouth, Gracton Co., coll., R.H. Hutchins, 11 VIII 1971 (USNM), no. 71-12455; *Quercus* sp., 2(1), all adult ♀♀, VPI Campus Lot 29/1, Blacksburg, VA, coll., R.C. Brachman, 20 V 1969 (USNM), nos. RB 40, Va 773; *Quercus montana*, 1(1), adult ♀, Sorry Co., NC, coll., A.H. Maxwell, det., M. Kosztarab, 26 VII 1965 (USNM), no. N.C. 17; *Quercus prinus*, 2(1), all adult ♀♀, Sleeping Giant State Park, Hamden Ct., CT, coll., M.S. McClure, det., A. Hamon 1 VI 1976, 18 XII 1975 (USNM), no. CT 004; *Quercus* sp., 3(1), all adult ♀♀, Stafford Co., VA, coll., J. Gray, 19 X 1988 (USNM), no. VA 1673; *Quercus alba*, 3(1), all adult ♀♀, Blacksburg, VA, VPI Plot 65 I/e, coll., M.L. Williams, det. M.L. Williams, 8 IV 1969 (USNM), nos. MW 09/c, VA 896; *Quercus alba*, 3(1), all adult ♀♀, Tazwell, VA, coll., J.W. Dick, det., M. Kosztarab, 14 VII 1967 (USNM), no. VA 500a; *Quercus alba*, 2(1), all adult ♀♀, Inghorn Co., MI, MSU campis, coll., M. Hanna, det., A. Hamon, 10 VIII 1974 (USNM); *Quercus* sp., 1(1), adult ♀,

V.P.I. Campus, Blacksburg, VA, Montgomery Co., Plot 65 II n. 051369, coll., D.K.

Pollet, det., D.K. Pollet, 13 V 1969 (USNM), nos. C-66, VA 726; *Quercus* sp., 3(1), all adult ♀♀, Brush Mt., Montgomery Co., colls., D.K. Pollet, M.L. Williams, det., D.K.

Pollet, 23 IV 1969 (USNM), nos. C-21, VA 685.

Additional hosts: Occurs on all available species of oaks; *Quercus agrifolia*, *Q. argenteo-marginata*, *Q. aurea*, *Q. bicolor*, *Q. castanaefolia*, *Q. cerris*, *Q. cerris pectinata*, *Q. coccifera*, *Q. concordia*, *Q. douglasii*, *Q. garryana*, *Q. glandulifera*, *Q. kelloggii*, *Q. lanuginosa*, *Q. lobata*, *Q. lusitanica*, *Q. pedunculata*, *Q. pedunculata thomasi*, *Q. petraea*, *Q. pontica*, *Q. prinus*, *Q. pubescens*, *Q. robur* var. *montrosa cucullata*, *Q. sessiliflora*, *Q. sessiliflora laciniata*, *Q. sessilis* var. *mespilifolia*, *Q. sideroxyla*, *Q. suber*, *Q. wislizenii* (Bodenheimer 1924; Della Beffa 1961; Fernald 1903; Ferris 1920, 1955; Gill 1993; Hecht-Poinar et al. 1989; Kosztarab 1959; Leonardi 1908, 1920; Okiwelu 1977; Russell 1941).

Description:

Body (Fig. a) subcircular, widest in spiracular area, 995 (660-1480) long, 853 (540-1100) wide, without anal indentation. Derm membranous with small 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Specimens of this species vary significantly in size and other characters depending upon the location on the host plant. These morphological forms were traditionally designated as different species, e.g., *Asterodiaspis minus*, *As. quercicola*, and *As. variolosa*, but were recently joined into one species, *As. variolosa*, based on extensive developmental studies by Podsiadlo (1990a, b).

Dorsal Surface

8-shaped pores on margin (Fig. b) form single row with 193 (146-312) pores that terminates shortly before apex of abdomen; each 9.5 (8.0-11.5) long, 5.5 (4.0-7.5) wide. Other pores (Fig. c) evenly distributed, only small pores present; each 3.4 (2.3-4.6) long, 2.1 (1.7-2.3) wide.

Simple disk pores (Fig. d) evenly distributed, with about 100 pores; each 1.9 (1.1-2.3) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 29.0 (19.5-40.2) long, 2.8 (2.3-3.4) wide.

Anal lobes (Fig. f) with 2 apical setae, 31.8 (23.0-36.8) long, 2 subapical setae, 6.0 (2.3-9.2) long, and 2 ventral setae, 5.6 (2.9-8.0) long.

Anal ring (Fig. f) heart-shaped, fused, 6.4 (5.7-6.9) long, 7.4 (5.2-10.3) wide; without pores; with one pair of slender setae, each 3.3 (1.7-4.6) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 124.4 (92.0-151.7), width 102.2 (73.6-148.3).

Labium (Fig. a) heart-shaped, 46.9 (35.6-58.6) long, 54.6 (42.5-60.9) wide; with 3 pairs of setae, each 2.5 (1.1-3.4) long.

Antennae (Fig. g) one-segmented, 10.3 (8.0-13.8) long, 9.5 (6.3-12.1) wide at base; with 2 fleshy setae 8.7 (6.9-10.3) long, and 2 (2-3) slender setae 1.7 (1.1-2.3) long.

Spiracles (Fig. h) located between median and margin; anterior 41.0 (34.5-48.3) long, 16.8 (13.8-20.7) wide, atrium 9.4 (6.9-11.5) in diam.; posterior 41.0 (35.6-49.4) long, 16.4 (13.2-19.5) wide, atrium 9.8 (6.9-13.2) in diam.; with 8 (7-10) quinquelocular

pores in folds around spiracles; anterior spiracular furrows with a band of 47 (32-80) quinquelocular pores, 3 (1-5) pores wide; posterior furrows with a band of 55 (36-80) quinquelocular pores, 3 (1-6) pores wide.

8-shaped pores (Fig. i) in submarginal band with 147 (100-200) pores; dark-rimmed pores in transverse bands with 100 (80-150) pores over venter and a row of 5 (2-7) pores on each side of mouthparts, each 2.7 (2.3-3.4) long, 1.8 (1.1-2.3) wide.

Marginal trilocular, quatlrolocular, quinquelocular, and multilocular pores (Figs. j, k, l, m, n) in spiracular furrows and in marginal row consisting of 215 (146-312) pores; row ends 21 (11-38) 8-shaped pore lengths before apex of abdomen and is interrupted for 20 (0-36) 8-shaped pore lengths anteriad; with 0-3 pores between margin and antennae; pores mostly quinquelocular, but single pores may have between 3 and 10 loculi, each 3.0 (2.3-4.0) in diam.

Segmental multilocular pores (Figs. j, k, l, m, n) in rows around genital opening; dependent upon the position on the host plant, specimens possess either 3-4 complete rows or 5-6 complete bands and 1 incomplete row; complete bands with 4 (0-12), 5 (0-15), 5 (0-12), 6 (1-14), 7 (2-14), and 5 (2-11) pores, respectively; sometimes with incomplete row with 3-5 pores; each with either 5 (3-6) or 10 (8-11) loculi and 5.1 (3.4-6.9) in diam.

Setae (Fig. o) with 5 segmental rows around genital opening corresponding to the complete rows of multilocular pores, with 2 (0-2), 2 (2-4), 2 (0-2), 4 (2-4), and 4 (0-6) setae, respectively; occasionally 1 or 2 more rows with 2 setae each present anteriad of

complete rows; each seta 5.7 (3.4-8.0) long; also complete submarginal row with about 40 tack-like setae, each 4.5 (2.9-6.9) long.

Biological data: Parthenogenetic, with one generation per year, but crawlers are produced throughout the growing season in California (Brown & Eads 1965, Okiwelu 1977). In the eastern U.S., females are present from August, overwinter, and lay eggs from late spring to early summer (Miller 1985). Podsiadlo (1975a) found similar results for Poland. The production of 86-176 eggs/female with an average of 141 eggs (Schmutterer 1952b, 1972) was reported from Germany, whereas Okiwelu (1977) found between 4 and 28 eggs/female under different temperature and relative humidity regimes in the laboratory. Podsiadlo (1975a) found an average of 41 eggs/female in June in Poland. As early as 1928, Richter studied the symbionts of this species in Germany. Additional studies on biology can be found in Parr (1940), Boratynski (1961), Koehler & Tamaki 1964, and Podsiadlo (1974a, b, 1976a, 1991).

Parasitoids and predators: Morley (1910) reported the parasitoid *Habrolepis dalmani* Westw. (Encyrtidae) from Europe and America. Gourlay (1935) and Sweetman (1935) documented the introduction of *H. dalmani* to New Zealand. This species was also introduced to Tasmania, Australia, and Chile, and is present in the U.S. (Bartlett 1978, Wilson 1960). Silvestri (1939), Zak-Ogaza (1958), Della Beffa (1961), and Gonzales & Rojas (1966) mentioned *H. dalmani*, Schmutterer (1953, 1972) reported *Habrolepis zetterstedti* (Westw.) (Encyrtidae), *H. dalmani*, *Metaphycus asterolecanii* (Mercet) (Encyrtidae), *Euaphycus* sp. (Encyrtidae), and *Microterys chalcostomus* (Dalm.) (Encyrtidae), and Sugonjaev (1958) listed *H. dalmani* and *M. asterolecanii* as parasitoids

of *As. variolosa*. Kosztarab (1959) reported *Aphycus intermedius* Mercet (Encyrtidae), *Habrolepis pascuorum* Mercet (Encyrtidae), and *H. dalmani* from Hungary. Schmutterer (1952c) reported the Heteropteran predators *Pilophorus perplexus* Dgl. Sc. and *Camptobrochis luteceus* Schill. from Germany. Tshumakova (1961) documented the encyrtid and aphelinid parasitoids *H. dalmani*, *M. asterolecanii*, *Microterys sylvius* Dalm., *Blastotrix ilicicola* (Dalm.), *Cheiloneurus claviger* Thoms, *Aspidiotiphagus citrinus* (Crawf.), *Comperiella bifasciata* How., *Coccidencyrtus dissimilis* Tshumakova, *Pteroptrix longicornis* Nik, *P. dimidiata* Westw., *P. maritima* Nik, *Hispaniella lauri* Merc., *Prospaltella gigas* Tshumakova, *P. perniciosi* Tow., and *Aphytis mytilaspidis* Le Baron from Russia. Herting (1972) listed *Deraecoris lutescens* Schilling and *Pilophorus perplexus* Douglas & Scott as mirid predators, *Chilocorus bipustulatus* L. and *Exochomus quadripustulatus* L. as coccinellid predators, *Brachytarsus nebulosus* Forster as anthribid predator, *Megastigmus* sp. as torymid parasitoid, *Apterencyrtus microphagus* Mayr, *H. zetterstedti*, *A. intermedius*, *Euaphycus variolosus* Alam, *H. dalmani*, *H. pascuorum* Mercet, *M. asterolecanii*, *M. punctipes* Dalman, and *Psyllaephagus cocci* Alam as encyrtid parasitoids, *Aphytis* sp., *A. mytilaspidis*, *Azotus* sp., and *A. chionaspidis* Howard as aphelinid parasitoids, *Oligosita* sp. as trichogrammatid parasitoid, and *Anaphes* sp. as mymarid parasitoid. Podsiadlo (1986a, b) performed studies on *H. dalmani* and *M. asterolecanii* and later (Podsiadlo 1991) compared the life-cycles of these two species with that of the host, *As. variolosa*. Kosztarab & Kozar (1988) listed *Habrolepis italicus* (Encyrtidae) as additional parasitoid. Predacious mites (Podsiadlo 1975a, 1986a) and thrips (Pritchard & Beer 1950a) also attack the golden oak scale. In Britain, blue tits,

Cyanistes caeruleus (L.), coal tits, *Periparus ater* (L.), marsh tits, *Poecile palustris* (L.), and long-tailed tits, *Aegithalos caudatus* (L.) were observed to feed on this species (Newstead 1895, 1897a, 1900, 1901; Silvestri 1939; Betts 1955, 1956).

Distribution: CA, CT, D.C., FL, IL, IN, MA, MD, ME, MI, MO, NC, NH, NJ, NY, OH, OR, PA, RI, TN, VA, VT, WI, WV; Argentina, Brazil, Chile, Jamaica; Canada: Ontario, British Colombia, Quebec; Algeria, Australia, Canary Islands, Israel, Japan, Kazakhstan, Lebanon, Madeira, Morocco, New Zealand, Russia, South Africa, Tazmania, Ukraine, Usbekistan; found everywhere in Europe, generally widespread worldwide where oaks grow.

Economic importance: Can cause severe damage to host trees by killing terminal growth, branches, and even smaller trees, while large trees may be seriously weakened (Gill 1993; Kosztarab 1996; Parr 1940; Pritchard & Beer 1950a, b; Russell 1941). In addition, the scale has been associated with twig blight of oaks in California and the associated fungi *Cryptocline cinerescens*, *Diplodia quercina*, and *Discula quercina* (Gill 1993, Hecht-Poinar et al. 1989). However, the species seems to be maintained by parasitoids in most areas.

Diagnosis: Apical setae not on separate lobes, 23-37 long; with 32-80 quinquelocular pores in each spiracular furrow.

Affinities: All *Asterodiaspis* species are closely related to each other as well as to the species of *Neoasterodiaspis*. Podsiadlo (1990a, 1990b, 1991) showed the great morphological variability of the parthenogenetically reproducing species, *As. variolosa*. Liu & Shi (1990, 1993) report dimorphism in *As. variabile* (Russell), *As. alba*

(Takahashi), *As. biformis* Liu & Shi, *As. glandulifera* Liu & Shi, *As. multipora* Liu & Shi, and *As. polypora* Liu & Shi. The leaf form exhibits 3 different forms of marginal 8-shaped pores, one of which looks exactly like the 8-shaped pores in *Neoasterodiaspis*. Future research may also show the species *Asterodiaspis ilicicola* (Targioni-Tozzetti) to be the leaf-form of *As. variolosa*.

Notes: Introduced from Europe to wherever species of oaks grow.

Genus *Asterolecanium* Targioni-Tozzetti, 1868

Asterolecanium Targioni-Tozzetti, 1868:734; Signoret, 1869:101, 1870:276, 1876b:643; Cockerell, 1893a:77, 1893b:8, 1893c:255, 1893d:373, 1896:8, 1897a:327, 1902b:251; Urich, 1893:196; Fernald, 1903:49; Newstead, 1903:150; Sanders, 1906:3; Leonardi, 1908:154, 1920:238; Green, 1909:311; Lindinger, 1912:44, 1937:180; Brain, 1920:108; MacGillivray, 1921:189; Morrison & Morrison, 1928:3, 1966:19; Takahashi, 1928:339, 1930:10, 1933:34, 1936:116, 1941:217, 1942:353, 1956:4; Balachowsky, 1932:XXIV; Wolcott, 1936:122, 1941:57; Archangelskaya, 1937:58; Borchsenius, 1937a:66, 1937b:169, 1950b:132, 1950c:781, 1960:157, 1961:65; Gomez-Menor, 1940:232; Russell, 1941:4; Zimmerman, 1948:277; Bodenheimer, 1951:328; Schmutterer, 1952b:562, 1972:420; Ferris, 1955:15; Kosztarab, 1959:404; Beardsley, 1966:497; Danzig, 1967:825; Tranfaglia, 1974:54; Miller, 1985:105, 1996:69; Kozar & Walter, 1985:80; Williams & Watson, 1990:192; Gill, 1993:98; Longo et al., 1995:125; Stumpf & Lambdin, 1998:35.

Type species: *Coccus aureus* Boisduval, 1868c:301, by monotypy.

Planchonia Maskell, 1895b:61, 1895c:134. *Asterilecanium* Lindinger, 1924:174.

Asterodiaspis Kosztarab, 1996:287

Generic description:

Dorsum: With marginal row or band of 8-shaped pores, bent, rarely flat; minute 8-shaped pores present in most species, absent in some; with simple disk pores over much of dorsum and in submarginal row, this row may shift to the venter in some species; tubular ducts without terminal filament, anal ring with 6 setae; with arched plates and 2 anal plates on anal lobes, plates sometimes fused; anal lobes only weakly developed, with small anal indentation. Venter: With one-segmented antennae, 8-shaped pores near mouthparts, in transverse rows, mainly on abdomen, and in marginal row, occasionally with large 8-shaped pores similar to dorsal pores in marginal band; legs absent, quinquelocular pores in spiracular furrows and marginal row, in some species also a few trilocular, quaterolocular, 6-locular, or 7-locular pores present; multilocular pores in abdominal rows, often extending to thoracal region.

Diagnosis: Paraphyletic genus, therefore, without unique characters. With 6 anal ring setae; in the New World present only with native species on native plants; no economic importance.

Hosts: All species of *Asterolecanium* in the New World are native species. The members of this genus can be found in various habitats on a variety of host plants including palms, orchids, agaves, and Compositae.

***Asterolecanium agavis* Russell, 1941**

Proposed Common Name: Agave Pit Scale

Fig. 7

Asterolecanium agavis Russell, 1941:40; Ferris, 1955:18; Gill, 1993:98.

Type material: On *Yucca*, 8(1), paratypes, 2 adult ♀♀, 2 adult ♂♂, each encircled, 2 fourth instar ♂♂, 2 first instars, TX: Franklin Mts., coll., W. Perrine, 27 II 1926 (USNM).

Additional material studied: On *Yucca*, 5(1), all adult ♀♀, Mexico: at Nogales, coll., Callaghan, Zuck, Furr, 13 II 1952 (USNM), no. 72D22 and 52576; *Agave*, 6(1), all adult ♀♀, Mexico: Huasteca Cannon, coll., W.K. Clore, no. 19, 17 III 1953 (USNM), no. 53689.

Additional hosts: *Agave lecheguilla*, *A. palmeri*, *Yucca brevifolia* (Ferris 1955, Gill 1993, Russell 1941).

Description:

Body (Fig. a) subcircular, variable in appearance, widest in spiracular area; 1270 (940-1860) long, 1182 (720-1760) wide, with anal indentation. Derm membranous with large and small 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin in single row that terminates 2-3 pore lengths before apex of abdomen; row with 195 (174-226) pores; pores bent, each 11.3 (9.8-12.6) long and 7.0 (6.3-8.0) wide.

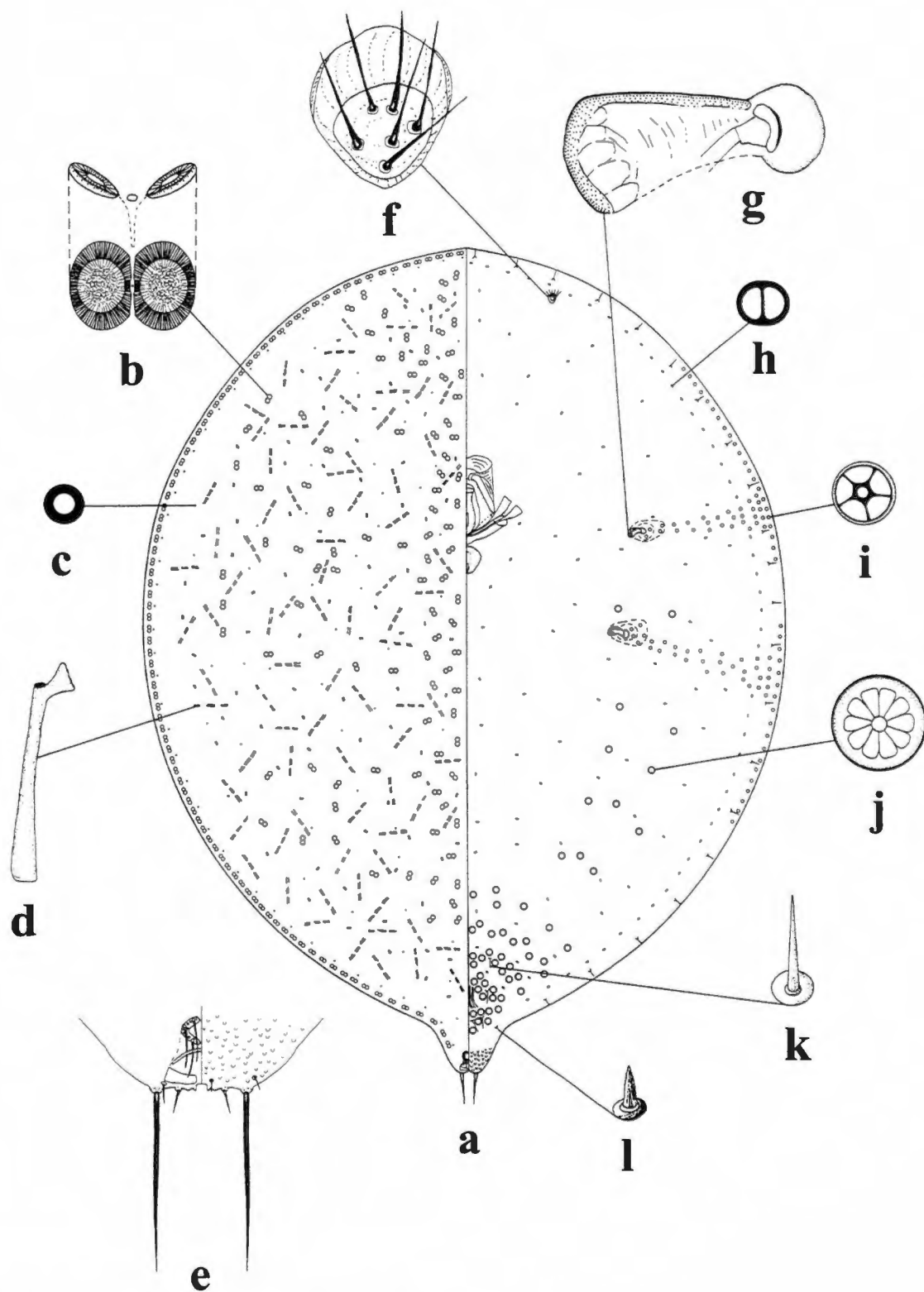


Fig. 7. *Asterolecanium agavis* Russell, 1941.

Other pores in 2-3 sizes, the number of pores may vary considerably; larger and occasional medial pores either more than 100, arranged in a medial band splitting into three arms anteriad and several submedial and submarginal swirls, or in a small medial band ranging from the anterior end to the area opposite to the mouthparts with only a few pores; smaller pores arranged evenly, without minute pores; all pores bent; larger pores 12.8 (11.5-13.8) long, 7.9 (6.9-8.6) wide; medial pores 9.2 (8.0-11.5) long, 5.9 (5.2-6.9) wide; and smaller pores 3.7 (3.4-4.6) long and 2.2 (1.7-2.3) wide.

Simple disk pores (Fig. c) in submarginal row close to marginal 8-shaped pores, consisting of 86 (68-110) pores; also evenly distributed over dorsum, with 97 (54-160) pores, each 1.5 (1.1-2.3) in diam.

Tubular ducts (Fig. d) numerous throughout derm, each 29.1 (25.3-32.2) long, 3.5 (2.9-4.0) wide.

Anal lobes (Fig. e) with indentation, sclerotized ventrally; each lobe with one apical seta, 91.7 (85.1-97.7) long, one subapical seta 13.9 (12.6-15.5) long, one dorsal seta 8.8 (6.9-10.9) long, one medial ventral seta 5.7 (3.4-8.6) long, and one outer ventral seta 7.4 (5.2-9.2) long.

Arched plate (Fig. e) 35.4 (32.2-39.1) long.

Anal plates (Fig. e) separated, rectangular, 20.2 (17.2-23.0) long, 11.3 (6.9-14.4) wide.

Anal ring (Fig. e) located anteriad of arched plate, divided medially, with 6 setae and 2 rows of pores; anal ring connected to anal plates through slightly sclerotized

membrane, anal ring 18.5 (13.8-24.1) long, 22.8 (19.5-28.7) wide; inner pore row with 6, outer with 14 pores; each seta 28.5 (23.0-34.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 146.9 (129.9-172.4), width 118.1 (103.4-132.2).

Labium (Fig. a) heart-shaped, 59.7 (49.4-74.7) long, 68.5 (55.2-80.5) wide; with 2 (1-3) pairs of setae, each 2.7 (2.3-2.9) long.

Antennae (Fig. f) one-segmented, with convex base, surrounded by membranous folds, 19.6 (13.8-27.6) long, 18.4 (13.8-21.8) wide at base; with 6 (2-8) fleshy setae 14.8 (11.5-23.0) long, and occasionally 2-4 slender setae 6.3 (5.7-6.9) long.

Spiracles (Fig. g) located between median and margin; anterior 39.8 (36.8-44.8) long, 16.6 (12.6-20.7) wide, atrium 9.7 (6.9-13.8) in diam.; posterior 44.8 (40.2-50.6) long, 16.9 (14.9-18.4) wide, atrium 9.7 (6.9-12.6) in diam; with 3-5 quinquelocular pores in folds around spiracles; anterior spiracular furrows with a band of 31 (23-40) quinquelocular pores, 2 (1-6) pores wide; posterior furrows with a band of 30 (22-36) quinquelocular pores, 2 (1-5) pores wide.

8-shaped pores (Fig. h) in a submarginal row with 91 (74-100) pores; dark-rimmed pores in transverse rows with 150 (112-226) pores, and a row of 3 (1-4) pores on each side of mouthparts; each 2.9 (2.3-3.4) long, 2.1 (1.7-2.3) wide.

Quinquelocular pores (Fig. i) in incomplete marginal row consisting of 79 (58-172) pores, number of pores may vary considerably, row may or may not be interrupted between spiracular furrows, row ends 31 (6-42) 8-shaped pore lengths before apex of

abdomen, and is interrupted for 43 (19-52) 8-shaped pore lengths anteriad; occasionally with a single pore between margin and antennae, each 3.3 (2.9-3.4) in diam.

Multilocular pores (Fig. j) with 5 (5-8) incomplete rows consisting of 4 (2-6), 4 (0-6), 4 (2-10), 6 (4-12), and 6 (2-12) pores, respectively; and with 5 (4-6) complete bands anterior to genital opening with 12 (4-18), 18 (12-22), 21 (15-24), 16 (11-22), and 14 (9-24) pores, respectively; sometimes with 2 additional rows anteriad and 1 row anteriad of metathoracic spiracles with 2-6 pores each; each 10 (10-12) loculi, 5.4 (4.6-5.7) in diam.

Setae with 3 segmental rows (Fig. k) corresponding to 3 complete bands of multilocular pores with 2 (0-2), 2 (2-4), and 4 (2-6) setae, respectively; each seta 6.4 (4.6-8.0) long; also submarginal row (Fig. l) with 38 (24-48) setae, each 4.6 (2.9-5.7) long.

Biological data: No biological data known.

Parasitoids and predators: No data available.

Distribution: AZ, CA, TX; Mexico.

Economic importance: No reports published.

Diagnosis: Marginal 8-shaped pores in single row; on *Agave* and *Yucca*.

Affinities: This species appears to be closely related to *Al. grandiculum*, which can also be found on species of *Agave* and *Yucca* in the same geographical area.

***Asterolecanium cristatum* Ferris, 1921**

Proposed Common Name: Ferris' Pit Scale

Fig. 8

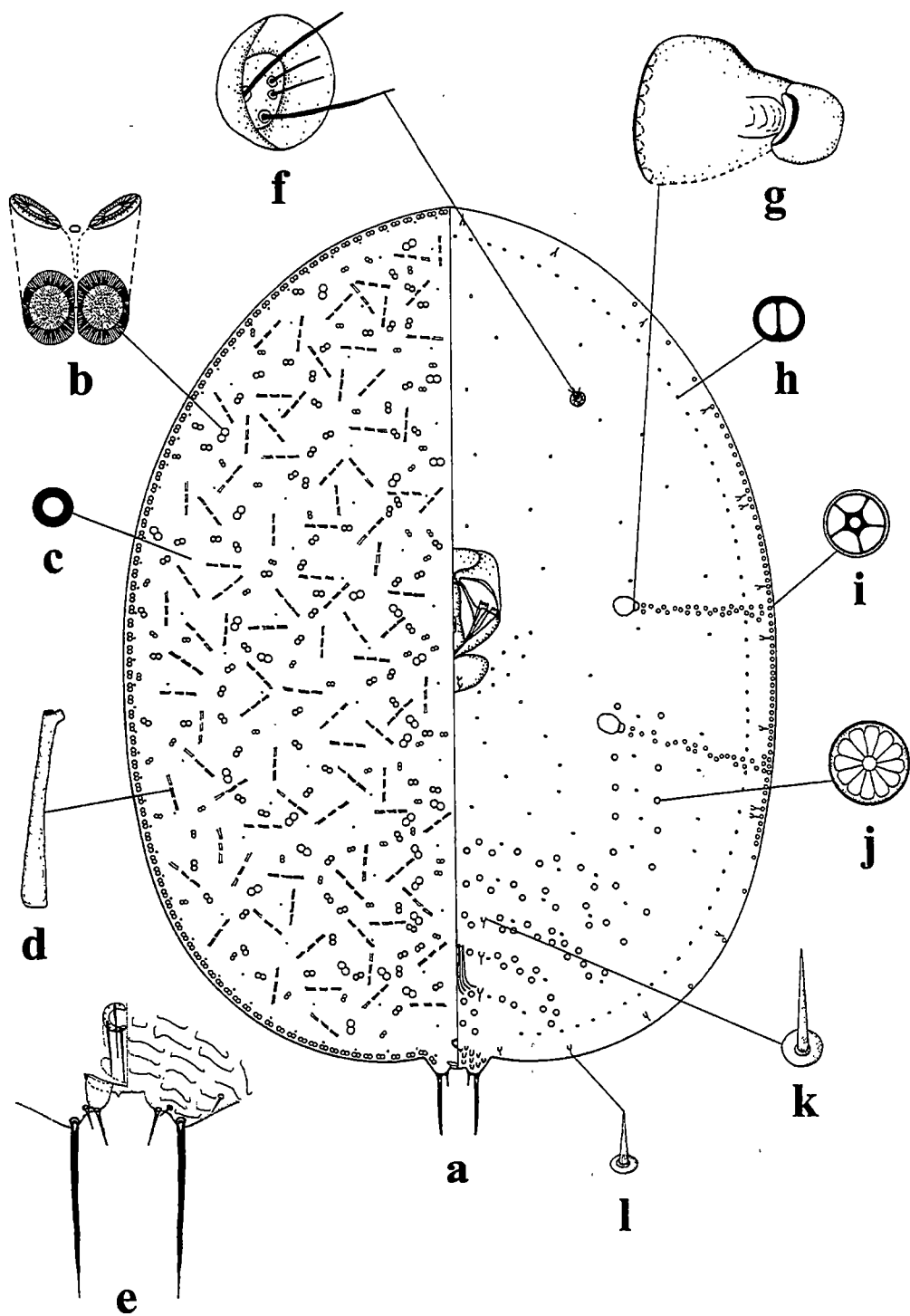


Fig. 8. *Asterolecanium cristatum* Ferris, 1921.

Asterolecanium cristatum Ferris, 1921:73, 1955:18; Russell, 1941:74; Borchsenius, 1960:158; Miller, 1996:69.

Type material: On *Jatropha canescens*, 7(1), paratypes, 1 adult ♀, 6 first instars, San Antonio, Dist. Sur, L. Calif., coll., G.F. Ferris, 1919 (USNM), no. 38-1621; *Tapirries edulis*, 3(1), paratypes, all adult ♀♀, San Bartolo, Dist. Sur, Baja Calif., coll., G.F. Ferris, Entomological Laboratory Stanford University, VII 1919 (USNM).

Additional hosts: *Celosia floribunda*, *Encelia palmeri*, *Heteromeles arbutifolia*, *Solanum hindnanian* (Ferris 1921, 1955; Russell 1941).

Description:

Body (Fig. a) subcircular, widest in spiracular area, 1008 (900-1050) long, 865 (720-980) wide, with anal indentation; derm membranous, with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) bent, with 185 (174-191) pores on margin in single row that terminates 1-2 pore lengths before apex of abdomen; each 10.9 (10.3-11.5) long, 6.6 (6.3-6.9) wide. Other pores arranged in swirls covering whole dorsum, differing continuously in size rather than in distinct sizes; however, 3 size classes measured; all pores bent, largest pores 18.2 (17.2-19.5) long, 12.3 (11.5-12.6) wide, medial pores 14.2 (13.8-14.9) long, 9.1 (8.6-9.2) wide; and smallest pores 10.3 (9.2-11.5) long, 7.0 (6.3-8.0) wide; without minute 8-shaped pores.

Simple disk pores (Fig. c) evenly distributed over dorsum, consisting of about 100 pores; also marginal row with 92 (74-110) pores, each 1.7 in diam.

Tubular ducts (Fig. d) evenly distributed, each 30.9 (29.9-32.2) long, 3.7 (3.4-4.0) wide.

Anal lobes (Fig. e) with anal indentation, sclerotized ventrally; each lobe with one apical seta, 96.6 (92.0-100.0) long, one subapical seta 14.1 (10.3-17.2) long, one dorsal seta 10.4 (9.2-11.5) long, one medial ventral seta 5.7 long, and one outer ventral seta 8.3 (8.0-8.6) long.

Arched plate (Fig. e) with seta-like projections, 37.6 (34.5-40.2) long.

Anal plates (Fig. e) cone-shaped, separated; each plate 16.4 (11.5-19.5) long, 18.7 (14.4-23.0) wide.

Anal ring (Fig. e) located anterior of anal plates, divided medially, covered by a thin membrane, and 2 rows of pores; number of pores in rows not determinable (illustration shows inner row with 6 and outer with 18 pores, similar to closely related *Al. viridulum*); anal ring length not measurable, width 18.8 (17.2-20.7); with 6 setae, each 36.2 (34.5-39.1) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 146.8 (137.9-157.5), width 117.2 (110.3-132.2).

Labium (Fig. a) heart-shaped, 35.6 (33.3-37.9) long, 67.3 (54.0-80.5) wide; with 2 pairs of setae, each 4.6 long.

Antennae (Fig. f) one-segmented, strongly indented, 20.1 (18.4-23.0) long, 22.4 (20.7-25.3) wide at base; with 2 fleshy setae, about 12.6 long, and 2 slender setae, about 4.6 long.

Spiracles (Fig. g) located between medial and marginal area; anterior 41.4 (40.2-43.7) long, 18.4 (16.7-21.8) wide, atrium 9.5 (9.2-10.3) in diam.; posterior 42.8 (41.4-44.8) long, 18.0 (13.8-20.7) wide, atrium 9.6 (9.2-10.3) in diam; anterior spiracular furrows with a band of 27 (24-31) quinquelocular pores, 2 (1-3) pores wide; posterior furrows with a band of 25 (24-26) quinquelocular pores, 2 (1-3) pores wide.

8-shaped pores (Fig. h) in submarginal row with ca. 125 pores; each 3.2 (2.9-3.4) long, 2.5 (2.3-2.9) wide; about 110 dark-rimmed pores in transverse rows over whole venter, and with 8 (7-10) pores in bands on each side of mouthparts; each 3.0 (2.9-3.4) long, 2.5 (2.3-2.9) wide.

Quinquelocular pores (Fig. i) in spiracular furrows and in a marginal row consisting of 134 (122-146) pores; row ends 26 (24-27) 8-shaped pore lengths before apex of abdomen; row less dense apically and anteriorly, interrupted for 29 (28-31) 8-shaped pore lengths anteriorly, each 3.6 (3.4-4.0) in diam.

Multilocular pores (Fig. j) with 5 incomplete rows with 4, 4 (0-6), 4 (2-6), 4 (2-4), and 4 (2-4) pores, respectively; and 5 complete bands anteriorly of genital opening with 19 (18-20), 21, 29 (28-30), 21 (20-22), and 14 (13-14) pores, respectively; each 12 (10-12) loculi, 4.8 (4.6-5.2) in diam.

Setae in 3 segmental rows (Fig. k) anteriorly of genital opening corresponding to 3 bands of multilocular pores; each with 2 setae each 8.6 (6.9-10.9) long, setae in posterior row a little longer than those in the other 2 rows; also submarginal row with about 30 tack-like setae (Fig. l), some setae in pairs, each 4.8 (4.6-5.2) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: Anal plates trapezoid-shaped, tentorial sclerotization present (Fig. 3), with single row of marginal 8-shaped pores.

Affinities: May be closely related to *Al. viridulum*.

Asterolecanium dorsisetosum, n.sp.

Proposed Common Name: Arthrostylidium Pit Scale

Fig. 9

Asterolecanium dorsisetosum, n.sp.

Type material: On "otate", *Arthrostylidium longifolium* Wild., 4(1), holotype circled, adult ♀, 3 paratypes, all adult ♀♀, Los Arboles, 24 km S. of Autlan, Jalisco, Mexico, coll., F.H. McClure, 31 VII 1943 (USNM), no. 2.

Description:

Body (Fig. a) oval, widest in metathoracic area, 3375 (3100-3600) long, 2495 (2300-2700) wide, with very small anal indentation. Derm membranous with large, medium, and small 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin in single row with 341 (298-378) pores; row becomes less dense in posterior abdominal area and terminates about 5 pore lengths before apex of abdomen; all pores bent, each 17.1 (16.7-17.2) long and 9.2 (8.6-9.8) wide.

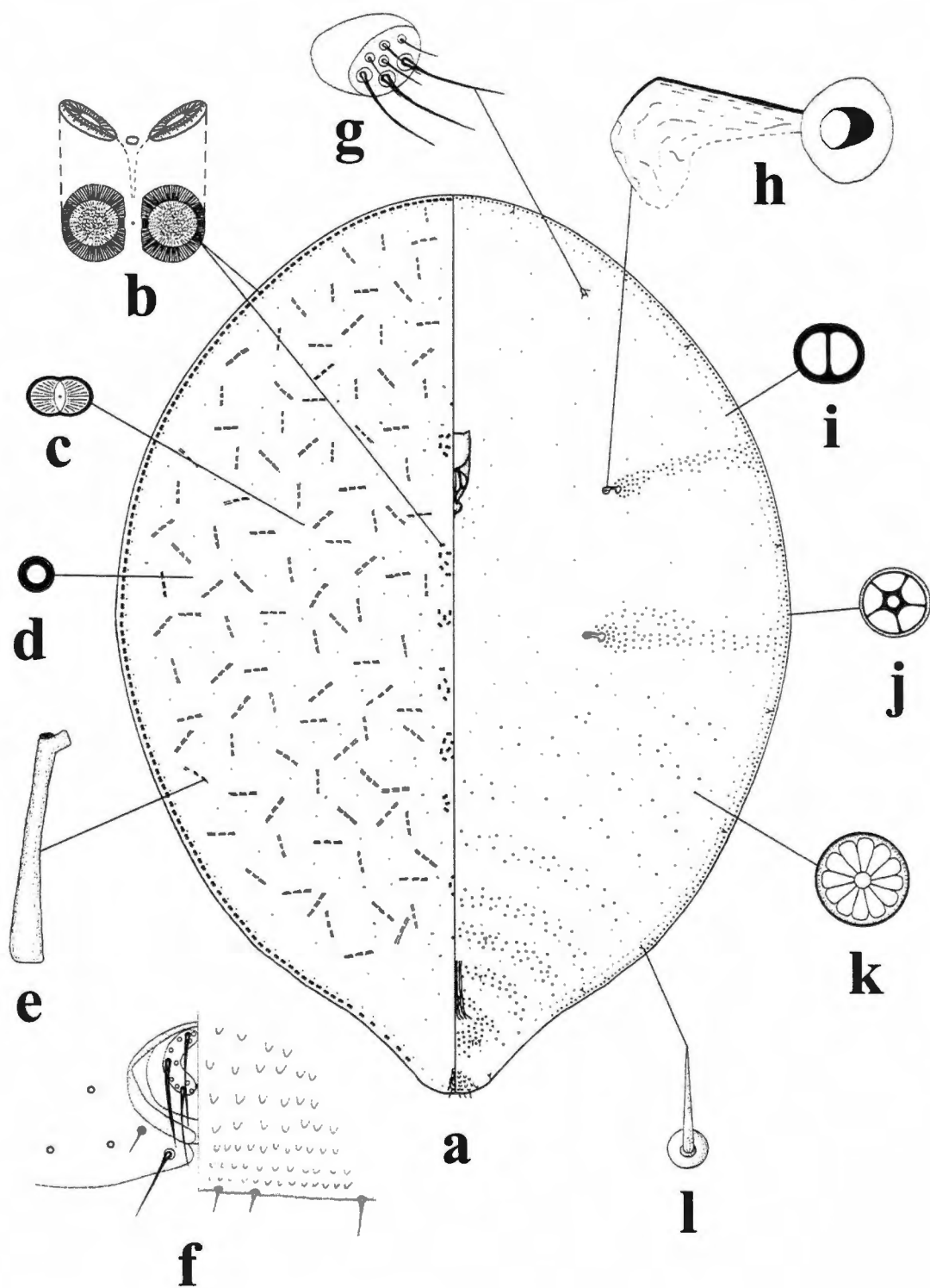


Fig. 9. *Asterolecanium dorsisetosum*, n.sp.

Other pores with 7-8 swirls of large and medial pores in median row, and a few minute pores (Fig. c) around swirls; large pores 17.7 (17.2-18.4) long, 9.8 (9.2-10.3) wide; medial bent pores 14.1 (13.8-14.9) long, 8.5 (8.0-8.6) wide; minute pores 2.7 (2.3-3.4) long, 1.7 (1.7-1.7) wide.

Simple disk pores (Fig. d) irregularly distributed throughout derm, consisting of about 300 pores; also submarginal row with 245 (220-320) pores, each 1.9 (1.7-2.3) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 31.0 (28.7-32.2) long, 3.4 wide.

Anal lobes (Fig. f) with very small anal indentation, sclerotized ventrally; each anal lobe with one apical seta, pointing dorsad, 8.9 (5.7-12.6) long, one dorsal seta 5.6 (4.6-6.3) long, one inner ventral seta 5.7 long, one medial ventral seta 4.0 (3.4-5.7) long, and one outer ventral seta 6.3 (4.0-8.6) long.

Anal plates (Fig. f) fused and connected to arched plate, 41.4 (39.1-42.5) wide.

Arched plate (Fig. f) connected to anal plates, together they form ring-like structure through which anal ring setae project, with same width as anal plates.

Anal ring (Fig. f) divided medially, anal ring 22.1 (19.5-26.4) long, 23.1 (21.8-24.1) wide, with 2 rows of pores, inner with 6 pores and outer row with 14 pores; with 6 setae, each 37.9 (34.5-41.4) long.

Ventral Surface

Clypeolabral shield (Fig. a) with a small spur on each antero-lateral edge; 225.0 (206.9-241.4) long, 142.8 (137.9-152.9) wide.

Labium (Fig. a) heart-shaped, 33.0 (31.0-35.6) long, 46.0 (34.5-59.8) wide; with 1 pair of setae 8.6 (8.0-9.2) long.

Antennae (Fig. g) one-segmented, conical, 19.5 (17.2-20.7) long, 15.4 (12.8-17.2) wide at base; with 3 (2-3) fleshy setae 15.7 (13.8-19.5) long, and 4 (4-5) slender setae 8.0 (5.7-11.5) long.

Spiracles (Fig. h) located between medial and marginal area; anterior 62.1 (57.5-64.4) long, 28.7 (26.4-31.0) wide, atrium 14.1 (11.5-16.1) in diam.; posterior 63.5 (58.6-67.8) long, 32.2 (29.9-34.5) wide, atrium 14.4 (13.8-14.9) in diam.; with 41 (30-45) quinquelocular pores around atria; anterior spiracular furrows with a band of 139 (120-164) quinquelocular pores, 3 (1-8) pores wide; posterior furrows with a band of 164 (140-185) quinquelocular pores, 4 (1-9) pores wide.

8-shaped pores (Fig. i) in a submarginal row (partial band) with 290 (246-328) pores, each 2.9 (2.9-2.9) long and 2.5 (2.3-2.9) wide; ca. 350 slightly more sclerotized pores in transverse bands over whole venter; also forms incomplete second submarginal row and band with 11 (9-12) pores on each side of mouthparts, each 2.5 (2.3-2.9) long, 2.2 (1.7-2.3) wide.

Quinquelocular pores (Fig. j) in marginal row (sometimes band) consisting of 791 (706-872) pores; row ends 6 (2-11) 8-shaped pore lengths before apex of abdomen; with 3 (2-4) quinquelocular pores between marginal row and each antenna, each 3.0 (2.9-3.4) in diam.

Multilocular pores (Fig. k) with 3-4 incomplete bands anterior of genital opening consisting of 12 (0-20), 24 (10-50), and 22 (20-26) pores, respectively; and 6-7

complete bands with 22 (20-25), 45 (30-60), 55 (40-60), 88 (80-100), 93 (70-100), 77 (60-90), and 69 (60-80) pores, respectively; each 12 loculi, 4.6 in diam.

Setae (Fig. 1) with 3 segmental rows anterior of genital opening corresponding to 3 complete bands of multilocular pores, each with 2 setae, posterior row with 4 setae, occasionally also fourth row with 2 setae; each seta 8.0 (6.3-9.8) long; also, submarginal row with 16 (12-22) setae, each 6.8 (6.3-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: Apical setae 5-13 long; clypeolabral shield with small spur on tentorial sclerotization; on *Arthrostylidium*.

Affinities: The relation of *Al. dorsisetosum* to other species in the genus *Asterolecanium* is not clear. Like the other new species, it was not used in the analysis, because of the general lack of morphological characters in adult female pit scales.

Etymology: This species is named for the apical setae projecting dorsad.

Asterolecanium epidendri (Bouché), 1844

Proposed Common Name: Orchid Pit Scale

Fig. 10

Lecanium epidendri Bouché, 1844:300, 1851:112; Signoret, 1868:852, 1876b:614.

Chermes epidendri Boisduval, 1868a:95, 1868b:281. *Coccus aureus* Boisduval, 1868c:301. *Asterolecanium aureum* Targioni-Tozzetti, 1868:734, 1892:304, 311;

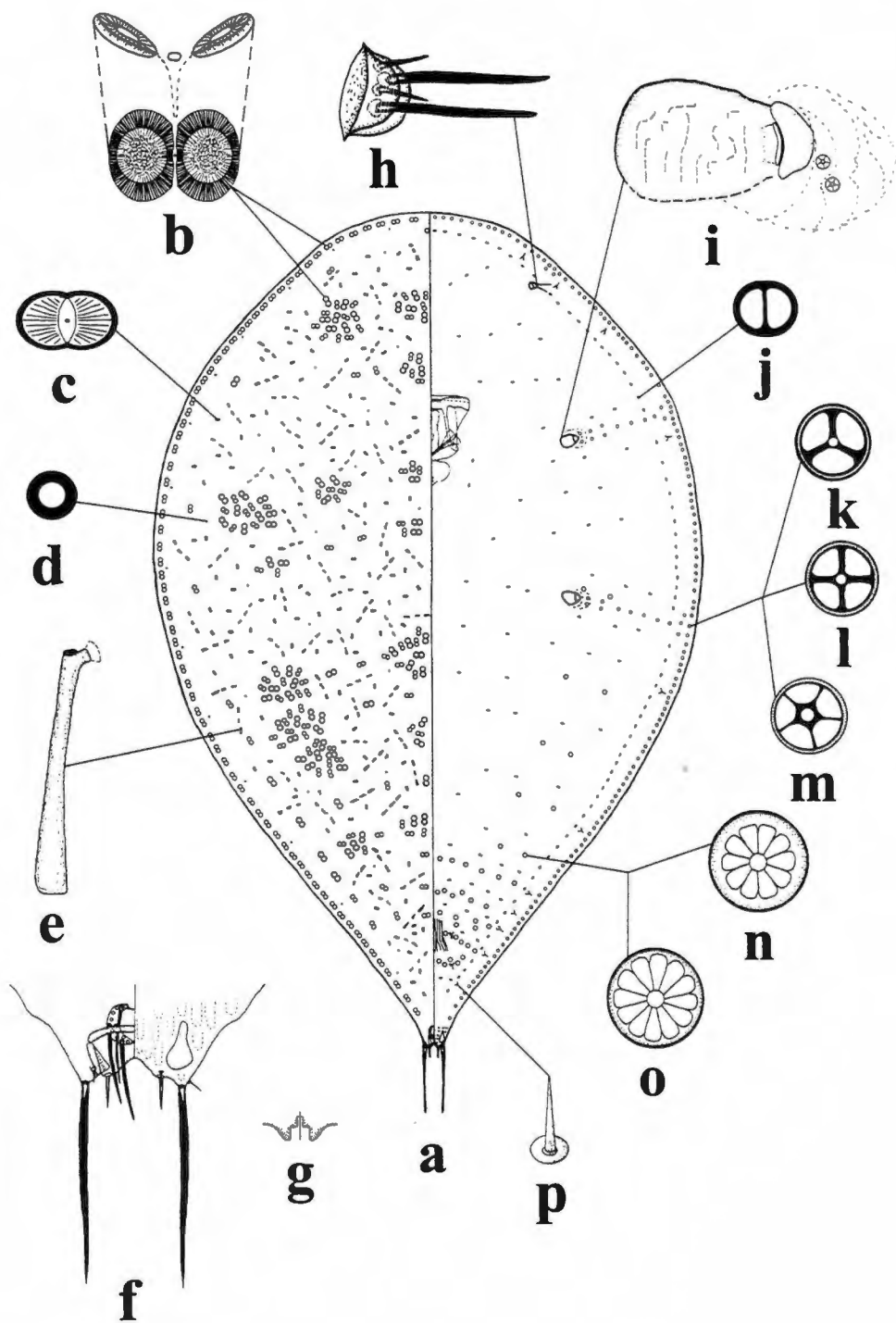


Fig. 10. *Asterolecanium epidendri* (Bouché), 1844.

Signoret, 1870:277, 1876b:643; Cockerell, 1893a:77, 1893d:373, 1896:8, 1897a:319, 327, 1902b:251; Maskell, 1894:94; Fernald, 1903:49; Leonardi, 1908:154, 1920:247; Green, 1909:320; MacGillivray, 1921:189; Richter, 1928:188; Wolcott, 1936:122; Borchsenius, 1937a:66, 1937b:189; Hunt, 1939:556; Della Beffa, 1961:264.

Asterolecanium aureus Signoret, 1868:844. *Planchonia oncidii* Cockerell, 1893a:78, 1893b:8, 1893c:255; Maskell, 1895c:135. *Planchonia aurea* Maskell, 1895c:135.

Asterolecanium oncidii Cockerell, 1896:8, 1897a:319, 327, 1899:269; Lindinger, 1936:153; Schmutterer, 1952a:378, 1952b:563, 1952c:79. *Asterolecanium epidendri* Cockerell, 1899:269, 1902b:251; Fernald, 1903:50; MacGillivray, 1921:189; Lindinger, 1934:162, 1936:153, 1937:180; Russell, 1941:83; Wolcott, 1948:160; Merrill, 1953:113; Ferris, 1955:20; Zahradnik, 1957:47; Borchsenius, 1950b:134, 1960:158; Danzig, 1967:825; D'Araujo e Silva et al., 1968:133; Bruner et al., 1975:39, 134; Kozar & Walter, 1985:80; Dziedzicka, 1990:25; Williams & Watson, 1990:194; Longo et al., 1995:125; Jansen, 1995:142; Miller, 1996:69. *Asterolecanium greeni* Marchal, 1904:456; Sanders, 1906:3. *Asterilecanium aureum* Lindinger, 1924:179.

Type material: Auf *Maranta vittata*, 1(1), adult ♀, type material of *aureum*, det. Sign., France, in Pflanzenhaus gefunden (USNM), no. 45 567.

Additional material studied: On orchid plant, 1(1), adult ♀, Ecuador: San Juan 7261, coll., C. B. Hiller, B. Feliu, 30 IV 1975 (USNM); *Brassavola* sp. (leaf), 4(1), 1 adult ♀, 2 adult ♀♀, 1 first instar, Guatemala, incp. Miami no. 6122, coll., E. B. Lee, no. 74-917, 9 X 1973 (USNM); orchid bulb, 13(3), 5 adult ♀♀, 8 first instars, Honduras, incp. Miami no. 064225, coll., P. Curran, no. 87-115, 19 XII 1986 (USNM); *Anthurum*

sp., 3(3), all adult ♀♀, Guatemala: via Miami Beach, FL, coll., G.H. Gwin, 28 IX 1971
 (FSCA); *Phaius* sp., 3(3), all adult ♀♀, FL, Orlando, coll., A.C. Crews, 10 XI 1966
 (FSCA); *Billbergia nutans*, 1(1), adult ♀, FL, Tampa, coll., C.W. Hale, 2 I 1962 (FSCA);
Tillandsia sp., 3(3), all adult ♀♀, FL, Dania, coll., R. Gaskalla, 29 XI 1976 (FSCA), (DPI
 no.126176); *Bauhinia* sp., 4(4), all adult ♀♀, FL, Margate, coll., R.L. Payne, 2 X 1985
 (FSCA); Orchidaceae, 3(3), all adult ♀♀, FL, Miami, coll., D. Gruber, 26 I 1991 (FSCA);
Anthurium sp., 3(3), all adult ♀♀, FL, Arcadia, coll., J. Bennett, 7 XII 1992 (FSCA);
Tillandsia spp., 3(3), all adult ♀♀, FL, Jensen Beach, coll., E.W. Campbell, 19 VII 1979
 (FSCA); *Philodendron* sp., 3(3), all adult ♀♀, FL, Conway, coll., A. C. Crews, 2 X 1968
 (FSCA), labeled I-152; shade tree, 1(1), adult ♀, Rio de Janeiro, Brazil, coll., G. Compere
 (USNM); *Billbergia* sp. leaf, 2(1), all adult ♀♀, Brazil, coll., E.B. Lee, 17 X 1973
 (USNM), no. Miami 6137; bromeliad leaf, 7(1), 2 adult ♀♀, 5 first instars, Guatemala,
 coll., J.C. Buff, 10 XI 1975 (USNM), no. Miami 11994; *Tillandsia punctulata* leaf, 1(1),
 adult ♀, Guatemala, coll., R. King, 14 IX 1977 (USNM), no. Los Angeles 18619;
Tillandsia utriculata leaf, 7(2), 5 adult ♀♀, 2 first instars, Guatemala, colls., J. Thew, R.
 Hashimoto, 11 IV 1978 (USNM), no. Los Angeles 21006; bromeliad leaf, 5(1), 4 adult
 ♀♀, 1 second instar ♀, Guatemala, coll., W. Turbeville, 4 X 1975 (USNM), no. New
 Orleans 8078; bromeliad leaf, 8(2), 5 adult ♀♀, 1 second instar ♀, 2 first instars,
 Guatemala, coll., B. Davis et al., 16 X 1975 (USNM), no. New Orleans 8096; bromeliad
 leaf, 5(1), 5 adult ♀♀, Guatemala, coll., H.L. Rubin, 21 X 1975 (USNM), no. Miami
 11967; *Myrica* sp., 7(3), all adult ♀♀, Archbold Research Sta., Highlands, FL, colls., J.A.
 Davidson, R.F. Denno, D.R. Miller, 28 IV 1975 (USNM), no. 2816; orchid plant, 1(1),

adult ♀, Guatemala, coll., coll., J.C. Buff, 1 VI 1965 (USNM), nos. Miami 34732, 65.11044; bromeliad, 1(1), adult ♀, Brazil, coll., W.A. Avazian, 17 III 1969 (USNM), no. Miami 51417; bromeliad leaf, 1(1), adult ♀, Guatemala, coll., F. Matthews, 6 VIII 1976 (USNM), no. Miami 14550; bromeliad, 2(1), all adult ♀♀, Brazil, at Hoboken, coll., Spessard, 30 X 1940 (USNM), no. Hoboken 660; bromeliad, 10(2), 4 adult ♀♀, 6 first instars, Brazil, at D.C., coll., Smith, 10 X 1939 (USNM), no. 67065; Epidendron, 1(1), adult ♀, Guatemala, at Hoboken, coll., Grayson, 24 V 1946 (USNM), no. Hoboken 6211; bromeliad leaf, 1(1), adult ♀, Brazil, coll., E. Bilee, 7 I 1974 (USNM), no. Miami 6388; Bromeliaceae, 6(2), all adult ♀♀, Brazil, coll., D. Pearson, 5 VI 1975 (USNM), no. JFKIA 19945; *Aechmea* sp., 7(2), all adult ♀♀, Brazil, coll., H.L. Rubin, 16 V 1975 (USNM), no. Miami 11375; *Chamaedorea* sp., 2(2), all adult ♀♀, Panama, coll., D. Riley, 26 X 1995 (USNM), nos. 2013210, Brownsville 027741, 027743, 96 00264, 96 00268; Orchidaceae, 2(1), all adult ♀♀, Philippines, 28 VI 1996 (USNM), nos. 2013210, San Francisco 23633; bromeliad plant, 7(2), all adult ♀♀, Belize, coll., E.B. Lee, 16 IV 1974 (USNM), no. Miami 7321.

Additional hosts: On various hosts belonging to families such as Araceae, Bromeliaceae, Moranthaceae, Orchidaceae, and Piperaceae: *Aechmea fasciata*, *Angraecum* sp., *A. sesquipedale*, *Anthurium leoconerion*, *A. regale*, *A. robustum*, *A. scandens*, *A. scherzerianum*, *Bifrenaria aureofulva*, *Bulbophyllum grandiflorum*, *Bougainvillea* sp., *Brassia caudata*, *Brassia* sp., *Broughtonia sanguinea*, *Broughtonia* sp., *Calathea vittata*, *Calathea* sp., *Cattleya* sp., *Celogine cristata*, *Chamaedorea* sp., *Cirrhopetalum* sp., *Coelogyne cristata*, *Ctenanthe scetosa*, *Cypripedium hamaldianum*,

Cypripedium sp., *Dendrochilum* sp., *Epidendrum cuspidatum*, *E. ibagaense*, *Epidendrum* sp., *Garcinia* sp., *Gongora* sp., *Hedychium coccineum*, *Hippeastrum* sp., *Keffersteinia gramine*, *Laelia* sp., *Nepenthes* sp., *Oncidium tetrapetalum*, *Oncidium* sp., *Ophiopogon jaburan*, *Ophiopogon* sp., *Philodendron* sp., *Piper betle*, *P. officinarum*, *P. nigrum*, *Piper* sp., *Rheedia lateriflora*, *Rheedia* sp., *Sansevieria nilotica*, *Vriesea glazioui*, *Zamia* sp. (Boisduval 1868a, b, c; Borchsenius 1950b; Bouché 1844; Bruner et al. 1975; Cockerell 1893a, 1893d, 1896; D'Araujo e Silva et al. 1968; Green 1909; Jansen 1995; Leonardi 1908, 1920; Lindinger 1924, 1936; MacGillivray 1921; Marchal 1904; Russell 1971; Schmutterer 1952b; Signoret 1870, 1876b; Williams & Watson 1990; Zahradnik 1957).

Description:

Body (Fig. a) oval, widest in spiracular area, 843 (680-1100) long, 650 (500-980) wide, with anal indentation. Derm membranous with four different sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

This species is highly variable in some morphological attributes. Three different variants were identified during this study with small differences in size, number, and distribution of pores, and in some anal area characteristics. However, the first impression of three different species did not stand a more thorough analysis. For all characters, intermediate stages could be found. Morphological variation seems to occur even in the normally highly invariable anal area, as can also be seen with other scale insect taxa (Liu et al. 1989). The arrangement of large 8-shaped pores on the dorsum alone cannot be used to reliably differentiate among species (Stumpf & Lambdin 2000a). Podsiadlo

(1990a, b), in her landmark studies on *As. variolosa*, showed how variable even a parthenogenetic species can be.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row with 160 (134-208) pores that terminates 1-2 pore lengths before apex of abdomen; pores bent, each 10.6 (9.8-12.1) long and 6.4 (5.7-7.5) wide. Other pores with 3 (2-5) different pores sizes; pores usually arranged in 12 (10-14) transverse bands with 7 (6-8) medial clusters and 7 (6-8) submarginal clusters on each side, but variations may also include transverse bands without clusters or presence of large pores only in submarginal row; largest pores 15.6 (14.4-16.7) long, 10.5 (9.8-10.9) wide; medial pores 11.7 (9.2-14.4) long, 7.0 (5.2-9.8) wide; smaller pores 10.4 (9.2-11.5) long, 6.0 (5.2-6.9) wide; and smallest pores 9.8 (9.8-9.8) long and 5.7 (5.7-5.7) wide, all pores bent; minute pores (Fig. c) evenly distributed over dorsum, each 2.4 (2.3-2.6) long and 1.3 (1.1-1.7) wide.

Simple disk pores (Fig. d) evenly distributed over dorsum consisting of 81 (12-148) pores; also in marginal row close to marginal 8-shaped pores with 66 (28-122) pores, with some pores in pairs, each 1.6 (1.1-2.3) in diam.

Tubular ducts (Fig. e) numerous throughout derm; each 28.0 (23.0-39.1) long, 3.3 (2.3-3.4) wide.

Anal lobes with indentation (Fig. f), with strongly sclerotized pear-shaped area ventrad, 28.7 (19.0-36.8) long and 8.0 (5.7-10.3) wide, this character sometimes missing; rest of anal lobes slightly sclerotized ventrally; the typical round anal indentation is replaced in some specimens by a strongly sclerotized posterior projection and a smaller

anterior projection mesad of each lobe (Fig. g); each anal lobe with one apical seta 86.9 (51.7-106.9) long, one subapical seta 14.5 (9.8-20.7) long, one dorsal seta 6.2 (3.4-13.2) long, one medial ventral seta 8.6 (4.0-13.8) long, and one outer ventral seta 8.0 (4.6-10.3) long.

Arched plate (Fig. f) length 32.2 (28.7-41.4).

Anal plates (Fig. f) triangular, separated, each plate 16.5 (11.5-23.0) long.

Anal ring (Fig. f) located anteriad of anal plate, divided medially, 20.4 (13.2-28.7) long and 19.9 (17.2-25.3) wide; with 2 rows of pores, inner row with 6 pores, outer row with 12 (12-14) pores; with 6 setae, each 35.3 (29.9-46.0) long.

Ventral Surface

Clypeolabral shield (Fig. a) 93.0 (69.0-117.2) long, 85.4 (59.8-112.6) wide.

Labium (Fig. a) heart-shaped, 42.1 (29.9-54.0) long, 50.8 (29.9-60.9) wide; with 2 (1-2) pairs of setae, each 2.7 (1.7-4.6) long.

Antennae (Fig. h) one-segmented, 8.5 (4.6-13.8) long, 10.2 (7.5-13.8) wide at base; with 2 fleshy setae 14.5 (6.9-21.8) long, and 2 (2-4) slender setae 5.5 (3.4-9.2) long.

Spiracles (Fig. i) located between medial and marginal area; anterior 33.4 (23.0-46.0) long, 12.7 (10.3-14.9) wide, atrium 6.3 (4.6-8.0) in diam.; posterior 34.4 (23.0-43.7) long, 13.4 (10.3-16.7) wide, atrium 7.0 (5.2-9.2) in diam.; with 4 (2-6) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 19 (7-26) quinquelocular pores 2 (1-5) pores wide; posterior furrows with a band of 17 (8-28) quinquelocular pores 2 (1-4) pores wide.

8-shaped pores (Fig. j) in a submarginal row (sometimes band) with 159 (120-218) pores; dark-rimmed pores in several transverse rows over venter with 120 (22-250) pores, and a row of 4 (1-8) pores on each side of mouthparts; each 2.4 (1.1-2.9) long, 1.6 (1.1-2.3) wide.

Trilocular pores (Fig. k) and **quatrolocular pores** (Fig. l) in marginal row and spiracular furrows together with quinquelocular pores; only a few pores found in a single specimen; same size as quinquelocular pores.

Quinquelocular pores (Fig. m) in spiracular furrows and in a marginal row consisting of 300 (168-473) pores with some occasional pores in a second row position; complete marginal row ends together with 8-shaped pores at apex of abdomen; or row may be incomplete ending ca. 29 8-shaped pore lengths before apex of abdomen, and interrupted for 27 8-shaped pore lengths anteriorly; with 2 (0-3) pores between margin and antennae; each 2.8 (2.3-3.4) in diam.

Multilocular pores (Figs. n, o) with 3-5 incomplete rows consisting of 4 (2-14) pores each; and 5-6 complete rows (sometimes also bands) anteriorly of genital opening with 12, 12 (0-21) or 36 (34-41), 11 (9-30) or 34 (29-37), 12 (9-23) or 30 (25-33), 10 (6-20), and 10 (6-20) pores, respectively; each 10-12 loculi, 4.8 (4.0-5.2) in diam.

Setae (Fig. p) with 2-3 segmental rows around genital opening corresponding to 2-3 complete rows of multilocular pores, each with 2 (2-4), 2 (0-4), and 2 (2-6) setae, respectively; each 4.2 (2.3-6.9) long; also submarginal row with 30 (10-42) setae, some setae in pairs, each 4.8 (3.4-6.9) long.

Biological data: Richter (1928) studied the symbionts of the orchid pit scale. Schmutterer (1952b) described 3-4 generations of the scale per year in greenhouses in Germany with a generation length of about 3 months. From 100 different females, he observed an average of 72 eggs/♀ with a variation of 20-110 eggs. Eggs hatched after 10-14 days. Signoret (1870) mentioned that males were unknown. Schmutterer (1952b, 1952c) could not find any males in his observations and concluded that this species reproduces parthenogenetically. Parthenogenesis may be an important factor in the distribution of economically important pit scales (see *Ba. bambusae*, genera *Asterodiaspis* and *Neoasterodiaspis*).

Parasitoids and predators: *Aphycus* sp. (Encyrtidae) was reported by D'Araujo e Silva et al. (1968).

Distribution: FL, NY; Belize, Brazil, British Guiana, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Jamaica, Mexico, Panama, Puerto Rico, Trinidad, Venezuela, West Indies; Antilles, Fiji, India, Sri Lanka. First described from greenhouses in Paris, France; occurs in greenhouses all over the world. This species is native to South and Central America.

Economic importance: The orchid pit scale can have a big impact on orchids in greenhouses. Schmutterer (1952b) describes strong colonies especially on *Anthurium* species with girdling and die-off of leaves.

Diagnosis: With pear-shaped anal sclerotization; on orchids.

Affinities: No clear sister group relationship could be established to any other species of *Asterolecanium*.

***Asterolecanium grandiculum* Russell, 1941**

Proposed Common Name: Yucca Pit Scale

Fig. 11

Asterolecanium grandiculum Russell, 1941:100; Ferris, 1955:20; Gill, 1993:99; Miller, 1996:69.

Type material: On *Yucca*, 7(1), paratypes, all adult ♀♀, Phoenix, AZ, coll., C.D. Lebert, 6 I 1936 (USNM).

Additional material studied: On *Yucca glauca*, 1(1), adult ♀, El Centro Imp., CA, coll., El Paddock, 16 IV 1970 (USNM), Calif. Dept. Agr., no. 70D2/-SA; Myrtle hedge, 3(1), all adult ♀♀, Imperial Co., Holtville, CA, cols., Flock, Jones, Ret. G.T., 5 X 1971 (USNM), Okumura no. 71-7341.

Additional hosts: *Agave* sp., *Fouquieria (Idria) columnaris*, *Myrtus communis*, *Yucca* sp. (Ferris 1955, Gill 1993, Russell 1941).

Description:

Body (Fig. a) subcircular, widest in area of metathoracic spiracles, 1248 (1020-1600) long, 1066 (720-1520) wide, with anal indentation. Derm membranous with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin in double row which becomes single in anal area, and terminates 4-5 pore lengths before apex of abdomen; row with 254 (202-288) pores; all pores bent, each 11.9 (10.3-13.8) long, 7.7 (6.9-8.6) wide. Other pores in 3 sizes; large pores in median band, medial and small pores in swirls over whole dorsum;

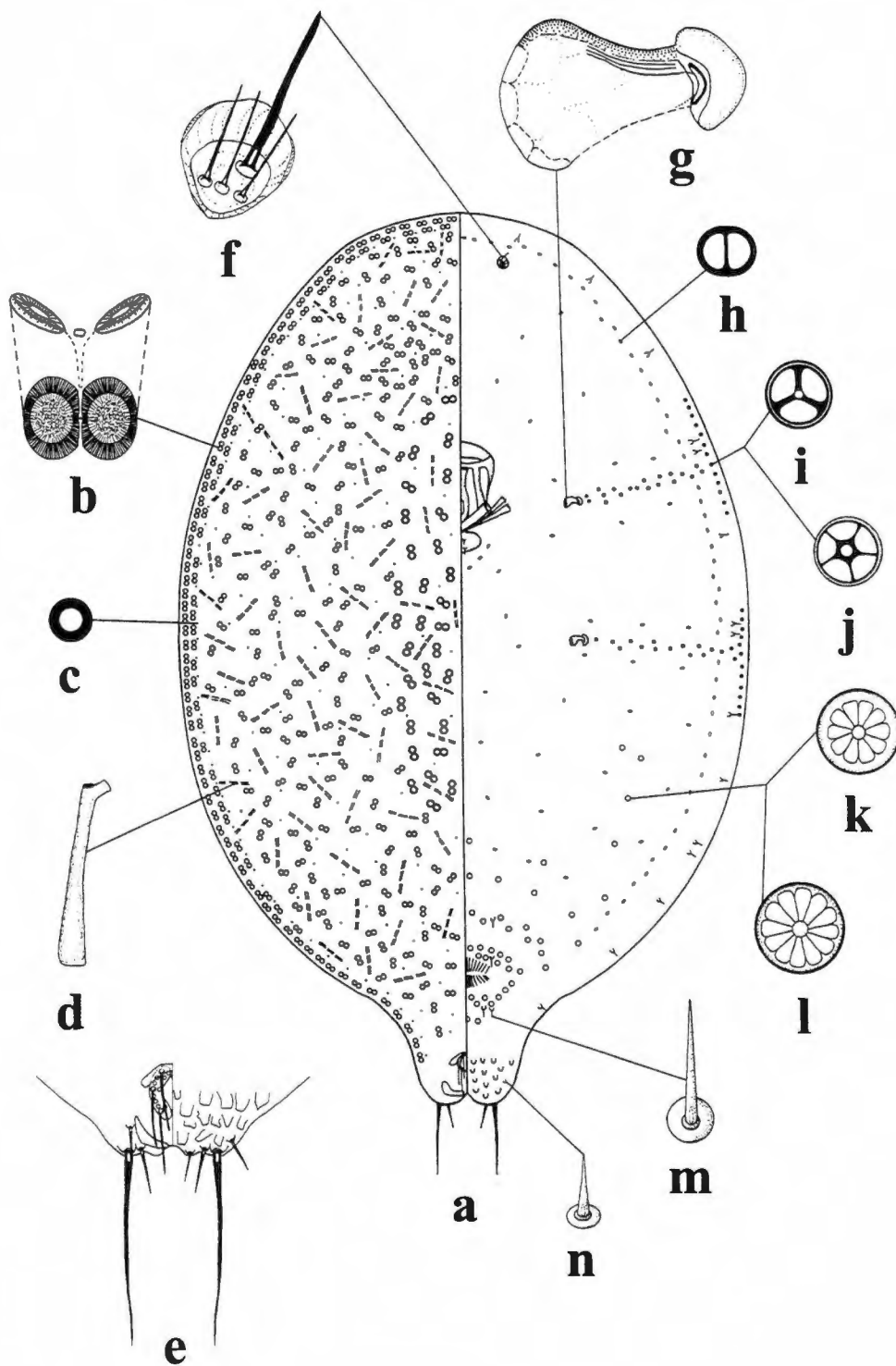


Fig. 11. *Asterolecanium grandicolum* Russell, 1941.

largest pores 16.3 (14.9-17.8) long, 10.4 (9.8-10.9) wide; medial pores 12.9 (11.5-13.8) long, 8.2 (6.9-9.2) wide; and smallest pores 4.2 (3.4-5.2) long, 2.5 (1.7-2.9) wide.

Simple disk pores (Fig. c) evenly distributed, consisting of 200 (150-332) pores; also in marginal row with 94 (80-116) pores, row sometimes appears to be on ventral margin; each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. d) evenly distributed, each 33.0 (28.7-39.1) long, 3.7 (3.4-4.6) wide.

Anal lobes (Fig. e) with anal indentation, sclerotized ventrally; each lobe with one apical seta 93.9 (88.5-100.0) long, one subapical seta 17.6 (14.9-19.5) long, one dorsal seta 11.8 (10.3-13.8) long, one medial ventral seta 8.3 (6.3-9.8) long, and one outer ventral seta 12.5 (10.9-14.9) long.

Arched plate (Fig. e) length 41.4 (37.9-46.0).

Anal plates (Fig. e) triangular, separated, same length as arched plate.

Anal ring (Fig. e) divided medially, appears to be located between arched plate and anal plates; 21.2 (19.5-21.8) long, 20.0 (13.8-21.8) wide; with 2 rows of pores, inner row of pores with 6, outer with 14 (12-14) pores; with 6 each setae, each 31.8 (27.6-34.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 163.1 (144.8-177.0), width 121.2 (103.4-142.5).

Labium (Fig. a) oval, 58.2 (44.8-69.0) long, 76.0 (62.1-90.8) wide; with 2 (1-2) pairs of setae, each 3.3 (2.3-4.0) long.

Antennae (Fig. f) one-segmented, circular, surrounded by membranous folds, 17.3 (14.9-19.5) long, 22.1 (19.5-25.3) wide; with 1 (0-2) fleshy 20.0 (17.2-21.8) long, and 3 (2-3) slender setae 15.2 (9.2-19.5) long.

Spiracles (Fig. g) located in submedial area; anterior 41.7 (36.8-47.1) long, 17.6 (14.9-19.0) wide, atrium 9.9 (9.2-11.5) in diam.; posterior 41.1 (34.5-48.3) long, 17.8 (16.1-20.7) wide, atrium 10.0 (8.0-11.5) in diam.; occasionally 3-4 quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 23 (18-27) quinquelocular pores, 2 (1-3) pores wide; posterior furrows with a band of 19 (13-22) pores, 1 (1-3) pores wide.

8-shaped pores (Fig. h) in submarginal row with 98 (70-130) pores; dark-rimmed pores in transverse rows with 74 (48-110) pores, and 3 (1-5) pores ventro-laterad of labium; each 3.3 (2.9-3.4) long, 2.3 (2.3-2.3) wide

Trilocular pores (Fig. i) in small numbers together with quinquelocular pores in spiracular furrows and marginal rows; same size as quinquelocular pores.

Quinquelocular pores (Fig. j) in spiracular furrows and four short marginal rows where spiracular furrows meet the margin; marginal rows with 41 (34-50) pores together; each 3.6 (3.4-4.0) in diam.

Multilocular pores (Figs. k, l) with 3 incomplete rows consisting of 4 (0-10), 2 (2-6), and 2 (2-4) pores, respectively; and 6 complete bands around genital opening with 6 (3-9), 11 (6-17), 18 (14-22), 20 (14-24), 14 (10-21), and 3 (2-6) pores, respectively; occasionally with 1-2 pores anterior of metathoracic spiracles; each pore 12 (10-12) loculi and 6.4 (5.7-6.9) in diam.

Setae with 3 segmental rows (Fig. m) around genital opening corresponding to 3 complete rows of multilocular pores with 2 (0-2), 2, and 4 setae, respectively; each seta 9.1 (5.7-11.5) long; also submarginal row with 32 (24-38) tack-like setae (Fig. n), sometimes in pairs; each seta 6.4 (5.7-8.0) long, with exception of the setae on the anal lobe which have the same length as segmental setae.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: AZ, CA, NM; Mexico.

Economic importance: This species is not economically important (Gill 1993).

Diagnosis: Marginal 8-shaped pores in double row; on *Agave*, *Fouqueria*, *Myrtus*, and *Yucca*.

Affinities: *Al. grandiculum* is morphologically very closely related to *Al. agavis*, with which it also shares geographic location and host plants.

Notes: This species was sometimes misinterpreted as *Planchonia stentae* because of the similar distribution of the large dorsal 8-shaped pores of both species. The new key addresses these problems. Clear differences in the morphology of anal plates and multilocular pores should make the correct identification easy.

***Asterolecanium ingae* Russell, 1941**

Proposed Common Name: Inga Pit Scale

Fig. 12

Asterolecanium sp. nov. Wolcott, 1936:122. *Asterolecanium ingae* Russell, 1941:111; Ferris, 1955:20; Borchsenius, 1960:158.

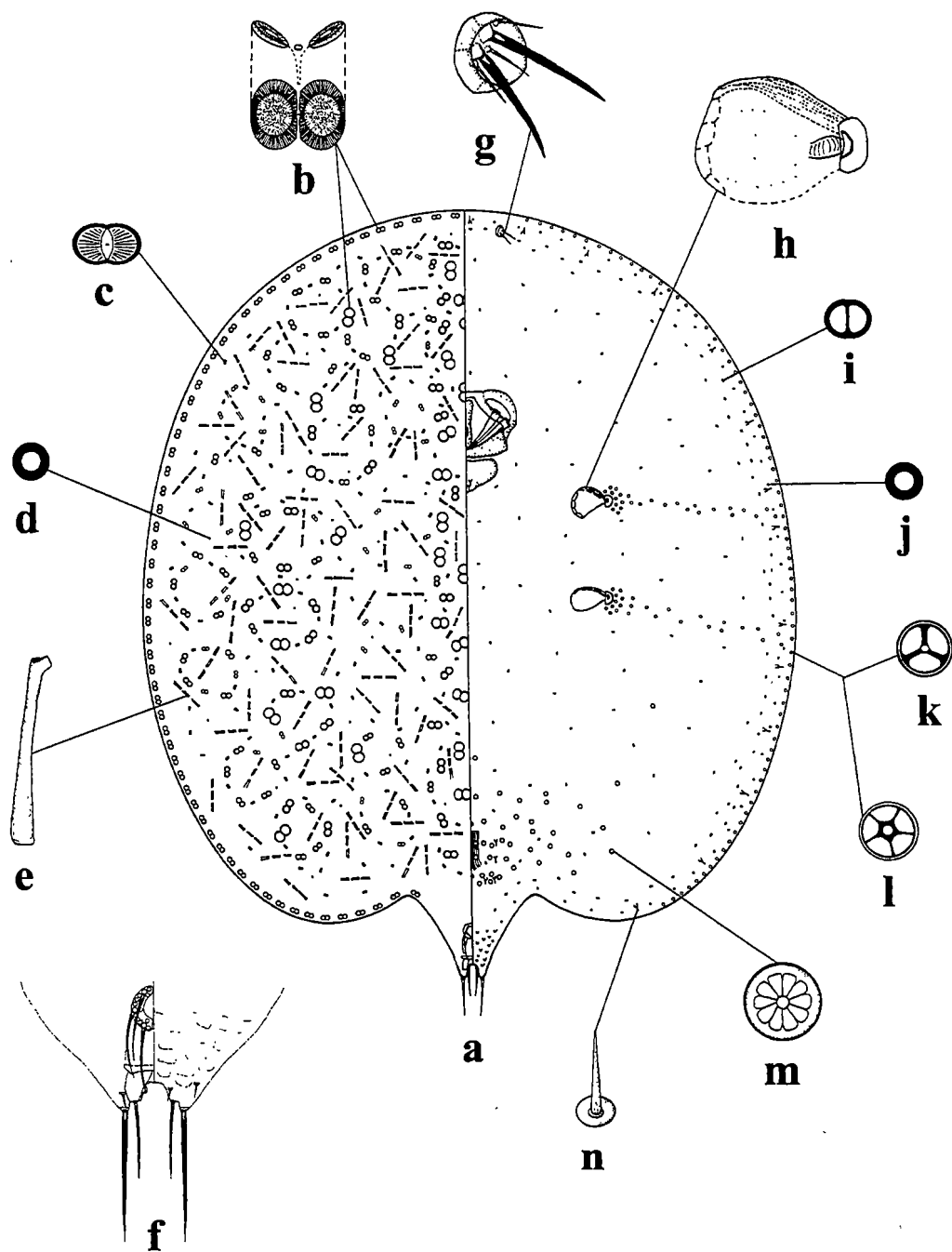


Fig. 12. *Asterolecanium ingae* Russell, 1941.

Type material: On *Inga vera*, 17(2), paratypes, 5 adult ♀♀, 12 first instars, Utuado, Puerto Rico, coll., v. Medino, fr. G.N. Wolcott, Let. March 21, 1935, P.R. Acc.no. 31-35, 18 III 1935 (USNM), no. 35-2993.

Description:

Body (Fig. a) subcircular, widest in spiracular area, with distinct apical indentations in older ♀♀; 850 (700-980) long, 575 (440-700) wide, with anal indentation. Derm membranous with 5 different sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin in single row with 130 (122-136) pores; row terminates 5-6 pore lengths before apex of abdomen; all pores bent, each 10.3 (9.8-10.9) long, 6.9 (5.7-7.5) wide. Other pores arranged in swirls over whole dorsum with tendency for bigger pores being concentrated in median swirls; with 4 different pore sizes; largest pores 15.8 (14.9-17.2) long, 11.6 (10.3-12.6) wide; medial pores 13.1 (12.1-14.4) long, 9.1 (8.0-10.3) wide; smaller pores 11.1 (9.8-11.5) long, 7.9 (7.5-8.0) wide; and smallest pores 9.1 (8.6-9.2) long, 6.0 (5.2-6.3) wide. Minute pores (Fig. c) numerous, form swirls together with large pores; each pore 3.6 (3.4-4.0) long, 2.1 (1.7-2.3) wide.

Simple disk pores (Fig. d) evenly distributed, consisting of 85 (80-90) pores, each 1.7 (1.7-1.7) in diam.

Tubular ducts (Fig. e) evenly distributed, each 33.3 (31.0-35.6) long, 3.3 (2.9-3.4) wide.

Anal lobes (Fig. f) sclerotized ventrally, with indentation; with slightly sclerotized dorsal membranous fold between anal ring and arched plate; each anal lobe with one apical seta 46.0 (46.0-46.0) long, one subapical seta 17.0 (13.8-18.4) long, one dorsal seta 9.4 (8.0-11.5) long, one medial ventral seta 3.2 (2.9-3.4) long, and one outer ventral seta 5.2 (4.6-5.7) long.

Arched plate (Fig. f) only slightly bent, 37.2 (34.5-39.1) long.

Anal plates (Fig. f) rectangular, occasionally fused medially, but usually separate; each plate 18.8 (14.9-23.0) long, 18.6 (16.1-21.8) wide.

Anal ring (Fig. f) located anterior of arched plate, divided medially, 20.7 (20.7-20.7) long, 23.2 (18.4-26.4) wide; with 2 rows of pores, inner row of pores with 6, outer with 16 pores; with 6 setae, each 37.5 (32.2-41.4) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 92.7 (80.5-100.0), width 90.6 (85.1-97.7).

Labium (Fig. a) triangular, 36.6 (34.5-39.1) long, 59.1 (55.2-66.7) wide; with 2 pairs of setae, each 2.3 (2.3-2.3) long.

Antennae (Fig. g) one-segmented, disk-shaped, slightly concave, 13.4 (12.1-14.4) long, 10.6 (9.8-12.1) wide at base; with 2 (2-3) fleshy setae 13.8 (12.6-14.9) long, and 3 (2-3) slender setae 6.9 (6.9-6.9) long.

Spiracles (Fig. h) located in submedial area; anterior 33.3 (31.0-34.5) long, 12.6 (11.5-13.8) wide, atrium 6.3 (5.7-6.9) in diam.; posterior 37.2 (35.6-39.1) long, 12.3 (10.3-13.2) wide, atrium 6.8 (6.3-6.9) in diam.; with 11 (10-12) pores in folds around

atria; anterior spiracular furrows with a band of 25 (21-29) quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a band of 26 (22-29) pores, 1 (1-3) pores wide.

8-shaped pores (Fig. i) in submarginal band with 99 (70-116) pores; pores 2.8 (2.3-2.9) long, 2.2 (1.7-2.3) wide; dark-rimmed pores in transverse bands with 140 pores; each 2.3 long, 1.7 wide.

Simple disk pores (Fig. j) in submarginal row consisting of 82 (74-96) pores, same size as dorsal pores.

Trilocular pores (Fig. k) present in small numbers among quinquelocular pores of spiracular furrows and marginal row; same size as quinquelocular pores.

Quinquelocular pores (Fig. l) in spiracular furrows and marginal row consisting of 148 (118-182) pores; marginal row is interrupted for 8 (4-9) 8-shaped pore lengths anteriad, and ends 8 (6-13) 8-shaped pore lengths before apex of abdomen; occasionally with a single pore between marginal row and each antenna, each 3.0 (2.9-3.4) in diam.

Multilocular pores (Fig. m) with 1 incomplete row consisting of 2 pores; and 6 complete bands around genital opening with 4, 17 (17-18), 19 (17-20), 15 (12-18), 8 (6-11), and 11 (9-14) pores, respectively; each 10 (10-12) loculi and 4.5 (4.0-4.6) in diam.

Setae (Fig. n) with 3 segmental rows around genital opening corresponding to 3 complete bands of multilocular pores with 2 (2-4), 2, and 4 setae, respectively; each seta 4.2 (3.4-4.6) long; also submarginal row with 28 (22-30) setae, each 3.6 (3.4-4.0) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Puerto Rico.

Economic importance: This species is of no economic importance.

Diagnosis: Anal plates rectangular, without tentorial sclerotization (Fig. 3), with single row of marginal 8-shaped pores; on *Inga*.

Affinities: *Asterolecanium ingae* may not be closely related to the other species on *Inga*, *Al. multioctoporosum*.

***Asterolecanium multioctoporosum*, n.sp.**

Proposed Common Name: Multipore Pit Scale

Fig. 13

Asterolecanium multioctoporosum, n.sp.

Type material: On *Inga marginata*, 6(3), holotype circled, adult ♀, 5 paratypes, all adult ♀♀, Apartadó, Antioquia, Colombia, coll., L. Gomez, no. 11, 18 XII 1973 (USNM), no. 74-4315.

Description:

Body (Fig. a) circular, widest in thoracic area, 1385 (1200-1500) long, 1507 (1200-1960) wide, without anal indentation. Derm membranous with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form quadruple band that extends over both dorsum and venter; band becomes double in posterior abdominal area and terminates 1-2 pore lengths before apex of abdomen, band with 502 (460-604) pores; most pores flat, only a few slightly bent; each 9.6 (9.2-9.8) long, 6.5 (6.3-6.9) wide.

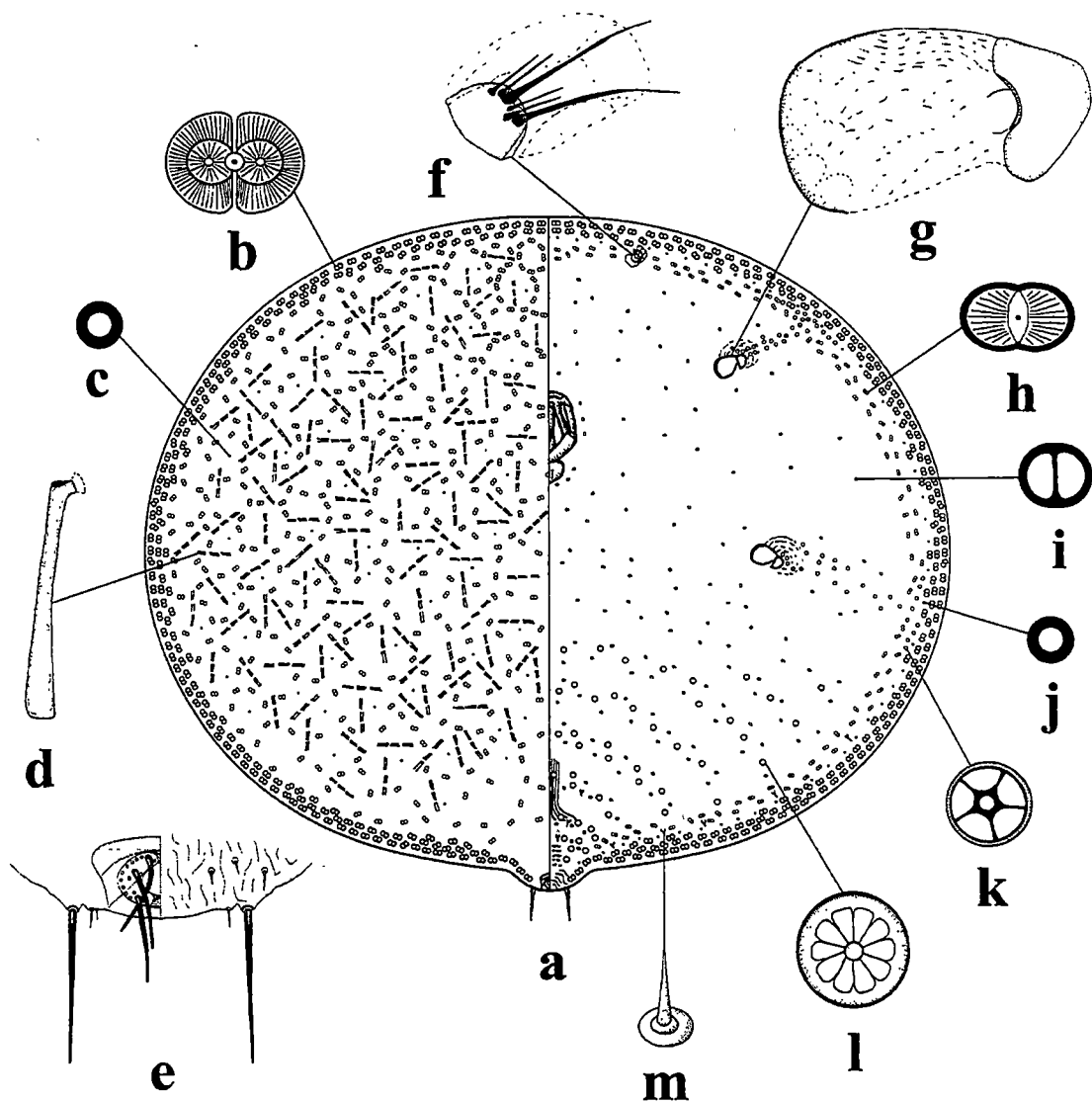


Fig. 13. *Asterolecanium multioctoporosum*, n.sp.

Other pores arranged in numerous swirls throughout dorsum; pores with varying sizes; largest pores 10.3 long, 5.7 wide (in 1 specimen); medial pores 6.5 (5.7-7.5) long, 4.8 (4.6-5.2) wide; and smallest pores 4.8 (4.0-5.2) long, 3.4 (2.9-4.0) wide, without minute pores.

Simple disk pores (Fig. c) spaced irregularly throughout derm, consisting of 100 (70-120) pores; without dorsal submarginal row, but with ventral row instead, each 2.3 (2.3-2.3) in diam.

Tubular ducts (Fig. d) numerous throughout derm, each 30.1 (26.4-34.5) long, 2.9 (2.3-3.4) wide.

Anal lobes (Fig. e) without indentation, apex rugose ventrad, with several rows of ventral microspines antieriad of anal ring; each anal lobe with one apical seta 65.5 (63.2-70.1) long, one subapical seta 7.9 (6.9-9.2) long, one dorsal seta 4.8 (4.6-5.2) long, one inner ventral seta 5.2 (4.6-5.7) long, one medial ventral seta 5.2 (3.4-6.9) long, and one outer ventral seta 6.3 (5.2-6.9) long.

Anal plates (Fig. e) anvil-shaped, fused, 54.6 (51.7-57.5) wide.

Arched plate (Fig. e) connected to anal plates, together they form ring-like structure at apical end enclosing anal ring.

Anal ring (Fig. e) divided medially, 24.7 (23.0-25.3) long, 28.4 (25.3-31.0) wide; with 3 rows of pores, inner row with 6, medial row with 4 (0-6), and outer row with 22 (20-24) pores; with 6 setae, each 39.5 (35.6-42.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 125.5 (114.9-133.3), width 119.1 (114.9-123.0).

Labium (Fig. a) heart-shaped, 57.1 (50.6-60.9) long, 71.3 (69.0-74.7) wide; with 3 (2-3) pairs of setae 4.7 (3.4-6.9) long.

Antennae (Fig. f) one-segmented, conical, completely surrounded by membranous folds, 16.0 (14.4-17.2) long, 16.4 (13.2-20.7) wide at base; with 2 fleshy setae 21.3 (17.2-24.1) long and 4 (3-4) slender setae 13.2 (12.6-13.8) long.

Spiracles (Fig. g) located between medial and marginal area; anterior 48.1 (46.0-51.7) long, 24.5 (23.0-26.4) wide, atrium 9.9 (8.6-11.5) in diam.; posterior 53.5 (46.0-59.8) long, 25.0 (21.8-27.6) wide, atrium 9.8 (9.2-11.5) in diam.; anterior spiracular furrows with a band of 23 (17-26) quinquelocular pores, 2 (1-4) pores wide; posterior furrows with a band of 27 (24-28) quinquelocular pores, 2 (1-4) pores wide.

8-shaped pores (Fig. h) in submarginal band with 205 (180-224) pores, these pores not similar to usual ventral pores, but like dorsal 8-shaped pores; each pore 5.2 (4.6-5.7) long, 3.5 (3.4-4.0) wide; dark-rimmed pores (Fig. i) form transverse bands consisting of 287 (175-350) pores; also with rows of 6 (5-6) pores on each side of mouthparts, each 3.7 (3.4-4.0) long, 3.2 (2.9-3.4) wide.

Simple disk pores (Fig. j) in submarginal row with 90 (66-126) pores, same diam. as dorsal pores.

Quinquelocular pores (Fig. k) in spiracular furrows and very short marginal rows where spiracular furrows meet margin; each pore 4.4 (4.0-4.6) in diam.; some pores may also be quaterolocular, 6-locular, or 7-locular.

Multilocular pores (Fig. l) with 2 (occasionally 3) incomplete rows consisting of 4, 2 (2-4), and 6 (2-8) pores, respectively; and 6 complete bands around genital opening with 9 (6-14), 17 (14-24), 18 (14-22), 11 (9-14), 8 (6-10), and 11 (7-16) pores, respectively; each 10 (6-10) loculi and 5.9 (5.2-6.3) in diam.

Setae (Fig. m) with 3 segmental rows corresponding to 3 complete bands of multilocular pores consisting of 2 (2-4) setae each; each 4.8 (4.6-5.7) long; also short incomplete submarginal row with 10 (6-14) setae on abdomen, each 6.3 (5.7-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Colombia.

Economic importance: This species is of no economic importance.

Diagnosis: Large 8-shaped pores on dorsum and venter flat or only slightly bent, pores in a marginal band on both dorsum and venter; apical setae 63-71 long.

Affinities: Closely related to *Al. quaesitum* based on pore distribution and similarities in the anal area. Both are at the base of the Asterolecaniinae clade together with the genus *Planchonia*.

Etymology: The name refers to the large number of 8-shaped pores found on dorsum and venter.

***Asterolecanium puteanum* Russell, 1941**

Proposed Common Name: Holly Pit Scale

Fig. 14

Asterolecanium sp. Felt & Bromley, 1937:20. *Asterolecanium puteanum* Russell, 1941:168; Merrill, 1953:117; Ferris, 1955:25; Dekle, 1963:1; Miller, 1985:106.

Asterodiaspis puteanum Kosztarab, 1996:295.

Type material: On *Pommelia* (*Bumelia*) *parvifolia*, 3(1), paratypes, all adult ♀♀, coll., H. George, Fr. Dr. Turner, FL, 10 V 1880 (USNM), no. 521, 1-41-13.

Additional material studied: On *I. c.* (*Ilex crenata*) *helleri*, 31(10), all adult ♀♀, coll., Dr. Hoffmaster, 4 II 1972 (UT); *I. c.* (*Ilex crenata*) *rotundifolia*, 19(6), all adult ♀♀, coll., Dr. Hoffmaster, 4 II 1972 (UT); *I. c.* (*Ilex crenata*) *rotundifolia*, 9(3), all adult ♀♀, coll., Dr. Hoffmaster, 4 II 1972 (UT); *Ilex opaca*, 4(4), all adult ♀♀, FL, Lake City (RFD), coll., A. E. Graham, 18 II 1979 (FSCA); *Persea borbonia*, 4(4), all adult ♀♀, FL, Groveland, Broward Co., coll., L.J. Chambliss & A.L. Bentley, 28 II 1980 (FSCA); *Ilex* sp., 2(2), all adult ♀♀, FL, Palm City, coll., E.W. Campbell, 12 II 1979 (FSCA); *Ilex crenata*, 3(3), all adult ♀♀, FL, Gainesville, coll., D. Culbert, 7 III 1979 (FSCA); *Ilex* sp., 1(1), adult ♀, Guatemala, coll., R.D. Clemens, 18 II 1942 (USNM), nos. San Francisco 18059, 42 1062.

Additional hosts: *Bumelia* sp., *Ilex cornuta*, *I. opaca*, *I. vomitaria*, *Ilex* sp. (Dekle 1963, Russell 1941).

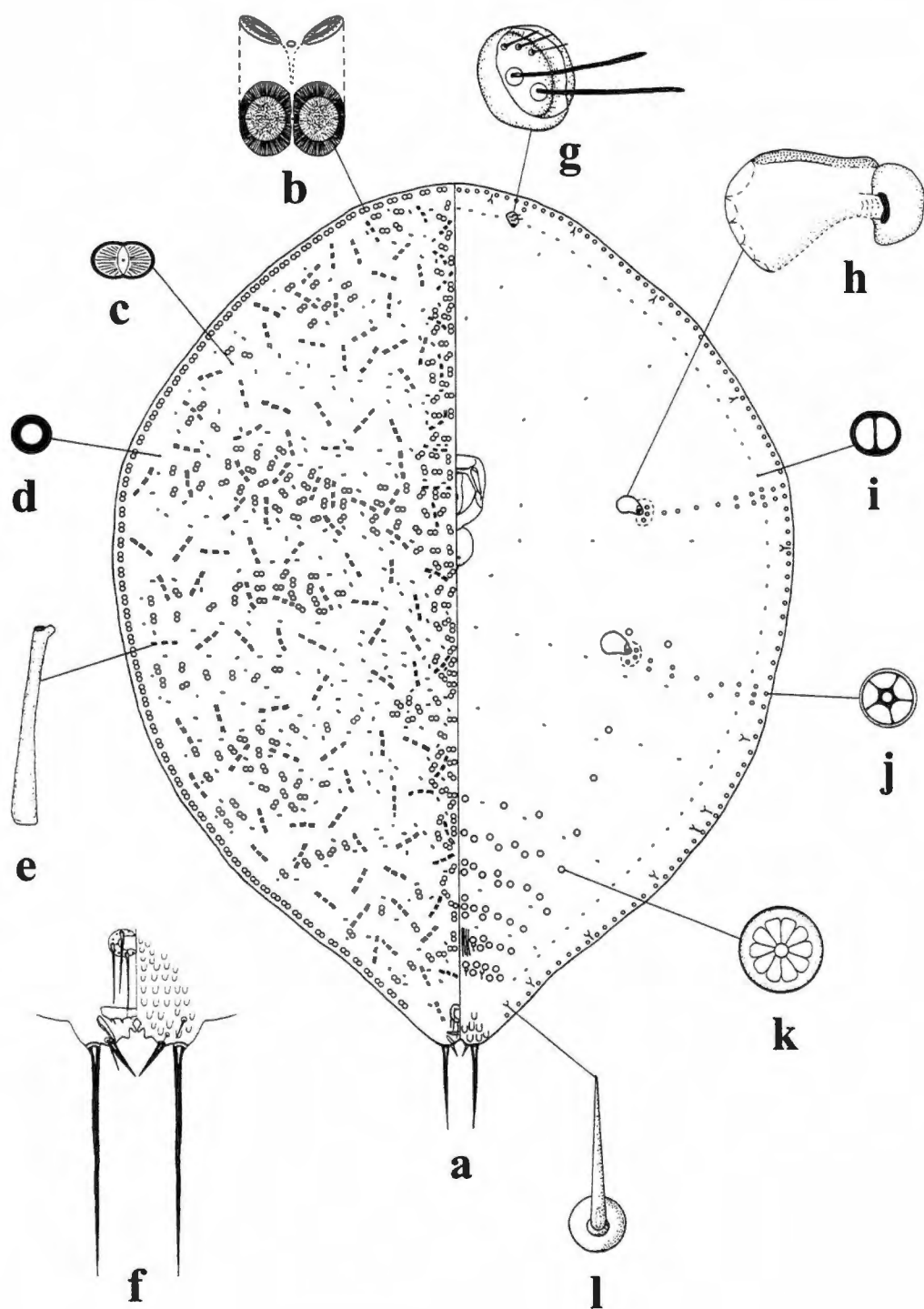


Fig. 14. *Asterolecanium puteanum* Russell, 1941.

Description:

Body (Fig. a) subcircular, widest in spiracular area, 1036 (850-1240) long, 824 (720-1000) wide, with anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 172 (146-200) pores; row terminates 3-4 pore lengths before apex of abdomen; pores bent, each 10.1 (9.2-10.9) long, 6.2 (5.2-6.9) wide. Other pores arranged in 14 (13-15) median clusters, with an irregular number of submedian and submarginal pore clusters connected to the medial clusters forming complete or incomplete transverse bands; pores bent, 9.8 (9.2-11.5) long, 6.0 (4.6-6.9) wide; minute pores (Fig. c) also arranged in transverse rows following the pattern of the large pores; each pore 2.7 (2.3-2.9) long, 1.6 (1.1-1.7) wide.

Simple disk pores (Fig. d) arranged within the transverse bands of 8-shaped pores; with 32 (14-50) pores, mostly in a submarginal position, sometimes in pairs, but do not form a complete submarginal row, each 1.4 (1.1-1.7) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 28.6 (24.7-32.2) long, 3.1 (2.3-4.0) wide.

Anal lobes (Fig. f) sclerotized ventrally, with indentation; each anal lobe with one apical seta 76.3 (42.5-89.7) long, one subapical seta 15.5 (11.5-22.4) long, one dorsal seta 10.6 (5.7-17.2) long, one medial ventral seta 7.7 (6.9-9.2) long, and one outer ventral seta 11.6 (8.6-16.1) long.

Arched plate (Fig. f) with several seta-like sclerotizations, 30.5 (25.3-34.5) long.

Anal plates (Fig. f) separated, each 17.4 (13.8-23.0) long.

Anal ring (Fig. f) located anterior of arched plate, divided medially, 11.7 (9.2-14.9) long, 18.7 (14.9-21.3) wide; with 2 rows of pores, inner row with 6, outer with 12 (12-14) pores; with 6 setae, each 31.8 (23.0-34.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 101.4 (90.8-118.3), width 85.6 (69.0-100.0).

Labium (Fig. a) heart-shaped, 44.9 (34.5-50.6) long, 54.5 (44.8-60.9) wide; with 2 (1-2) pairs of setae, each 4.2 (2.3-6.9) long.

Antennae (Fig. g) one-segmented, 12.8 (11.5-14.9) long, 13.4 (10.3-16.1) wide at base; with 2 (2-2) fleshy setae 12.5 (6.9-17.2) long, and 3 (2-4) slender setae 8.0 (5.7-9.2) long.

Spiracles (Fig. h) located between medial and marginal area; anterior 37.6 (32.2-44.8) long, 15.1 (13.8-17.2) wide, atrium 8.2 (6.9-10.3) in diam.; posterior 38.5 (32.8-43.7) long, 15.7 (12.1-21.3) wide, atrium 8.4 (6.9-10.9) in diam.; with 3 (2-4) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 14 (10-23) quinquelocular pores, 1 (1-3) pores wide; posterior furrows with a band of 13 (9-18) quinquelocular pores, 2 (1-3) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 110 (88-136) pores; each pore 2.8 (2.3-2.9) long, 2.0 (1.7-2.3) wide; dark-rimmed pores with 60 (30-100) pores in a few transverse rows covering whole venter, and a row of 3 (2-5) pores on each side of mouthparts; each 2.3 (2.3-2.3) long, 2.0 (1.7-2.3) wide.

Quinquelocular pores (Fig. j) in spiracular furrows and marginal row consisting of 240 (178-336) pores; row ends 1 (0-2) 8-shaped pore lengths after the corresponding 8-shaped pores row stops; also with 1 (0-5) pores between margin and antennae, each 3.1 (2.9-3.4) in diam.

Multilocular pores (Fig. k) with 3-5 incomplete rows consisting of 2-4 pores in 2 occasional thoracic rows, and 4 (2-6), 2 (2-6), and 2 (2-4) pores in 1 thoracic and 2 abdominal rows, respectively; and 6 complete bands around genital opening with 7 (2-11), 16 (9-24), 18 (14-24), 16 (11-19), 12 (8-17), and 11 (8-15) pores, respectively; each 10 (10-12) loculi and 4.8 (4.0-5.7) in diam.

Setae (Fig. l) with 2, occasionally 3, segmental rows around genital opening corresponding to 3 complete bands of multilocular pores with 2 setae in anterior rows and 4 (2-4) setae in posterior row; each 7.2 (4.0-8.6) long; also submarginal row with 22 (16-30) setae, each 7.3 (5.7-10.3) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: AL, DE, FL, GA, MD, NC, NJ, PA, SC, VA; Brazil.

Economic importance: Occasionally destructive to hollies (Dekle 1963, Miller 1985).

Diagnosis: Large dorsal 8-shaped pores in transverse bands, same size as marginal 8-shaped pores; on hollies.

Affinities: No clear relationships are established.

Asterolecanium quaesitum Russell, 1941

Proposed Common Name: Tusca Pit Scale

Fig. 15

Asterolecanium quaesitum Russell, 1941:171.

Type material: On Tusca (*Acacia moniliformis*), 19(7), paratypes, 9 adult ♀♀, 7 second instar ♀♀, 1 third instar ♂, 2 first instars, Cordoba, Argentina, coll., Kisliuk (no. 8820), 20 VI 1927 (USNM), no. 39-1042, 3 slides mounted from dry material.

Description:

Body (Fig. a) oval, widest in metathoracic area, 1045 (1000-1120) long, 733 (700-760) wide, with small anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form double row that becomes single in posterior abdominal area; row less dense anteriad, with 255 (230-272) pores; pores terminate 4-5 pore lengths before apex of abdomen; all pores bent, 11.1 (10.3-11.5) long, 7.5 (6.9-8.0) wide. Other pores of varying sizes, arranged in numerous swirls throughout dorsum, with submarginal row of pores parallel to marginal pores, 8.6 (8.0-9.2) long, 6.1 (5.2-6.9) wide; smaller pores 7.8 (6.9-9.2) long, 5.3 (4.6-6.9) wide; without minute pores.

Simple disk pores (Fig. c) spaced irregularly throughout derm, only a few pores present, each 2.5 (2.3-2.9) in diam.

Tubular ducts (Fig. d) numerous throughout derm, each 32.8 (31.0-34.5) long, 3.6 (3.4-4.0) wide.

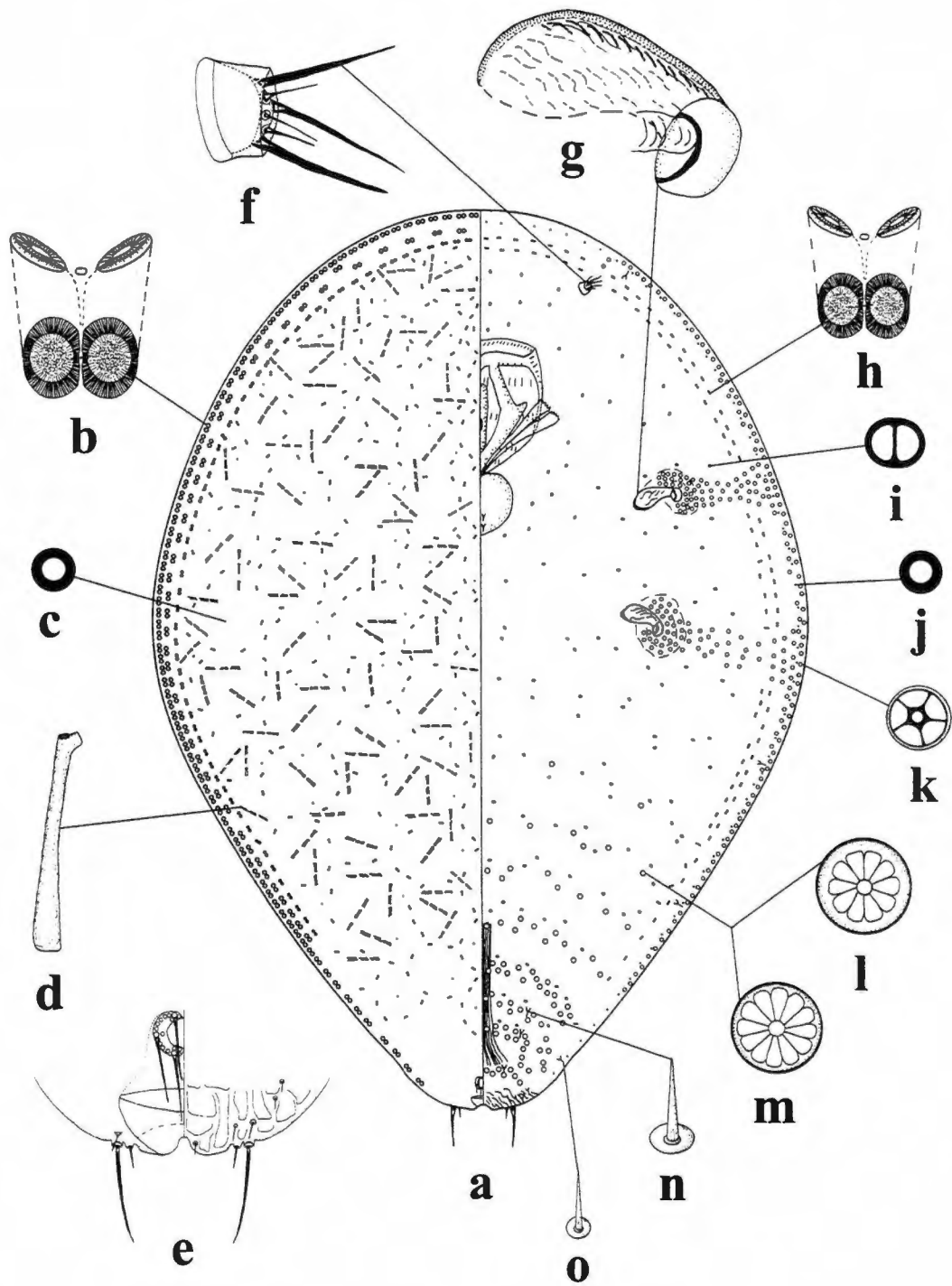


Fig. 15. *Asterolecanium quaesitum* Russell, 1941.

Anal lobes (Fig. e) with small indentation, sclerotized ventrally; each anal lobe with one apical seta 31.4 (25.3-34.5) long, one subapical seta 12.1 (10.3-13.8) long, one dorsal seta 7.8 (6.9-8.6) long, one inner ventral seta 7.2 (6.3-8.0) long, one medial ventral seta 9.8 (9.2-10.3) long, and one outer ventral seta 11.1 (10.3-11.5) long.

Anal plates (Fig. e) anvil-shaped, fused, 66.7 (62.1-74.7) long.

Arched plate (Fig. e) connected to anal plates, together they form ring-like structure through which anal ring setae project; also connected to anal ring by a slightly sclerotized membranous fold.

Anal ring (Fig. e) divided medially, with 6 setae and 2 rows of pores, 29.9 (28.7-31.0) long, 32.2 (28.7-34.5) wide; with inner row of pores with 8 and outer with 22 pores; with 6 setae, each 51.2 (46.0-55.2) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 179.4 (169.0-189.7), width 178.2 (166.7-189.7).

Labium (Fig. a) heart-shaped, 76.7 (69.0-92.0) long, 93.5 (80.5-103.4) wide; with 2 pairs of setae, 4.0 (4.0-4.0) long, these setae sometimes missing.

Antennae (Fig. f) one-segmented, cylindrical, surrounded by membranous folds, 19.9 (17.2-21.8) long, 24.3 (20.1-27.6) wide at base; with 3 (3-4) fleshy setae 26.4 (24.1-28.7) long, and 3 (2-3) slender setae 16.8 (16.1-17.2) long.

Spiracles (Fig. g) located between medial and marginal area; anterior 52.3 (48.3-56.3) long, 29.3 (28.7-29.9) wide, atrium 14.4 (13.8-14.9) in diam.; posterior 60.4 (58.6-62.1) long, 30.5 (28.7-32.2) wide, atrium 15.5 (14.9-16.1) in diam.; with 34 (30-37)

quinelocular pores in folds around atria; anterior spiracular furrows with a band of 58 (53-65) quinelocular pores, 4 (2-8) pores wide; posterior furrows with a band of 62 (50-69) quinelocular pores, 4 (2-7) pores wide.

8-shaped pores (Fig. h) in submarginal band with 194 (188-200) pores; band becomes a single row in posterior abdominal area; these pores not similar to usual ventral pores, but like dorsal 8-shaped pores; each bent, 6.3 (5.7-6.9) long, 4.6 (4.0-5.2) wide; also with rather large dark-rimmed pores (Fig. i) in transverse bands with about 250 pores, each 4.4 (4.0-4.6) long, 3.3 (3.0-3.4) wide.

Simple disk pores (Fig. j) in marginal row consisting of 97 (84-110) pores located in between marginal quinelocular pores, each 2.8 (2.3-2.9) in diam.

Quinelocular pores (Fig. k) in spiracular furrows and incomplete marginal band 1 pore wide anteriad and posteriad, and 2 pores wide in areas adjacent to spiracular furrows; band consists of 167 (152-186) pores; row ends 7 (5-12) 8-shaped pore lengths before apex of abdomen, and is interrupted for 12-20 8-shaped pore lengths anteriad; with 2 (0-3) pores between marginal band and each antenna, each 4.4 (4.0-4.6) in diam.

Multilocular pores (Figs. l, m) with 1 incomplete band consisting of 4 (0-6) pores; and 7 complete bands around genital opening with 11 (10-12), 15 (14-15), 23 (19-25), 30 (20-38), 29 (23-33), 22 (21-24), and 15 (7-20) pores, respectively; each 10 (9-14) loculi and 6.8 (6.3-6.9) in diam.

Setae with 3 segmental rows (Fig. n) corresponding to 3 bands of multilocular pores with 2 (0-2), 2 (2-3), and 2 setae, respectively; each 7.5 (5.7-9.2) long; also submarginal row with 10-12 setae (Fig. o), with 1 or 2 of these setae in sclerotized area

on either side of anal lobe, without setae in thoracic area, each 6.3 (5.7-6.9) long, setae on anal lobes 10.9 (10.3-11.5) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Argentina.

Economic importance: This species is of no economic importance.

Diagnosis: Large 8-shaped pores on dorsum and venter bent; pores in a marginal band on dorsum, similar smaller pores in a submarginal band on venter; apical setae 25-35 long; on *Acacia* from Argentina.

Affinities: *Asterolecanium quaesitum* seems to be closely related to the newly discovered species, *Al. multioctoporum*.

***Asterolecanium sanbernardense* Hempel, 1937**

Proposed Common Name: Sanbernard Pit Scale

Fig. 16

Asterolecanium sanbernardensis Hempel, 1937:18; D'Araujo e Silva et al., 1968:133.

Asterolecanium sanbernardense Russell, 1941:181; Lindinger, 1943:207; Borchsenius, 1960:158.

Type material: On Forest shrub, 10(5), cotype, 9 adult ♀♀, 1 first instar, São Bernardo, State of São Paulo, Brazil, coll., H.S. Lepage, 13 IV 1934 (USNM), no. 38-568, 2 slides mounted from dry material.

Additional host: On Myrtaceae (D'Araujo e Silva et al. 1968).

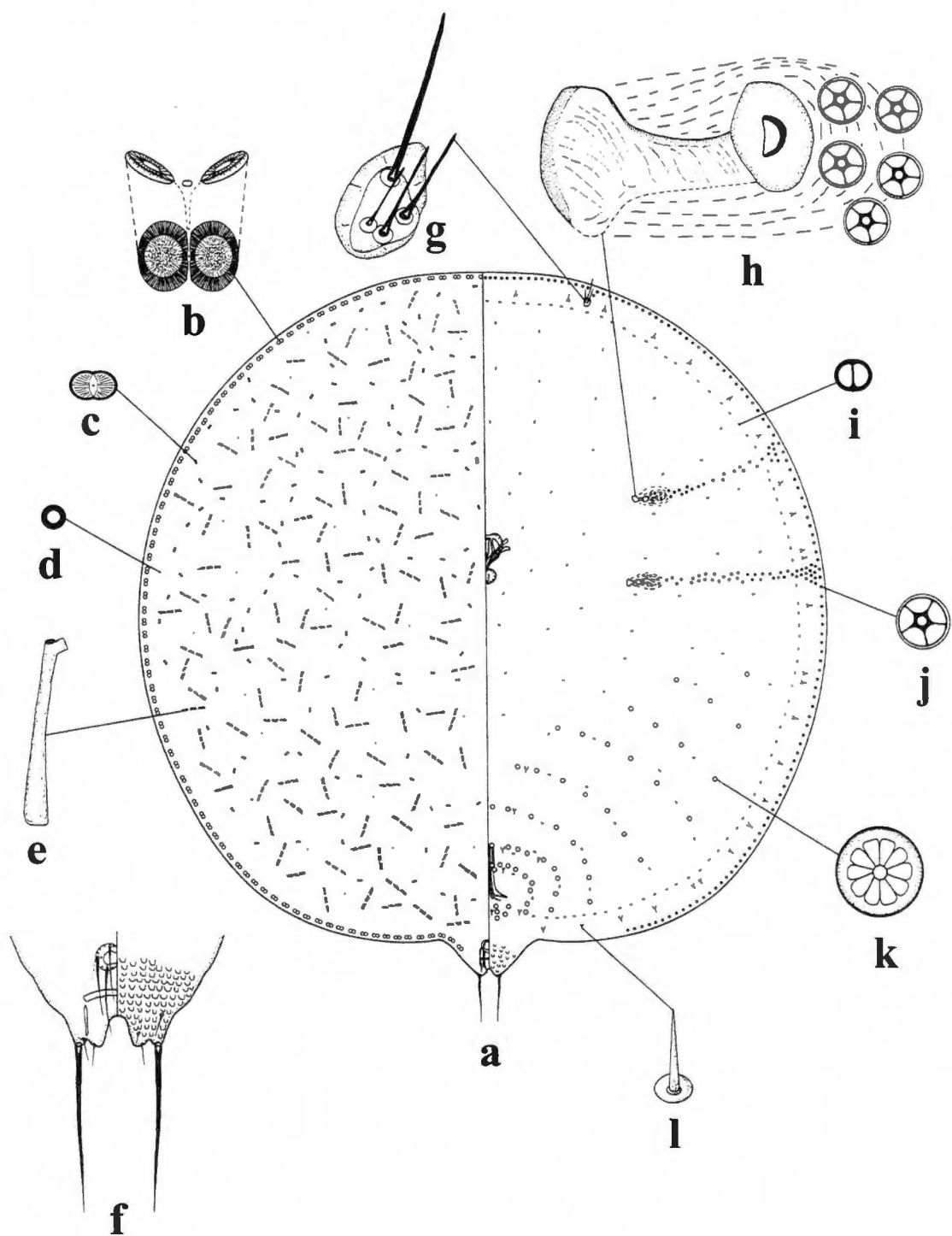


Fig. 16. *Asterolecanium sanbernardense* Hempel, 1937.

Description:

Body (Fig. a) circular, widest in metathoracic area, 1133 (980-1320) long, 1077 (770-1420) wide, with anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 185 (170-200) pores that terminates 2-3 pore lengths before apex of abdomen; pores bent, each 10.7 (10.3-10.9) long, 6.3 (5.7-6.9) wide; a large pore similar to marginal pores may also be present; minute pores (Fig. c) arranged in wide swirls over whole dorsum, consisting of 206 (170-248) pores; each 2.5 (2.3-2.9) long, 1.7 (1.4-2.0) wide.

Simple disk pores (Fig. d) spaced irregularly throughout derm; about 50 pores present, each 1.1 (1.1) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 23.4 (21.8-25.3) long, 3.2 (2.9-3.4) wide.

Anal lobes (Fig. f) with indentation, sclerotized ventrally; each anal lobe with one apical seta 77.6 (74.7-80.5) long, one subapical seta 10.1 (8.6-11.5) long, one dorsal seta 9.5 (7.5-11.5) long, one medial ventral seta 6.1 (5.7-6.3) long, and one outer ventral seta 11.2 (10.9-11.5) long.

Arched plate (Fig. f) length 36.4 (34.5-39.1).

Anal plates (Fig. f) separate, each 21.1 (17.2-23.0) long.

Anal ring (Fig. f) divided medially, 13.8 (13.0-14.2) long, 21.6 (19.0-26.4) wide, with 2 rows of pores, inner row of with 6 and outer with 14 pores; with 6 setae, each 36.4 (35.6-36.8) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 86.8 (80.5-93.1), width 81.7 (71.3-92.0).

Labium (Fig. a) heart-shaped, 41.4 (34.5-43.7) long, 52.9 (51.7-54.0) wide; with 3 pairs of setae, each 5.7 (5.7-5.7) long.

Antennae (Fig. g) one-segmented, 9.9 (8.0-11.5) long, 9.2 (8.0-11.5) wide at base; with 1 fleshy seta 24.5 (23.0-26.4) long, 2 (1-2) slender setae 16.8 (13.8-19.5) long, and 1 small seta 5.7 (3.4-8.0) long.

Spiracles (Fig. h) located between medial and marginal area; anterior 37.4 (36.8-37.9) long, 17.9 (16.7-19.0) wide, atrium 9.5 (8.0-10.9) in diam.; posterior 40.2 long, 18.1 (17.2-19.0) wide, atrium 9.8 (9.2-10.3) in diam.; with 11 (5-16) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 34 (22-44) quinquelocular pores, 2 (1-6) pores wide; posterior furrows with a band of 40 (25-59) quinquelocular pores, 2 (1-4) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 170 (136-192) pores; each 2.7 (2.3-2.9) long, 2.1 (1.7-2.3) wide; dark-rimmed pores with 124 (120-128) pores in transverse bands on whole venter; each 1.9 (1.7-2.3) long and wide.

Quinquelocular pores (Fig. j) in spiracular furrows and in a marginal row consisting of 244 (224-272) pores; row ends 10 (7-13) 8-shaped pore lengths before apex

of abdomen; with 1 (1-2) pores between marginal row and each antenna; each 3.2 (2.9-3.4) in diam.

Multilocular pores (Fig. k) with 4 incomplete rows consisting of 2, 6 (2-8), 8 (6-14), and 12 (12-14) pores, respectively; and 5 complete rows around genital opening with 15 (10-19), 16 (10-20), 18 (17-21), 15 (12-19), and 14 (11-16) pores, respectively; each 10 (8-10) loculi and 4.6 in diam.

Setae (Fig. l) with 5 segmental rows around genital opening corresponding to 5 complete rows of multilocular pores; rows with 2 setae in the two anterior rows, and with 4 (2-4), 2, and 4 (2-4) setae, respectively, in the posterior rows; each 5.2 (4.6-5.7) long; also submarginal row with 50 (44-56) setae, these sometimes in pairs, each 5.9 (4.6-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil.

Economic importance: This species is of no economic importance.

Diagnosis: Dorsal 8-shaped pores smaller than marginal 8-shaped pores; on Myrtaceae from Brazil.

Affinities: *Al. sanbernardense* may be an advanced species. According to the cladistic analysis, it clusters close to the *Palmaspis*-*Grammococcus*-*Asterodiaspis*-*Neoasterodiaspis* clade.

Asterolecanium townsendi Cockerell, 1902

Proposed Common Name: Townsend's Pit Scale

Fig. 17

Asterolecanium townsendi Cockerell, 1902e:468, 1903:112; Fernald, 1903:53; MacGillivray, 1921:189; Russell, 1941:207; Habib, 1943:87; Ferris, 1955:26; Miller, 1996:69.

Type material: On Guasima (wild), 32(2), type, 1 adult ♀, 6 second instar ♀♀, 25 first instars, Platanas, Jalisco, Mexico, VII 1903 (USNM), T.B.Cy no. 68.

Description:

Body (Fig. a) subcircular, widest in spiracular area, 1360 long and wide, with anal indentation; specimen folded, therefore actual length underestimated. Derm membranous, with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row that terminates 4 pore lengths before apex of abdomen; row with 180 pores, all pores bent, 11.5 long, 6.9 wide. Other pores in 3 sizes; arranged in swirls over whole dorsum; largest pores 16.7 long, 11.5 wide; medial pores 14.9 long, 10.3 wide; and smallest pores 13.2 long, 9.2 wide; without minute 8-shaped pores.

Simple disk pores (Fig. c) evenly distributed over dorsum, consisting of about 100 pores; also marginal row with 100 pores, each 1.7 in diam.

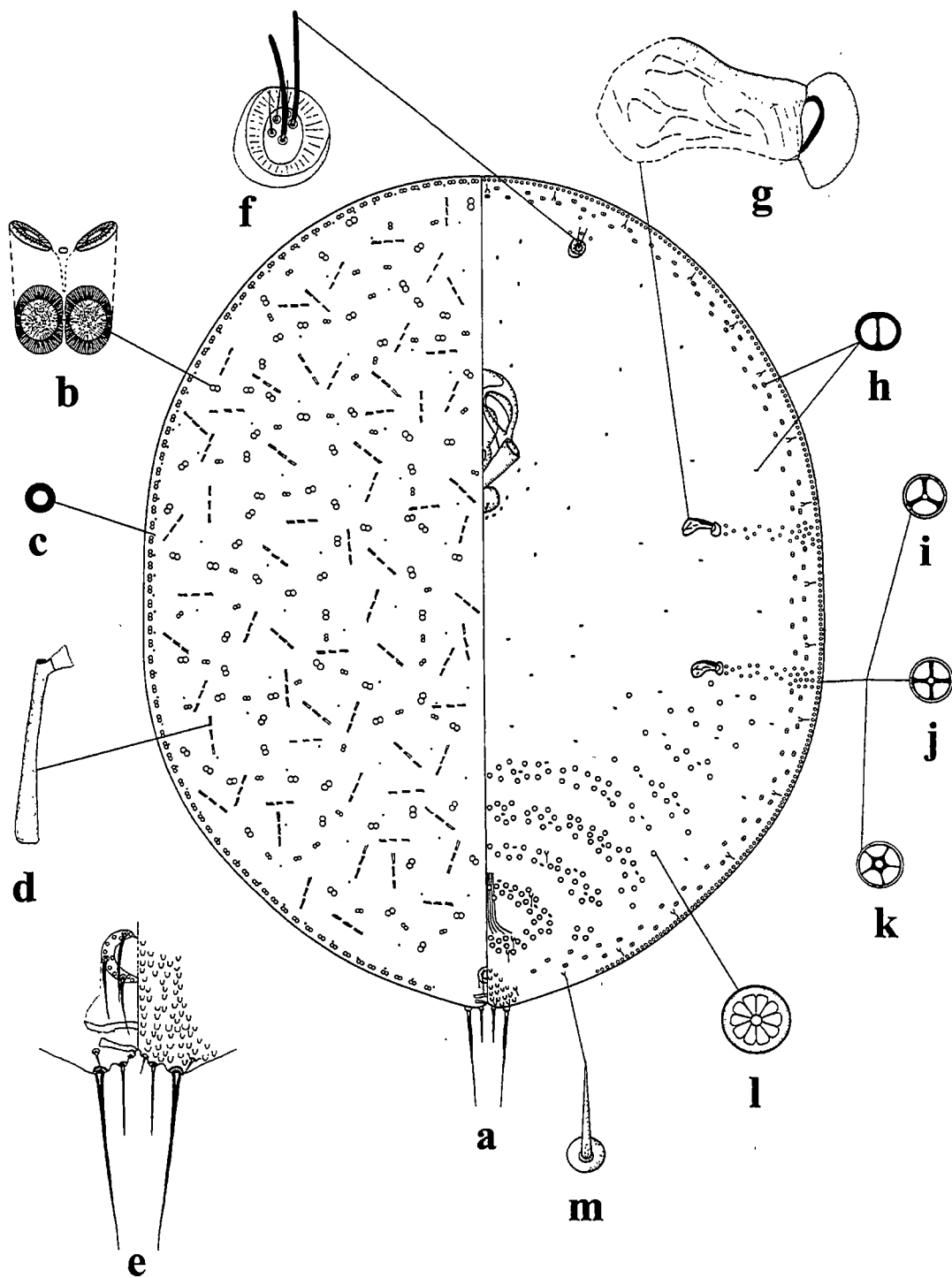


Fig. 17. *Asterolecanium townsendi* Cockerell, 1902.

Tubular ducts (Fig. d) evenly distributed throughout derm, each 35.6 long, 4.6 wide.

Anal lobes (Fig. e) with anal indentation, sclerotized ventrally; each anal lobe with one apical seta, one subapical seta, and one dorsal seta, these setae all broken; each lobe also with one medial ventral seta 9.2 long, and one outer ventral setae 12.6 long. Broken setae are drawn according to Russell's (1941) illustration.

Arched plate (Fig. e) bar-shaped, 50.6 long.

Anal plates (Fig. e) separated, bar-shaped, each plate 28.7 long.

Anal ring (Fig. e) located anteriad of arched plate, divided medially, 20.7 long and 24.1 wide; with 2 rows of pores number of pores in rows indeterminable, according to Russell (1941) inner row with 6 pores and outer row with 14 pores, illustration also depicted in this way; with 6 setae, each 33.3 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 187.4, width 132.2.

Labium (Fig. a) heart-shaped, 69.0 long, 77.0 wide; with 2 pairs of setae, 2.3 long.

Antennae (Fig. f) one-segmented, circular, sunken into derm, 26.4 long, 28.7 wide at base; with 2 fleshy setae 20.7 long, and 3 slender setae 5.7 long.

Spiracles (Fig. g) located in submarginal area; anterior 57.5 long, 25.9 wide, atrium 13.8 in diam.; posterior 49.4 long, 24.7 wide, atrium 14.9 in diam.; anterior spiracular furrows with a band of 24 quinquelocular pores, 2 (1-3) pores wide; posterior furrows with a band of 31 quinquelocular pores, 2 (1-3) pores wide.

8-shaped pores (Fig. h) in submarginal band with 170 pores; each 4.6 long and 3.4 wide; dark-rimmed pores with about 100 pores in rows over whole venter, and with 7 pores in two clusters laterad of labium and ventro-laterad of clypeolabral shield; each 3.4 long, 2.9 wide.

Trilocular pores (Fig. i) and **quatrolocular pores** (Fig. j) in spiracular furrows and marginal row together with quatrolocular and quinquelocular pores, only a few pores present, same size as quinquelocular pores.

Quinquelocular pores (Fig. k) in spiracular furrows and in marginal row consisting of 452 pores; row ends about 5 8-shaped pore lengths before apex of abdomen; with 5 pores between margin and each antenna; each 3.4 in diam.

Multilocular pores (Fig. l) with 5 incomplete bands consisting of 4 pores in the anterior 2 rows, and 12, 14, and 20 pores in the other 3 rows; and 5 complete bands around genital opening with 52, 74, 50, 43, and 19 pores, respectively; each 10 (9-11) loculi and 6.3 in diam.

Setae (Fig. m) with 3 segmental rows around genital opening corresponding to 3 complete bands of multilocular pores, each with 2 setae, posterior row with 4 setae, each 10.3 long; also submarginal row with 34 setae, each 9.2 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: With several 8-shaped pore sizes in swirls over dorsum, large 8-shaped pores larger than marginal 8-shaped pores; on Guasima from Mexico.

Affinities: *Asterolecanium townsendi* may be closely related to *Al. viridulum* based on pore distribution and spiracular and antennal morphology.

***Asterolecanium viridulum* Cockerell, 1902**

Proposed Common Name: Argentine Pit Scale

Fig. 18

Asterolecanium viridulum Cockerell, 1902a:89, 1902b:251, 1903:112; Fernald, 1903:54; Morrison, 1919:66; MacGillivray, 1921:189; Hempel, 1937:36; Russell, 1941:223; Habib, 1943:87; D'Araujo e Silva et al., 1968:134.

Type material: On "kind of iron weed", 4(1), type, all adult ♀♀, Tucuman, Argentina, coll., J. Brunoso, 26 VII 1897 (USNM), no. 14564, "Ckll. Coll".

Additional material studied: On "Mio-Mio", 4(1), all adult ♀♀, Corrientes, Argentina, coll., H.H. Kisliuk, 20 I 1927 (USNM), Kisliuk no. 882, "Mio-Mio", *Baccharis cordifolia*, no. 39-1044.

Additional hosts: Compositae, *Eupatorium* sp., *Vernonia* sp. (D'Araujo e Silva et al. 1968, Morrison 1919, Russell 1941).

Description:

Body (Fig. a) circular, widest in spiracular area, 1472 (1300-1680) long, 1452 (1360-1600) wide, with anal indentation. Derm membranous with 4 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

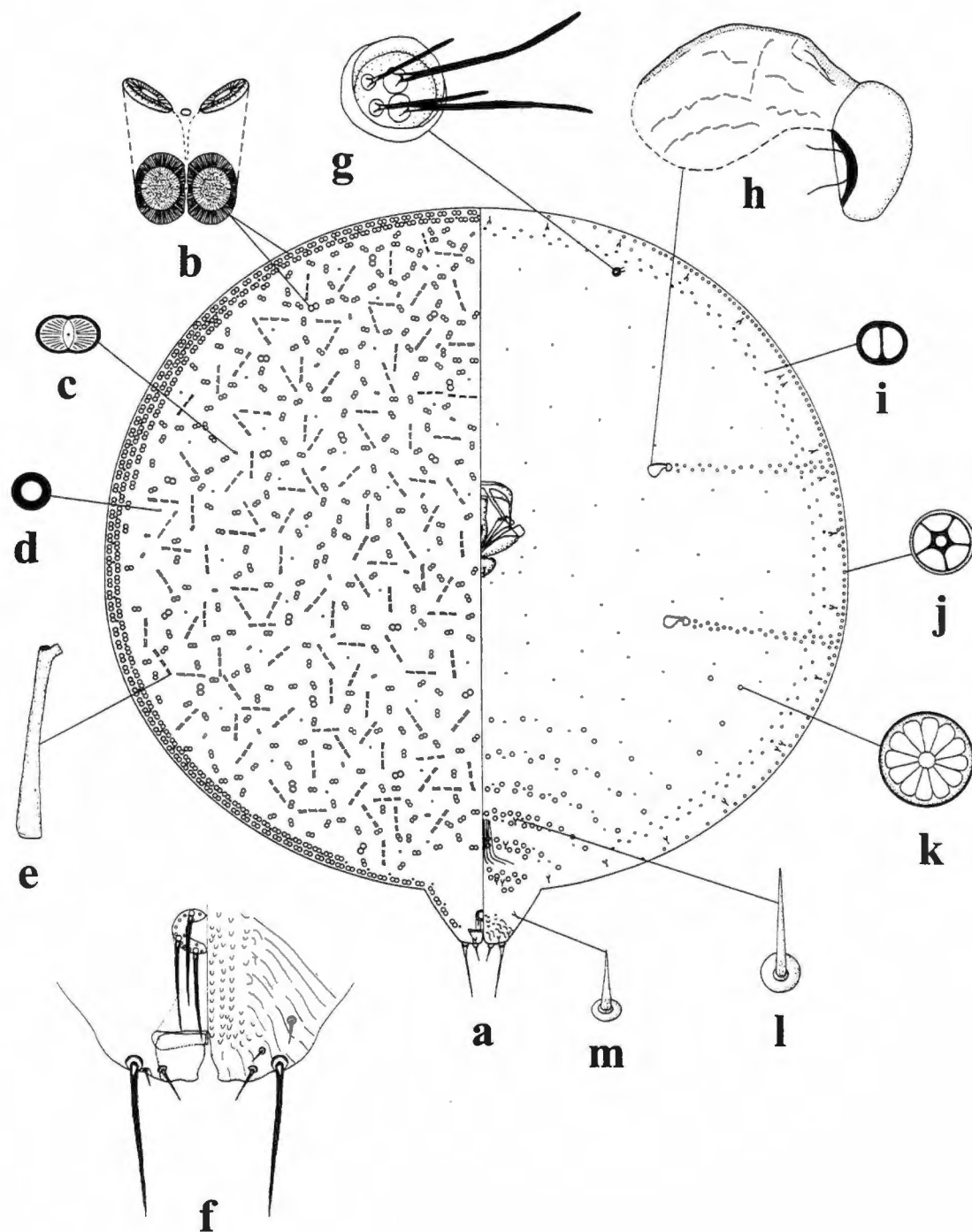


Fig. 18. *Asterolecanium viridulum* Cockerell, 1902.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a double row with 375 (304-446) pores; row becomes single in anal area, and becomes triple where prothoracic spiracular furrows meet the margin; row terminates 2-3 pore lengths before apex of abdomen; all pores bent, 11.5 (10.9-12.1) long, 6.9 (6.3-7.5) wide. Other pores in 4 sizes; pores arranged in swirls over whole dorsum; largest pores 11.9 (11.5-12.6) long, 6.8 (6.3-6.9) wide; medial pores 9.4 (8.0-10.3) long, 5.6 (4.6-6.3) wide; and smallest pores 6.2 (5.7-6.9) long, 4.0 (3.4-4.6) wide; minute pores (Fig. c) arranged within swirls; each 3.6 (2.9-4.6) long, 2.3 (1.7-2.9) wide.

Simple disk pores (Fig. d) evenly distributed over dorsum, consisting of about 80 pores; also a marginal row with about 70 pores among marginal 8-shaped pore; each 2.4 (2.3-2.9) in diam.

Tubular ducts (Fig. e) evenly distributed, each 30.8 (27.6-34.5) long, 3.5 (3.4-4.0) wide.

Anal lobes (Fig. f) with indentation, sclerotized ventrally; each anal lobe with one apical seta 55.2 (42.5-69.0) long, one subapical seta 13.9 (13.8-14.4) long, one dorsal seta 5.7 (4.6-6.9) long, one medial ventral seta 5.7 (4.6-8.0) long, and one outer ventral seta 8.8 (8.0-9.8) long.

Arched plate (Fig. f) bar-shaped, 55.8 (51.7-59.8) long.

Anal plates (Fig. f) separated, rectangular, each plate 28.0 (26.4-29.9) long, 24.8 (20.7-34.5) wide.

Anal ring (Fig. f) located anteriorly of arched plate, divided medially, 28.7 long and 40.2 (31.0-48.3) wide; with 2 rows of pores, inner row of pores with 6 and outer with 18 pores; with 6 setae, each 50.6 (46.0-57.5) long, setae in thin membranous fold between anal ring and anal plates.

Ventral Surface

Clypeolabral shield (Fig. a) length 135.6 (126.4-155.2), width 128.6 (125.3-133.3).

Labium (Fig. a) heart-shaped, 60.7 (55.2-69.0) long, 69.4 (63.2-74.7) wide; with 2 pairs of setae, 4.3 (3.4-5.7) long.

Antennae (Fig. g) one-segmented, circular, sunken into derm, 19.9 (17.2-23.0) long, 21.6 (18.4-31.0) wide at base; with 2 fleshy setae 21.8 (17.2-28.7) long, and 2 slender setae 9.4 (6.9-13.8) long.

Spiracles (Fig. h) located between medial and marginal area; anterior 49.6 (42.5-55.2) long, 24.0 (21.3-26.4) wide, atrium 11.4 (9.2-13.2) in diam.; posterior 52.5 (49.4-55.2) long, 24.1 (23.6-25.3) wide, atrium 11.7 (10.3-13.2) in diam; anterior spiracular furrows with a band of 27 (25-29) quinquelocular pores, 2 (1-3) pores wide; posterior furrows with a band of 28 (25-31) quinquelocular pores, 2 (1-3) pores wide.

8-shaped pores (Fig. i) in a submarginal band with 202 (160-248) pores; each 3.8 (3.4-4.0) long, 3.0 (2.3-3.4) wide; dark-rimmed pores with 130 (120-140) pores in transverse rows over whole venter; also with 6 (5-6) pores on each side of mouthparts; each 2.7 (2.3-3.4) long, 2.2 (1.7-2.9) wide.

Quinquelocular pores (Fig. j) in spiracular furrows and marginal row consisting of 224 (184-264) pores; row ends 17 (5-27) 8-shaped pore lengths before apex of abdomen; row occasionally double, less dense apically, interrupted for 16 (0-30) 8-shaped pores anteriorly, with 1 (0-2) pores between margin and each antenna, each 3.9 (3.4-4.0) in diam.

Multilocular pores (Fig. k) with 3 incomplete rows consisting of 4 pores in the anterior row and 2 pores in the other rows; and with 6 complete bands around genital opening with 13 (7-18), 19 (16-22), 26 (24-28), 31 (22-40), 23 (20-26), and 20 pores, respectively; each 12 (10-12) loculi, 5.9 (5.7-6.3) in diam.

Setae with 3 segmental rows (Fig. l) around genital opening corresponding to 3 complete bands of multilocular pores, each with 2 setae, posterior row with 4 setae, each 7.9 (6.9-8.6) long; also submarginal row with 39 (32-44) setae (Fig. m), these occasionally in pairs, each 6.2 (5.7-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Argentina, Brazil.

Economic importance: This species is of no economic importance.

Diagnosis: Anal plates rectangular, tentorial sclerotization present (Fig. 3), with double or triple row of marginal 8-shaped pores.

Affinities: Pore distribution and spiracular and antennal morphology place *Al. viridulum* close to *Al. townsendi*.

Genus *Bambusaspis* Cockerell, 1902

Bambusaspis Cockerell, 1902c:114; Sanders, 1906:3; Borchsenius, 1950c:781, 1960:133, 1961:65; Bodenheimer, 1951:328; Morrison & Morrison, 1966:22; Kozar & Walter, 1985:80; Williams & Butcher, 1987:94; Williams & Watson, 1990:199; Gill, 1993:102; Longo et al., 1994:22, 1995:125; Stumpf & Lambdin, 1998:35.

Type species: *Chermes miliaris* Boisduval, 1869:262, by subsequent designation of Sanders (1906:3).

Asterolecanium Fernald, 1903:49; Takahashi, 1928:339, 1930:10, 1933:34, 1936:116, 1941:217, 1942:353, 1956:4; Wolcott, 1936:122, 1941:57; Russell, 1941:4; Zimmerman, 1948:277; Ferris, 1955:15; Beardsley, 1966:497; Lambdin, 1977a:625; Bennett & Alam, 1985:12; Miller, 1985:105. *Asterodiaspis* Koteja, 1976:278.

Generic description:

Dorsum: With marginal row or band of 8-shaped pores, bent, rarely flat, row sometimes interrupted; dorsal 8-shaped pores present or absent, minute 8-shaped pores present in most species, absent in some; with simple disk pores and tubular ducts, simple disk pores on whole dorsum and in submarginal row, in some species also on venter; anal ring with 6 setae in most species, reduced and plate-like in some species; with arched plates and 2 anal plates on anal lobes present in all species with 6 anal ring setae; anal lobes only weakly developed, with small anal indentation; with a pair of caudal tubes. Venter: With one-segmented antennae, tentorial sclerotization arch-like in most species, labium without setae in most species; 8-shaped pores near mouthparts, in marginal row, and in transverse rows, mainly on abdomen; legs absent, quinquelocular pores in spiracular

furrows and marginal row; with multilocular pores in abdominal rows present in a few species; submarginal row of setae restricted to thoracic and abdominal region in most species.

Diagnosis: With a pair of caudal tubes. On bamboo.

Hosts: Members of the genus *Bambusaspis* are restricted to bamboo as host plant.

This genus was most likely introduced from the Oriental faunal region with ornamental bamboo.

***Bambusaspis bambusae* (Boisduval), 1869**

Proposed Common Name: Bamboo Pit Scale

Fig. 19

Chermes bambusae Boisduval, 1869:261. *Asterolecanium bambusae* Signoret, 1870:280, 1876b:643; Targioni-Tozzetti, 1892:301; Cockerell, 1893a:77, 1893b:8, 1893c:255, 1893e:382, 1894a:307, 1896:9, 1897a:328, 1902b:251, 1902c:114, 1902d:454; Maskell, 1894:94; Hempel, 1900:409; King, 1902:404; Newstead, 1903:151; Fernald, 1903:49; Kuwana, 1909:151; Green, 1909:328, 1928:Plate II; Kotinsky, 1910:127; Lindinger, 1912:82, 379, 1935:130; Ehrhorn, 1913:123; Doane & Ferris, 1916:399; Brain, 1920:112; MacGillivray, 1921:189; Wilson, 1921:21; Hall, 1922:3; Bodenheimer, 1924:73; Laing, 1927:35; Ogilvie, 1928:24; Alfieri, 1929:8; Takahashi, 1930:41, 42, 1936:116, 1941:217, 1942:353, 1956:6; Balachowsky, 1932:XXIV; Wolcott, 1936:122, 1941:57, 1948:160, 1953:230, 1960:169; Borchsenius, 1937b:8, 170, 243, 1950b:134; Bartlett, 1938:493, 1939a:100, 103, 104, 106, 1939b:339; Silvestri, 1939:688; Russell, 1941:47; Fullaway, 1946:158; Zimmerman, 1948:278; Merrill, 1953:112; Ferris, 1955:18; Habib, 1957:376;

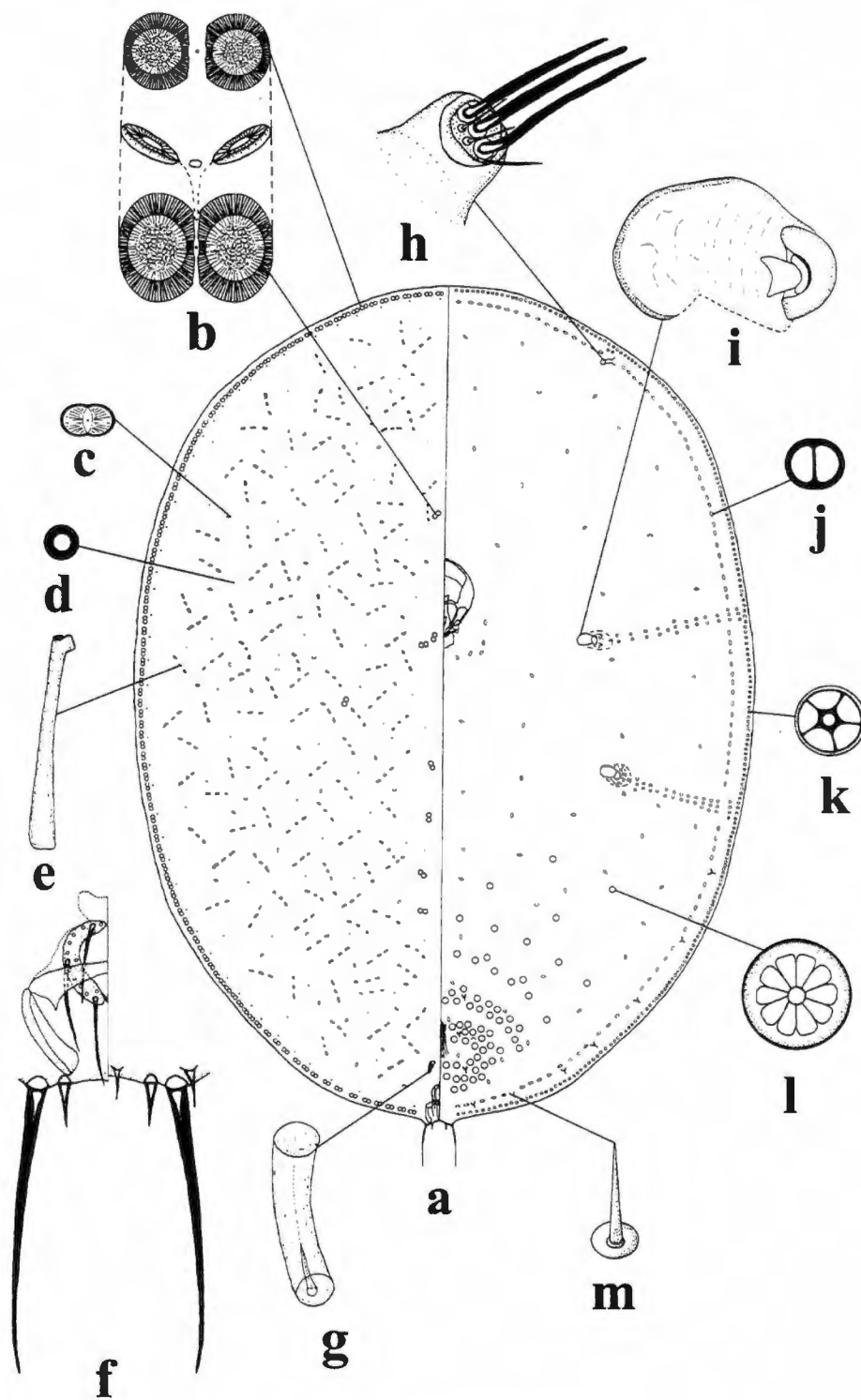


Fig. 19. *Bambusaspis bambusae* (Boisduval), 1869.

Mamet, 1957:369; Cohic, 1958:8, 21; Essig, 1958:301; Hinckley, 1963:30; Beardsley, 1966:499; D'Araujo e Silva et al., 1968:132; Herting, 1972:135; Bruner et al., 1975:34, 125; Koteja & Liniowska, 1976:675; Bartlett, 1978:46; Hamon, 1980:1; Bennett & Alam, 1985:12; Miller, 1985:106; Farag et al., 1990:153; Zohdi et al., 1990:149. *Planchonia fimbriata* var. *bambusae* Maskell, 1895b:62. *Planchonia bambusae* Maskell, 1895c:135; Green, 1896:5; Newstead, 1897b:75. *Asterolecanium bambusae* var. *bambusulae* Cockerell, 1897b:590; Fernald, 1903:50. *Asterilecanium bambusae* Lindinger, 1924:179. *Bambusaspis bambusae* Borchsenius, 1960:134; Kozar & Walter, 1985:80; Williams & Butcher, 1987:94; Williams & Watson, 1990:201; Zhang, 1992:53; Gill, 1993:102; Longo et al., 1994:18, 1995:125; Jansen, 1995:134, 142. *Asterodiaspis bambusae* Koteja, 1976:278.

Type material: Auf *Bambusa* sp., 1(1), type series, adult ♀, Algerium, det. Sign., det. Löw (USNM), no. 44 1404.

Additional material studied: On bamboo, 5(1), type of *Ba. bambusae bambusulae* (Bdv.), all adult ♀♀, Botanic gardens, Grenada, W. Indies, coll., W.E. Broadway, 16 II 1896 (USNM); *Bambusa* sp., 4(4), all adult ♀♀, FL, Coral Gables, coll., D. Martinelli, 14 II 1987 (FSCA), labeled K-846; *Bambusa* sp., 2(2), all adult ♀♀, FL, Arcadia, coll., Z. Smith & T. Smith, 6 XI 1979 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, FL, Crescent City, coll., W. J. Shirley & G.T. Smith, 29 XI 1978 (FSCA), labeled L-113; *Bambusa* sp., 6(6), all adult ♀♀, FL, Vero Beach, coll., S.P. Beidler, 25 VIII 1979 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, FL, Lake Buena Vista, coll., F.L. Ware, 12 VIII 1974 (FSCA), labeled K-342; *Bambusa* sp., 3(3), all adult ♀♀, FL, Jacksonville, coll., K.

Elliott, 12 II 1976 (FSCA); *Bambusa* sp., 5(5), all adult ♀♀, FL, Salt Springs, coll., F.
 McHenry, 24 X 1977 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, FL, Leesburg, coll., R.
 Driggers, 4 XII 1979 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, FL, Ft. Myers Beach, K.
 Delate, 4 IV 1980 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, FL, Cocoa, coll., R.E. Burns,
 29 X 1979 (FSCA); dry bamboo, 1(1), adult ♀, Chicago, IL, coll., F.O. Dadd, 12 X 1944
 (USNM), nos. Chicago 1165, H.P.O. 25, 44 1755; bamboo, 39(10), 18 adult ♀♀, 1
 second instar ♀, 20 first instars, Rio Frio Province, Heredia, Costa Rica, coll., M.
 Kosztarab, 7 I 1970 (USNM), no. Herb. C-417.

Material studied with several different spp.: On bamboo, 2(1), 2 adult ♀♀,
Bambusaspis bambusae, 5 adult ♀♀, *Bambusaspis tetrasetosa*, Cuba, at Key West, coll.,
 R.G. Milner, 11 II 1960 (USNM), no. 463; bamboo, 2(1), 2 adult ♀♀, *Bambusaspis*
bambusae, 3 adult ♀♀, *Bambusaspis tetrasetosa*, St. Leo Abbey, San Antonia, FL, coll.,
 E.A. Black, VI 1938 (USNM), no. 38-312728.

Additional hosts: *Alphonse kurri*, *Arundinacea* sp., *Arundinaria* sp., *Arundo*
donax, *Bambusa alphonse kurri*, *B. argentea-striata*, *B. arundinacea*, *B. aurea*, *B. aureo-*
striata, *B. balcoa*, *B. beecheyana*, *B. blumeana*, *B. distorta*, *B. macroculmis*, *B. multiplex*
var. disticha, *B. multiplex var. distincta*, *B. nana*, *B. palmata*, *B. spinosa*, *B. thouarsii*, *B.*
tulda, *B. ventricosa*, *B. viridis-striata*, *B. vulgaris*, *Bambusa* sp., *Dendrocalamus*
giganteus, *D. latiflorus*, *D. strictus*, *Dendrocalamus* sp., *Gigantochloa aspera*, *G.*
scribneriana, *Gigantochloa* sp., *Oxytenanthera abyssylvania*, *Oxytenanthera* sp.,
Phyllostachys sp., and *Schizostachyum glaucifolium* (Alfieri 1929, Bartlett 1939a,
 Boissduval 1869, Borchsenius 1950b, Bruner et al. 1975, Farag et al. 1990, Gill 1993,

Green 1909, Habib 1957, Hamon 1980, Hinckley 1963, Jansen 1995, Longo et al. 1994, Newstead 1897b, Russell 1941, Signoret 1870, Wilson 1921). Apparently, the bamboo pit scale may also occur on hosts different from bamboo. Habib (1957) describes this species from Egypt occurring on the following additional host plants: *Acalipha marginata*, *Dianthus* sp., *Thuja orientalis*, and on orchids.

Description:

Body (Fig. a) semicircular, widest in spiracular area, 1546 (1300-1870) long, 1182 (900-1520) wide, without anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row with 336 (286-387) pores that terminates 1-2 pore lengths before apex of abdomen; pores bent, each 10.0 (9.2-11.5) long and 5.0 (4.6-5.7) wide. Other pores with 2 pore sizes; large pores arranged in 6 (3-8) medial clusters with 2 (1-5) pores in each cluster, sometimes with additional submedian pores; pores bent, each 12.6 (10.3-13.8) long, 8.3 (6.9-9.8) wide; minute pores (Fig. c) evenly distributed, each 2.0 (1.7-2.3) long, 1.3 (1.1-1.7) wide.

Simple disk pores (Fig. d) evenly distributed, consisting of 106 (30-200) pores; each 1.3 (1.1-1.7) in diam.; also submarginal row close to marginal 8-shaped pores with 109 (84-133) pores.

Tubular ducts (Fig. e) numerous throughout derm, each 27.3 (24.3-29.3) long, 3.4 (2.9-3.4) wide.

Anal lobes (Fig. f) without indentation; each anal lobe with one apical seta 77.1 (69.0-85.1) long, one subapical seta 9.3 (6.3-11.5) long, one inner ventral seta 6.4 (4.6-8.0) long, and one outer ventral seta 9.6 (8.0-11.5) long.

Arched plate (Fig. f) with distinct lateral spike, 32.3 (26.4-37.9) long.

Anal plates (Fig. f) separated, bar-shaped, 19.4 (12.6-23.0) long.

Anal ring (Fig. f) located anterior of anal plates, divided medially, 13.9 (10.3-23.0) long, 19.5 (17.2-21.8) wide; with 2 rows of pores inner row with 6, outer with 18 (16-20) pores; with 6 setae, each 35.0 (27.6-41.4) long.

Caudal tubes (Fig. g) anterior of anal ring; each caudal tube 26.3 (18.4-29.9) long, 5.8 (4.6-8.0) wide.

Ventral Surface

Clypeolabral shield (Fig. a) with tentorial sclerotization arch-like; clypeolabral shield 170.2 (151.7-186.2) long, 130.8 (112.6-147.1) wide.

Labium (Fig. a) heart-shaped, without setae, 29.5 (25.9-35.1) long, 40.2 (36.2-44.8) wide.

Antennae (Fig. h) one-segmented, 9.9 (6.9-13.8) long, 10.6 (6.3-13.8) wide at base; with 2 (2-4) fleshy setae 14.5 (9.2-21.8) long, and 2 (1-2) slender setae 4.7 (1.7-11.5) long.

Spiracles (Fig. i) located between medial and marginal area; anterior 37.9 (35.6-40.2) long, 14.8 (12.6-17.2) wide, atrium 8.8 (8.0-10.3) in diam.; posterior 41.7 (35.6-46.0) long, 16.1 (13.8-20.1) wide, atrium 9.4 (8.0-10.9) in diam.; with 3 (0-5) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 30

(19-42) quinquelocular pores, 2 (1-3) pores wide; posterior furrows with a band of 34 (24-42) quinquelocular pores, 2 (2-3) pores wide.

8-shaped pores (Fig. j) in a submarginal row with 202 (171-234) pores; dark-rimmed pores in transverse rows over whole venter with 119 (60-200) pores; also with row of 4 (0-6) pores on each side of mouthparts; pores 2.2 (1.7-2.3) long, 1.5 (1.1-1.7) wide.

Quinquelocular pores (Fig. k) in spiracular furrows and in a marginal row consisting of 494 (346-693) pores, row ends together with 8-shaped pores before apex of abdomen; with 3 (0-6) pores between margin and antennae, each 2.4 (2.3-2.9) in diam.

Multilocular pores (Fig. l) with 1 (0-3) incomplete rows consisting of 4 (0-8) pores each; and 5-6 complete bands around genital opening with 4 (0-8), 10 (6-16), 16 (10-29), 32 (20-37), 30 (20-37), and 28 (16-38) pores, respectively; each 10 (10-11) loculi and 4.5 (4.0-4.6) in diam.

Setae (Fig. m) with 3 segmental rows corresponding to 3 complete bands of multilocular pores, each with 2 setae, anterior row sometimes missing; each 5.1 (3.4-6.3) long; also submarginal row restricted to abdominal area with 14 (8-16) setae, each 4.0 (1.7-5.2) long.

Biological data: Cockerell (1893e) believes to have seen both males and females of this species. Green (1896) states "male unknown". Newstead (1897b) did not observe the male in any stage. Green (1909) claims to possibly have found a male puparium, but is not certain. Hamon (1980) and Gill (1993) refer to the bamboo pit scale as a parthenogenetic species. Gill (1993) states that all generations can be found on the host

plant at all times. *Ba. bambusae* is the only known parthenogenetic species in the genus *Bambusaspis*. Parthenogenesis may have evolved several times independently in the pit scales (see genera *Asterodiaspis* and *Neoasterodiaspis*, and *Asterolecanium epidendri*).

Parasitoids and predators: The following coccinellid species were listed by Bartlett (1938) from Puerto Rico and Guiana: *Azya trinitatis* Marshall, *A. pontbrianti* Mulsant, *Cryptognatha nodiceps* Marshall, *Delphastus* sp., *Pentilia castanea* Mulsant, and *Pentilia* sp. Bartlett (1939a, b) described the release of *A. trinitatis*, *Cheiloneurus* sp. (Encyrtidae), *Delphastus* sp., *Exochomus* sp. (Coccinellidae), *E. orbiculus* (Weise), *Hyperaspis bellotii* (Coccinellidae), *Scymnillodes* sp. (Coccinellidae), *Scymnus* sp. (Coccinellidae), *Stethorus* sp. (Coccinellidae), *P. castanea*, *P. egena* Mulsant, and *Curinus* sp. (Coccinellidae) against the bamboo pit scale. Wolcott (1953, 1960) reported consistent feeding of the imported coccinellids *Cladis nitidula* F. and *Chilocorus cacti* L. on the bamboo pit scale in Puerto Rico. Bruner et al. (1975) reported *Catana clauseni* Chpn., *Exochomus cubensis* Dimm., and *Egius platycephalus* Mulsant (Coccinellidae) as predators of *Ba. bambusae*. Herting (1972) listed *Azya* nr. *luteipes* Mulsant, *A. trinitatis*, *Chilocorus cacti*, *C. stigma* Say, *Cladis nitidula*, *Cryptognatha nodiceps*, *Cryptolaemus montrouzieri* Mulsant, *Curinus* sp., *Cycloneda sanguinea* L., *Delphastus* sp., *E. platycephalus* Mulsant, *Exochomus jourdani* Mulsant, *E. orbiculus*, *Hyperaspis festiva* Mulsant, *Ladoria desarmata* Mulsant, *Pentilia* sp., *P. castanea*, *P. egena*, *Scymnillodes cyanescens* Sicard, and *Scymnus* sp. as coccinellid predators, *Kearfottia* sp. (Tineidae) as lepidopteran predator, and *Cheiloneurus* sp. (Encyrtidae) as possible hyperparasitoid. Bartlett (1979) reported the establishment of *C. nitidula* in Martinique and Puerto Rico

and of *C. cacti* in Cuba, TX, and LA. The stigmaeid mite, *Agistemus exsertus* Gonzalez was found to consume a large number of eggs of *Ba. bambusae* (Farag et al. 1990, Zohdi et al. 1990).

Distribution: AL, CA, D.C., FL, GA, HI, IL, IN, LA, MO, MS, NY, PA, SC, TX; Antigua, Argentina, Barbados, Bermuda, Brazil, British Guiana, Costa Rica, Cuba, Dominica, Dominican Republic, Dutch Guiana, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Panama, Puerto Rico, Tobago, Trinidad, Venezuela, Virgin Islands, West Indies; Algeria, Angola, Australia, China, Cook Island, Congo, Egypt, French Polynesia, Gold Coast, Great Britain, Guam, Guyana, India, Israel, Italy, Japan, Marianna Islands, Mauritius, Namibia, Netherlands, New Caledonia, Palau Islands, Papua New Guinea, Philippines, Reunion, Samoa, Sri Lanka, Vanuatu, Western Samoa. This species is distributed worldwide in greenhouses and where bamboo is grown.

Economic importance: This species, along with *Ba. miliaris*, is perhaps the most important pest on bamboo. However, it is of no importance in California (Gill 1993). Hamon (1980) refers to this insect as being "a serious pest when populations become very large".

Diagnosis: With arch-like tentorial sclerotization and multilocular pores; length of body 1300-1900; length of apical setae 69-85.

Affinities: Closely related to other *Bambusaspis* species with the tentorial arch on the clypeolabral shield, especially to *Ba. miliaris*, *Ba. bambusicola*, and *Ba. caudata*.

***Bambusaspis bambusicola* (Kuwana), 1916**

Proposed Common Name: Kuwana's Pit Scale

Fig. 20

Asterolecanium bambusicola Kuwana, 1916:146; Russell, 1941:49; Takahashi, 1956:6.

Asterolecanium bambusae var. *tuberculata* Takahashi, 1928:339. *Bambusaspis*

bambusicola Borchsenius, 1960:134; Koteja & Liniowska, 1976:675; Kozar & Walter, 1985:80.

Type material: On bamboo stem, 1(1), type?, adult ♀, Japan, colls., J.

Kuwana, E.E. Green, rec'd XII 1933, 5 X 1913 (USNM), no. 37 9468, this specimen called "possibly type" by Russell (1941).

Additional material studied: On *Bambusa* sp., 2(2), all adult ♀♀, FL, Glen St. Mary, coll., C. Webb, 23 I 1978, (FSCA); *Bambusa* sp., 1(1), adult ♀, FL, West Palm Beach, coll., J. Bennett, 27 X 1977, (FSCA); *Bambusa* sp., 1(1), adult ♀, FL, Bushnell, coll., G.T. Smith, 5 XII 1977, labeled K-802, (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, FL, Miami, coll., T. Stansbery, 28 IV 1977, labeled K-704, (FSCA); *Bambusa nana*, 3(3), all adult ♀♀, FL, Sarasota, coll., C. J. Bickner, 18 I 1972, labeled J-6, (FSCA); *Bambusa multiplex* "Fernleaf", 1(1), adult ♀, FL, Daytona Beach, coll., J. N. Pott, 10 VI 1968, (FSCA); *Bambusa* sp., 4(4), all adult ♀♀, FL, Winter Haven, coll., "Training Class no. 21", 15 VIII 1970, labeled I-360, (FSCA); *Bambusa* sp., 1(1), adult ♀, FL, Gainesville, coll., A.E. Graham, 23 II 1970, labeled I-466-B, (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, Georgia: Clinch Co., R. Beshear, 1 X 1966, labeled H964, (FSCA).

Additional host: *Phyllostachys bambusoides* (Russell, 1941).

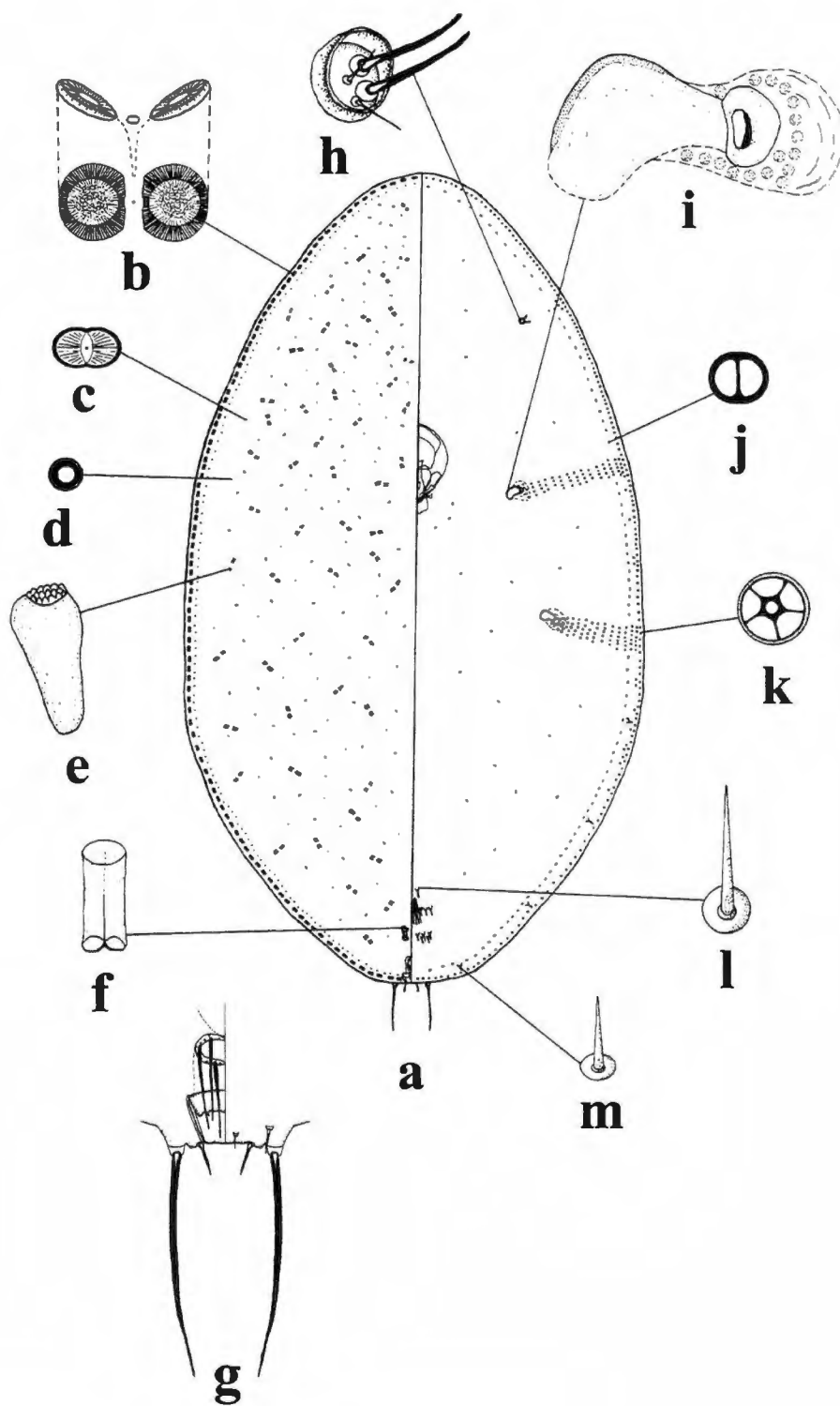


Fig. 20. *Bambusaspis bambusicola* (Kuwana), 1916.

Description:

Body (Fig. a) elongate, widest in spiracular area, 2065 (1660-2360) long, 1037 (800-1480) wide, without anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row consisting of 381 (331-427) pores; row terminates 1-2 pore lengths before apex of abdomen; all pores bent, each 11.0 (9.8-11.5) long, 5.5 (4.6-6.3) wide. Minute pores (Fig. c) evenly distributed; each 2.3 long, 1.9 (1.7-2.3) wide.

Simple disk pores (Fig. d) evenly distributed, consisting of 85 (40-128) pores; also submarginal row with of 242 (108-312) pores, each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. e) numerous throughout derm, ducts very small and different from those of other species; each 7.9 (6.9-9.2) long, 3.5 (2.3-5.7) wide.

Caudal tubes (Fig. f) anterior of anal ring, 13.2 (9.2-16.1) long, 5.6 (5.2-5.7) wide.

Anal lobes (Fig. g) without indentation; each anal lobe with one apical seta, 101.2 (89.7-109.2) long, one subapical seta 10.5 (5.7-13.8) long, one inner ventral seta 7.1 (5.7-8.6) long, and one outer ventral seta 10.5 (8.6-13.2) long.

Arched plate (Fig. g) length 32.7 (28.7-35.6).

Anal plates (Fig. g) separated, thin and bar-shaped; each anal plate 20.3 (17.8-23.0) long.

Anal ring (Fig. g) located anteriorad of arched plate, divided medially, anal ring 11.3 (8.6-14.9) long, 19.8 (18.4-21.8) wide; with 2 rows of pores, inner row with 6 and outer with 12 (10-16) pores; with 6 setae, each 32.3 (29.9-34.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) with tentorial sclerotization arch-like; clypeolabral shield 179.5 (159.8-206.9) long, 128.8 (108.0-144.8) wide.

Labium (Fig. a) heart-shaped, without setae, 34.1 (29.9-37.9) long, 51.0 (46.0-60.9) wide.

Antennae (Fig. h) one-segmented, 13.5 (9.2-18.4) long, 15.1 (12.6-17.2) wide at base; with 2 fleshy setae 15.2 (11.5-19.5) long, and 2 (2-3) slender setae 5.7 long.

Spiracles (Fig. i) located between medial and marginal area; anterior 43.5 (37.9-50.6) long, 18.4 (16.1-21.8) wide, atrium 11.0 (9.2-12.6) in diam.; posterior 42.8 (36.8-47.7) long, 16.8 (10.3-19.5) wide, atrium 11.6 (8.0-17.2) in diam.; with 19 (7-26) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 78 (60-100) quinquelocular pores, 4 (3-5) pores wide; posterior furrows with a band of 90 (66-108) quinquelocular pores, 5 (4-6) pores wide.

8-shaped pores (Fig. j) in a submarginal row with 246 (184-294) pores; dark-rimmed pores evenly distributed over venter with 44 (0-130) pores; also with row of 3 (0-5) pores on each side of mouthparts; each 2.2 (1.7-2.9) long, 1.3 (1.1-1.7) wide.

Quinquelocular pores (Fig. k) in spiracular furrows and in a marginal row consisting of 745 (600-874) pores, some pores occasionally in a second row; row ends

with 8-shaped pores before apex of abdomen; with 5 (2-9) pores between margin and antennae, each 2.4 (2.3-2.9) in diam.

Setae with 3 segmental rows (Fig. l) around genital opening, consisting of 2 (2-4), 6 (6-8), and 10 (8-14) setae, respectively; each 8.5 (6.3-11.5) long; without corresponding rows of multilocular pores; also with submarginal row (Fig. m) restricted to abdomen with 8 (4-10) setae, each 5.4 (3.4-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: FL, LA, MS; Japan, Taiwan.

Economic importance: This species is of no economic importance.

Diagnosis: Tubular ducts less than 10 long; with arch-like tentorial sclerotization, without multilocular pores.

Affinities: Closely related to other *Bambusaspis* species with tentorial arch, such as *Ba. miliaris*, *Ba. caudata*, or *Ba. bambusae*.

***Bambusaspis brasiliensis*, n.sp.**

Proposed Common Name: Brazilian Pit Scale

Fig. 21

Bambusaspis brasiliensis, n.sp.

Type material: On Bamboo, 3(2), holotype circled, adult ♀, paratypes, 1 adult ♀, 1 second instar ♀, Campinas, Brazil, coll., H.L. Parker, S.A. Par. Lab. 506.2, 4 IX 1941 (USNM), no. 431 331.

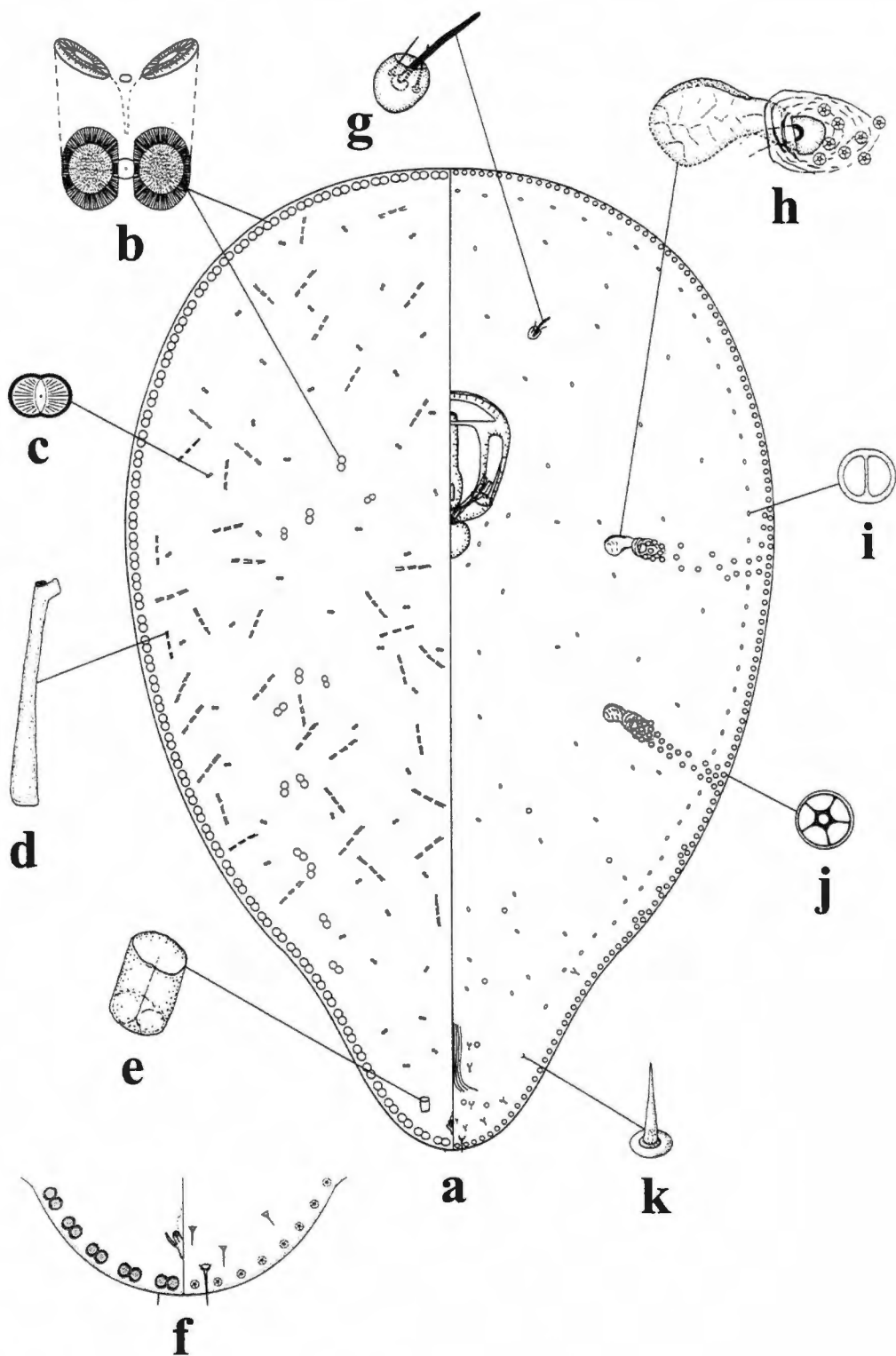


Fig. 21. *Bambusaspis brasiliensis*, n.sp.

Description:

Body (Fig. a) subcircular, 700 long, 400 wide, without anal indentation. Some measurements were taken only from the holotype, because the paratype is contorted. Derm membranous with 3 sizes of 8-shaped pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single complete row with 114 (108-120) pores, all pores bent; each 9.3 (8.6-10.3) long, 5.5 (5.2-6.3) wide. Other pores in 3 sizes, larger pores and medial pores consist of several clusters in submedial and submarginal area forming two loose bands, minute pores (Fig. c) form transverse bands over whole dorsum; larger pores 8.2 (8.0-8.6) long, 4.6 (4.0-5.2) wide; medial pores 5.6 (4.6-6.9) long, 3.7 (3.4-4.6) wide; minute pores 3.2 (2.9-3.4) long and 2.2 (1.7-2.3) wide.

Simple disk pores are not present in the available specimens.

Tubular ducts (Fig. d) in 6 longitudinal bands, each 26.2 (25.3-27.6) long, 3.3 (2.9-3.4) wide.

Caudal tubes (Fig. e) antero-laterad of anal ring; each 11.5 (10.3-13.8) long, 5.9 (5.7-6.3) wide.

Anal lobes (Fig. f) without anal indentation; each anal lobe with one apical seta 8.1 (6.9-9.2) long, one inner seta 3.4 long, one medial seta 4.6 long, and one outer seta 3.4 long; all setae located on ventral surface of anal lobes; outer setae may also be interpreted as part of the short submarginal row of setae.

Anal ring (Fig. f) completely fused, apparently with 2 setae, these hard to see, without pores; and with membranous area anteriad, 3.4 long and wide; anal ring 10.3 (8.0-12.6) long, 9.8 (9.2-10.3) wide, each seta 4.6 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 88.0 (87.4-88.5), width 82.8 (80.5-85.1).

Labium (Fig. a) heart-shaped, without setae, 27.0 (25.3-28.7) long, 35.7 (34.5-36.8) wide.

Antennae (Fig. g) one-segmented, 8.9 (8.0-10.3) long, 8.3 (8.0-9.2) wide at base; with 1 fleshy seta 9.9 (9.2-10.3) long, and 1-2 slender setae 4.6 (4.6-4.6) long.

Spiracles (Fig. h) located in submarginal area; anterior 24.0 (23.0-25.9) long, 9.5 (8.0-10.3) wide, atrium 4.2 (3.4-4.6) in diam.; posterior 25.3 (25.3-25.3) long, 9.0 (8.0-10.3) wide, atrium 4.8 (4.6-5.2) in diam; with 11 (7-16) pores in folds around atria; anterior spiracular furrows with a band of 22 (20-24) quinquelocular pores, 2(1-3) pores wide; posterior furrows with a band of 23 (21-25) quinquelocular pores, 2(1-4) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 76 pores; also with ca. 80 pores in transverse bands over venter, and with 4 (4-5) pores on each side of mouthparts; each 2.2 (1.7-2.3) long and wide.

Quinquelocular pores (Fig. j) in spiracular furrows and in a complete marginal row consisting of 266 pores; row becomes double shortly anteriad and posteriad of each spiracular furrow; also with 5 transverse rows of pores around and anteriad of genital

opening, each with 2 pores, anterior and posterior rows with 4 pores, each 2.3 (2.3-2.9) in diam.

Setae (Fig. k) with 3 segmental rows laterad of genital opening; each row with 2 setae corresponding to transverse rows of quinquelocular pores; each 3.2 (2.9-3.4) long; and with 6-8 setae in incomplete submarginal row on abdomen; each 3.2 (2.9-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Only known from Brazil.

Economic importance: This species is of no economic importance.

Diagnosis: With rows of marginal 8-shaped pores and quinquelocular pores completely encircling margin; anal ring with 2 setae; from Brazil.

Affinities: *Bambusaspis brasiliensis* seems to be closely related to two new species, *Ba. tetrasetosa*, and *Ba. octocircularis*.

Etymology: The name derives from Brazil, the country from which this species was collected.

***Bambusaspis caudata* (Green), 1930**

Proposed Common Name: Caudate Pit Scale

Fig. 22

Asterolecanium caudatum Green, 1930:214; Russell, 1941:61; D'Araujo e Silva et al., 1968:132; Gaedike, 1971:335. *Bambusaspis caudatum* Kozar & Walter, 1985:80.

Type material: On *Bambusa nana*, 2(1), part of type material, all adult ♀♀, Brazil, Sao Paulo, coll., J. Melzer, rec'd 1934 (USNM), no. 37230.

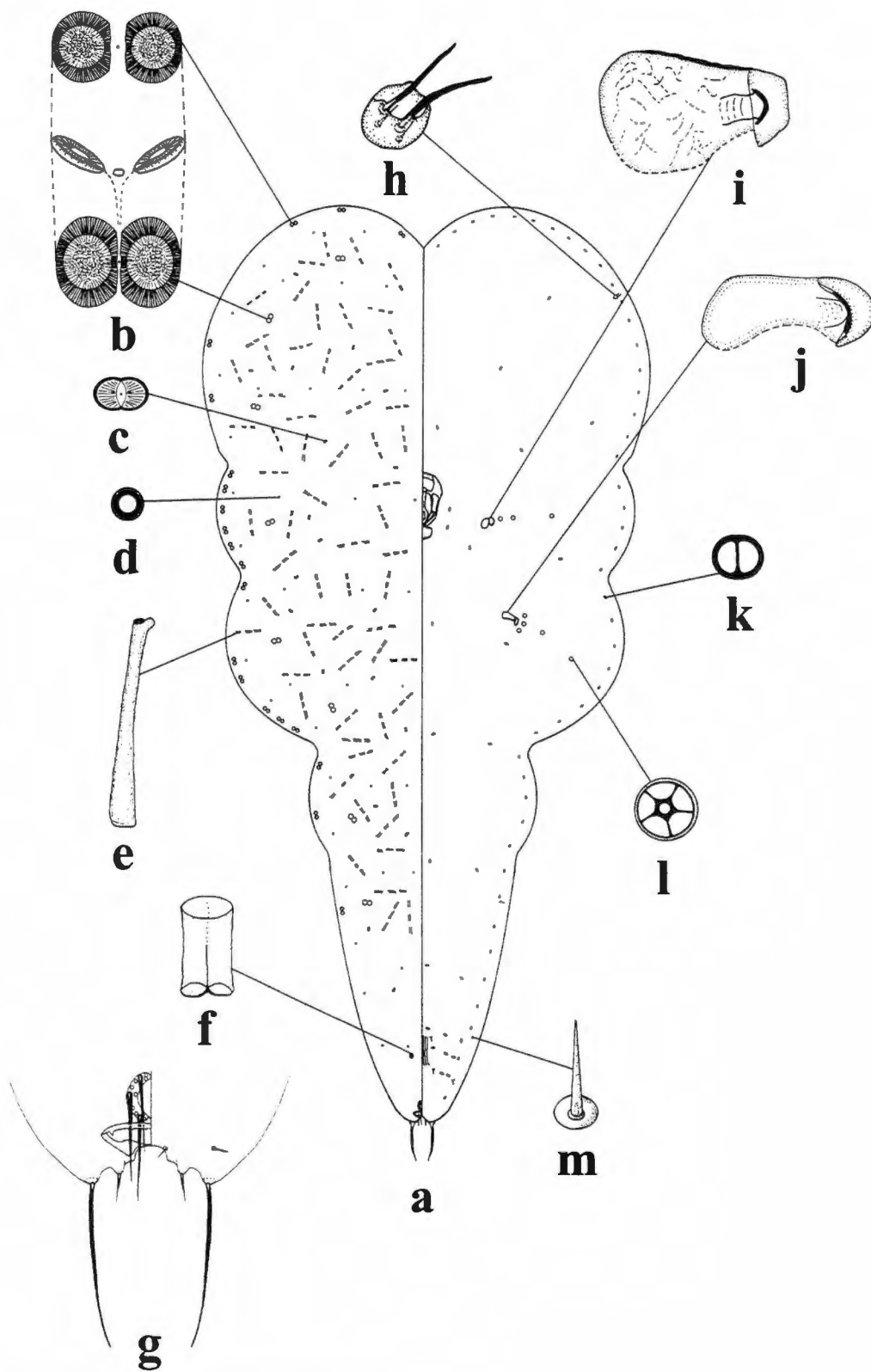


Fig. 22. *Bambusaspis caudata* (Green), 1930.

Additional material studied: On *Bambusa pallescens*, 4(1), all adult ♀♀, Brazil, Rio de Janeiro, coll., A. Chase, 26 IV 1930 (USNM), no. 1448467, no. 45484; *Bambusa vulgaris*, 3(1), all adult ♀♀, Brazil, coll., P.H. Dorsett (USNM), no. 1037439, no. 441484; *Dendrocalamus*, 1(1), adult ♀, China, Wuchow, Kwangtung, Kwangsi, coll., F.A. McClure, 19 XII 1928 (USNM), McClure no. 20365, Lingnan U. no. 19167, no. 45481; *Bambusa nana*, 3(1), all adult ♀♀, China, Kwangtung, Lingnan Univ., bamboo garden, coll., F.A. McClure, 24 XII 1929 (USNM), McClure no. 20322, Lingnan U. no. 18630, no. 45483; *Bambusa*, 1(1), adult ♀, China, Pot'engshi, Kwangtung, Ling Shui distr., coll., F.A. McClure, 29 IV 1932 (USNM), McClure no. 20447, U. Ping no. 20036, no. 45487; *Bambusa flexuosa*, 1(1), adult ♀, IndoChina, Ding Bang, Bet. Hanoi, Boc, 3 V 1891 (USNM), no. 1505005, no. 441485; *Dendrocalamus*, 1(1), adult ♀, China, Sailin, Kwangtung, coll., F.A. McClure, 21 I 1925 (USNM), McClure no. 518, Lingnan U., no. 13811, no. 411500; bamboo, 2(1), all adult ♀♀, Brazil, Rio de Janeiro, coll., D.T. Fullaway, 6 XI 1935 (USNM), nos. 37364, 37365.

Material studied with several different spp.: On *Bambusa (Guadua)* sp., 1(1), 1 adult ♀, *Bambusaspis caudata*, 2 adult ♀♀, *Bambusaspis miliaris*, Brazil, Rio de Janeiro, Bot. Gard., coll., A.M. Currant, XI 1915, (USNM), no. 1037427, nos. 441494, 441495; *Bambusa pallescens*, 2(1), 2 adult ♀♀, *Bambusaspis caudata*, 2 adult ♀♀, *Bambusaspis miliaris*, Brazil, Rio de Janeiro, Bot. Garden, Uic, coll., H.M. Curran, XI 1915 (USNM), no. 920240, nos. 441430, 441439, and 441492; *Bambusa pallescens*, 1(1), 1 adult ♀, *Bambusaspis caudata*, 1 adult ♀, *Bambusaspis miliaris*, Brazil, Juiz de Fora, Nimas Gereas, coll., A. Chase, 21 II 1925 (USNM), nos. 1255412, 441498, 441499.

Additional hosts: *Bambusa spinosa*, *B. vulgaris*, *Bambusa* sp., *Dendrocalamus strictus* (Gaedike 1971, Green 1930, Russell 1941).

Description:

Body (Fig. a) elongate, outline variable, with distinct tail-like posterior abdominal region, 945 (800-1320) long, 480 (400-560) wide, with anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes.

Dorsal Surface

8-shaped pores (Fig. b) on margin form incomplete row with 52 (32-102) pores, often big gaps between pores, these at least a pore's length apart; pores bent, each 6.9 (5.7-7.5) long, 3.5 (2.9-4.0) wide. Other pores with 2 sizes; large pores bent, forming an incomplete submarginal row; each pore 9.0 (8.0-9.8) long, 5.7 (5.2-6.3) wide; minute pores (Fig. c) evenly distributed over dorsum, with very few pores present; each 1.8 (1.7-2.3) long, 1.1 (1.1-1.1) wide.

Simple disk pores (Fig. d) in transverse rows over whole dorsum, consisting of 43 (24-62) pores; also in submarginal row with 31 (30-34) pores, each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. e) throughout derm with exception of the posterior abdominal area; each 26.7 (23.0-32.2) long, 3.6 (3.4-4.6) wide.

Caudal tubes (Fig. f) antieriad of anal ring; each caudal tube 6.9 (6.9-6.9) long, 3.4 (3.4-3.4) wide.

Anal lobes (Fig. g) with indentation; each anal lobe with one apical seta 60.6 (56.3-65.5) long, one subapical seta 12.2 (10.3-13.8) long, one inner ventral seta 6.6 (5.2-8.6) long, and one outer ventral seta 8.0 (6.9-9.8) long.

Arched plate (Fig. g) with one distinct spike on each side, 26.3 (17.2-34.5) long.

Anal plates (Fig. g) triangular, yoked medially and with arched plate; each anal plate 12.6 (11.5-12.6) long.

Anal ring (Fig. g) located anterior of arched plate, divided medially, 17.3 (16.1-18.4) long, 18.0 (15.5-20.7) wide; with 2 rows of pores, inner row with 6 and outer with 14 (12-16) pores; with 6 setae, each 31.9 (27.6-34.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) with tentorial sclerotization arch-like; clypeolabral shield 84.5 (69.0-98.9) long, 66.8 (56.3-82.8) wide.

Labium (Fig. a) heart-shaped, without setae, 21.3 (14.9-25.3) long, 30.0 (23.0-35.6) wide.

Antennae (Fig. h) one-segmented, 5.8 (3.4-7.5) long, 7.2 (6.3-8.6) wide at base; with 2 (1-2) fleshy setae 8.8 (3.4-11.5) long, and 2 (2-3) slender setae 3.3 (2.3-4.6) long.

Spiracles in 2 different forms, located between medial and marginal area; anterior (Fig. i) 23.9 (20.1-27.6) long, 11.6 (10.3-13.8) wide, atrium 5.2 (3.4-6.3) in diam.; posterior (Fig. j) 24.3 (21.3-28.7) long, 11.5 (8.6-14.9) wide, atrium 5.1 (4.6-5.7) in diam.; posterior spiracles similar to those of *Ba. miliaris*, sometimes both pairs *miliaris*-like; anterior spiracular furrows with a row of 3 (1-6) quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a row of 4 (3-6) quinquelocular pores, 1 (1-4) pores wide.

8-shaped pores (Fig. k) in a submarginal row with 100 (90-120) pores; each pore 1.1 long and wide; dark-rimmed pores distributed in transverse rows over venter, especially among segmental setae, with 38 (32-44) pores; also form a row of 2 (1-2) pores on each side of mouthparts; each 1.7 (1.7-1.7) long, 1.6 (1.1-1.7) wide.

Quinquelocular pores (Fig. l) only in very short spiracular furrows, each 2.4 (2.3-2.9) in diam.

Setae (Fig. m) with 2 segmental rows around genital opening with 2 and 4 setae, respectively; each 3.9 (2.3-4.6) long; without corresponding multilocular pores; and with incomplete submarginal row restricted to posterior abdominal area with 4 (2-4) setae; each 2.9 (2.3-4.0) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Known from Brazil, Algeria, China, and Vietnam. If members of the genus evolved in Southeast Asia, then this species was very likely introduced into the New World with infested plant material before its discovery.

Economic importance: This species is of no economic importance.

Diagnosis: Without marginal row of quinquelocular pores, marginal row of 8-shaped pores sporadic; without multilocular pores; with 6 anal ring setae; with arch-like tentorial sclerotization.

Affinities: *Bambusaspis caudata* is closely related to *Ba. miliaris*. It is probably just another variation of this morphologically plastic species. The USNM has specimens

of *Ba. caudata* that seem to be intermediates to the *pseudomiliaris*-variant of *Ba. miliaris*. However, the evidence is not conclusive enough to merge these two species at this time.

Notes: In the cladistic analysis, *Ba. caudata* clusters either with *Ba. bambusicola* and *Ba. miliaris*, or with *Ba. miliaris* alone. Based on the specimens observed, this species is expected to be eventually merged with *Ba. miliaris*. The inclusion of more characters from several instars or the use of different methods, such as molecular techniques, may help better resolve this group in the future. With the generic name change from *Asterolecanium* to *Bambusaspis*, the grammatic gender also changed from neuter to feminine. Therefore, a name emendation is proposed for this species.

***Bambusaspis hemisphaerica* (Kuwana), 1916**

Proposed Common Name: Hemispherical Pit Scale

Fig. 23

Asterolecanium hemisphaericum Kuwana, 1916:147; Russell, 1941:104; Takahashi, 1956:5. *Bambusaspis hemisphaerica* Borchsenius, 1960:134. *Bambusaspis hemisphaerica* Wu, 1983:77. *Bambusaspis hemisphaericum* Kozar & Walter, 1985:80.

Type material: No type material available.

Additional material studied: On *Bambusa metake*, 2(1), all adult ♀♀, Riverton, NJ, coll., H.B. Weiss, LMR, 18 V 1916, remounted Nov. 1932 (USNM); *Arundinaria chino*, 1(1), adult ♀, Naqamachi, Sendai, Japan, coll., E. Ishiba, 16 V 1926 (USNM), Unic. Calif. Herb. no. 342368, H.Y.B.G., no. 45 625; *Phyllostachys chino*, 2(1), all adult ♀♀, Kashikawa, Tokyo, cols. Asano, Togsisi, H.N.Y.B.G., 2 IV 1952 (USNM).

Additional host: *Phyllostachys* sp. (Russell 1941).

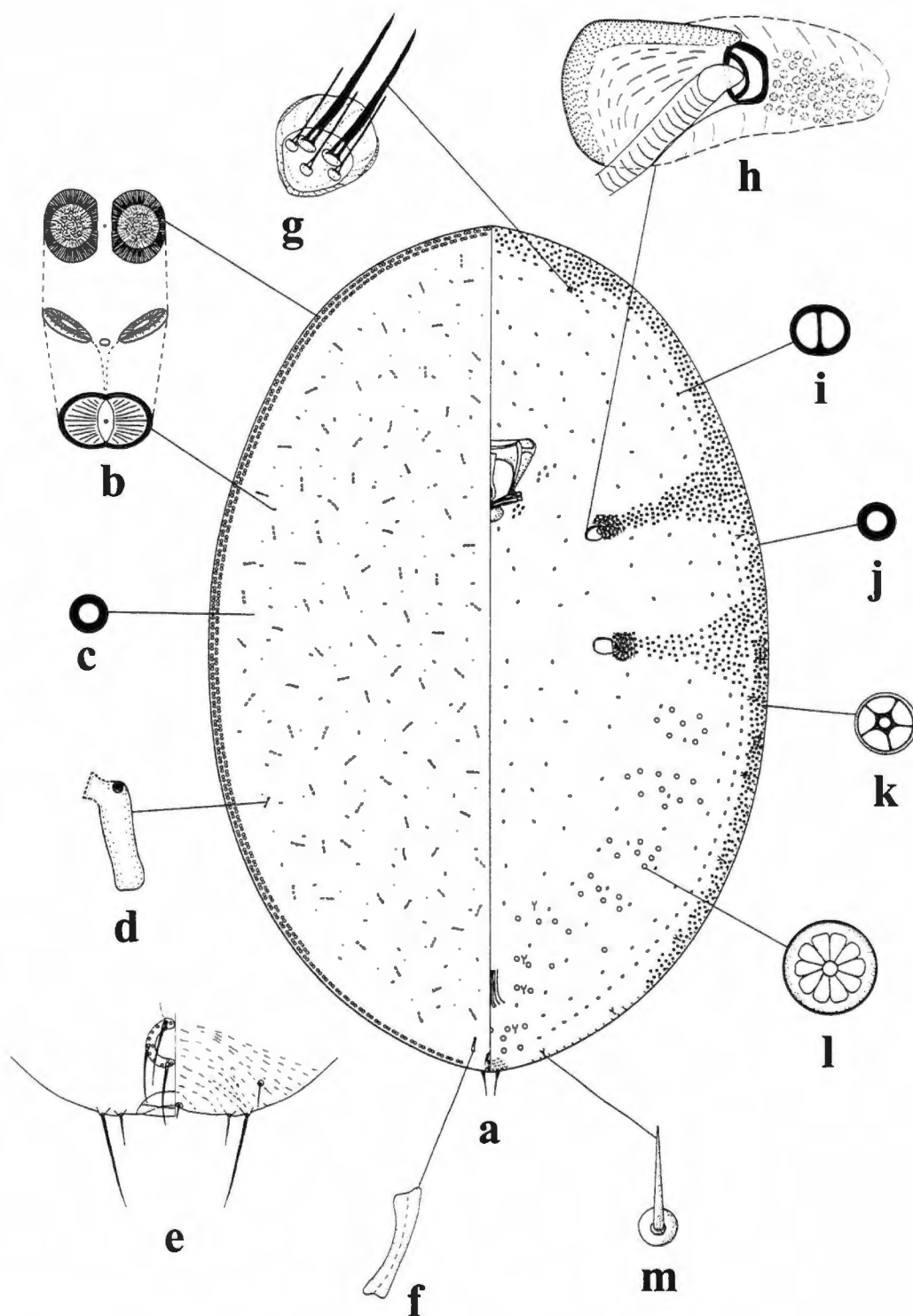


Fig. 23. *Bambusaspis hemisphaerica* (Kuwana), 1916.

Description:

Body (Fig. a) subcircular, 1628 (1400-1880) long, 1320 (1140-1520) wide, with small anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, small tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a band consisting of 392 (304-474) pores that terminates 2-3 pore lengths before apex of abdomen; band consists of a double row of pores which is replaced by a single row in the posterior abdominal area; all pores bent, each 11.8 (10.9-13.2) long, 6.7 (5.7-6.9) wide. Minute pores (Fig. c) evenly distributed; each 2.9 (2.3-3.4) long, 1.7 (1.7-1.7) wide.

Simple disk pores (Fig. d) in transverse rows, consisting of 175 (160-204) pores; each 1.7 (1.7-1.7) in diam.

Tubular ducts (Fig. e) small, throughout derm, each 13.3 (12.6-13.8) long, 3.9 (3.4-4.6) wide.

Anal lobes (Fig. f) with small indentation, venter sclerotized; each anal lobe with one apical seta 28.3 (24.1-34.5) long, one subapical seta 10.8 (9.8-12.6) long, one inner ventral seta 6.4 (5.7-6.9) long, and one outer ventral seta 8.8 (8.0-9.2) long.

Anal plates (Fig. f) fused, no distinction between plates possible; form circular opening together with arched plate; anal plates 36.5 (32.2-42.5) long.

Arched plate (Fig. f) fused with anal plates; same width as anal plates.

Anal ring (Fig. f) located anterior of anal plates, divided medially, length of anal ring not measurable, width 25.7 (21.8-31.0); with 6 setae, inner row with 6, outer with 18 pores; with 6 setae, each 34.5 (33.3-35.6) long.

Caudal tubes (Fig. g) anterio-laterad of anal ring; each caudal tube 33.3 (26.4-40.2) long, 7.0 (5.2-8.0) wide.

Ventral Surface

Clypeolabral shield (Fig. a) length 151.4 (141.4-163.2), width 160.4 (151.7-175.9).

Labium (Fig. a) triangular, without setae, 36.5 (34.5-39.1) long, 53.8 (50.6-57.5) wide.

Antennae (Fig. h) one-segmented, circular, with raised outer edge, 13.9 (12.1-17.2) long, 14.4 (12.6-17.2) wide at base; with 2 fleshy setae 13.8 (13.8-13.8) long, and 3 (1-3) slender setae 9.8 (6.9-12.6) long.

Spiracles (Fig. i) located between medial and marginal area; anterior 47.4 (41.4-56.3) long, 21.4 (19.5-24.1) wide, atrium 9.5 (8.0-10.9) in diam.; posterior 46.5 (43.7-50.6) long, 21.1 (19.5-23.0) wide, atrium 11.3 (8.0-13.8) in diam; with 43 (24-55) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 146 (118-180) quinquelocular pores, 5 (1-10) pores wide; posterior furrows with a band of 153 (140-170) quinquelocular pores, 5 (1-12) pores wide.

8-shaped pores (Fig. j) in a submarginal band with 139 (104-180) pores; dark-rimmed pores with 210 (150-280) pores distributed over whole venter; and with 11 (6-15) pores in clusters laterad of mouthparts; each 3.1 (2.9-3.4) long, 2.4 (2.3-2.9) wide.

Simple disk pores (Fig. k) in marginal row, consisting of 258 (220-324) pores; row ventrad of marginal 8-shaped pores and dorsad of marginal quinquelocular pores; with several pores in a second row position; each 1.7 (1.7-1.7) in diam.

Quinquelocular pores (Fig. l) in spiracular furrows and marginal band of about 700 pores, occasionally a few trilocular, quaterolocular, or 7-locular pores together with quinquelocular pores; band several pores wide, ends prior to ca. 15 (9-18) 8-shaped pore lengths before apex of abdomen; pores also form a short band between margin and each antenna consisting of 24 (18-30) pores; each 3.2 (2.9-3.4) in diam.

Multilocular pores (Fig. m) with 7-8 incomplete bands consisting of 12 (10-14), 14 (12-30), 20 (12-24), 14 (6-16), 12 (12-16), 10 (6-12), 6 (6-10), and 4 (4-6) pores, respectively; and 2 complete bands around genital opening with 7 (5-8) and 4 (2-5) pores, respectively; each pore 10 (10-12) loculi and 5.9 (5.7-6.3) in diam.

Setae (Fig. n) with 4-5 segmental rows around genital opening corresponding to 2 complete and 3 incomplete bands of multilocular pores, each with 2 (0-4) setae; each 7.6 (6.3-9.2) long; also with 14 (12-18) setae in incomplete submarginal row on abdomen and thorax, each 8.6 (8.0-9.2) long.

Biological data: No data available.

Parasitoids and predators: Wu (1983) reported the use of *Anagyrus* sp. and *Prospaltella* sp. (both Encyrtidae) against the hemispherical pit scale in China.

Distribution: NJ; China, Japan.

Economic importance: This species is of no economic importance in the New World.

Diagnosis: Tubular ducts 12-14 long; with marginal bands of 8-shaped pores and quinquelocular pores; with multilocular pores.

Affinities: The bamboo infesting pit scales without the typical arch-like tentorial sclerotization seem to form a sister group to the *bambusae-bambusicola-miliaris-caudata* clade. *Ba. hemisphaerica* and its closest relative *Ba. scirrosis* may be two of the most primitive of all the species of *Bambusaspis* present in the New World.

***Bambusaspis magna*, n.sp.**

Proposed Common Name: Great Pit Scale

Fig. 24

Bambusaspis magna, n.sp.

Type material: On dry bamboo, *Guadua* sp., 3(1), holotype circled, adult ♀, 2 adult ♀♀, paratypes, Rosario, Sin., at Nogales, Mexico, colls., Schoeninger, Ehringer, 21 XII 1942 (USNM), Nogales nos. 56179, 43839; on dry bamboo, 1(1), paratype, adult ♀, Mexico, colls., Schoeninger, Ehringer, 21 XII 1942 (UT).

Description:

Body (Fig. a) subcircular, 2700 (2260-3600) long, 2290 (2120-2560) wide, with small anal indentation. Derm membranous with 4 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a row consisting of 304 (295-318) pores that terminates 3-4 pore lengths before apex of abdomen; pores bent, each 18.4 (17.2-20.7) long, 10.7 (9.2-12.6) wide.

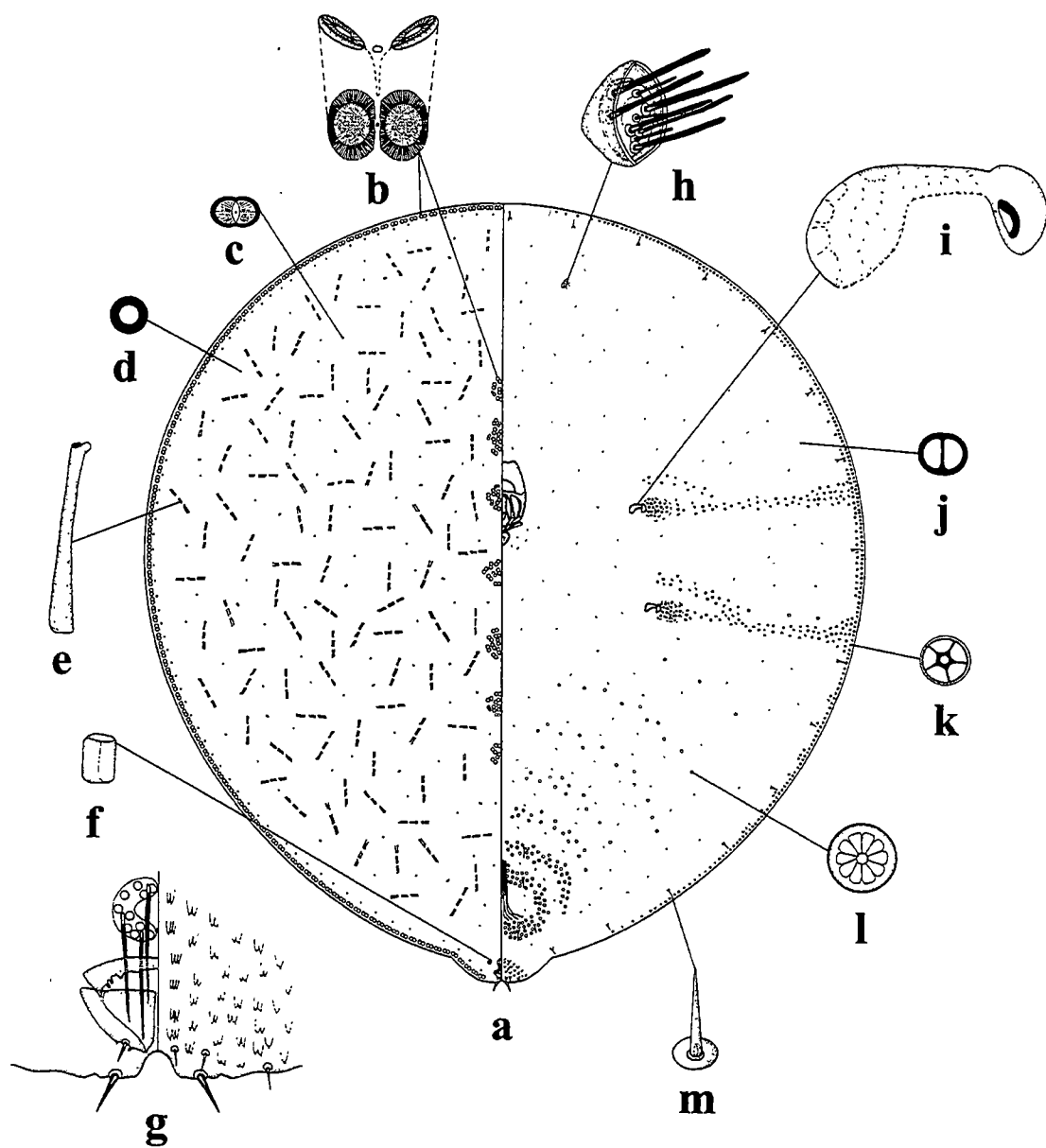


Fig. 24. *Bambusaspis magna*, n.sp.

Larger, medial, and smaller pores in 7 longitudinal swirls on head, thorax, and abdomen, all pores bent; larger pores 18.4 (17.2-19.5) long, 10.5 (8.6-11.5) wide; medial pores 15.3 (14.9-16.1) long, 8.2 (8.0-8.6) wide; and smaller pores 9.8 (8.0-11.5) long, 5.8 (4.6-6.9) wide. A few minute pores (Fig. c) evenly distributed; each 3.6 (3.4-4.0) long, 2.1 (1.7-2.3) wide.

Simple disk pores (Fig. d) equally distributed throughout derm, consisting of ca. 150 pores; each pore 2.1 (1.7-2.3) in diam.; also with 150 (132-167) pores in submarginal row, each 2.5 (2.3-2.9) in diam.

Tubular ducts (Fig. e) distributed throughout derm, each 41.0 (36.8-44.8) long, 4.8 (4.0-5.2) wide.

Caudal tubes (Fig. f) laterad of anal ring; caudal tubes hard to see, each 12.1 long and 8.0 wide.

Anal lobes (Fig. g) with small indentation, venter sclerotized; each anal lobe with one apical seta 10.4 (9.2-12.1) long, one inner ventral seta 6.3 (5.7-6.9) long, one medial ventral seta 8.1 (7.5-8.6) long, and one outer ventral seta 8.4 (7.5-9.8) long.

Anal plates (Fig. g) anvil-shaped, very close together, but not fused; form circular opening together with arched plate; one specimen with one pair of setae 6.3 long; anal plates 24.2 (23.0-25.3) long, both plates together 49.8 (48.3-51.7) wide.

Arched plate (Fig. g) forms circular opening together with anal plates, same width as anal plates.

Anal ring (Fig. g) located anterior of anal plates, divided medially, length 25.3 (25.3-25.3), width 26.0 (23.0-28.7); with 2 rows of pores inner row with 6, outer with 14 pores; with 6 setae, each 37.4 (36.8-37.9) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 211.1 (203.4-217.2), width 154.0 (143.7-166.7).

Labium (Fig. a) heart-shaped, 40.2 long, 49.4 wide, only measurable in one specimen; with 1 (0-1) pair of labial setae, each 5.7 long; *Ba. magna* is the only species of the genus *Bambusaspis* with labial setae.

Antennae (Fig. h) one-segmented, circular, strongly indented, with raised outer edge, 18.0 (16.1-19.5) long, 29.5 (27.6-31.0) wide at base; with 4-6 fleshy setae 13.4 (11.5-14.9) long, and 2-3 slender setae, length not measurable.

Spiracles (Fig. i) located between medial and marginal area; anterior 57.1 (52.9-60.9) long, 31.0 (28.7-34.5) wide, atrium 11.5 (11.5-11.5) in diam.; posterior 63.6 (58.6-66.7) long, 32.6 (28.7-34.5) wide, atrium 13.8 (12.6-14.9) in diam; with 19 (16-20) quinquelocular pores in folds around atria; each spiracular furrow composed of two bands that merge in the middle of the furrow; anterior spiracular furrows 2 (1-4) pores wide, with 103 (88-130) quinquelocular pores; posterior furrows 3 (1-5) pores wide, with 122 (105-140) quinquelocular pores.

8-shaped pores (Fig. j) distributed in transverse bands over whole venter consisting of ca. 500 pores, and with 6 (3-9) pores in a band on each side of mouthparts; without separate row of submarginal pores; each 3.4 (3.4-3.4) long, 2.9 (2.3-3.4) wide.

Quinquelocular pores (Fig. k) in spiracular furrows and marginal band consisting of 556 (489-638) pores; band one pore wide at anterior and posterior ends, and two pores wide between spiracular furrows and in several areas anterior and posterior of furrows; band interrupted anteriorly for 10 (5-16) corresponding 8-shaped pore lengths, and ends prior to 13 (7-18) 8-shaped pore lengths before apex of abdomen; each 3.6 (3.4-4.0) in diam.

Multilocular pores (Fig. l) with one incomplete row anterior of metathoracic spiracular furrows consisting of 6-8 pores, and 4(3-5) incomplete bands on abdomen consisting of 6-8, 19 (12-30), 25 (14-32), and 21 (12-32) pores, respectively; and 4(3-5) complete bands around and anterior of genital opening with 33 (28-40), 83 (50-100), 69(50-84), and 63 (50-74) pores, respectively; each 10 loculi, and 5.2 (4.6-5.7) in diam.

Setae (Fig. m) with 3(2-3) segmental rows around genital opening corresponding to 3 complete bands of multilocular pores; each row with 2 setae, posterior row with 4 setae; each 9.0 (6.9-10.9) long; also with 30 setae in complete submarginal row, making *Ba. magna* the only species of *Bambusaspis* with a complete setal row; each 6.5 (5.7-7.5) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: With arch-like tentorial sclerotization and multilocular pores; length of body 2300-3600; length of apical setae 8-11.

Affinities: *Bambusaspis magna* is unique in many characters. It is the only species of *Bambusaspis* with labial setae, a complete row of submarginal setae, and anvil-shaped anal plates. These characters appear to be plesiomorphic, therefore placing *Ba. magna* at the base of the *Bambusaspis* clade. It is the only new species of *Bambusaspis* that is clearly described on a species of bamboo native to the New World (Gentry 1996).

Etymology: This is a large species, hence the name *Ba. magna*.

Bambusaspis mexicana, n.sp.

Proposed Common Name: Mexican Pit Scale

Fig. 25

Bambusaspis mexicana, n.sp.

Type material: On Bamboo stem, 6(1), holotype circled, adult ♀, paratypes, 5 adult ♀♀, Mexico (Int.), coll., A.D. Thompson, 23 III 1974 (USNM), San Diego no. 2434.

Description:

Body (Fig. a) subcircular, 1353 (1280-1500) long, 1150 (1100-1200) wide, with small anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row with 281 (212-313) pores that terminates about 4 pore lengths before apex of abdomen; pores bent, each 10.3 (9.2-11.5) long, 5.6 (5.2-6.3) wide. Other pores in medial band, some forming clusters;

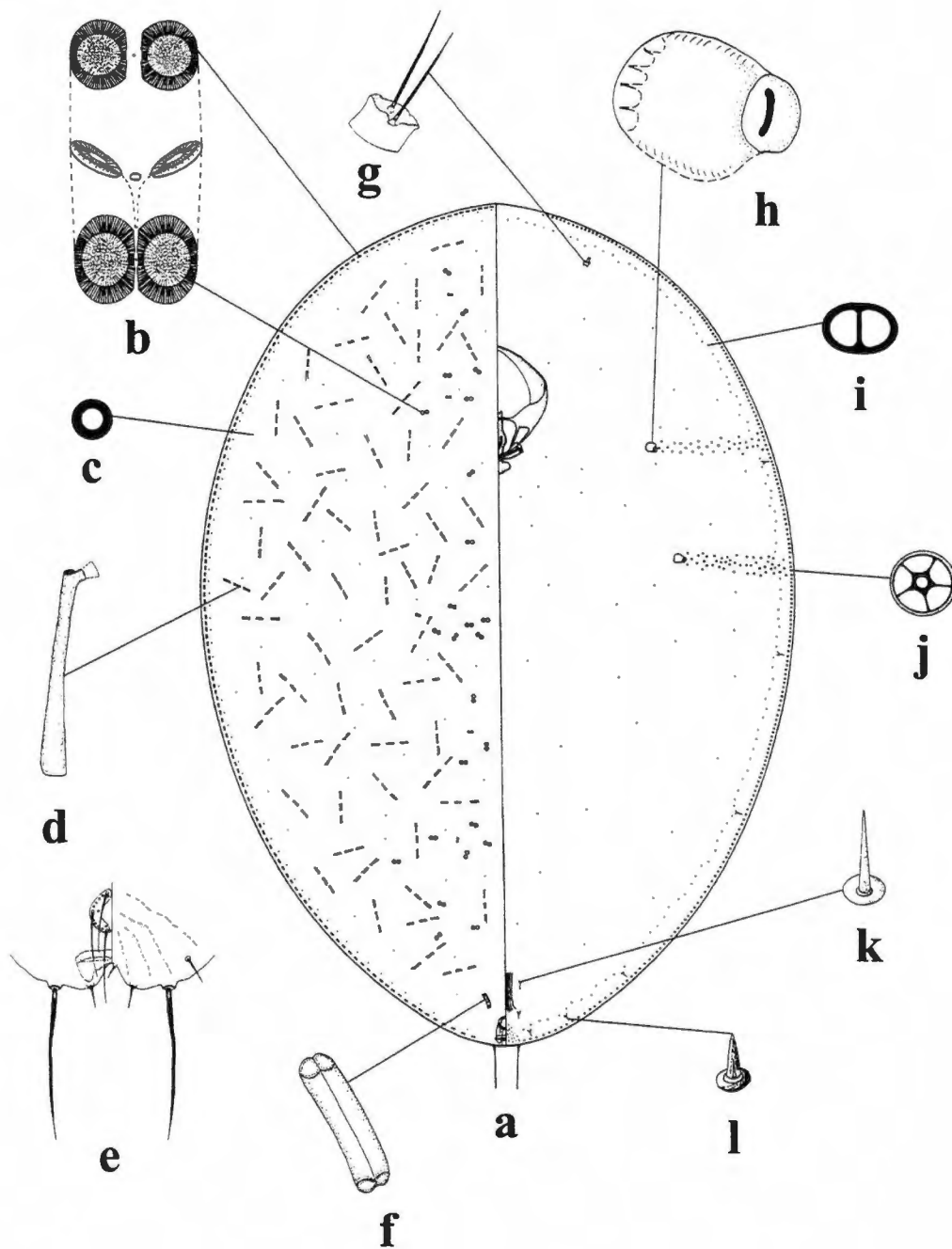


Fig. 25. *Bambusaspis mexicana*, n.sp.

with 2 pore sizes, all pores bent; large pores 13.5 (12.1-14.9) long, 8.6 (8.0-9.2) wide; small pores 8.8 (8.0-9.2) long, 5.7 (5.7-5.7) wide; without minute pores.

Simple disk pores (Fig. c) irregularly distributed over dorsum, consisting of about 100 pores; also in submarginal row with 167 (140-190) pores; each 1.6 (1.1-1.7) in diam.

Tubular ducts (Fig. d) throughout derm, each 32.7 (26.4-36.8) long, 3.4 (2.9-4.0) wide.

Anal lobes (Fig. e) with small indentation, ventral surface slightly rugose; each anal lobe with one apical seta 81.8 (74.7-87.4) long, one subapical seta 10.2 (9.2-12.1) long, one inner ventral seta 7.0 (5.7-8.0) long, and one outer ventral seta 10.8 (10.3-12.6) long; one specimen with an additional pair of setae posterio-laterad of anal ring.

Anal plates (Fig. e) triangular, fused, form ring with arched plate; both plates together same length as arched plate.

Arched plate (Fig. e) forms ring together with anal plates; arched plate 33.0 (29.9-35.6) long.

Anal ring (Fig. e) located anteriorad of anal plates, divided medially, anal ring 19.9 (17.2-21.8) long, 21.3 (20.1-23.0) wide; with 2 rows of pores, inner row with 6, outer with 16 (14-18) pores; with 6 setae, each 36.5 (29.9-41.4) long;.

Caudal tubes (Fig. f) anterio-laterad of anal ring; each caudal tube 21.1 (19.5-23.0) long, 6.3 (5.7-6.9) wide.

Ventral Surface

Clypeolabral shield (Fig. a) with tentorial sclerotization arch-like; clypeolabral shield 174.4 (127.6-195.4) long, 151.4 (128.7-172.4) wide.

Labium (Fig. a) heart-shaped, without setae, 30.2 (26.4-32.2) long, 44.3 (41.4-48.3) wide.

Antennae (Fig. g) one-segmented, 9.5 (9.2-10.3) long, 13.1 (12.1-14.4) wide at base; with 2 (1-2) fleshy setae, each 9.2 long.

Spiracles (Fig. h) located between medial and marginal area; anterior 37.5 (35.6-39.1) long, 16.3 (15.5-17.2) wide, atrium 10.5 (10.3-10.9) in diam.; posterior 37.9 (36.8-39.1) long, 16.4 (14.9-17.2) wide, atrium 9.9 (8.6-11.5) in diam; anterior spiracular furrows with a band of 48 (40-56) quinquelocular pores, 2 (1-4) pores wide; posterior furrows with a band of 51 (33-60) quinquelocular pores, 2 (1-4) pores wide.

8-shaped pores (Fig. i) in a submarginal row with about 200 pores, each 2.3 (1.7-2.9) long and 1.7 (1.7-1.7) wide; about 75 dark-rimmed pores distributed over whole venter; each 1.7 long, 1.1 wide.

Quinquelocular pores (Fig. j) in spiracular furrows and in a marginal row consisting of 428 (377-460) pores; row ends 2 (0-3) 8-shaped pore lengths before apex of abdomen, and is interrupted for 5 (0-8) 8-shaped pore lengths anteriad; each 2.4 (2.3-2.9) in diam.

Setae with 2 segmental rows (Fig. k) around genital opening, each with 2 (0-2) setae; each 6.3 (4.6-8.0) long; without corresponding multilocular pores; and with 12 (10-12) tack-like setae (Fig. l) in incomplete submarginal row; each 4.1 (3.4-4.6) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: Marginal row of quinquelocular pores ends together with marginal 8-shaped pores ca. two 8-shaped pore lengths before apex of abdomen; without multilocular pores; with 6 anal ring setae; with arch-like tentorial sclerotization.

Affinities: *Bambusaspis mexicana* is distantly related to the other pit scales with an arched tentorial sclerotization.

Etymology: The name derives from the country where it was discovered.

Notes: The Mexican pit scale may not originate from this country. The genus *Bambusaspis* may have evolved in the Oriental faunal region, and was inadvertently introduced into different areas of the globe by agricultural trade.

***Bambusaspis miliaris* (Boisduval), 1869**

Proposed Common Name: Miliaris Pit Scale

Fig. 26

Chermes miliaris Boisduval, 1869:262. *Asterolecanium miliaris* Signoret, 1870:281, 1876b:643; Targioni-Tozzetti, 1892:301; Cockerell, 1893a:77, 1893e:382, 1894a:307, 1895b:167, 1896:9, 1897a:328, 1902b:251, 1902c:114; Maskell, 1894:94; Hempel, 1900:409; Fernald, 1903:51; Sanders, 1906:3; Green, 1908:41, 1909:338; Kotinsky, 1910:127; Lindinger, 1912:82, 1935:130; MacGillivray, 1921:189; Ogilvie, 1928:24; Balachowsky, 1932:XXV; Bartlett, 1938:493, 1939a:103, 104, 106, 1939b:339;

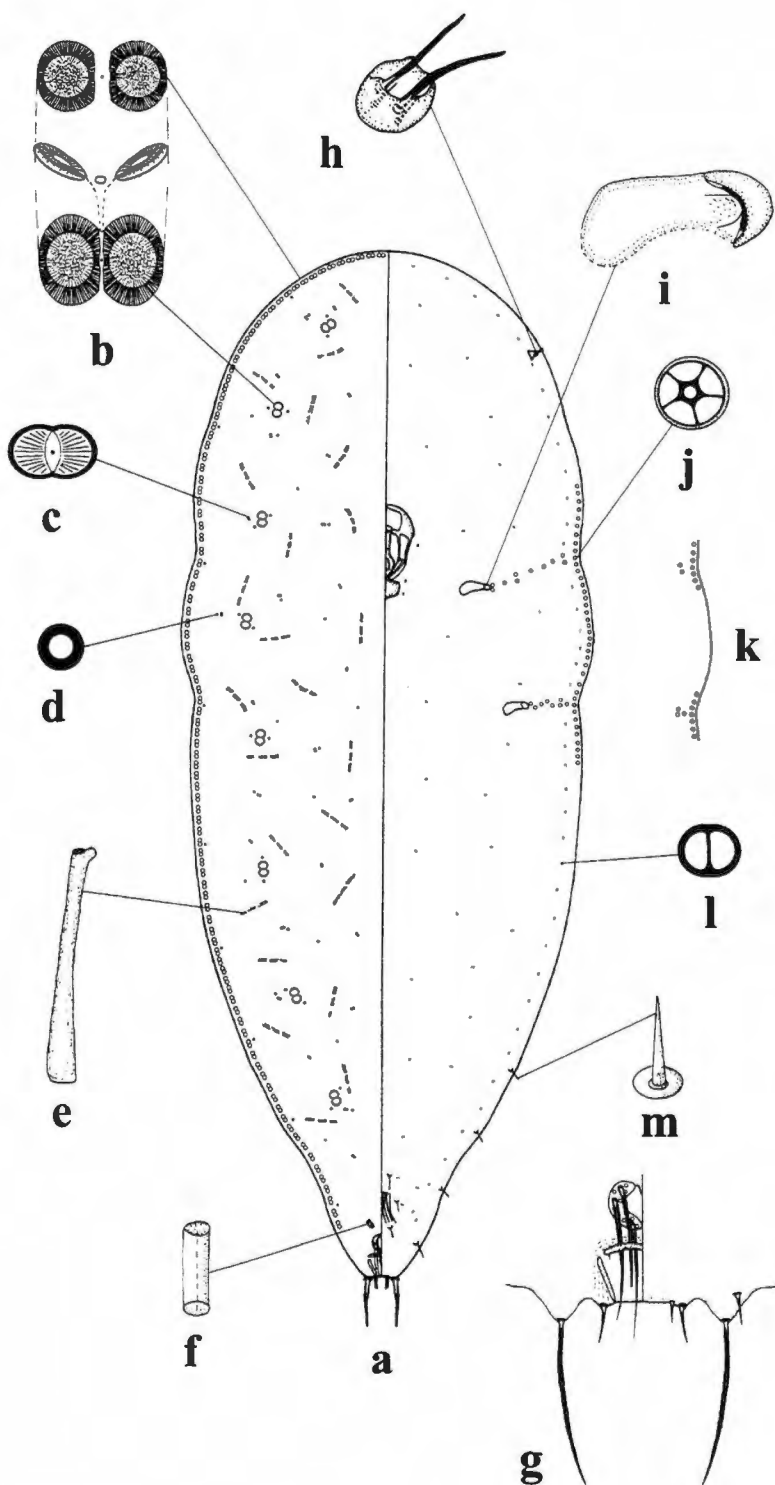


Fig. 26. *Bambusaspis miliaris* (Boisduval), 1869.

Wolcott, 1941:57, 1953:230; Ferris, 1955:20; Beardsley, 1966:499; D'Araujo e Silva et al., 1968:133; Herting, 1972:135; Hattingh & Samways, 1992:327, 1993:13, 1995:88. *Asterolecanium miliaris* var. *robusta* Green, 1908:19, 41; Maxwell-Lefroy, 1908:121. *Asterolecanium miliaris* var. *longum* Green, 1909:339, 1915:44. *Asterolecanium pseudomiliaris* Green, 1922a:1036; Russell, 1941:160; Merrill, 1953:115; Ferris, 1955:25; Mamet, 1957:374; Beardsley, 1966:500; D'Araujo e Silva et al., 1968:133; Bruner et al., 1975:34; Nakahara, 1980:163. *Asterolecanium charmoyi* Green, 1924:45; Takahashi, 1933:35, 1936:116, 1941:217, 1942:353; Gaedike, 1971:336. *Asterolecanium pseudomiliaris* var. *bambusifoliae* Takahashi, 1930:11, 38. *Asterolecanium miliaris* var. *miliaris* Russell, 1941:129; Zimmerman, 1948:279; Merrill, 1953:113; Bruner et al., 1975:34; Miller, 1985:106. *Asterolecanium miliaris* var. *robustum* Russell, 1941:130; Wolcott, 1948:160; Merrill, 1953:115; Miller, 1985:106. *Bambusaspis miliaris* Bodenheimer, 1951:328; Borchsenius, 1960:133; Kozar & Walter, 1985:80; Williams & Watson, 1990:199. *Asterolecanium robustum* Ferris, 1955:26; Beardsley, 1966:501. *Bambusaspis pseudomiliaris* Kozar & Walter, 1985:80; Williams & Watson, 1990:203. *Bambusaspis robusta* Williams & Watson, 1990:203.

Type material: Auf *Bambusa* spec.?, 26(1), *Asterolecanium miliaris* (Bdv.), type, 24 first instars, 2 adult ♀♀, det. Sign., det. Löw, Algerium, (USNM), nos. 45 770, 45 771; on *Bambusa* sp. stem, 8(1), *Asterolecanium miliaris robusta* Green, type, 6 first instars, 2 adult ♀♀, India, Pusa, Bengal, IV 1906, rec'd Dec. 1933, coll., E.E. Green (left label), *Asterolecanium miliaris miliaris* (Bdv.) (right label), (USNM), nos. 45 878, 37 9466; on *Bambusa oliveriana*, 10(1), *Asterolecanium miliaris*, type, 8 first instars, 2 adult

♀ ♀, Perideniya, Ceylon, XII 1898, coll., E.E. Green (left label), *Asterolecanium miliaris robustum* Gr. (right label) (USNM); bamboo, 9(2), *Asterolecanium pseudomiliaris* Green, syntype, 2 first instars, 3 second instar ♀ ♀, 4 adult ♀ ♀, Ceylon, Peredernija, McKenzie Coll., III 1910 (USNM); *Bambusa* sp., 5(1), *Asterolecanium pseudomiliaris* Gr., *Asterolecanium longum* (Green), from type mat., all adult ♀ ♀, Mauritius, coll., de Charmoy, Reed 1925, det. L.M.R., XI 1932 (USNM), nos. 451254, 451255.

Additional material studied: On *Bambusa* sp., 5(5), all adult ♀ ♀, HI, via Boynton Beach, FL, coll., D. Leone, det. A. Hamon '93, 7 III 1991 (FSCA); *Bambusa* sp., 1(1), adult ♀, Bradenton, Fla., coll., G.Q. Quin, det. A. Hamon '80, 26 VIII 1980 (FSCA); *Bambusa* sp., 1(1), adult ♀, Immokalee, FL, det. A. Hamon '80, 16 V 1980 (FSCA); *Bambusa* sp., 1(1), adult ♀, Estero, Fla., coll., K. Delate, det. A. Hamon '80, 14 XII 1979 (FSCA); *Bambusa multiplex*, 2(2), all adult ♀ ♀, FL, Miami, colls., J. Frankel, D. Gwin, det. A. Hamon, 12 IX 1983 (FSCA); *Bambusa* sp., 1(1), adult ♀, FL, Arcadia, coll., J. Bennett, det. A. Hamon, 7 VIII 1987 (FSCA); *Bambusa* sp., 3(3), all adult ♀ ♀, Melbourne, FL, coll., F.A. Smith, det. A. Hamon '80, 25 VII 1980 (FSCA); *Bambusa* sp., 1(1), adult ♀, FL, Ft. Lauderdale, coll., S. Fazli, det. A. Hamon '89, 24 XI 1989 (FSCA); *Bambusa* sp., 1(1), adult ♀, West Palm Beach, FL, colls., R. Buchholz, J. Bennett, no. L-221, det. A. Hamon '79, 17 V 1979 (FSCA); *Bambusa* sp., 2(2), all adult ♀ ♀, Cocoa, FL, coll., R.E. Burns, det. A. Hamon, 10 XII 1979 (FSCA); Bamboo, 2(2), all adult ♀ ♀, Tarpon Springs, FL, coll., F.M. O'Byrne, 13374 det. GBM, 4 IX 1922 (FSCA); *Bambusa* sp., 1(1), adult ♀, Miami, FL, coll., E.L. Kelly, det. H. Morrison & G.B. Merrill 13130, 30 VIII 1922 (FSCA); *Bambusa* sp., 3(3), all adult ♀ ♀, Winter Haven, FL, coll., W.P.

Henderson, nos. I 595, 125364, det. S. Nakahara '71, 7 VIII 1970 (FSCA); bamboo, 3(3), all adult ♀♀, Vero Beach, FL, coll., O.W. Calkins, no. 92387, det. G.B.M., 22 V 1946 (FSCA); *Bambusa* sp., 15(15), 2 second instar ♀♀, 13 adult ♀♀, Vero Beach, FL, coll., S.P. Beidler, no. NY. K-746, det. A. Hamon '79, 24 VIII 1977 (FSCA), 15 slides studied with same data; *Bambusa* sp., 3(3), all adult ♀♀, Winter Heaven, FL, coll., C. Roberts, no. L-17, det. A. Hamon '78, 3 I 1978 (FSCA); *Bambusa* sp., 1(1), adult ♀, Coconut Grove, FL, coll., J.F. Dillon, no. I-450, det. A. Hamon '80, 23 II 1970 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, Okeechobee, FL, coll., S.P. Beidler, det. A. Hamon '80, 26 IX 1978 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, Stuart, FL, coll., S.P. Beidler, no. DPI 126273a, det. D.R. Miller '78, 21 V 1978 (FSCA); *Bambusa* sp., 5(5), all adult ♀♀, Gainesville, FL, coll., A. Beck, det. A. Hamon '82, 28 XII 1981 (FSCA); *Bambusa vulgaris*, 3(3), all adult ♀♀, Corozal, Puerto Rico, coll., S.M. Gaud, Acc. no. 101-71, det. D.R. Miller '73, 4 II 1971 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, FL, Delray Beach, Palm Beach Co., coll., E. Tannehill, det. A. Hamon, 28 XI 1988 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, Punta Gorda, FL, coll., A. Gambill, det. A. Hamon '80, 17 III 1980 (FSCA); *Bambusa* sp., 2(2), all adult ♀♀, Miami, FL, coll., K. Martin, det. A. Kamon '80, 25 IX 1980 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, Bonita Springs, FL, coll., K. Delate, det. E. Mercer, conf. A. Hamon '80, 30 VII 1980 (FSCA); *Bambusa* sp., 3(3), all adult ♀♀, Ft. Lauderdale, FL, coll., M. McCulloch, det. A. Hamon '80, 6 III 1980 (FSCA); *Bambusa* sp. stem, 2(1), all adult ♀♀, Barbados, coll., L. Gary, nos. V81, JFKIA 38944, 21 IV 1981 (USNM); Bambu, 5(1), all adult ♀♀, Salazar, Angola, Dina Almeida, reg. 9781, 3 II 1973 (USNM); *Bambusa* sp., 4(1), all adult ♀♀, Casablanca, Morocco,

coll., Sanders, 10 VI 1945 (USNM), nos. 451587, 451588; *Bambusa* sp., 11(1), all adult ♀♀, Colonia, Ponape: at HI, coll., M.M. Ross, 30 I 1949 (USNM), nos. HI 5384, 491250, 491251, 491252; 8(1), all adult ♀♀, S/Caña Tucuman, El. Timbo Tuc, Argentina, coll., Saeg. Wul., XII 1994 (INSUE); *Bambusa* sp., 2(1), all adult ♀♀, Caqua, Ar., Venezuela, coll., Cermeli, 29 III 1961 (USNM), nos. 61 1254, 37; *Epidendrum* sp., 1(1), adult ♀, Brazil, at D.C., colls., Sanford, Wood, 7 V 1938 (USNM), nos. 17 48192, 57 7200 (possible host plant misidentification).

Material studied with several different spp.: On *Bambusa* (*Guadua*) sp., 2(1), 1 adult ♀, *Bambusapis caudata*, 2 adult ♀♀, *Bambusaspis miliaris*, Brazil, Rio de Janeiro, Bot. Gard., coll., A.M. Curren, XI 1915 (USNM), no. 1037427, nos. 441494, 441495; *Bambusa pallescens*, 2(1), 2 adult ♀♀, *Bambusapis caudata*, 2 adult ♀♀, *Bambusaspis miliaris*, Brazil, Rio de Janeiro, Bot. Garden, Uic, coll., H.M. Curran, XI 1915 (USNM), no. 920240, nos. 441430, 441439, and 441492; *Bambusa pallescens*, 1(1), 1 adult ♀, *Bambusapis caudata*, 1 adult ♀, *Bambusaspis miliaris*, Brazil, Juiz de Fora, Nimas Gereas, coll., A. Chase, 21 II 1925 (USNM), no. 1255412, nos. 441498, 441499.

Additional hosts: *Arundinaria glaucescens*, *Arundinaria* sp., *Bambusa argentea*, *B. arundinacea*, *B. balcooa*, *B. dissimulator*, *B. distorta*, *B. nana*, *B. oliveriana*, *B. spinosa*, *B. tulda*, *B. tuldoides*, *B. vulgaris* var. *aureo-striata*, *B. vulgaris* var. *aureo-variegata*, *Dendrocalamus giganteus*, *D. strictus*, *D. thouarsii*, *Linganis fimbriolata*, *Oxytenanthera abyssinica*, *Phyllostachys* sp., *Schizostachium glaucifolium*, and *Schizostachium* sp. (Boisduval 1869; D'Araujo e Silva et al. 1968; Green 1915; Hattingh

& Samways 1991, 1992, 1993, 1995; Russell 1941; Williams & Watson 1990); but also found on palm leaves by D'Araujo e Silva et al. (1968).

Description:

Body (Fig. a) oval, with variable outline, 817 (600-1200) long, 384 (200-560) wide, with small anal indentation. Derm membranous with 1 or 2 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row consisting of 203 (158-237) pores; row terminates 2-4 pore lengths before apex of abdomen; all pores bent, each pore 6.3 (4.6-6.9) long, 3.0 (2.3-3.4) wide. Other pores in 2 sizes; large pores either present or absent, if present, then in submarginal row with 2-31 pores, each 8.5 (6.9-9.8) long, 5.4 (4.0-5.7) wide; minute pores (Fig. c) evenly distributed, each 2.3 (1.7-2.9) long, 1.4 (1.1-1.7) wide.

Simple disk pores (Fig. d) evenly distributed over dorsum, consisting of 49 (24-120) pores; with two disk pores closely associated with each large dorsal 8-shaped pore; and in submarginal row with 23 (14-36) pores, each 1.1 (0.6-1.1) in diam.

Tubular ducts (Fig. e) throughout derm, but less numerous than in other species, in 6 loose longitudinal rows; each 22.5 (17.2-26.4) long, 3.4 (2.3-4.6) wide.

Caudal tubes (Fig. f) anterior of anal ring, each 6.3 (5.7-6.9) long, 3.7 (3.4-4.0) wide.

Anal lobes (Fig. g) with small indentation, apical ventral edge slightly sclerotized; each anal lobe with one apical seta 57.1 (41.4-65.5) long, one subapical seta 11.6 (9.8-

13.2) long, one inner ventral seta 6.6 (4.6-8.6) long, and one outer ventral seta 8.1 (5.7-12.6) long.

Arched plate (Fig. g) length 22.4 (17.2-26.4).

Anal plates (Fig. g) separated, thin, bar-shaped; each anal plate 11.8 (6.9-16.1) long.

Anal ring (Fig. g) located anterior of arched plate, divided medially, anal ring 10.3 (6.9-14.9) long, 16.7 (13.8-21.8) wide; with 2 rows of pores, inner row with 6 and outer with 12 (10-16) pores; with 6 setae, each 31.2 (27.6-35.6) long.

Ventral Surface

Clypeolabral shield (Fig. a) with tentorial sclerotization arch-like; clypeolabral shield 94.6 (74.7-113.8) long, 63.2 (42.5-79.3) wide.

Labium (Fig. a) heart-shaped, without setae, 22.5 (17.2-29.9) long, 27.8 (23.0-36.4) wide.

Antennae (Fig. h) one-segmented, 6.7 (3.4-18.4) long, 7.4 (4.6-10.3) wide at base; with 2 (2-3) fleshy setae, 8.6 (5.7-12.6) long, and 2 (1-3) slender setae, 3.6 (1.7-5.2) long.

Spiracles (Fig. i) located in submedial area; anterior 22.1 (17.2-26.4) long, 8.6 (6.9-10.9) wide, atrium 5.1 (2.9-6.3) in diam.; posterior 22.8 (17.8-27.6) long, 8.8 (5.2-11.5) wide, atrium 5.2 (3.4-7.5) in diam.; occasionally derm around atrium slightly folded including 1 or 2 quinquelocular pores; anterior spiracular furrows with a band of 12 (8-23) quinquelocular pores, 1 (1-3) pores wide; posterior furrows with a band of 11 (5-20) quinquelocular pores, 1 (1-3) pores wide.

Quinquelocular pores in spiracular furrows (Fig. j) and in an incomplete marginal row (Figs. j, k); row on both sides either interrupted (Fig. j) or not interrupted (Fig. k), with 23 (4-56) pores on each side, each 2.1 (1.1-3.4) in diam.

8-shaped pores (Fig. l) in a submarginal row with 84 (70-106) pores; each 1.8 (1.1-2.9) long, 1.2 (1.1-1.7) wide; dark-rimmed pores in transverse rows evenly distributed over venter, consisting of 48 (24-94) pores, and with a row of 2 (0-3) pores on each side of mouthparts; each 2.1 (1.7-2.3) long, 1.5 (1.1-1.7) wide.

Setae (Fig. m) with 3 segmental rows around genital opening, each with 2 (2-4) setae, anterior row occasionally missing; each 5.1 (3.4-6.9) long; without corresponding multilocular pores; and incomplete submarginal row on abdomen with 8 (2-12) setae, each 4.1 (3.4-5.7) long.

Biological data: No data available.

Parasitoids and predators: The following coccinellid species were listed by Bartlett (1938) from Puerto Rico and Guiana: *Azya trinitatis* Marshall, *A. pontbrianti* Mulsant, *Cryptognatha nodiceps* Marshall, *Cycloneda sanguinea* (L.), *Delphastus* sp., *Exochomus* sp., *Pentilia castanea* Mulsant, *Pentilia* sp., and *Scymnillus* sp. Bartlett (1939a, b) described the release of *A. trinitatis* (Coccinellidae), *Cheiloneurus* sp. (Encyrtidae), *Delphastus* sp., *Hyperaspis bellotii* (Coccinellidae), *Scymnillodes* sp. (Coccinellidae), *Stethorus* sp. (Coccinellidae), *P. castanea* (Coccinellidae), *P. egena* Mulsant, *P. sp.*, *Scymnus* sp. (Coccinellidae), and *Curinus* sp. (Coccinellidae) against the bamboo pit scale. Wolcott (1953) reported consistent feeding of the imported coccinellids *Cladis nitidula* F. and *Chilocorus cacti* L. on the miliaris pit scale in Puerto

Rico. Herting (1972) listed *Azya* nr. *luteipes* Mulsant, *A. trinitatis*, *Chilocorus cacti*, *C. stigma* Say, *Cladis nitidula*, *Cryptognatha nodiceps*, *Curinus* sp., *Cycloneda sanguinea*, *Delphastus* sp., *E. platycephalus*, *Exochomus orbiculus* Weise, *Ladoria desarmata* Mulsant, *Pentilia* sp., *P. castanea*, *P. egena*, and *Scymnus* sp. as coccinellid predators, *Kearfottia* sp. (Tineidae) as a lepidopteran predator, and *Proaphelinoides elongatiformis* Gir. (Aphelinidae) as a parasitoid. In a series of papers, Hattingh & Samways (1991, 1992, 1993, 1995) reported their findings on artificial diet, prey searching and prey switching behavior of the coccinellids *Chilocorus bipustulatus* (L.), *C. infernalis* Mulsant, and *C. nigritus* (F.) against several pest species including *Ba. miliaris*.

Distribution: FL, HI, IL; Antigua, Bermuda, Brazil, British Guiana, Cuba, Culebro Island, Dutch Guiana, El Salvador, Grenada, Jamaica, Montserrat, Panama, Puerto Rico, St. Kitts, Tobago, Trinidad, Venezuela, West Indies; Algeria, Angola, Australia, Burma, Caroline Islands, China, Culebra Island; Fiji, Guam, India, Japan, Lesser Antilles, Marianna Islands, Mauritius, Palau Islands, Philippines, Sri Lanka, Taiwan, Tanganyika, Tonga, Western Samoa. This species can be expected in every subtropical and tropical environment where bamboo is grown.

Economic importance: Can cause severe damage on bamboo.

Diagnosis: Marginal row of quinquelocular pores interrupted anteriorly and posteriorly, never ends together with marginal 8-shaped pores before apex of abdomen; without multilocular pores; with 6 anal ring setae; with arch-like tentorial sclerotization.

Affinities: This species is closely related to *Ba. caudata*. The latter may eventually turn out to be conspecific with *Ba. miliaris*.

Notes: *Bambusaspis miliaris* has a long history of misidentifications. *Ba. pseudomiliaris* and *Ba. robusta* were recently synonymized with *Ba. miliaris* by Stumpf & Lambdin (2000a). For a list of characters and an evaluation of their differences, see Stumpf & Lambdin (2000a).

***Bambusaspis octocircularis*, n.sp.**

Proposed Common Name: Strange Pit Scale

Fig. 27

Bambusaspis octocircularis, n.sp.

Type material: On *Bambusa* sp., 2(1), holotype circled, adult ♀, paratype, adult ♀, Balboa, C.Z., at San Diego, # 1566, coll., Warren, 18 VI 1948 (USNM), nos. 48-1334, 49-365.

Description:

Body (Fig. a) pear-shaped, 1030 (1020-1040) long, 760 (740-780) wide, without anal indentation. Derm membranous with 4-5 sizes of 8-shaped pores, disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form an incomplete row with 125 (122-127) pores that is replaced by a row of 12 (10-13) minute pores (Fig. c) on each side of posterior abdominal region; 8-shaped pores bent, each pore 12.2 (11.5-12.6) long, 6.9 (6.3-7.5) wide; minute pores 3.3 (2.9-3.4) long, 2.3 (2.3-2.3) wide. Other pores with 4-5 sizes; larger pores (Fig. b) surrounded by circles of smaller pores form a broad submarginal ring; minute pores (Fig. c) in transverse bands over whole dorsum;

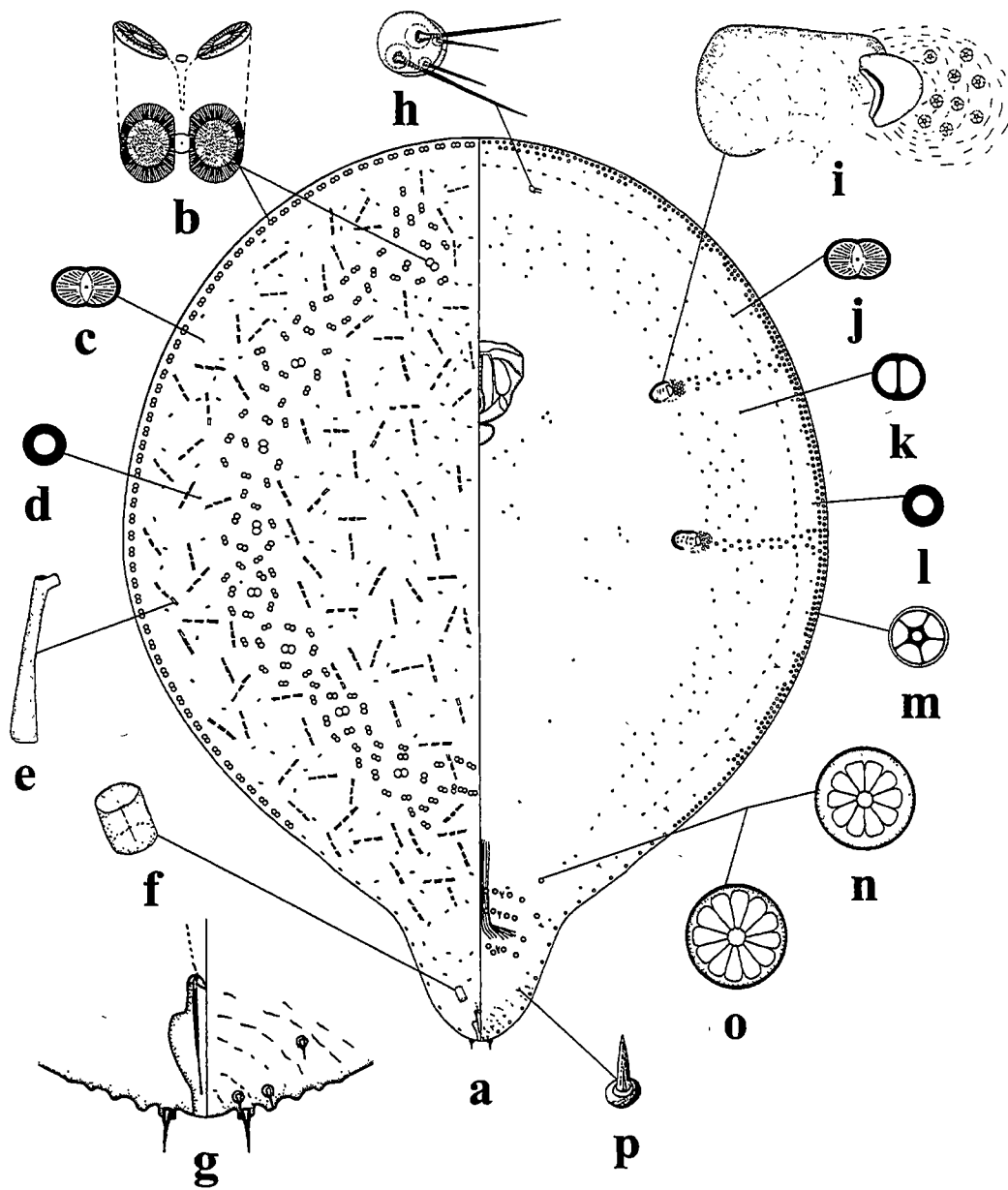


Fig. 27. *Bambusaspis octocircularis*, n.sp.

larger pores 17.8 (17.8-17.8) long, 12.5 (12.1-12.6) wide; medial pores 13.8 (13.8-13.8) long, 8.8 (8.0-9.2) wide; smaller pores 12.2 (11.5-12.6) long, 7.2 (6.9-8.0) wide; occasionally a single pore 6.9 long and 4.6 wide; all pores bent; minute pores same size as marginal minute pores.

Simple disk pores (Fig. d) consist of ca. 20 pores evenly distributed over dorsum, each 2.0 (1.7-2.3) in diam.

Tubular ducts (Fig. e) on whole dorsum with exception of anal lobes; each 26.7 (25.3-28.7) long, 3.4 (3.4-3.4) wide.

Caudal tubes (Fig. f) antero-laterad of anal ring, each 8.2 (6.9-9.8) long, 5.9 (5.2-6.9) wide.

Anal lobes (Fig. g) without anal indentation; each anal lobe with one apical seta 4.6 (4.0-5.2) long, and 3 ventral setae 3.4 long.

Anal ring (Fig. g) completely fused, amphora-shaped, and with membranous area anteriorad, 18.7 (15.5-21.8) long, 14.1 (13.8-14.4) wide; without pores; with 2 setae, each 13.2 (12.1-14.4) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 117.3 (116.1-118.4), width 127.0 (126.4-127.6).

Labium (Fig. a) heart-shaped, without setae, 29.9 (29.9-29.9) long, 40.8 (40.2-41.4) wide.

Antennae (Fig. h) one-segmented, 9.8 (9.2-10.3) long and wide at base; with 2 (1-2) fleshy setae 16.7 (16.1-17.2) long, and 2 slender setae 8.0 (8.0-8.0) long.

Spiracles (Fig. i) located in submarginal area; anterior 30.2 (28.7-32.2) long, 13.4 (13.2-13.8) wide, atrium 7.3 (6.9-8.0) in diam.; posterior 30.5 (29.9-31.0) long, 13.6 (12.6-14.9) wide, atrium 7.3 (6.9-8.0) in diam.; with 12-13 pores in folds around anterior atria and 5-7 pores in folds around posterior atria; anterior spiracular furrows with a band of 31 (29-36) quinquelocular pores, 2 (1-4) pores wide; posterior furrows with a band of 32 (24-41) quinquelocular pores, 2 (1-4) pores wide.

8-shaped pores in a submarginal row (Fig. j) with 109 (107-111) pores; pores similar to dorsal minute pores, each 3.0 (2.9-3.4) long and 2.3 (2.3-2.3) wide; also with ca. 290 pores (Fig. k) in submarginal band and segmental clusters, and with 7 (6-7) pores on each side of mouthparts; pores on head and thorax 2.6 (2.3-2.9) long, 2.3 (2.3-2.3) wide, abdominal pores 2.3 (2.3-2.3) long, 1.9 (1.7-2.3) wide.

Simple disk pores (Fig. l) in a submarginal row close to marginal quinquelocular pores, consisting of 47 (44-50) pores; each 1.7 (1.7-1.7) in diam.

Quinquelocular pores (Fig. m) in spiracular furrows and in a complete marginal row consisting of 573 (514-631) pores; row sporadically a double-row over whole margin, but becomes a complete double-row between spiracular furrows, and becomes a widely spaced single row in posterior part of abdomen where corresponding marginal 8-shaped pores are replaced by minute pores; each 2.8 (2.3-2.9) in diam.

Multilocular pores (Figs. n, o) with or without incomplete band consisting of 2 pores; and with 3 complete bands around genital opening with 10-11, 9-10, and 8-9 pores, respectively; each pore 10 (10-12) loculi, and 5.1 (4.6-5.2) in diam.

Setae (Fig. p) with 3 segmental rows around genital opening corresponding to complete rows of multilocular pores; each row with 2 setae; each 3.4 (2.9-4.0) long; and with 10-12 setae in incomplete submarginal row on abdomen; each 3.2 (2.9-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Only known from Balboa, Panama.

Economic importance: This species is of no economic importance.

Diagnosis: With band of submarginal 8-shaped pores completely encircling dorsum; anal ring with 2 setae; from Panama.

Affinities: *Bambusaspis octocircularis* seems to be closely related to *Ba. tetrasetosa* and *Ba. brasiliensis*, two new species known from Florida, Cuba, Brazil, and Puerto Rico.

Etymology: The name is derived from the submarginal ring of 8-shaped pores on the dorsum.

***Bambusaspis scirrosis* (Russell), 1941**

Proposed Common Name: Scirrosis Pit Scale

Fig. 28

Asterolecanium scirrosis Russell, 1941:184; Zimmerman, 1948:280; D'Araujo e Silva et al., 1968:134; Bruner et al., 1975:34. *Bambusaspis scirrosis* Kozar & Walter, 1985:80.

Type material: On *Bambusa nana*, 8(3), from type material, 5 adult ♀♀, 3 first instars, Kwantung, China, coll. McClure, 1929 (USNM), Lingnan U. no. 8630, McClure no. 20322, no. 45 2107, 1 slide mounted from dry material.

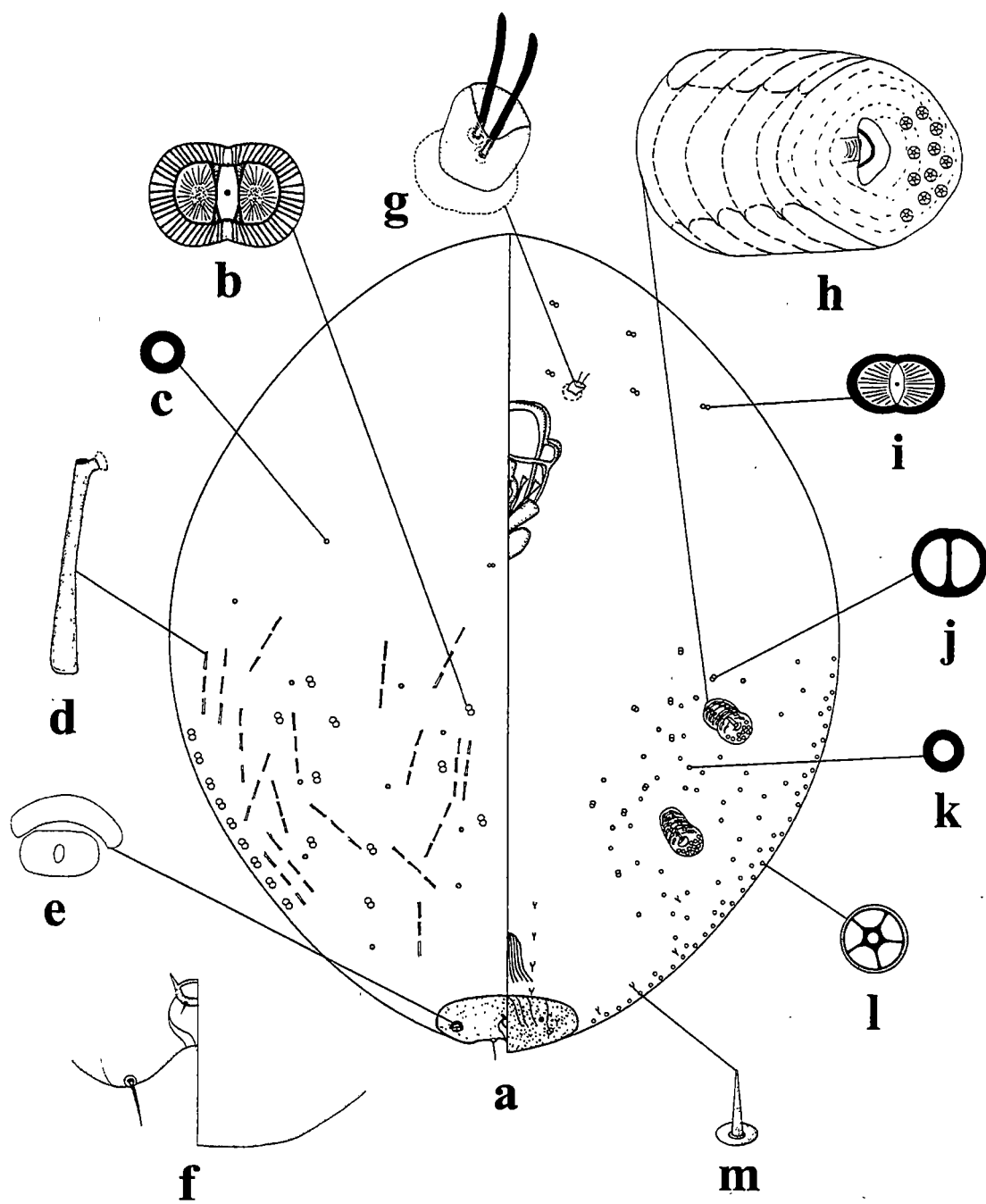


Fig. 28. *Bambusaspis scirrosis* (Russell, 1941).

Additional material studied: On Bamboo, 29(1), 10 adult ♀♀, 19 first instars, Salazar, Angola, coll. D. Almeida, Reg. 9781, 3 II 1973 (USNM).

Additional hosts: *Bambusa vulgaris*, *Bambusa thuarsii*, *Dendrocalamus* sp. (Bruner et al. 1975, Russell 1941).

Description:

Body (Fig. a) subcircular, 435 (300-510) long, 338 (220-420) wide, widest in area anterior of prothoracic spiracles; with pygidium-like dorsal and ventral anal sclerotization, similar to diaspidids. Derm membranous with one to three sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a short incomplete row in posterior cephalothoracic and abdominal area; row with 9 (7-11) pores on each side; pores slightly bent; each pore 7.0 (6.9-7.5) long, 5.0 (4.6-5.7) wide. Other pores restricted to posterior region, consisting of about 20 pores; pores in two submarginal and submedial bands; usually only large pores present, but occasionally also with 2 smaller pore sizes; largest pores 7.0 (6.3-8.0) long, 4.8 (4.6-5.7) wide; medial pores 3.7 (3.4-4.0) long, 2.6 (2.3-2.9) wide; and smallest pores 2.7 (2.3-2.9) long, 1.5 (1.1-1.7) wide; all pores slightly bent.

Simple disk pores (Fig. c) primarily on posterior part of cephalothorax and on abdomen, consisting of 21 (15-25) pores, each 1.6 (1.1-1.7) in diam.

Tubular ducts (Fig. d) in two submarginal and submedial bands in posterior area together with 8-shaped pores and disk pores, each 34.5 (29.9-39.1) long, 4.4 (3.4-5.7) wide.

Caudal tubes (Fig. e) laterad of anal ring, each 4.8 (4.0-5.7) long, 3.7 (3.4-4.6) wide, associated with an anterior sclerotized plate.

Anal lobes (Fig. f) with dorsal indentation; anal area strongly sclerotized ventrally and somewhat less sclerotized dorsally, giving a pygidium-like impression such as in armored scales; sclerotized area 44.1 (35.6-48.3) long, 80.6 (78.2-83.9) wide; each anal lobe with one apical seta dorsad 10.1 (8.0-11.5) long.

Anal ring (Fig. f) complete, not divided medially, anal ring 6.7 (4.6-9.2) long, 7.7 (5.7-9.8) wide; with 2 spine-like projections and 1 pair of setae, each seta 2.9 (2.3-4.0) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 80.9 (69.0-93.1), width 75.8 (64.4-81.6).

Labium (Fig. a) v-shaped, without setae, 26.3 (23.0-29.9) long, 36.3 (33.3-39.1) wide.

Antennae (Fig. g) one-segmented, cup-shaped, 6.7 (4.0-8.6) long, 7.1 (6.3-8.0) wide at base, surrounded by slightly sclerotized dermal folds; with 2 (2-3) fleshy setae 5.2 (3.4-6.9) long.

Spiracles (Fig. h) located in submarginal area in posterior region; anterior 22.1 (19.5-24.1) long, 7.4 (5.7-8.6) wide, atrium 4.0 (3.4-4.6) in diam.; posterior 21.3 (20.1-23.0) long, 7.0 (5.7-8.0) wide, atrium 4.3 (3.4-6.3) in diam; without spiracular furrows, instead each spiracle surrounded by 19 (10-26) quinquelocular pores; each atrium embedded in spiracular fold that includes 11 (8-15) quinquelocular pores.

8-shaped pores with two types of dark-rimmed pores; with a few large pores (Fig. i) anterior of clypeolabral shield; each 3.5 (2.9-4.6) long, 2.7 (2.3-3.4) wide; and with several smaller pores (Fig. j) mesad of spiracles; each 2.6 (1.9-3.4) long, 2.2 (1.7-2.9) wide.

Simple disk pores (Fig. k) in thoracic and anterior abdominal region together with small 8-shaped pores and quinquelocular pores; only a few pores present, each 1.8 (1.7-2.3) in diam.

Quinquelocular pores (Fig. l) in a band on each side of margin, from sclerotized anal area to midsection of the body anterior of prothoracic spiracles; band consisting of 43 (33-50) pores, and with some pores around spiracles, each 2.3 (2.3-2.3) in diam.

Setae (Fig. m) with 4 segmental rows around genital opening, each with 2 (2-4) setae, anterior row sometimes missing, each 2.9 (2.3-3.4) long; without corresponding rows of multilocular pores, and with incomplete submarginal row with 5 (4-7) setae on each side of abdomen, each 3.2 (2.9-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: HI; Antigua, Brazil, Cuba, St. Kitts, Trinidad; China, Philippines.

Economic importance: This species is of no economic importance.

Diagnosis: Anal area sclerotized dorsally and ventrally, pygidium-like; marginal rows of 8-shaped pores and quinquelocular pores incomplete, interrupted in cephalic area.

Affinities: Adelphotaxon to *Ba. hemisphaerica*. The two species may be closely

related to a clade including three new species, *Ba. brasiliensis*, *Ba. octocircularis*, and *Ba. tetrasetosa*.

***Bambusaspis tetrasetosa*, n.sp.**

Proposed Common Name: Puerto Rican Pit Scale

Fig. 29

Bambusaspis tetrasetosa, n.sp.

Type material: On *Bambusa* sp. stem, at nodes beneath leaf scales, on twig, 73(5), holotype circled, adult ♀, paratypes, 13 adult ♀♀, 59 first instars, nr. Arus, Puerto Rico, coll., S. Nakahara, no. N-77-123, 17 VII 1977 (USNM).

Material studied with several different spp.: On bamboo, 5(1), 5 adult ♀♀, *Bambusaspis tetrasetosa*, 2 adult ♀♀, *Bambusaspis bambusae*, Cuba, at Key West, coll., R.G. Milner, 11 II 1960 (USNM), no. 463; bamboo, 4(1), 4 adult ♀♀, *Bambusaspis tetrasetosa*, 1 adult ♀, *Bambusaspis bambusae*, St. Leo Abbey, San Antonio, FL, coll., E.A. Black, VI 1938 (USNM), no. 38-312728.

Description:

Body (Fig. a) subcircular, 708 (510-800) long, 498 (340-560) wide, without anal indentation or with very small indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, tubular ducts, and a pair of caudal tubes on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row that terminates about 7 pore lengths before apex of abdomen; row with 60 (44-78) pores, all pores bent; each 13.3 (12.1-14.9) long, 9.7 (8.0-10.9) wide.

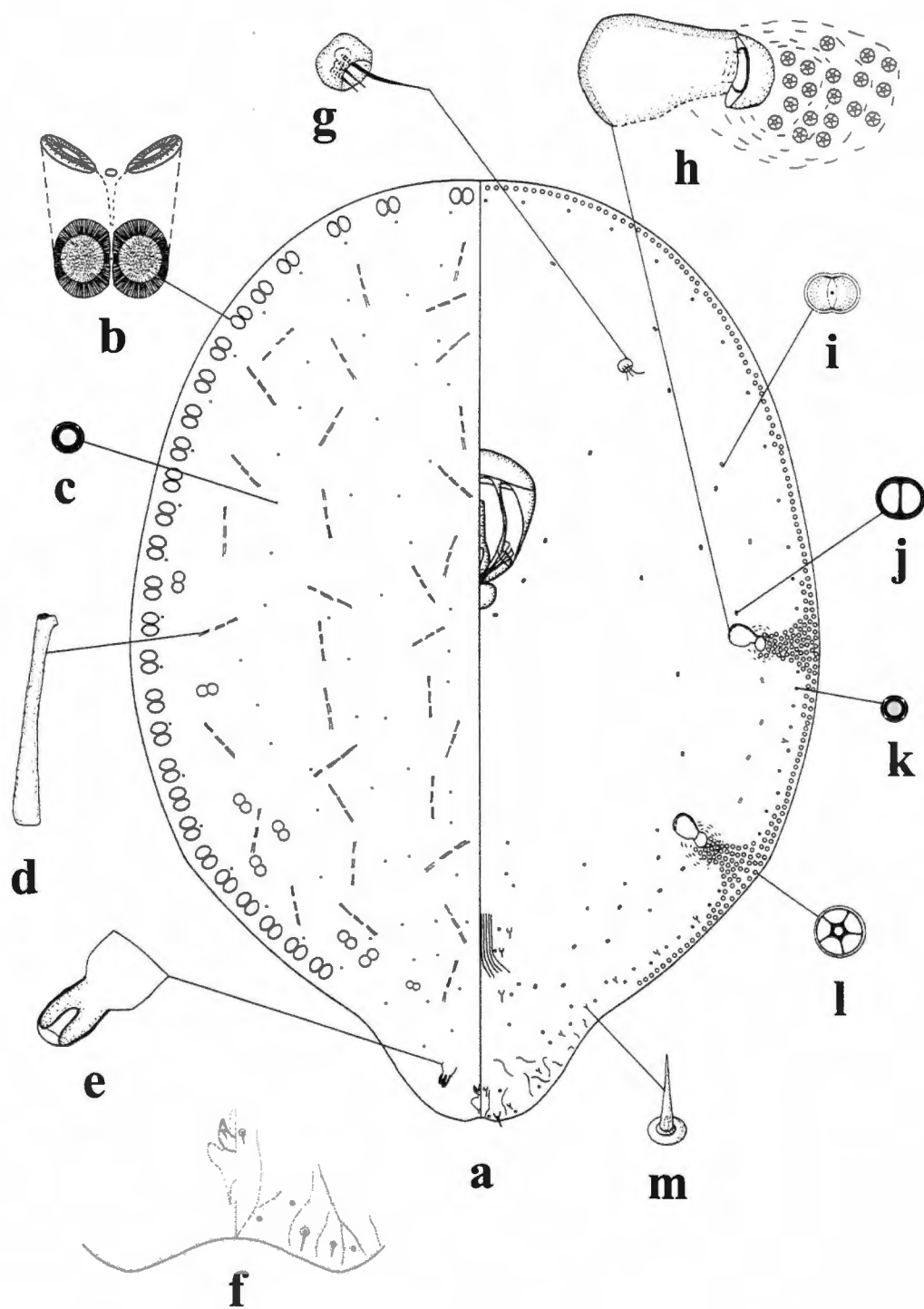


Fig. 29. *Bambusaspis tetrasetosa*, n.sp.

Other pores with 2 sizes, in small submarginal band, mostly on thorax and abdomen; all pores bent; large pores 9.7 (8.0-10.3) long, 6.5 (5.7-7.5) wide; small pores rare, 5.8 (5.2-6.3) long, 4.0 (4.0-4.0) wide; without minute pores.

Simple disk pores (Fig. c) in transverse rows, consisting of 95 (50-160) pores; and in submarginal row with 41 (32-56) pores, each 1.1 (1.1-1.1) in diam.

Tubular ducts (Fig. d) in 6 longitudinal bands, each 29.2 (25.9-33.3) long, 3.4 (2.9-4.0) wide.

Caudal tubes (Fig. e) antero-laterad of anal ring, with finger-like projections; each 9.0 (5.7-13.8) long, 4.7 (3.4-6.3) wide.

Anal lobes (Fig. f) with small indentation, ventral surface slightly rugose; each anal lobe with one apical seta 4.9 (3.4-5.7) long; apical setae located on ventral surface, only slightly larger than submarginal setae; with one subapical seta on each anal lobe; each seta 2.3 long, not present in most specimens.

Anal ring (Fig. f) completely fused, with strongly sclerotized anterior margin, and with membranous areas anterior and posterior; posterior membranous area pyramid-shaped 11.1 (9.8-12.6) long, 14.4 (11.5-23.0) wide, ending in dorsal anus; anal ring 7.1 (5.7-9.2) wide; without pores; with 2 setae, each 2.3 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 102.3 (94.3-111.5), width 80.7 (69.0-100.0).

Labium (Fig. a) heart-shaped, without setae, 27.6 (21.8-32.2) long, 36.8 (32.2-43.7) wide.

Antennae (Fig. g) one-segmented, 8.2 (6.9-10.3) long, 9.0 (8.0-9.8) wide at base; with 1 (1-2) fleshy setae 10.8 (9.2-13.2) long, and 2 (2-3) slender setae 5.4 (3.4-6.9) long.

Spiracles (Fig. h) located in submarginal area; anterior 23.0 (20.7-26.4) long, 8.5 (7.5-9.8) wide, atrium 4.5 (3.4-5.2) in diam.; posterior 22.7 (19.5-26.4) long, 8.9 (7.5-11.5) wide, atrium 4.7 (4.0-5.2) in diam; anterior spiracular furrows with a band of 50 (30-70) quinquelocular pores, 1-12 pores wide; posterior furrows with a band of 47 (30-63) quinquelocular pores, 2-9 pores wide; furrows gradually widen from spiracles to margin, with 22 (14-32) pores in folds around atria.

8-shaped pores (Fig. i) in a submarginal row on head and thorax; only a few pores present, these pores further mesad than usually, not close to submarginal setae; each 2.8 (2.3-3.4) long and 2.1 (1.7-2.3) wide; dark-rimmed pores (Fig. j) in a submarginal band mesad of 8-shaped pores consisting of 29 (12-44) pores; also with 3 (0-5) pores on each side of mouthparts; each 2.4 (2.3-2.9) long, 1.9 (1.7-2.3) wide.

Simple disk pores (Fig. k) in submarginal row close to submarginal setae, consisting of 81 (66-90) pores; and several pores in transverse rows on abdomen; pores larger than dorsal disk pores; each 1.6 (1.1-1.7) in diam.

Quinquelocular pores (Fig. l) in spiracular furrows and in a marginal row consisting of 379 (294-466) pores; row ends together with marginal 8-shaped pores before apex of abdomen; row becomes double shortly anteriad and posteriad of each spiracular furrow; also some pores in a second row position in head region; each 2.7 (2.3-3.4) in diam.

Setae (Fig. m) with 4 segmental pairs laterad of genital opening, the posterior pair exactly opposite (ventrad) of anal ring; each 3.9 (3.4-4.6) long; without corresponding multilocular pores; and with 16 (12-20) setae in incomplete submarginal row, usually with 14 setae on abdomen and 2 on thorax; in 2 specimens, 2 setae were also found on head, which is atypical for this genus, each seta 3.4 (2.9-4.0) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Only known from Puerto Rico so far.

Economic importance: This species is of no economic importance.

Diagnosis: Caudal tubes with finger-like projections; marginal row of large 8-shaped pores incomplete, less dense anteriorly; from Puerto Rico.

Affinities: *Bambusaspis tetrasetosa* seems to be closely related to the two new species *Ba. octocircularis* and *Ba. brasiliensis*.

Etymology: The name derives from the 4 pairs of segmental setae on the venter in the posterior abdominal area.

Genus *Grammococcus* Miller & Lambdin, 1978

Grammococcus Miller & Lambdin, 1978:240; Kosztarab et al., 1986:7; Matile-Ferrero, 1996:252; Stumpf & Lambdin, 1998:35.

Type species: *Grammococcus adetocorymbus* Miller & Lambdin, 1978:240, by original designation.

Generic description (from Miller & Lambdin 1978):

Dorsum: Quinquelocular pores in clusters on dorsosubmargin, without large 8-shaped pores, minute 8-shaped pores and simple pores present, and tubular ducts in 2 longitudinal bands. Venter: With unsegmented antennae, 8-shaped pores near mouthparts and in submarginal row, legs absent, trilocular pores near spiracle, and multilocular pores in 2 or 3 transverse rows near vulva.

Matile-Ferrero (1996) described the presence of a green translucent test for *Gr. corymbus*. This type of test only occurs in the subfamily Asterolecaniinae. The anal ring in *Grammococcus* is similar to the anal ring in some species of *Pálmaspis*, e.g., *Pa. bondari* and *Pa. pallida*. The clusters of multilocular pores on the dorsum and the extreme reduction of marginal pores puts *Grammococcus* in a possible sister group relationship to the Old World genus *Polea*. These characters may be seen as autapomorphies of the two genera.

Diagnosis: With unique quinquelocular pore clusters on dorsum.

Hosts: Palms.

Species not included in the study:

***Grammococcus adetocorymbus* Miller & Lambdin, 1978**

Proposed Common Name: Trinidad Pit Scale

Grammococcus adetocorymbus Miller & Lambdin, 1978:243.

Host: Palm.

Distribution: Trinidad.

Affinities: *Grammococcus corymbus*. *Grammococcus* is closely related to the Old World genus *Polea*.

Notes: Types available in CDFA, FSCA, MNC, MNHN, NHM, SA, UCD, UT, VPI, ZI.

***Grammococcus corymbus* Miller & Lambdin, 1978**

Proposed Common Name: Colombian Pit Scale

Grammococcus corymbus Miller & Lambdin, 1996:257; Matile-Ferrero, 1996:252.

Host: *Astrocaryum chonta*, *Elaeis guineensis*, *Scheelea brachyclada*.

Distribution: Colombia, Peru.

Affinities: *Grammococcus adetocorymbus*.

Notes: Types available in MNHN, NHM, SA, UCD, UT, and ZI.

Genus *Neoasterodiaspis* Borchsenius, 1960

Neoasterodiaspis Borchsenius, 1960:208, 1961:64; Morrison & Morrison, 1966:129; Kozar & Walter, 1985:80; Liu & Shi, 1990:85, 1993:188; Stumpf & Lambdin, 1998:35. Type species: *Asterolecanium pasaniae* Kuwana & Cockerell, in Kuwana, 1909:152, by original designation.

Generic description and diagnosis:

see *Neoasterodiaspis adjuncta*, the only species present in the Americas.

Borchsenius (1960) described this genus as being different from *Asterodiaspis* by having lateral sclerotized projections on the marginal 8-shaped pores. However, Liu & Shi (1990, 1993) found some species of *Neoasterodiaspis* with these projections, with intermediate morphological stages of the projections, or without the projections,

depending on the position on the host plant. Therefore, future research may show a synonymy of *Neoasterodiaspis* with *Asterodiaspis*.

***Neoasterodiaspis adjuncta* (Russell), 1941**

Proposed Common Name: Adjunct Pit Scale

Fig. 30

Asterolecanium adjunctum Russell, 1941:39; Ferris, 1955:18. *Neoasterodiaspis adjuncta* Borchsenius, 1960:208.

Type material: On *Quercus hemisphaerica*, 1(1), holotype, adult ♀, Indo China, H.N.Y.B.G., VIII 1922 (USNM), no. 44 1390.

Description:

Body (Fig. a) subcircular, widest in area of prothoracic spiracles, 540 long and 380 wide, without anal indentation. Derm membranous with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a single row consisting of 126 pores; row terminates about 2 pore lengths before apex of abdomen; pores flat or only slightly bent, with a very distinct spike dorsad; each 8.0 long and 4.0 wide. Other pores consist of 3 different pore sizes; all pores flat or only slightly bent; large and medial pores (Fig. c) in incomplete swirls forming a submarginal band, and an incomplete median band, ranging from the anterior end to about half the length of the entire body; minute pores (Fig. d) evenly distributed; largest pores 6.9 long, 4.6 wide; medial pores 4.6 long, 2.3 wide; and minute pores 3.4 long, 2.3 wide.

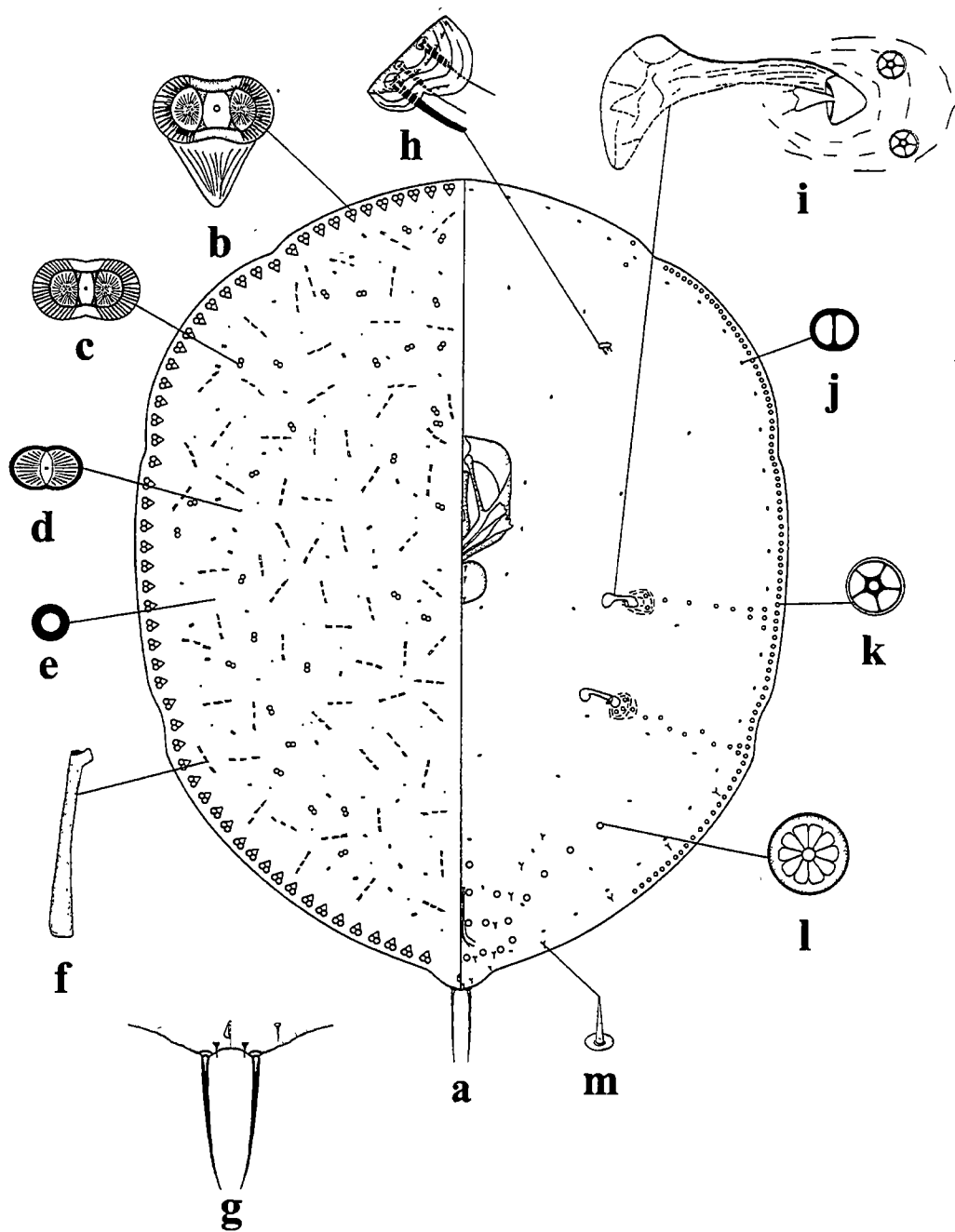


Fig. 30. *Neoasterodiaspis adjuncta* (Russell), 1941.

Simple disk pores (Fig. e) evenly distributed over dorsum, consisting of ca. 40 pores, each 1.7 in diam.

Tubular ducts (Fig. f) throughout derm, each 19.5 long, 2.3 wide.

Anal lobes (Fig. g) without indentation; each anal lobe with one apical seta 54.0 long, one subapical seta 3.4 long, and one ventral seta 4.6 long.

Anal ring (Fig. g) pear-shaped, similar to anal ring of the genus *Asterodiaspis*, 5.7 long and 4.6 wide; with one pair of setae, each 2.3 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 80.5, width 66.7.

Labium (Fig. a) heart-shaped, 26.4 long, 39.1 wide; with 3 pairs of setae, each 3.4 long.

Antennae (Fig. h) one-segmented, 4.6 long, 5.7 wide at base; with 1 fleshy seta 5.7 long, and 2 slender setae 4.6 long.

Spiracles (Fig. i) located between medial and marginal area; anterior 26.4 long, 9.2 wide, atrium 5.7 in diam.; posterior 27.6 long, 9.2 wide, atrium 5.7 in diam.; with 3 (2-4) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 9-10 quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a band of 12-13 quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. j) in a submarginal row with 70 pores; dark-rimmed pores in transverse rows throughout venter with 34 pores, and with 4 pores on each side of mouthparts; each 1.7 long, 1.1 wide.

Quinquelocular pores (Fig. k) in spiracular furrows and in a marginal row with 178 pores; row ends ca. 8 8-shaped pore lengths before apex of abdomen, and is interrupted for 20 8-shaped pore lengths anteriorly; and with 2 pores between margin and each antenna; each 2.3 in diam.

Multilocular pores (Fig. l) with 2 incomplete rows consisting of 2 pores in each row; and 4 complete rows around genital opening with 4, 5, 5, and 8 pores, respectively; each 10 loculi, and 3.4 in diam.

Setae (Fig. m) with 5 segmental rows around genital opening corresponding to 4 complete rows and 1 incomplete row of multilocular pores; each row with 2 setae, posterior row with 4 setae; and with submarginal row with 6 setae on each side of abdomen ranging from the anal area to the metathoracic spiracles; each 2.9 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Presumably Indo-China, only two specimens known from the New York Botanical Gardens.

Economic importance: This species is of no economic importance.

Diagnosis: Marginal 8-shaped pores flat with distinct dorsal spike, *Neoasterodiaspis*-type (Fig. 2d). On oaks, only recorded from New York Botanical Gardens in the New World.

Affinities: The genus *Neoasterodiaspis* is closely related to the genus *Asterodiaspis*.

Genus *Palmaspis* Bodenheimer, 1951

Palmaspis Bodenheimer, 1951:328; Borchsenius, 1960:172; Morrison & Morrison, 1966:142; Kozar & Walter, 1985:80; Matile-Ferrero, 1996:252; Stumpf & Lambdin, 1998:35.

Type species: *Asterolecanium phoenicis* Ramachandra Rao, 1922:11, by original designation.

Asterolecanium Ferris, 1955:15; Miller, 1996:69.

Generic description:

Dorsum: With marginal row of 8-shaped pores, only in *Pa. longifila* with band, all pores bent, rarely flat, row sometimes interrupted; dorsal 8-shaped pores present or absent, minute 8-shaped pores present in most species, absent in some; with simple disk pores and tubular ducts, simple disk pores usually on whole dorsum, not in submarginal row in most species; *Pa. longifila* is the only species with simple disk pores on the venter; anal ring reduced, plate like, with 4, 2, or without setae, in some species anal ring completely reduced; without arched plate or anal plates.

Venter: With one-segmented antennae, extremely reduced; some species without lateral clypeal sulcus; with 8-shaped pores near mouthparts, in marginal row, and in transverse rows, mainly on abdomen; legs absent, most species with quinquelocular pores in spiracular furrows and trilocular pores in marginal row, some species with trilocular, quaturolocular, and quinquelocular pores in spiracular furrows and in marginal row; multilocular pores in abdominal rows present or absent, with submarginal row of setae.

Diagnosis: Paraphyletic genus, therefore, without unique characters. Anal ring fused, but never heart-shaped or triangular, with 0-4 setae; large dorsal and marginal 8-shaped pores typical (Fig. 2b). On palms.

Hosts: Members of the genus *Palmaspis* are restricted to palms as host plants. The genus occurs worldwide wherever palms grow, no biogeographic region can be pinpointed as center of origin.

***Palmaspis asetosa*, n.sp.**

Proposed Common Name: Asetose Pit Scale

Fig. 31

Palmaspis asetosa, n.sp.

Type material: On palm leaf, 6(1), holotype circled, adult ♀, paratypes, 3 adult ♀♀, 2 first instars, Costa Rica, at Miami, no. 18811, coll., E.B. Lee, 28 VII 1978 (USNM).

Description:

Body (Fig. a) oval, widest in area of metathoracic spiracles, 920 long, 393 (350-420) wide, without anal indentation or anal setae. Derm membranous with 2 sizes of 8-shaped pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single complete row around margin, consisting of 135 (126-142) pores; all pores bent, each 9.9 (9.2-10.3) long, 4.3 (4.0-4.6) wide.

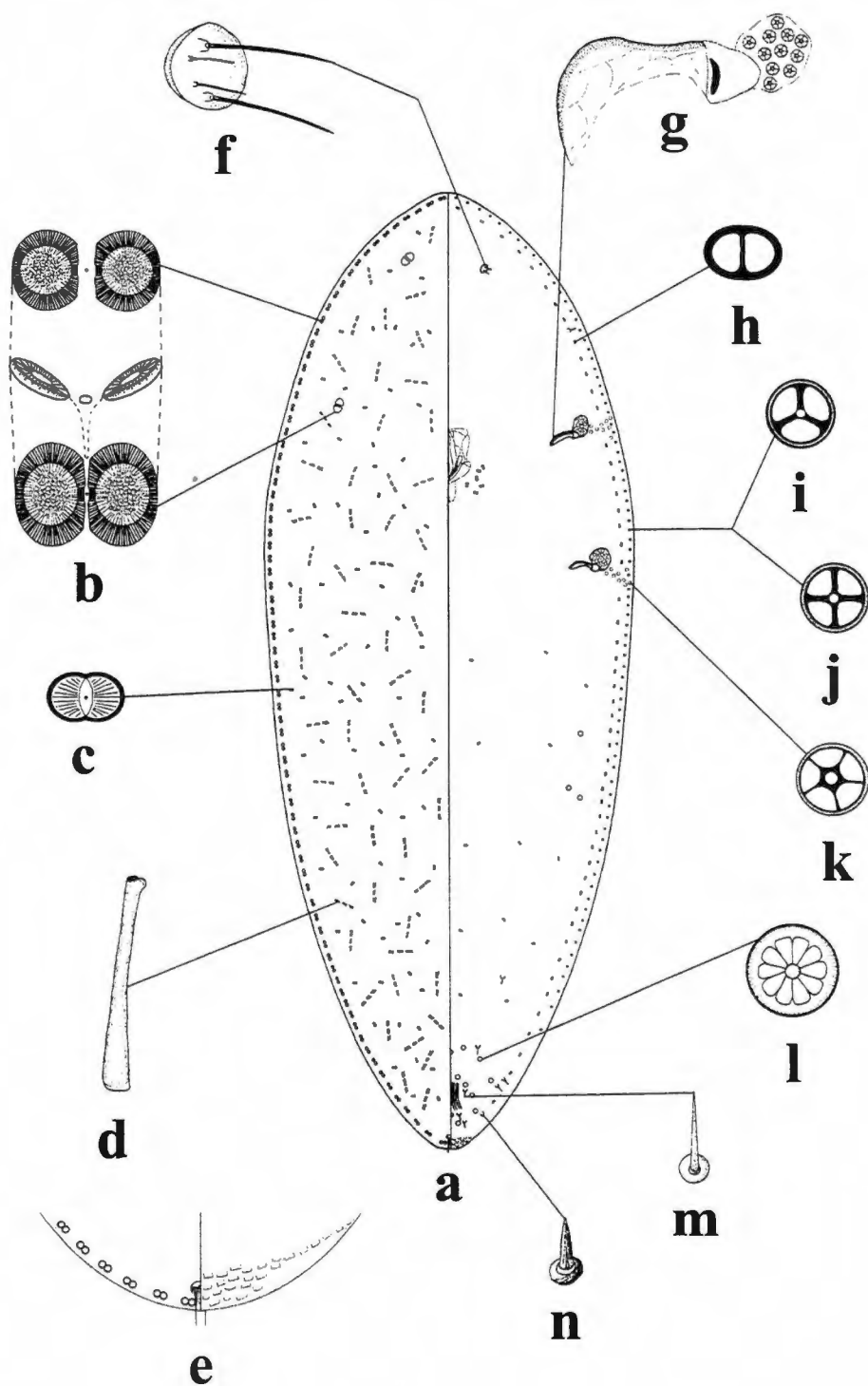


Fig. 31. *Palmaspis asetosa*, n.sp.

Other pores with 2 sizes; large pores present in 2 out of 4 adult ♀♀, with 2-4 such pores, each pore 12.9 (12.6-13.2) long, 9.2 (8.6-9.8) wide; with 176 (160-192) minute pores (Fig. c) in transverse rows, each 2.6 (2.3-3.4) long, 1.9 (1.7-2.3) wide.

Simple disk pores not present in the available specimens.

Tubular ducts (Fig. d) throughout derm, each 20.8 (19.0-21.8) long, 3.0 (2.9-3.4) wide.

Anal lobes (Fig. e) without anal indentation, marginal 8-shaped pores not interrupted; without apical setae.

Anal ring (Fig. e) plate-like, fused, anal ring 4.0 (3.4-4.6) long, 8.8 (8.0-9.2) wide; with 2 setae, and with 1 seta-like collar on each side, each seta 12.8 (10.9-13.8) long; anal tube 5.8 (5.2-6.3) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 74.7 (69.0-79.3), width 64.1 (55.2-77.0).

Labium (Fig. a) heart-shaped, 34.5 (32.2-36.8) long, 27.6 (25.3-31.0) wide; with 2 pairs of setae, each 2.3 (2.3-2.3) long, setae sometimes missing.

Antennae (Fig. f) one-segmented, disk-shaped, 8.1 (6.3-9.2) long, 9.5 (8.0-10.3) wide at base; with 2 fleshy setae 10.9 (9.2-13.8) long, and 2-3 slender setae 3.4 (2.3-5.7) long.

Spiracles (Fig. g) located in submarginal area; anterior 22.8 (20.7-24.7) long, 7.5 (6.9-8.0) wide, atrium 3.0 (2.3-3.4) in diam.; posterior 25.3 (23.0-26.4) long, 8.2 (8.0-8.6) wide, atrium 3.4 in diam.; with 11 (9-13) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 20 (18-22) quinquelocular pores, 2 (1-3) pores

wide; posterior furrows with a band of 21 (18-24) quinquelocular pores, 2 (1-2) pores wide.

8-shaped pores (Fig. h) in a submarginal row with 99 (98-100) pores; each 1.9 (1.7-2.3) long, 1.3 (1.1-1.7) wide; dark-rimmed pores consist of two types; with 6 (5-8) strongly sclerotized pores on each side of mouthparts, each 2.5 (2.3-2.9) long, 2.0 (1.7-2.3) wide; and with 22 lesser sclerotized pores (measurable only from holotype) in transverse abdominal rows, same size as submarginal pores.

Trilocular pores (Fig. i) in a marginal row with 152 (140-164) pores that ends 10 (8-12) corresponding 8-shaped pores before apex of abdomen; each 1.9 (1.7-2.3) in diam.

Quatrolocular pores (Fig. j) with a few pores present in marginal row together with trilocular pores; same size as trilocular pores.

Quinquelocular pores (Fig. k) in spiracular furrows, each 2.3 (2.3-2.3) in diam.

Multilocular pores (Fig. l) with 2 incomplete rows consisting of 4 pores in posterior row and 2 pores in anterior row; and with 3 complete rows of pores around genital opening, with 3 pores in posterior row and 7 pores in the 2 other rows; each 10 (9-10) loculi and 3.9 (3.4-4.0) in diam.

Setae with 3 segmental rows (Fig. m) around genital opening corresponding to complete rows of multilocular pores, and 1 additional setal row anteriad; with 4 setae in posterior row and 2 setae in each of the following 3 rows; each 3.8 (2.9-4.6) long; and with submarginal row with 8-10 tack-like setae (Fig. n), primarily in abdominal area, but with at least 1 seta on each side in cephalothoracic area, each 3.2 (2.9-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Costa Rica.

Economic importance: This species is not considered economically important.

Diagnosis: Without apical setae; marginal row of 8-shaped pores not interrupted at apex of abdomen; from Costa Rica.

Affinities: The asetose pit scale may be related to other species that possess two anal ring setae. Similarities in the anal ring and the general appearance of the scale seem to indicate a close relationship to *Pa. boliviae* and *Pa. urichi*.

Etymology: The name derives from the complete lack of apical setae.

***Palmaspis bicircularis*, n.sp.**

Proposed Common Name: Guatemalan Pit Scale

Fig. 32

Palmaspis bicircularis, n.sp.

Type material: On palm leaf, 5(1), holotype circled, adult ♀, paratypes, 3 second instar ♀♀, 1 fourth instar ♂, Guatemala, coll., J. Thew, 21 III 1979 (USNM), Los Angeles no. 2224.

Description:

Body (Fig. a) elongate, widest in spiracular area, 660 long, 230 wide, with very small anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

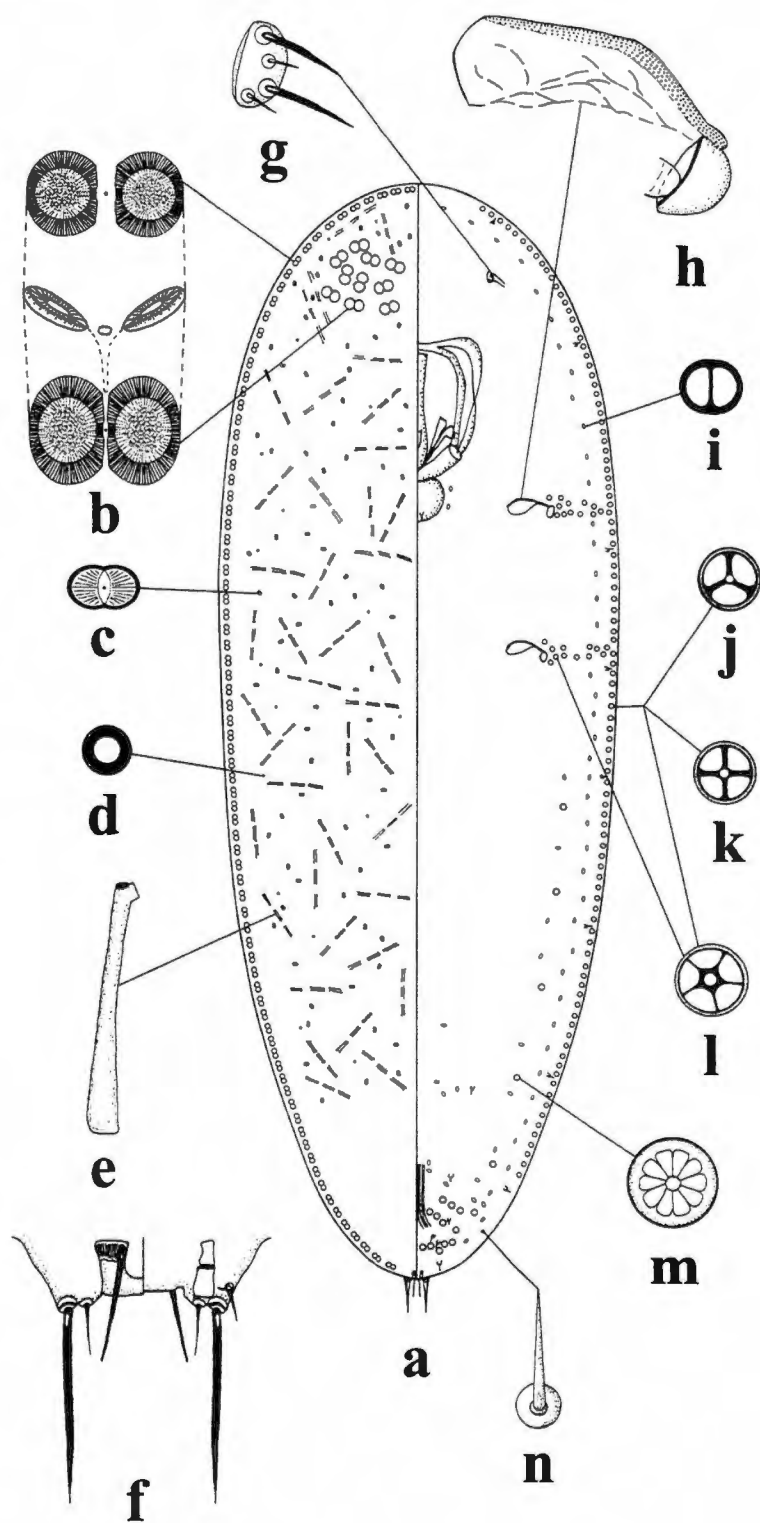


Fig. 32. *Palmaspis bicircularis*, n.sp.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row that terminates ca. 2 pore lengths before apex of abdomen; with 184 pores, all bent; each pore 6.9 (6.3-7.5) long, 3.6 (3.4-4.0) wide. Other pores with 2 different pore sizes; large pores in two swirls anteriad, pores slightly bent; about 280 minute pores (Fig. c) in numerous swirls over whole dorsum with exception of anal area; large pores 10.1 (9.8-10.3) long, 5.9 (5.7-6.3) wide; minute pores 2.3 (2.3-2.3) long, 1.7 (1.7-1.7) wide.

Simple disk pores (Fig. d) mainly in loose submarginal row, consisting of about 20 pores; each 1.1 (1.1-1.1) in diam.

Tubular ducts (Fig. e) distributed throughout derm with exception of the anal area; each 25.9 (25.3-26.4) long, 3.4 wide.

Anal lobes (Fig. f) with very small anal indentation, and with very distinct elongate, rectangular, ventral sclerotization laterad; each anal lobe with one apical seta, 23.0 long, one subapical seta 8.0 long, and one ventral seta 5.7 long.

Anal ring (Fig. f) horseshoe-shaped, two halves connected apically, with one seta on each half; anal ring 5.7 long, 8.0 wide, each seta 17.2 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 73.6, width 55.2.

Labium (Fig. a) heart-shaped, 23.0 long, 31.0 wide; with 1 pair of setae, each seta 2.3 long.

Antennae (Fig. g) one-segmented, 4.6 long, 6.9 wide at base; with 2 fleshy setae 6.9 long, and 2 slender setae 2.3 long.

Spiracles (Fig. h) located between medial and marginal area; anterior 22.4 (21.8-23.0) long, 9.5 (9.2-9.8) wide, atrium 2.6 (2.3-2.9) in diam.; posterior 21.0 (20.7-21.3) long, 7.5 (6.9-8.0) wide, atrium 3.2 (2.9-3.4) in diam.; anterior spiracular furrows with a band of 12-15 quinquelocular pores, 2 (1-2) pores wide; posterior furrows with a band of 11-13 quinquelocular pores, 2 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 82 pores; each 1.7 long, 1.1 wide; dark-rimmed pores in transverse rows on posterior abdomen, with about 35 pores, and with 2 pores on each side of labium; each 1.7 long and wide.

Trilocular pores (Fig. j) in a marginal row with 216 pores together with quatuorlocular and quinquelocular pores, row terminates 14 8-shaped pore lengths before apex of abdomen, and is interrupted for 8 8-shaped pore lengths anteriad; each 1.7 (1.7-1.7) in diam.

Quatuorlocular pores (Fig. k) in a marginal row together with trilocular and quinquelocular pores; same size as trilocular pores.

Quinquelocular pores (Fig. l) in spiracular furrows, also present in marginal row; each 2.3 (2.3-2.3) in diam.

Multilocular pores (Fig. m) with 6 incomplete rows consisting of 2 pores in each row, and 7 pores in the posterior row; and 2 complete rows around genital opening, each with 9-10 pores; each 10 loculi, 3.2 (3.0-3.5) in diam.

Setae (Fig. n) with 4 segmental rows corresponding to 2 complete and 2 incomplete rows of multilocular pores; each with 2 setae, posterior row with 4 setae, each

3.8 (2.9-4.6) long; also submarginal row with 20 setae, seta closest to anal lobe 4.6 long, each remaining seta 3.4 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Guatemala.

Economic importance: This species is of no economic importance.

Diagnosis: Large dorsal 8-shaped pores in two anterior swirls; anal ring forms two plates, connected by a bar posteriad; anal lobes with distinct bar-like sclerotization ventrad; from Guatemala.

Affinities: The relationships are unclear, but *Pa. bicircularis* appears to share a common ancestor with all other species with two anal ring setae.

Etymology: The name refers to the two anterior swirls of large dorsal 8-shaped pores.

***Palmaspis boliviae* (Russell), 1941**

Proposed Common Name: Bolivian Pit Scale

Fig. 33

Asterolecanium boliviae Russell, 1941:52. *Palmaspis boliviae* Matile-Ferrero, 1996:252, 263.

Type material: On *Palmae* (*Catostigma radiata*?), 1(1), paratype, adult ♀, Colombia, Cauca, Cordoba State, coll., C. B. Doyle, XII 1905 (USNM), no. 690432, labeled no. 5, no. 44 1473.

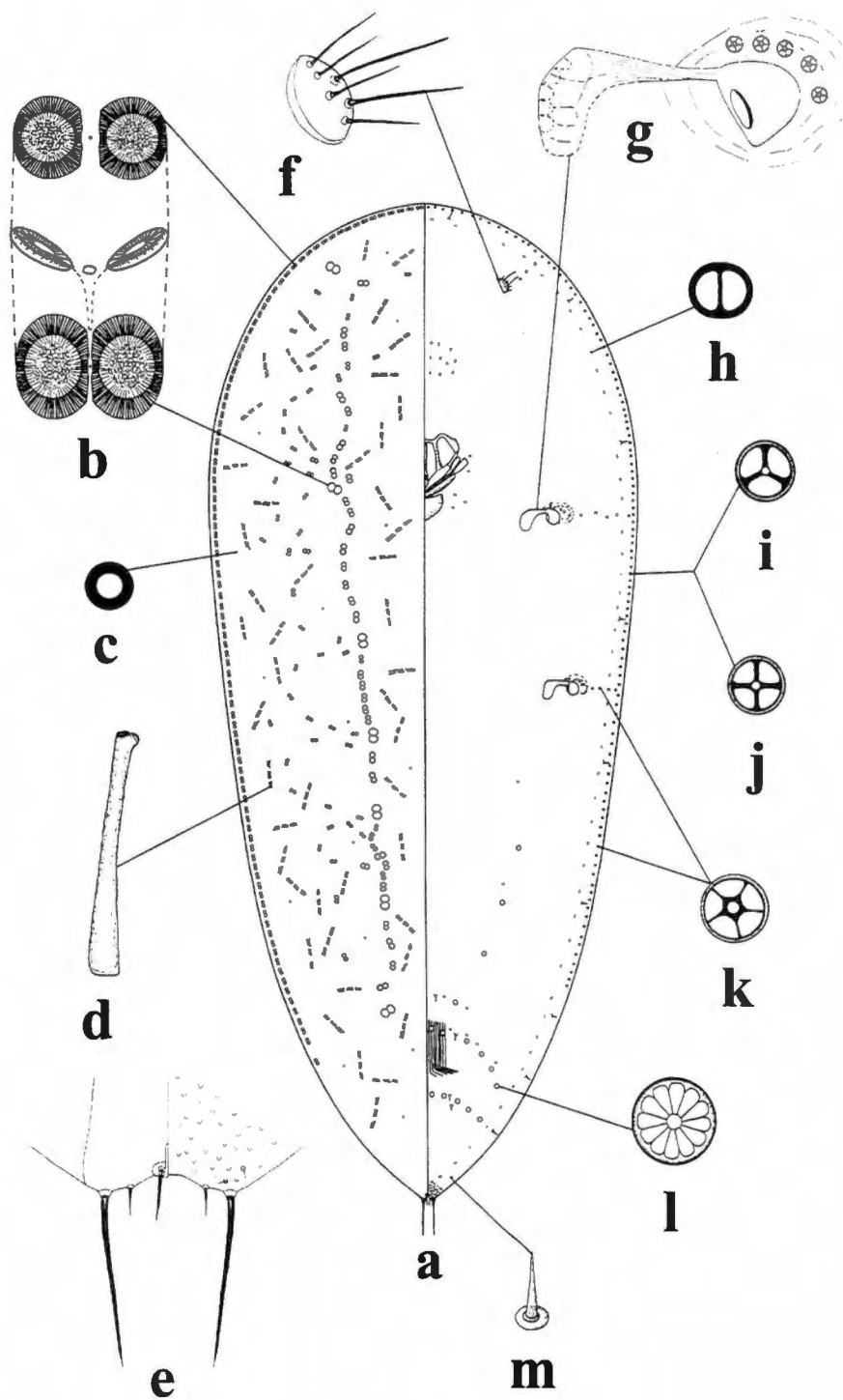


Fig. 33. *Palmaspis boliviae* (Russell), 1941.

Additional material studied: On palm leaf, 4(4), all adult ♀♀, Ecuador, incp. Miami no.13788, coll., F. Matthews, 14 VI 1976 (USNM), labeled XI 76; on palm leaf, 1(1), adult ♀, Ecuador, incp. Miami no.17719, coll., F. Matthews, 24 III 1978 (USNM), labeled IV 78.

Additional hosts: *Euterpe precatoria*, *Jessenia bataua* (Matile-Ferrero 1996).

Description:

Body (Fig. a) longitudinal, widest in spiracular area, 757 (560-960) long, 298 (260-360) wide, with anal indentation. Derm membranous with 4 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row that terminates conspicuously before anal lobes, at around area of genital opening; row with 198 (136-252) pores, all bent; each 7.4 (6.9-9.2) long, 3.7 (3.4-4.6) wide. Other pores with 4 different pore sizes; the 3 largest pore sizes arranged in two submedial rows, smallest pores in swirls, adjoining submedial rows laterad; largest pores 14.4 (12.6-16.7) long, 10.2 (8.0-11.5) wide; medial pores 11.3 (9.2-13.8) long, 7.6 (6.3-9.2) wide; smaller medial pores 9.4 (8.0-11.5) long, 5.8 (5.7-6.3) wide; and smallest pores 7.3 (6.3-9.2) long, 4.5 (2.9-5.7) wide, all pores bent; without minute pores.

Simple disk pores (Fig. c) evenly distributed over dorsum, consisting of 28 (20-38) pores, each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. d) in 2 submarginal and 2 submedial bands; each 20.8 (18.4-23.0) long, 2.8 (2.3-3.4) wide.

Anal lobes (Fig. e) with indentation; each anal lobe with one apical seta 47.6 (39.1-57.5) long, one subapical seta 8.9 (6.9-12.1) long, one medial ventral seta 2.9 (2.3-3.4) long, and one outer ventral seta 2.4 (2.3-2.9) long.

Anal ring (Fig. e) located at apex of abdomen, plate-like, with one seta on each side; anal tube originating from the basis; anal ring 3.5 (2.3-4.0) long, 8.1 (6.9-9.8) wide, anal tube 6.4 (4.6-7.5) long, each seta 17.7 (13.8-21.8) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 81.0 (56.3-103.4), width 59.8 (48.3-66.7).

Labium (Fig. a) heart-shaped, 28.4 (23.0-32.2) long, 33.6 (31.0-37.9) wide; usually without setae, but 1 specimen with one pair of setae, each seta 2.3 long.

Antennae (Fig. f) one-segmented, extremely reduced, 6.1 (4.0-8.0) long, 9.7 (8.6-11.5) wide at base; with 2 fleshy setae 12.0 (10.9-14.9) long, and 4 (3-6) slender setae 7.0 (5.2-9.2) long.

Spiracles (Fig. g) located in submarginal area; anterior spiracles 26.9 (20.7-28.7) long, 8.8 (6.9-9.8) wide, atrium 5.6 (4.6-6.9) in diam.; posterior spiracles 27.1 (23.0-28.7) long, 9.3 (8.0-10.3) wide, atrium 5.9 (4.6-7.5) in diam.; with 5 (4-6) quinquelocular pores in folds around atria; anterior spiracular furrows with a row of 10 (9-12) quinquelocular pores, 1 (1-3) pores wide; posterior furrows with a row of 9 (7-10) quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. h) in a submarginal row with 106 (98-114) pores; each 1.6 (1.1-1.7) long, 1.3 (1.1-1.7) wide; dark-rimmed pores in two swirls in median area anterior of mouthparts, consisting of about 20 pores; and with a band of 5 (3-10) pores on

each side of mouthparts, with a row of about 5 pores accompanying the second row of multilocular pores, and with a few more irregular abdominal rows with 2-4 pores; all together about 36 (32-44) pores; each 1.9 (1.7-2.3) long, 1.6 (1.1-1.7) wide.

Trilocular pores (Fig. i) in a marginal row with 210 (162-308) pores; row ends 7 (0-13) 8-shaped pore lengths before marginal 8-shaped pore row terminates; row complete at anterior end, but is interrupted for 4 8-shaped pore lengths in a single specimen; each 1.7 in diam.

Quatrolocular pores (Fig. j) occasionally in marginal row; same size as trilocular pores.

Quinquelocular pores (Fig. k) in spiracular furrows; and in a row between margin and antennae consisting of 3 (2-5) pores; also found in marginal row of trilocular pores; each 2.3 in diam.

Multilocular pores (Fig. l) with 4 incomplete rows on metathorax and on abdomen, row with 2 pores on metathorax, and with 2 (0-2) pores in abdominal rows; sometimes a fifth incomplete row with 2 pores, and with 2 complete rows around genital opening consisting of 9 (8-12) and 6 (5-10) pores, respectively; each 12 (8-12) loculi and 3.6 (3.4-4.0) in diam.

Setae (Fig. m) with 3 segmental rows around genital opening corresponding to one incomplete and two complete rows of multilocular pores; rows with 2 (0-2), 2 (2-4), and 4 (2-4) setae, respectively; each 3.2 (2.3-4.0) long; also submarginal row with 18 (14-24) setae, each 2.9 (2.3-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Bolivia, Colombia, Peru.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring a single plate with two setae, without pores; apical setae much longer than anal ring setae; anal tube visible; large dorsal 8-shaped pores in two submedial rows with varying pore sizes, smaller pores in adjoining circles.

Affinities: *Palmaspis boliviae* appears to be closely related to *Pa. difficilis* and *Pa. urichi*, based on anal area characters.

***Palmaspis bondari* (Lepage), 1940**

Proposed Common Name: Lepage's Pit Scale

Fig. 34

Asterolecanium bondari Lepage, 1940:69; Russell, 1941:210; D'Araujo e Silva et al., 1968:132. *Palmaspis bondari* Matile-Ferrero, 1996:263.

Type material: On *Attalea funifera*, 6(1), type material, all adult ♀♀, Brazil, Baia, coll., G. Bondari, (USNM), in slide engraved 24hBbx, no. 50 2552.

Additional material studied: On *Attalea funifera* (Piattava), 1(1), adult ♀, Brazil, Bahia, coll., G. Bondari, 27 VII 1923 (USNM), no. 619; on Cocos, 3 (1), all adult ♀♀, Venezuela, Catalina, Lower Orinoco, coll., Rusby, Squires, III 1896 (USNM), nos. 936893, 44 1478.

Additional hosts: *Maximilliana caribaea*, *Maximilliana* sp. (D'Araujo e Silva et al. 1968, Russell 1941).

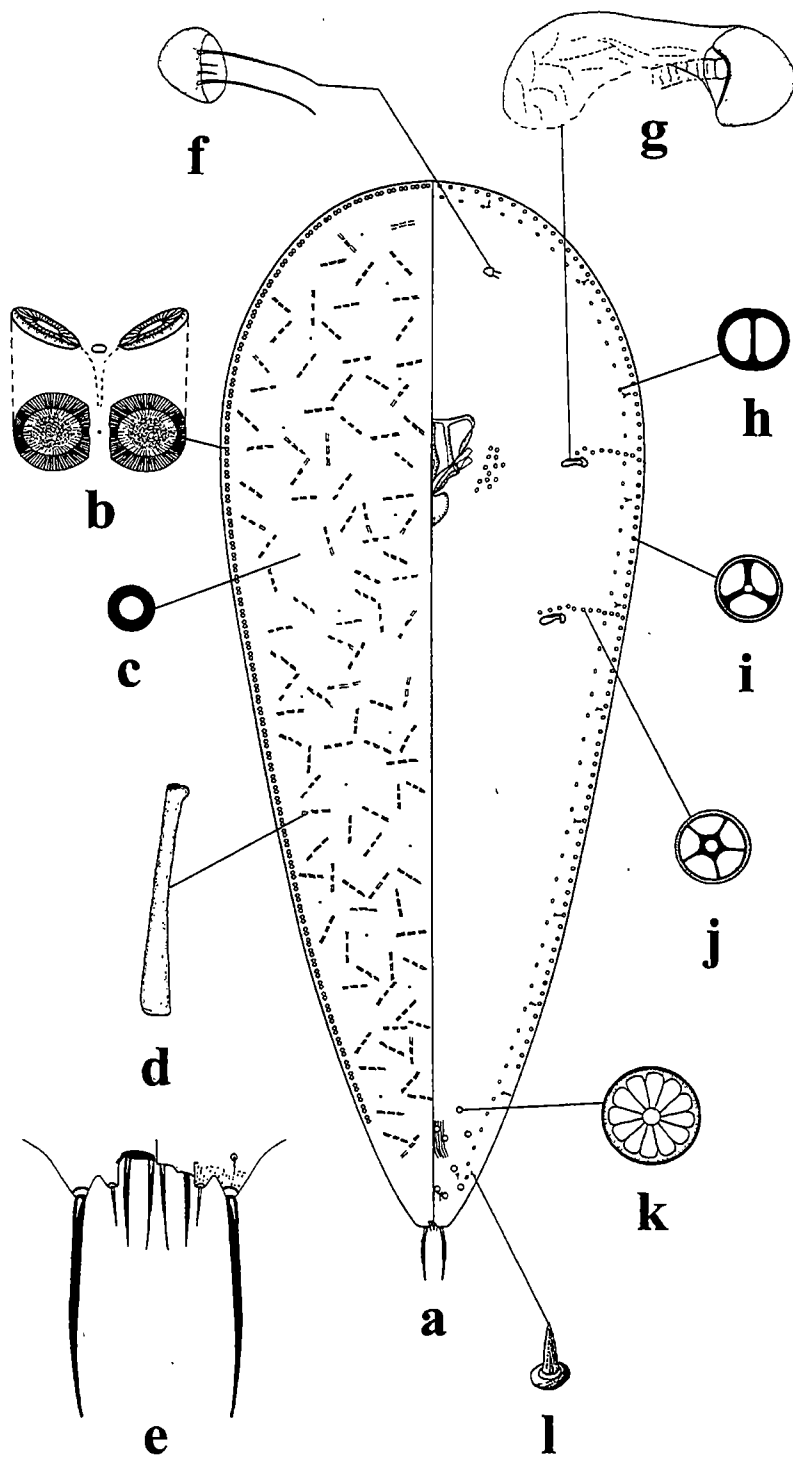


Fig. 34. *Palmaspis bondari* (Lepage), 1940.

Description:

Body (Fig. a) longitudinal, widest in spiracular area, 960 (920-1000) long, 420 (400-440) wide, with small anal indentation. Derm membranous with simple disk pores and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row that terminates conspicuously before anal lobe, at around area of genital opening; row with 185 (182-188) pores, all bent; each 6.4 (5.7-6.9) long, 2.7 (2.3-3.4) wide. Other pores usually missing, occasionally a few pores of varying size present in area posteriad of mouthparts; largest pores 6.9 long, 4.0 wide; medial pores 3.4 long, 2.3 wide; and smallest pores 1.7 long, 1.1 wide.

Simple disk pores (Fig. c) evenly distributed, consisting of only a few pores, each 1.1 in diam.

Tubular ducts (Fig. d) appear to be distributed in 4 longitudinal bands, but difficult to see in available specimens; each 22.4 (17.2-25.3) long, 3.3 (2.9-3.4) wide.

Anal lobes (Fig. e) with small indentation; each anal lobe with one apical seta 45.5 (34.5-54.0) long, one subapical seta 10.3 (6.9-16.1) long, and one outer ventral seta 3.0 (1.7-3.4) long; bases of apical and subapical setae slightly sclerotized ventrally.

Anal ring (Fig. e) located at apex of abdomen, plate-like, with four setae; anal ring 4.6 (4.6-4.6) long, 11.9 (10.3-12.6) wide, each seta 20.5 (18.4-21.8) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 74.6 (60.9-100.0), width 58.5 (52.9-66.7).

Labium (Fig. a) heart-shaped, 31.0 (27.6-33.3) long, 37.2 (32.2-49.4) wide; with 2 (1-2) pairs of setae, each 2.7 (2.3-3.4) long.

Antennae (Fig. f) one-segmented 7.4 (4.6-10.3) long, 8.9 (6.3-10.3) wide at base; with 2 fleshy setae 11.9 (10.3-13.8) long, and 2 slender setae 2.7 (2.3-3.4) long.

Spiracles (Fig. g) located in submarginal area; anterior 21.7 (17.8-24.1) long, 8.4 (7.5-9.2) wide, atrium 4.8 (3.4-6.9) in diam.; posterior 23.1 (19.5-25.3) long, 8.2 (7.5-9.2) wide, atrium 4.8 (3.4-5.7) in diam; anterior spiracular furrows with a row of 8 (6-9) quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a row of 11 (7-15) quinquelocular pores, 1 (1-2) pores wide; row of quinquelocular pores may reach proximal end of spiracular arm.

8-shaped pores (Fig. h) in a submarginal row with about 130 pores; each 1.5 (1.1-1.7) long, 1.3 (1.1-1.7) wide; dark-rimmed pores form a cluster consisting of 13 (9-15) pores on each side of mouthparts; each 1.8 (1.7-2.3) long, 1.8 (1.7-2.3) wide.

Trilocular pores (Fig. i) in marginal row that ends 5 (0-14) 8-shaped pore lengths before corresponding 8-shaped pore row terminates; row with 179 (158-200) pores, each 1.8 (1.7-2.3) in diam.

Quinquelocular pores (Fig. j) in spiracular furrows, each 2.2 (1.7-2.3) in diam.

Multilocular pores (Fig. k) with 1 incomplete row consisting of 4 pores, occasionally also with second incomplete row with 2 pores, and with 2 complete rows around genital opening; rows with 7 (5-8) and 2 (2-3) pores, respectively; each 12 (9-12) loculi and 3.6 (3.4-4.6) in diam.

Setae (Fig. 1) in 2 segmental rows corresponding to 2 complete rows of multilocular pores, each with 2 (2-4) setae, and occasionally with third setal row with 2 setae; each 3.3 (2.3-5.7) long; also submarginal row with 22 setae, each 2.3 (2.3-2.3) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil, Trinidad, Venezuela.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring located at apex of abdomen, plate-like, with four setae; lateral clypeal sulcus present.

Affinities: Distantly related to the genus *Grammococcus*. In one of the 40 most parsimonious trees of the cladistic analysis, it forms a sister taxon to *Grammococcus* and *Pa. gilva*.

***Palmaspis degenerata* (Russell), 1941**

Proposed Common Name: Degenerate Pit Scale

Fig. 35

Asterolecanium degeneratum Russell, 1941:75; D'Araujo e Silva et al., 1968:133.

Palmaspis degenerata Matile-Ferrero, 1996:263.

Type material: On Coconut palm, 1(1), paratype, adult ♀, Brazil, Bahia, incp. Phila no. 20329, coll., W.J. Ehinger, 12 I 1934 (USNM), no. 38 2847.

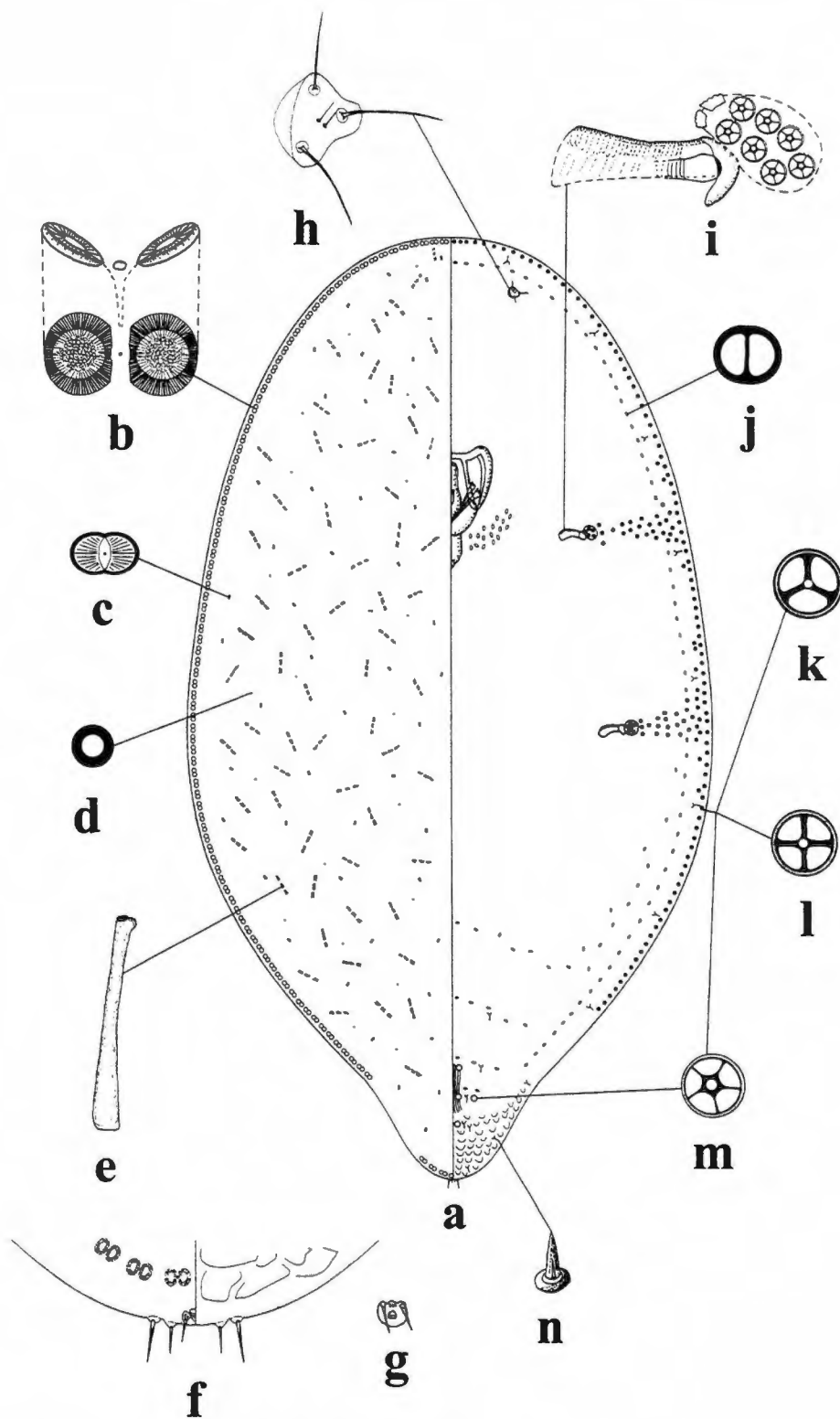


Fig. 35. *Palmaspis degenerata* (Russell), 1941.

Additional material studied: On *Cocos nucifera*, 4(1), all adult ♀♀, Brazil:

Brazilia, incp. Ho. no. 17169, colls., Adams, McMaster, 2 IX 1952 (USNM), no. 53

0030; *Cocos nucifera*, 2(1), all adult ♀♀, Ecuador: Guayaquil, incp. San Diego For., coll.,

E. B. Francis, 10 VII 1952 (USNM), no. 52 1247; *Attalea* sp., 1(1), adult ♀, Brazil:

Vicosa, coll., S.W. Brown, no. 163, fr. R.F. Wilkey, U.C. Davis, Ent. Museum

Collection, 10 VII 1962 (USNM), no. 63 0001; palm leaf, 4(1), all adult ♀♀, Brazil, coll.,

F. Nieves, 25 III 1981 (USNM), no. u81.

Additional host: *Maximilliana* sp. (Russell 1941).

Description:

Body (Fig. a) longitudinal, widest in area of metathoracic spiracles, 925 (680-1180) long, 650 (440-960) wide, without anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form a single row that is often interrupted near genital opening; row with 174 (112-220) pores, all bent; each 7.7 (6.9-8.6) long, 4.1 (3.4-4.6) wide. Minute pores (Fig. c) in transverse rows, fairly numerous, each 2.2 (1.7-2.3) long, 1.5 (1.1-1.7) wide; without large 8-shaped pores.

Simple disk pores (Fig. d) evenly distributed, consisting of ca. 30 pores; each 1.1 in diam.

Tubular ducts (Fig. e) throughout derm, each 21.3 (18.4-26.4) long, 3.0 (2.9-3.4) wide.

Anal lobes (Fig. f) without anal indentation, sclerotized ventrally; each anal lobe with one apical seta 10.6 (8.6-12.6) long, and one subapical seta 4.1 (3.4-5.2) long.

Anal ring (Fig. f) located at apex of abdomen, circular, plate-like; with anal tube, 3.7 (3.4-4.6) long originating from the basis; dorsal aspect drawn enlarged (Fig. g); anal ring 4.6 (2.9-6.3) long, 8.7 (8.0-10.3) wide, with 2 setae laterad, each 7.4 (4.6-11.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 87.4 (74.7-97.7), width 71.0 (60.9-83.9).

Labium (Fig. a) heart-shaped, 34.6 (27.6-37.9) long, 39.3 (35.6-44.8) wide; with 1 pair of setae, each 2.6 (2.3-3.4) long.

Antennae (Fig. h) one-segmented, triangular, 7.9 (6.3-11.5) long, 11.1 (8.0-18.4) wide at base; with 3 (2-3) fleshy setae 10.9 (9.2-12.6) long, and 2 (2-3) slender setae 3.9 (2.9-4.6) long.

Spiracles (Fig. i) located in submarginal area; anterior 24.2 (21.8-26.4) long, 8.7 (7.5-9.8) wide, atrium 4.9 (3.4-6.3) in diam.; posterior 24.6 (22.4-28.7) long, 8.2 (6.9-9.8) wide, atrium 4.5 (3.4-5.7) in diam.; with 10 (7-18) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 33 (24-48) quinquelocular pores, 2 (1-6) pores wide; posterior furrows with a band of 33 (23-41) quinquelocular pores, 3 (1-5) pores wide; spiracular furrows also with quatuorocular and trilocular pores.

8-shaped pores (Fig. j) in a submarginal row with 141 (108-214) pores, row double on abdomen; each 2.1 (1.7-2.3) long and 1.5 (1.1-1.7) wide; dark-rimmed pores in two sizes; large pores form a band consisting of 17 (13-20) pores on each side of mouthparts; small pores with 40 (26-58) pores in several transverse rows on abdomen;

large pores 2.7 (2.3-3.4) long, 2.2 (1.7-2.9) wide, small pores same size as submarginal pores.

Trilocular pores (Fig. k) in a marginal row consisting of 228 (152-350) pores; row terminates 9 (4-21) 8-shaped pore lengths before marginal 8-shaped pore row ends; row usually complete, but sometimes interrupted at anterior end for 3-15 8-shaped pore lengths; trilocular pores also in spiracular furrows; each 2.3 (1.7-2.9) in diam.

Quatrolocular pores (Fig. l) in the marginal row and in spiracular furrows; only a few pores present; same size as trilocular pores.

Quinquelocular pores (Fig. m) with 2 sizes; small pores form major part of spiracular furrows, and are present in marginal row; same size as trilocular pores; large pores with 3 complete rows around genital opening consisting of 2 (0-3), 3 (2-4), and 2 (0-3) pores, respectively; each 5 (4-5) loculi and 3.0 (2.3-3.4) in diam.

Setae (Fig. n) with 3, occasionally 4, segmental rows around genital opening corresponding to complete rows of quinquelocular pores; each row with 2 setae, posterior row with 4-6 setae; each 2.9 (2.3-3.4) long; also submarginal row with 20 (18-26) setae; same size as segmental setae.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil, Ecuador, Venezuela.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring located at apex of abdomen, circular, plate-like; with 2 setae

originating laterally, same size or slightly shorter than apical setae; marginal row of 8-shaped pores interrupted laterally on anal lobes.

Affinities: Closely related to *Pa. similis*, based on antennal, spiracular, and anal area characteristics.

***Palmaspis difficilis* (Russell), 1941**

Proposed Common Name: Panama Pit Scale

Fig. 36

Asterolecanium difficile Russell, 1941:78; Ferris, 1955:20. *Palmaspis difficilis* Matile-Ferrero, 1996:263.

Type material: On Palmae, Aristaceae, 2(1), paratypes, all adult ♀♀, Panama, C. Zone, bet. Gorgona + Gatun, coll., H. Pittier, 7 VI 1911 (USNM), no. 2293, no. 45 557; on Palmae, 2(1), paratypes, all adult ♀♀, Panama, C. Zone, bet. Gorgona + Gatun, coll., H. Pittier, 7 VI 1911 (USNM), no. 2295, no. 45 557.

Additional material studied: On palm leaf, 1(1), adult ♀, Panama, incp. Miami. no. 056972, coll., G. Muraoka, 19 II 1986 (USNM), no. 86-2158; palm leaf, 1(1), adult ♀, Costa Rica, coll., L. Castanada, 19 VIII 1996 (USNM), nos. 2013210, Miami 149572.

Additional host: *Cocos* sp. (Ferris 1955).

Description:

Body (Fig. a) pear-shaped, widest in spiracular area, 620 (500-740) long, 390 (300-480) wide, without anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

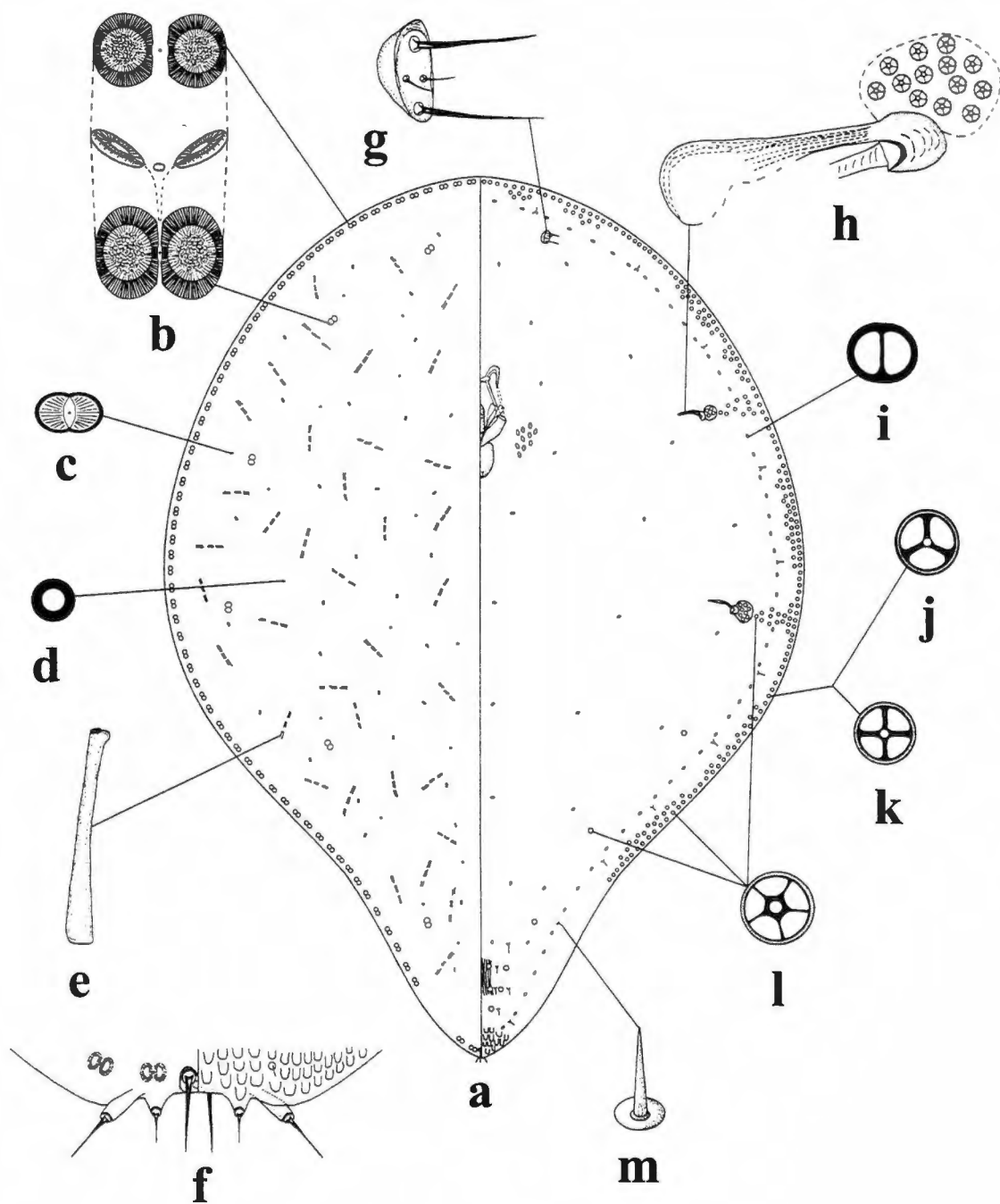


Fig. 36. *Palmaspis difficilis* (Russell), 1941.

Dorsal Surface

8-shaped pores (Fig. b) on margin form a single row with 146 (120-182) pores; row often interrupted near genital opening; all pores bent, each 7.6 (6.9-8.0) long, 4.0 (3.4-5.2) wide. Other pores in 2 sizes, occasionally with a third pore size; large pores and occasional medial pores in submarginal row consisting of 0-16 pores, large pores 8.8 (8.0-9.2) long, 5.3 (4.6-5.7) wide; and medial pores 3.4 long, 2.3 wide; minute pores (Fig. c) evenly distributed; each 2.3 long, 1.7 wide.

Simple disk pores (Fig. d) evenly distributed, only a few pores present; each 1.1 in diam.

Tubular ducts (Fig. e) throughout derm, each 20.4 (17.2-23.0) long, 2.7 (2.3-2.9) wide.

Anal lobes (Fig. f) without anal indentation, apex sclerotized ventrally; apical setae on raised projections; each anal lobe with one apical seta 7.8 (5.7-9.8) long, one subapical seta 4.6 (3.4-5.7) long, and one outer ventral seta 4.0 (3.4-4.6) long.

Anal ring (Fig. f) located at apex of abdomen, plate-like; anal ring 4.0 long, 9.2 wide; with two setae, each 13.5 (10.9-16.1) long.

Ventral Surface

Clypeolabral shield (Fig. a) usually without lateral clypeal sulcus which is present occasionally; clypeolabral shield 73.0 (59.8-82.8) long, 56.4 (52.9-62.1) wide.

Labium (Fig. a) heart-shaped, 30.4 (28.7-31.0) long, 34.2 (28.7-47.1) wide; with 2 (1-2) pairs of setae, each 2.3 long.

Antennae (Fig. g) one-segmented, elliptical, 5.3 (4.6-5.7) long, 7.2 (6.3-8.0) wide at base; with 2 fleshy setae 7.9 (5.7-9.8) long, and 2 slender setae 3.2 (2.9-3.4) long.

Spiracles (Fig. h) located in submarginal area; anterior 18.4 (17.2-19.5) long, 5.3 (4.6-5.7) wide, atrium 3.2 (2.3-4.0) in diam.; posterior 24.5 (20.7-29.9) long, 6.5 (6.3-6.9) wide, atrium 4.0 (2.9-4.6) in diam.; with 13 (9-18) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 24 (20-30) quinquelocular pores, 3 (1-4) pores wide; posterior furrows with a band of 23 (16-30) quinquelocular pores, 2 (1-5) pores wide; spiracular furrows also with quatrolocular and trilocular pores.

8-shaped pores (Fig. i) in a submarginal row with approximately 100 pores; each pore 2.1 (1.7-2.3) long, 1.5 (1.1-1.7) wide; dark-rimmed pores in 2 sizes; large pores in a band consisting of 10 (8-10) pores on each side of mouthparts, each 2.8 (2.3-2.9) long, 2.2 (1.7-2.3) wide; and with several transverse rows of small pores same size as submarginal pores.

Trilocular pores (Fig. j) in a marginal band with 296 (220-338) pores, band ends 10 (5-14) 8-shaped pore lengths before marginal 8-shaped pore row terminates; each 2.1 (1.7-2.3) in diam.

Quatrolocular pores (Fig. k) in marginal band, only a few pores present, same size as trilocular pores.

Quinquelocular pores (Fig. l) in 2 sizes; small pores form major part of spiracular furrows; also in marginal band, each pore 2.3 (2.3-2.3) in diam.; large pores with 2-3 incomplete rows, each represented by 2 pores, and with 3 complete rows around

genital opening consisting of 4, 3, and 2 (1-2) pores, respectively; each 3.0 (2.9-3.4) in diam.

Setae (Fig. m) with 4 segmental rows around genital opening corresponding to 3 complete rows of multilocular pores; rows with 2 (0-2), 2, 4 (2-4), and 2 setae, respectively; each 2.9 (2.3-3.4) long; also submarginal row with 20 (16-22) setae, each 2.9 (2.3-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Costa Rica, Panama.

Economic importance: This species is of no economic importance.

Diagnosis: Apical setae on raised projections; lateral clypeal sulcus usually missing; marginal row of 8-shaped pores interrupted laterally on anal lobes; with marginal band of trilocular pores; from Costa Rica and Panama.

Affinities: *Palmaspis difficilis* is closely related to *Pa. urichi* and *Pa. boliviae*, based on anal area characters.

***Palmaspis distincta* (Russell), 1941**

Proposed Common Name: Distinct Pit Scale

Fig. 37

Asterolecanium distinctum Russell, 1941:80; Ferris, 1955:20. *Bambusaspis distinctum* Kozar & Walter, 1985:80. *Palmaspis distincta* Matile-Ferrero, 1996:263.

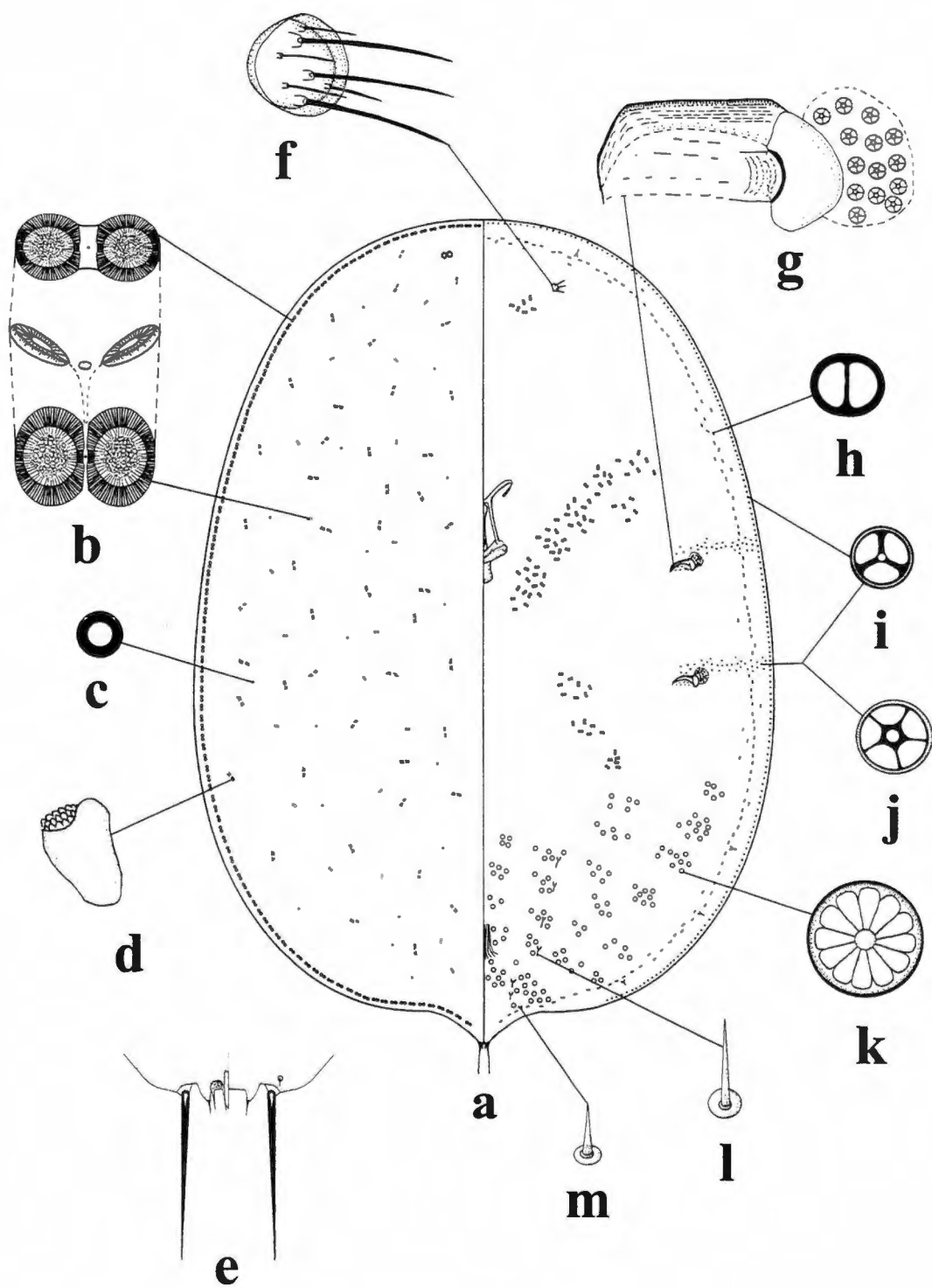


Fig. 37. *Palmaspis distincta* (Russell), 1941.

Type material: On Calhoun or Corozal palm, *Ceiba* sp., 3(1), paratypes, all adult ♀♀, Honduras, at New Orleans, LA, colls., Benton, Kostal, 24 XI 1920 (USNM), no. 217; on *Attalea cohune*, 4(1), paratypes, all adult ♀♀, Livingston, Guatemala, coll., O.F. Cook, 7 IV 1902 (USNM), no. 408531, no. 45 561.

Description:

Body (Fig. a) oval, widest in spiracular area, 1326 (1080-1600) long, 960 (780-1200) wide, without anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single complete row consisting of 239 (232-256) pores; pores bent, each 6.9 (6.3-8.0) long, 3.4 (3.4-3.4) wide. Other pores in 2 sizes, all bent; large pores rare; if present, usually only with 1 or 2 such pores; small pores throughout derm, relatively abundant; large pores 8.2 (8.0-8.6) long, 4.4 (4.0-4.6) wide; small pores 3.8 (3.4-4.0) long, 2.0 (1.7-2.3) wide; without minute pores.

Simple disk pores (Fig. c) evenly distributed, consisting of 27 (14-36) pores; each 1.7 (1.1-2.3) in diam.

Tubular ducts (Fig. d) small, throughout derm; each 4.6 (3.4-5.7) long, 4.3 (3.4-5.2) wide.

Anal lobes (Fig. e) without indentation; each anal lobe with one apical seta 63.6 (52.9-69.0) long, one subapical seta 2.9 (2.3-3.4) long, and one ventral seta 3.0 (2.3-3.4) long.

Anal ring (Fig. e) completely separated into 2 plates with setae-like collars on each side; anal ring 6.8 (4.6-9.8) long, 10.7 (8.0-15.5) wide; anal tube 5.0 (2.3-6.9) long, hardly visible between the 2 anal ring plates.

Ventral Surface

Clypeolabral shield (Fig. a) without lateral clypeal sulcus; clypeolabral shield 146.9 (135.6-158.6) long, 96.6 (86.2-109.2) wide.

Labium (Fig. a) heart-shaped, 47.1 (42.5-54.0) long, 49.6 (44.8-55.2) wide; with 2 pairs of setae, each 3.5 (2.9-4.0) long.

Antennae (Fig. f) one-segmented, circular, 8.7 (6.9-10.3) long, 11.6 (11.5-12.1) wide at base; with 3 (2-3) fleshy setae 16.4 (14.9-17.2) long, and 4 (3-4) slender setae 9.6 (6.3-11.5) long.

Spiracles (Fig. g) located in submarginal area; anterior 40.1 (36.8-41.4) long, 16.4 (13.8-17.8) wide, atrium 7.8 (5.7-10.3) in diam.; posterior 41.2 (37.9-47.1) long, 17.6 (14.4-20.7) wide, atrium 7.3 (6.3-8.6) in diam.; with 13 (8-17) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 49 (31-63) quinquelocular pores, 2 (1-4) pores wide; posterior furrows with a band of 50 (33-59) quinquelocular pores, 2 (1-3) pores wide.

8-shaped pores (Fig. h) in a submarginal row with 298 (240-366) pores; each 2.3 long, 1.7 wide; dark-rimmed pores with 1 small cluster close to each antenna, with 1 prominent band on each side of mouthparts, and with 3 clusters in thoracic and anterior abdominal areas posterio-mesad of metathoracic spiracles; with 180 (128-255) pores, each 2.3 (2.3-2.3) long, 1.9 (1.7-2.3) wide.

Trilocular pores (Fig. i) in a marginal row that ends 8 (3-20) 8-shaped pore lengths before corresponding 8-shaped pore row terminates; row with 381 (302-424) pores, and with a few pores in distal part of spiracular furrows, each 1.7 in diam.

Quinquelocular pores (Fig. j) in spiracular furrows, each 2.4 (2.3-2.9) in diam.

Multilocular pores (Fig. k) with 3 (occasionally 4 or 5) incomplete bands consisting of 6, 4 (0-20), 15 (0-48), 27 (8-56), and 25 (10-48) pores, respectively, and with 5 complete bands around genital; bands with 48 (34-64), 43 (20-68), 37 (6-70), 36 (8-62), and 41 (2-80) pores, respectively; each 12 (10-12) loculi. and 5.0 (4.6-5.7) in diam.

Setae with 5-6 segmental rows (Fig. l) around genital opening corresponding to 1 incomplete and 5 complete bands of multilocular pores; rows with 2 (0-4) setae, posterior row with 4 (0-4) setae; each 4.6 (4.0-5.2) long; also submarginal row of tack-like setae (Fig. m), consisting of 10 (6-14) setae, primarily in abdominal area, with at least 1 seta close to each antenna, each 3.0 (2.3-4.0) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Guatemala, Honduras.

Economic importance: This species is of no economic importance.

Diagnosis: Tubular ducts atypical, about as long as wide; anal ring without setae, but with four seta-like sclerotizations; with several clusters and bands of dark-rimmed 8-shaped pores on venter; with numerous multilocular pores on venter; from Guatemala and Honduras.

Affinities: The distinct pit scale may be at the base of the clade that also includes the genus *Grammococcus*.

***Palmaspis gilva* (Russell), 1941**

Proposed Common Name: Yellow Pit Scale

Fig. 38

Asterolecanium gilvum Russell, 1941:99; Ferris, 1955:20. *Palmaspis gilva* Matile-Ferrero, 1996:263.

Type material: On *Attalea cohune*, 7(2), paratypes, all adult ♀♀, Culabra, Canal Zone, coll., H. Pittier, Colr. No. 4813, XI 1911 (USNM), nos. 679980, 45 622.

Additional host: *Attalea gomphococca* (Ferris 1955, Russell 1941).

Description:

Body (Fig. a) pear-shaped, widest in area of metathoracic spiracles, 406 (340-470) long, 324 (280-360) wide, with small anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form single row that ends 2-3 pore lengths before apex of abdomen, with lower pore density in anal area; row with 95 (86-105) pores; all pores flat or only slightly bent, each 6.9 (6.3-7.5) long and 3.7 (3.4-4.0) wide. Minute pores (Fig. c) in submarginal and submedial bands; bands with 85 (35-120) pores; each 2.6 (2.3-2.9) long, 1.8 (1.7-2.3) wide.

Simple disk pores (Fig. d) evenly distributed, consisting of ca. 30 pores, each 1.2 (1.1-1.7) in diam.

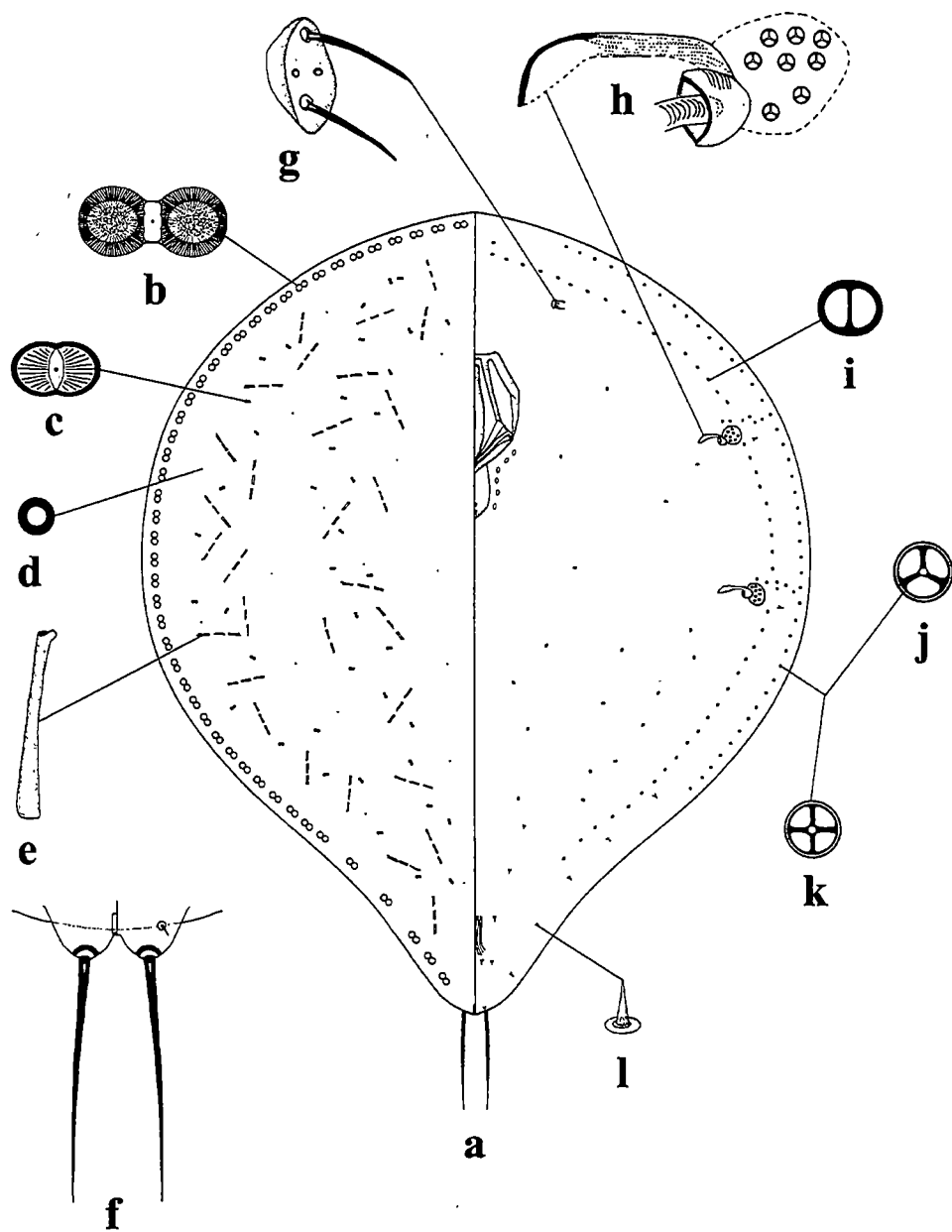


Fig. 38. *Palmaspis gilva* (Russell), 1941.

Tubular ducts (Fig. e) in submarginal and submedial bands together with minute 8-shaped pores; each 23.6 (21.8-26.4) long, 3.4 (3.4-3.4) wide.

Anal lobes (Fig. f) small, dorsad, with small indentation, without anal ring, each anal lobe with one apical seta 45.2 (43.7-47.1) long, and one ventral seta 3.0 (2.3-3.4) long; with anal tube ending in anus 6.3 (5.2-6.9) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 68.3 (60.9-85.1), width 51.7 (44.8-57.5).

Labium (Fig. a) elongated, 33.0 (29.9-36.8) long, 27.7 (23.0-31.0) wide; with 2 (1-2) pairs of setae, each 2.0 (1.1-2.3) long.

Antennae (Fig. g) one-segmented, disk-shaped, 3.3 (2.3-4.6) long, 5.8 (5.7-6.3) wide at base; with 2 fleshy setae 7.2 (5.7-9.2) long, and 2 (0-2) slender setae 1.3 (1.1-1.7) long.

Spiracles (Fig. h) located in submarginal area; anterior 20.2 (16.7-21.8) long, 8.1 (7.5-8.6) wide, atrium 3.3 (2.3-4.0) in diam.; posterior 22.2 (20.7-25.3) long, 7.9 (6.9-8.6) wide, atrium 3.5 (2.9-4.6) in diam.; with 6 (4-8) trilocular pores in folds around atria; anterior spiracular furrows with a band of 14 (10-18) trilocular and quaterolocular pores, 1 (1-2) pores wide; posterior furrows with a band of 16 (12-20) trilocular and quaterolocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 87 (74-102) pores; each 1.8 (1.7-2.3) long, 1.1 (1.1-1.1) wide; dark-rimmed pores in 2 sizes; large pores in 2 single rows, 1 on each side of labium; each row with 6 (6-8) pores; each 3.3 (2.3-4.0) long, 2.4

(1.7-3.4) wide; small pores in transverse rows on abdomen and on cephalothorax; rows with 34 (30-40) pores; pores same size as submarginal 8-shaped pores.

Trilocular pores (Fig. j) in a marginal row with 89 (80-98) pores, row ends 9 (7-11) 8-shaped pore lengths before marginal 8-shaped pore row terminates, row interrupted for 3 (0-6) 8-shaped pore lengths anteriorly, pores also in spiracular pore bands; each 1.8 (1.7-2.3) in diam.

Quatrolocular pores (Fig. k) in spiracular pore bands and in marginal row; only a few pores present; same size as trilocular pores.

Setae (Fig. l) with 4 segmental rows around genital opening; each row with 2 (0-2) setae, posterior row with 4 setae; each 2.3 (2.3-2.3) long; without corresponding rows of multilocular pores; also submarginal row with 10 (6-16) setae, primarily in abdominal area, each 2.4 (1.7-2.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Panama.

Economic importance: This species is of no economic importance.

Diagnosis: Without anal ring, but with anal tube; marginal 8-shaped pore row with lower pore density in anal area; from Panama.

Affinities: *Palmaspis gilva* may be a sister taxon to the genus *Grammococcus*.

***Palmaspis inlabefacta* (Russell), 1941**

Proposed Common Name: Cordoba Pit Scale

Fig. 39

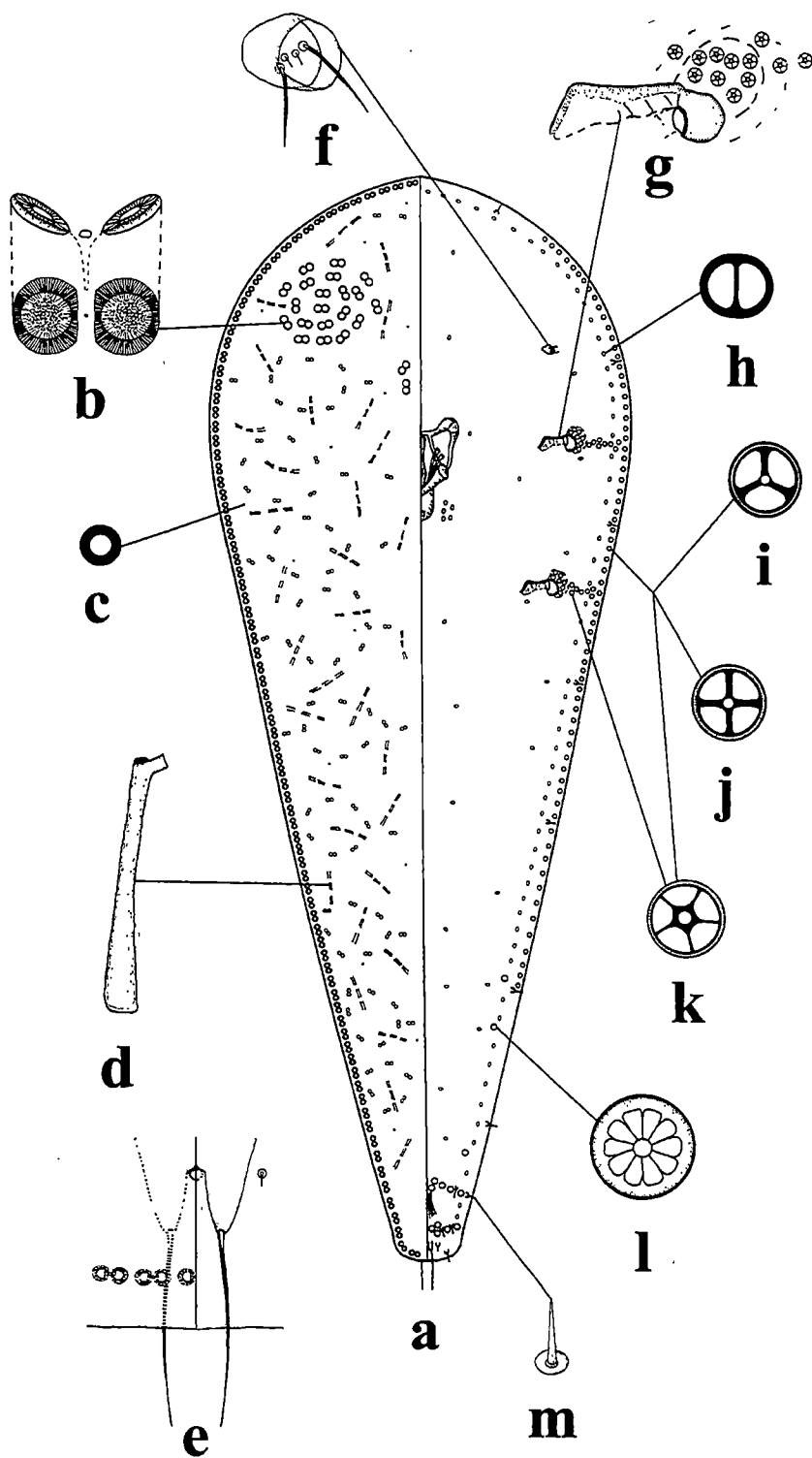


Fig. 39. *Palmaspis inlabefacta* (Russell), 1941.

Asterolecanium inlabefactum Russell, 1941:112; Ferris, 1955:20; Miller, 1996:69.

Palmaspis inlabefacta Matile-Ferrero, 1996:263.

Type material: On Palmae (*Chamaedorea* ?), 1(1), paratype, adult ♀, Cordoba, Mexico, coll., O.F. Cook, USNM, no. 45 747.

Additional material studied: On Palmaceae leaf, 6(1), 3 adult ♀♀, 3 second instar ♀♀, coll., P. Whitby, Los Angeles 035 862, no. 85-11/22, 16 VI 1985 (USNM), possibly plant quarantine material; *Chamaedorea* sp., 6(6), 3 adult ♀♀, 3 second instar ♀♀, Mexico via FL, via Okahumpka, coll., S.P. Beidler, 13 III 1989 (FSCA).

Description:

Body (Fig. a) elongate, variable in shape, widest in area between antennae and prothoracic spiracles, 928 (740-1120) long, 360 (280-440) wide, without anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single complete row with 210 (186-236) pores, row not interrupted posteriad; all pores bent, each 8.4 (7.5-9.8) long, 4.2 (4.0-4.6) wide. Other pores with 2 different pore sizes; large pores in two big swirls at anterior end, and with a few additional pores in anterior median area, small pores in 9-10 submarginal swirls connected by transverse rows, a few pores stronger bent; large pores 9.2 (8.6-10.3) long, 4.8 (4.6-5.7) wide; small pores 4.0 (3.4-4.6) long, 2.1 (1.7-2.9) wide; occasionally with one or two pores larger than other pores, each 11.5 long, 6.9 wide; usually without minute pores, but occasionally a few pores present, 1.7 long, 1.1 wide.

Simple disk pores (Fig. c) regularly distributed over dorsum, only a few pores present, each 1.1 in diam.

Tubular ducts (Fig. d) distributed throughout derm, each 19.4 (17.2-23.0) long, 2.9 (2.3-3.4) wide.

Anal lobes (Fig. e) without indentation, without anal ring, but with small anal tube, apical setae on distinct ventral lobes; marginal 8-shaped pore row usually not interrupted, only occasionally interrupted for a single pore length; each anal lobe with one apical seta 51.7 (49.4-55.2) long, and one ventral seta 4.3 (3.4-5.7) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 72.2 (63.2-78.2), width 55.2 (48.3-63.2).

Labium (Fig. a) heart-shaped, 28.1 (25.3-31.0) long, 31.6 (28.7-34.5) wide; with 2 (1-2) pairs of setae, each 2.3 (1.7-2.9) long.

Antennae (Fig. f) one-segmented, 6.9 (5.7-10.3) long, 9.0 (6.9-11.5) wide at base; with 2 fleshy setae 10.1 (8.0-11.5) long, and 2 slender setae 3.4 long.

Spiracles (Fig. g) located in submarginal area; anterior 24.6 (23.0-28.7) long, 7.1 (6.9-7.5) wide, atrium 4.9 (4.0-5.7) in diam.; posterior 23.7 (19.5-27.6) long, 7.3 (6.9-8.0) wide, atrium 4.6 (4.0-5.2) in diam.; with 7 (5-9) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 18 (15-20) quinquelocular pores, 2 (1-2) pores wide; posterior furrows with a band of 18 (16-20) quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. h) in a submarginal row with 97 (94-100) pores; each 1.8 (1.7-2.3) long, 1.2 (1.1-1.7) wide; dark-rimmed pores in two sizes, large pores in a band

consisting of 5 (4-8) pores on each side of mouthparts, small pores in transverse rows with 35 (30-40) pores; large pores 2.0 (1.7-2.3) long, 1.7 (1.7-1.7) wide, small pores same size as submarginal pores.

Trilocular pores (Fig. i) and **quatrolocular pores** (Fig. j) in a marginal row together with quinquelocular pores, each 2.2 (1.7-2.9) in diam.

Quinquelocular pores (Fig. k) in a marginal row that ends 19 (10-26) marginal 8-shaped pore lengths before apex of abdomen, row interrupted for 10 (0-26) 8-shaped pore lengths anteriorly, row with 201 (162-248) pores; quinquelocular pores also in spiracular furrows, with same size as trilocular pores.

Multilocular pores (Fig. l) with 3 incomplete rows, each with 2 pores, posterior row with 2-6 pores; sometimes with 1 or 2 additional incomplete rows, each with 2-4 pores; and with 2 complete bands around genital opening consisting of 10 (8-11) and 8 (4-10) pores, respectively; each 10 (10-11) loculi, 3.7 (3.4-4.0) in diam.

Setae (Fig. m) with 3-4 segmental rows around genital opening corresponding to 1-2 incomplete and 2 complete rows of multilocular pores, each with 2 setae, posterior row with 4 setae, each 3.0 (1.7-4.6) long; also submarginal row with 20 setae, each 2.9 (2.3-4.0) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: CA; Mexico. Material from CA possibly from plant quarantine, therefore, *Pa. inlabefacta* may not occur in CA.

Economic importance: This species is of no economic importance.

Diagnosis: Large dorsal 8-shaped pores in two distinct anterior swirls; apical setae on ventral lobes; marginal row of 8-shaped pores not interrupted at apex of abdomen; from Mexico and CA.

Affinities: The taxonomic position of the Cordoba pit scale is not well understood. It may be in a basic position in the *Asterodiaspis-Neoasterodiaspis-Grammococcus-Palmaspis* clade.

***Palmaspis inusitata* (Russell), 1941**

Proposed Common Name: Unusual Pit Scale

Fig. 40

Asterolecanium inusitatum Russell, 1941:113. *Palmaspis inusitata* Matile-Ferrero, 1996:263.

Type material: On *Caryota* sp., 1(1), holotype, adult ♀, Venezuela, Cerro del Galipan 4500, 10000'N of Caracas, 15 VIII 1891 (USNM), nos. 12 34726, 45 748.

Description:

Body (Fig. a) semi-circular, widest in spiracular area, 520 long, 400 wide, with small anal indentation. Derm membranous with 4 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) form single row that ends 3-4 pore lengths before apex of abdomen, row less dense at posterior part of abdomen, row with 114 pores, all bent; each 8.0 long, 3.4 wide.

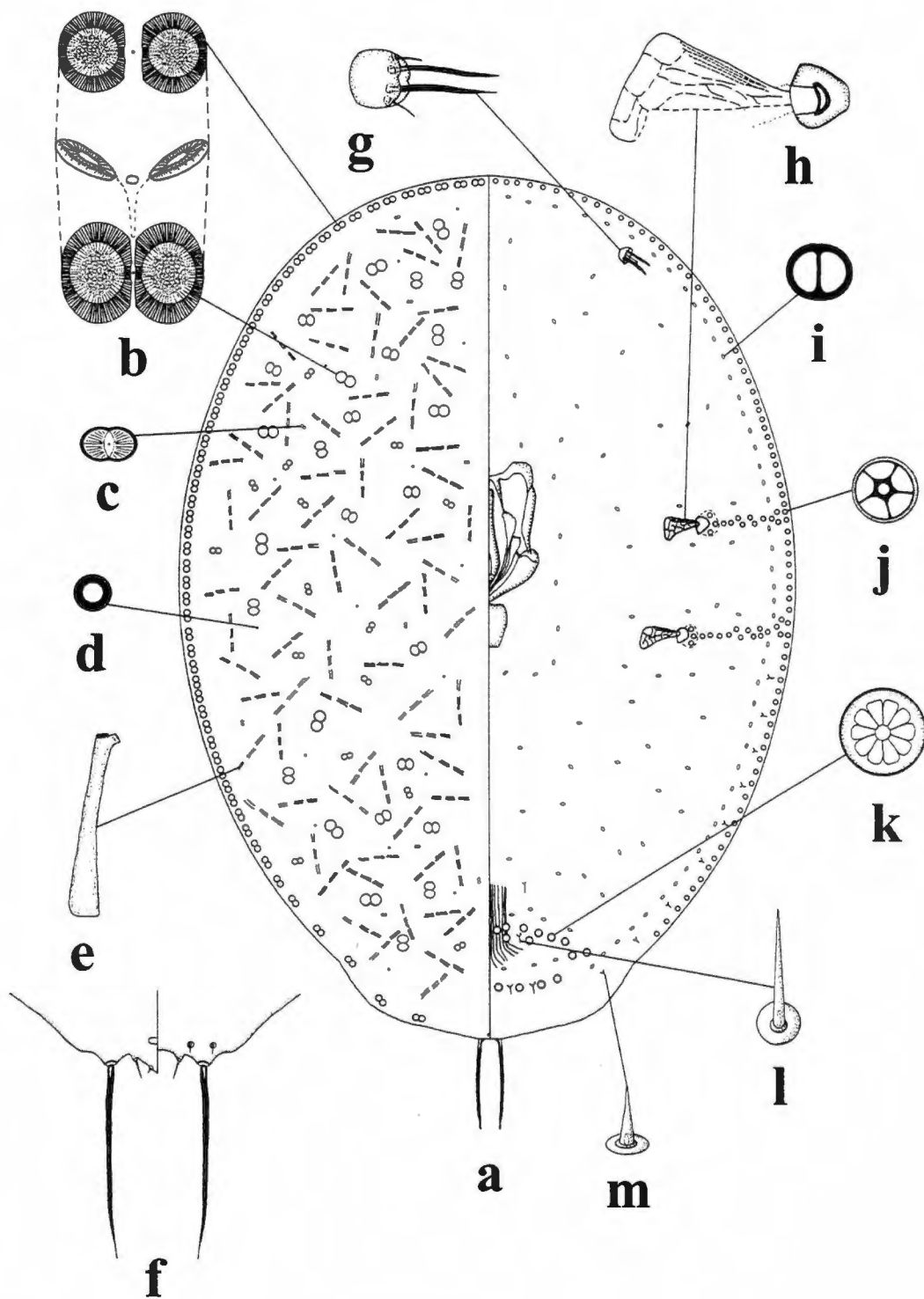


Fig. 40. *Palmaspis inusitata* (Russell), 1941.

Other pores with 4 different pore sizes, pores unevenly distributed over dorsum; largest pores 13.2 long, 10.3 wide; medial pores 11.5 long, 9.2 wide; and smallest pores 7.5 long, 5.2 wide; minute pores (Fig. c) 1.7 long, 1.1 wide, only a few pores present.

Simple disk pores (Fig. d) evenly distributed, number of pores could not be determined due to condition of the specimen, each 1.1 in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 20.7 long, 2.9 wide.

Anal lobes (Fig. f) with small indentation and very small anal ring, plate-like; each anal lobe with one apical seta 66.7 long, one subapical seta 8.0 long, one dorsal seta 1.7 long, one medial ventral seta 2.9 long, and one outer ventral seta 3.4 long.

Ventral Surface

Clypeolabral shield (Fig. a) length 93.1, width 78.2.

Labium (Fig. a) heart-shaped, 29.9 long, 39.1 wide, no setae visible; Russell (1941) states "beak broken, presence of setae indeterminable".

Antennae (Fig. g) one-segmented, 4.6 long, 6.9 wide at base; with 2 fleshy setae 12.6 long, and 2 slender setae 6.3 long.

Spiracles (Fig. h) located in submarginal area; anterior 29.9 long, 12.1 wide, atrium 6.3 in diam.; posterior 31.0 long, 10.3 wide, atrium 6.3 in diam.; with 3 (3-4) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 15 quinquelocular pores, 1 (1-2) pores wide; posterior furrows with a band of 16 quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 98 pores; dark-rimmed pores form transverse rows over whole venter with 84 pores, and a row of 9 pores on each side of mouthparts; each 2.3 long, 1.7 wide.

Quinquelocular pores (Fig. j) in a marginal row with 152 pores, row ends 3-7 marginal 8-shaped pore lengths before apex of abdomen, pores also in spiracular furrows; each 2.3 in diam.

Multilocular pores (Fig. k) with 2 complete bands of pores around genital opening consisting of 19 and 8 pores, respectively; each 10 loculi and 3.4 in diam.

Setae with 3 segmental rows (Fig. l) around genital opening corresponding to 2 bands of multilocular pores, each with 2 setae, posterior row with 4 setae; each 4.6 long; also incomplete submarginal row of tack-like setae (Fig. m) on abdomen with 9 setae on each side, each 1.7 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Venezuela.

Economic importance: This species is of no economic importance.

Diagnosis: Marginal 8-shaped pore row with lower pore density in anal area; small anal ring, plate-like, without setae; from Venezuela.

Affinities: In the cladistic analysis, *Pa. inusitata* is at the base of the *Asterodiaspis*-*Neoasterodiaspis*-*Grammococcus*-*Palmaspis* clade, thus rendering *Palmaspis* paraphyletic.

***Palmaspis jubae*, n.sp.**

Proposed Common Name: Chilean Gigantic Palm Scale

Fig. 41

Palmaspis jubae, n.sp.

Type material: On *Jubaea chilensis*, 8(2), holotype circled, adult ♀, paratypes, 7 adult ♀♀, Chile, 17 XII 1999, CDFA, no. 11 99 210; *Jubaea chilensis*, 4(2), paratypes, 1 adult ♀, 3 second instar ♀♀, La Campana, NH Park, Chile, coll., D.Riley, 10 II 1991 (USNM).

Description:

Body (Fig. a) oval, widest in spiracular area, 1025 (660-1200) long, 803 (500-960) wide, without anal indentation. Derm membranous with minute 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 171 (164-176) pores, row either interrupted for width of anal ring or complete; in one specimen, row interrupted for complete posterior abdomen with exception of two pores on apex of abdomen; all pores bent, with 2 (2-10) pores on each side of apex of abdomen projecting upright in a right angle; each 9.1 (8.6-9.2) long, 6.3 (5.7-6.9) wide. Minute pores (Fig. c) in submarginal band with 132 (124-140) pores, each 3.7 (3.4-4.0) long, 2.3 (2.3-2.3) wide.

Simple disk pores (Fig. d) in a submarginal band, consisting of 58 (44-72) pores in association with submarginal 8-shaped pores, each 1.9 (1.1-2.3) in diam.

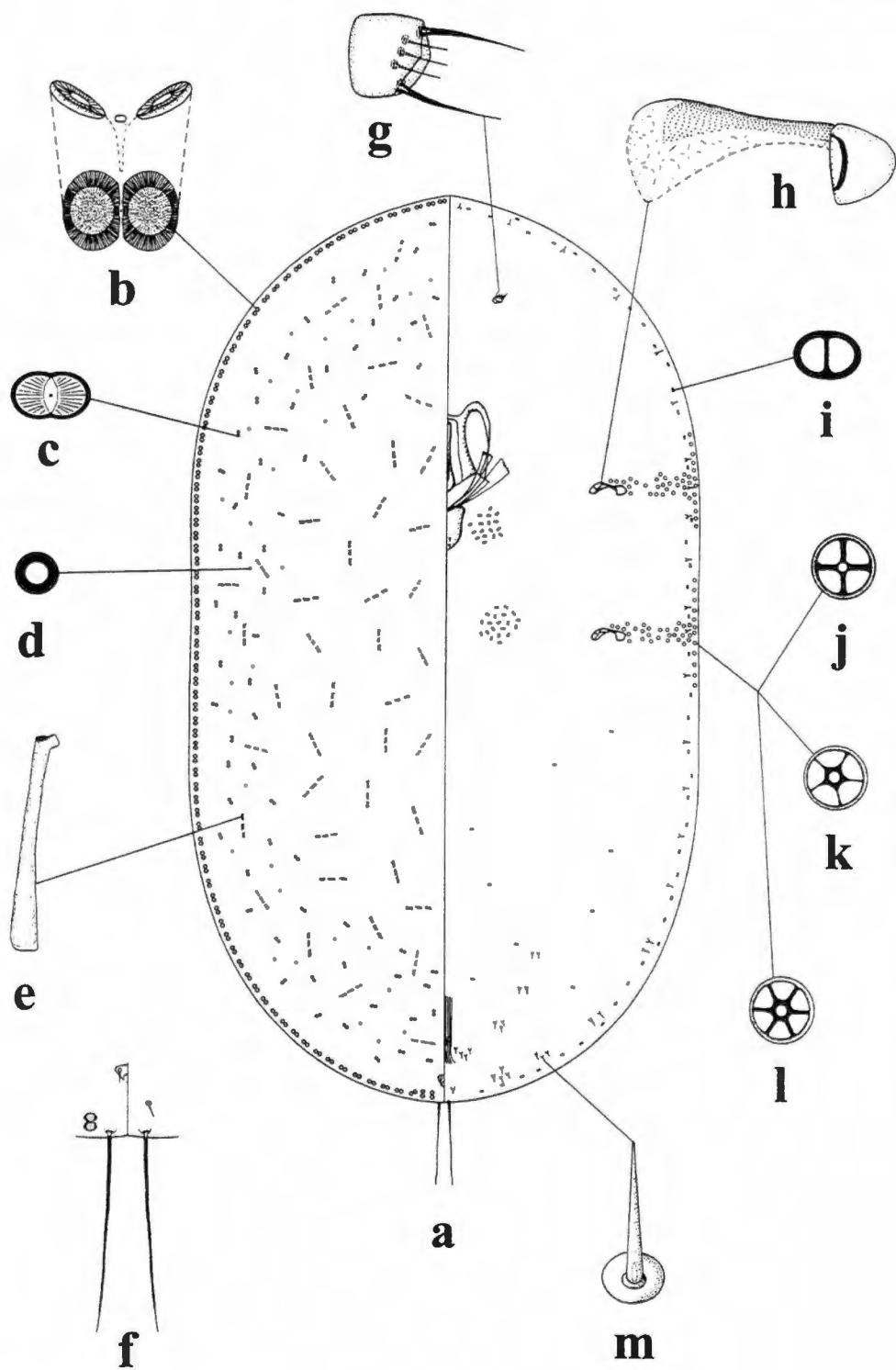


Fig. 41. *Palmaspis jubae*, n.sp.

Tubular ducts (Fig. e) throughout derm, each 27.6 (23.6-31.0) long, 3.1 (2.3-3.4) wide.

Anal lobes (Fig. f) without indentation, each anal lobe with one apical seta 66.7 (58.6-74.7) long, and one ventral seta 6.9 (5.2-8.0) long.

Anal ring (Fig. f) plate-like, fused, anal ring 12.8 (9.8-16.1) long, 14.9 (11.5-17.2) wide; with 1 pair of setae 9.5 (8.6-10.3) long, sometimes also with smaller second pair of setae; with anal tube 7.2 (6.9-7.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 118.4 (96.6-132.2), width 84.7 (74.7-95.4).

Labium (Fig. a) heart-shaped, 58.6 (54.0-62.1) long, 49.8 (43.7-55.2) wide; with 1 (1-2) pairs of setae, each 4.0 (3.4-4.6) long.

Antennae (Fig. g) one-segmented, cylindrical, with one side longer than other, 15.5 (9.2-20.7) long, 14.2 (9.2-19.5) wide at base; with 2 (1-3) fleshy seta 10.7 (9.8-11.5) long, and 3 (2-3) slender setae 5.2 (5.2-5.2) long.

Spiracles (Fig. h) located in submarginal area; anterior 34.9 (33.3-36.8) long, 12.5 (9.8-13.8) wide, atrium 8.2 (5.7-9.8) in diam.; posterior 37.9 (32.2-41.4) long, 12.4 (11.5-13.2) wide, atrium 7.8 (6.3-9.2) in diam.; anterior spiracular furrows with a band of 34 (26-40) quinquelocular pores, 3 (1-4) pores wide, posterior furrows with a band of 34 (28-37) pores, 3 (1-3) pores wide; also with a short row of 5 (1-5) pores along margin anteriad and posteriad of each furrow.

8-shaped pores (Fig. i) in a submarginal row with 98 (80-116) pores, each pore 1.8 (1.7-2.3) long, 1.2 (1.1-1.7) wide; dark-rimmed pores form a cluster with 5-18

stronger sclerotized pores on each side of mouthparts, and two more clusters (not always present) with 20 pores on thorax postero-laterad of mouthparts, also a few pores present in transverse abdominal rows, each 2.4 (2.3-2.9) long, 2.1 (1.7-2.3) wide.

Quatrolocular pores (Fig. j) in spiracular furrows, only a few pores present; same size as quinquelocular pores.

Quinquelocular pores (Fig. k) form major part of spiracular furrows, each 2.6 (2.3-2.9) in diam.

6-locular pores (Fig. l) in spiracular furrows, only a few pores present, same size as quinquelocular pores.

Setae (Fig. m) with 4 segmental rows around genital opening, and with a similar number of submarginal setae corresponding to each row of segmental setae; rows with 4 (2-4), 4, 6 (4-6), and 8 (6-8) setae, respectively; each 6.9 (4.6-8.0) long; without corresponding multilocular pores; also, complete submarginal row with 34-56 setae, in abdominal area often with several setae together in clusters, each 4.6 (4.0-5.2) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Chile.

Economic importance: This species is not economically important.

Diagnosis: Without marginal row of trilocular or quinquelocular pores, or with very short incomplete row where spiracular furrows meet margin; marginal row of 8-shaped pores complete, not interrupted posteriad, with some apical 8-shaped pores

oriented in right angle to margin; anal ring plate-like, fused, triangular; setae in clusters on posterior abdomen; occurs exclusively on Chilean gigantic palm.

Affinities: *Palmaspis jubae* may be closely related to *Pa. sabalis*, based on anal area characters.

Etymology: The specific epithet refers to the host plant, the gigantic Chilean palm, *Jubaea chilensis*.

***Palmaspis pallida* (Russell), 1941**

Proposed Common Name: Pale Pit Scale

Fig. 42

Asterolecanium pallidum Russell, 1941:145; Ferris, 1955:25. *Palmaspis pallida* Matile-Ferrero, 1996:263.

Type material: On *Attalea cohune*, 1(1), paratype, adult ♀, Culebra, Canal Zone, coll., H. Pittier, XI 1911 (USNM), nos. 679980, 45 1138; *Attalea* sp., 1(1), paratype, adult ♀, Prov. of Colon, Panama, coll., H. Pittier, no. 423 F, VII-VIII 1911 (USNM), nos. 716063, 45 1137.

Description:

Body (Fig. a) oval, widest in spiracular area, with anal indentation, 600 (540-660) long, 490 (480-500) wide. The two available specimens are strongly compressed. This unfortunate characteristic interfered with several measurements. Russell (1941) described this species as being around 1750 long and 650 wide. Derm membranous with tubular ducts on dorsum, possibly also with minute 8-shaped pores and disk pores, but these not found in the study.

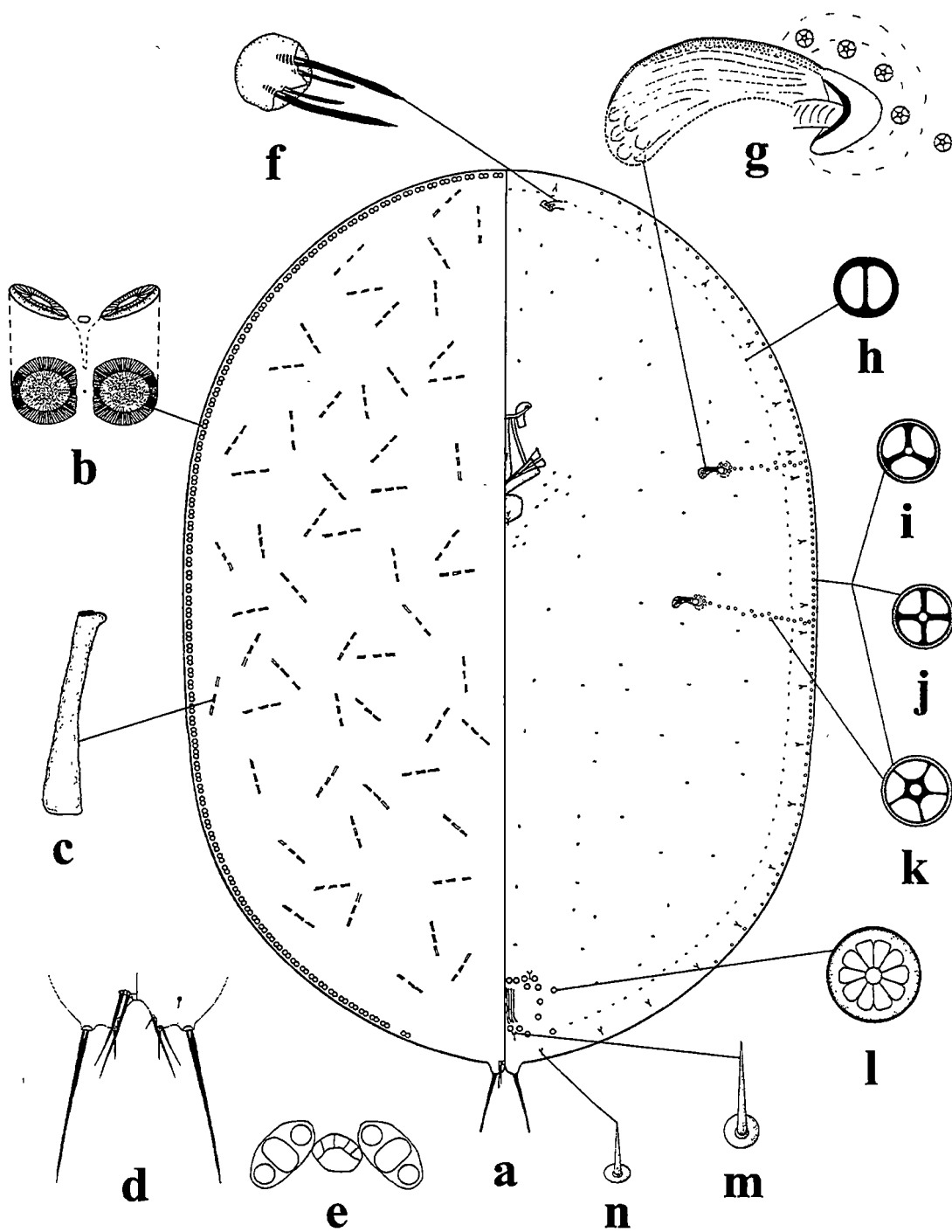


Fig. 42. *Palmaspis pallida* (Russell), 1941.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 196 pores; row less dense in anal region, terminating about 10 pore lengths before apex of abdomen; each pore bent, 6.6 (6.3-6.9) long, 2.6 (2.3-2.9) wide. No dorsal 8-shaped pores were found in the two specimens available, but Russell (1941) described the presence of a few minute pores.

Simple disk pores were not found in the two specimens available, but described by Russell (1941) as being sparsely present.

Tubular ducts (Fig. c) throughout derm, each 22.4 (19.5-25.3) long, 4.0 (3.4-4.6) wide.

Anal lobes (Fig. d) with indentation; each anal lobe with one apical seta, 60.9 long, one subapical seta 18.4 long, one inner ventral seta 4.6 (3.4-5.7) long, and one medial ventral seta 3.7 (3.4-4.0) long.

Anal ring plate-like, two halves connected basically with circular plate (dorsal cross-section, Fig. e); both halves together 3.4 (3.4-3.4) long, 15.2 (13.2-17.2) wide (Fig. d); each half with 2 setae and 1 medial plate, each seta 31.0 long; anal tube hardly visible, 4.6 long.

Ventral Surface

Clypeolabral shield (Fig. a) without lateral clypeal sulcus, 90.3 (80.5-100.0) long, 69.6 (69.0-70.1) wide.

Labium (Fig. a) rectangular, 37.9 long, 38.5 (36.8-40.2) wide; with 2 pairs of setae, length not measurable.

Antennae (Fig. f) one-segmented, subcircular, 5.7 long, 8.1 (6.9-9.2) wide at base; with 2 (2-3) fleshy setae 13.2 (10.3-16.1) long, and 2 (1-2) slender setae 4.6 (3.4-5.7) long.

Spiracles (Fig. g) located in submarginal area; anterior 29.9 (28.7-31.0) long, 12.1 (11.5-12.6) wide, atrium 4.0 (3.4-4.6) in diam.; posterior spiracle not measurable; with 5 (3-6) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 15 quinquelocular pores, 1 (1-2) pores wide, posterior furrows with a band of 21 quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. h) in a submarginal row with ca. 150 pores, each 1.7 (1.7-1.7) long, 1.4 (1.1-1.7) wide; also with about 130 dark-rimmed pores in transverse rows and with 11 (10-12) pores in short bands on each side of mouthparts, each 1.7 long and wide.

Trilocular pores (Fig. i) in a marginal row with about 190 pores, row ends 12 (11-13) marginal 8-shaped pore lengths before apex of abdomen, row less dense at anterior and posterior ends, interrupted for 11 8-shaped pore lengths anteriad; each 1.7 (1.7-1.7) in diam.

Quatrolocular pores (Fig. j) in marginal row, only a few pores present, same size as trilocular pores.

Quinquelocular pores (Fig. k) in spiracular furrows and in marginal row, each 2.3 (2.3-2.3) in diam.

Multilocular pores (Fig. l) with 2 complete bands around genital opening consisting of 17 (16-18) and 9 (7-11) pores, respectively; each 10 loculi and 4.0 (3.4-4.6) in diam.

Setae with 2 segmental rows (Fig. m) corresponding to 2 complete bands of multilocular pores, each with 2 setae 4.9 (4.0-5.7) long; also submarginal row with about 40 tack-like setae (Fig. n), each 3.4 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Panama.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring plate-like, two halves connected basically with circular plate, with 4 setae; labium rectangular; lateral clypeal sulcus missing.

Affinities: The phylogenetic relationships are not clear for the pale pit scale, but it seems to belong to the clade that includes the genus *Grammococcus*.

***Palmaspis palmae* (Cockerell), 1893**

Proposed Common Name: Palm Pit Scale

Fig. 43

Asterolecanium palmae Cockerell, 1893a:77, 1893b:8, 1893c:255, 1894a:308, 1896:9, 1897a:328, 1902c:114; MacGillivray, 1921:189; Lindinger, 1936:153; Russell, 1941:146; Ferris, 1955:25; D'Araujo e Silva et al., 1968:133. *Asterolecanium lineare* Lindinger, in Brick, 1909:449; Lindinger, 1909:464. *Palmaspis palmae* Matile-Ferrero, 1996:254, 263.

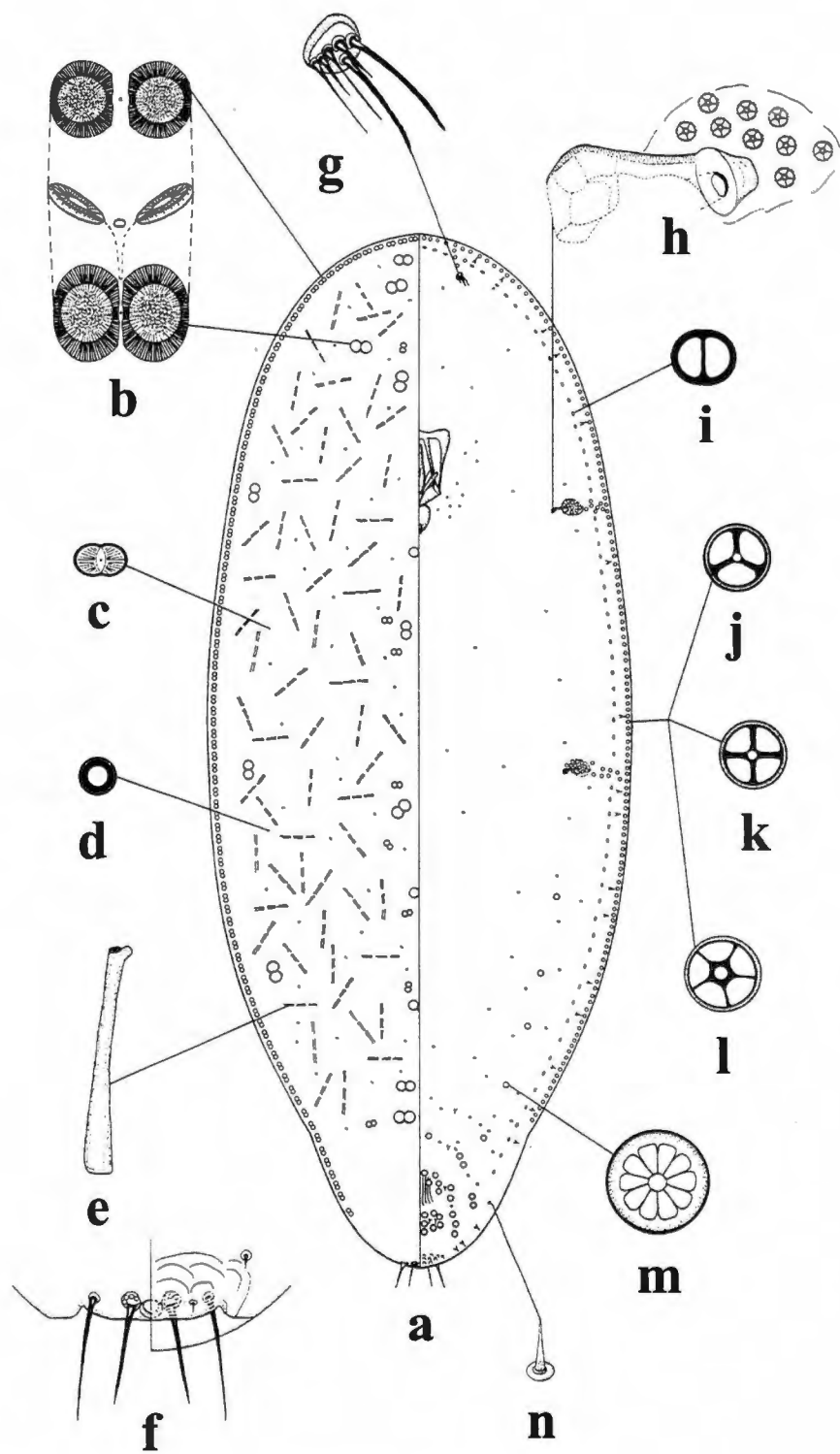


Fig. 43. *Palmaspis palmae* (Cockerell), 1893.

Type material: On coconut, 1(1), type, adult ♀, Jamaica, Gath. Hall, coll., Dr. Sinclair, (USNM).

Additional material studied: On *Corozo oleifera*, 3(3), all adult ♀♀, Honduras: C.A.: La Mosquitia, coll., H.E. Ostmark, 3 III 1976 (FSCA), DPI no. 126150, no. 445-64, labeled K599; *Chamaedorea geonoma* leaf, 6(1), all adult ♀♀, Panama, coll., J. Russo, Miami 053414, 8 VIII 1985 (USNM), no. 85-8188; Coconut palm, 3(1), all adult ♀♀, Dominica, Clarke Hall, coll., D.F. Bray, 13 II 1964 (USNM); coconut, 4(1), all adult ♀♀, Barnett Estate, Jamaica, coll., R. Latta, 25 VI 1964 (USNM).

Additional hosts: *Attalea cohune*, *Cocos nucifera*, *Elais melanococca*, *E. oleifera*, *E. guineensis*, *Elais* sp., *Guilielma* sp., and *Martinezia aiphanes* (Ferris 1955, Russell 1941, Matile-Ferrero 1996).

Description:

Body (Fig. a) longitudinal, 1095 (960-1260) long, 423 (340-500) wide, without anal indentation. Derm membranous with 4 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row that terminates about 8-10 pore lengths before apex of abdomen, with 211 (178-243) pores, all bent; each 8.3 (7.5-9.8) long, 4.5 (3.4-5.2) wide. Other pores with 4 sizes; large, medial, and small pores arranged in a few irregular medial clusters, mainly concentrated at anterior and posterior ends, and in a few submarginal pores; a few minute pores (Fig. c) distributed irregularly over dorsum; large pores 13.3 (12.1-13.8) long, 9.5 (8.0-10.3) wide; medial pores 11.1

(9.2-11.5) long, 6.8 (5.7-8.0) wide; small pores 8.5 (8.0-9.8) long, 5.5 (4.6-6.3) wide; and minute pores 1.7 (1.1-2.3) long, 1.2 (1.1-1.7) wide.

Simple disk pores (Fig. d) evenly distributed, consisting of about 40 pores, each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 23.2 (21.8-25.3) long, 2.9 (2.3-3.4) wide.

Anal lobes (Fig. f) with apex somewhat indent, slightly sclerotized ventrally; each anal lobe with one apical seta 19.5 (13.8-23.0) long, and one ventral seta 2.0 (1.7-2.3) long; the posterior-most setae of the ventral submarginal setal row may also be interpreted as outer ventral setae, each seta 2.4 (2.3-3.4) long.

Anal ring (Fig. f) small, plate-like, with a hole or slit in the middle, anal ring 10.2 (7.5-11.5) wide; with 3-4 minute pores on each setal base; with one seta on each side, each 18.3 (6.9-25.9) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 92.2 (80.5-105.7), width 71.2 (55.2-82.8).

Labium (Fig. a) heart-shaped, 31.2 (27.6-34.5) long, 35.3 (31.0-44.8) wide; with 2 (1-2) pairs of slender setae, each 3.3 (2.3-4.6) long.

Antennae (Fig. g) one-segmented, 7.7 (6.3-8.6) long, 9.7 (7.5-12.1) wide at base; with 2 fleshy setae 14.3 (12.1-16.1) long, 2 (2-4) slender setae 10.5 (6.9-14.9) long, and 2 (0-2) small setae 3.6 (2.9-6.9) long.

Spiracles (Fig. h) located in submarginal area; anterior 32.2 (27.6-36.8) long, 10.7 (7.5-12.1) wide, atrium 7.3 (5.7-9.2) in diam.; posterior 34.3 (28.7-37.9) long, 11.1 (9.2-

12.6) wide, atrium 6.9 (4.6-8.0) in diam.; with 8 (4-12) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 16 (6-25) mostly quinquelocular pores (but also trilocular and quatrolocular pores), 1 (1-3) pores wide, posterior furrows with a band of 18 (8-28) pores, 2 (1-3) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 124 (100-150) pores, each 2.2 (1.7-2.3) long, 1.4 (1.1-1.7) wide; dark-rimmed pores in irregular transverse rows consisting of 129 (76-180) pores, and with a row of 8 (5-12) pores on each side of mouthparts; each 1.8 (1.7-2.3) long, 1.5 (1.1-1.7) wide.

Trilocular pores (Fig. j) in a marginal row that ends 10 (0-19) 8-shaped pore lengths before marginal 8-shaped pore row terminates; row with 247 (158-322) pores, also with 4 (2-7) pores between margin and each antenna, and with some trilocular pores in spiracular furrows, each 2.1 (1.7-2.9) in diam.

Quatrolocular pores (Fig. k) in marginal row and in spiracular furrows, only a few pores present, same size as trilocular pores.

Quinquelocular pores (Fig. l) in spiracular furrows, a few pores also in marginal row, each 2.4 (2.3-2.9) in diam.

Multilocular pores (Fig. m) with 5-6 incomplete rows on anterior abdomen and thorax, each with 2 (2-6) pores; anterior row with 2 (0-4) pores, and with 3 complete bands around genital opening consisting of 9 (4-15), 19 (12-24), and 13 (10-16) pores, respectively; each 10 (8-11) loculi and 4.2 (3.4-4.6) in diam.

Setae (Fig. n) with 4-5 segmental rows around genital opening corresponding to 1-2 incomplete rows and 3 complete bands of multilocular pores, each with 2 (0-4) setae,

posterior row with 4 (4-6) setae, each 3.9 (3.4-5.2) long; also submarginal row with 40 (28-50) setae, each 3.8 (2.3-4.6) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil, Dominica, Colombia, Costa Rica, Honduras, Jamaica, Panama, Peru, Venezuela.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring with two lateral plates carrying setae and 3-4 minute pores; apical setae about same size or slightly longer than anal ring setae; anal tube not visible; large dorsal 8-shaped pores in medial band and loose submarginal row with varying pore sizes.

Affinities: *Palmaspis palmae* may belong in a group that includes *Pa. boliviae*, *Pa. degenerata*, *Pa. difficilis*, *Pa. similis*, and *Pa. urichi*.

***Palmaspis sabalis* (Russell), 1941**

Proposed Common Name: Sabal Pit Scale

Fig. 44

Asterolecanium sabalis Russell, 1941:180; Ferris, 1955:26; Bruner et al., 1975:292.

Palmaspis sabalis Matile-Ferrero, 1996:263.

Type material: On Palmetto (Sabal), 15(5), paratypes, 8 adult ♀♀, 7 first instars, Cayamas, Cuba, coll., E.A. Schwarz, 23 VI 1904 (USNM), no. 6867, 2 slides mounted from dry material.

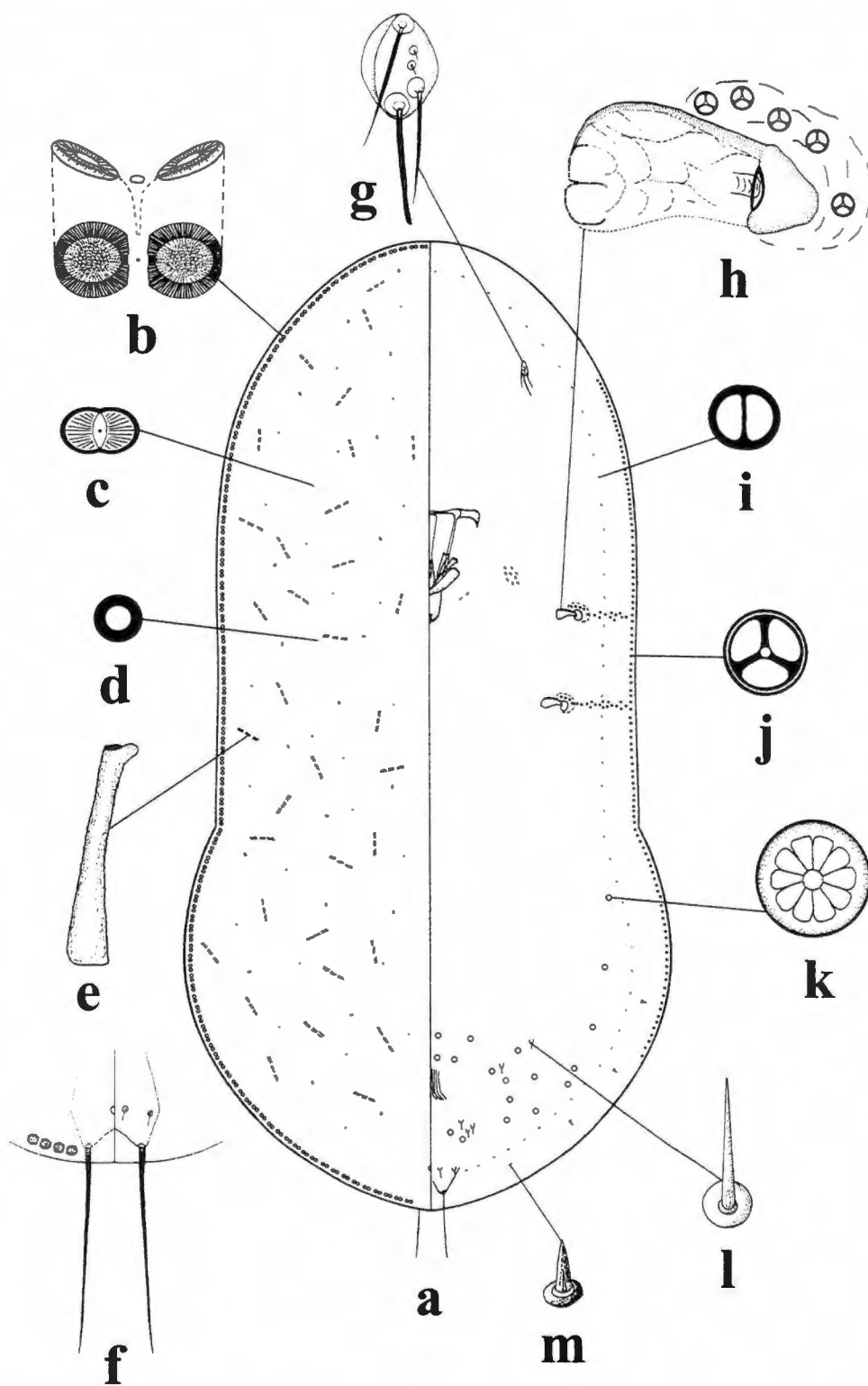


Fig. 44. *Palmaspis sabalis* (Russell), 1941.

Additional material studied: On *Cocos nucifera*, 3(1), all adult ♀♀, Ft. Pierce 000482, Bahamas, coll., R. Morris, 20-VII 1985 (USNM), no. 85-9646; *Hemithrinax* sp., 3(1), all adult ♀♀, Llano de Moa, Oriente, Cuba, coll., B. Leon, 23 VII 1941 (USNM), no. 41 2277; *Thrinax ekmanii*, 2(1), all adult ♀♀, Dominican Rep., coll., L. Tydal, 12 XII 1996 (USNM), nos. 2013210, JKFIA 115855; *Thrinax spissa*, 2(1), all adult ♀♀, Dominican Rep., coll., L. Schroeder, 12 XII 1996 (USNM), nos. 2013210, JKFIA 115857.

Description:

Body (Fig. a) oval in cephalothoracic and anterior abdominal area, widening toward a round posterior abdominal area. However, specimens were somewhat distorted. Body 694 (580-800) long, 428 (350-540) wide, derm membranous with minute 8-shaped pores, tubular ducts, and disk pores on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 237 (220-264) pores; pores bent, each 8.0 (6.9-9.2) long, 3.4 (3.4-3.4) wide. Minute pores (Fig. c) irregularly distributed, each 1.8 (1.7-2.3) long, 1.1 (1.1-1.1) wide.

Simple disk pores (Fig. d) irregularly distributed, each 1.1 in diam.

Tubular ducts (Fig. e) throughout derm, each 21.8 (19.5-26.4) long, 3.4 (3.4-3.4) wide.

Anal lobes (Fig. f) ventrad, each anal lobe with one apical seta 53.7 (46.0-58.6) long, one inner ventral seta 3.2 (2.3-4.0) long, and one outer ventral seta 3.2 (2.9-3.4) long.

Anal ring (Fig. f) plate-like, without pores or setae; anal ring 2.9 (2.3-3.4) long, 2.6 (2.3-2.9) wide.

Ventral Surface

Clypeolabral shield (Fig. a) without lateral clypeal sulcus, 85.7 (77.0-92.0) long, 67.7 (64.4-71.3) wide.

Labium (Fig. a) rectangular, 40.2 (36.8-42.5) long, 37.5 (33.3-46.0) wide; with 1 pair of setae, each 2.3 long.

Antennae (Fig. g) one-segmented, subcircular, 9.7 (8.0-12.6) long, 7.1 (5.7-9.2) wide at base; with 1 fleshy seta 13.2 (11.5-14.9) long, 2 (1-2) slender setae 10.9 (8.0-12.6) long, and 2 (2-3) small setae 1.1 long.

Spiracles (Fig. h) located in submarginal area; anterior 23.6 (20.7-25.3) long, 9.3 (8.6-10.3) wide, atrium 4.7 (3.4-5.7) in diam.; posterior 23.1 (20.1-25.3) long, 9.1 (8.0-9.2) wide, atrium 4.4 (3.4-5.7) in diam; with 4(3-5) pores in folds around atria; anterior spiracular furrows with a band of 19 (16-25) trilocular pores, 1 (1-3) pores wide; posterior furrows with a band of 19 (16-20) trilocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with about 100 pores; each 1.6 (1.1-1.7) long and 1.1 (1.1-1.1) wide; dark-rimmed pores form one small and one large cluster on each side of mouthparts, consisting of 11 (9-15) pores; each 1.7 long and wide.

Trilocular pores (Fig. j) in spiracular furrows and in a marginal row with 216 (196-236) pores, row ends 26 (15-50) corresponding 8-shaped pore lengths before apex of abdomen, and is interrupted for 34 (18-54) 8-shaped pore lengths anteriad; each 2.1 (1.7-2.3) in diam.

Multilocular pores (Fig. k) with 4-5 incomplete rows consisting of 2 (0-4) pores, posterior row with 4 (2-6) pores, and with 3 complete rows around genital opening; rows with 10 (8-11), 11 (5-15), and 4 (4-5) pores, respectively; each 10 loculi and 4.5 (4.0-4.6) in diam.

Setae with 3 segmental rows (Fig. l) around genital opening corresponding to 3 complete rows of multilocular pores, each with 2 (2-4) setae, posterior row with 6 setae; each 4.5 (3.4-5.2) long; also submarginal row with 8 (4-8) tack-like setae (Fig. m) in posterior abdominal area, each 2.1 (1.1-2.3) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Bahamas, Cuba, Dominican Republic.

Economic importance: This species is of no economic importance.

Diagnosis: Anal lobes ventrad; anal ring plate-like, without pores or setae; clypeolabral shield without lateral clypeal sulcus; from the Bahamas, Cuba, and the Dominican Republic.

Affinities: The sabal pit scale is related to a whole group of pit scales that also includes the genus *Grammococcus*.

***Palmaspis similis* (Russell), 1941**

Proposed Common Name: Similar Pit Scale

Fig. 45

Asterolecanium simile Russell, 1941:187; Ferris, 1955:26. *Palmaspis similis* Matile-Ferrero, 1996:263.

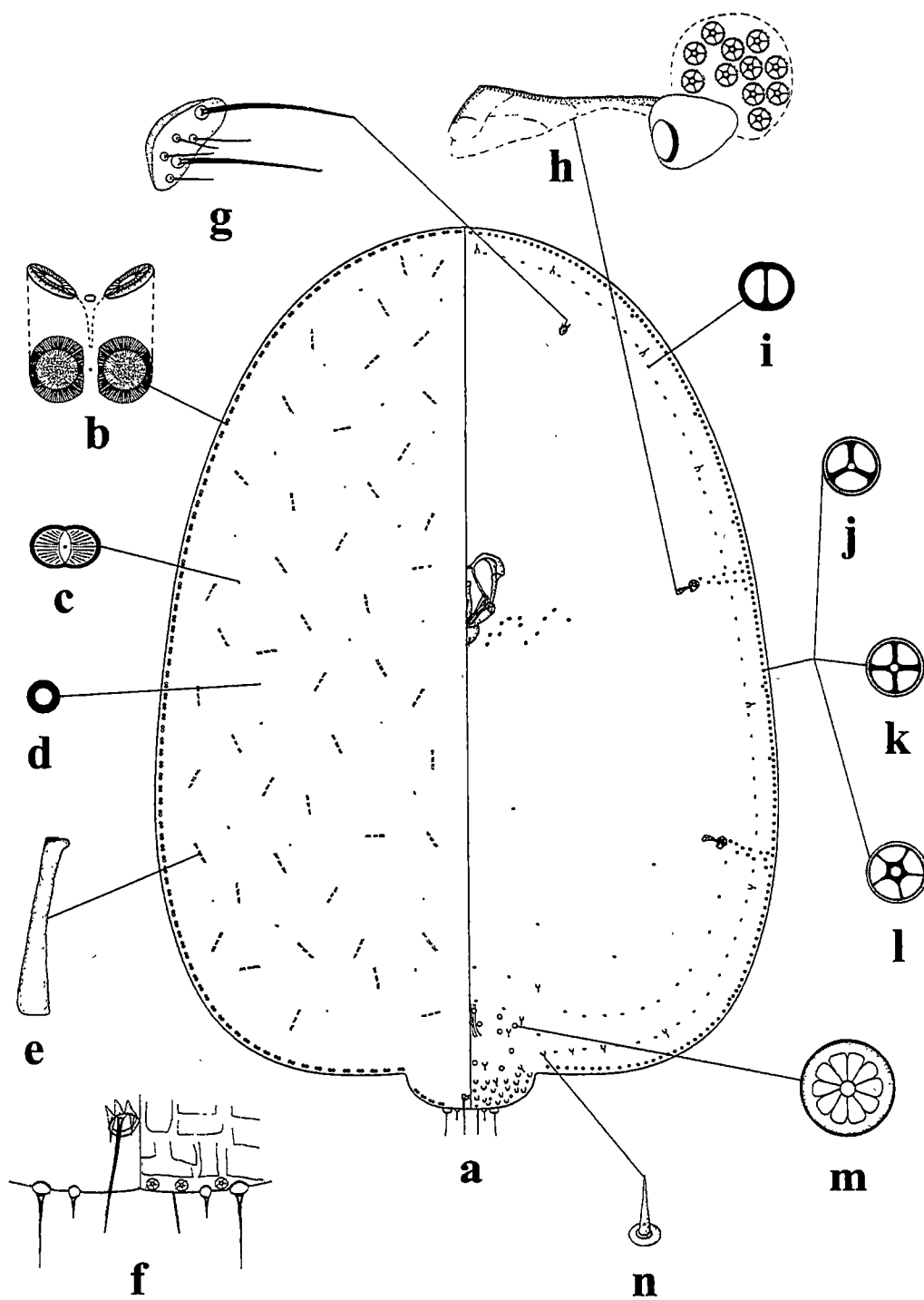


Fig. 45. *Palmaspis similis* (Russell), 1941.

Type material: On palm, 20(1), paratypes, 4 adult ♀♀, 16 first instars, Jamaica, interc. at Phila., coll., M. Kisliuk, 6 VII 1934 (USNM), no. Phila 23242; palm, *Ceiba* sp., 8(4), paratypes, all adult ♀♀, Honduras, interc. at New Orleans, LA, colls., Benton, Costal, no. 2/7, 24 XI 1920 (USNM), 2 slides mounted from dry material.

Additional material studied: Coconut palm, 8(1), 4 adult ♀♀, 4 first instars, Fair Prospect, Portland, Jamaica, colls., C.G. Johnson, Dr. D.J. Williams, 1973 (USNM); coconut, 3(1), all adult ♀♀, Barnett Estate, Jamaica, coll., R. Latta, 25 VI 1964 (USNM).

Additional host: *Attalea cohune* (Russell 1941).

Description:

Body (Fig. a) oval, with distinct anal lobe, without anal indentation, 866 (720-1020) long, 754 (500-880) wide. Derm membranous with minute 8-shaped pores, tubular ducts, and disk pores on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row, shortly interrupted at anal lobe for 4-6 pores, row with 199 (180-224) pores, all bent; each 7.3 (6.9-8.0) long, 3.9 (3.4-4.6) wide. Minute pores (Fig. c) irregularly distributed, each 2.3 (1.7-2.9) long, 1.3 (1.1-1.7) wide.

Simple disk pores (Fig. d) irregularly distributed, consisting of about 40-50 pores, each 1.1 in diam.

Tubular ducts (Fig. e) throughout derm, each 20.8 (18.4-24.1) long, 2.7 (2.3-3.4) wide.

Anal lobes (Fig. f) very distinct, strongly sclerotized ventrally, sometimes with side-lobes; each anal lobe with one apical seta, occasionally bifurcate, 9.3 (8.0-10.3) long, one subapical seta 4.1 (2.9-5.7) long; sometimes 1 pair of inner ventral setae present, each 6.3 (4.6-8.0) long.

Anal ring (Fig. f) plate-like, with two halves, connected basically, with several strong anterior spikes; anal ring 3.2 (2.9-3.4) long, 7.6 (6.9-8.6) wide; with one pair of setae, each 12.5 (11.5-13.8) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 98.9 (83.9-108.0), width 74.1 (67.8-93.1).

Labium (Fig. a) triangular, 39.2 (36.8-42.5) long, 37.6 (31.0-46.0) wide; with 2 pairs of setae, each 2.6 (1.7-3.4) long.

Antennae (Fig. g) one-segmented, triangular, 6.0 (5.2-6.9) long, 9.8 (6.9-11.5) wide at base; with 2 fleshy setae 9.5 (6.9-11.5) long, and 4 (2-6) slender setae 2.3 long.

Spiracles (Fig. h) located in submarginal area; anterior 25.4 (23.0-27.6) long, 7.7 (6.9-9.2) wide, atrium 5.5 (5.2-5.7) in diam.; posterior 27.0 (21.8-32.2) long, 7.6 (6.9-9.2) wide, atrium 5.2 (4.6-6.9) in diam; spiracular furrows consist of trilocular, quaterolocular, and quinquelocular pores; anterior spiracles with 11 (6-14) pores in folds around atrium, furrows with a band of 12 (9-16) pores, 2 (1-4) pores wide; posterior spiracles with 11 (9-13) pores in folds around atrium, furrows with a band of 12 (8-17) pores, 2 (1-3) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 108 (100-122) pores, each 1.7 (1.7-1.7) long, 1.2 (1.1-1.7) wide; dark-rimmed pores with two pore sizes: large pores in a

cluster with 12 (10-14) pores on each side of mouthparts, each 2.2 (1.7-2.3) long, 1.9 (1.7-2.3) wide; small pores in transverse abdominal rows, with 50 (34-72) pores, same size as submarginal pores.

Trilocular pores (Fig. j) in spiracular furrows and in a marginal row; row complete, not interrupted posteriad, with some pores in second row positions, row less dense in anal area, marginal row with 342 (282-444) pores; each 2.3 (2.3-2.3) in diam.

Quatrolocular pores (Fig. k) and **quinquelocular pores** (Fig. l) in spiracular furrows and in marginal row; same size as trilocular pores.

Multilocular pores (Fig. m) with 3 complete rows around genital opening, each with 6 (4-8) pores, posterior row with 4 (3-6) pores; each 10 (8-12) loculi and 3.9 (3.4-4.6) in diam.

Setae (Fig. n) with 4 segmental rows around genital opening corresponding to 3 rows of multilocular pores, each with 2 (2-4) setae, each 3.3 (2.3-4.0) long; also complete submarginal row with 20 (16-24) setae, row denser in abdominal area, each 3.2 (2.3-4.6) long, posterior setae on anal lobe a little longer.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Honduras, Jamaica.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring in two parts, with lateral areas connected mesad and several strong spikes antero-dorsad; marginal row of trilocular, quatrolocular, and

quinelocular pores not interrupted posteriorly; anal lobes distinct, with ventral sclerotization; from Honduras and Jamaica.

Affinities: Closely related to *Pa. degenerata*, based on antennal, spiracular, and anal area characteristics.

***Palmaspis trisetosa*, n.sp.**

Proposed Common Name: Trisetose Pit Scale

Fig. 46

Palmaspis trisetosa, n. sp.

Type material: On palm seed, 1(1), holotype, adult ♀, Brazil, coll., L.A. McClain, 3 VII 1968 (USNM), Miami no. 49393.

Description:

Body (Fig. a) oval, without anal indentation, 1090 long, 800 wide. Derm membranous with 1-2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores on margin (Fig. b) form single row with 182 pores, row terminates a pore's length before apex of abdomen, each pore bent, 9.2 long, 6.3 wide. Other pores (Fig. c) in submarginal band in 2 sizes; larger pores 3.4 long, 2.3 wide; smaller pores 2.3 long, 1.7 wide.

Simple disk pores (Fig. d) in submarginal band together with 8-shaped pores, band consisting of 86 pores, each 2.0 (1.7-2.3) in diam.

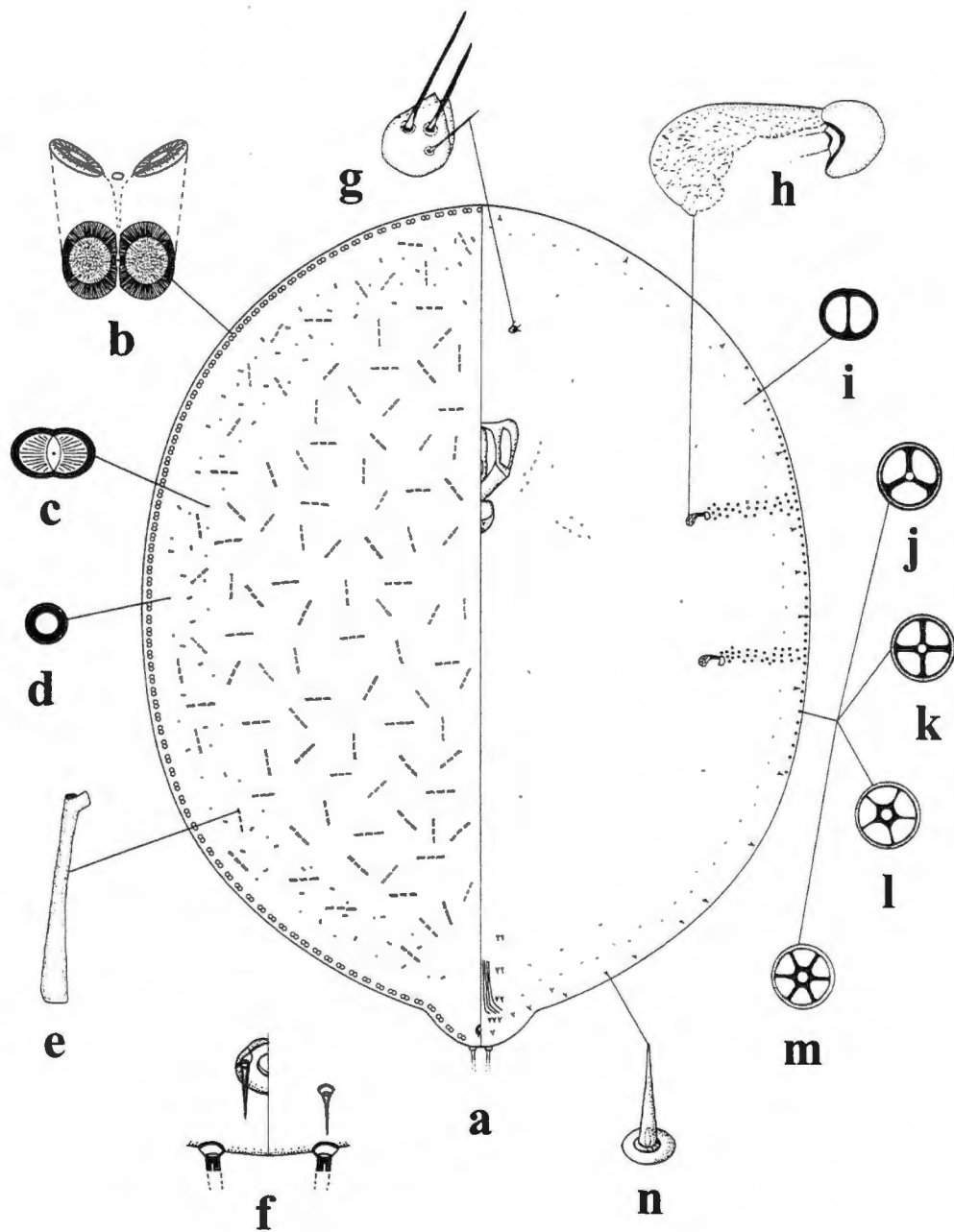


Fig. 46. *Palmaspis trisetosa*, n.sp.

Tubular ducts (Fig. e) numerous throughout derm, each 23.6 (23.0-24.1) long, 3.4 wide.

Anal lobes (Fig. f) without indentation, each anal lobe with one apical seta, broken, and one ventral seta, 8.0 long.

Anal ring (Fig. f) plate-like, with a circular opening in the center, 9.8 long, 10.3 wide; with 2 setae, each 8.0 long.

Ventral Surface

Clypeolabral shield (Fig. a) 111.5 long, 80.5 wide.

Labium (Fig. a) heart-shaped, 46.0 long, 47.1 wide; with 2 pairs of setae, each 1.7 long.

Antennae (Fig. g) one-segmented, subcircular, 8.6 long, 9.2 wide at base; with 2 fleshy setae 13.8 long, and 1 slender seta 8.0 long.

Spiracles (Fig. h) located in submarginal area; anterior spiracles 29.9 long, 11.5 wide, atrium 6.3 in diam.; posterior spiracles 35.6 long, 11.5 wide, atrium 6.9 in diam.; anterior spiracular furrows with a band of 33 pores, 2 (1-4) pores wide; posterior furrows with a band of 30 pores, 2 (1-3) pores wide; pores either trilocular, quatuolocular, quinquelocular, or 6-ocular, most pores quinquelocular.

8-shaped pores (Fig. i) in a submarginal row with 94 pores, row does not reach anal lobe, each pore 1.7 long, 1.1 wide; dark-rimmed pores in two bands with 6-8 pores each on either side of mouthparts, also with 30 pores in transverse rows, each pore 2.3 long, 1.7 wide.

Trilocular pores (Fig. j), **quatrolocular pores** (Fig. k), **quiquelocular pores** (Fig. l), and **6-locular pores** (Fig. m) in spiracular furrows and two short marginal rows where spiracular furrows meet margins, marginal rows consisting of 102 pores, most pores quinquelocular; each 2.3 (2.3-2.3) in diam.

Setae (Fig. n) with 4 segmental rows around genital opening, each row with 3, 5, 4, and 6 setae, respectively; length of setae variable, each 5.9 (4.0-4.8) long; without corresponding multilocular pores; also complete submarginal row with 36 setae, each 4.6 long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil.

Economic importance: This species appears to be of no economic importance.

Diagnosis: Anal ring fused, plate-like, circular, with 2 setae; without subapical setae; with 3 pairs of setae in posterior segmental row on abdomen.

Affinities: *Palmaspis trisetosa* may be closely related to *Pa. difficilis*, based on anal area characters.

Etymology: This species is named after the 3 conspicuous pairs of setae in the posterior row of segmental setae on abdomen.

***Palmaspis truncata* (Russell), 1941**

Proposed Common Name: Truncate Pit Scale

Fig. 47

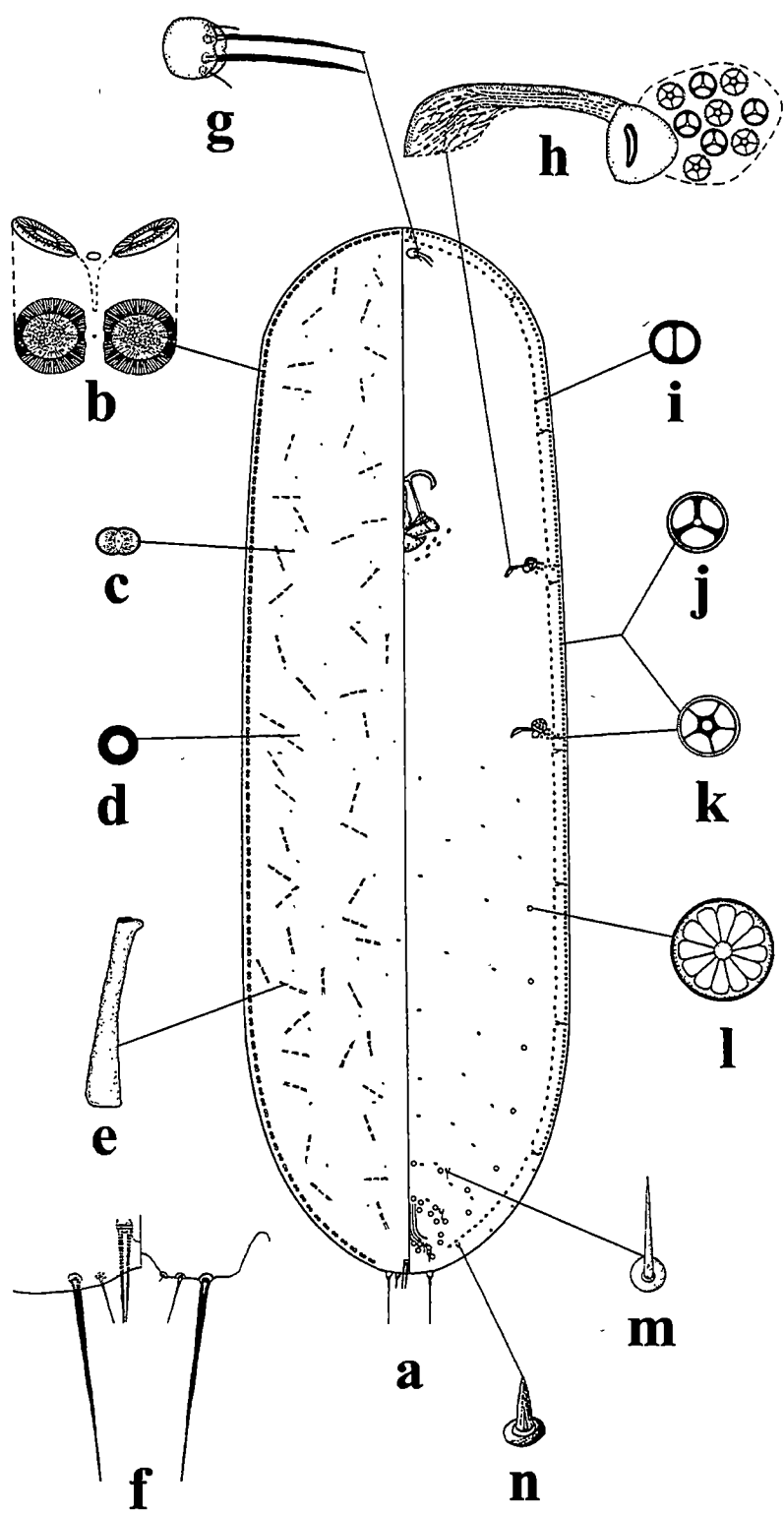


Fig. 47. *Palmaspis truncata* (Russell), 1941.

Asterolecanium truncatum Russell, 1941:211; Ferris, 1955:26; Miller, 1996:69.

Palmaspis truncata Matile-Ferrero, 1996:263.

Type material: On *Attalea cohune*, 3(1), paratypes, all adult ♀♀, Manzanillo, Mexico, coll., E. Palmer, no. 1063, XII 1890 (USNM), no. 45 2193.

Additional material studied: On *Attalea* palm, 4(1), all adult ♀♀, Costa Rica: at Hoboken, coll., J. Adams, 9 III 1950 (USNM), no. 50 2106, Ho. no. 15153.

Additional hosts: *Maximilliana carabaea* (Russell 1941).

Description:

Body (Fig. a) at least twice as long as wide, folding of specimens interfered with measurements, probably rather three times as long as wide; anal lobes with small indentation, 720 (520-1000) long, 386 (340-440) wide. Russell (1941) described this species as being 1500-1750 long, 500-700 wide. Derm membranous with minute 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 292 (140-356) pores, row terminates 5-6 pore lengths before apex of abdomen, all pores bent, each 6.8 (5.7-8.6) long, 3.0 (2.3-4.0) wide. Minute pores (Fig. c) distributed regularly over whole dorsum, only a few pores present, each 1.4 (1.1-1.7) long, 1.1 (1.1-1.1) wide.

Simple disk pores (Fig. d) regularly distributed over dorsum, consisting of about 50 pores, each 1.2 (1.1-1.7) in diam.

Tubular ducts (Fig. e) in 2 submarginal and 2 submedial bands, each 20.7 (18.4-24.7) long, 3.6 (3.4-4.0) wide.

Anal lobes (Fig. f) small, with small indentation, separate from apex of abdomen, all setae ventrad; each anal lobe with one apical seta 59.8 (58.6-60.9) long, one subapical seta 17.9 (13.8-21.8) long, and one ventral seta 4.5 (3.4-5.7) long.

Anal ring (Fig. f) on small dorsal lobe, plate-like, with two halves, connected basically, each half 2.6 (1.7-2.9) long, 6.6 (5.2-7.5) wide; anal tube 5.6 (4.6-6.9) long; with 2 setae and 2 pores, each seta 32.0 (28.7-35.6) long;.

Ventral Surface

Clypeolabral shield (Fig. a) with lateral clypeal sulcus missing, 91.5 (87.4-94.3) long, 68.0 (59.8-72.4) wide.

Labium (Fig. a) triangular, 30.8 (28.7-33.3) long, 37.7 (34.5-39.1) wide; with 2 pairs of setae, each 2.5 (2.3-2.9) long.

Antennae (Fig. g) one-segmented, subcircular, 8.2 (5.7-10.3) long, 6.4 (5.7-7.5) wide at base; with 2 fleshy setae 13.8 (12.6-16.1) long, and 2 (1-3) slender setae 6.3 (3.4-9.2) long.

Spiracles (Fig. h) located in submarginal area; anterior 29.0 (25.3-31.0) long, 11.3 (10.3-12.6) wide, atrium 5.9 (4.6-6.9) in diam.; posterior 29.2 (26.4-32.2) long, 12.3 (11.5-13.2) wide, atrium 5.6 (5.2-6.9) in diam.; with 9 (8-10) trilocular and quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 20 trilocular and quinquelocular pores, 1 (1-3) pores wide; posterior furrows with a band of 19 trilocular and quinquelocular pores, 1 (1-2) pores wide.

8-shaped pores (Fig. i) in a submarginal row with about 230 pores, each 1.5 (1.1-1.7) long, 1.2 (1.1-1.7) wide; dark-rimmed pores in a band with 6 (5-8) pores on each side

of labium, each 1.7 long and wide; and with about 50 pores in transverse rows on abdomen, same size as submarginal 8-shaped pores.

Trilocular pores (Fig. j) in a marginal row with 408 (394-422) pores, row ends 22 (12-33) marginal 8-shaped pore lengths before apex of abdomen, and is formed by only a few pores at posterior end; row sometimes with quinquelocular pores instead of trilocular pores; with 1 (0-2) pores between margin and each antenna, each 1.8 (1.7-2.3) in diam.

Quinquelocular pores (Fig. k) in spiracular furrows, sometimes also in marginal row; same size as trilocular pores.

Multilocular pores (Fig. l) with 5 incomplete rows consisting of 2 pores, second row with 2-4 pores, and 3 complete bands around genital opening; each row with 8 (5-10), 17 (11-25), and 11 (8-13) pores, respectively; each 12 (10-12) loculi and 4.4 (4.0-4.6) in diam.

Setae with 3 segmental rows (Fig. m) around genital opening corresponding to 3 complete bands of multilocular pores, each with 2 setae, posterior row with 4 setae, each 5.6 (4.6-6.3) long; also complete submarginal row with 18 tack-like setae (Fig. n), each 4.2 (3.4-5.7) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Costa Rica, Guatemala, Honduras, Mexico.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring on small dorsal lobe, plate-like, with two halves connected basically, with 4 setae; labium triangular, lateral clypeal sulcus missing.

Affinities: *Palmaspis truncata* is part of the clade that includes the genus *Grammococcus*.

***Palmaspis urichi* (Cockerell), 1894**

Proposed Common Name: Urich's Pit Scale

Fig. 48

Asterolecanium urichi Cockerell, 1894a:308, 1895b:167, 1896:9, 1897a:328, 1902b:251, 1902c:114; Fernald, 1903:53; MacGillivray, 1921:189; Russell, 1941:215; Ferris, 1955:26; D'Araujo e Silva et al., 1968:134; Miller, 1996:69. *Palmaspis urichi* Matile-Ferrero, 1996:254, 263.

Type material: On palm, 3(3), types, all adult ♀♀, Port-of-Spain, Trinidad, Coll., F.W. Urich, (USNM), no. 4.

Additional material studied: On *Guilielma speciosa*, 4(1), all adult ♀♀, Brazil, at D.C., coll., Spessard, 12 VII 1939 (USNM), no. E.Q. 065407, no. 39 3822; *Bactris minor*, 5(1), 2 adult ♀♀, 3 first instars, Grenada, ws no. 25 (USNM); *Bactris gasipaes* (Palmae), 125(16), 49 adult ♀♀, 12 adult ♂♂, 5 fourth instar ♂♂, 12 second instar ♀♀, 47 first instars, Las Palmas, Santafé de Bogotá, Colombia, coll., E.E. Malagon, det., C. Stumpf, 19 VI 1997 (UT).

Additional hosts: *Bactris gasipaes*, *B. minor*, *Guilielma* sp., *Pyrenoglyphis major* (Russell 1941).

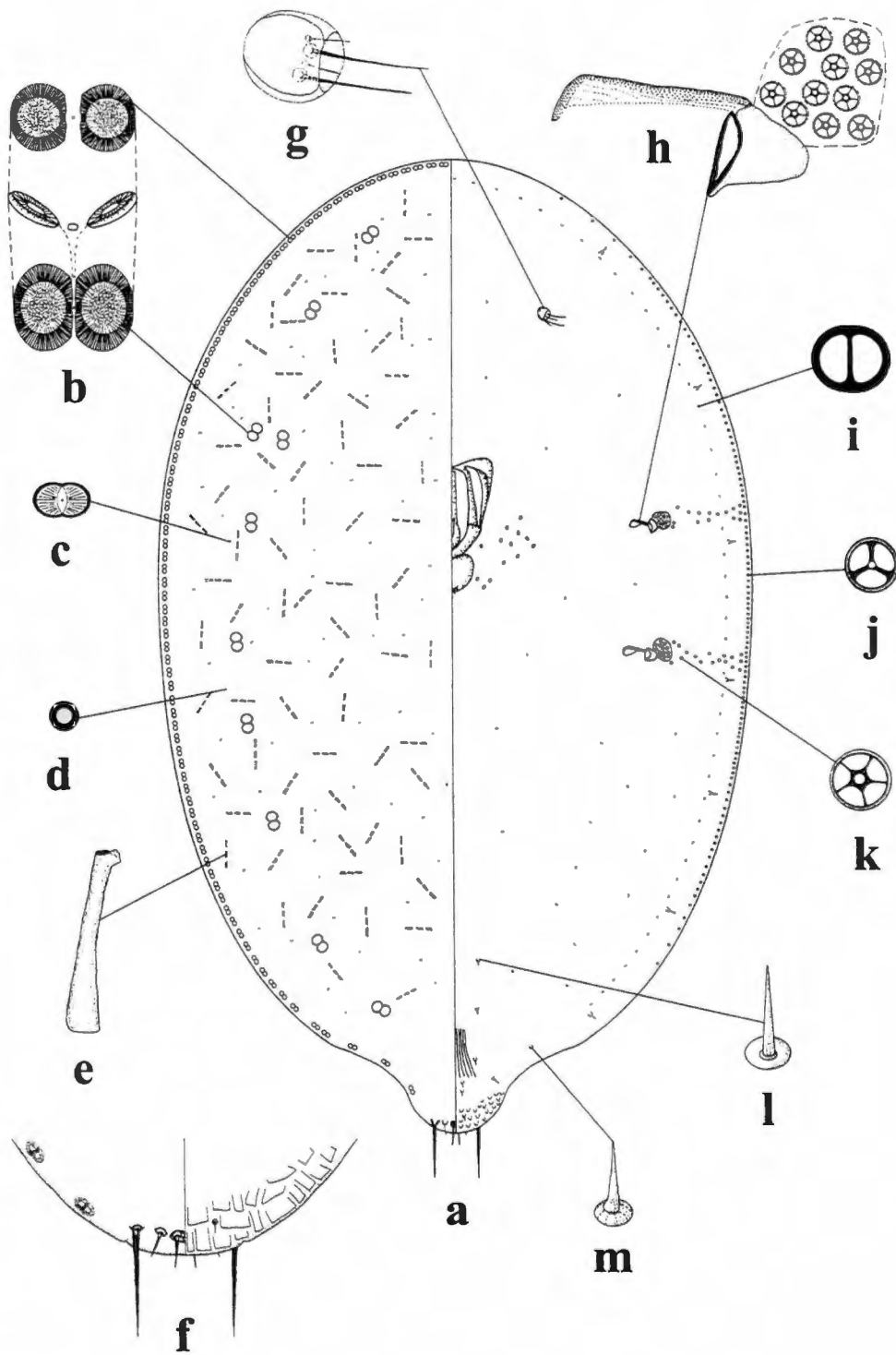


Fig. 48. *Palmaspis urichi* (Cockerell), 1894.

Description:

Body (Fig. a) oval, without anal indentation, 844 (680-1060) long, 496 (440-540) wide. Derm membranous with 1-2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row with 162 (118-208) pores, row less dense in posterior abdominal area, and terminates 6-7 pore lengths before apex of abdomen; each pore bent, 8.2 (8.0-8.6) long, 4.0 (2.9-5.2) wide. Other pores in 2 sizes; large pores may or may not be present; Russell (1941) notes the rare presence of 3 or 4 pores, Matile-Ferrero (1996) describes this species without large 8-shaped pores, which may lead to incorrect identifications; in the material at hand, specimens with large pores were only present in the sample from Colombia, where all adult ♀♀ had a submarginal row; with about 20 8-shaped bent pores, each 14.1 (13.2-14.9) long, 9.8 wide; all specimens with about 50-80 minute pores (Fig. c) in transverse rows, each 1.8 (1.1-2.9) long, 1.2 (1.1-1.7) wide.

Simple disk pores (Fig. d) regularly distributed over dorsum, only a few pores present, each 1.1 in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 22.1 (19.0-26.4) long, 3.0 (2.3-3.4) wide.

Anal lobes (Fig. f) without indentation, sclerotized ventrally; each anal lobe with one apical seta 18.5 (12.6-24.1) long, one subapical seta 7.9 (5.7-9.2) long, one ventral seta, 3.0 (2.3-3.4) long. Matile-Ferrero (1996) describes the apical setae to be 36 long,

and uses this character in her key. This length does not coincide with the measurements in this study and those of Russell (1941).

Anal ring (Fig. f) plate-like, with a small circular opening in the center, 4.7 (3.4-5.7) long, 9.8 (8.0-11.5) wide; with 2 setae, each accompanied by a pore, 8.9 (6.3-11.5) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 83.0 (69.0-92.0), width 61.2 (51.7-80.5).

Labium (Fig. a) heart-shaped, 33.0 (27.6-35.6) long, 37.7 (33.3-46.0) wide; with 2 pairs of setae very close together, each 2.9 (2.3-3.4) long.

Antennae (Fig. g) one-segmented, subcircular, 7.2 (5.7-9.2) long, 8.6 (6.9-12.6) wide at base; with 2 (2-3) fleshy setae 10.1 (8.0-12.6) long, and 2 (2-3) slender setae 4.6 (3.4-5.2) long.

Spiracles (Fig. h) located in submarginal area; anterior spiracles 24.6 (21.8-27.6) long, 7.5 (5.7-9.2) wide, atrium 3.9 (3.4-4.6) in diam., with 11 (7-15) quinquelocular pores in folds around atrium; posterior spiracles 24.3 (21.8-27.6) long, 7.8 (6.9-9.2) wide, atrium 4.0 (3.4-4.6) in diam., with 13 (9-23) quinquelocular pores in folds around atrium; anterior spiracular furrows with a band of 16 (9-22) quinquelocular pores, 2 (1-5) pores wide; posterior furrows with a band of 17 (10-27) quinquelocular pores, 2 (1-5) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 92 (74-114) pores, row does not reach anal lobe, each 1.8 (1.7-2.3) long, 1.2 (1.1-1.7) wide; with two types of dark-rimmed pores; large pores in a band with 13 (8-19) pores on each side of mouthparts;

each 2.5 (2.3-2.9) long, 2.1 (1.7-2.9) wide; small pores in transverse rows over venter, consisting of 52 (28-76) pores, with same size as submarginal pores.

Trilocular pores (Fig. j) in a marginal row with 221 (172-296) pores, row ends 13 (2-22) marginal 8-shaped pore lengths before apex of abdomen, and is interrupted for 11 (0-21) 8-shaped pore lengths anteriad, row less dense both at anterior and posterior ends, and sometimes double around spiracular furrows, each 1.7 (1.7-1.7) in diam.

Quinquelocular pores (Fig. k) in spiracular furrows, each 2.2 (1.7-2.3) in diam.

Setae with 1 band and 3 rows of segmental setae (Fig. l) around genital opening, each row with 2 setae, posterior band with 4-5 setae, each 3.3 (2.9-3.4) long; without corresponding multilocular pores; also complete submarginal row with 18 (14-22) tack-like setae (Fig. m), row denser in posterior abdominal area, each 3.1 (2.3-3.4) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: Brazil, Colombia, Grenada, Mexico, Nicaragua, Panama, Peru, Trinidad, West Indies.

Economic importance: This species is of no economic importance.

Diagnosis: Anal ring with 2 setae and 2 pores; apical setae longer than anal ring setae; anal lobes sclerotized ventrally.

Affinities: *Palmaspis urichi* is closely related to *Pa. boliviae* and *Pa. difficilis*, based on anal area characters.

Species not available for study:

***Palmaspis elvae* Matile-Ferrero, 1996**

Proposed Common Name: Elva Pit Scale

Palmaspis elvae Matile-Ferrero, 1996:254.

Host: *Bactris gasipaes*.

Distribution: Peru.

Affinities: Further studies are necessary to evaluate this species.

Notes: Types available in MNHN.

***Palmaspis jesseniae* Matile-Ferrero, 1996**

Proposed Common Name: Jessenia Pit Scale

Palmaspis jesseniae Matile-Ferrero, 1996:256.

Host: *Jessenia bataua*.

Distribution: Peru.

Affinities: Further studies are necessary to evaluate this species.

Notes: Types available in MNHN.

***Palmaspis longifila* (Borchsenius), 1950**

Proposed Common Name: Borchsenius' Pit Scale

Asterolecanium longifilum Borchsenius, 1950a:727. *Palmaspis longifilum* Matile-Ferrero, 1996:254.

Transcription (translation from Russian) (Borchsenius 1950a)

Host: Palm tree (Palmae). From Brazil, Rio de Janeiro. Adult ♀♀ located along main vein on upper side of leaves.

This scale was described by Borchsenius (1950a) from material collected by E.A. Pesotskaya during a South America expedition of the Botany Institute of the Russian Academy of Sciences under B.K. Shishikima. The cover of the adult ♀ is long-stretched, with nearly parallel margins, flat yellowish green, 2-2.5mm long and 0.9-1mm wide. A double row of marginal 8-shaped pores produces long filamentous wax threads that are between $\frac{1}{2}$ to $\frac{2}{3}$ of the width of the scale cover. The body of the adult ♀ is long and oval, with indentations toward apex of abdomen, sometimes tapering toward apex. Ventral spiracles small, with small sclerotized plate. Located near spiracles are 7-12 bilocular and trilocular pores with a diameter of 2.5. In the spiracular furrows are 24-27 trilocular and quaterolocular pores. The anal ring is small, about 18 wide, with 4 setae, 36-39 long. (The anal ring seems to be plate-like according to Borchsenius' illustrations.) Anal lobes not well developed with apical setae about 30 long. Two additional setae (ventral setae?) are located beneath anal ring, 12 long. Marginal row of large 8-shaped pores usually double, sometimes threefold, but single at anal lobe; pores 16-18 long and 9-10 wide. Parallel to marginal 8-shaped pores a row of marginal multilocular pores is present, pores with 5-10 loculi and 4 diam; row becomes double in cephalothoracic area. Both marginal 8-shaped pores and marginal multilocular pores are not interrupted at apex of abdomen. Simple disk pores with a diam. of 1.5 are present along dorsal margin and sometimes also on dorsal surface. Tubular ducts are randomly distributed over dorsum with a length of 36-39. Simple disk pores are also found on ventral thoracal margin. Typical ventral submarginal 8-shaped pores are present, also 29-35 dark-rimmed 8-shaped pores, 30 long, on both sides of mouthparts. Without cribriform plates. Form 2

rows of segmental setae with 3 setae each around genital opening. Without segmental multilocular pores.

Distribution: Brazil.

Affinities: According to Borchsenius (1950a), this species is closely related to *Pa. sabalis* and *Asterolecanium flagellariae*.

Notes: Types available in ZI. With the generic name change from *Asterolecanium* to *Palmaspis*, the grammatic gender also changed from neuter to feminine. Therefore, a name emendation is proposed for this species.

***Palmaspis loretoensis* Matile-Ferrero, 1996**

Proposed Common Name: Loreto Pit Scale

Palmaspis loretoensis Matile-Ferrero, 1996:256.

Host: *Oenocarpus mapora*.

Distribution: Peru.

Affinities: *Palmaspis pallida* (according to Matile-Ferrero 1996).

Notes: Types available in MNHN.

***Palmaspis marfil* Matile-Ferrero, 1996**

Proposed Common Name: Marfil Pit Scale

Palmaspis marfil Matile-Ferrero, 1996:260.

Host: *Phytelephas macrocarpa*.

Distribution: Peru.

Affinities: *Palmaspis singularis*, native to the Philippines (according to Matile-Ferrero 1996).

Notes: Types available in MNHN.

***Palmaspis ucayali* Matile-Ferrero, 1996**

Proposed Common Name: Ucayali Pit Scale

Palmaspis ucayali Matile-Ferrero, 1996:260.

Host: *Cocos nucifera*.

Distribution: Peru.

Affinities: *Palmaspis degenerata* (according to Matile-Ferrero 1996).

Notes: Types available in MNHN.

Genus *Planchonia* Signoret, 1870

Planchonia Signoret, 1870:282, 1876b:608; Maskell, 1882:223, 1884:134, 1887:91, 1894:94, 1895a:19, 1895b:61, 1895c:134; Cockerell, 1893a:76, 1893b:8, 1893c:255; Bodenheimer, 1951:328; Borchsenius, 1960:144, 1961:65; Morrison & Morrison, 1966:156; Danzig, 1967:825; Komosinska & Podsiadlo, 1967:685; Kosztarab & Kozar, 1978:139, 1988:318; Bognar & Vinis, 1979:16; Schmutterer, 1980:51; Tereznikova, 1981:80; Martin Mateo, 1984:64; Kozar & Walter, 1985:80; Pellizzari, 1994:32; Longo et al., 1995:125.

Type species: *Coccus fimbriatus* Boyer de Fonscolombe, 1834:209, by monotypy.

Asterolecanium Cockerell, 1893d:373, 1897a:327; Fernald, 1903:49; Lindinger, 1937:193; Gomez-Menor, 1940:232; Russell, 1941:4; Ferris, 1955:15; Tranfaglia, 1974:54; Miller, 1985:105; Gill, 1993:98. *Asterodiaspis* Kosztarab, 1996:287.

Generic description:

Dorsum: With marginal band of 8-shaped pores, bent; dorsal 8-shaped pores in median swirls and transverse bands, pores bent, minute 8-shaped pores present or absent, with simple disk pores and tubular ducts, simple disk pores throughout dorsum and in submarginal rows on dorsum and venter; with arched plate and anal plates fused and anvil-shaped, anal ring with 6 setae; anal lobes only weakly developed, with small indentation, sclerotized ventrally. Venter: With one-segmented antennae, legs absent, 8-shaped pores near mouthparts, in marginal bands, and in transverse rows. With simple disk pores, and quinquelocular pores in spiracular furrows and forming a marginal row; multilocular pores in abdominal bands, with submarginal row of setae.

Diagnosis: Marginal or submarginal rows of simple disk pores on dorsum and venter; apical plates fused, anvil-shaped.

Hosts: Members of the genus *Planchonia* are found on a variety of host plants. Most members of the genus inhabit the Palearctic faunal region, but some also exist in the Ethiopian and Oriental regions. Two species have been introduced into the New World.

***Planchonia arabidis* Signoret, 1876**

Proposed Common Name: Pittosporum Pit Scale

Fig. 49

Planchonia arabidis Signoret, 1876b:608, 643; Lichtenstein, 1880:45; Cockerell, 1893a:79; Maskell, 1895b:62, 1895c:135; Bodenheimer, 1953:135; Borchsenius, 1960:145; Danzig, 1967:825; Komosinska & Podsiadlo, 1967:685; Kosztarab & Kozar, 1978:139, 1988:319; Bognar & Vinis, 1979:16; Schmutterer, 1980:51;

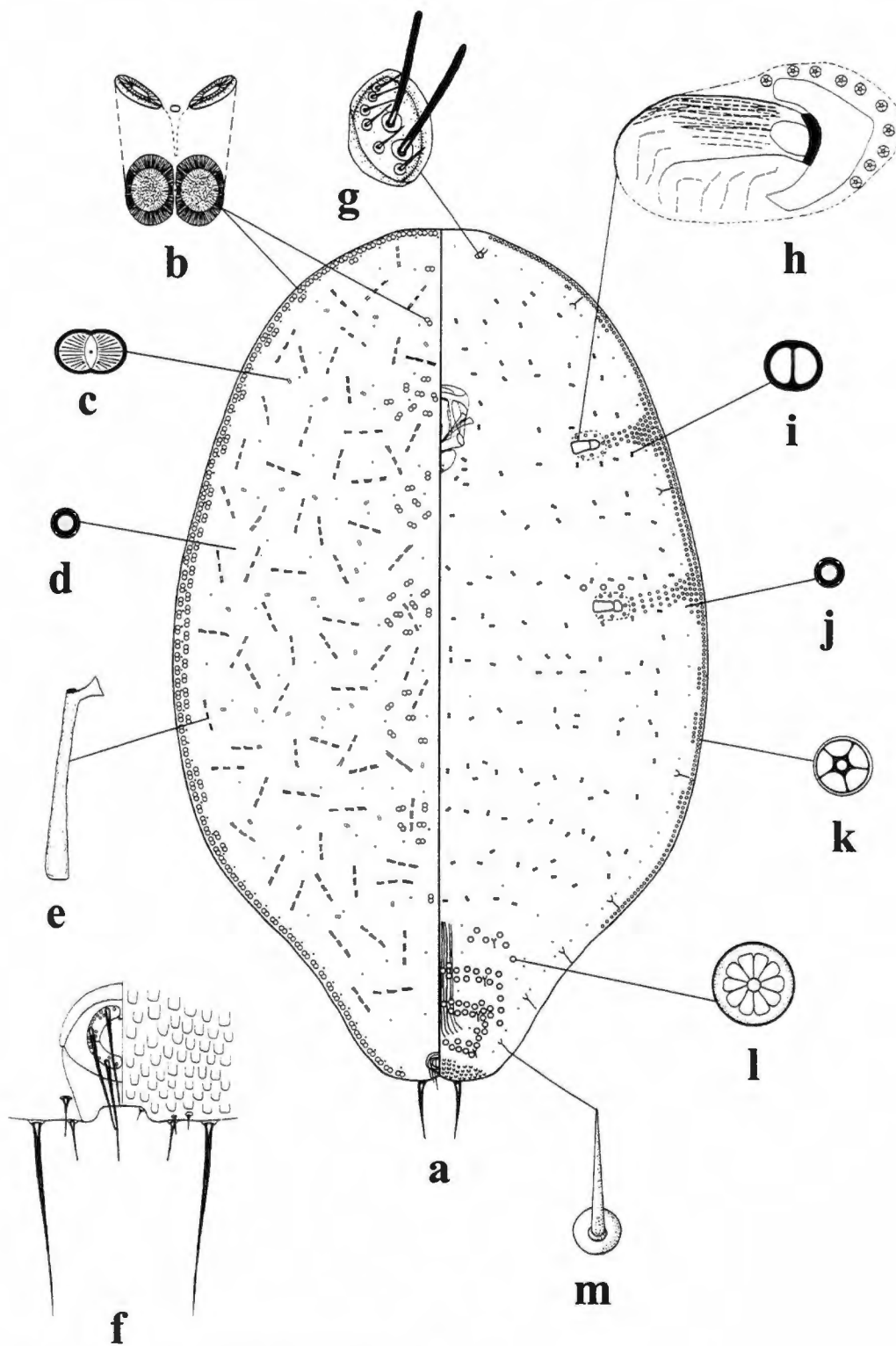


Fig. 49. *Planchonia arabidis* Signoret, 1876.

Tereznikova, 1981:80; Martin Mateo, 1984:64; Kozar & Walter, 1985:80; Kozar et al., 1994:155; Pellizzari, 1994:32; Longo et al., 1995:125; Lagowska & Koteja, 1996:35. *Planchonia hederæ* Lichtenstein, 1880:45; Cockerell, 1893a:79; Maskell, 1895b:62, 1895c:135. *Planchonia valloti* Lichtenstein, 1882:75. *Asterolecanium massalongianum* Targioni-Tozzetti, 1892:295, 312. *Pollinia thesii* Douglas, 1893:55. *Asterolecanium hederæ* Cockerell, 1894b:211, 1897a:327; Fernald, 1903:51. *Asterolecanium arabidis* Cockerell, 1897a:327; Fernald, 1903:49; Leonardi, 1908:154; Russell, 1941:44; Essig, 1945:134; Borchsenius, 1950b:135; Breaky & Howitt, 1954:227; Ferris, 1955:18; Kosztarab, 1959:404; Buhr, 1964:75; Landis, 1968:871; Frick & Hawkes, 1970:1085; Allen, 1971:16; Herting, 1972:135; Tranfaglia, 1974:54; Miller, 1985:106; Gill, 1993:98. *Asterolecanium thesii* Cockerell, 1897a:328; Newstead, 1903:154; Fernald, 1903:53; Leonardi, 1908:155, 1920:244; Green, 1922b:19, 1928:8. *Asterodiaspis arabidis* Kosztarab, 1996:290.

Type material: Auf *Arabis stricta*, 56(2), type, 1 adult ♀, 55 first instars, Montpellier, Gall. mer., (USNM), no. 44 1402.

Additional material studied: On *Thesium humifusum*, 1(1), adult ♀, type of *Pollinia thesii*, Corfe Castle, Wareham, Isle of Purbeck, Brit. Isles, Coll., E.R. Banks, 12 VII 1892 (USNM), no. 44 1403; *Hedera helix*, 1(1), adult ♀, Chermotheca Italica, Northern Italy, (USNM); *Panax* sp., 9(9), all adult ♀♀, Canada: Ottawa, Ontario, coll., J. Schooley, 13 VII 1995 (UT).

Additional hosts: *Achillea millefolium*, *Achillea* sp., *Arabis collima*, *A. stricta*, *A. sp.*, *Aralia nudicaulis*, *Arabis* sp., *Arctostaphylos franciscana*, *A. hookeri*, *Aster*

frikartii, *Atriplex patula* var. *hastata*, *Berberis* sp., *Beta vulgaris*, *Brassica nigra*,
Cardaria draba, *C. pubescens* var. *elongata*, *Carpenteria californica*, *C. divergens*, *C.*
gloriosus, *C. impressus*, *C. interregimus*, *C. purpurea*, *Ceanothus* sp., *Centaurea diffusa*,
Centaurea sp., *Cestrum* sp., *Chaenomeles japonica*, *Chenopodium album*, *Cirsium*
arvense, *Cistus* sp., *Cotoneaster horizontalis*, *Cytisus kewensis*, *C. scoparius*,
Daubentonia tripetii, *Deutzia scabra*, *Dianthus* sp., *Epilobium paniculatum*, *Erodium*
moschatum, *Fraxinus americana*, *F. pennsylvanica*, *F. pennsylvanica lanceolata*,
Fraxinus sp., *Fremontia* sp., *Gentiana germanica*, *Hedera helix*, *Hedera* sp.,
Helianthemum nummularium, *Hieracium umbellatum*, *Hieracium* sp., *Hosackia glabra*,
Hypericum perforatum, *Jasminum* sp., *Lechea* sp., *Lepidium latifolium*, *L. perfoliatum*,
Ligustrum ovafolium, *L. sinense*, *L. vulgare*, *Ligustrum* sp., *Linaria canadensis*, *Linaria*
sp., *Lithospermum purpureocoeruleum*, *Lithospermum* sp., *Lotus scoparius*, *Lynchnis*
alba, *Lynchnis* sp., *Medicago* sp., *Mentha citrata*, *Nemophila heterophylla*, *Origanum*
sp., *Osmodium carolinum*, *Osmodium* sp., *Penstemon* sp., *Philadelphus mexicanus*,
Phlox divaricata, *P. sublata*, *P. subulata* lilacina, *P. paniculata*, *Phlox* sp., *Pittosporum*
tobira, *Pittosporum* sp., *Pyracantha* sp., *Salvia* sp., *Senecio jacobaea*, *Syringa japonica*,
S. persica, *S. vulgaris*, *Teucrium* sp., *Thabdotypus kernioides*, *Thesium humifusum*,
Thesium sp., *Thymus serpyllum*, *Thymus* sp., *Trifolium pratense*, *Trifolium* sp.,
Verbascum sp., *Veronica buxifolia*, *V. hulkeana*, *Vicia* sp., *Viola odorata*, *Vitex negundo*
incisa, *Weigelia rosea*, and *Weigelia* sp. (Allen 1971, Bognar & Vinis 1979, Borchsenius
1950c, Breaky & Howitt 1954, Buhr 1964, Cockerell 1893a, Essig 1945, Frick & Hawkes

1970, Gill 1993, Komosinska & Podsiadlo 1967, Kosztarab 1959, Kosztarab & Kozar 1988, Kozar et al. 1994, Landis 1968, Leonardi 1908, Russell 1941, Tranfaglia 1974).

Description:

Body (Fig. a) pear-shaped, widest in area posteriad of metathoracic spiracles, 2180 (1400-2840) long, 1569 (1000-1900) wide, with small anal indentation. Derm membranous with 3 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin with alternating single and double rows of pores, but single rows dominate, double rows mostly in area between spiracular furrows and in anterior abdominal area; with 295 (258-390) pores, row terminates 3-4 pore lengths before apex of abdomen, all pores bent, each 13.9 (12.6-14.9) long, 8.8 (7.5-9.2) wide. Other pores with 2-3 sizes; large and occasionally also medial pores arranged in 5 (4-6) median clusters with 12 (10-16) pores, and a few median pores anteriad and posteriad of the pore clusters; minute pores (Fig. c) in transverse rows; large pores 14.0 (12.6-14.9) long, 8.5 (7.5-9.2) wide; medial pores 10.4 (9.2-11.5) long, 6.6 (6.3-6.9) wide; and minute pores 5.6 (4.6-6.9) long, 3.5 (2.9-4.6) wide.

Simple disk pores (Fig. d) in transverse rows, consisting of 151 (56-308) pores; and in submarginal row close to marginal 8-shaped pores with 113 (90-140) pores, each 2.3 (2.3-2.3) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 35.7 (28.7-40.2) long, 3.9 (2.9-5.7) wide.

Anal lobes (Fig. f) with small indentation, sclerotized ventrally; each anal lobe with one apical seta 100.6 (80.5-110.3) long, one subapical seta 36.3 (13.8-44.8) long, one dorsal seta 35.3 (27.6-39.1) long, one inner ventral seta 7.4 (5.7-9.8) long, one medial ventral seta 9.6 (8.0-11.5) long, and one outer ventral seta 14.1 (8.6-18.4) long.

Arched plate (Fig. f) semi-circular, 75.0 (63.2-83.9) long.

Anal plates (Fig. f) fused, anvil-shaped, each plate 39.9 (35.6-46.0) long.

Anal ring (Fig. f) located between arched plate and anal plates, divided medially, anal ring 42.4 (35.6-52.9) long, 41.9 (34.5-46.0) wide; with 3 rows of pores, inner row with 10 (8-16) pores, medial row with 16 (14-18) pores, and outer row; with 14 (10-16) pores with 6 setae, each 95.3 (73.4-124.1) long;.

Ventral Surface

Clypeolabral shield (Fig. a) length 157.5 (141.4-172.4), width 154.9 (128.7-178.2).

Labium (Fig. a) heart-shaped, 69.2 (60.9-80.5) long, 82.1 (69.0-100.0) wide, with 2 (0-3) pairs of setae, each 4.3 (2.3-6.9) long.

Antennae (Fig. g) one-segmented, 15.4 (11.5-17.2) long, 19.3 (17.2-23.6) wide at base; with 2 fleshy setae 17.1 (13.8-20.7) long, and 6 (6-7) slender setae 5.6 (4.6-6.9) long.

Spiracles (Fig. h) located in submarginal area; anterior 74.6 (69.0-83.9) long, 40.0 (37.9-42.5) wide, atrium 16.9 (10.9-25.3) in diam.; posterior 73.4 (64.4-80.5) long, 40.9 (36.8-44.8) wide, atrium 17.4 (12.1-20.7) in diam.; with 6 (3-10) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 41 (23-51) quinquelocular

pores, 3 (1-5) pores wide; posterior furrows with a band of 41 (30-47) quinquelocular pores, 3 (1-5) pores wide.

8-shaped pores (Fig. i) in transverse bands with 268 (150-380) pores covering whole venter with exception of the posterior abdominal area, and in a row with 5 (4-5) pores along each side of mouthparts, submarginal bands present as extension of transverse bands; each pore 4.1 (3.4-4.6) long, 2.9 (2.3-3.4) wide.

Simple disk pores (Fig. j) in a few transverse rows, mainly in anal area, consisting of 23 (10-32) pores, also in submarginal row with 90 (56-140) pores, each 2.3 (2.3-2.3) in diam.

Quinquelocular pores (Fig. k) in a marginal band that is 1 pore wide at anterior and posterior ends, 2 to 3 pores wide between spiracular furrows, and alternating 1 or 2 pores wide in areas anterior of prothoracic spiracular furrows and posterior of metathoracic spiracular furrows; marginal band with 442 (282-548) pores, ends 18 (11-25) marginal 8-shaped pore lengths before apex of abdomen, and is interrupted for 11 (0-22) marginal 8-shaped pore lengths anterior; with 0-3 pores between margin and each antenna, each 4.0 (3.4-5.2) in diam.

Multilocular pores (Fig. l) with 2-6 incomplete bands, each band consisting of 2-4 pores, anterior band with 6 (4-8) pores, and posterior band with 12 (2-18) pores, and 3 complete bands around genital opening with 30 (26-32), 27 (22-33), and 22 (16-29) pores, respectively; each 10 (6-14) loculi and 7.8 (6.9-8.6) in diam.

Setae (Fig. m) with 4 segmental rows around genital opening corresponding to 1 incomplete and 3 complete bands of multilocular pores, each with 2 (0-4) setae, each 7.2 (5.2-9.8) long; also submarginal row with 14 (12-26) setae, each 8.0 (6.3-9.2) long.

Biological data: With one generation per year. In Italy, first instars appear in April and May, and egg laying begins in August (Tranfaglia 1974). In the Caucasus region, the life cycle starts a month earlier (Kosztarab & Kozar (1988). The scale overwinters in the egg stage (Gill 1993).

Parasitoids and predators: Kosztarab (1959) reported three species of Encyrtidae from Hungary: *Cheiloneurus kollari* Mayr, *Discodes aeneus* (Dalm.), and *D. cercopiformis* (Walker). Herting (1972) listed *D. cercopiformis* and *Aphytis aonidia* Mercet (Aphelinidae) as parasitoids, and *C. kollari* and *Cheiloneurus paralia* Walker as possible hyperparasitoids of the pittosporum scale. In addition, *Discodes differens* Jasnosh (Encyrtidae) was listed as a parasitoid (Kosztarab & Kozar 1988, Tranfaglia 1974).

Distribution: Originally described from France, but prevalent throughout Europe; now also distributed in CA, CT, D.C., MA, NJ, NY, OH, OR, PA, VA, WA, WV, and Ontario, Canada, as well as "several western states" (Gill 1993); also known from Algeria, Philippines, Singapore, and Turkey.

Economic importance: The pittosporum pit scale is not always a problem, but may "get out of control at any time" (Allen 1971). This species can distort *Pittosporum* and English ivy, *Hedera helix*. It caused up to 50% loss in a commercial sugar beet field

(Gill 1993, Landis 1968). In Canada, it is seen as a potential threat to *Panax* sp. (E. Maw 1996, pers. comm.).

Diagnosis: With at least five transverse abdominal bands of multilocular pores on venter around vulva; simple disk pores on venter in submarginal row and in transverse rows.

Affinities: The genus *Planchonia* is at the base of the pit scale clade, and is closely related to *Asterolecanium quaesitum*.

***Planchonia stentae* (Brain), 1920**

Proposed Common Name: South African Pit Scale

Fig. 50

Asterolecanium stentae Brain, 1920:114; Russell, 1941:196; Gill, 1993:101. *Planchonia stentae* Borchsenius, 1960:145.

Type material: On *Huernia transvaalensis*, 1(1), paratype, adult ♀, Pretoria, coll., S. Slene, Brain coll. no. 29, 8 VII 1916 (USNM), no. 39 2508.

Additional material studied: On *Kalanchoe* sp., 4(4), all adult ♀♀, FL, Miami, coll., D. Storch, 1 V 1987 (FSCA), DPI no. 126403; *Kalanchoe* sp., 11(11), all adult ♀♀, FL, Miami, coll., D. Chalot, 21 XII 1989 (FSCA); *Cucurbita muschata*, 27(27), all adult ♀♀, FL, Homestead, coll., H. Glenn, 14 VIII 1987 (FSCA); *Ipomoea carnea fistulosa*, 4(4), all adult ♀♀, FL, Palmetto, coll., M. Runnals, 15 XII 1993 (FSCA); *Chrysanthemum frutescens*, 3(3), all adult ♀♀, FL, Golden Gate, coll., M. Peacock & A. Gambill, 19 V 1989 (FSCA); *Euphorbia lactea* 'Cristata', 9(9), all adult ♀♀, FL, Apopka, coll., C. Murphy, 1 III 1991 (FSCA);

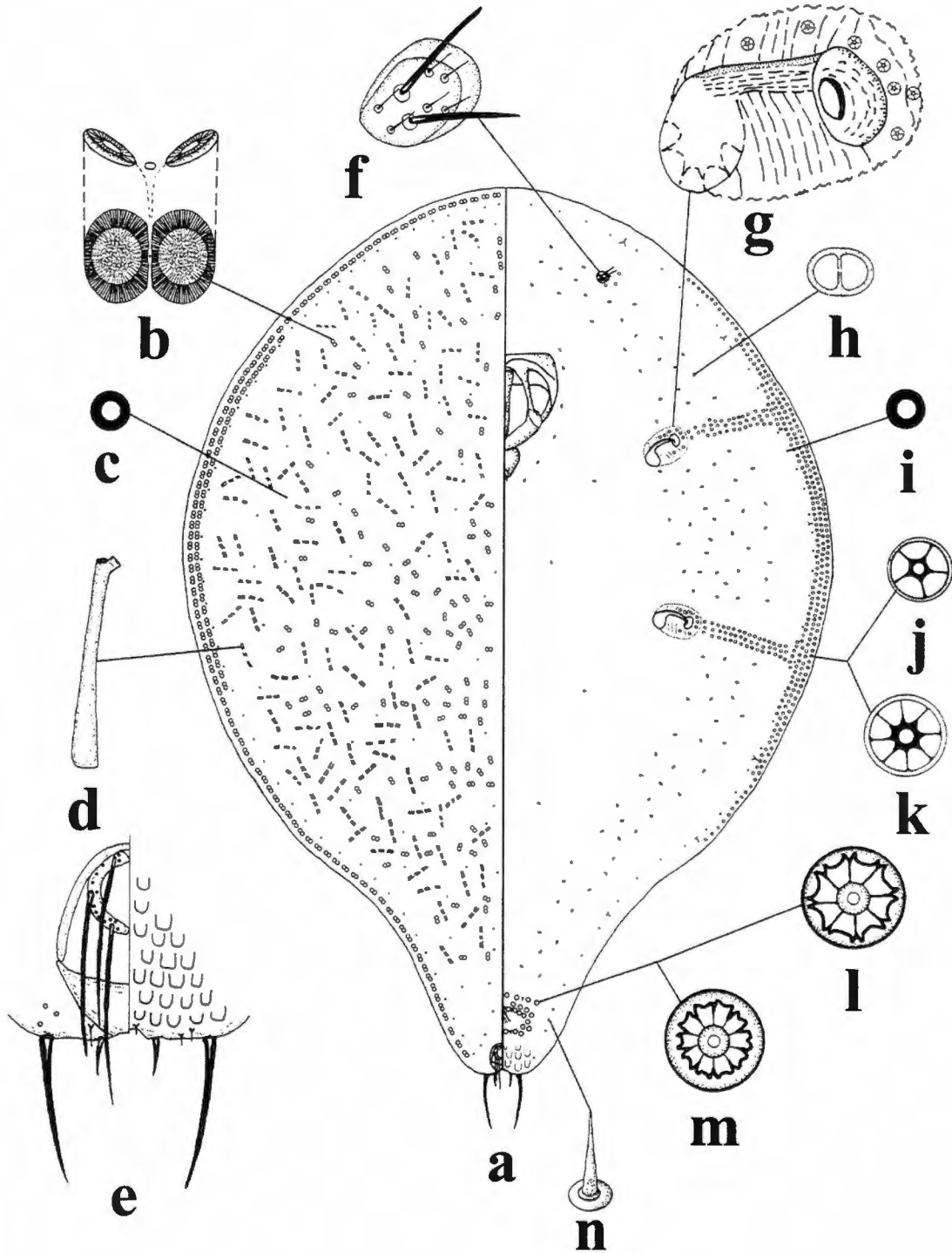


Fig. 50. *Planchonia stentae* (Brain), 1920.

Evolvulus glomeratus, 3(3), all adult ♀♀, FL, Miami, coll., D. Storch, 27 V 1987 (FSCA); *Evolvulus glomeratus*, 5(5), all adult ♀♀, FL, Ft. Myers, coll., W. I. Walsh, 23 II 1987 (FSCA), DPI no. 126-404; *Chamaesyce hirta*, 16(3), 2 adult ♀♀, 14 first instars, San Juan, Puerto Rico, coll., F.D. Bennett, 19 V 1990 (UT); *Pueraria phaseoloides* (Leguminaceae), 9(9), 6 adult ♀♀, 3 first instars, Buga Valle, Colombia, coll., T. Kondo, 28 I 1995 (AUEM), no. AL 003 98; cactus? (succulent?), 2(1), all adult ♀♀, Los Angeles, L.A. Co., CA, coll., H. Miller, det., E. Chao, conf., D.R. Miller, 4 XII 1980 (CDFA), no. 80112; *Euphorbia*, 3(1), all adult ♀♀, San Jamul, Diego Co., CA, coll., J. Kenyon, det., R.J. Gill, 17 X 1988 (CDFA), no. 805505; *Euphorbia*, 3(1), all adult ♀♀, Anaheim, Orange Co., CA, coll., M. Ragasol, det., R.J. Gill, 26 X 1995 (CDFA), no. 1097194; *lantana*, 7(2), all adult ♀♀, La Mesa, San Diego Co., CA, coll., Kellum, Potocki, det., R.J. Gill, 31 I 1996 (CDFA), no. 1041810.

Additional hosts: *Asclepias fruticosa*, *Asclepias* sp., *Bidens pilosa*, *Cajanus cajan*, *Caralluma caudata*, *Caralluma* sp., *Calotropis gigantea*, *Chamaecrista fasciculata*, *C. hyssopifolia*, *C. maculata*, *C. ophthalmica*, *Coleus blumei*, *Crotalaria* sp., *Desmodium tortuosum*, *Dicerandra frutescens*, *Echeveria* sp., *Euphorbia trigona*, *Fraxinus caroliniana*, *Gloxinia sylvatica*, *Hoodia* sp., *Hoya* sp., *Huernia bicampanulata*, *Huernia* sp., *Ilex cassine*, *Indigofera hirsuta*, *Ipomoea carnea*, *Kalanchoe beharensis*, *Megaskepasma erythrochlamys*, *Monarda punctata*, *Nashia inaguensis*, *Pedimelum canescens*, *Piloblephis rigida*, *Portulaca* sp., *Ruellia* sp., *Solanum seaforthianum*, *Solidago* sp., *Stephanotis floribunda*, *Stapelia kavirondo*, *Stapelia* sp., *Steirodiscus chrysanthemoides* (Brain 1920, Russell 1941, Stumpf & Lambdin 2000c).

Description:

Body (Fig. a) pear-shaped, widest in spiracular area, 1666 (1020-2540) long, 1216 (660-1720) wide, with small anal indentation. Derm membranous with large 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form mostly single row, but with double row between spiracular furrows, and anteriad and posteriad of spiracular furrows, row with 291 (201-467) pores, terminates about 4 pore lengths before apex of abdomen; all pores bent, each 13.2 (10.3-14.9) long, 7.9 (5.7-10.3) wide. Other pores arranged in 9 (7-10) transverse bands with medial pore clusters, width of bands 2-5 pores, each 14.0 (12.6-16.7) long, 8.6 (8.0-9.8) wide; without minute pores.

Simple disk pores (Fig. c) evenly distributed, consisting of 160 (40-428) pores, and with marginal row close to marginal 8-shaped pores, row with 112 (82-160) pores, each 2.4 (1.7-2.9) in diam.

Tubular ducts (Fig. d) numerous throughout derm, each 33.8 (27.6-40.2) long, 3.4 (2.3-4.6) wide.

Anal lobes (Fig. e) with small indentation, sclerotized ventrally; each anal lobe with one apical seta 83.1 (64.4-92.0) long, one subapical seta 23.9 (17.2-28.7) long, one dorsal seta 11.9 (5.7-19.0) long, one inner ventral seta 4.7 (3.4-7.5) long, one medial ventral seta 5.5 (3.4-6.9) long, and one outer ventral seta 6.5 (4.6-9.2) long.

Arched plate (Fig. e) semicircular, 68.9 (51.7-89.7) wide.

Anal plates (Fig. e) fused, anvil-shaped, 30.7 (13.8-44.8) long, same width as arched plate.

Anal ring (Fig. e) located between arched plate and anal plate, divided medially, anal ring 28.1 (14.9-39.1) long, 41.6 (34.5-51.7) wide; with 2 rows of pores, inner row with 8 (6-12), outer with 20 (14-26) pores; with 6 setae, each 80.0 (57.5-94.3) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 143.5 (114.9-185.1), width 132.6 (103.4-185.1).

Labium (Fig. a) heart-shaped, 60.8 (44.8-69.0) long, 71.3 (50.6-98.9) wide; with 2 (1-3) pairs of slender setae, each 4.6 (2.5-6.3) long.

Antennae (Fig. f) one-segmented, 13.7 (6.9-27.6) long, 15.2 (11.5-20.7) wide at base; with 2 (2-3) fleshy setae 14.6 (8.0-21.8) long, and 5 (2-8) slender setae 5.8 (4.0-8.6) long.

Spiracles (Fig. g) located between medial and marginal area; anterior 62.2 (50.6-74.7) long, 32.8 (27.6-40.2) wide, atrium 14.8 (11.5-17.2) in diam.; posterior 63.6 (52.9-77.0) long, 32.2 (25.3-41.4) wide, atrium 14.3 (11.5-17.2) in diam.; with 7 (3-14) quinquelocular pores in sclerotized folds around atria; anterior spiracular furrows with a band of 75 (32-124) quinquelocular pores, 3 (2-4) pores wide; posterior furrows with a band of 80 (40-135) quinquelocular pores, 3 (2-4) pores wide; both furrows 5-6 pores wide close to margin.

8-shaped pores (Fig. h) in a submarginal band with 240 (96-600) pores; also in a row with 5 (2-9) pores on each side of mouthparts, and with several pores distributed loosely over venter, each 3.6 (2.9-4.0) long, 2.5 (2.3-3.4) wide.

Simple disk pores (Fig. i) restricted to submarginal row, consisting of 85 (60-120) pores; same size as dorsal pores.

Quinquelocular pores (Fig. j) in a marginal band 1 pore wide at anterior and posterior end, 2 pores wide between and outside of spiracular furrows and 3 pores wide where spiracular furrows meet margin, band with 509 (226-950) pores, marginal band interrupted for 28 (0-78) marginal 8-shaped pore lengths anteriorly and terminates 21 (9-37) 8-shaped pore lengths before apex of abdomen, and with 4 (0-7) pores between margin and antennae; each 3.1 (2.3-3.4) in diam.

Multilocular pores in spiracular furrows and in marginal band (Fig. k), only a few pores present; very rarely with incomplete abdominal row consisting of 2 pores; and with 3 complete bands around genital opening (Figs. l, m), each with 6 (2-13), 5 (8-27), and 12 (5-18) pores, respectively; each 8 (7-10) loculi and 7.6 (6.9-8.6) in diam.; multilocular pore shape unique.

Setae (Fig. n) with 3-4 segmental rows around genital opening corresponding to 3-4 bands of multilocular pores, each with 2 (0-4) setae; each 3.7 (1.7-6.9) long; also submarginal row with 16 (10-26) setae, each 5.7 (4.6-6.9) long.

Biological data: No data available.

Parasitoids and predators: No data available.

Distribution: CA, FL; Colombia, Puerto Rico; Kenya, South Africa; originally described from South Africa, but distributed to New World with exotic plant material.

Economic importance: This species is a serious pest on a variety of host plants in Florida (Stumpf & Lambdin 2000c).

Diagnosis: With three transverse abdominal bands of multilocular pores on venter around vulva, occasionally with additional 4th row, edges of locular plates in pores fringed; simple disk pores on venter in submarginal row.

Affinities: The genus *Planchonia* is at the base of the pit scale clade, and is closely related to *Asterolecanium quaesitum*.

Species questionable for the New World:

***Planchonia fimbriata* (Fonscolombe), 1834**

Proposed Common Name: Fringed Pit Scale

Coccus fimbriatus Fonscolombe, 1834:209; Signoret, 1868:515. *Asterolecanium fimbriatum* Cockerell, 1897a:327; Fernald, 1903:50; Russell, 1941:91; Habib, 1943:87; Tranfaglia, 1974:55, 57. *Planchonia fimbriata* Signoret, 1870:283; Maskell, 1894:61, 1895a:20, 1895c:135; Craw, 1896:43. *Planchonia fimbrinata* Martin Mateo, 1984:64.

Notes: The only record of this species from the New World is from Craw (1896) who writes "This interesting scale was found upon climbing plants from Mexico, presumably from Mazatlan. The waxy test and fringe of this scale resembles *Asterolecanium pustulans*, Cockerell." This description and the accompanying photo cannot be used to identify the species. It leaves the strong possibility that not *Pl. fimbriata*, but another species, possibly *Pl. arabidis*, was found. There are numerous

records for *Pl. arabidis* in North America (see description). Because Craw's findings have not been confirmed, *Pl. fimbriata* is not included in this work.

Genus *Russellaspis* Bodenheimer, 1951

Russellaspis Bodenheimer, 1951:328; Borchensius, 1960:156, 1961:65; Morrison & Morrison, 1966:177; Kozar & Walter, 1985:80.

Type species: *Asterodiaspis pustulans* Cockerell, 1892c:143, by original designation.

Asterolecanium Ferris, 1955:15; Beardsley, 1966:497; Castel-Branco, 1971:27; C.I.E., 1984:1; Bennett & Alam, 1985:12; Miller, 1985:105, 1996:69. *Asterodiaspis* Kosztarab, 1996:287.

Generic description and diagnosis:

see *Russellaspis pustulans*, the only species present in the Americas. Bodenheimer (1951) erected the genus *Russellaspis* based on Russell's (1941) morphological categories. However, in a cladistic analysis, *Ru. pustulans* clusters at the base of the subfamily Asterolecaniinae, but still inside the genus *Asterolecanium*. These results are not conclusive due to the lack of morphological characters in adult pit scales. Therefore, future research including more species of the genus *Russellaspis* and the use of a greater number of characters (e.g., by taking advantage of modern techniques such as DNA sequencing or by the use of all instars) may show a synonymy of *Russellaspis* with *Asterolecanium*.

***Russellaspis pustulans* (Cockerell), 1892**

Common Name: Oleander Pit Scale

Fig. 51

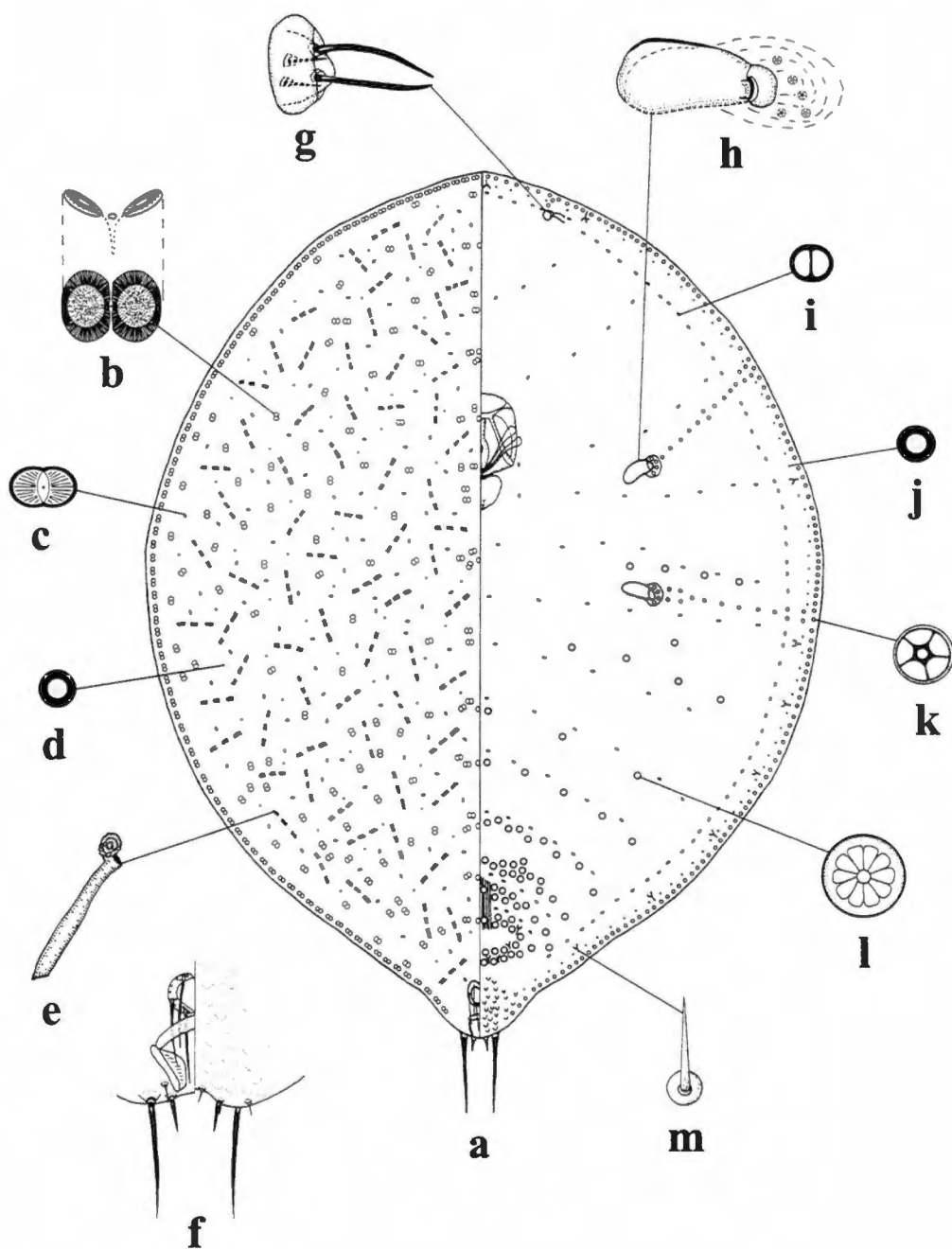


Fig. 51. *Russellaspis pustulans* (Cockerell), 1892.

Planchonia fimbriata Cockerell, 1892a:334, 1892b:55. *Asterodiaspis pustulans* Cockerell, 1892c:143; Kosztarab, 1996:292. *Planchonia pustulans* Cockerell, 1893a:77, 1893b:8, 1893c:255; Maskell, 1895c:135; Craw, 1896:43. *Asterolecanium pustulans* Cockerell, 1895a:306, 1896:8, 1897a:327, 1902b:251, 1903:112; Hempel, 1900:409; King, 1902:404; Fernald, 1903:53; Green, 1910:5; Ballou, 1912:109; Ehrhorn et al., 1913:300; Hall & Debski, 1918:11, 12, 13, 15, 16, 18, 19, 21, 22, 23, 24, 31, 33; Timberlake, 1919:217, 1924:425; Brain, 1920:111; Fullaway, 1920:240, 1946:159; MacGillivray, 1921:189; Ferris, 1921:72, 1955:25; Wilson, 1921:21; Dozier, 1926:100, 101, 1933:87, 96; Wolcott, 1936:122, 1941:57, 1948:161, 1953:229, 1958:511; Hunt, 1939:555; Silvestri, 1939:688; Bianchi, 1940:386; Russell, 1941:165; Habib, 1943:87, 1957:374; Hargreaves, 1948:36; Zimmerman, 1948:279; Merrill, 1953:116; Reyne, 1961:123; Hinckley, 1963:30; Gentry, 1965:14, 64, 112, 123; Beardsley, 1966:500; D'Araujo e Silva et al., 1968:133; Yinon, 1969:141; Dean & Schuster, 1970:158; Swirski & Arenstein, 1970:13; Castel-Branco, 1971:27; El-Minshawy et al., 1971:441; Herting, 1972:136; Salama & Hamdy, 1974:200; Bruner et al., 1975:23, 35, 37, 38, 57, 70, 98, 118, 120, 137, 143, 145, 146, 162, 165, 170, 174, 181, 187, 197, 199, 205, 208, 212, 213, 217, 226, 244, 272, 276, 278, 284, 285, 328, 337; Hamon, 1977:1; C.I.E., 1984:1; Bartlett, 1978:47; Chang et al., 1982:2; Bennett & Alam, 1985:12; Miller, 1985:106, 1996:69; Devnath, 1986:27; Borges Soto et al., 1988:92; Ben-Dov, 1990:98; Williams & Watson, 1990:196; Jansen, 1995:134. *Asterolecanium pustulans* var. *sambuci* Cockerell, 1903:112; Sanders, 1906:3; Hall, 1922:4; Bodenheimer, 1924:73; Bodenheimer & Theodor, 1929:104; Carmin, 1956:15. *Asterolecanium pustulans* var. *seychellarum*

Green, 1910:3, 5; Sasscer, 1911:62; Mamet, 1938:239. *Asterolecanium pustulans* var. *brachylenae* Brain, 1920:plates VII, VIII. *Asterolecanium sambuci* Alfieri, 1929:8. *Asterolecanium morini* Mamet, 1937:176. *Russellaspis pustulans* Bodenheimer, 1951:328; Borchsenius, 1960:154; MacGregor Loaeza, 1974:82; Kozar & Walter, 1985:80. *Asterolecanium pustulans* var. *princeps* Castel-Branco, 1971:31.

Type material: On oleander, 3(1), cotypes, all adult ♀♀, Kingston, Jamaica, Coll., Ckll., (USNM).

Additional material studied: On *Yucca elephantipes*, 2(2), all adult ♀♀, FL, Coral Gables, coll., J.E. Deisler, labeled L-262, 25 VI 1979 (FSCA); *Malus* sp., 2(2), all adult ♀♀, FL, Fort Pierce, coll., E.W. Campbell, 3 VIII 1979 (FSCA); *Pentas lanceolata*, 4(4), all adult ♀♀, FL, Coconut Creek, Broward Co., coll., N. Regalado, 30 XII 1988 (FSCA); *Kigelia pinnata*, 2(2), all adult ♀♀, FL, N. Miami, coll., M. Corman, 19 XII 1977 (FSCA); *Nerium oleander*, 2(2), all adult ♀♀, FL, Miami, coll., G. Hoffman, labeled K-695, 3 III 1977 (FSCA); *Befaria racemosa*, 2(2), all adult ♀♀, FL, Port St. Lucie, coll., E.W. Campbell, 21 XI 1978 (FSCA); *Malus communis*, 3(3), all adult ♀♀, FL, Florida City, coll., W.E. Wyles, 10 X 1977 (FSCA), no. K-770; *Blighia sapida*, 3(3), all adult ♀♀, FL, Miami, coll., H. Gwin, 3 X 1979 (FSCA); *Dovyalis hebecarpa*, 3(3), all adult ♀♀, FL, Titusville (Campus), coll., K. Hibbard, 2 II 1989 (FSCA); *Cupaniopsis anacardioides*, 2(2), all adult ♀♀, FL, Fort Lauderdale, coll., Coy B., 2 XII 1993 (FSCA); *Nerium*, 4(2), all adult ♀♀, Aruba, coll., P.D., leg., T. Putters, 18 VI 1998 (UT), no. 98805975; *Pyrus malus*, 6(3), all adult ♀♀, La Union (Valle), Colombia, colls., F. Mosquero, H. Martin, 6 VIII 1971 (UT), no. 71-13465-69; *Lindenia rivalis* (Rubiaceae),

13(6), all adult ♀♀, waterfall of Hacienda Ciruelas, 28 km N.W. Cañas, Costa Rica, coll., M. Kosztarab, 23 I 1970 (USNM), no. C-656.

Additional hosts: Russell (1941) reported this species from 46 different host plant families. Hosts include *Abutilon* sp., *Acacia arabica*, *A. decurrens*, *A. farnesiana*, *A. lebbek*, *Acacia* sp., *Acer* sp., *Achras sapota*, *Agave* sp., *Albizia lebbek*, *Allamanda nerifolia*, *Alternanthera* sp., *Amygdalus communis*, *Anona muricata*, *A. reticulata*, *A. squamosa*, *Anona* sp., *Artocarpus artilis*, *Baryxylum africanum*, *Bauhinia champinii*, *B. fortificata*, *Bauhinia* sp., *Bignonia speciosa*, *Boehmeria nivea*, *Bombax malabaricum*, *Bougainvillea spectabilis*, *Bougainvillea* sp., *Brassica oleracea*, *Bryophyllum* sp., *Butea frondosa*, *Caesalpinia* sp., *Cajanus indicus*, *Calocarpum mammosum*, *Calotropis* sp., *Camellia sinensis*, *Capania edulis*, *Capsicum frutescens*, *Carica papaya*, *Carissa edulis*, *C. grandiflora*, *Caryota* sp., *Casimiroa tetromeria*, *Cassia alata*, *C. fistulosa*, *C. grandis*, *Cassia* sp., *Castilloa* sp., *Casuarina equisetifolia*, *Cecropia* sp., *Ceiba pentandra*, *Ceratonia siliqua*, *Cestrum nocturnum*, *Chalcas exotica*, *Chrysophyllum caissita*, *Clusia rosea*, *Coffea arabica*, *Colubrina ferruginos*, *Conocarpus erectus*, *Cordia mixa*, *Crataegus* sp., *Crotalaria* sp., *Croton* sp., *Cupania edulis*, *C. macrophylla*, *Cydonia oblonga*, *Cydonia* sp., *Daedalacanthus* sp., *Dioscorea* sp., *Dombeya wallachi*, *Duranta* sp., *Eriobotria* sp., *Erythrina glauca*, *Erythrina* spp., *Erythroxylon coca*, *Eucalyptus* sp., *Euphorbia pulcherrima*, *Euphorbia* sp., *Fevillea* sp., *Ficus carica*, *F. infestoria*, *F. nitida*, *F. pedunculata*, *F. religiosa*, *F. sycomorus*, *Ficus* sp., *Flacourtia catafracta*, *F. ramontchi*, *Gossypium* sp., *Grevillea robusta*, *Grevillea* spp., *Guazuma tomentosa*, *Hedera helix*, *Heliotropium arborescens*, *Hevea brasiliensis*, *Hevea* sp., *Hibiscus*

mutabilis, *H. esculentes*, *H. rosae*, *H. rosa-sinensis*, *H. syriacus*, *Hibiscus* sp., *Inga vera*,
Ipomoea sp., *Jacaranda* sp., *J. mimosaeifolia*, *Jacobinia mohintli*, *Jasminum sambac*,
Jasminum sp., *Kalanchoe* sp., *Kigelia aethiopica*, *Lantana* sp., *Leucaena glauca*, *L.*
leucocephala, *Lycopersicum* sp., *Magnolia* sp., *Malachra* sp., *Malus pumila*, *Mangifera*
indica, *Mangifera* sp., *Manihot* sp., *Manilkara zapotilla*, *Manilkara* sp., *Melia azederach*,
Melocactus sp., *Mommordica balsaminal*, *Montezuma speciosissima*, *Morinda citrifolia*,
Morus nigra, *M. alba*, *Morus* spp., *Murraya paniculata*, *Nerium* spp., *Ochroma lagopus*,
O. pyramidale, *Olea europaea*, *Orthosiphon stamineus*, *Passiflora quadrangularis*, *P.*
edulis, *P. edulis* var. *flavicarpa*, *P. vitifolia*, *Passiflora* sp., *Pedilanthus* sp., *Pelargonium*
odoratissimum, *Pelargonium* sp., *Pentas carnea*, *Peothus carnea*, *Persea* sp., *Pirus*
malus, *Pitheolobium* sp., *Pittosporum tobira*, *Pittosporum* sp., *Plectrum minthus*,
Plumeria sp., *Poinciana* sp., *Porana paniculata*, *Prosopis* sp., *Prunus armeniaca*, *P.*
domestica, *P. persica*, *Prunus* sp., *Psidium guajava*, *Psychotria* sp., *Pyrus communis*, *P.*
cydoniae, *Quisqualis indica*, *Rapanea guianensis*, *Robinia pseudacacia*, *Rosa* sp.,
Russelia juncea, *Salix* sp., *Sambucus* sp., *Sapium* sp., *Sapota achras*, *Sciacassia siamea*,
Sedum sp., *Sesbania aegyptiaca*, *Sida antillensis*, *S. rhombifolia*, *Solanum* sp.,
Stephanotis floribunda, *Tamarinda* sp., *Taonabo stahlil*, *Sterculia* sp., *Tamarindus*
indica, *Tecomas grandis*, *T. mithii*, *Tephrosia toxicara*, *Theobroma cacao*, *Thespesia*
populnea, *Tipuana speciosa*, *Tragia volubilis*, *Trema* sp., *Vachellia farnesiana*, *Vanda*
teres, *Viburnum tinus*, *Vitis vinifera*, *Xantophyllum* sp., *Xiburnum tinus*, *Zanthoxylum*
flavum, and *Zizyphus* spp. (Alfieri 1929; Ballou 1912; Beardsley 1966; Bennett & Alam
1985; Bodenheimer 1924; Borges Soto et al. 1988; Bruner et al. 1975; Castel-Branco

1971; Chang et al. 1982; Cockerell 1892a, b, c, 1893a, 1895a, 1896, 1903; D'Araujo e Silva et al. 1968; Dean & Schuster 1970; Devnath 1986; Dozier 1933; Ferris 1921; Fullaway 1946; Gentry 1965; Green 1910; Habib 1943, 1957; Hall 1922; Hall & Debski 1918; Hamon 1977; Hargreaves 1948; Hinckley 1963; Hunt 1939; Jansen 1995; King 1902; Mamet 1937; Merrill 1953; Reyne 1961; Russell 1941; Salama & Hamdy 1974; Swirski & Arenstein 1970; Williams & Watson 1990; Wilson 1921; Wolcott 1936, 1941, 1948, 1953, 1958; Zimmerman 1948).

Description:

Body (Fig. a) subcircular, widest in area of metathoracic spiracles, 933 (660-1250) long, 806 (320-1200) wide, with very small anal indentation. Derm membranous with 2 sizes of 8-shaped pores, simple disk pores, and tubular ducts on dorsum.

Dorsal Surface

8-shaped pores (Fig. b) on margin form single row, sometimes with a few pores in a short double row, all pores bent, row with 199 (160-229) pores and terminates 4-5 pore lengths before apex of abdomen; each 10.5 (9.2-12.6) long, 6.7 (5.7-8.0) wide.

Other pores with 2 different pore sizes: large pores bent, arranged in 13 (12-14) transverse rows with medial clusters, and sometimes with a few more irregular rows without medial clusters; minute pores (Fig. c) evenly distributed over dorsum; large pores 13.2 (11.5-16.1) long, 8.7 (8.0-10.3) wide, minute pores 2.4 (2.3-2.9) long, 1.4 (1.1-1.7) wide.

Simple disk pores (Fig. d) evenly distributed over dorsum, consisting of 96 (30-140) pores, each 1.8 (1.7-2.3) in diam.

Tubular ducts (Fig. e) numerous throughout derm, each 24.5 (20.7-28.7) long, 3.3 (2.3-3.4) wide.

Anal lobes (Fig. f) with very small indentation, ventral surface heavily sclerotized; each anal lobe with one apical seta 78.2 (69.0-88.5) long, one subapical seta 11.6 (9.2-12.6) long, one dorsal seta 9.5 (6.9-11.5) long, one inner ventral seta 5.0 (3.4-6.9) long, one medial ventral seta, 5.4 (4.6-5.7) long, and one outer ventral seta, 7.6 (6.9-8.6) long.

Arched plate (Fig. f) length 29.9 (23.0-35.6).

Anal plates (Fig. f) separated, 18.8 (16.1-22.4) long.

Anal ring (Fig. f) located anterior of arched plate, divided medially, anal ring 11.8 (8.0-16.1) long, 16.7 (9.2-20.1) wide; with 2 rows of pores inner row with 6, outer with 14 pores; with 6 setae each seta 34.7 (28.9-37.9) long.

Ventral Surface

Clypeolabral shield (Fig. a) length 104.1 (89.7-118.3), width 94.0 (86.2-103.4).

Labium (Fig. a) heart-shaped, 40.6 (25.3-55.2) long, 54.8 (47.1-60.9) wide, with 2 (1-3) pairs of setae, each 3.5 (1.7-5.7) long.

Antennae (Fig. g) one-segmented, 13.8 (8.0-18.4) long, 14.3 (10.3-18.4) wide at base; with 2 fleshy setae 13.2 (11.5-14.9) long, and 2 slender setae 2.7 (2.3-3.4) long.

Spiracles (Fig. h) located between medial and marginal area; anterior 42.4 (39.7-46.0) long, 16.1 (13.2-21.8) wide, atrium 8.3 (5.7-11.5) in diam.; posterior 42.2 (33.3-51.7) long, 16.6 (12.6-25.3) wide, atrium 9.0 (6.9-12.6) in diam.; with 4 (3-5) quinquelocular pores in folds around atria; anterior spiracular furrows with a band of 18

(12-23) quinquelocular pores, 1 (1-3) pores wide; posterior furrows with a band of 18 (11-23) quinquelocular pores, 1 (1-3) pores wide.

8-shaped pores (Fig. i) in a submarginal row with 124 (69-165) pores, each 2.6 (2.3-2.9) long, 1.8 (1.7-2.3) wide; dark-rimmed pores in several transverse rows with 113 (60-184) pores, and a row of 3 (1-5) pores on each side of mouthparts, each 2.0 (1.7-2.3) long and wide.

Simple disk pores (Fig. j) in a submarginal row close to marginal quinquelocular pores, consisting of 133 (88-159) pores, same size as dorsal disk pores.

Quinquelocular pores (Fig. k) in spiracular furrows and in a marginal row with 241 (175-290) pores, row ends together with marginal 8-shaped pores before apex of abdomen, and with 3 (2-5) pores between margin and each antenna, each 3.2 (2.9-3.4) in diam.

Multilocular pores (Fig. l) with 3 incomplete rows on metathorax and anterior abdomen, consisting of 8 (6-10), 2 (0-8), and 8 (0-12) pores, respectively, an occasional row of 2 to 4 pores on prothorax, and with 7 complete bands of pores around genital opening on abdomen; each band with 6 (4-14), 10 (8-25), 18 (13-33), 28 (17-33), 22 (16-33), 16 (12-25), and 18 (13-21) pores, respectively; each 10 (10-11) loculi and 4.8 (4.0-5.7) in diam.

Setae (Fig. m) with 2-3 segmental rows around genital opening corresponding to 2-3 complete bands of multilocular pores, each row with 2 (2-4) setae, posterior row with 6 (2-6) setae, each 6.4 (3.4-8.0) long; also forming submarginal row with 18 (12-20) setae, each 6.8 (4.6-8.0) long.

Biological data: Habib (1943) conducted a detailed study on the biology and bionomics of this important pest. He reported the insect to be found between the 10°C winter isotherm and the 32°C summer isotherm which corresponds to a 100% death rate in eggs at 32.2°C. The oleander pit scale has three generations in Egypt. It prefers relative humidities over 70%. An average of 128 eggs/female was observed with a range from 66 to 192. However, on average only 50 to 60 eggs actually hatched. The average life span of a female in Egypt was determined to be 80 (73-87) days. El-Minshawy et al. (1971) observed an average of 113.13 eggs/female on peach tress and 90.33 eggs/female on fig trees in winter in Egypt, and 194.73 eggs/female on fig trees in summer. Salama & Hamdy (1974) confirmed the presence of 3 generations for Egypt and found the optimal temperature range to be 23-25.3°C.

Parasitoids and predators: Cockerell (1893a) reported a mite, chalcid, and an encyrtid from Jamaica, but did not give any identifications. Timberlake (1919) and Fullaway (1920) listed the encyrtids *Tomocera californica* Howard as a parasitoid and *Quaylea aliena* Timberlake as a hyperparasitoid of the oleander pit scale from Hawaii. Timberlake (1924) mentioned *Tomocera ceroplastis* (Encyrtidae) from Hawaii, which had apparently been introduced by Koebele from China. Dozier (1926) described two new encyrtid species, *Mercetiella reticulata* (Encyrtidae) and *Euaphycus portoricensis* (Encyrtidae), as parasitoids from Puerto Rico, and listed *T. californica* from Hawaii. Later, he reported *Marietta busckii* (Howard) (Aphelinidae) from Puerto Rico and *E. portoricensis* from Haiti (Dozier 1933). The presence of *T. californica* in Hawaii was confirmed by Bianchi (1940). Wolcott (1936, 1953) reported the encyrtids *M. reticulata*

and *E. portoricensis*, the aphelinid *Aspidiotiphagus citrinus* Craw, and the imported coccinellid *Chilocorus cacti* L. from Puerto Rico. After about 15 years of complete control of the oleander pit scale by the lady beetle, *Ru. pustulans* appeared again, coinciding with the disappearance of *C. cacti*, supposedly because of the previous control success and the subsequent lack of scales to feed on (Wolcott 1958). Habib (1943) found *Eublemma gayneri* Rothschild (Noctuidae), *Karnyothrips flavipes* Jones and *Haplothrips cahirensis* Trybom (both species in order Thysanoptera) as possible predators and *Enargopelta* sp. (Encyrtidae) as parasitoids in Egypt. Zimmerman (1948) and Williams & Watson (1990) reported *T. californica* from Hawaii. D'Araujo e Silva et al. (1968) documented the coccinellids *Scymnus* sp. and *Coccidophilus citricola* Brèthes feeding on the scale. Yinon (1969) reported *Chilocorus bipustulatus* (L.) (Coccinellidae) as a predator of *Ru. pustulans*. Predaceous mites, *Cheletogenes ornatus*, were reported by Dean & Schuster (1970). However, they may have been feeding on plant feeding mites. Castel-Branco (1971) documented the encyrtids *Alaptus boriquensis*, *Aspidiotiphagus citrinus*, *E. portoricensis*, *M. reticulata*, *Quaylea wittieri*, and *T. californica* from Sao Tomé e Principe. Herting (1972) listed *H. cahirensis*, *K. flavipes*, *C. cacti*, and *E. gayneri* as predators of the oleander pit scale, *E. portoricensis*, *M. reticulata*, *Aphytis mytilaspidis* Le Baron (Aphelinidae), *A. citrinus*, and *Scutellista* sp. (Pteromalidae) as parasitoids, and *Marietta exitiosa* Compere (Aphelinidae) as a possible hyperparasitoid. Bartlett (1978) described the use of *C. cacti* and *Metaphycus* sp. (Encyrtidae) against this pest. Devnath (1986) reported the fungus *Aschersonia* sp. to attack the oleander pit scale on tea in India.

Distribution: The oleander pit scale was first described in Jamaica on oleander. However, this plant may not be the original host. The European Mediterranean river flora is the native home of the oleander plant. Longo et al. (1994) do not list the oleander pit scale in their comprehensive report on the Italian scale insect fauna. This species may therefore have originated in the New World, the place of its original description. It can now be found worldwide in tropical and subtropical climates. The oleander pit scale has been reported from CA, FL, HI, LA, MD, TX, VA; Anguilla, Antigua, Bahamas, Barbados, Bermuda, Brazil, British Guiana, Colombia, Costa Rica, Cuba, Curacao, Dominica, Dominican Republic, Ecuador, El Salvador, Galapagos Islands, Grenada, Guadeloupe, Guyana, Haiti, Honduras, Jamaica, Lesser Antilles, Mexico, Montserrat, Netherlands Antilles, Nevis, Nicaragua, Panama, Peru, Puerto Rico, St. Kitts, St. Lucia, St. Thomas, St. Vincent, Trinidad, Venezuela, Virgin Islands; Aldabra Islands, Brunei, Caroline Islands, Comoro Islands, Cyprus, East Africa, Egypt, Fiji, French Polynesia, Gabon, Guam, India, Irian Jaya, Israel, Italy, Kenya, Kiribati, Madagascar, Malawi, Malta, Marianas Islands, Marshall Islands, Mauritius, Micronesia, Mozambique, New Caledonia, New Guinea, Oman, Pakistan, Palestine, Papua New Guinea, Principe, Rodriguez Islands, Sandwich Islands, Sao Tomé e Príncipe, Saudi Arabia, Seychelles, Sierra Leone, Society Islands, South Africa, Sri Lanka, Taiwan, Tanganyika, Tanzania, Tuvalu, UK, Western Samoa, West Indies, Yemen, and various subtropical and tropical islands.

Economic importance: In 1940, Bianchi reported that *Ru. pustulans* was not found on crops of economic importance in Hawaii. However, the oleander pit scale can

severely damage a wide variety of host plants (Devnath 1986, Russell 1941, Wolcott 1953). It settles on the stems, green shoots, stalks of the leaves, mid-ribs, and sometimes on the fruits (Habib 1943). Host plants may die in case of a heavy infestation. Death or severe injury as a result of an infestation was shown by Chang et al. (1982) for the Giant leucaena tree, *Leucaena leucocephala* (Lam.).

Diagnosis: With submarginal row of simple disk pores on venter; with tentorial sclerotization on clypeolabral shield.

Affinities: In the cladistic analysis, *Ru. pustulans* clusters inside *Asterolecanium*. Further research may show the relationships of the oleander pit scale to other species of the same genus and to the genus *Asterolecanium*, and may therefore challenge the validity of the genus.

CHAPTER VI

PHYLOGENETIC ANALYSIS OF ADULT FEMALES

OF THE SUBFAMILY ASTEROLECANIINAE

One of the more fascinating aspects of the Asterolecaniinae is the extensive reduction in the number of morphological characters as well as the characters themselves. However, this character reduction poses a serious threat to a successful phylogenetic analysis. In this study, a cladistic analysis was performed using PAUP (Swofford 1993). Only adult females were available for the analysis. The following characters and character states were used:

- [1] Caudal tube: 0 = absent; 1 = present
- [2] Antenna: 0 = several segments; 1 = 1 segment
- [3] Antenna indented: 0 = no; 1 = yes
- [4] Clypeolabral shield with additional tentorial arm: 0 = no; 1 = yes
- [5] Additional tentorial arm arch-shaped: 0 = no; 1 = yes
- [6] Lateral clypeal sulcus: 0 = present; 1 = absent
- [7] Labial setae: 0 = present; 1 = absent
- [8] Spiracles long and slender, *Palmaspis* type: 0 = no; 1 = yes
- [9] Spiracles completely enveloped in dorsal folds, *Planchonia* type: 0 = no; 1 = yes
- [10] Anal dorsal setae: 0 = present; 1 = absent
- [11] Position of apical setae: 0 = apical or slightly dorsal; 1 = ventral
- [12] Subapical setae: 0 = present; 1 = absent
- [13] Anal ventral setae: 0 = 3 pairs; 1 = 2 pairs; 2 = 1 pair; 3 = 0 pairs
- [14] Arched plate: 0 = present; 1 = absent
- [15] Anal plates: 0 = fused; 1 = separated; 2 = absent
- [16] Anal plates fused, anvil-shaped: 0 = no; 1 = yes
- [17] Anal ring setae: 0 = 8 setae; 1 = 6 setae; 2 = 4 setae; 3 = 2 setae; 4 = setae absent; 5 = anal ring absent
- [18] Anal ring circular, *Asterolecanium* type: 0 = yes; 1 = no
- [19] Anal ring circular, plate-like: 0 = no; 1 = yes
- [20] Anal ring triangular, *Asterodiaspis* type: 0 = no; 1 = yes
- [21] Anal ring plate-like: 0 = no; 1 = yes
- [22] Anal ring in 2 connected plates: 0 = no; 1 = yes
- [23] Anal ring in 2 separated plates: 0 = no; 1 = yes
- [24] Anal ring absent: 0 = no; 1 = yes

- [25] Anal lobes sclerotized ventrally: 0 = yes; 1 = no
- [26] Large dorsal 8-shaped pores: 0 = present; 1 = absent
- [27] Marginal 8-shaped pores: 0 = band on dorsum and venter; 1 = dorsal band; 2 = dorsal row; 3 = absent
- [28] Large dorsal 8-shaped pores bent: 0 = yes; 1 = no
- [29] Marginal 8-shaped pores flat, *Asterodiaspis* type: 0 = no; 1 = yes
- [30] Marginal 8-shaped pores long and thin, *Palmaspis* type: 0 = no; 1 = yes
- [31] Simple disk pores: 0 = on venter and dorsum; 1 = in submarginal row; 2 = on dorsum only
- [32] Submarginal row of simple disk pores on venter only: 0 = no; 1 = yes
- [33] Simple disk pores in ventral and dorsal submarginal rows: 0 = no; 1 = yes
- [34] Tubular ducts in longitudinal bands: 0 = no; 1 = yes
- [35] Ventral submarginal bilocular pores: 0 = band; 1 = extension of transverse bands; 2 = row
- [36] Marginal quinquelocular or trilocular pores: 0 = absent; 1 = strongly reduced row; 2 = row; 3 = band
- [37] Marginal pores: 0 = mainly quinquelocular; 1 = mainly trilocular
- [38] Pores in spiracular furrows: 0 = mainly quinquelocular; 1 = mainly trilocular
- [39] Segmental multilocular pores: 0 = present; 1 = absent
- [40] Segmental multilocular pore loculi : 0 = 5-12 loculi; 1 = only 5 loculi
- [41] No. of multilocular pore bands: 0 = 5 or more bands; 1 = 4 or fewer bands
- [42] No. of multilocular pores: 0 = more than 74; 1 = fewer than 60
- [43] Row of ventral submarginal setae: 0 = complete; 1 = incomplete

All characters were treated as unordered. Due to the limited number of characters, only previously described species were used in the analysis. Table 1 gives the distribution of character states for all included species. PAUP excluded character 2, antennal segments, and character 23, anal ring forming two separate plates, from the analysis, because in both cases one of the two character states was scored only once. Additionally, character 27, the presence of large dorsal 8-shaped pores, exhibited character state 3 only once, but was not excluded from the analysis. The original data matrix included more species than shown here.

Table 1 continued.

Character	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	4	4			
<i>Palmaspis boliviae</i>	0	1	1	0	0	0	1	0	1	0	0	1	2	-	3	1	0	0	1	0	0	0	0	2	0	0	2	0	0	1	2	2	1	0	0	0	1	0	
<i>Palmaspis bondari</i>	0	1	1	0	0	0	1	0	1	0	0	2	1	2	-	2	1	0	0	0	1	0	0	1	2	0	0	1	2	0	0	1	2	2	1	0	0	1	0
<i>Palmaspis degenerata</i>	0	1	1	0	0	0	1	0	1	0	0	3	1	2	-	3	1	1	0	0	0	0	0	1	2	0	0	2	0	0	2	2	1	0	0	1	1	0	
<i>Palmaspis difficilis</i>	0	1	1	0	0	1	0	1	0	0	2	1	2	-	3	1	0	0	1	0	0	0	0	2	0	0	2	0	0	2	3	1	0	0	1	0	1	0	
<i>Palmaspis distincta</i>	0	1	1	0	0	1	0	1	0	0	2	1	2	-	4	1	0	0	0	1	0	1	0	2	0	0	1	2	0	0	2	2	1	0	0	0	0	0	
<i>Palmaspis gilva</i>	0	1	1	0	0	0	1	0	1	0	1	2	1	2	-	5	1	0	0	0	0	1	1	2	0	0	1	2	0	0	1	2	2	1	1	-	-	1	
<i>Palmaspis inlabefacta</i>	0	1	1	0	0	0	1	0	1	1	2	1	2	-	5	1	0	0	0	0	1	1	2	0	0	0	2	0	0	2	2	0	0	0	0	0	1	0	
<i>Palmaspis inusitata</i>	0	1	1	0	0	0	?	1	0	0	0	1	1	2	-	5	1	0	0	0	0	1	1	2	0	0	0	2	0	0	2	2	0	0	0	1	1	1	
<i>Palmaspis pallida</i>	0	1	1	0	0	1	0	1	0	0	1	1	2	-	2	1	0	0	0	1	0	0	1	1	2	0	0	1	2	0	0	2	2	1	0	0	1	0	
<i>Palmaspis palmae</i>	0	1	1	0	0	0	1	0	1	0	1	2	1	2	-	3	1	1	0	0	0	0	0	2	0	0	2	0	0	2	2	1	0	0	0	1	0		
<i>Palmaspis sabalis</i>	0	1	1	0	0	1	0	1	1	1	1	1	2	-	4	1	0	0	1	0	0	1	1	2	0	0	1	2	0	0	2	2	1	1	0	0	0	1	
<i>Palmaspis similis</i>	0	1	1	0	0	0	1	0	1	0	0	3	1	2	-	3	1	0	0	0	0	0	1	2	0	0	0	2	0	0	2	2	1	1	0	0	1	0	
<i>Palmaspis truncata</i>	0	1	1	0	0	1	0	1	1	1	2	1	2	-	2	1	0	0	0	1	0	0	1	1	2	0	0	1	2	0	0	1	2	2	1	0	0	0	1
<i>Palmaspis urichi</i>	0	1	1	0	0	0	1	0	1	0	0	2	1	2	-	3	1	0	0	1	0	0	0	2	0	0	2	0	0	2	2	1	0	1	-	-	-	0	
<i>Planchonia arabis</i>	0	1	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	1	0	1	3	0	0	0	0
<i>Planchonia stentae</i>	0	1	1	1	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	1	1	0	1	3	0	0	0	1	0
<i>Russellaspis pustulans</i>	0	1	1	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	2	0	0	0	1	1	0	2	2	0	0	0	0	0	0	0	0

0, 1, 2, 3, 4, 5: character states; -: character not applicable; ?: character not known.

Because of the lack of characters, species were excluded from the analysis, which led to the subsequent removal of two characters from the analysis considered uninformative by PAUP.

In addition to the 37 known species of Asterolecaniinae in the genera *Asterodiaspis*, *Asterolecanium*, *Bambusaspidis*, *Neoasterodiaspidis*, *Palmaspidis*, and *Planchonia*, *Grammococcus adetocorymbus* was also included in the analysis. Matile-Ferrero (1996) mentioned the presence of green translucent tests for *Grammococcus*. These tests, the distribution of pores and ducts, and anal area characters clearly define this genus as belonging to the subfamily Asterolecaniinae, and therefore, justify its inclusion in the analysis. Because *Gr. corymbus* scored identical for all character states, it was excluded from the test. The families Cerococcidae and Lecanodiaspididae are considered to be the closest relatives to the Asterolecaniidae (Ben-Dov 1990; Foldi 1995, 1997a; Foldi & Lambdin 1995; Hodgson 1997; Kosztarab 1996; Lambdin & Kosztarab 1977; Miller 1990; Miller & Hodgson 1997; Miller & Williams 1993). Many similarities in the arrangement of ducts, pores, setae, and anal area characters exist among the three pit scale families. Therefore, the genera *Cerococcus* and *Lecanodiaspidis* were chosen as outgroups for the analysis. Because the phylogenetic relationships among species of these two genera are not clearly delineated, no particular species were chosen as outgroups (Table 1). Instead, a typical character state arrangement for both genera was deduced from Howell & Kosztarab (1972) and Lambdin & Kosztarab (1977). Most characters were scored unanimously for all species. If a character varied among species of *Cerococcus* or *Lecanodiaspidis*, the more complete character state was chosen for the analysis (e.g.,

number of anal setae not reduced). This decision was made on the assumption of a general tendency toward character reduction in the pit scales, e.g., a less reduced character is more primitive than a reduced one. The six recently described species of the subfamily Asterolecaniinae not available for study (*Palmaspis elvae*, *Pa. jesseniae*, *Pa. longifila*, *Pa. loretoensis*, *Pa. marfil*, and *Pa. ucayali*) and genera outside of the Asterolecaniinae (e.g., *Mycococcus*, *Mycetococcus*, *Sclerosococcus*, *Pollinia*) were not included in the analysis, because the general lack of characters in the adult females necessitated a reduction in species to be tested. Additionally, the phylogenetic position of some genera, such as *Mycetococcus* or *Pollinia*, is not clearly understood (Borchsenius 1960, Ferris 1955, Koteja 1976). In many morphological characters, the Asterolecaniinae may have more in common with the genera *Cerococcus* and *Lecanodiaspis* than with the other genera currently placed in the family Asterolecaniidae. These characters include the anal plates and the arched plate in the anal area, and the arrangement of ducts and pores over the derm. These similarities justify the use of *Cerococcus* and *Lecanodiaspis* as outgroups for the phylogenetic analysis.

The analysis with PAUP was performed as a heuristic search with one tree held at each step during stepwise addition using tree-bisection-reconnection (TBR) branch-swapping. The 40 shortest trees found were retained with a length of 129 steps. Tree one is shown as a cladogram (Fig. 52) with the following statistics:

consistency index (CI) = 0.43,
homoplasy index (HI) = 0.57,
CI excluding uninformative characters = 0.42,
HI excluding uninformative characters = 0.58,

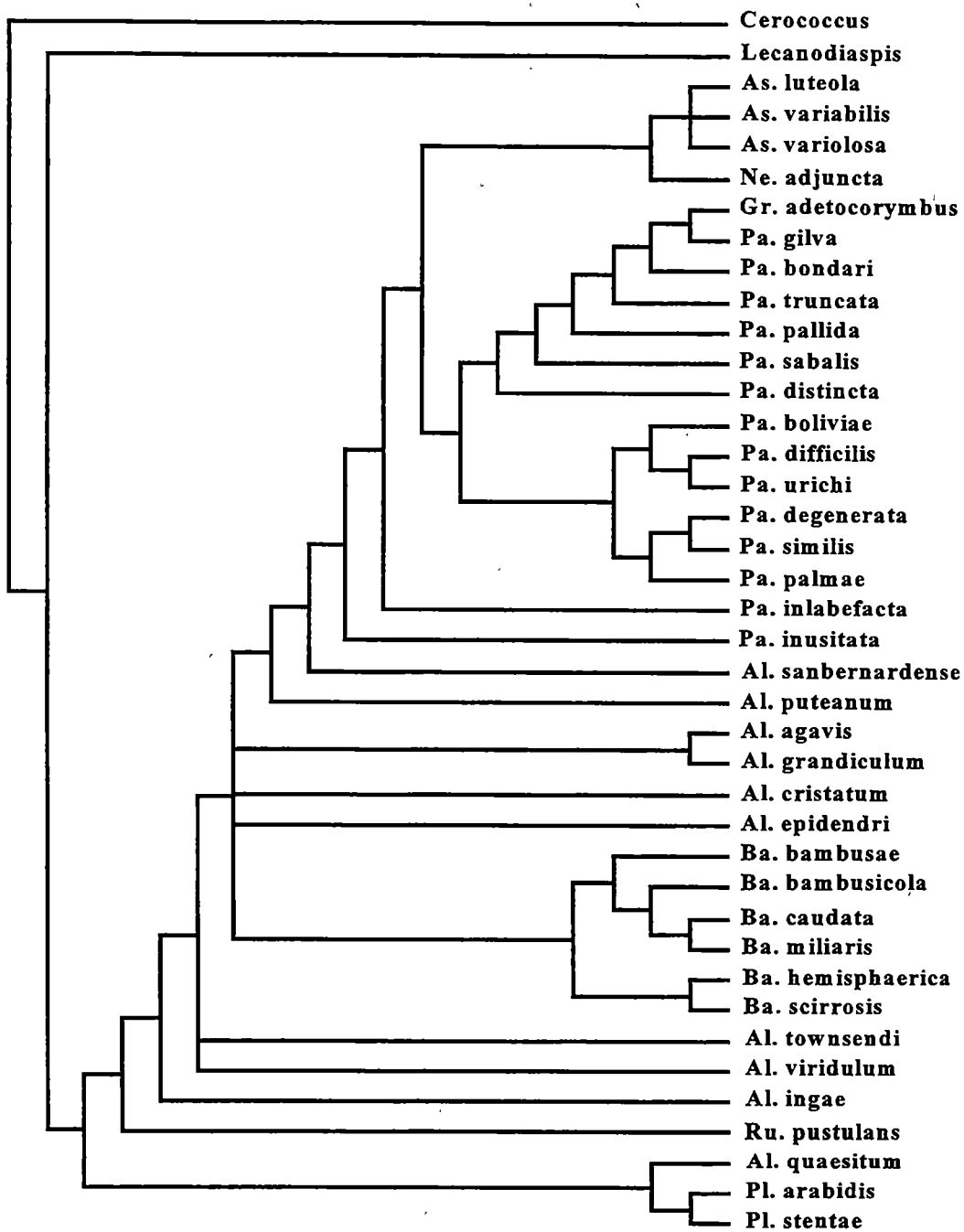


Fig. 52. Tree 1 of 40 most parsimonious trees. Tree length = 129, CI = 0.43, HI = 0.57, CI excluding uninformative characters = 0.42, HI excluding uninformative characters = 0.58, RI = 0.77, RC = 0.33. *Cerococcus* and *Lecanodiaspis* are used as outgroups.

retention index (RI) = 0.77,
and rescaled consistency index (RC) = 0.33.

The strict consensus tree is presented as a cladogram in Fig. 53. The following statistics were derived from the strict consensus tree:

component information (consensus fork) = 26 (normalized = 0.684),
Nelson-Platnick term information = 345,
Nelson-Platnick total information = 371,
Mickey's consensus information = 0.447,
Colless weighted consensus fork (proportion max. information) = 0.476,
Schuh-Farris levels sum = 4625 (normalized = 0.468),
Rohlf's CI(1) = 0.725,
and Rohlf's -ln CI(2) = 114.259 (CI(2) = 2.39e-50).

The statistics for Fig. 52 and Fig. 53 show that the data are not well explained by the phylogenetic trees. However, the low number of characters (43) available for this analysis made it impossible to derive a better estimate of phylogenetic relationships. Indices used in the analysis are explained by Swofford (1991, 1993) and Rohlf (1982). Two types of analytical procedures were performed to indicate branch support for the strict consensus tree. The first analytical procedure included two bootstrap analyses in PAUP (Swofford 1993) resulting in the same tree topology, but with slightly different support values. The first bootstrap analysis was performed with 100 bootstrap replicates and 10 random addition replicates for each bootstrap replicate. The second bootstrap analysis included 1000 bootstrap replicates without random addition replicates. Because both analyses yielded the same result, the greater of the two support numbers for each clade is depicted in a cladogram. Bootstrap numbers are shown in the strict consensus tree (Fig. 53) above the horizontal line indicating each clade of the ingroup. Only bootstrap values equal to or greater than 50% are presented.

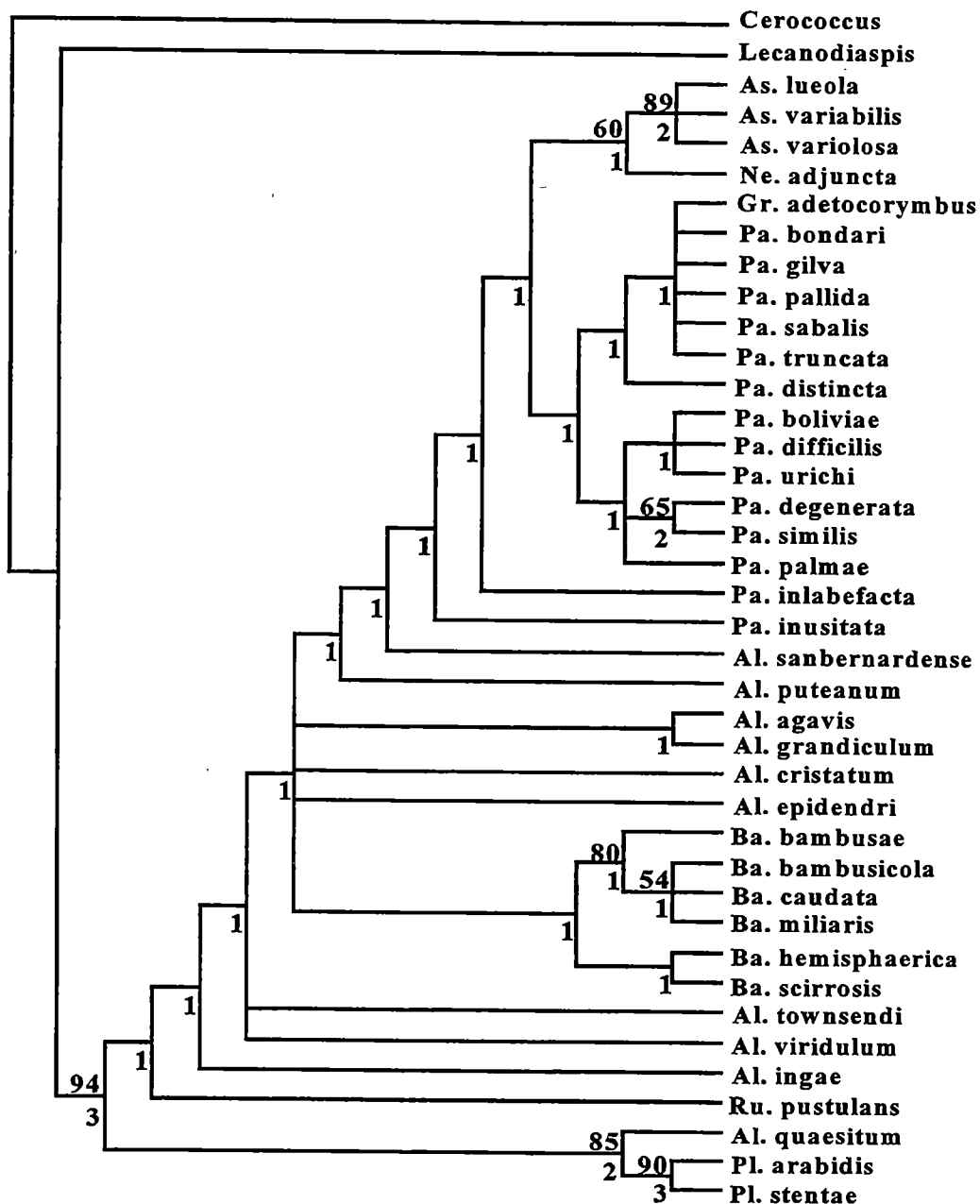


Fig. 53. Strict consensus tree of 40 most parsimonious trees (cladogram). Numbers above branches indicate bootstrap support, numbers below branches show decay values. Only bootstrap values 50% or greater are presented. *Cerococcus* and *Lecanodiaspis* are used as outgroups.

The main difference of the bootstrap analyses to the general heuristic analysis was the presence of *Ba. scirrosis* in the clade including the genera *Asterodiaspis*, *Grammococcus*, and *Palmaspis*. This difference may be explained by the large number of characters (12) defining *Ba. scirrosis* (Fig. 54), which shares several characters with the *Asterodiaspis*-*Grammococcus*-*Palmaspis* clade. The second analytical procedure was a decay analysis performed with TreeView (Page 1996) and PAUP. Decay indices of the ingroup are presented below the horizontal line indicating each clade in the strict consensus tree (Fig. 53).

The strict consensus tree was transferred into Mac-Clade (Maddison & Maddison 1992). Characters supporting each individual clade are presented in a phylogram (Fig. 54) depicting branch lengths. The numbers for each branch correspond to the list of characters presented above and the character numbers in Table 1.

Because of their use as outgroups, the analysis cannot establish which of the two genera *Lecanodiaspis* and *Cerococcus* is more closely related to the *Asterolecaniinae*. PAUP lets the user choose how to present the outgroup in the cladogram. Figs. 51 and 52 present the two outgroups as being paraphyletic to the ingroup. The phylogram generated by Mac-Clade (Fig. 54) only presents the relationships of the ingroup taxa. The literature either recognizes a clade *Lecanodiaspididae*-*Asterolecaniidae* as the sister group of the *Cerococcidae* (Foldi 1997a) or concludes that *Cerococcidae* and *Lecanodiaspididae* together form the sister group of the *Asterolecaniidae* (Miller & Williams 1993, Miller & Hodgson 1997, and Hodgson 1997).

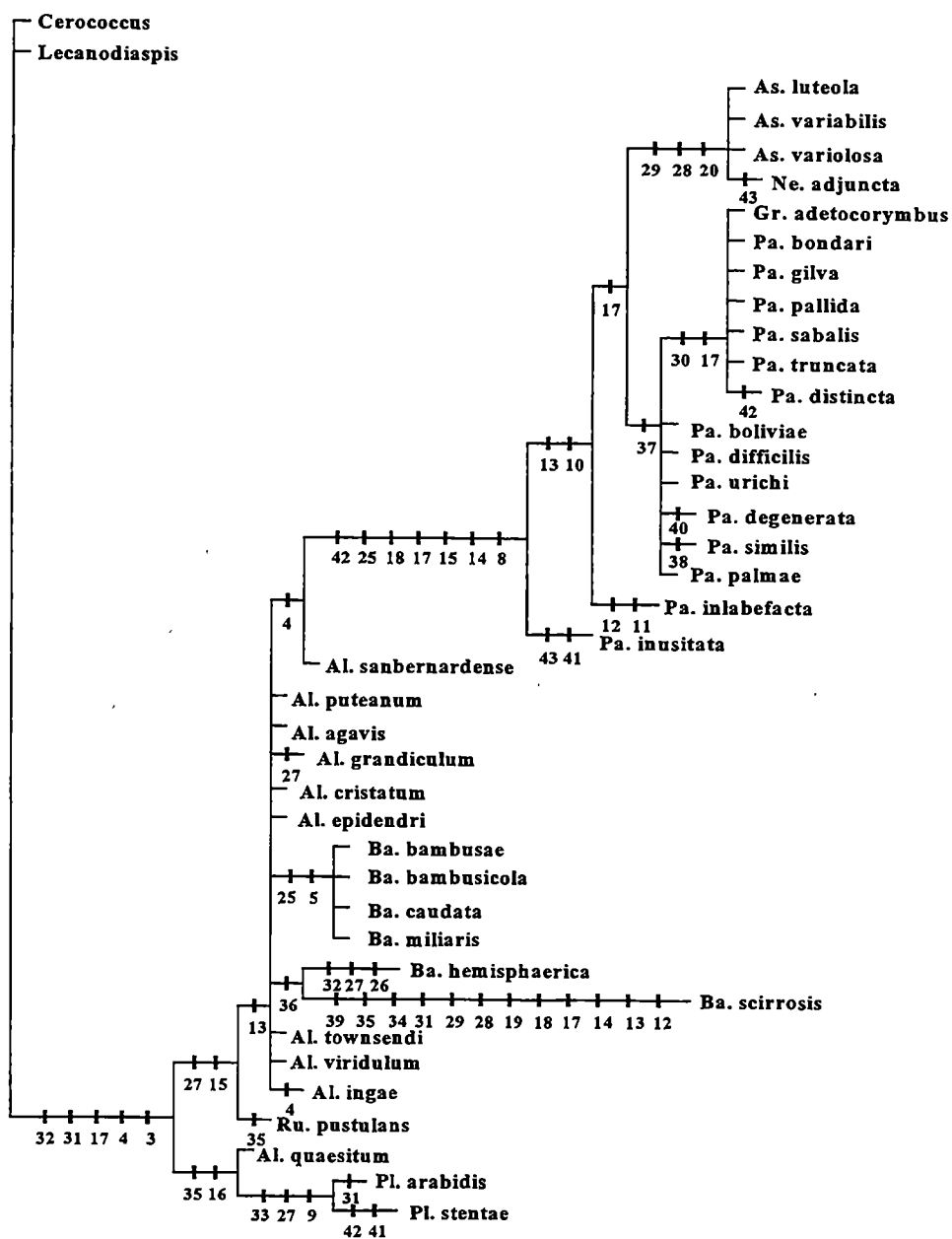


Fig. 54. Strict consensus tree of 40 most parsimonious trees (phylogram). Branch lengths indicate the number of characters supporting each clade. Numbers shown on each branch depict the characters contributing to branch support (numbers correspond to list in text and Table 1). *Cerococcus* and *Lecanodiaspis* are used as outgroups.

The picture that emerges from a close inspection of the ingroup *Asterolecaniinae* supports Russell's (1941) suspicion over splitting the genus *Asterolecanium*. She introduced 12 groups based on morphological and host plant characters without giving them official status. Borchsenius (1950c, 1960, 1961) and Bodenheimer (1951) then elevated these groups to the generic level. The cladistic analysis of adult females (Figs. 51, 52, 53) clearly indicates the genus *Asterolecanium* to be paraphyletic. The basic split into the clades *quaesitum-arabidis-stentae* and the rest of the *Asterolecaniinae* is well supported (Fig. 53, bootstrap value = 94, decay index = 3). The position of *Al. quaesitum* and of both species of *Planchonia* in the cladogram also shows a high level of bootstrap and decay index support (Fig. 53, bootstrap values = 85 and 90, decay indices = 2 and 3, respectively). However, most of the other clades do not show any bootstrap support and only have a decay value of one. The genera *Russellaspis* and *Bambusaspis* seem to be part of a basal group of species within *Asterolecanium*. The genus *Bambusaspis* is split into two groups, from which the clade *bambusae-bambusicola-caudata-miliaris* is relatively well supported (Fig. 53, bootstrap value = 80, decay index = 1). The agave-feeding species *Al. agavis* and *Al. grandiculum*, both ranging from California to Texas and Mexico, fall together as sister species on the tree (Fig. 53). The clade *Asterodiaspis-Grammococcus-Palmaspis* is clearly delineated by 7 characters (Fig. 54). However, no bootstrap support is available for this clade, because the bootstrap analysis also placed *Ba. scirrosis* within this group. *Ba. scirrosis* is a distinct species delineated by 12 characters from *Ba. hemisphaerica*. The large number of distinctive characters may have led to the inclusion of *Ba. scirrosis* into the *Asterodiaspis-Grammococcus-Palmaspis*

group. *Palmaspis* is paraphyletic in regard to both *Grammococcus* and *Asterodiaspis*, but with low support values (Fig. 53). Only the relationship between *Pa. degenerata* and *Pa. similis* shows at least some support with a bootstrap value of 65 and a decay index of 2 (Fig. 53). The genus *Grammococcus* clusters well inside *Palmaspis* with both genera exclusively feeding on palms. Monophyly of the pit scales on oak represented by the genera *Asterodiaspis* and *Neoasterodiaspis* is relatively highly supported with bootstrap values of 60 for the whole clade and 89 for *Asterodiaspis*, and decay indices of 1 and 2, respectively (Fig. 53). However, this clade also originates within *Palmaspis*.

CHAPTER VII

CONCLUSIONS

Species of the genus *Asterolecanium* present in the New World appear to be native to the region. However, the apparent paraphyly of the genus creates a problem that may not be easy to solve. Genera are erected, because they have one or several characteristic features in common (autapomorphies). Nevertheless, autapomorphies do not tell the author of a new genus from which part of the phylogenetic tree this genus arises. Therefore, problems with paraphylies seem almost unavoidable. The tree presented in Fig. 53 is based on the outgroup criterion and on the assumption of a close relationship of the Cerococcidae and Lecanodiaspididae to the Asterolecaniidae, which is widely accepted in the scientific community (Ben-Dov 1990; Foldi 1995, 1997a; Hodgson 1997; Kosztarab 1996; Lambdin & Kosztarab 1977; Miller 1990; Miller & Hodgson 1997; Miller & Williams 1993). Ornate pit scales and false pit scales generally possess a greater number of pores that are distributed over both venter and dorsum. Therefore, species with many pores, such as *Al. quaesitum*, *Pl. arabidis*, and *Pl. stentae*, appear at the base of the tree (Fig. 53). The genus *Planchonia* stems from the Old World, and was introduced into the U.S. several times (Gill 1993, Stumpf & Lambdin 2000c). Its position at the base of the tree is well supported (Fig. 53). However, the position of *Al. quaesitum* is also well supported. No conclusions can be drawn about the origin of the Asterolecaniinae. Both a New World and an Old World origin with further vicariant events is possible. All pit scale genera worldwide have to be incorporated for a detailed biogeographic analysis. However, it is interesting to see that the three genera

(*Asterolecanium*, *Planchonia*, and *Russellaspis*) (Fig. 53) in the analysis whose members occur on a variety of different host plant families, are also morphologically the most primitive ones, e.g., they generally possess a large number of pores. *Russellaspis pustulans*, the oleander pit scale, is an interesting case, because its origin is not known. It occurs on at least 46 different host plant families (Russell 1941). It is believed to be a native of tropical Central and South America, from where it has spread recently with the tropical plant trade. Each of the other genera that are recognized in the Asterolecaniinae in North and South America can be characterized by an association with a single host plant family or a similar subgroup of a particular family, e.g., *Bambusaspis* on bamboo, *Grammococcus* and *Palmaspis* on palms, and *Asterodiaspis* and *Neoasterodiaspis* on oaks. *Arundinaria gigantea* is the only native species of bamboo in the U.S., while several genera (e.g., *Arundo*, *Bambusa*, *Phyllostachys*) have been introduced from the Old World (Gleason & Cronquist 1991, Radford et al. 1968, Stupka 1989, Wunderlin 1997). Clearly, all previously described species of *Bambusaspis* have been introduced from the Old World (Russell 1941). Not much can be said about the four new species described on "bamboo" or *Bambusa* sp. (*Ba. brasiliensis*, *Ba. mexicana*, *Ba. octocircularis*, and *Ba. tetrasetosa*), other than they have possibly been introduced into the region. However, *Ba. magna* is found on *Guadua* sp., a native bamboo in South America (Gentry 1996). Thus, the origins of the genus *Bambusaspis* are also not clear. The other four genera, *Asterodiaspis*, *Neoasterodiaspis*, *Grammococcus*, and *Palmaspis*, form a monophyletic group, even though this group appears as the sister taxon of *Al. sanbernardense* in the analysis (Figs. 51, 52, 53). The position of the other three genera

clearly defines *Palmaspis* as paraphyletic. With the exception of the basal position of *Pa. inusitata* and *Pa. inlabefacta*, two groups can be recognized. The oak-inhabiting genera *Asterodiaspis* and *Neoasterodiaspis* are closely related to each other (Fig. 53). Future studies based on data presented by Liu & Shi (1990, 1993) may make it necessary to suppress the genus *Neoasterodiaspis* as a morphological variant of *Asterodiaspis*. Both genera have been introduced from the Old World. The golden oak scale, *As. variolosa*, is now distributed worldwide (C.I.E. 1983). The sister taxon of the *Asterodiaspis*-*Neoasterodiaspis* group is split into two clades (Fig. 53). All of the species in these two clades occur on palms. The genus *Palmaspis* is widespread throughout the world wherever palms grow (Russell 1941, Matile-Ferrero 1996). Therefore, only limited conclusions can be drawn about the origin of the genus. However, most species of *Palmaspis* are found in the Neotropical faunal region. None of the species from this region exist anywhere else, as is demonstrated by the new species *Pa. jubae* (not included in the analysis), which only occurs on the Chilean gigantic palm, *Jubaea chilensis*. Therefore, at least some species must have evolved in the New World, or the genus originates from this region. The inclusion of the genus *Grammococcus* into *Palmaspis* (Figs. 51, 52, 53; both species had identical character scores, therefore, only one was used in the analysis) is a typical case for paraphyly. A reduction in many characters is typical for *Grammococcus*, but this genus also shows some unique apomorphies, such as dorsal multilocular pores. It shares these apomorphies with the almost identical genus *Polea* (Lambdin 1977b, 1999) in the Oriental faunal region, which does not occur on palms, and should be considered as the adelphotaxon of *Grammococcus*.

The positions of the other pit scale genera may be clarified by comprehensive studies. Some of them may not belong into either Asterolecaniidae, Cerococcidae, or Lecanodiaspididae, but cluster at the base of the pit scale tree. Genera belonging to this category are: *Callococcus* Ferris, which was placed into the Asterolecaniidae by Ferris (1918). Coles et al. (1988) recently confirmed this view. However, based on published descriptions and illustrations (Coles et al. 1988), *Callococcus* seems to be related to *Pollinia*, and so may actually not belong to any of the three pit scale families. Ferris (1955), Brown & McKenzie (1962), and Gill (1993) placed *Mycetococcus* Ferris in the Asterolecaniidae, but from descriptions and illustrations in Ferris (1955), Brown & Eads (1965), and Gill (1993) can be concluded that it does not belong into the Asterolecaniinae. This genus may actually belong at the base of the three pit scale families. *Pollinia* Targioni-Tozzetti was placed into the Asterolecaniidae by Ferris (1955), Danzig (1967), and Gill (1993), and into the Cerococcinae by Borchsenius (1960, 1961) and Tereznikova (1981). However, adult female morphology does not indicate a close relationship to any of the pit scale families. McKenzie (1958, 1963) and Lambdin (1980) placed the genus *Sclerosococcus* McKenzie into the Asterolecaniidae, but recognized a difference to the other pit scales by "the nature and distribution of its various ducts and pores" (McKenzie 1958). The position of this genus is not clear, but it may not belong to either of the three pit scale families.

Accepting the authors opinions, the following three monotypic pit scale genera are considered to belong to the subfamily Asterolecaniinae: *Abditicoccus* Lambdin & Kosztarab, *Amorphococcus* Green, and *Endernia* Danzig. Each of these three genera

lives completely enclosed inside the host gall. *Abditococcus* occurs on *Acacia* sp. in South Africa (Lambdin & Kosztarab 1975b), while *Amorphococcus* is found on *Mesua ferrea* L. in Sri Lanka (Lambdin & Kosztarab 1975a). *Endernia* lives on oaks in a gall inside plant tissue covered by larval exuviae. Adult females exist without scale cover formation (Danzig 1971, 1986). Her illustrations, especially of the anal ring, clearly indicate a close relationship to the parthenogenetic genus *Asterodiaspis*. However, Danzig (1986) described the presence of male “horny pupae” alongside the main leaf vein, but not the males themselves, which possibly constituted a misidentification of a female leaf form with the male scale cover.

Ferris (1950) described the case of *Hsuia* Ferris to be “hard, glassy, and transparent”, but believed it to be most closely related to *Pollinia*. Borchsenius (1960) placed this genus into the Asterolecaniidae. Based on Ferris’ (1950) illustrations and description, it clearly belongs into the Asterolecaniinae. The same conclusions can be drawn for the genus *Hyalococcus* Borchsenius (Borchsenius 1950c, 1960, 1961; Danzig 1986). The monotypic genus *Liuaspsis* Borchsenius (Borchsenius 1960) occurs on bamboo. It may be related to *Bambusaspis*, but is apparently without caudal tubes. The genus *Polea* Green is very likely the sister taxon of *Grammococcus*, and therefore belongs into the Asterolecaniinae, accepting Borchsenius’ (1961) placement of the genus. It occurs in the Oriental faunal region, and its host plants are not palms, but *Calophyllum*, family Guttiferae, tropical shrubs and trees (Lambdin 1977b, 1999; Heywood 1978). The monotypic genus *Trachycoccus* Borchsenius (Borchsenius 1950c, 1960, 1961) with the type species *Asterolecanium tenax* (Bodenheimer & Theodor 1929) was simply

erected because of the lack of apical setae. The illustrations in Bodenheimer & Theodor (1929) depict it as a member of the genus *Asterolecanium*, or possibly *Planchonia*.

Frenchia Maskell is considered a distinct branch of the family Asterolecaniidae (Lambdin & Kosztarab 1981), and possibly belongs into a separate subfamily. However, Borchsenius (1960) tentatively placed it into the Cerococcinae. Because of its extreme reduction in morphological characters, *Mycococcus* Ferris is hard to place into any group. Ferris (1955) placed it into the Asterolecaniidae, while Borchsenius (1960) included it in the Cerococcinae.

Borchsenius (1961) distinguished three groups in the Asterolecaniinae: (1) *Bambusaspis*, *Planchonia*, *Russellaspis*, *Asterolecanium*, and *Hyalococcus*, (2) *Trachycoccus* and *Hsuia*, (3) *Palmaspis*, *Asterodiaspis*, and *Neoasterodiaspis*. These groups coincide with the cladistic analysis of North and South American genera (Fig. 53). The new genera that were erected after Russell's (1941) monumental work may all eventually fit into the picture of pit scale evolution. However, at the same time these new genera seem to increase the basic problem of paraphyly in the pit scales. A more conclusive analysis of generic formation in pit scales will have to incorporate all genera with as many species as possible on a worldwide basis. Not much is known about the biology, distribution, and morphology of the various instars besides adult females, or even specific host plants in most species. For many species, adult males have never been found, but it is not known whether these species are parthenogenetic or just not sampled well enough. Only slide specimens of a few adult females, collected on research trips or intercepted at a port of entrance, are available for study of many species. For modern

analysis techniques, such as electron microscopy or molecular techniques, fresh material is needed or at least material that has been placed into 95% alcohol immediately after collecting. Only an analysis of all these factors can better elucidate the position of the pit scales in the tree of life.

LIST OF REFERENCES

LIST OF REFERENCES

- Alfieri, A. 1929. Les principaux insectes nuisibles infestant le jardin de Nouzha. (In French). Bull. Soc. R. Entomol. Egypte. 13:7-9.
- Allen, R.P. 1971. *Asterolecanium arabis* (Signoret) (pit making pittosporum scale). In: Insect distribution studies. Pan-Pac. Entomol. 47:16-17.
- Altum, B. 1882. Chapter 7. Ordnung Halbflügler, Hemiptera: 2. Familie. Coccinea, Schildläuse. (In German). In: Forstzoologie, J. Springer. Berlin.361-370.
- Andrianova, N.S. 1960. On some characteristics of the fauna of insects in the forested ravines of the Stalingrad area. (In Russian). Nauch. Dokl. Visshi. Shkoli. Biol. Nauk. 4:13-18.
- Archangelskaya, A.D. 1937. The Coccidae of Middle Asia. (In Russian). Izdat. Komit. Nauk. UZSSR. Tashkent.158pp.
- Balachowsky, A. 1932. Étude biologique des coccides du Bassin Occidental de la Méditerranée. (In French). Encypl. Entomol. ser. A. XV:214+LXXIpp.
- Ballou, H.A. 1912. Insect pests of the Lesser Antilles. Advocate, Bridgetown, Barbados.210pp.
- Banks, H.J. 1990. Physiology and Biochemistry. In: Rosen, D., ed. Armored Scale Insects - Their Biology, Natural Enemies and Control. Elsevier. World Crop Pests, 4A.267-274.
- Bartlett, B.R. 1978. Asterolecaniidae. In: U.S. Dept. Agric., Agric. Handb. 480.46-48.
- Bartlett, K.A. 1938. A search in the Guianas and Trinidad for predatory beetles of the bamboo scale. P.R. Univ. J. Agric. 22:493-495.
- Bartlett, K.A. 1939a. Biological control activities. Rep. P.R. Agric. Exp. Stn.(1938).94-109.
- Bartlett, K.A. 1939b. The collection in Trinidad and Southern Brazil of coccinellids predatory on bamboo scales. Proc. 6th Pac. Sci. Congr. 4:339-343.
- Baxendale, R.W. & W.T. Johnson. 1990. Efficacy of summer oil spray on thirteen commonly occurring insect pests. J. Arboric. 16:89-94.
- Beardsley, J.W. 1966. Insects of Micronesia. Homoptera: Coccoidea. Insects of Micronesia. 6:377-562.

- Ben-Dov, Y. 1990. Classification of diaspidoid and related Coccoidea. In: Rosen, D., ed. Armored Scale Insects - Their Biology, Natural Enemies and Control. Elsevier. World Crop Pests, 4A:97-128.
- Bennett, F.D. & M.M. Alam. 1985. An annotated check-list of the insects and allied terrestrial arthropods of Barbados. Caribbean Agric. Res. Dev. Inst. 81pp.
- Berlese, A. & G. Leonardi. 1898. Notize intorno cocciniglie americane che minacciano la frutticoltura europea. Riv. Patol. Veg. 6:284-352.
- Betts, M.M. 1955. The food of titmice in oak woodland. J. Anim. Ecol. 24:282-323.
- Betts, M.M. 1956. A list of insects taken by titmice in the forest of Dean (Gloucestershire). Entomol. Mon. Mag. 92:68-71.
- Bianchi, F.A. 1940. Annual address: notes on the role of the self-introduced insects in the economic entomology of Hawaii. Proc. Hawaii. Entomol. Soc. 10:377-388.
- Boas, J.E.V. 1898. Dansk Forstzoologi. Nordiske Forlag. Copenhagen. 441pp.
- Bodenheimer, F.S. 1924. The Coccidae of Palestine. First report on this family. Zion. Org. Inst. Agric. Nat. Hist. Agric. Exp. Stn. Bull. 1:100pp.
- Bodenheimer, F.S. 1951. Description of some new genera of Coccoidea. Entomol. Ber. 13:328-331.
- Bodenheimer, F.S. 1952. The Coccoidea of Turkey. Rev. Fac. Sci. Univ. Istanbul. Ser. B. 17:315-351.
- Bodenheimer, F.S. 1953. The Coccoidea of Turkey III. Rev. Fac. Sci. Univ. Istanbul. Ser. B. 18:91-164.
- Bodenheimer, F.S. & O. Theodor. 1929. Ergebnisse der Sinai-Expedition 1927 der hebräischen Universität, Jerusalem. (In German). J.C. Hinrichs'sche Buchhandlung. Leipzig. 141pp.
- Bognar, S. & G. Vinis. 1979. Scale insects in the parks and avenues of Budapest. Acta Agric. Acad. Sci. Hung. 28:13-26.
- Boisduval, J.B.A. 1868a. Les Kermès. (In French). Insect. Agric. 2:84-95.
- Boisduval, J.B.A. 1868b. Conference faite le 18 août par le Dr. Boisduval, au Palais de L'Industrie, sur les insectes qui ont ravagé les plantes exposées par MM. Burel et Rivière. (In French). Insect. Agric. 2:266-283.

- Boisduval, J.B.A. 1868c. Note sur deux coccides nouvelles trouvées par M. Burel dans les serres chaudes à Paris. (In French). Insect. Agric. 2:301.
- Boisduval, J.B.A. 1869. Note sur deux espèces nouvelles de Coccides vivant sur les Bambous cultivés au jardin du Hamma. (In French). Insect. Agric. 3: 260-262.
- Boratynski, K. 1961. A note on the species of *Asterolecanium* Targioni-Tozzetti, 1869 (Homoptera, Coccoidea, Asterolecaniidae) on oak in Britain. Proc. R. Entomol. Soc. London. Ser. B 30:4-14.
- Borchsenius, N.S. 1937a. Tables for the identification of coccids (Coccidae) injurious to cultivated plants and forests in the USSR. (In Russian). Leningrad. 148pp.
- Borchsenius, N.S. 1937b. Coccidae of quarantine value for U.S.S.R. and their allied species. (In Russian). Pl. Quar. Insp. Georgia. Tbilisi. 272pp.
- Borchsenius, N.S. 1950a. A new species of scale insect with 8-shaped pores from Brazil (Insecta, Coccoidea, Asterolecaniidae). (In Russian, Engl. transl. avail.). Dokl. Akad. Nauk. SSSR. Moscow. (N.S.) 70:727-728.
- Borchsenius, N.S. 1950b. Mealybugs and scale insects of USSR (Coccoidea). (In Russian). Akad. Nauk. SSSR. Zool. Inst. Moscow. 32:250pp.
- Borchsenius, N.S. 1950c. Toward the revision of the genus *Asterolecanium* (Targ.) Sign. (Insecta, Homoptera, Coccoidea). (In Russian, Engl. transl. avail.). Dokl. Akad. Nauk SSSR. Leningrad. (N.S.) 71:781-783.
- Borchsenius, N.S. 1959. Notes on the Coccoidea of China. VII. A new family of Coccoidea, Lecanodiaspididae, Fam. n. (Homoptera). The scientific results of the Chinese-Soviet expeditions of 1955-1957. (In Russian). Rev. Entomol. URSS. 38:840-846.
- Borchsenius, N.S. 1960. Fauna of USSR, Homoptera, Kermococcidae, Asterolecaniidae, Lecanodiaspididae, Aclerdidae. (In Russian, Engl. transl. avail.). Akad. Nauk. SSR. Zool. Inst. 8:282pp.
- Borchsenius, N.S. 1961. Some data on the generic classification of Coccoidea of the family Asterolecaniidae (Homoptera, Coccoidea). 11th Internatl. Kongr. Entomol. Wien. 1:63-65.
- Borges Soto, M., D. Pla & L.L. Vazquez Moreno. 1988. El te de rinon (*Orthosiphon stamineus* Benth.), nueva planta hospedante de la guagua de pustula, *Asterolecanium pustulans* Cockerell (Homoptera: Asterolecaniidae). (In Spanish). Fac. Cien. Agric. Univ. Centr. Vill. Santa Clara. 15:91-92.

- Bouché, F.F. 1844. Beiträge zur Naturgeschichte der Scharlachläuse (Coccina). (In German). Stett. Entomol. Z. 5:293-302.
- Bouché, F.F. 1851. Neue Arten der Schildlaus-Familie, beobachtet von J. Fr. Bouché in Berlin. (In German). Stett. Entomol. Z. 12:110-112.
- Boyer de Fonscolombe, E.L.J.H. 1834. Description des Kermes qu'on trouve aux environs d'Aix. (In French). Ann. Soc. Entomol. France. 3:201-218.
- Brain, C.K. 1920. The Coccidae of South Africa-IV. Bull. Entomol. Res. 10:95-128.
- Breakey, E.P. & A.J. Howitt. 1954. Cooperative economic insect report. Plant Pest Contr. Div., Agric. Res. Serv. USDA. 4:227.
- Brick, C. 1909. XI. Bericht über die Tätigkeit der Abteilung für Pflanzenschutz für die Zeit vom 1. Juli 1908-30. Juni 1909. (In German). Jahrb. Hamb. Wiss. Anst. 26:445-464.
- Britton, W.E. 1924. Some of the principal insects attacking shade trees in Connecticut. Bull. Conn. Agric. Exp. Stn. 263:156-170.
- Britton, W.E. 1926. Entomological features of 1927. Bull. Conn. Agric. Exp. Stn. 275:219-231.
- Britton, W.E. 1928. Entomological features of 1925. Bull. Conn. Agric. Exp. Stn. 294:198-209.
- Britton, W.E. 1938. Connecticut State Entomologist thirty-seventh report. Bull. Conn. Agric. Exp. Stn. 408:137-152.
- Brown, L.R. & C.O. Eads. 1965. A technical study affecting the oak tree in Southern California. Calif. Agric. Exp. Stn. Bull. 810:105pp.
- Brown, S.W. & H.L. McKenzie. 1962. Evolutionary patterns in the armored scale insects and their allies (Homoptera: Coccoidea: Diaspididae, Phoenicococcidae, and Asterolecaniidae). Hilgardia. 33:141-171.
- Bruner, S.C., L.C. Scaramuzza & A.R. Otero. 1975. Catalogo de los insectos que atacan a las plantas economicas de luba. (In Spanish). 2da Revis. Autment. Inst. Zool. Acad. Lien Luba. La Habana. 399pp.
- Buhr, H. 1964. *Smicronyx reichi* (Gyll) und weitere Parasiten am Enzian in Thüringen. (In German). Nachr. Bayerischen. Entomol. 13:73-79.

- Carmin, J. 1956. *Nerium oleander* L. Bull. Indep. Biol. Lab. Kefar-Malal. 12:1-20.
- Castel-Branco, A.J.F. 1971. Cochonilhas de S. Tomé e Príncipe. *Asterolecanium pustulans* (Cockerell) e *A. pustulans princeps* nov. var. (Hem. Homoptera). (In Portuguese). EOS. 46:27-36.
- Chang, Y.C., C.C.C. Tao & C.Y. Wong. 1982. Three species of scale insects injurious to "giant" *Leucaena* tree. (In Chinese). Bull. Taiwan. For. Res. Inst. 369:1-8.
- C.I.E. 1983. *Asterodiaspis variolosa* (Ratz.). Commw. Inst. Entomol. Distrib. Map. Pest. Ser. A. 453:1-2.
- C.I.E. 1984. *Asterolecanium pustulans* (Cockerell). Commw. Inst. Entomol. Distrib. Map. Pest. Ser. A. 460:1-2.
- Cockerell, T.D.A. 1892a. List of Coccidae observed in Jamaica. Insect Life. 4:333-334.
- Cockerell, T.D.A. 1892b. Additions to the museum. J. Inst Jam. 1:54-56.
- Cockerell, T.D.A. 1892c. Coccidae of Jamaica. J. Inst Jam. 1:142-143.
- Cockerell, T.D.A. 1893a. A curious group of Coccidae-The Lecanodiaspini. Hardw. Sci. Gos. 29:76-79.
- Cockerell, T.D.A. 1893b. Coccidae, or scale insects.-II. Bull. Bot. Dept. Jam. 40:7-9.
- Cockerell, T.D.A. 1893c. A list of West Indian Coccidae. J. Inst Jam. 1:252-256.
- Cockerell, T.D.A. 1893d. Records of West Indian Coccidae, I. J. Inst Jam. 1:373.
- Cockerell, T.D.A. 1893e. Science notes. J. Inst Jam. 1:382.
- Cockerell, T.D.A. 1894a. Notes on some Trinidad Coccidae. J. Trinidad Field Nat. Club. 1:306-310.
- Cockerell, T.D.A. 1894b. The Coccidae found on ivy (*Hedera*). Entomol. News. 5:210-212.
- Cockerell, T.D.A. 1895a. On a small collection of Coccidae from the island of Grenada. J. Trinidad Field Nat. Club. 2:306-307.
- Cockerell, T.D.A. 1895b. Science notes. Three new scale insects. J. Inst. Jam. 2:167.

- Cockerell, T.D.A. 1895c. Scale insects liable to be introduced into the United States. Garden For. 8:513.
- Cockerell, T.D.A. 1896. Coccidae or scale insects.-VIII. Bull. Bot. Dept. Jam. n.s. 3:8-10.
- Cockerell, T.D.A. 1897a. A check-list of the Coccidae. Bull. Ill. Stn. Lab. Nat. Hist. 4:318-339.
- Cockerell, T.D.A. 1897b. Contributions to coccidology.-II. Americ. Nat. 31:588-592.
- Cockerell, T.D.A. 1899. Some notes on Coccidae. Proc. Acad. Nat. Sci. Phila. 1899:259-275.
- Cockerell, T.D.A. 1900. Some Coccidae quarantined at San Francisco. Psyche. 9:70-72.
- Cockerell, T.D.A. 1902a. New Coccidae from the Argentine Republic and Paraguay. Can. Entomol. 34:88-93.
- Cockerell, T.D.A. 1902b. A catalogue of the Coccidae of South America. Rev. Chil. Hist. Nat. 6:250-257.
- Cockerell, T.D.A. 1902c. The nomenclature of the Coccidae. The Entomol. 35:114.
- Cockerell, T.D.A. 1902d. A contribution to the knowledge of the Coccidae. Ann. Mag. Nat. Hist. Zool. Bot. Geol. 7:450-456.
- Cockerell, T.D.A. 1902e. Some Coccidae from Mexico. Ann. Mag. Nat. Hist. Zool. Bot. Geol. 7:465-472.
- Cockerell, T.D.A. 1903. A new coccid of the genus *Asterolecanium* from Egypt. The Entomol. 36:112.
- Cockerell, T.D.A. 1927. The entomological station at Tashkent, Usbekistan. J. Econ. Entomol. 20:834-836.
- Cohic, F. 1958. Contribution à l'étude des cochenilles d'intérêt économique de Nouvelle-Calédonie et dépendances. (In French). S. Pac. Comm. Tech. P. 116:36pp.
- Coles, R.B., F. Verberne & H.M. Brookes. 1988. The immature and adult stages of *Callococcus leptospermi* (Maskell) (Homoptera: Coccoidea: Asterolecaniidae), with observations on life history. J. Aust. Entomol. Soc. 27:15-25.

- Comstock, J.H. 1881. Report of the Entomologist. Part II. Report on scale insects. Rep. Comm. Agr., U.S. Dept. Agric. 1880:276-349.
- Craw, A. 1896. Injurious insect pests found on trees and plants from foreign countries. Bienn. Rep. Calif. St. Bo. Hort. 5:33-52.
- Danzig, E.M. 1967. Suborder Coccinea - Coccids or mealybugs and scale insects. (Transl. from Russian, Keys to the insects of the European USSR., G. Y. Bei-Bienko, ed., Akad. Nauk. SSSR. Zool. Inst., 1964, Vol. 1). Israel Progr. Sci. Transl. Jerusalem.800-850.
- Danzig, E.M. 1971. Three new species of coccids (Homoptera, Coccoidea) from the Far East. (In Russian, with English abstract). Zool. Zhur. 50:1414-1417.
- Danzig, E.M. 1986. Coccids of the Far-Eastern USSR (Homoptera: Coccinea). Phylogenetic Analysis of Coccids in the World Fauna. (Transl. from Russian, Nauka Pub., Leningrad, 1980). Amerind Pub. Co. New Delhi.450pp.
- D'Araújo e Silva, A.G., C.R. Goncalves, D.M. Galvao, A.J.L. Goncalves, J. Gomes, M. do Nascimento Silva & L. de Simoni. 1968. Insetos, hospedeiros e inimigos naturais. (In Portuguese). Quar. Cat. Ins. Viv Plant Brasil Paras. Pred. II Tom.1:132-134.
- Dean, H.A. & M.F. Schuster. 1970. A pit-making scale, *Asterolecanium pustulans* (Cockerell), on Rio Grande Valley ornamentals. J. Rio Gr. Val. Hort. Soc. 24:158-163.
- DeBach, P. 1962. An analysis of successes in biological control of insects in the Pacific area. Proc. Hawaii. Entomol. Soc. 18:69-79.
- Dekle, G.W. 1963. Puteanum scale (*Asterolecanium puteanum* Russell) (Homoptera: Asterolecaniidae). Entomol. Circ., Florida. Dept. Agric. Cons. Serv. Div. Plant. Ind. 13:1p.
- Della Beffa, G. 1961. Gli insetti dannosi all'agricoltura ed i moderni metodi e mezzi di lotta. Ulrico Hoepli, ed. Milano.1106pp.
- Devnath, S. 1986. A new scale insect *Asterolecanium pustulans* (Asterolecaniidae: Coccoidea) recorded in Darjeeling. Two and a Bud. 33:27-28.
- Doane, R.W. & G.F. Ferris. 1916. Notes on Samoan Coccidae with descriptions of three new species. Bull. Entomol. Res. 6:399-402.
- Douglas, J.W. 1885. Notes on some British Coccidae. Entomol. Mon. Mag. 22:157-160.

- Douglas, J.W. 1886. Notes on some British Coccidae (No. 2). Entomol. Mon. Mag. 22:243-250.
- Douglas, J.W. 1893. Notes on some British and exotic Coccidae. Entomol. Mon. Mag. 25:55-57.
- Dozier, H.L. 1926. Some new Puerto Rican scale parasites (Hymenoptera: Encyrtidae). Proc. Entomol. Soc. Wash. 28:97-102.
- Dozier, H.L. 1933. Miscellaneous notes and descriptions of chalcidoid parasites (Hymenoptera). Proc. Entomol. Soc. Wash. 35:85-100.
- Dziedzicka, A. 1990. The characteristic of scale insects (Coccinea) occurring in Polish greenhouses. Part II. Coccidae. Acta Biol. Cracov. 32:17-27.
- Ehrhorn, E.M. 1913. Report of the Superintendent of Entomology. Rep. Hawaii. Board. Comm. Agric. For. Honolulu. 101-151.
- Ehrhorn, E.M., D.T. Fullaway & O.H. Swezey. 1913. Report of committee on common names of economic insects in Hawaii. Proc. Hawaii. Entomol. Soc. 2:295-300.
- El-Minshawy, A.M., S.K. El-Sawaf, S.M. Hammad & A. Donia. 1971. The biology of *Asterolecanium pustulans* Cockerell in Alexandria district (Homoptera: Asterolecaniidae). Bull. Soc. Entomol. Egypt. 55:441-446.
- Enderlein, G. 1914. III. Coccoidea, Schildläuse. (In German). In: Brohmer, P., Fauna von Deutschland. Ein Bestimmungsbuch unserer heimischen Tierwelt. Quelle & Meyer. Leipzig. 369-370.
- Essig, E.O. 1945. The pit-making pittosporum scale. Bull. Calif. Dept. Agric. 34:134-136.
- Essig, E.O. 1958. Insects and mites of Western North America. Macmillan. New York. 1050pp.
- Farag, A.I., G.E.S. Abo El-Ghar, G.I. Zohdi & A.E. Sand. 1990. Predatory efficiency, development and reproduction of *Agistemus exsertus* on juvenoid-treated scale insects (Acarina, Stigmaeidae -- Homoptera: Coccoidea). In: Proc. 6th Int. Symp. Scale. Insect. Stud., Part II. Agric. Univ. Press. Cracow. 153-156.
- Felt, E.P. & S.W. Bromley. 1937. Holly scale *Asterolecanium*. Bull. Bartlett Tree Res. Lab. 2:20.

- Fernald, M.E. 1903. A catalogue of the Coccidae of the world. Bull. Hatch Exp. Stn. Mass. Agric. Coll. 88:1-360.
- Ferris, G.F. 1918. Notes on Coccidae II. (Hemiptera). Can. Entomol. 50:323-332.
- Ferris, G.F. 1920. Scale insects of the Santa Cruz peninsula. Stanford Univ. Publ. Univ. Ser. Biol. Sci. 1:1-57.
- Ferris, G.F. 1921. Report upon a collection of Coccidae from Lower California. Stanford Univ. Publ. Univ. Ser. Biol. Sci. 1:61-132.
- Ferris, G.F. 1950. Contribution Number 68. Report upon scale insects collected in China (Homoptera: Coccoidea). Part II. Microentomol. 15:69-124.
- Ferris, G.F. 1955. Atlas of the Scale Insects of North America. Vol. VII. The Families Aclerdidae, Asterolecaniidae, Conchaspidae, Dactylopiidae and Lacciferidae. Stanford Univ. Press. Palo Alto. Calif. 233pp.
- Foldi, I. 1981. Ultrastructure of the wax-gland system in subterranean scale insects (Homoptera, Coccoidea, Margarodidae). J. Morphol. 168:159-170.
- Foldi, I. 1990. Internal anatomy. In: Rosen, D., ed. Armored Scale Insects - Their Biology, Natural Enemies and Control. Elsevier. World Crop Pests, 4A.65-80.
- Foldi, I. 1991. The wax glands in scale insects: comparative ultrastructure, secretion, function and evolution (Homoptera: Coccoidea). Ann. Soc. Entomol. France. (N.S.) 27:163-188.
- Foldi, I. 1995. A taxonomic revision of *Limacoccus* Bondar with a cladistic analysis of its relationships with other scale insects (Hemiptera: Coccoidea). Syst. Entomol. 20:265-288.
- Foldi, I. 1997a. Defense strategies in scale insects: phylogenetic inference and evolutionary scenarios (Hemiptera, Coccoidea). In: Grandcolas, P., ed. The origin of biodiversity in insects: phylogenetic tests of evolutionary scenarios. Mem. Mus. Natl. Hist. Nat. 173:202-230.
- Foldi, I. 1997b. Internal anatomy of the adult female. In: Ben-Dov, Y. & C.J. Hodgson, eds. Soft scale insects - Their biology, natural enemies and control. Elsevier, World Crop Pests 7A.73-90.
- Foldi, I. 1997c. Ultrastructure of integumentary glands. In: Ben-Dov, Y. & C.J. Hodgson, eds. Soft scale insects - Their biology, natural enemies and control. Elsevier. World Crop Pests, 7A.91-109.

- Foldi, I. & P. Cassier. 1985. Ultrastructure comparée des glandes tégumentaires de treize familles de Cochenilles (Homoptera: Coccoidea). (In French). *Int. J. Insect Morphol. Embryol.* 14:33-50.
- Foldi, I. & P. Lambdin. 1995. Ultrastructural and phylogenetic assessment of wax glands in pit scales (Homoptera: Coccoidea). *Int. J. Insect Morphol. Embryol.* 24:35-49.
- Foldi, I. & M.J. Pearce. 1985. Fine structure of wax glands, wax morphology and function in the female scale insect, *Pulvinaria regalis* Canard (Hemiptera: Coccidae). *Int. J. Insect. Morphol. Embryol.* 14:259-271.
- Frick, K.E. & R.B. Hawkes. 1970. Additional insects that feed upon tansy ragwort, *Senecio jacobaea*, an introduced weedy plant, in Western United States. *Ann. Entomol. Soc. Am.* 63:1085-1090.
- Friend, R.B. 1930. Miscellaneous insect notes. *Bull. Conn. Agric. Exp. Stn.* 315:614-617.
- Fullaway, D.T. 1920. Natural control of scale insects in Hawaii. *Proc. Hawaii. Entomol. Soc.* 4:237-246.
- Fullaway, D.T. 1946. Insects of Guam-II. Coccidae of Guam. *Bull. B.P. Bishop Mus.* 189:157-162.
- Gaedike, H. 1971. Katalog der in den Sammlungen des ehemaligen Deutschen Entomologischen Institutes aufbewahrten Typen - VI. (Homoptera (exklusive Aphidina)). (In German). *Beitr. Entomol.* 21:315-339.
- Gentry, J.W. 1965. Crop insects of Northeast Africa - Southwest Asia. U.S. Dept. Agric. *Agric. Handb.* 273:210pp.
- Gentry, A.H. 1996. A field guide to the families and genera of woody plants of Northwest South America (Colombia, Ecuador, Peru) with supplementary notes on herbaceous taxa. Univ. Chicago Press. Chicago, IL. 895pp.
- Giliomee, J.H. 1968. Morphology and relationships of the male of an *Asterolecanium* species (Homoptera: Coccoidea: Asterolecaniidae). *J. Entomol. Soc. S. Afr.* 31:297-308.
- Giliomee, J.H. & J. Munting. 1968. A new species of *Asterolecanium* Targ. (Homoptera: Coccoidea: Asterolecaniidae) from South Africa. *J. Entomol. Soc. S. Afr.* 31:221-229.

- Gill, R.J. 1993. Family Asterolecaniidae. In: The scale insects of California. Part 2. The minor families. Calif. Dept. Food Agric. Tech. Ser. Agric. Bios. Pl. Path. 2:96-114.
- Gleason, H.A. & A. Cronquist. 1991. Manual of vascular plants of Northeastern United States and adjacent Canada. N.Y. Botanic. Garden. NY.910pp.
- Gomez-Menor, J. 1940. Coccidos de Espana. (In Spanish). Estac. Fitopat. Agric., Madrid. 2nd ed.432pp.
- Gonzales, R.H. & S.P. Rojas. 1966. Estudio analitico del control biologico de plagas agricolas en Chile. Agric. Tech. 26:133-147.
- Gourlay, E.S. 1935. Parasites of the golden oak scale. The establishment in New Zealand of *Habrolepis dalmanni* Westw. N.Z. J. Sci. Technol. 16:216-235.
- Green, E.E. 1895. Notes on coccids from Kent. Entomol. Mon. Mag. 31:229-233.
- Green, E.E. 1896. Catalogue of Coccidae collected in Ceylon. Ind. Mus. Notes. 4:2-10.
- Green, E.E. 1908. Remarks on Indian scale insects (Coccidae). Part III. With a catalogue of all species hitherto recorded from the Indian continent. Mem. Dept. Agric. India. Entomol. Ser. 11:15-46.
- Green, E.E. 1909. The Coccidae of Ceylon. Part IV. Dulau & Co. London.344pp.
- Green, E.E. 1910. On some Coccid pests of economic importance. J. Econ. Biol. 5:1-8.
- Green, E.E. 1915. Notes on Coccidae collected by F. P. Jepson, Government Entomologist, Fiji. Bull. Entomol. Res. 6:44.
- Green, E.E. 1922a. Supplementary notes on the Coccidae of Ceylon. Part IV. J. Bombay Nat. Hist. Soc.1007-1037.
- Green, E.E. 1922b. A brief review of the indigenous Coccidae of the British Islands. Proc. S. London Entomol. Nat. Hist. Soc. 1922.12-25.
- Green, E.E. 1924. On some new species of Coccidae from various sources. Bull. Entomol. Res. 15:41-48.
- Green, E.E. 1928. A brief review of the indigenous Coccidae of the British Islands, with emendations and additions. Entomol. Rec. J. Var. Suppl. 40:5-14.

- Green, E.E. 1930. Notes on some Coccidae collected by Dr. Julius Melzer, at Sao Paulo, Brazil. (Rhynch.). Stett. Entomol. Z. 91:214-219.
- Habib, A. 1943. The biology and bionomics of *Asterolecanium pustulans* Ckll. (Hemiptera - Coccidea). Bull. Soc. Fouad 1^{er} Entomol. 27:87-111.
- Habib, A. 1957. The Asterolecaniinae of Egypt (Hemiptera-Homoptera: Coccoidea-Coccidae). Bull. Soc. Entomol. Egypte. 41:371-379.
- Hagen, H.A. 1887. The Coccidae in the museum of Comparative Zoology. Cambridge, Mass. Can. Entomol. 19:60.
- Hall, W.J. 1922. Observations on the Coccidae of Egypt. Bull. Min. Agric. Egypt. Tech. Scien. Serv. 22:1-54.
- Hall, W.J. & B. Debski. 1918. Liste des cecidies signalées en Egypte jusqu'à ce jour. Deuxième partie: hotes et leurs cecidies. Mem. Soc. Entomol. Egypte. 11-38.
- Hamon, A.B. 1977. Oleander pit scale, *Asterolecanium pustulans* (Cockerell). (Homoptera: Coccoidea: Asterolecaniidae). Fla. Dept. Agric. & Cons. Serv. Div. Pl. Ind., Bur. Entomol. Contr. No. 481. Entomol. Circ. 184:2pp.
- Hamon, A.B. 1980. Bamboo pit scale, *Asterolecanium bambusae* (Boisduval). (Homoptera: Coccoidea: Asterolecaniidae). Fla. Dept. Agric. & Cons. Serv. Div. Pl. Ind., Bur. Entomol. Contr. No. 481. Entomol. Circ. 220:2pp.
- Hargreaves, H. 1948. List of recorded cotton insects of the world. Commw. Inst. Entomol. London. 50pp.
- Hattingh, V. & M.J. Samways. 1991. Determination of the most effective method for field establishment of biocontrol agents of the genus *Chilocorus* (Coleoptera: Coccinellidae). Bull. Entomol. Res. 81:169-174.
- Hattingh, V. & M.J. Samways. 1992. Prey choice and substitution in *Chilocorus* spp. (Coleoptera: Coccinellidae). Bull. Entomol. Res. 82:327-334.
- Hattingh, V. & M.J. Samways. 1993. Evaluation of artificial diets and two species of natural prey as laboratory food for *Chilocorus* spp. Entomol. Exp. Appl. 69:13-20.
- Hattingh, V. & M.J. Samways. 1995. Visual and olfactory location of biotypes, prey patches, and individual prey by the ladybeetle *Chilocorus nigritus*. Entomol. Exp. Appl. 75:87-98.

- Hecht-Poinar, E.I., L.R. Costello & J.R. Parmeter, Jr. 1989. Twig blight of oaks in California. Calif. Agric. Jan.-Feb. 1989.15-16.
- Hempel, A. 1900. As coccidas brasileiras. (In Portuguese). Rev. Mus. Paulista. Sao Paulo. 4:365-537.
- Hempel, A. 1937. Novas especies de coccideos (Homoptera) do Brasil. (In Portuguese). Arch. Inst. Biol. Sao Paulo. 8:5-36.
- Herbert, F.B. 1936. Insects of Western oaks and their control. Proc. Annu. Meet. West. Sh. Tree Conf. 3:32-43.
- Herting, B. 1972. A catalogue of parasites and predators of terrestrial arthropods. Section A, vol.2. Homoptera. Commw. Inst. Biol. Contr.210pp.
- Heywood, V.H. 1978. Flowering plants of the world. Mayflower Books. N.Y.335pp.
- Hinckley, A.D. 1963. Trophic records of some insects, mites, and ticks in Fiji. Bull. Fiji Dept. Agric. 45:116pp.
- Hodgson, C.J. 1995a. Observations on the structure of the spiracles of adult female Coccidae. Isr. J. Entomol. 29:47-55.
- Hodgson, C.J. 1995b. The possible evolution of the plate-like structures associated with the anal area of lecanoid Coccoidea. Isr. J. Entomol. 29:57-65.
- Hodgson, C.J. 1997. Classification of the Coccidae and related coccoid families. In: Ben-Dov, Y. & C.J. Hodgson, eds. Soft scale insects - Their biology, natural enemies and control. Elsevier. World Crop Pests, 7A.157-201.
- Hollister, W.O. 1920. Distribution of shade tree insects in 1919. J. Econ. Entomol. 13:143-147.
- Howell, J.O. & M. Kosztarab. 1972. Studies on the morphology and systematics of scale insects - no. 5. Morphology and systematics of the adult females of the genus *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). VA. Polytech. Inst. St. Univ. Res. Div. Bull. 70:248pp.
- Howell, J.O. & M.L. Williams. 1976. An annotated key to the families of scale insects (Homoptera: Coccoidea) of America, north of Mexico, based on characteristics of the adult female. Ann. Entomol. Soc. Am. 69:181-189.
- Hunt, H.A. 1939. Plant quarantine. Annu. Rep. Calif. Agric. Exp. Stn. 28:548-566.

- Jansen, M.G.M. 1995. Scale insects (Homoptera: Coccinea) from import interceptions and greenhouses in the Netherlands. *Isr. J. Entomol.* 29:131-146.
- Judeich, J.F. & H. Nitsche. 1895. *Lehrbuch der Mitteleuropäischen Forstinsektenkunde*. Vol. II. (In German). Wien. Hölzel. 1421pp.
- Kawai, S. & Y. Tamaki. 1967. Morphology of *Ceroplastes pseudoceriferus* Green with special reference to the wax secretion. *Appl. Entomol. Zool.* 2:133-146.
- King, G.B. 1899. Contributions to the knowledge of Massachusetts Coccidae.-I. *Can. Entomol.* 31:109-112.
- King, G.B. 1901. The Coccidae of Brithish North America. *Can. Entomol.* 33:193-200.
- King, G.B. 1902. The association of Coccidae. *Psyche.* 9:401-404.
- Kloet, G.S. & W.D. Hincks. 1945. A check list of British insects. Stockport. 483pp.
- Koehler, C.S. & G. Tamaki. 1964. Studies on the distribution of the pit scale *Asterolecanium minus* on oak trees. *Ann. Entomol. Soc. Am.* 57:146-150.
- Komosinska, H. & E. Podsiadlo. 1967. Materials to the fauna of scale insects (Homoptera, Coccoidea) - Steppe reservations in the Nida Valley (South Poland). I. *Bull. Acad. Pol. Sci. Cl. V. Ser. Sci. Biol.* 15:683-686.
- Kosztarab, M. 1959. Biological notes on the scale insects of Hungary. *Ann. Entomol. Soc. Am.* 52:401-420.
- Kosztarab, M. 1977. Status of scale insects of forest trees - on overview (Homoptera: Coccoidea). *J. N.Y. Entomol. Soc.* 85:184-185.
- Kosztarab, M. 1996. Family Asterolecaniidae. In: *Scale insects of Northeastern North America. Identification, biology, and distribution*. VA. Mus. Nat. Hist. Spec. Publ. 3:287-299.
- Kosztarab, M. & F. Kozar. 1978. Scale Insects-Coccoidea. (In Hungarian). In: *Fauna Hungariae*. 17:192pp.
- Kosztarab, M. & F. Kozar. 1988. Family Asterolecaniidae-pit scales. In: *Scale insects of Central Europe*. Akadémiai Kiadó. Budapest. 312-320.
- Kosztarab, M., Y. Ben-Dov & M.P. Kosztarab. 1986. An annotated list of generic names of the scale insects (Homoptera: Coccoidea). 3rd Suppl. *Stud. Morphol. Syst. Scale. Insects* VA. Polytech. Inst. St. Univ. Agric. Stn. Bull. 86-2. 13:38pp.

- Koteja, J. 1974a. Comparative studies on the labium in the Coccinea (Homoptera). Zesz. Nauk. Akad. Rol. Krakov. 89:162pp.
- Koteja, J. 1974b. On the phylogeny and classification of the scale insects (Homoptera, Coccinea) (discussion based on the morphology of the mouthparts). Acta Zool. Cracov. 19:267-326.
- Koteja, J. 1976. The salivary pump in the taxonomy of the Coccinea (Homoptera). Acta Zool. Krakov. 21:263-290
- Koteja, J. 1990. Paleontology. In: Rosen, D., ed. Armored Scale Insects - Their Biology, Natural Enemies and Control. Elsevier. World Crop Pests, 4A.149-163.
- Koteja, J. & E. Liniowska. 1976. The clypeolabral shield in the taxonomy of the Coccinea (Homoptera). Bull. Entomol. Pol. 46:653-681.
- Kotinsky, J. 1910. Coccidae not hitherto recorded from these islands. Proc. Hawaii. Entomol. Soc. 2:127-131.
- Kozar, F., E. Guignard, F. Bachmann, E. Mani & C. Hippe. 1994. The scale insect and whitefly species of Switzerland (Homoptera: Coccoidea and Aleyrodoidea). Mitt. Schw. Entomol. Ges. 67:151-161.
- Kozar, F. & J. Walter. 1985. Check-list of the Palaearctic Coccoidea (Homoptera). Folia Entomol. Hungar. 46:63-110.
- Kuwana, S.I. 1909. Coccidae of Japan (III). First supplemental list of Japanese Coccidae, or scale insects, with description of eight new species. J. N.Y. Entomol. Soc. 17:150-158.
- Kuwana, S.I. 1916. Some new scale insects of Japan. Annot. Zool. Japan. 9:145-153.
- Lagowska, B. & J. Koteja. 1996. Czerwce (Homoptera, Coccinea) Roztocza. (In Polish). Fragm. Faun. 39:29-42.
- Laing, F. 1927. Coccidae, Aphididae and Aleyrodidae. Ins. Samoa. 2:35-45.
- Lambdin, P. 1977a. *Asterolecanium notatum* (Homoptera: Coccoidea: Asterolecaniidae): New species of pit scale on bamboo from the Philippine Islands. Ann. Entomol. Soc. Am. 70:625-627.
- Lambdin, P.L. 1977b. A revision of the genus *Polea* Green (Homoptera: Coccoidea: Asterolecaniidae). Ann. Entomol. Soc. Am. 70:911-915.

- Lambdin, P. 1980. Two new species of pit scales on bromeliads from South America (Homoptera: Coccoidea: Asterolecaniidae). *Ann. Entomol. Soc. Am.* 73:468-471.
- Lambdin, P.L. 1999. New pit scale species of *Polea* (Hemiptera: Asterolecaniidae). *Ann. Entomol. Soc. Am.* 92:188-192.
- Lambdin, P.L. & M. Kosztarab. 1973. Studies on the morphology and systematics of scale insects - no. 5. A revision of the seven genera related to *Lecanodiaspis* (Homoptera: Coccoidea: Lecanodiaspididae). VA. Polytech. Inst. St. Univ. Res. Div. Bull. 83:110pp.
- Lambdin, P.L. & M. Kosztarab. 1975a. A redescription of *Amorphococcus mesuae* Green with notes on its systematic position (Homoptera: Coccoidea: Asterolecaniidae). *Proc. Entomol. Soc. Wash.* 77:376-381.
- Lambdin, P.L. & M. Kosztarab. 1975b. A new genus *Abditicoccus* (Homoptera: Coccoidea: Asterolecaniidae) with a redescription of its type species *A. acaciae* (Brain). *Ann. Entomol. Soc. Am.* 68:316-318.
- Lambdin, P.L. & M. Kosztarab. 1977. Studies on the morphology and systematics of scale insects - no. 10. Morphology and systematics of the adult females of the genus *Cerococcus* (Homoptera: Coccoidea: Cerococcidae). VA. Polytech. Inst. St. Univ. Res. Div. Bull. 128:252pp.
- Lambdin, P.L. & M. Kosztarab. 1981. A revision of the genus *Frenchia* with description of a new species (Homoptera: Coccoidea: Asterolecaniidae). *Proc. Entomol. Soc. Wash.* 83:105-128.
- Landis, B.J. 1968. *Asterolecanium arabidis*, a scale attacking sugar beets. *J. Econ. Entomol.* 61:871-872.
- Leonardi, G. 1908. Seconda contribuzione alla conoscenza delle cocciniglie italiane. *Boll. Lab. Zool. Gen. Agrar. Scuola Super. Agric. Portici.* 3:150-192.
- Leonardi, G. 1920. *Monografia delle Cocciniglie Italiane.* Della Torre. Portici. 555pp.
- Lepage, H.S. 1940. Notas sobre coccideos do Brasil (Com descricao de especie nova) (Homoptera-Coccoidea). (In Portuguese). *Pap. Avul. Dept. Zool.* 1:69-78.
- Lichtenstein, M.J. 1880. Séance du 24 Mars 1880. (In French). *Bull. Soc. Entomol. France.* 45-46.
- Lichtenstein, M.J. 1882. Séance du 12 Avril 1882. (In French). *Bull. Soc. Entomol. France.* 74-75.

- Lindinger, L. 1909. Verzeichnis der aufgeführten Pflanzenschädiger und -schädigungen. (In German). Jahrb. Hamb. Wiss. Anst. 26:464-466.
- Lindinger, L. 1912. Die Schildläuse (Coccidae) Europas, Nordafrikas und Vorderasiens, einschließlich der Azoren, der Kanaren und Madeiras. (In German). Eugen Ulmer. Stuttgart. 379pp.
- Lindinger, L. 1923. Einführung in die Kenntnis der deutschen Schildläuse. (In German). Entomol. Jahrb. 32:138-152.
- Lindinger, L. 1924. Die Schildläuse der mitteleuropäischen Gewächshäuser. (In German). Entomol. Jahrb. 33/34:167-191.
- Lindinger, L. 1934. Die Schildlaus-Arten P. Fr. Bouchés und ihre Deutung. (In German). Entomol. Jahrb. 43:153-169.
- Lindinger, L. 1935. Die nunmehr gültigen Namen der Arten in meinem "Schildlausbuch" und in den "Schildläusen der mitteleuropäischen Gewächshäuser". (In German). Entomol. Jahrb. 44:127-149.
- Lindinger, L. 1936. Über einige Schildläuse des Berliner botanischen Gartens (Coccidae). (In German). Arb. Physiol. angew. Entomol. Berlin-Dahlem. 3:153-155.
- Lindinger, L. 1937. Verzeichnis der Schildlaus-Gattungen (Homoptera-Coccoidea Handlirsch 1903). (In German). Kranch. Entomol. Jahrb. 46:178-198.
- Lindinger, L. 1943. Verzeichnis der Schildlaus-Gattungen, 1. Nachtrag. (Homoptera Coccoidea.). (In German). Z. Wien. Entomol. Ges. 28:205-208.
- Liu, T., M. Kosztarab & M. Rhoades. 1989. 1. Biosystematics of the adult females of the genus *Chionaspis* (Homoptera: Coccoidea: Diaspididae) of North America, with emphasis on polymorphism. Stud. Morphol. Syst. Scale. Insects. VA. Polytech. Inst. St. Univ. Agric. Stn. Bull. 88-2. 15:1-126.
- Liu, Y. & Y. Shi. 1990. Systematic status of *Asterodiaspis* with description of a new species (Homoptera: Asterolecaniidae). Proc. ISSIS-VI. Krakov. 2:85-59.
- Liu, Y. & Y. Shi. 1993. Discussion on the systematic status of the genus *Asterodiaspis* (Homoptera: Coccinea: Asterolecaniidae) with description of a new species. Entomotax. 15:187-188.
- Longo, S., G. Mazzeo & A. Russo. 1994. Le cocciniglie delle piante ornamentali in Italia meridionale. Inform. Fitopatol. 5:15-28.

- Longo, S., S. Marotta, G. Pellizzari, A. Russo & A. Tranfaglia. 1995. An annotated list of the scale insects (Homoptera: Coccoidea) of Italy. *Isr. J. Entomol.* 29:113-130.
- Lowe, V.H. 1897. Inspection of nurseries and treatment of infested nursery stock. *Bull. New York Agric. Exp. Stn.* 136:573-602.
- MacGillivray, A.D. 1921. The Coccidae. Tables for the identification of the subfamilies and some of the more important genera and species, together with discussions of their anatomy and life history. *Scarab. Urbana.* 502pp.
- MacGregor Loaeza, R. 1974. Algunos coccidos de importancia económica en Mexico (Homoptera: Coccoidea). (In Spanish). *Folia Entomol. Mex.* 29:81-82.
- Maddison, W.P. & D.R. Maddison. 1992. Mac-Clade: Analysis of phylogeny and character evolution. Vers. 3.0. Sinauer. Sunderland. 398pp.
- Mamet, R. 1937. New species of Coccidae (Hemipt. Homopt.) from Mauritius. *Proc. R. Entomol. Soc. London. Ser. B.* 6:173-176.
- Mamet, R. 1938. On two coccids recently described from Mauritius (Hem.). *Proc. R. Entomol. Soc. London. Ser. B.* 8:238-239.
- Mamet, R. 1957. On some Coccoidea from Reunion island (Homoptera). *Mém. Inst. Scient. Madag. Ser. E. Tome VII.* 367-386.
- Marchal, M.P. 1904. Sur quelques cochenilles nouvelles. (In French). *Bull. Mus. Natl. Hist. Nat.* 10:448-459.
- Marlatt, C.L. 1899. Temperature control of scale insects. *Proc. 11th Annu. Meet. Assoc. Econ. Entomol. U.S. Dept. Agric. Div. Entomol. Bull.* 20:73-76.
- Martin Mateo, M.P. 1984. Inventario preliminar de los coccidos de España. II. Asterolecanidae, Kermococcidae, Coccidae y Aclerdidae. (In Spanish). *Graellsia.* 40:63-79.
- Maskell, W.M. 1882. Further notes on Coccidae in New Zealand, with descriptions of new species. *Trans. Proc. New Zeal. Inst.* 14:215-229.
- Maskell, W.M. 1884. Further notes on Coccidae in New Zealand, with descriptions of new species. *Trans. Proc. New Zeal. Inst.* 16:120-144.
- Maskell, W.M. 1887. An account of insects noxious to Agriculture and plants in New Zealand. The scale-insects (Coccidae). *St. For. Agric. Dept. Wellington.* 116pp.

- Maskell, W.M. 1894. Remarks on certain genera of Coccidae. *The Entomol.* 27:44-46, 93-95, 166-168.
- Maskell, W.M. 1895a. Synoptical list of Coccidae reported from Australia and the Pacific Islands up to December 1894. *Trans. Proc. New Zeal. Inst.* 27:1-35.
- Maskell, W.M. 1895b. Art. II.- Further coccid notes: With description of new species from New Zealand, Australia, Sandwich Islands, and elsewhere, and remarks upon many species already reported. *Trans. Proc. New Zeal. Inst.* 27:36-75.
- Maskell, W.M. 1895c. Notes on some genera and species of Coccidae. *Ann. Mag. Nat. Hist.* 16:129-138.
- Maskell, W.M. 1896. Art. XXXVIII.- Further coccid notes: With descriptions of new species, and discussion of questions of interest. *Trans. Proc. New Zeal. Inst.* 28:380-411.
- Matile-Ferrero, D. 1996. La faune des Asterolecaniidae palmicoles de L'Amazonie péruvienne (Homoptera: Coccoidea). (In French). *Ann. Soc. Entomol. France.* (N.S.). 32:251-264.
- Matile-Ferrero, D. 1997. Morphology. The adult female. In: Ben-Dov, Y. & C.J. Hodgson, eds. *Soft scale insects - Their biology, natural enemies and control.* Elsevier. *World Crop Pests*, 7A.5-21.
- Maxwell-Lefroy, H. 1908. Notes on Indian scale insects (Coccidae). *Mem. Dept. Agric. India.* 2:111-137.
- McKenzie, H.L. 1958. A new asterolecaniid scale on succulents from Mexico (Homoptera: Coccoidea: Asterolecaniidae). *Pan Pac. Entomol.* 34:169-172.
- McKenzie, H.L. 1963. Miscellaneous diaspidid scale studies, including a new asterolecaniid from Florida (Homoptera; Coccoidea; Diaspididae; Asterolecaniidae). *Scale studies - Part XV.* *Bull. Calif. Agric. Exp. Stn.* 52:29-39.
- Merrill, G.B. 1953. A revision of the scale insects of Florida. Order: Homoptera. Superfamily: Coccoidea. *Bull. Fla. State Plant Board.* 1:143pp.
- Miller, D.R. 1985. Superfamily Coccoidea. Scale insects. In: Drooz, A.T., ed. *Insects of Eastern forests.* U.S. Dept. Agric. For. Serv. Misc. Publ. 1426:87-123.
- Miller, D.R. 1990. Phylogeny. In: Rosen, D., ed. *Armored Scale Insects - Their Biology, Natural Enemies and Control.* Elsevier. *World Crop Pests*, 4A.169-178.

- Miller, D.R. 1996. Checklist of the scale insects (Coccoidea: Homoptera) of Mexico. *Proc. Entomol. Soc. Wash.* 98:68-86.
- Miller, D.R. & C.J. Hodgson. 1997. Phylogeny. In: Ben-Dov, Y. & C.J. Hodgson, eds. *Soft scale insects - Their biology, natural enemies and control*. Elsevier. *World Crop Pests*, 7A:229-250.
- Miller, D.R. & P.L. Lambdin. 1978. A new genus and two new species of asterolecaniid scale insects on palm from Colombia and Trinidad (Homoptera: Coccoidea: Asterolecaniidae). *Proc. Entomol. Soc. Wash.* 80:240-263.
- Miller, D.R. & D.J. Williams. 1993. Systematic revision of the family Micrococcidae (Homoptera: Coccoidea), with a discussion of its relationships, and a description of a gynandromorph. *Boll. Lab. Entomol. Agrar. Filippo Silvestri.* 50:199-247.
- Morley, C. 1910. On the hymenopterous parasites of Coccidae. *The Entomol.* 43:94-96.
- Morrison, H. 1919. A report on a collection of Coccidae from Argentina, with descriptions of apparently new species (Hom.). *Proc. Entomol. Soc. Wash.* 21:63-91.
- Morrison, H. & E.R. Morrison. 1928. The Maskell species of the scale insects of the subfamily Asterolecaniinae. *Proc. U.S. Natl. Mus.* 71:607pp.
- Morrison, H. & E.R. Morrison. 1966. An annotated list of generic names of the scale insects (Homoptera: Coccoidea). *U.S. Dept. Agric. Misc. Pub.* 1015:206pp.
- Nakahara, S. 1980. *Asterolecanium pseudomiliaris* Green. *Proc. Hawaii. Entomol. Soc.* 23:163.
- Newstead, R. 1895. Coccids preyed upon by birds. *Entomol. Mon. Mag.* 31:84-86.
- Newstead, R. 1897a. Coccids preyed upon by birds. *Ind. Mus. Notes.* 4:81-82.
- Newstead, R. 1897b. Addenda by Dr. Newstead. *Entomol. Mon. Mag.* 33:74-76.
- Newstead, R. 1900. The injurious scale insects and mealy bugs of the British Isles. *J. R. Hort. Soc.* 23:219-262.
- Newstead, R. 1901. *Monograph of the Coccidae of the British Isles. Vol I.* Ray Society. London.220pp.

- Newstead, R. 1903. Monograph of the Coccidae of the British Isles. Vol II. Ray Society. London. 270pp.
- Ogilvie, L. 1928. Family Coccidae (Scale insects). In: The insects of Bermuda. Dept. of Agric. Bermuda. 24-28.
- Okiwelu, S.N. 1977. Studies on a pit-making scale, *Asterolecanium minus*, on *Quercus lobata*. Ann. Entomol. Soc. Am. 70:615-621.
- Packard, A.S. 1890. Insects injurious to forest and shade trees. U.S. Dept. Agric., 5th Rep. U.S. Entomol. Comm. 7:1-957.
- Page, R.D. 1996. TREEVIEW: An application to display phylogenetic trees on personal computers. Comput. Applic. Biosci. 12:357-358.
- Parr, T. 1940. *Asterolecanium variolosum* Ratzeburg, a gall-forming coccid, and its effect upon the host trees. Yale Univ. School of For. Bull. 46:49pp.
- Pellizzari, G. 1994. Primo repertorio degli Homoptera Coccoidea delle Tre Venezie. (In Italian). Boll. Zool. Agric. Bachic. Ser. II. 26:27-34.
- Pesson, P. 1944. Contribution à l'étude morphologique et fonctionnelle de la tête, de l'appareil buccal et du tube digestif des femelles de Coccides. Centre. Natl. Rech. Agronom., Serv. Document. Versailles. 266pp.
- Podsiadlo, E. 1972. A contribution to the explanation of the status of *Asterodiaspis variolosum* (Ratzeburg) (Homoptera, Coccoidea, Asterolecaniidae) on the basis of materials from Poland. Acta Zool. Krakov. 17:389-404.
- Podsiadlo, E. 1974a. Comparative morphological studies on populations of *Asterodiaspis variolosum* (Ratzeburg) (Homoptera, Coccoidea, Asterolecaniidae) from the Swietokrzyskie Mts. (Poland). Ann. Zool. Warszawa. 32:75-102.
- Podsiadlo, E. 1974b. Taxonomic studies on the species of *Asterodiaspis* Signoret, 1876 (Homoptera, Coccoidea, Asterolecaniidae) on oak in Poland. Acta Zool. Krakov. 19:487-530.
- Podsiadlo, E. 1975a. Life-cycle of *Asterodiaspis variolosa* (Ratzeburg, 1870) (Homoptera, Coccoidea, Asterolecaniidae) in Poland. Ann. Zool. Warszawa. 32:347-355.

- Podsiadlo, E. 1975b. Studies on the identification and occurrence of species of the genus *Asterodiaspis* Signoret, 1876 (Homoptera, Coccoidea, Asterolecaniidae) in Poland. (In Polish). *Przeg. Zool.* 19:211-216.
- Podsiadlo, E. 1976a. Dispersal of individuals of *Asterodiaspis variolosa* (Ratzeburg) (Homoptera, Coccoidea, Asterolecaniidae) on host plants from their hatching place. *Ekolog. Pol. Warszawa.* 24:69-76.
- Podsiadlo, E. 1976b. Instructions for the identification of the species of *Asterodiaspis* Signoret, 1876 (Homoptera, Coccoidea, Asterolecaniidae) damaging oak in Poland. (In Polish). *Bull. Entomol. Pol.* 46:401-409.
- Podsiadlo, E. 1986a. Morpho-biological studies on primary parasites (Hymenoptera, Chalcidoidea, Encyrtidae) of scale insects from the genus *Asterodiaspis* Signoret (Homoptera, Coccoidea, Asterolecaniidae) in Poland. *Ann. Zool. Warszawa.* 40:255-296.
- Podsiadlo, E. 1986b. Interrelations of the scale insects from the genus *Asterodiaspis* Signoret and their encyrtid parasites in Poland. *Boll. Lab. Entomol. Agrar. Filippo Silvestri.* 43:185-188.
- Podsiadlo, E. 1989. Morphology of the second instar nymphs of *Asterodiaspis quercicola* (Bouché) and *Asterodiaspis variolosa* (Ratz.) (Homoptera, Coccoidea, Asterolecaniidae). *Pol. Pismo Entomol. Warszawa.* 59:3-8.
- Podsiadlo, E. 1990a. Concept of the species of *Asterodiaspis variolosa* (Ratzeburg, 1870) (Homoptera, Coccoidea, Asterolecaniidae). *Ann. Zool. Warszawa.* 43:363-371.
- Podsiadlo, E. 1990b. The species concept of *Asterodiaspis variolosa* (Ratzeburg 1870) (Homoptera: Asterolecaniidae). *Proc. ISSIS-VI. Krakov.* II:90.
- Podsiadlo, E. 1991. On the biology of *Asterodiaspis variolosa* (Ratzeburg) (Homoptera, Asterolecaniidae) and its primary parasites (Hymenoptera, Encyrtidae) in Poland. (In Polish). *Wiad. Entomol. Poznan.* 10:177-181.
- Porter, C.E. & P. Vayssière. 1914. *L'Asterolecanium variolosum* (Ratzeburg) au Chili. *Bull. Soc. Pathol. Veg. France.* 1:49-50.
- Pritchard, A.E. & R.E. Beer. 1950a. Biology and control of *Asterolecanium* scales on oaks in California. *J. Econ. Entomol.* 43:494-497.
- Pritchard, A.E. & R.E. Beer. 1950b. Oak pit scales. *Calif. Agric.* 4:9, 14.

- Radford, A.E., H.E. Ahles & C. R. Bell. 1968. Manual of the vascular flora of the Carolinas. Univ. North Carolina Press, Chapel Hill. 1183pp.
- Ramachandra Rao, Y. 1922. The pests of the date palm in the Iraq. Mem. Mesopotamia Dept. Agric. 6 (1921):1-12.
- Ratzeburg, J.T.C. 1870. Eichenbeschädigung durch Schildläuse (*Coccus*). (In German). Tharandter Forstl. Jahrb. Dresden. 20:187-194.
- Reyne, A. 1961. Scale insects from Dutch New Guinea. Beaufortia. 8:121-167.
- Richter, G. 1928. Untersuchungen an Hompterensymbionten. 1. Die Symbionten der Diaspinen und Asterolekanien. 2. Die Symbionten einiger exotischer Zikaden. (In German). Z. Morphol. Ökol. Tiere. 10:174-206.
- Rohlf, F.J. 1982. Consensus indices for comparing classifications. Math. Biosci. 59:131-144.
- Rübsaamen, E.H. 1902. Mittheilung über die von Herrn J. Bornmüller im Oriente gesammelten Zoocecidien. (In German). Zool. Jahrb. Abt. Syst. Geog. Biol. Tiere. 16:243-336.
- Russell, L.M. 1941. A classification of the scale insect genus *Asterolecanium*. U.S. Dept. Agric. Misc. Pub. 424:322pp.
- Saccardo, F. 1895. Manipolo di cocciniglie raccolte in provincia d'Avellino. Riv. Patol. Veget. 4:46-55.
- Salama, H.S. & M.K. Hamdy. 1974. Studies on populations on two scale insects infesting fig trees in Egypt (Coccoidea). Z. Angew. Entomol. 75:200-204.
- Sanders, J.G. 1906. Catalogue of recently described Coccidae. Bureau of Entomol. U.S. Dept. Agric. Tech. Ser. 12:1-18.
- Sanders, J.G. 1909. The identity and synonymy of some of our soft scale insects. J. Econ. Entomol. 2:428-448.
- Sasscer, E.R. 1911. Papers on Coccidae or scale insects. Catalogue of recently described Coccidae-III. U.S. Dept. of Agric. Bur. of Entomol. Tech. Ser. 16:61-73.
- Schmutterer, H. 1952a. Die Ökologie der Cocciden (Homoptera, Coccoidea) Frankens. 1. Abschnitt. (In German). Z. angew. Entomol. 33:24-420.

- Schmutterer, H. 1952b. Die Ökologie der Cocciden (Homoptera, Coccoidea) Frankens. 2. Abschnitt. (In German). Z. angew. Entomol. 33:544-584.
- Schmutterer, H. 1952c. Die Ökologie der Cocciden (Homoptera, Coccoidea) Frankens. 3. Abschnitt (Schluß). (In German). Z. angew. Entomol. 34:5-100.
- Schmutterer, H. 1953. Ergebnisse von Zehrwespenzuchten aus Schildläusen (Hymenoptera: Chalcidoidea). (1. Teil). (In German). Beitr. Entomol. 3:55-69.
- Schmutterer, H. 1972. Unterordnung Coccoidea, Schildläuse. (In German). In: Schwenke, W., ed. Die Forstschädlinge Europas. Vol. 1. Paul Parey. Hamburg, Berlin. 387-446.
- Schmutterer, H. 1980. Zum Stand der Erforschung der Schildläuse (Homoptera, Coccoidea) in der Bundesrepublik Deutschland. (In German). Mitt. Dtsch. Ges. Allg. Angew. Entomol. 2:49-56.
- Signoret, V. 1868. Essai sur les cochenilles (Homopteres - Coccides) (1), 2^e partie (2). Séance du 25 Mars 1868. (In French). Ann. Soc. Entomol. France. (Ser. 4). 8:829-876.
- Signoret, V. 1869. Essai sur les cochenilles ou gallinsectes (Homopteres - Coccides), 3^e partie (1). Séance du 23 Mars 1868. (In French). Ann. Soc. Entomol. France. (Ser. 4). 9:97-104.
- Signoret, V. 1870. Essai sur les cochenilles ou gallinsectes (Homopteres - Coccides), 7^e partie (1). Séance du 25 Mars 1868. (In French). Ann. Soc. Entomol. France. (Ser. 4). 10:267-286.
- Signoret, V. 1876a. Séance du 22 Novembre 1876. (In French). Bull. Soc. Entomol. France. 206-214.
- Signoret, V. 1876b. Essai sur les cochenilles ou gallinsectes (Homopteres - Coccides), 18^e et dernière partie (1). Séance du 22 Novembre 1876. (In French). Ann. Soc. Entomol. France. (Ser. 5). 6:591-676.
- Silvestri, F. 1939. Pseudococcini - Asterolecani. Gen. *Asterolecanium* Targioni. In: Compendio di Entomologia Applicata. Portici. 1:686-688.
- Stumpf, C.F. & P.L. Lambdin. 1998. The pit scales (Asterolecaniidae) of the New World. VIIIth Int. Symp. Scale. Insect. Stud. Wye College. 34-35.

- Stumpf, C.F. & P.L. Lambdin. 2000a. Taxonomic status of *Bambusaspis miliaris*, *B. robusta*, and *B. pseudomiliaris* (Hemiptera: Coccoidea: Asterolecaniidae). *Insecta Mundi*. (in press).
- Stumpf, C.F. & P.L. Lambdin. 2000b. A comparison of the pit scale genera of North and South America. *Proc. ISSIS-VIII. Entomologica*. (in press).
- Stumpf, C.F. & P.L. Lambdin. 2000c. Distribution and known host records for *Planchonia stentae* (Hemiptera: Coccoidea: Asterolecaniidae). *Florida Entomol.* (in press).
- Stupka, A. 1989. Trees, shrubs, and woody vines of Great Smoky Mountains National Park. Univ. Tennessee Press. Knoxville. 186pp.
- Sturgis, W.C. 1895. Notes on injurious insects. *Ann. Rep. Conn. Agric. Exp. Stn.* 1895.191-194.
- Sugonjaev, E.S. 1958. On some parasitic chalcid-wasps infesting scale-insects (Hymenoptera, Chalcidoidea) in Leningrad region. (In Russian). *Rev. Entomol. USSR.* 37:308-318.
- Sweetman, H.L. 1935. Successful examples of biological control of pest insects and plants. *Bull. Entomol. Res.* 26:373-377.
- Swirski, E. & Z. Arenstein. 1970. List of common insects found in subtropical orchards. In: Diseases and pests of fruit trees (except citrus) in Israel. *Volcani Inst. Agric. Res. Bet Dadan.* 12-16.
- Swofford, D.L. 1991. When are phylogeny estimates from molecular and morphological data incongruent? In: Miyamoto, M.M. & J. Cracraft, eds. *Phylogenetic analysis of DNA sequences*. Oxford Univ. Press. New York. 295-333.
- Swofford, D.L. 1993. PAUP: Phylogenetic analysis using parsimony. Vers. 3.1.1. *Illinois Nat. Hist. Surv. Champaign.* 257pp.
- Takahashi, R. 1928. Coccidae of Formosa. *Phil. J. Sci.* 36:327-349.
- Takahashi, R. 1930. Observations on the Coccidae of Formosa. Part II. *Dept. Agric. Gov. Res. Inst. Formosa.* 48:1-45.
- Takahashi, R. 1933. Observations on the Coccidae of Formosa. Part III. *Dept. Agric. Gov. Res. Inst. Formosa.* 60:25-64.

- Takahashi, R. 1936. Some Aleyrodidae, Aphididae, Coccidae (Homoptera), and Thysanoptera from Micronesia. *Tenthredo.* 1:109-120.
- Takahashi, R. 1941. Some species of Aleyrodidae, Aphididae, and Coccidae from Micronesia (Homoptera). *Tenthredo.* 3:208-220.
- Takahashi, R. 1942. Some species of Aleyrodidae, Aphididae and Coccidae in Micronesia (Homoptera). *Tenthredo.* 3:349-358.
- Takahashi, R. 1956. A new scale insect of *Asterolecanium* from Japan (Asterolecaniidae, Coccoidea, Homoptera). *Akitu.* 5:4-6.
- Tamaki, Y. 1970. Studies on waxy coverings of *Ceroplastes* scale insects. *Bull. Natl. Inst. Agric. Sci. Japan. Ser. C.* 24:1-111.
- Tamaki, Y., T. Yushima & S. Kawai. 1969. Wax secretion in a scale insect, *Ceroplastes pseudoceriferus* Green (Homoptera: Coccidae). *Appl. Entomol. Zool.* 4:126-134.
- Targioni-Tozzetti, A. 1868. Introduzione alla seconda memoria per gli studji sulle Cocciniglie, catalogo dei generi e delle specie della famiglie dei Coccidi. (In Italian). *Atti Soc. Ital. Sci. Nat.* 11:694-738.
- Targioni-Tozzetti, A. 1888. Relazione intorno ai lavori della R. Stazione di Entomologia agraria di Firenze per gli anni 1883-84-85. Article IV. Ord. eterotteri-omotteri. Hemiptera, 1. pars. Rhyngota, F. Rhyncota, Fieb. (sottord. coccidi). (In Italian). *Annal. Agric. Firenze, Roma.* 415-437.
- Targioni-Tozzetti, A. 1892. Cocciniglie nuove, critiche o poco note. (In Italian). *Bull. Soc. Entomol. Ital.* 24:285-312.
- Tereznikova, E.M. 1981. Scale insects. Eriococcidae, Kermesidae and Coccidae. (In Ukrainian). *Fauna Ukraini. Akad. Nauk. Ukrain. RSR. Inst. Zool. Kiev.* 20:1-215.
- Timberlake, P.H. 1919. Observations on the sources of Hawaiian Encyrtidae (Hymenoptera). *Proc. Hawaii. Entomol. Soc.* 4:183-231.
- Timberlake, P.H. 1924. Records of introduced and immigrant chalcid-flies of the Hawaiian Islands (Hymenoptera). *Proc. Hawaii. Entomol. Soc.* 5:418-449.
- Tranfaglia, A. 1974. Studi sugli Homoptera Coccoidea. II. Notizie biologiche sull'*Asterolecanium arabidis* (Signoret) su *Hedera helix* L. (In Italian). *Boll. Lab. Entomol. Agrar. Filippo Silvestri.* 31:54-60.

- Tshumakova, B.M. 1961. Parasites of injurious scale-insects from Karbadino-Balkaria (Hymenoptera, Chalcidoidea). (In Russian). Rev. Entomol. URSS. 40:315-338.
- Urich, F.W. 1893. Notes on some insect pests of Trinidad, British West Indies. Insect Life. 6:196-198.
- Van Rensburg, L., G.H.J. Krüger, B. Ubbink, M.C. Scholes & J. Peacock. 1997. A phytocentric perspective of *Asterolecanium quercicola* Bouché infestation on *Quercus robur* L. trees along an urbanization gradient. S. Afr. J. Bot. 63:25-31.
- Watson, J.K., P.L. Lambdin & K. Langdon. 1994. Diversity of scale insects (Homoptera: Coccoidea) in the Great Smoky Mountains National Park. Ann. Entomol. Soc. Am. 87:225-230.
- Wilkey, R.F. 1962. A simplified technique for clearing, staining and permanently mounting small arthropods. Ann. Entomol. Soc. Am. 55:606.
- Williams, D.J. & C.F. Butcher. 1987. Scale insects (Hemiptera: Coccoidea) of Vanatu. New Zealand. Entomol. 9:88-99.
- Williams, D.J. & G.W. Watson. 1990. The scale insects of the tropical South Pacific region. Pt. 3: The soft scales (Coccidae) and other families. CAB Int. Inst. Entomol. Wallingford. 267pp.
- Williams, J.R. & D.J. Williams. 1980. Excretory behavior in soft scales (Hemiptera: Coccidae). Bull. Entomol. Res. 70:253-257.
- Wilson, C.E. 1921. Report of the Entomologist. Rep. Virgin. Isl. Agric. Exp. Stn. 1920. Gov. Print. Off. Washington. 20-34.
- Wilson, F. 1960. A review of the biological control of insects and weeds in Australia and Australian New Guinea. Commw. Inst. Biol. Control. Tech. Commun. 1:102pp.
- Wolcott, G.N. 1936. "Insectae borinquenses". A revision of "Insectae portoricensis" a preliminary annotated checklist of the insects of Porto Rico with descriptions of some new species and "first supplement to Insectae portoricensis". J. Agric. Univ. Puerto Rico. 20:1-627.
- Wolcott, G.N. 1941. Supplement to "Insectae borinquenses. J. Agric. Univ. Puerto Rico. 25:33-158.
- Wolcott, G.N. 1948. The insects of Puerto Rico. J. Agric. Univ. Puerto Rico. 32:1-223.

- Wolcott, G.N. 1953. Biological control of the pustule scale in Puerto Rico. J. Agric. Univ. Puerto Rico. 37:228-233.
- Wolcott, G.N. 1958. The evanescens of perfect biological control. Proc. 10th Int. Congr. Entomol. Montreal. 4:511-513.
- Wolcott, G.N. 1960. Efficiency of ladybeetles (Coccinellidae: Coleoptera) in insect control. J. Agric. Univ. Puerto Rico. 44:166-172.
- Wu, S.J. 1983. Studies on the bionomics and control of *Bambusaspis hemisphaerica* Kuwana. (In Chinese). Kunchong Zhishi. 20:77.
- Wunderlin, R.P. 1997. Guide to the vascular plants of Florida. Univ. Press Florida. Gainesville. 806pp.
- Yinon, U. 1969. Food consumption of the armored scale lady-beetle *Chilocorus bipustulatus* (Coccinellidae). Ent. Exp. Appl. 12:139-146.
- Zahradnik, J. 1957. Neue Schildlausfunde in den Gewächshäusern der Tschechoslowakei. (In German). Pflanzensch. Ber. 19:45-52.
- Zak-Ogaza, B. 1958. Matériaux à la connaissance de Chalcidiens parasites des cochenilles. (In Polish). Bull. Entomol. Pologne. 28:141-150.
- Zhang, X. 1992. A new species of the *Bambusaspis* (Homoptera: Asterolecaniidae). (In Chinese). J. Nanjing. For. Univ. 16:53-54.
- Zimmerman, E.C. 1948. Homoptera: Sternorhyncha. Insects of Hawaii. 5:464pp.
- Zohdi, G.I., A.I. Farag, G.E.S. Abo El-Ghar & A.E. Sand. 1990. Effect of scale insects as prey on development and reproduction of *Agistemus exsertus*. Proc. ISSIS-VI. Krakov. II:149-152.

VITA

Christof Stumpf was born in Baden, Austria on July 4, 1968. He attended schools in the public school system of Baden, Austria, where he graduated from Bundesgymnasium und Bundesrealgymnasium Baden in June 1986. He entered the University of Vienna in October 1986 studying biology, with a major in zoology and a minor in human biology. In 1990, he started working on his research with the Australian ladybeetle, *Cryptolaemus montrouzieri* Mulsant at the Federal Institute for Plant Protection, Vienna. In 1993, he worked for two months as a field biologist for Shell Agrochemicals in Sittingbourne, England. Graduating with distinction, he received the Master of Natural Sciences degree in May 1994 from the University of Vienna. He entered the United States in May 1994, where he enrolled in the Graduate Studies in Ecology program of the University of Tennessee, which was later incorporated into the Department of Ecology and Evolutionary Biology. He was supported by a Fulbright Grant from 1994 to 1997, and worked as a teaching assistant (General Biology, Comparative Invertebrate Biology) from 1997 to 2000. His research was a revision of the scale insect subfamily Asterolecaniinae in North and South America, and was performed in the Department of Entomology and Plant Pathology under the supervision of Paris Lambdin. He received the doctoral degree in May 2000.