REVISION OF THE TRIBE SERROLECANIINI SHINJI (PSEUDOCOCCIDAE) WITH DISCUSSION ON OTHER "LEGLESS" MEALYBUGS

by

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ENTOMOLOGY

(ABSTRACT)

Of the estimated 1100 species of mealybugs, approximately 6% are described as possessing degenerative legs and antennae in the adult female developmental stage or having lost these structures altogether. Fifteen genera composing 63 species are often separated into their own taxonomic group based on these vestigial features (e.g., Sphaerococcinae), and are collectively known as the "legless" mealybugs. A comparative morphological analysis of adult females was undertaken to clarify the taxonomic placement of these species and to determine their relationships. Methods were included on collecting, preserving, slide-mounting, and measuring specimens, and on preparing illustrations. Keys to genera and species of "legless" mealybugs were developed.

Reduction or loss of legs and antennae apparently occurred convergently in response to similar environmental conditions and was not found supportive of homogeneity in the "legless" group as a whole. However, the genera *Chaetococcus* Maskell, *Idiococcus* Takahashi & Kanda, *Kermicus* Newstead, *Serrolecanium* Shinji, *Tangicoccus* Kozár & Walter, and a newly established genus share many characteristics and were treated as the tribe Serrolecaniini Shinji. The adult females of 13 species contained in these genera were redescribed, with illustrations produced for 12. A phylogenetic analysis of the tribe showed that converse to simplification in appendages, adaptations in other features (e.g., latero-projecting lobes and a caudally-directed vulva) probably developed to increase reproductive success and survivorship.

The genera *Acinococcus* Williams, *Antonina* Signoret, *Antoninoides* Ferris, *Cypericoccus* Williams, *Nesticoccus* Tang, *Paludicoccus* Ferris, *Parapaludicoccus* Mamet, *Peridiococcus* Williams, *Pseudantonina* Green, and *Sphaerococcus* Maskell are

not closely related to one another or to members of the tribe Serrolecaniini based on adult female morphology. These 10 genera and their type species were redescribed, and illustrations produced for all but *Nesticoccus sinensis* Tang. Comments or redescriptions are provided for the 21 additional species that comprise these genera; however, the taxonomic placement of 18 additional species erroneously assigned to *Pseudantonina* and *Sphaerococcus* is uncertain.

Lectotypes were designated for *Antonina crawi* Cockerell, *A. graminis* Parrott, *A. phragmitis* Marchal, *A. purpurea* Signoret, *A. waterstoni* Newstead, *Idiococcus bambusae* Takahashi & Kanda, *Pseudantonina bambusae* Green, *Pseudolecanium disticlium* Kuwana, and *Sphaerococcus ethelae* Fuller. A replacement name was proposed for the junior homonym *Antoninella* Sulc. The species names *Antonina anceps* Green, *Antonina maritima* Green, and *Idiococcus maanshanensis* Tang & Wu are considered junior synonyms. Two species of *Serrolecanium* were described, and a new genus was established for the placement of *Serrolecanium jiuhuaensis* Wu and *Serrolecanium sasae* (Siraiwa). Six new name combinations are also made.

I dedicate this thesis
to my wife, **Mary Beth**, and parents,
Thelma Louise and **Willis Merriman**,
for their enduring love and support.

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INTRODUCTION

"La simplicité affecteé est une imposture délicate"

La Rochefoucauld, 1665

The family Pseudococcidae, or mealybugs, is a diverse group and ranks second only to the family Diaspididae in size and importance among Coccinea (Williams 1985). Most of the estimated 1100 species infest grasses (Poaceae), but a variety of woody and herbaceous plants serve as hosts (Kosztarab & Kozár 1988). Due to the family's immense size and diversity, generic revisions and subfamilial classifications have often relied on local or regional studies of the adult female (Ferris 1950b & 1953, Beardsley 1966, Danzig 1980, Williams 1985, Cox 1987, Williams & Watson 1988, Williams & Granara de Willink 1992, Tang 1992), thus omitting related taxa.

Afifi's (1968) division of the family was developed from a comprehensive treatment of adult male morphology; however, it was based on a limited number of genera. Previous works also have frequently established taxa at and above the genus-level using obscure or limited number of characters. A detailed comparative analysis of the mouthparts (Koteja 1974a, 1976, Koteja & Liniowska 1976) was the basis of a commonly recognized classification (Koteja 1974b).

Further difficulties have been demonstrated in determining relationships between species which show character regression, and moreover, their taxonomic placement within the family. Table I presents genera whose members have reduced or lost structures, particularly antennae and legs. Each has been reported potentially related to at least one of the other genera simply because of their regressive attributes, and they are often referred to as the "legless" mealybugs.

Most classificatory schemes of Pseudococcidae have a separate category designated for these unusual mealybugs. Koteja's (1974b) classification of four subfamilies, followed by Williams (1985), places *Antonina* Signoret, *Chaetococcus* Maskell, and *Sphaerococcus* Maskell in Sphaerococcinae Cockerell. Danzig (1980) and Varshney (1985) divide the family into four similar tribes, one of which is Sphaerococcini. The former of the two classifications has *Antonina* and *Serrolecanium* Shinji within this tribe, while the latter contains *Antonina*, *Chaetococcus*, and *Pseudantonina* Green. Varshney's (1985) interpretation also has *Kermicus* Newstead placed within the tribe Pseudococcini Cockerell. Yang (1982) recognized six tribes with *Antonina*, *Chaetococcus*, and

Table I. Genera of "Legless" Mealybugs

Acinicoccus Williams	2[a]
Antonina Signoret	18
Antoninoides Ferris	1
Chaetococcus Maskell	6
Cypericoccus Williams	1
Idiococcus Takahashi & Kanda	2
Kermicus Newstead	1
Nesticoccus Tang	1
Paludicoccus Ferris	1
Parapaludicoccus Mamet	1
Peridiococcus Williams	2
Pseudantonina Green	6
Serrolecanium Shinji	4
Sphaerococcus Maskell	16
Tangicoccus Kozár & Walter	1

[a]Number of species recognized to date.

Serrolecanium forming Sphaerococcini. *Pseudantonina* is placed within the tribe Trabutini Silvestri because the reduced legs exhibit segmentation. Avasthi & Shafee (1987) list *Antonina*, *Chaetococcus*, and *Kermicus* under Sphaerococcinae in their division of the family into three subfamilies.

The latest proposed classification by Tang (1992) divides the family into five subfamilies. The subfamily Sphaerococcinae contains a single tribe, Antoninini Borchsenius, which is further divided into two subtribes. The subtribe Serrolecaniina Shinji is composed of *Idiococcus* Takahashi & Kanda, *Kermicus*, *Nesticoccus* Tang, and *Serrolecanium*. The genus *Kuwanina* Cockerell, typically considered a member of Cryptococcidae (Kosztarab 1968), is also included in this subtribe. *Antonina*, *Chaetococcus*, and *Tangicoccus* Kozár & Walter compose the subtribe Antoninina. Again, most of these classifications were proposed in faunal reports, thus only genera of certain regions were included; furthermore, several of these workers indicated that the placement of some genera were done with hesitation or out of convention.

Three higher category names have been proposed for the inclusion of these genera and are acceptable according to the International Code of Zoological Nomenclature. Cockerell (1899a) suggested Sphaerococcini be used with the genus *Sphaerococcus* as its type. Shinji (1935a) erected the subfamily Serrolecaniniinae (*lapsus*) for his monotypic genus *Serrolecanium*. Borchsenius (1949a) referred to the group name Antoninini for the genera *Antonina* and *Chaetococcus*. The *Sphaerococcus*-group name has priority over the other two group names, but both of these are also available if necessary (Williams 1969).

It was the original intent of this study to revise the subfamily Sphaerococcinae based on a comparative analysis of the adult female. After the complexity and magnitude of this undertaking was realized, the study refocused on revising and analyzing a particular group, the tribe Serrolecaniini. So as not to completely disregard the original proposal, a discussion on the genera assigned to the heterogeneous subfamily is given.

Chapter I includes the general morphology of adult females and a key to the genera of "legless" mealybugs. Characteristics of the antennae and legs are often used to diagnose mealybugs, especially at the generic level. Because these are regressive structures in the species under investigation, I have sought additional characters that would help distinguish species and reveal relationships. Chapters II and III are devoted to the tribe Serrolecaniini. In the first of these two chapters are redescriptions of genera,

species distribution maps, keys to species, and redescriptions with illustrations of species. A phylogenetic analysis of the tribe follows in the next chapter.

Chapter IV is a detailed genus-level revision of the genera often assigned to Sphaerococcinae. This chapter follows a similar format to Chapter II; however, only type species are measured and illustrated, and no distribution maps are presented. Indices of host plant species and scale insect species are also provided.

MATERIALS AND METHODS

Most specimens used in this study were borrowed from several institutions and private collections throughout the world. These repositories are listed below. Some additional materials were also collected by associates of the author, and these individuals are recognized in the "Acknowledgments" section.

Collection and preservation. Almost all species of "legless" mealybugs occur on various species of Poaceae at the base of culms or under leaf sheaths. Their presence on the plant is often revealed by a white, mealy or powdery wax which covers the bodies. A fewer number of species infest various other hosts, such as members of Myrtaceae and Cyperaceae, and may induce gall formation. A list of recorded hosts for each species covered in this study is provided within species descriptions and in the "Index to Host Species" appendix.

I did not collect specimens for this study, but suggest the following procedures for their preservation based on personal experiences and conventional practices. Place the collected specimens and data label into a 15 X 17 cm cellophane envelope. To help prevent molding, allow the material to dry at least 2-4 days before sealing the envelope. It is also highly recommended to include a section of the host, including if possible the inflorescence, with the specimen to aid in host identification.

Specimens may also be preserved in 70% ethyl alcohol (EtOH) and stored in 4 dram glass vials closed with neoprene stoppers. Specimens preserved in this manner should be quick-fixed by slightly heating the preservative with the specimens, then replacing the heated alcohol with new. Alcohol preservation is preferable only if the specimen is properly fixed.

Preparation of material for study. The identification and description of species demanded the examination of material at magnifications up to 2000X. This was accomplished by viewing permanent slide-mounts of specimens under phase contrast microscope.

Much of the material used in this study had previously been slide-mounted; however, on occasion it was necessary to mount additional material. Teneral females fixed by the methods described above and dry specimens were found to be the most suitable for slide-mounting. Although workable, specimens preserved in alcohol for long periods of time frequently proved difficult to clearing. The general slide-mounting procedure used in this study was modified from Wilkey's (1977) as follows:

1. Carefully removed specimen from host. Rehydrated host when necessary to soften tissues for easier removal of specimen. This was frequently done with specimens under bamboo sheaths and within galls.

2. Soaked specimen in 10% KOH for 12-36 hr to clear and soften integument, and to loosen and dissolve body contents. After at least 6 hr, tested softness of integument and body contents by gently pressing the body with a microspatula. When pliable, the side of body was pierced with a sharp needle to facilitate penetration of clearing agent. For heavily sclerotized individuals, such as some *Chaetococcus* spp., it was often necessary to heat the KOH to expedite the process.

3. When soft, gently pressed body contents out with a spatula. When previous methods did not sufficiently clear the integument, temporarily transferred specimen to hydrogen peroxide before proceeding to the next step.

4. Transferred to distilled water for 2-3 min. to remove or dilute KOH. If needed, one drop of alcohol was added to break surface tension. Pressed again to remove any remaining body contents.

5. Transferred to Essig's Aphid Fluid containing 2 drops of Wilkey's modified double stain (Wilkey 1977) for 20 min.

6. Transferred to EtOH and dehydrated at gradients of 70 and 100% for 2-3 min. If specimens did not have a deep pink color, they were returned to step "5" for a few minutes before continuing with this step.

7. Transferred to clove oil for at least 6 hr.

8. Embedded specimen ventral side up in drop of Canada balsam on glass microscope slide and covered with glass cover slip. If available, an additional specimen was mounted dorsal side up. Slivers of cover slips were often used to support the coverslip over large or heavily sclerotized specimens.

9. Placed slide-mount in drying oven at 40°C for 2 wk.

A description of the specimen's general appearance was recorded before mounting with the aid of a stereomicroscope. All mounting steps that required a liquid took place in small glass dishes (≤1 ml).

Measurements and counts. At least 10 specimens were selected for quantitative measurements when possible; however, qualitative data usually employed all examined material. A Zeiss RA phase contrast microscope with a calibrated ocular micrometer was used for observing and measuring structures.

All measurements given in the descriptions are in micrometers (μm), unless specified otherwise, and are typically represented by the mean followed by the range in parentheses. Some structures, however, showed great variation and have only the range given (eg., setal length). Even though means are provided for most measurements, these were calculated from small, biased samples and may represent but a small portion of the total variation which occurs.

Body length and width were measured at the longest and widest points. Glandular structures found in heavily sclerotized regions appear larger and were avoided when possible to prevent misinterpretation. The diameter of cylindrical ducts and duct-like pores were taken midway down the inner bore. Unless specified, the lengths of structures were measured along the midline. Cylindrical ducts normally project at an angle to the body wall, thus making it difficult to measure the exact length. Those found along the body's margin and at folds in the derm were often perpendicular to the angle of view and were selected for measurement.

The location and distribution of various structures were determined by dividing the body into four body regions (Pl. 1) (median, submedian, submargin, and margin). The width of each region varied from one specimen to another, and from one body segment to the next. Nonetheless, each region always represented one-fourth of the total surface of each segment. Unless specified (e.g., 'anterior border'), distributions of ultrastructures are for the entire area of the region given for the respective segment.

Material examined. For some species such as the cosmopolitan *Antonina graminis* (Maskell), there was a plethora of specimens available to examine ($n > 850$). Unfortunately there were but a few for others (i.e., *Parapaludicoccus isaloensis* Mamet, $n = 2$). Under each species description is a list of material examined. The records of each lot are arranged alphabetically first by host, then by country. Also included when available are locality, date, collector(s), identification marks, number of slides, number of specimens in parenthetical notation, and repositories. The number of specimens listed represents adult females only; some slide-mounts possessed several specimens of different developmental stages.

Because of the inconsistencies associated with common names, host data without a scientific name are often listed as "Undetermined" with common names included within the respective record. The same is done for uncertain identifications (e.g., possibly *Miscanthus*).

Among some records I have placed in braces "{}" relevant data that was provided with dry material but was not included on the slide-mounts of the same lot. This was a problem with some material, especially with lots from the G.F. Ferris China Collections. Information deduced from literature related to particular lots was also treated in this manner.

Terminology. The terms used for structures in this study in general are those of Beardsley (1984b), Danzig (1986), Williams (1985), Foldi (1991), and Williams & Granara de Willink (1992). Further discussions of terminology are covered with each structure in the next chapter.

Illustrations. A diagrammatic illustration of slide-mounted specimens is provided for all but one species of Serrolecaniini and for most type species of other genera discussed in this study. Body outlines and details of morphological structures were traced using a Zeiss RA phase contrast microscope with an attached camera lucida.

Each plate consists of a central drawing of the entire body surrounded by enlargements of various morphological structures. The body is longitudinally divided with the left half representing the dorsal surface and the right half the ventral surface. In reality, the various dermal ultrastructures drawn on the body outline are usually much smaller in proportion to body size. They were enlarged to make them visible and to help interpret their distribution; therefore, their adjusted size often precluded the placement of actual density. One should consult the respective species description for actual measurements because the structures are not drawn to scale.

The proportions used for the enlargement of morphological structures on the same plate or between plates are not uniform; therefore, questions regarding actual size or proportion should utilize the measurements given in the descriptions. Four common structures were consistently drawn in the same corners of plates as follows: antenna - upper left; spiracle - upper right; anal ring - lower left; and leg when present - lower right.

Figures of species distributions and cladograms utilized FreeLance Plus (Lotus Development Corporation 1989) and were printed with Hewlett Packard Laserjet III. The mapped distributions were taken from available specimen labels and literature records, but do not represent complete distributions. Only those sites which were found in available maps or atlases are plotted. Some reported locations had multiple listings within the same region, were old names not present in available sources, or incorrectly translated.

Literature citations. The amount of literature available on species covered in this study fluctuated as much as specimen availability. Included with each species description are the original description and any other major redescription. Articles of lesser importance, such as those providing only host or distributional records were often omitted; however, many of the citations used provide additional articles. A complete list of utilized references is given in the "Cited References" section.

Repositories

AM	Australian Museum, Sydney, N.S.W.
AMNH	American Museum of Natural History, New York
ANIC	Australian National Insect Collection, Canberra City, ACT
AU	Entomology Collection of Auburn University, Alabama
AUS	Agricultural University of Shanxi, Taiku, China
BM	British Museum (= The Natural History Museum), London
BRI	Biosystematics Research Institute, Ottawa, Ontario
CIE	CAB International Institute of Entomology, London, England
CBM	Collection of Burruss McDaniel, South Dakota State University, Brookings
CLA	County of Los Angeles, Museum of Natural History, California
DASF	Department of Agriculture, Stock & Fisheries; Port Moresby, New Guiana
FAHU	Faculty of Agriculture, Hokkaido University, Sapporo, Japan
FSCA	Florida State Collection of Arthropods, Gainesville
HAS	Collection of Plant Protection, Hungarian Academy of Science, Budapest
HS	Collection of Heinrich Schmutterer, Giessen, Germany
JWB	Collection of John W. Beardsley, Honolulu, Hawaii
KSU	Entomology Collection of Kansas State University, Manhattan
LSU	Entomology Collection of Louisiana State University, Baton Rouge
MDA	Maryland Department of Agriculture, Annapolis
MM	Moravian Museum, Oddeleni Entomologieké, Brno, Czechoslovakia
MNHNE	Museum National d'Historie Naturelle, Laboratoire d'Entomologie, Paris, France
NHMV	Natural History Museum of Vienna, Austria
NZAC	New Zealand Arthropod Collection, Entomology Division, Auckland
OMNH	Osaka City Museum of Natural History, Japan
PPRI	Plant Protection Research Institute, Pretoria, South Africa
SAM	South Australian Museum, Adelaide
TUA	Tokyo University of Agriculture, Japan
UCD	University of California, Davis
UGES	University of Georgia Experiment Station, Experiment, Georgia
USNM	United States National Museum of Natural History, Smithsonian Institute, Washington, D.C.
UST	University of Stellenbosch, Cape Province, South Africa
VPI	Virginia Polytechnic Institute & State University, Blacksburg
WARI	Waite Agricultural Research Institute, Adelaide, South Australia
ZIL	Zoological Institute, Leningrad, Russia

Abbreviations

&	ampersand
Apr.	April
Aug.	August
C	centigrade
ca.	approximately
CI	consistency index
coll.	collection/collector
d	day
Dec.	December
det.	determined
EtOH	ethyl alcohol
Feb.	February
fig.	figure
µm	micrometer
hr	hour
Jan.	January
Jul.	July
Jun.	June
KOH	potassium hydroxide
Mar.	March
µm	micrometer
mm	millimeter
Mt.	Mount
n	sample size
no.	number
NE	northeast
Nov.	November
nr.	near
NW	northwest
Oct.	October
Pl.	Plate
Res.	Research
RI	retention index
Sep.	September
sp.	species
Stat.	Station
USA	United States of America
USSR	former Union of Soviet Socialist Republics
wk	week

CHAPTER I
GENERAL MORPHOLOGY OF ADULT FEMALES
Plates 1, 2

Body form and segmentation (Pl. 1). The shape and size of the body varies among the species, and to a lesser extent from one individual to another within a given species. Factors causing intraspecific variation in these characteristics include host species, location on host, parasitism, and age of the adult female.

Although the body of adult females takes on a variety of forms, two general designs which reflect the habitat of the species predominate. Those species found more or less in the open environment, either at the base of culms or partly concealed by leaf sheaths, are often globular in shape. Those found concealed deep beneath leaf sheaths of their host are typically flattened dorso-ventrally and elliptical in outline. When slide-mounted, the former appear broadly oval to circular in outline, whereas the latter often remains elliptical.

Following Williams' (1985) interpretation, the body is generally divided into head, three thoracic segments, and eight abdominal segments. In most "legless" mealybugs, abdominal segment I appears completely fused with the metathorax. The distinction between body segments varies, especially among genera. Segmentation appears obsolete in some genera (*Sphaerococcus* Maskell), yet very distinct at least on the abdomen in others (*Serrolecanium* Shinji). Among all species, segmentation is more evident dorsally. Whether or not segmentation is distinct, several morphological structures help serve as markers to the location of the various segments. These structures will be discussed in more detail later.

In addition to distinct segmentation dorso-ventrally, some species also have well-defined lateral constrictions between abdominal segments. At times the depth of these constrictions causes the segments to appear laterally expanded. The body drawn in Plate 1 has distinct abdominal segmentation and lateral constriction between segments VII and VIII. A diverse array of abdominal outlines are present, particularly along the terminal segments. Among the "legless" mealybugs examined, only *Antonina australis* Froggatt has anal lobes present on abdominal segment VIII, while most others have this segment rounded to slightly concave in shape. *Idiococcus bambusae* Takahashi & Kanda has an apical cleft (Pl. 7, fig. A). Members of the genera *Porisaccus* and *Serrolecanium* have latero-posterior lobes on at least segment VIII (Pl. 10, fig. A), and these lobes are often densely covered with conical setae (Pl. 10, fig. B).

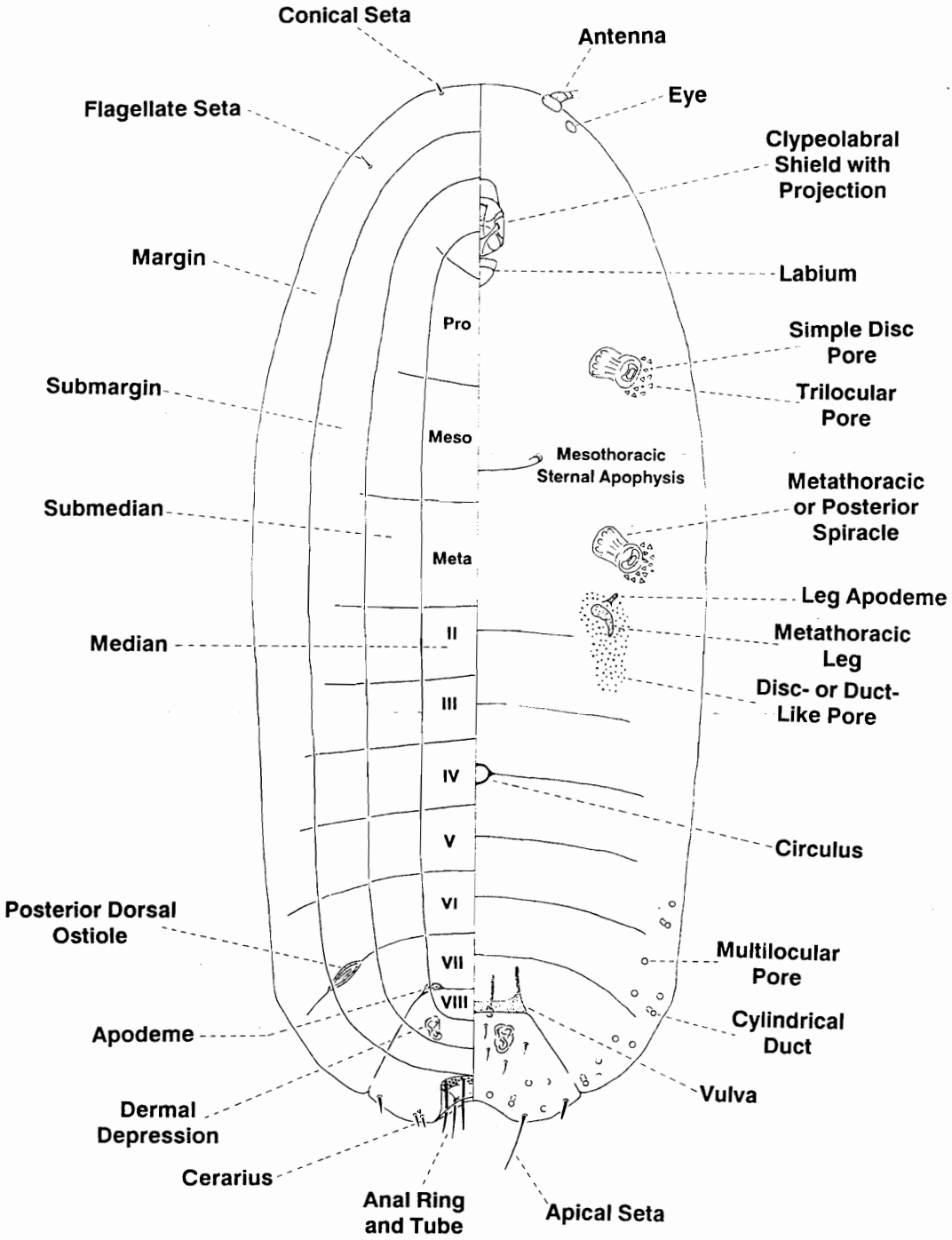

Plate 1. General Morphology of Adult Female "Legless" Mealybug.

The derm or integument of few genera (e.g., *Cypericoccus* Williams) appear entirely membranous at maturity. In most genera at least the margins of the body and the posterior segments become heavily sclerotized. To emphasize the degree of sclerotization that may be present, Maskell (1898) found it necessary to soak specimens of *Chaetococcus* Maskell five years in a "dammar solution" to clear them. Most structures in these sclerotized regions have their true design obscured. For example, the collars of ducts are also sclerotized and appear much wider than those in membranous areas. It is for this reason that the diameter of the various ducts were taken inside the bore. Pores recessed in heavily sclerotized regions have also been misidentified as ducts (e.g., *Antonina pretiosa* Ferris). In addition to being heavily sclerotized, the integument in some species appears squamate (Pl. 10, fig. B) in addition to being sclerotized.

Dorsal Structures

Ostiole (Pl. 1). Normally when developed, this slit-like organ resembles a set of lips and may be represented at most by two pairs. An anterior pair may be situated more or less between head and prothorax, and a posterior pair between segments VI-VII. Ostioles are believed to be defensive organs capable of releasing a fast-drying substance on antagonists (Cox 1987).

Ostioles are characteristic of Phenacoleachiidae and some Pseudococcidae, and are seldom present in adult "legless" mealybugs. They are typically reduced when present and represented by the posterior pair only. Yang & Kosztarab (1967) reported their presence in the immature stages of several species which lack them as adults.

Anal ring (Pl. 1, 2). As in most other mealybugs, the anal ring typically consists of a sclerotized ring with six flagellate setae and 2-3 rows of glandular pores. It may be flush with the derm, slightly recessed, or positioned at the end of an invaginated tube. Often between the anus and sclerotized ring is a membranous zone. The anus in those species with anal tubes often appears caudad to the anal ring (Pl. 3, fig. I).

The ring or the anal tube orifice is frequently located at the apex of abdominal segment VIII or slightly dorsad. In some species it is found centrally on segment VIII's dorsum (Pl. 19, fig. A) or slightly ventrad (Pl. 22, fig. A).

The entire structure shows tendencies toward general reduction, particularly in the sclerotized ring. In several species the ring is not fully complete and has a small, nonsclerotized area (Pl. 9, fig. G); whereas, in others the gap is greater and the ring is "U" shaped or semicircular (Pl. 2). In *Cypericoccus* the sclerotized ring is absent, and in

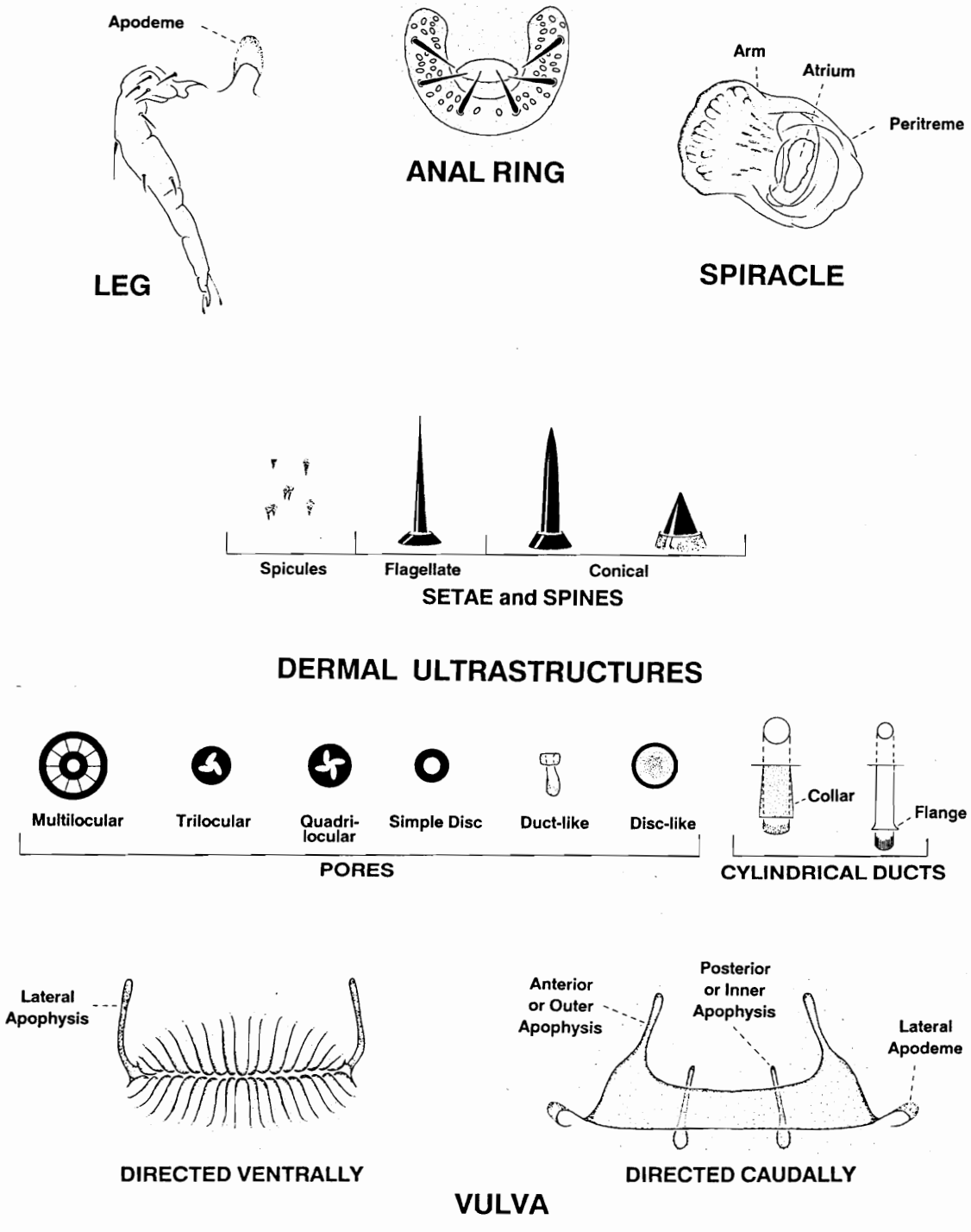

Plate 2. Morphological Details of Adult Female "Legless" Mealybug.

Peridiococcus Williams the entire structure is lacking. Not all species exhibit reduction in the anal ring. *Acinococcus triodiae* Williams and *Kermicus wroughtoni* Newstead show an increase in setal numbers to 8 and 26 setae, respectively.

Cerarii (Pl. 1). Found only in Pseudococcidae, a cerarius is composed of a marginal group of setae and occasionally trilocular pores. The setae are typically conical, but may be accompanied by flagellate forms called auxiliary setae. Cerarii are responsible for the formation of lateral wax filaments characteristic of some mealybugs. There may be as many as 18 pairs along the margin of the body or absent entirely.

Cerarii are found but in a few "legless" mealybugs and are reduced in nature. *Sphaerococcus casuarinae* Maskell possesses a pair on each of the last three abdominal segments. On the margin of the posterior abdominal segments in some *Antonina* Signoret are 1-2 conical setae that may be remnants of cerarii.

Other structures (Pl. 1). Between abdominal segments VII-VIII in some species is located a pair of apodemes for muscle attachment. Also seen in some species are irregular dermal depressions or "rosettes". They are also points for muscle attachment and their distinction is more prominent in older sclerotized individuals. Although they may be present on most body segments, they are best distinguished on the posterior abdominal segments.

Ventral Structures

Eyes (Pl. 1). Most species lack eyes. When present, they are often reduced or represented by small invaginated pits. Eyes mark the latero-posterior corner of the head.

Antennae (Pl. 1). There is a general reduction in the antenna of "legless" mealybugs, with a decrease seen in length and segmental number. Unlike eyes or legs which also show reduction, antennae are never absent. Rosciszewska (1989) included two species of "legless" mealybug in a detailed study of antennal characteristics and evolution.

Most have only 1-2 segments remaining with the terminal segment bearing various sensilla including trichoid, coeloconic, and thick-walled pegs. Campaniform sensilla, which are found on the pedicel of fully developed antennae (Rosciszewska 1989), are absent. In few species are the antennae plate-like (Pl. 6, fig. I). The presence and distribution of various sensilla appear more normal in those species that have 3-6 antennal segments (Pl. 22, fig. H).

Certain sensilla invariably appeared in the same position on the antennae of first instars of the same species. This consistency in markers should allow one to follow the fusion or loss of antennal segments during development.

Mouthparts (Pl. 1). The clypeolabral shield and labium mark the medio-posterior region of the head. The subordinal placement of the mouthparts is between the prothoracic coxae; however, legs or remnants of them are not always present. Their location was found to vary intraspecifically. In most of the bamboo-infesting genera, such as *Tangicoccus elongatus* (Tang), they are transposed caudally during maturation and are often superimposed with the anterior sternal apophyses (Pl. 14, fig. A). The mouthparts of *Acinococcus triodiae* are located further cephalad, very near the margin.

The clypeolabral shield varies in outline, but is typically 1.2-1.4X longer than broad. It is 1.7X longer than broad in *Cypericoccus multipori* Williams. In a detailed analysis of the shield, Koteja & Liniowska (1976) described the shape in six species of "legless" mealybugs as subrectangular. Some species possess an anterior, sclerotized projection which may attain a length subequal to the shield (Pl. 3, fig. A). It may serve as a place of muscle attachment for the salivary pump, although its true function is unknown. It appeared that the position of tentorial arms may serve as a diagnostic feature, but was invariably broken or shifted in mounted specimens.

Koteja (1974a) described the labium as 3-segmented for six species used in a comparative study of this structure; however, he further indicated that the basal segment was fused to the medial one. All labia examined in this study appeared two-segmented. When measuring across the base, most genera have a labium that is at least 1.2X wider than long, while some have these dimensions subequal. Few, such as *Peridiococcus*, have long labia.

Legs (Pl. 1, 2). A typical mealybug leg starting at the base consists of a coxa, trochanter, femur, tibia, and single tarsal segment with one claw. Prothoracic and mesothoracic legs are found more or less between the anterior and posterior borders of their respective segments. The metathoracic legs mark the posterior margin of its respective segment. Various sensilla may be found on the legs, such as digitules which are trichoid-like and located at the base of the claw. On the metathoracic legs of adult females in several species are glandular structures called translucent pores. It has been postulated that these pores, which are located primarily on the coxae, emit sex pheromones (Williams 1985). A discussion supporting this hypothesis is provided later.

The primary basis on which all the species covered in this study have been grouped into the Sphaerococcinae, or other such group, is that legs are absent or greatly reduced. The loss and fusion of segments may be seen as early as the second instar (Yang & Kosztarab 1967). At least one pair of legs are typically absent, but when lacking their location is often revealed by remnants such as apodemes (Pl. 2), pleural vestiges (Pl. 16, fig. L), or clusters of setae (Pl. 19, fig. J). Those legs that are present show various degrees of reduction and specialization. Frequently represented are small evaginated pouches covered by setae (Pl. 20, fig. G). Others possess legs less reduced and more like a typical mealybug leg (Pl. 17, fig. K); however, these moderately reduced legs are often broken off during mounting and may be portrayed as being absent or knob-like.

Some species have some or all segments of the metathoracic legs modified into large structures covered with glandular ultrastructures. These modifications may be described as being bag-like (Pl. 9, fig. I), or as plate-like if extremely flattened. The coxae in *Pseudantonina giganticoxa* Lobdell are greatly enlarged with the remaining leg segments present but reduced in nature (see Ferris 1953). Most other species merely have a bag or plate-like structure without any visible leg segments, though flagellate setae or the claw may be retained. Some species do not have modified metathoracic legs, but still possess similar glandular structures (see Dermal Ultrastructures below).

Spiracles (Pl. 1, 2). Ezzat & McConnell (1956) indicated the mesothoracic and metathoracic spiracles of Planococcini were within the intersegmental membrane between the nominal and preceding segments. This interpretation is followed here with each pair marking the anterior border of their respective segments. The spiracles are generally positioned in the submarginal region of the thorax; however, some species have them located along the margin of the body (e.g., *Serrolecanium kawaii*).

Unlike the typical spiracular arm which is narrow, most are very broad and heavily sclerotized. The atrium and immediate area are recessed into the body. Atria may also be surrounded by a sclerotized peritreme. The size of the posterior pair are normally larger than the anterior pair. The difference in size may be related to amount of tissue they serve for metabolic activity. In a specimen of *Idiococcus bambusae*, the secondary tracheae of the anterior pair were seen serving the head and mouthparts. Those of the posterior pair led to the mouthparts and abdomen, supplying oxygen to the vulva, anal ring, and other vital organs.

Several species also have several glandular structures associated with their atria. Determining the exact number present is often difficult because of dermal folding and

sclerotization in the nearby region; therefore, estimations of their range are provided in the descriptions. The wax produced by these glandular structures fill the atrial region and probably help conserve water during respiration. Wax-filled atria can easily be seen in unmounted specimens.

Circuli (Pl. 1). Found on the ventral midline of some Pseudococcidae are circuli which are probably adhesive organs (Williams 1978). A main circulus is located in the intersegmental membrane between abdominal segments III-IV, while additional ones may be present in other intersegmental membranes.

Few species in this study possess circuli. *Peridiococcus stypheliae* (Maskell) has a single circulus in the general location discussed above. The circuli of *Acinococcus* Williams are reduced and located on the body segment instead of in the intersegmental membrane.

Vulva (Pl. 1, 2). Often neglected for taxonomic studies, but found to be a strong diagnostic characteristic in at least the generic level are the vulva and its surrounding region. Positioned between abdominal segments VII-VIII, the genital opening in mealybugs is typically directed ventrally with the walls appearing wrinkled. There is a pair of apophyses laterally for muscle attachment, and at times there may be a medial pair posterior to the opening (Pl. 2). In several *Antonina* species the vulva is found between segments VI-VII or on VI itself.

The direction of the opening has shifted caudally in several species found deep under the leaf sheaths of their host. This transposition, which seems to have evolved independently in several groups, would facilitate mating and egg deposition in restricted microhabitats. In this design, the lateral apophyses appear to have moved anteriorly and the walls of the vulva are smooth. Some species also possess lateral apodemes for additional muscle attachment. The posterior pair of apophyses in *Serrolecanium* have moved caudally and arise from dermal depressions located on segment VIII.

Other Structures (Pl. 1). As on the dorsum, intersegmental apodemes and dermal depressions may be present on the ventral surface. Following the successive reduction of legs are the thoracic sternal apophyses which are absent or greatly reduced.

Dermal Ultrastructures

Numerous types of glandular structures, outgrowths, and sensilla are found on the mealybug body. The presence and distribution of these ultrastructures are often used to distinguish between species.

The terms 'duct' and 'pore' are used in accordance to general description and to current terminology. The inner ductule (Foldi 1991) which distinguishes ducts from pores is seldom evident. This is probably a reflection of the amount of sclerotization in the specimen in relation to the mounting techniques used. Ductules were seen arising from the trilocular pores of some *Chaetococcus bambusae*. This contradiction in diagnostic characteristics between 'duct' and 'pore' warrants a reevaluation of nomenclature for glandular structures. A classification of the various ultrastructures found among species included in this study is provided below.

Trilocular Pores (Pl. 1, 2). Trilocular pores produce the coarse, spiral wax often described as mealy and which constitutes the greater part of the body cover in most Pseudococcidae (Cox 1987, Foldi 1991). Typically found on much of the dorsum and venter, the pore has three locules or openings and a sclerotized rim that is slightly triangular to circular. Although frequently uniform in size, two distinct size groups can be found in some species (e.g., *Antonina pretiosa*). In *Antonina australis*, the septa are elongate and cause the pore to appear somewhat tritubular. Most species examined in this study possess trilocular pores.

Quadrilocular Pores (Pl. 2). These pores are very similar to trilocular pores and are found associated with the spiracular openings of *Porisaccus sasae* (Siraiwa) and *Peridiococcus stypheliae*. The outer margin of the rim is circular to quadrate.

Multilocular Pores (Pl. 1, 2). These wax producing glands may have 8-11 locules surrounding a central hub, but 10 is predominant among the species examined. The outer margin of the hub is raised and gives the appearance of a central or inner "rim" in mounted specimens. The short, curved wax filaments (Cox 1987, Foldi 1991) produced by these pores form a powder. The distribution of multilocular pores varies among those species that possess them, but they were found most often along the body's margin and on the posterior abdominal segments. It is the only pore type present in *Cypericoccus multipori*.

Quinquelocular Pores. This type of wax gland with five locules is found among several species erroneously assigned to the heterogeneous *Sphaerococcus*. It produces wax similar to multilocular pores (Foldi 1991).

Simple Disc Pores (Pl. 1, 2). This minute pore is also known as discoidal (Williams & Granara de Willink 1992), or simple (Cox 1987). It is seldom larger than a trilocular pore and was found in all species examined. Classifying it as a "pore" may be incorrect because its function is currently unknown.

The ultrastructure consists of a sclerotized rim and what appears under light transmission to be a single locule. The "locule" may be granular, and is either concave or convex. Its distribution among specimens invariably follows that of known wax-producing glands and suggests that it may be sensory in nature. This structure could serve to regulate wax production if it were a temperature or humidity receptor.

Other Pores (Pl. 1, 2). Two types of glandular structures termed duct-like and disc-like are found on the venter of several species. Although structurally different, they are treated together because of their homology with translucent pores discussed above under "Legs".

Duct-like pores are short, tubular structures with or without a sclerotized collar near their orifice. The orifice is circular or irregular in shape, and the inner end of the tube may be faintly sclerotized as it is in cylindrical ducts. Some inner ends appeared granular when looking down the bore at different focal planes. In general the pore length is approximately 2X the diameter, which itself is typically smaller than that of a simple disc pore. The term "duct-like" is adapted from Williams & Watson's (1988) usage; however, this structure has also been called tubular micropore (Goux 1935), pore-like duct (Williams & Watson 1988), and minute duct (Williams & Granara de Willink 1992).

Duct-like pores in some species are grouped around the base of reduced metathoracic legs (Pl. 22, fig. A), while in several other species they are grouped in a region typically occupied by metathoracic legs (Pl. 4, fig. A). The glandular structures found on bag-like metathoracic legs (e.g., *I. bambusae*) are of this type (Pl. 7, fig. A). They form a marginal band on the abdomen in *Tangicoccus elongatus* (Tang). Most unusual is their added presence around the mesothoracic legs of *Pseudantonina bambusae* Green. Tang (1984a, 1984b) proposed that duct-like pores secrete an exudate that adheres the body to its host. This hypothesis is disputed in Chapter III and in the "Conclusion" chapter.

Disc-like pores (Williams 1985), like duct-like pores, are usually found in the vicinity of the metathoracic legs, whether these appendages are present or not. The pore usually has a sclerotized rim and is circular in outline. Some, however, are irregular in outline whether or not a rim is present. The single locule appears granulate under light transmission and is typically concave. The curvature of the locule when concave is often shallow with the depth less than the pore's diameter. The diameters of these pores on a given specimen are usually subequal; however, in some *Antonina* the size range on a

given individual may be great. In *Antonina purpurea* Signoret for example, the smallest diameter on a given specimen is subequal to a simple disc pore while the largest is subequal to a multilocular pore.

Disc-like pores have also been called sieve-like (Ferris 1953) because of the granular locule, and discoidal (Williams & Watson 1988) because of their similarities to simple disc pores. In some genera (e.g., *Sphaerococcus*) they are found on the coxal remnants, while in others (e.g., *Acinococcus*) they are grouped on the body immediately around the reduced appendages. Their distribution among *Antonina* species is too variable for a detailed discussion here; nevertheless, it is worth noting that disc-like pores in *Antonina thaiensis* Takahashi are additionally found in the area where mesothoracic legs are typically located.

Cylindrical Ducts (Pl. 1, 2). These glandular structures are invaginated, cuticular tubes that secrete the long, hollow filaments of wax which typically make up the ovisac in Pseudococcidae (Williams 1985, Cox 1987). The inner end is sclerotized, and either flat or slightly rounded. As indicated earlier, the ductule which characterizes a duct is seldom evident; however, the region where it passes through the inner end is often less sclerotized. The term "tubular duct" has typically been used to describe this structure (Beardsley 1984b, Cox 1987, Williams & Granara de Willink 1992). The descriptive "tubular" was dropped because of its redundancy and replaced with "cylindrical" to distinguish it from flattened ducts which are also found among Coccinea.

There are a variety of sizes and forms which are often diagnostic at the generic level, but the spectrum of designs is discussed in more detail within the individual descriptions which follow. In addition to the tube, there may be a sclerotized collar which surrounds some or most of the duct. A small flange or lip may be present near the inner end of the duct in addition to the collar or alone.

Setae (Pl. 1, 2). Two general shapes of setae, or trichoid sensilla, are present among the species examined. Flagellate setae are thin and hair-like with an acute tip. In outline, the sides from base to tip appear convex. Conical setae in general are robust with a blunt tip, and appear concave in outline from base to tip. Needless to say, some setae do not easily fit into either one of these generalities.

Although the distributions and sizes vary among the two types, both are usually longer and more numerous along the margins of the body and on the posterior abdominal segments. It was observed that setae typically formed staggered, transverse rows across the abdominal segments. This distributional pattern helped locate and number these

segments in species without distinct segmentation. Ventrally near the posterior apex of some species is a pair of enlarged flagellate setae called apical setae (= anal lobe setae). Cisanal and obanal setae which are present in some mealybugs were not evident in the species examined.

Spicules (Pl. 2). Spicules or microspines are small, tooth-like projections on the derm. Typically confined to the medial regions of the abdomen, they may be separate or in groups of two or more. Their visibility is very dependent on adequate staining and proper mounting of specimens. They are not drawn on the body outline of the species illustrations due to their minuteness; however, enlargements are included within circles.

Aberrations. Ultrastructural abnormalities were observed in almost every species. The predominant aberration was the fusion of a simple disc pore to another ultrastructure, including setae. Two simple disc pores linked to each other were at first confused as bilocular pores on many occasions. Trilocular and multilocular pores were observed fused to others of the same type, and a few setae were joined at the their bases. Yet fusion was not the only change seen. Trilocular pores occasionally had an extra locule or lacked a locule.

KEY TO GENERA OF ADULT FEMALE "LEGLESS" MEALYBUGS*

1. Vulva directed caudally and with smooth walls (Pls. 1, 2); clypeolabral shield with anterior projection (Pl. 1), except in *Paludicoccus* **2**

   Vulva directed ventrally and with wrinkled walls (Pl. 2); clypeolabral shield without anterior projection **9**

2. Specialized pores on abdominal venter disc-like (Pl. 15, fig. L), located around reduced metathoracic legs (Pl. 15, fig. A); cylindrical ducts of two types (Pl. 15, figs. D, E), both subequal in length and with oral collar, diameter of one type about 2X greater than second type; antennae with 3-6 segments ..... ***Acinococcus***, p. 115

   Specialized pores on abdominal venter duct-like (Pl. 2), distribution variable, often on modified metathoracic legs or in region typically occupied by these appendages; cylindrical ducts of one size or absent; antennae with 1-4 segments **3**

3. Antennae 3-4 segmented (Pl. 15, fig. I); multilocular pores normally with 7 locules (Pl. 15, fig. B); cylindrical ducts ca. 2.5X longer than wide, with oral collar one-half length of duct (Pl. 15, fig. E) ..... ***Paludicoccus***, p. 188

   Antennae 1-2 segmented; multilocular pores absent or with 9-10 locules; cylindrical ducts absent or ca. 2.0X longer than wide (Serrolecaniini) **4**

4. 26 anal ring setae; no lateral constrictions between abdominal segments; dorsum densely covered by long flagellate setae ..... ***Kermicus***, p. 64

   6 anal ring setae; lateral constriction present at least between last two abdominal segments; dorsum not densely covered with setae **5**

5. Anal ring semicircular or U-shaped (Pl. 2), located more or less centrally on dorsum of abdominal segment VIII; conical setae absent **6**

   Anal ring circular or nearly so, never U-shaped, located terminally on abdominal segment VIII or at end of invaginated tube (Pl. 1); conical setae present **7**

6. Multilocular pores present on abdominal venter (Pl. 7, fig. A); metathoracic legs modified into large, flattened pouch, with numerous duct-like pores; apex of abdomen often with anal cleft ..... ***Idiococcus***, p. 55

   Multilocular pores absent from venter; metathoracic legs absent, duct-like pores form marginal band between metathoracic spiracles and last abdominal segment (Pl. 14, fig. A); no anal cleft ..... ***Tangicoccus***, p. 101

7. One to several abdominal segments with latero-posterior lobes; multilocular pores absent **8**

   Abdominal segments without latero-posterior lobes (Pl. 3, fig. A); multilocular pores often present ..... ***Chaetococcus***, p. 29

8. Latero-posterior lobes limited to last abdominal segment (Pl. 9, fig. A); metathoracic legs bag-like and covered with numerous duct-like pores (Pl. 9, fig. I); posterior vulvar apophyses arise near vulvar orifice ..... ***Porisaccus***, p. 66

   Latero-posterior lobes on two or more abdominal segments (Pl. 10, fig. A); metathoracic legs absent, duct-like pores grouped posterior to metathoracic spiracles; posterior vulvar apophyses arise from dermal plates on abdominal segment VIII ..... ***Serrolecanium***, p. 79

9. Trilocular pores absent (Pl. 18, fig. A); multilocular pores numerous and of 2 sizes (Pl. 18, fig. B, C), one type ca. 1.3X larger than other; duct-like or disc-like pores absent from venter; spiracles without distinct crescentic band of glandular pores at opening ..... ***Cypericoccus***, p. 181

Trilocular pores present; multilocular pores absent or of one general size; abdominal venter or modified metathoracic legs typically with duct-like or disc-like pores; spiracular opening with distinct band of glandular pores **10**

10. Without duct-like or disc-like pores on venter (Pl. 20, fig. A); labium ca. 1.5X wider than long; with two types of cylindrical ducts (Pl. 20, fig. B, C), small collared-type with length and width subequal, second type ca. 4.5X longer than broad and with oral collar about 1/4 length of duct ..... ***Parapaludicoccus***, p. 194

Abdominal venter or modified metathoracic legs with duct-like or disc-like pores; labium width ≤1.2X length; cylindrical ducts not as above if of two types **11**

11. Duct-like pores present around base of reduced mesothoracic legs (Pl. 22, fig. A); anal ring semicircular or U-shaped; metathoracic coxae reduced, not enlarged and covered by disc-like or duct-like pores ..... ***Pseudantonina***, p. 206

Duct-like pores not present around base of reduced mesothoracic legs; anal ring complete or absent; metathoracic coxae absent, or enlarged and covered by disc-like or duct-like pores **12**

12. Length of labium > 1.2X width; metathoracic coxae enlarged and covered by disc-like or duct-like pores **13**

Length of labium < 1.2X width; metathoracic coxae not enlarged and covered by disc-like or duct-like pores (except the questionable *Antonina australis*) **14**

13. Posterior dorsal ostioles present (Pl. 23, fig. A), reduced at times; anal ring present and at end of invaginated tube; antennae with 2-5 segments; cylindrical ducts absent, or few collarless ducts present with length ≤2.5X width (Pl. 23, fig. L) ..... ***Sphaerococcus***, p. 212

Posterior dorsal ostioles absent (Pl. 21, fig. A); anal opening simple, without sclerotized ring or setae (Pl. 21, fig. H); antennae unsegmented; cylindrical ducts numerous with at least one collared type ca. 4X as long as wide (Pl. 21, fig. E) ..... ***Peridiococcus***, p. 199

14. Anal opening simple, without complete ring, possibly with two setae; cylindrical ducts ca. 4X longer than broad, with oral collar that extends 3/4 length of duct; posterior dorsal ostioles absent ..... ***Nesticoccus***, p. 186

Anal ring present with six setae, often at end of invaginated tube; if cylindrical duct ca. 4X longer than broad, then oral collar extends 1/3 length of duct or duct with flange near inner end only **15**

15. Cylindrical ducts on head and thorax with flange near inner end (Pl. 16, fig. F); disc-like pores present on abdominal venter (Pl. 16, fig. E), pore diameter ≥ that for trilocular pore [*A. vera* without disc-like pores; *A. australis* without cylindrical ducts, disc-like pores on modified metathoracic coxae].....***Antonina***, p. 121

    Cylindrical ducts on head and thorax with oral collar at base that extends 1/3 length of duct (Pl. 17, fig. F), never with flange near inner end; duct-like pores present on abdominal venter (Pl. 17, fig. M), pore diameter ≤ 1/2 that for trilocular pore .....***Antoninoides***, p. 168

*Based on adult female morphology of species recognized as belonging to those genera covered in this study.

CHAPTER II
REVISION OF THE TRIBE SERROLECANIINI

Serrolecaniini Shinji, 1935

Serrolecaniniinae Shinji, 1935a: 106. (*lapsus*)
Serrolecaniinae Shinji; Ferris 1950a: 72; Williams, 1969: 336; Ali, 1970: 100.
Serrolecaniina Shinji; Tang, 1992: 32-33.

Species belonging to the tribe Serrolecaniini are found predominantly in the eastern Palearctic and Oriental realms. *Chaetococcus* spp. are located primarily in central and western Palearctic regions, except for *Chaetococcus bambusae* (Maskell) which is worldwide in distribution. Host plants attacked by this diverse group are limited to the Poaceae, especially bamboos. The six genera included can be distinguished from other mealybugs by the following combinations of characters.

DEFINITION

General. Body of adult female variable, typically ovate or elliptical with parallel sides, flattened dorso-ventrally or convex dorsally; abdominal segmentation often distinct, lateral constriction between segments VII-VIII distinct with segment VIII appearing expanded laterally (except *Kermicus*), constrictions between other segments may also be distinct; abdominal segments with or without latero-posterior lobes; anal lobes absent, but anal cleft may be present (*Idiococcus*).

Dorsal Structures. Ostioles and cerarii absent; anal ring circular or semicircular, with numerous pores and typically six setae (26 in *Kermicus*), ring terminal or centrally located on segment VIII, at end of tube or slightly recessed; body often with pair of sclerotized apodemes between abdominal segments VII-VIII; segment VIII typically with pair of dermal depressions on submedial-submarginal region, depression devoid of ultrastructures.

Ventral Structures. Antennae reduced, 1-2 segments; eyes usually absent, represented by invaginated pits when present; clypeolabral shield with prominent anterior projection; labium broader than long, 2-segmented; spiracles typically as broad as long, heavily sclerotized, often with peritreme and numerous glandular pores associated with atria (see *Kermicus*); legs absent or represented by evaginated pouches, diameter of metathoracic leg when pouch-like as equal to greater than spiracle; vulva distinct and slit-like, directed caudally, with four apophyses, at times with two lateral apodemes (*Chaetococcus*);

segment VIII typically with submedial pair of dermal depressions near vulva, depression clothed with flagellate setae at times; circuli absent.

Dermal Ultrastructures. Trilocular pores and simple disc pores present, typically distributed over most of body; multilocular pores present or absent, confined to venter when present. Large, cylindrical ducts with collar present or absent, distribution varies, tube length approximately 2X the diameter, collar about 2/3 length of tube, species which lack them as adult females often have them present in earlier instars. Duct-like pores present, typically grouped posterior to metathoracic spiracle in area once occupied by legs or on modified metathoracic legs. Spicules present, solitary or in groups of two or more, often confined to inner regions of abdomen; flagellate setae present with variable distribution; conical setae present or absent, located primarily along margin when present; apical setae present or absent.

First Instar Nymphs. Although this study is a comparative analysis of adult females, an unusual structure present in the first instar developmental stage appears relevant to understanding the relationship between species of "legless" mealybugs. In first instars of *Antoninella* (= *Chaetococcus*) *sulci*, Sulc (1944) described a pair of elliptical clusters containing cylindrical ducts on the venter of abdominal segment I. Tang (1984a, 1984b) later discovered a pair of small, oval "plates" immediately behind the metathoracic legs in first instars of his newly described *Idiococcus maanshanensis* (= *I. bambusae*). He suggested that bag-like appendages seen in genera such as *Idiococcus* probably develop from these "plates", and are not vestiges of the metathoracic legs.

Information supporting the vestigial leg hypothesis can be found under "Legs" in Chapter I. Furthermore, the glandular bag-like leg of adult females was seen within the metathoracic leg of molting third instars of several species that were available for study, thus identifying their structural origin. Despite Sulc's and Tang's mistaken interpretations of this structure in first instars and its function, the existence of such a morphological structure led me to investigate its presence in other species of "legless" mealybugs.

This first instar structure was found to be a lightly sclerotized, funnel-shaped invagination located latero-posterior to the metathoracic legs. Illustrations of its location can be found in Sulc (1944) and Tang (1984a, 1984b). It is evident in both late embryonic and hatched first instars, but detecting it is often difficult and dependent on the degree of sclerotization and staining. This unusual structure of unknown function was seen in *Chaetococcus bambusae*, *Chaetococcus sulci*, *Idiococcus bambusae*,

Kermicus wroughtoni, *Porisaccus jiuhuaensis*, *Porisaccus sasae*, *Serrolecanium indocalamus*, *Serrolecanium tobai*, and *Tangicoccus elongatus*. First instars and embryos were not available for the other four species assigned to the tribe; however, there were specimens for several non-serrolecaniine species. In none of these other species was this structure observed, including those of *Antonina* Signoret and *Sphaerococcus* Maskell.

Remarks. Although *Chaetococcus* as a whole best represents the tribe structurally, priority dictates the use of the *Serrolecanium*-group name. Shinji (1935a) established the subfamily Serrolecaniinae for inclusion of his *Serrolecanium bambusae* (= *Serrolecanium tobai*), which he shortly transferred to Lecaniinae Targioni-Tozzetti (Shinji, 1935b). Tang's (1992) subtribal use is the only other time that it has been applied for a taxonomic group.

The genera included here appear to form a natural group and can be distinguished from other mealybugs by the following combination of characteristics: duct-like pores present on modified metathoracic coxae or immediate area of body, clypeolabral shield with anterior projection, vulva directed caudally and with four prominent apophyses; prominent pair of dermal depressions present on venter of abdominal segment VIII; and first instars with a pair of invaginated pits latero-posterior to the metathoracic legs. Most species also have conical setae and cylindrical ducts as described above in at least one developmental stage.

Key to Genera of Tribe Serrolecaniini

1. 26 anal ring setae; no lateral constrictions between abdominal segments; dorsum densely covered by long flagellate setae..... ***Kermicus***, p. 64
   6 anal ring setae; lateral constriction present at least between last two abdominal segments; dorsum not densely covered with setae..... **2**
2. Anal ring semicircular or U-shaped (Pl. 2), located more or less centrally on dorsum of abdominal segment VIII; conical setae absent..... **3**
   Anal ring circular or nearly so, never U-shaped, located terminally on abdominal segment VIII or at end of invaginated tube (Pl. 1); conical setae present..... **4**
3. Multilocular pores present on abdominal venter (Pl. 7, fig. A); metathoracic legs modified into large, flattened pouch, with numerous duct-like pores; apex of abdomen often with anal cleft..... ***Idiococcus***, p. 55

Multilocular pores absent from venter; metathoracic legs absent, duct-like pores form marginal band between metathoracic spiracles and last abdominal segment (Pl. 14, fig. A); no anal cleft ..... ***Tangicoccus***, p. 101

4. One to several abdominal segments with latero-posterior lobes; multilocular pores absent **5**

Abdominal segments without latero-posterior lobes (Pl. 3, fig. A); multilocular pores often present ..... ***Chaetococcus***, p. 29

5. Latero-posterior lobes limited to last abdominal segment (Pl. 9, fig. A); metathoracic legs bag-like and covered with numerous duct-like pores (Pl. 9, fig. I); posterior vulvar apophyses arise near vulvar orifice..... ***Porisaccus***, p. 66

Latero-posterior lobes on two or more abdominal segments (Pl. 10, fig. A); metathoracic legs absent, duct-like pores grouped posterior to metathoracic spiracles; posterior vulvar apophyses arise from dermal plates on abdominal segment VIII..... ***Serrolecanium***, p. 79

Chaetococcus Maskell

Type Species: *Sphaerococcus bambusae* Maskell (1893); by subsequent designation of Fernald, 1903: 120.

Chaetococcus Maskell, 1893: 237-238; Maskell, 1898: 249-250; Fernald, 1903: 120; Morrison & Morrison 1922: 55-58; Goux, 1935: 95-96; Goux, 1937: 94; Borchsenius, 1949a: 314-315; 1949b: 137-139; 1950: 113-115; Morrison & Morrison 1966: 33; Ter-Grigoryan, 1973: 227; Tereznikova, 1975: 168-170; Kosztarab & Kozár, 1978: 36-38; Wang, 1982: 130-131; Williams, 1985: 67-69; Kosztarab & Kozár, 1988: 79-80; Williams & Watson, 1988: 29; Williams & Granara de Willink, 1992: 96-98; Tang, 1992: 27-28.

Antoninella Sulc, 1944: 148-149; Morrison & Morrison, 1966:12. [junior homonym of *Antoninella* Kiritshenko, 1938: 233.]

Sulcicoccus Hendricks & Kosztarab, **nomen novum** [replacement name for *Antoninella* Sulc, 1944. Type species: *Antonina sulci* Green; Sulc, 1944: 150, by original designation and monotypy]

Members of *Chaetococcus* Maskell are found on bamboos, reeds, and grasses in the Palearctic Region (Fig. 1), except *Chaetococcus bambusae* (Maskell) which is worldwide

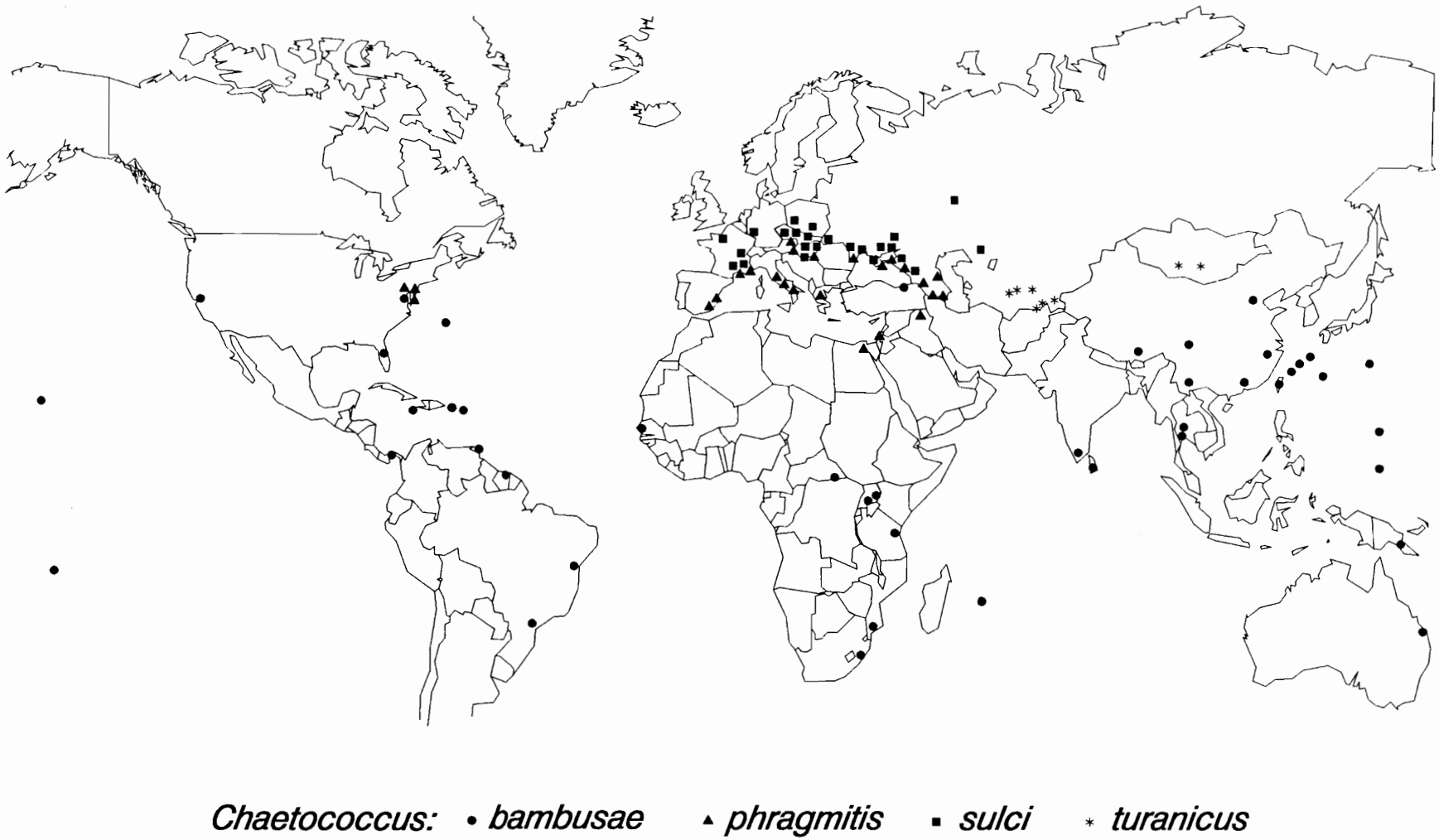

Figure 1. Distribution of *Chaetococcus* species.

in distribution. Maskell (1898) established *Chaetococcus* for *Sphaerococcus bambusae* Maskell and *Chaetococcus* (= *Antonina*) *graminis* Maskell. The only definition given for the genus was that anal ring hairs were present in adult females, which were thought absent in *Sphaerococcus* Maskell. Morrison & Morrison (1922) provided the first generic description for the then monotypic genus; however, its distinctness from *Antonina* Signoret was questioned.

Goux (1935, 1937) recognized similarities between *Antonina bambusae* (Maskell), *Antonina australis* Green, *Antonina phragmitis* Marchal, and *Antonina sulci* Green, and classified these species in the subgenus *Chaetococcus*. Among the characters used to define the subgenus was the presence of "de micropores tubulaires" (duct-like pores) behind the posterior spiracles. Borchsenius (1949a) elevated the group to the genus level and described the species *Chaetococcus turanicus* and *Chaetococcus transcaucasicus* as new from the former Union of Soviet Socialist Republics. The former was later treated as a species of *Antonina* Signoret (Danzig 1972). Tang (1992) transferred *Antonina zonata* Green to *Chaetococcus*.

Four species are recognized to belong to *Chaetococcus*. Species *australis* and *zonata* are returned herein to the genus *Antonina*. Neither possess characteristics which describe *Chaetococcus*, such as duct-like pores in area posterior to the metathoracic spiracles and vulvar design. *Chaetococcus transcaucasicus* is transferred herein to *Antonina* for it also has disc-like pores posterior to the metathoracic spiracles (Borchsenius 1949a, Ter-Grigoryan 1973).

Sulcicoccus is a replacement name for *Antoninella* Sulc, a junior homonym of the coccid *Antoninella* Kiritshenko, 1938. This name honors Dr. Sulc for his contributions to our knowledge of Central European scale insects. The type species is the only species ever assigned to *Antoninella* Sulc, and this species is presently treated under *Chaetococcus* Maskell; therefore, *Sulcicoccus* is treated as junior synonym of *Chaetococcus*. Ironically, Kiritshenko (1938) found *Antonina sulci* in a mixed infestation with *Antoninella inaudita* Kiritshenko, the type species of this genus.

DEFINITION

General. Body of adult female elliptical with parallel sides to circular, flattened dorso-ventrally or convex dorsally; lateral constriction between abdominal segments VII-VIII prominent, thus causing segment VIII to appear laterally expanded, constrictions sometimes evident between segments IV-VII.

Dorsal Surface. Ostioles absent; cerarii absent; anal ring with numerous pores and 6 setae, setae with knob at tip, ring located at end of invaginated tube or flush with derm, anal ring or opening to anal tube at end of segment VIII or slightly dorsad; sclerotized apodemes submedially between abdominal segments VII-VIII or absent; segment VIII often with pair of dermal depressions on submedial-submarginal region.

Trilocular pores and simple disc pores distributed over much of surface; cylindrical ducts with long collars typically present; conical setae present, located primarily along margin; flagellate setae occasionally present.

Ventral Surface: Antennae reduced to 1-2 segments; eyes absent; clypeolabral shield with prominent anterior projection; labium broader than long, 2-segmented; spiracles heavily sclerotized, as broad as long, often with sclerotized peritreme, numerous trilocular and simple disc pores associated with atria; legs absent but with compact group of duct-like pores behind posterior spiracles in area typically occupied by metathoracic legs; vulva distinct and slit-like, directed caudally, with four slender apophyses, at times with two lateral apodemes (*C. bambusae*), posterior or inner pair of vulvar apophyses partially arise from segment VIII; segment VIII with submedial pair of dermal depressions which are devoid of ultrastructures.

Trilocular and simple disc pores distributed over much of surface, multilocular pores present or absent (*C. sulci*); cylindrical ducts with long collar present (absent in some *C. bambusae*); conical and flagellate setae present, conical found primarily along margin of body; apical setae sometimes evident (*C. sulci*); circuli absent.

Remarks. *Chaetococcus* appears most similar to the genera *Porisaccus* Hendricks & Kosztarab, and *Serrolecanium* Shinji. Members of these three genera possess conical setae, cylindrical ducts with long collars during at least one stage of development, an anterior projection on the clypeolabral shield, duct-like pores behind the metathoracic spiracles, a caudally directed vulva with two pairs of apophyses, and a distinct constriction between abdominal segment VII-VIII. *Chaetococcus* spp., however, do not have latero-posterior lobes on any of the abdominal segments as do these other genera. *Porisaccus* spp. also have their duct-like pores located on evaginated pouch or bag and *Serrolecanium* spp. have the posterior vulvar apophyses arising from the dermal depression on abdominal segment VIII.

Key to Species of Genus *Chaetococcus*

1. Multilocular pores absent; cylindrical ducts present on medio-submedial region of dorsum (Plate 5, A)..... ***sulci***, p. 46

   Multilocular pores present; medio-submedial region of dorsum without cylindrical ducts.....**2**

2. Vulva with associated lateral apodemes (Plate 3, A); multilocular pores restricted to posterior abdominal segments; length of anterior projection subequal to length of shield..... ***bambusae***, p. 33

   Vulva without lateral apodemes (Plate 4, A); multilocular pores present along entire margin of body; length of clypeolabral shield's anterior projection ca. 1/3 that of shield.....**3**

3. Anal ring complete, at end of invaginated tube (Plate 4, H); cylindrical ducts distributed along entire margin of body (Plate 4, A) ..... ***phragmitis***, p. 40

   Anal ring divided in halves, not at end of invaginated tube (Plate 6, H); cylindrical ducts restricted to latero-posterior region on each of last 3 abdominal segments..... ***turanicus***, p. 51

Chaetococcus bambusae (Maskell)
Plate 3

Sphaerococcus bambusae Maskell, 1893: 237-238. [lectotype designated by Williams, 1985: 71]

Chaetococcus bambusae (Maskell) Maskell, 1898: 249-250; Morrison and Morrison, 1922: 55-58; Borchsenius, 1949a: 315-316; Williams, 1958a: 206-209; Beardsley, 1966: 407; DeLotto, 1969: 2; Kawai, 1980: 122-123; Wang, 1982: 131-132; Yang, 1982: 98; Williams, 1985: 71; Williams & Watson, 1988: 29-31; Williams & Granara de Willink, 1992: 98; Tang, 1992: 28-29.

Kermicus (*Chaetococcus*) *bambusae* (Maskell) Cockerell, 1899a: 392.

Kermicus bambusae (Maskell) Kirkaldy, 1902: 104.

Antonina (*Chaetococcus*) *bambusae* (Maskell) Green, 1907: 199; Goux, 1935: 96.

Antonina bambusae (Maskell) Ferris, 1921: 211; Green, 1922: 397-398; Fullaway, 1923: 308; Zimmerman, 1948: 150-151; Merrill, 1953: 111; Tao, 1978: 110.

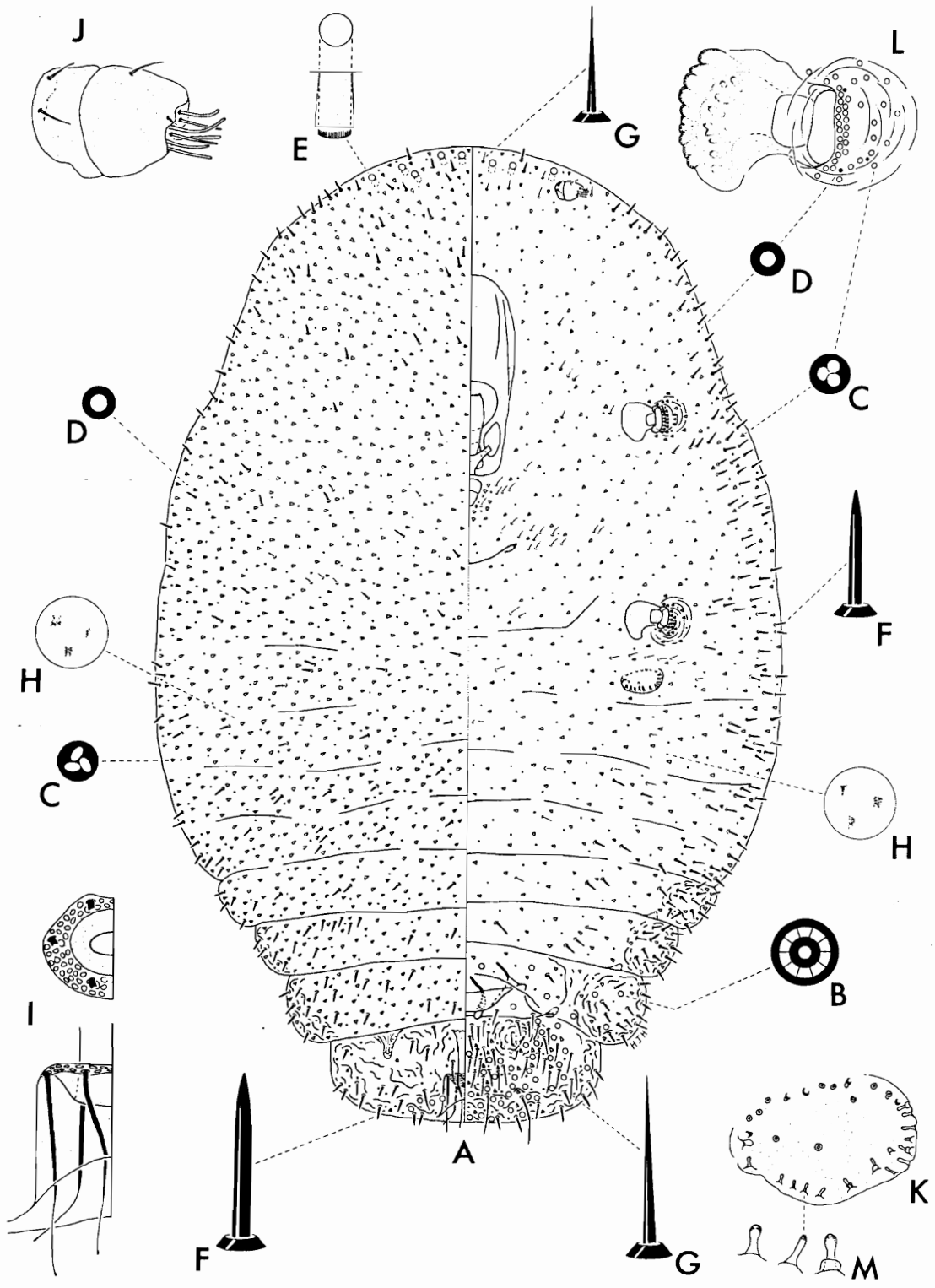

Plate 3. ***Chaetococcus bambusae*** **(Maskell), Adult Female.**

GENERAL DESCRIPTION

Body of Adult Female. Unmounted individuals broadly ovate to obovate, flattened dorso-ventrally or slightly convex dorsally; anterior end rounded, caudal end truncate or concave, often dependent on location of anal tube opening; abdominal segmentation distinct, lateral constriction between abdominal segments IV-VIII great, last four abdominal segments well-defined laterally; mouthparts typically positioned between anterior spiracles, sometimes located further posteriad; color yellow-brown to dark brown.

On microscope slide (fig. A): 3258μm (2295-6699) long, 2225μm (1465-4681) wide; body outline as mentioned above; only the posterior segments heavily sclerotized in young adult females, entire body of mature adult females may be sclerotized.

Dorsal Surface

Multilocular Pores (fig. B, venter). 9.31μm (6.65-12.4) in diameter, with 10 locules; located around anal tube opening.

Trilocular Pores (fig. C). 5.05μm (3.80-6.65) in diameter, rim triangular to circular; distributed over entire surface, fewer found medially and on abdominal segment VIII.

Simple Disc Pores (fig. D). 3.35μm (1.90-4.75) in diameter, with circular rim, scattered over entire surface.

Cylindrical Ducts (fig. E). Large, with collar approximately 2/3 length of tube, 9.67μm (8.55-11.4) in diameter, 17.5μm (14.3-22.8) long; distributed along margin of head, rarely extending down margin of thorax.

Setae. Of two types. Conical (fig. F): 6.65-34.2μm long, usually stout, shortest lengths located medially; distributed over entire surface, but found primarily along margin. Flagellate (fig. G, venter): sparsely scattered on head and thorax, and on medial region of abdominal segment VIII; those on head and thorax slender and 5.70-9.50μm long, those on segment VIII thick and 24.7-38.0μm long.

Spicules (fig. H). Minute, 0.95-2.85μm long, either solitary or in groups of two or more; located on medio-submarginal region of metathorax and abdomen, occasionally on margin of abdomen.

Anal Ring (figs. I). 97.1μm (85.8-104) in diameter; at base of anal tube that is 83.1μm (71.9-88.2) long, tube opening terminal or slightly dorsad; anal ring pores numerous, 2.28μm (1.90-2.85) in diameter; with 6 anal ring setae 81.2-150μm long, setae extend beyond length of anal tube, tips slightly knobbed.

Other Structures. Sclerotized depression located submarginally on anterior half of abdominal segment VIII, depression devoid of ultrastructures.

Ventral Surface

Antennae (fig. J). Two-segmented, 52.6μm (40.95-61.8) long, diameter at base 45.8μm (39.0-55.1).

Clypeolabral Shield. Approximately 1.3X longer than broad, 228μm (210-260) long, 175μm (139-208) wide; length of anterior projection subequal to that of shield, 182μm (143-280) long.

Labium. Approximately 1.2X wider than long, 60.3μm (46.4-78.9) long, 72.9μm (60.3-90.5) wide at base; two-segmented.

Legs. Absent. Compact group of duct-like pores behind posterior spiracles (fig. K) in area typically occupied by metathoracic legs; pore group slightly raised and with distinct boundary in some individuals, thus appearing plate-like; remnants of metathoracic legs represented at times by 1-2 flagellate setae among pore group.

Spiracles (fig. L). Anterior: spiracular arm 109μm (90.5-128) long, as broad as long, peritreme indistinct or entirely absent; atrium 66.4μm (55.7-81.2) wide; with 34-82 trilocular pores associated with atrium, some of which form a crescent-shaped band at opening, 2-5 simple disc pores may also be associated with atrium. Posterior: similar to anterior pair, but slightly larger; arm 118μm (99.8-137) long; atrium 79.3μm (60.3-92.8) wide; 45-130 trilocular pores and 1-9 simple disc pores associated with atrium.

Multilocular Pores (fig. B). Structure as that on dorsum, 9.76μm (6.65-12.4) in diameter; distributed over entire surface of abdominal segments VII-VIII.

Trilocular Pores (fig. C). Structure as that on dorsum, 5.50μm (3.80-4.75) in diameter; distribution similar to that on dorsal surface but less dense, grouped around labium and at spiracular opening.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.43μm (1.90-5.70) in diameter; distribution similar to that on dorsal surface, also grouped around labium and scattered at spiracular opening.

Duct-like Pores (fig. M). Large, 4.59μm (2.85-6.65) in diameter, 8.96μm (7.60-11.4) long, some with collar at base; grouped in area typically occupied by metathoracic legs (see "Legs" above).

Cylindrical Ducts (fig. E, dorsum). Structure and distribution as that on dorsum, 9.14μm (7.60-10.5) in diameter, 17.4μm (16.2-19.0) long.

Setae. Of two types. Conical (fig. F): Structure as that on dorsum, 7.60-36.1μm long; distributed on submargino-marginal region of head, thorax and abdominal segments II-VII, and along margin of abdominal segment VIII. Flagellate (fig. G): few sporadically distributed on margin of head, medio-submarginal region of thorax and abdominal segments II-VII, those on segment VII located near vulva; more found on entire surface of segment VIII; the setae on segments VII-VIII long and thick, 19.0-90.3μm long, all others slender and 7.60-23.8μm long; no distinct apical setae among flagellate setae.
Spicules (fig. H). Structure as that on dorsal surface, 0.95-3.80μm long; located on medial region of metathorax, medio-submarginal region of abdominal segments II-V, submedio-submarginal region of segment VI, and sparsely along submargin of segments VII-VIII.
Vulva. Distinct, smooth, with opening directed toward caudal end; with four associated apophyses and two lateral apodemes.
Other Structures. Mesothoracic sternal apophyses evident; sclerotized apodemes sometimes present submarginally between segments V-VII; sclerotized depression located submedially on anterior half of abdominal segment VIII, depression devoid of ultrastructures.
Type Material Examined. Lectotype on undetermined bamboo, **USA**, Hawaii, as "Sandwich Islands", Honolulu, date unknown, coll. A. Koebele, 2(1) NZAC (slides labeled as "*Chaetococcus ~~Sphaerococcus~~ bambusae*, adult female, 1892, W.M.M." and "*Chaetococcus ~~Sphaerococcus~~ bambusae*, antenna of adult female, 1892, W.M.M.") Paralectotype data same as lectotype, 1(1) NZAC (slide label same as lectotype).
Other Material Examined. ***Bambusa blumiana*: THAILAND**, Sara Buri, 16 Sep. 1971, coll. Pisit, 3466/11, 2(2) VPI. ***Bambusa multiplex*: PUERTO RICO**, Rio Piedras, 24 May 1990, coll. F.D. Bennett, no. SP008, 1(1) VPI; **TAIWAN**, written as "Formosa", Ken-ting, near Cape Garambi, 3 Feb. 1949, coll. G.F. Ferris, Ferris China Coll. 406, 1(1) VPI. ***Bambusa stenostachya*: TAIWAN**, written as "Formosa", Taihoku, Dec. 1914, coll. M. Maki, "*Antonina bambusae*", 1(2), UCD. ***Bambusa textilis*: PUERTO RICO**, Mayagüez, 27 Jun. 1950, coll. F.A. McClure, P.I. no. 80872, "*Antonina bambusae*", 1(3) USNM. ***Bambusa vulgaris*: BERMUDA**, Botanical Gardens, Paget, 29 Dec. 1990, coll. C.J. Hodgson, Wye no. 583, 3(3) BM; **PUERTO RICO**, Rio Piedras, 24 May 1990, coll. F.D. Bennett, no. SP004, 2(3) VPI; **THAILAND**, Dhonburi, Bankoknoi, 16 Sep. 1971, coll. Chanchai, 3466/10, 3(3) VPI. ***Bambusa* sp.: BRAZIL**, Bahia, Salvador, Brotas District, 25 Nov. 1967, coll. P. Silva,

4(5) VPI; **CENTRAL AFRICAN REPUBLIC**, La Maboké {possibly Mboki}, 6 Jan. 1966, coll. A. Balachowsky, no. 37, 2(4) VPI; **SOUTH AFRICA**, Natal, Durban, 27 Oct. 1964, coll. G. DeLotto, H.C. no. 921, "*Antonina bambusae*", 3(3) PPRI; **UGANDA**, Entebbe, 26 Mar. 1971, coll. D.N. McNutt, H.C. no. 4483, 3(3) PPRI; Mbale, 10 Oct. 1970, coll. D.N. McNutt, H.C. no. 4150, 1(1) PPRI. ***Dendrocalamus latiflorus*: USA**, Maryland, Glenn Dale, 15 Dec. 1952, coll. W.B. Wood, E.Q. no. X26.543, "*Antonina bambusae*", 1(5) USNM. ***Gigantichloa verticillata*: USA**, Florida, no locality data, {intercepted} at Washington D.C., 19 Sep. 1956, coll. W.B. Wood, no. W-4691, "*Antonina bambusae*", 1(5) USNM. ***Lingnania chungii*: CHINA**, no locality data, {intercepted} at Washington D.C., 29 Jan. 1941, coll. Gouldman, E.Q. no. 074560, 1(1) USNM. ***Phyllostachys nigra*: TANZANIA**, written as "East Africa", Amani, Sigi Gardens, Nov. 1921, coll. A.H. Ritchie, I.B.E. no. 546, "*Antonina bambusae*", 1(1) BRI. ***Phyllostachys* sp.: TAIWAN**, written as "Formosa", Ken-ting, near Cape Garambi, 6 Feb. 1949, coll. G.F. Ferris, Ferris China Coll. 430, 9(12) VPI. **Undetermined Bamboo: BRAZIL**, Campinas, "Japanese bamboo", 4 Sept. 1941, coll. H.L. Parker, S.A. Par. Lab 506.4, "*Antonina bambusae*", 1(1) USNM; Campinas, "Japanese bamboo", 1942, coll. H.L. Parker, S.A. Par. Lab 611-11, 2(2) USNM; **CHINA**, {Guangzhou, written as "Canton"}, Lingnan {University}, 20/22 Oct. 1948, {coll. G.F. Ferris}, Ferris China Coll. 8, 2(3) UCD; "Canton" {= Guangzhou}, Lingnan University, 23 Oct. 1948, coll. G.F. Ferris, Ferris China Coll. 2, 1(1) UCD, 1(1) VPI; "Canton" {= Guangzhou}, Lingnan University, 16 Nov. 1948, coll. G.F. Ferris, Ferris China Coll. 81, 1(1) VPI; Fei Ha, {NW of "Canton" on North River}, {coll. G.F. Ferris}, Ferris China Coll. 62, 1(1) UCD; **JAPAN**, no other locality data, {intercepted} at Quarantine, San Francisco, Feb. 1912, coll. unknown, 3(3) UCD; **PUERTO RICO**, Mayagüez, 20 Nov. 1912, coll. C.W. Hooker, 1(3) UCD; Mayagüez, Mar. 1922, coll. G.N. Walcott, "*Antonina bambusae*", 2(2) UCD; **TAIWAN**, Chai-I (= Kagi), 25 Oct. 1949, coll. T. Maa, Ferris China Coll. 270, 1(1) UCD; Chai-I (= Kagi), "spring/spiny bamboo", 28 Oct. 1949, coll. unknown, Ferris China Coll. 265, 2(2) UCD, 1(1) VPI; written as "Formosa", Ken-ting, near Cape Garambi, "thorny bamboo", 5 Feb. 1949, coll. G.F. Ferris, Ferris China Coll. 419, 2(3) VPI; **USA**, Hawaii, Honolulu, "TYPE", no collection date, coll. unknown, Koebele Coll. 1375, "*Antonina bambusae*", 2(2) UCD; Honolulu, 13 Dec. 1915, coll. T.D.A. Cockerell, 2(2) VPI; Honolulu, 1917, coll. E.M. Ehrhorn, 1(1) UCD; Honolulu, 25 Mar. 1955, coll. C.E. Pemberton, "*Antonina bambusae*", 1(3) JWB; Oahu Island, no other locality data, 15 Aug. 1958, coll. L. Chilson, no. 59-0256, "*Antonina bambusae*", 1(1) USNM.

Undetermined Grass: TAIWAN, near T'ai-nan, "large grass possibly *Miscanthus*", 2 Feb. 1949, coll. G.F. Ferris, Ferris China Coll. 617, 3(3) UCD. **Undetermined Host:** no locality data, no collection date, coll. unknown, "loose material from drawer 5, Maskell Coll.", 1(1) USNM.

Remarks. Maskell (1893) described this species from material collected by Albert Koebele in Honolulu, Hawaii. It should be noted that the Ferris Collection, Bohart Museum, University of California at Davis, contains at least two slides from Koebele's Collection (no. 1375) that have "TYPE" written on the label (see "Other Material Examined"). These specimens are also identified as "*Antonina bambusae* (Maskell)" and should not be confused with Maskell's type series. Unfortunately, Maskell did not provide Koebele's collection number with his original description. These two slide series may have been prepared from the same lot.

Chaetococcus bambusae is collected from underneath the sheaths of bamboo in many tropical areas of the world (Williams 1985). In addition to the hosts listed above, this species has been collected on *Bambusa maxima* (Williams & Granara de Willink 1992), *Dendrocalamus gigantea*, *D. stricta*, and *Gigantichloa aspera* (Green 1922). The collection of this species on "*Miscanthus*" by G. F. Ferris (see "Other Material Examined") is questionable because *C. bambusae* typically does not infest grasses.

This species is also recorded from Jamaica, Panama, Trinidad, and the Virgin Islands (Williams & Granara de Willink 1992); Paramaribo, Suriname (Yang & Kosztarab 1967); Dakar, Senegal (Williams 1958a); Umbelúzi, Mozambique (Almeida 1974); Mauritius (Maskell 1898); Peradeniya and Colombo, Sri Lanka, and southern India (Green 1922, Varshney 1992); Daito, Ogasawara, Okinawa, Miyako, and Yaeyama Islands of Japan (Takahashi 1940, Kawai et al. 1971, Kawai 1980); Caroline and Mariana Islands of Micronesia (Beardsley 1966); French Polynesia (Reboul 1976); Central Province, Papua New Guinea (Williams & Watson 1988); Brisbane, Queensland, Australia (Williams 1985).

Borchsenius (1937a, 1937b) reported *C. bambusae* (as *Antonina bambusae*) from Abkazia, Adzharia, Azerbaijan, and Crimea of the former USSR. This material must have been transferred to *Chaetococcus phragmitis* because Borchsenius (1949a) did not include any of these localities among its distribution in this later treatment of *C. bambusae*. Bodenheimer (1953) recorded *C. bambusae* from a horticultural nursery at Rize, Turkey. In addition to the examined material from Guangzhou (Guangdong

Province), *C. bambusae* has also been reported from the Hebei, Zhejiang, Sichuan, and Yunnan Provinces of China, as well as from Tibet (Wang 1982).

With a widespread distribution, one would suspect variation to exist. Although large cylindrical ducts are typically present along the margin of the head and thorax, some specimens lack them entirely. There appears to be no correlation between the presence or number of these ducts and the geographic locality or host plant of the specimen. Variation in number was often observed among individuals of similar lots (e.g., the specimens on *Bambusa* from Salvador, Brazil possessed 0-4 ducts per individual). Though most specimens possess stout conical setae, some individuals have conical setae that are slender and closely approach the condition of being flagellate. Observed specimens collected in Durban, South Africa (see "Other Material Examined"), were unusual in that some possessed fimbriated conical setae. Despite the aforementioned differences, these specimens possess the other characteristics which define this species.

Diagnosis. Unlike other *Chaetococcus* spp., *Chaetococcus bambusae* has lateral apodemes associated with vulva and the projection associated with the clypeolabral shield is as long as the shield. This species also lacks a distinct spiracular peritreme. The average diameter of cylindrical ducts in *C. bambusae* is approximately 2X greater than that in the other species; however, this does not serve as a strong diagnostic feature because cylindrical ducts are absent in some individuals.

Chaetococcus phragmitis (Marchal)
Plate 4

Antonina phragmitis Marchal, 1909: 872; Lindinger, 1912: 249; La Face, 1921: 254-267; Hall, 1923: 1-2; Goux, 1935: 94; Bodenheimer, 1943: 25; Parker, 1960: 170-172; Ezzat, 1962: 159; Yang & Kosztarab, 1967: 28-30; Afifi & Kosztarab, 1967: 21-24, 37-42; Gómez-Menor Ortega, 1968: 557-563 (as "*phragmitidis*"). **LECTOTYPE**, adult female, FRANCE, Var Department, Agay, on *Phragmites gigantea* (MNHNE), examined and here designated.

Antonina waterstoni Newstead, 1920: 182-185. **LECTOTYPE**, adult female, YUGOSLAVIA, on *Phragmites communis* (BM), examined and here designated. [synonymized Bodenheimer, 1943: 25]

Antonina (*Chaetococcus*) *phragmitis* Marchal; Goux, 1937: 94.

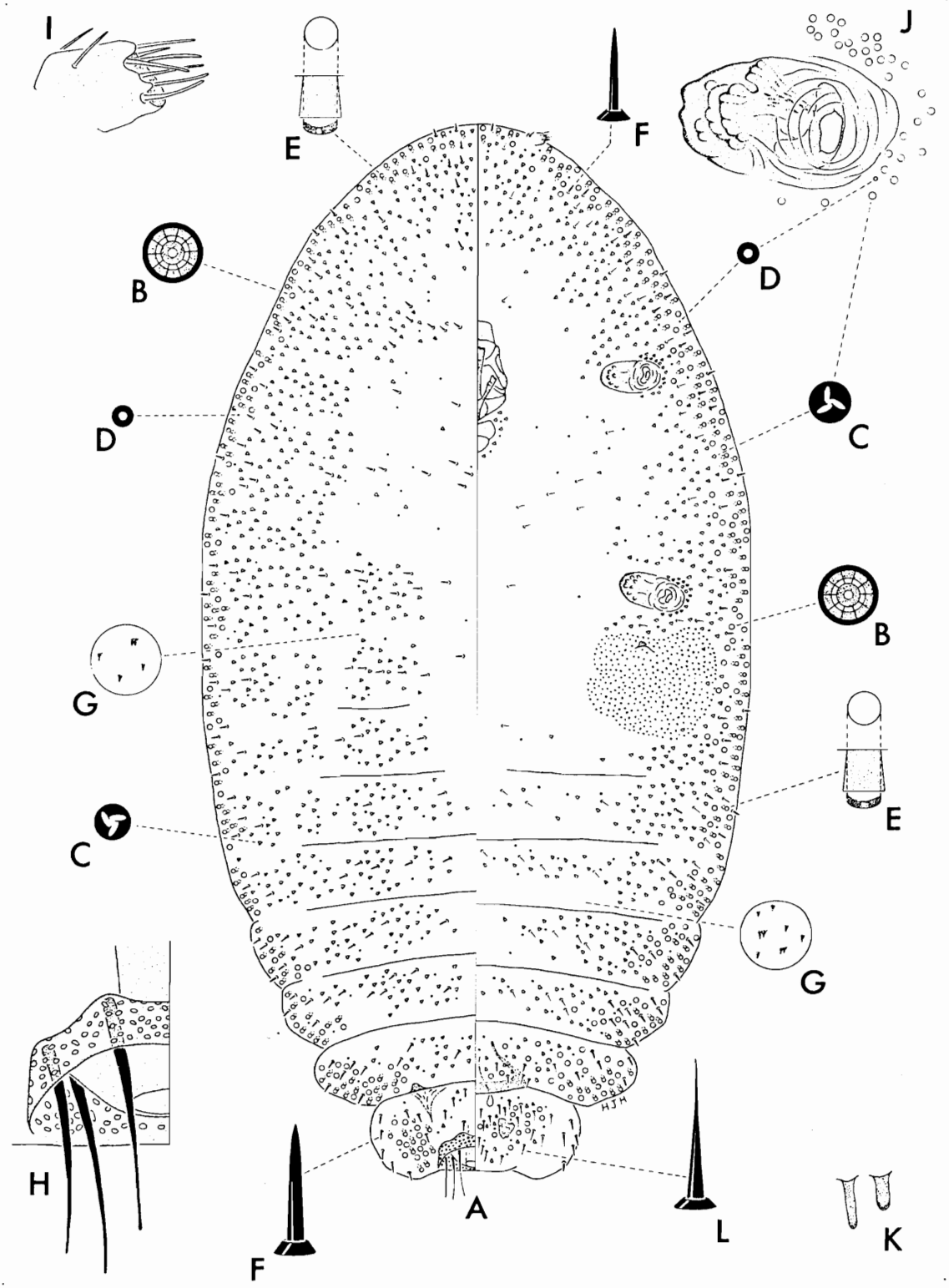

Plate 4. ***Chaetococcus phragmitis*** **(Marchal), Adult Female.**

Chaetococcus phragmitis (Marchal) Borchsenius, 1949a: 318; 1949b: 138-139; 1950: 114; Danzig, 1964: 626; 1967: 813; Ter-Grigoryan, 1973: 227-229; Nakahara, 1975: 875; Tereznikova, 1975: 171-172; Tranfaglia, 1976: 132-134; Kosztarab & Kozár, 1978: 37-38; 1988: 80-82.

GENERAL DESCRIPTION

Body of Adult Female. Unmounted individuals are oval to elliptical with parallel sides, flattened dorso-ventrally or slightly convex dorsally; anterior end rounded, caudal end truncate or concave, often dependent on location of anal tube opening; abdominal segmentation distinct; last four abdominal segments well-defined laterally, segment VIII expanded laterally with distinct constriction between segments VII-VIII, lateral expansions of segments V-VII variable, sometimes obsolete; position of mouthparts varies, typically at some point between anterior spiracles; color yellow-brown to dark brown with maturation.

On microscope slide (fig. A): 4092µm (1863-7161) long, 2400µm (955-3280) wide; body outline as mentioned above, caudal end becomes rounded with mounting at times.

Dorsal Surface

Multilocular Pores (fig. B). 8.32µm (7.60-9.50) in diameter, with 9-11 locules; distributed along margin of head, thorax and abdominal segments II-VI; also located on submargino-marginal region of segments VII-VIII, those on VIII are found laterally.

Trilocular Pores (fig. C). 4.59µm (3.80-5.70) in diameter, rim triangular to circular; distributed over entire surface of body with few located medially on head and thorax.

Simple Disc Pores (fig. D). 2.25µm (1.90-2.85) in diameter, with circular rim; distributed over entire surface.

Cylindrical Ducts (fig. E). 4.50µm (3.80-4.75) in diameter, 8.95µm (7.60-10.5) long, with collar approximately two-thirds length of tube; located along margin of head, thorax and abdominal segments II-VI; distributed on submargino-marginal region of segments VII-VIII, those on segment VIII are found laterally.

Setae (fig. F). Conical, slender, 5.70-20.0µm long; distributed over entire surface.

Spicules (fig. G). Minute, 0.95-1.90µm long, either solitary or in groups of two or more; located on medio-submedial region of mesothorax, metathorax, and abdominal segments II-V; also found over entire surface of segments VII-VIII.

Anal Ring (fig. H). 116μm (97.5-128) in diameter, with numerous pores 2.81μm (1.90-3.80) in diameter; with 6 setae 100-175μm long, setae occasionally knobbed at end; ring at end of short tube 28.3μm (20.0-45.0) long, tube opening terminal or slightly dorsad, dorsal and ventral lengths often unequal.

Other Structures. Small apodemes located submarginally between abdominal segments VII-VIII; segment VIII with pair of dermal depressions in antero-submarginal region, depressions devoid of ultrastructures and continue as crevices toward anal ring.

Ventral Surface

Antennae (fig. I). Typically unsegmented, occasionally 2-segmented, 32.2μm (22.5-45.0) long, diameter at base 33.0μm (25.0-37.5).

Clypeolabral Shield. Approximately 1.4X longer than broad, 141μm (128-155) long, 102μm (95.0-110) wide; anterior projection nearly one-third length of shield, 53.3μm (40.0-75.0) long, projection slightly tapered.

Labium. Approximately 1.3X broader than long, 55.0μm (50.0-60.0) long, 71.7μm (65.0-82.5) wide at base, two-segmented.

Legs. Absent, but with group of duct-like pores behind posterior spiracles in area typically occupied by metathoracic legs, small apodeme sometimes present near spiracle within pore group.

Spiracles (fig. J). Anterior: spiracular arm 78.6μm (67.5-87.5) long, as broad as long, with sclerotized peritreme; atrium 43.5μm (35.0-67.5) wide; with 14-45 trilocular pores grouped around peritreme, occasionally with 1-3 simple disc pores among group. Posterior: similar to anterior pair but larger; arm 93.9μm (80.0-108) long, atrium 49.4μm (37.5-80.0) wide; associated pores same.

Multilocular Pores (fig. B). Structure as that on dorsum, 8.41μm (7.60-9.50) in diameter; distributed along margin of head, thorax and abdominal segments II-V, occasionally submarginally; also found on submarginal-marginal region of segment VI and entire surface of segments VII-VIII with fewer located laterally on VIII.

Trilocular Pores (fig. C). Structure as that on dorsum, 4.49μm (3.80-4.75) in diameter; distributed along submargino-marginal region of head and thorax, occasionally submedially; also located over entire surface of abdominal segments II-VI, and on medio-submarginal region of segments VII-VIII; grouped around labium.

Simple Disc Pores (fig. D). Structure as that on dorsum, 2.49μm (1.90-3.80) in diameter; located over entire venter, clustered with trilocular pores at mouthparts.

Duct-like Pores (fig. K). 2.03μm (1.90-2.85) in diameter, 8.48μm (6.65-12.4) long, occasionally with vague collar at base; grouped immediately posterior to metathoracic spiracles in area typically occupied by metathoracic legs; few trilocular pores often found dispersed in group.

Cylindrical Ducts (fig. E). Structure as that on dorsum, 4.62μm (3.80-4.75) in diameter, 9.11μm (7.60-10.5) long; distributed along margin of head, thorax, and abdominal segments II-VII, occasionally on submargin of VI-VII.

Setae. Of two types. Conical (fig. F): structure as that on dorsum, 5.70-21.0μm long; distributed along margin of body, occasionally on submedio-submarginal region. Flagellate (fig. L): 5.70-30.4μm long; distributed over entire surface with few found marginally.

Spicules (fig. G). Structure as that on dorsum, 0.95-1.90μm long; located on medio-submedial region of thorax, medio-submarginal region of abdominal segments II-V, and entire surface of segments VI-VIII.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four associated apophyses, posterior pair of apophyses arise from segment VIII near vulva.

Other Structures. Mesothoracic sternal apophyses vaguely evident at times; segment VIII with submedial pair of small dermal depressions, depressions devoid of ultrastructures.

Type Material Examined. *Antonina phragmitis* Marchal: lectotype on *Phragmites gigantea*, **FRANCE**, Var Department, Agay, 4 May 1908, coll. M.P. Marchal, MNHNE (slide labeled "*Phragmites gigantea*, ~~*Arundo donax*~~, Agay, 4 Mai 1908, Extercl. coloration juere d'orge") [examined, here designated]. Paralectotype (one female) on same slide.

Antonina waterstoni Newstead: lectotype on *Phragmites communis*, **YUGOSLAVIA**, Macedonia, 1917, coll. J. Waterston, BM (slide labeled "I.B.E. No 135, Macedonia, on *Arundo phragmites*, 1917, J. Waterston, *Antonina waterstoni* Newst., Cotype female"). Paralectotypes consist of two females on same slide as lectotype and four first instars on slide deposited in BM. Also available were four subsequent slides containing 1 female (VPI) and three males (BM).

Other Material Examined. ***Arundo donax*: EGYPT**, "M Gezrich", 11 Sep. 1924, Hall Collection BM Reg. No. 1926-415, 2(6) BM. ***Phragmites communis*: AUSTRIA**, Lake Neusiedler See, 25 Mar 1953, coll. S. Noritzky, 1(1) HS; **HUNGARY**, Makó, 12 Sep. 1981, coll. Kozár, no. 1680, 1(2) VPI; Velencefürdo, 22 Jul. 1975, coll. M. Kosztarab,

no. 274, 2(2) VPI; **USA**, Maryland, Calvert Co., Calvert Cliffs Nat. Park, 20 Nov. 1988, Coll. M. Rhoades, VPI SP005, 2(6) VPI; Maryland, Harford Co., nr Creswel, 20 Nov. 1990, coll. M. & M. Kosztarab, VPI SP049, 6(6) VPI; Maryland, Harford Co., Perryman, 20 Mar. 1984, coll. L.M. Goff, no. 372, 13(13) MDA; New Jersey, Oldsman District, at Oldman Creek, 20 Nov. 1990, M. & M. Kosztarab, VPI SP048, 5(6) VPI. ***Phragmites* sp.: FRANCE**, Bouches-du-Rhone, St. Chamas, 25 Mar. 1952, coll. H.L. Parker, no. 52-465, 1(6) USNM; **USA**, Delaware, Delaware Seashore St. Park, 22 Jun. 1980, coll. M. Rhoades, 5(7) VPI; Maryland, Cecil Co. Cayots, 10 Aug. 1976, coll. W.F. Gimpel, no. 571, 10(35) MDA. **Undetermined Host: AUSTRIA**, in quarantine, on "breadfruit", 10 Apr. 1968, coll. J. Mills, 1(1) VPI; **FRANCE**, S. et O., 8 May 1952, coll. H.L. Parker, no. 52-546, 1(4) USNM; Aix-en-Provence, 8 Jul. 1954, coll. H.L. Parker, no. 5510, 1(6) USNM; **RUSSIA**, Dagestan, Manaskent, 13 Jul. 1960, coll. E. Sugonyaev, 1(2) ZIL.

Remarks. *Chaetococcus phragmitis* is common on reed (*Phragmites* and *Arundo* spp.) along banks and shores of waterways in the Mediterranean and Black Sea/Caspian Sea Regions. In addition to the above localities, this species was reported from the Alicante and Murcia Districts of Spain (Gómez-Menor Ortega 1968); much of southeastern France (LaFace 1921, Goux 1935, Parker 1960); Italy (LaFace 1921, Tranfaglia 1976); in USA quarantined from Germany and Poland (Nakahara 1975); Karavamilos, Greece (Kozár 1985); Kodry, Moldavia (Kozár & Ostafichuk 1987); Crimean Province of Ukraine (Kiritshenko 1940); Krasnodarski Kraj of Russia, Abkhazskaya of Georgia, and environs of Lenkoran, Azerbaidzhan (Borchsenius 1949a); Armenia (Borchsenius 1950, Ter-Grigoryan 1966, 1973); Erbil, Iraq (Bodenheimer 1943); Israel (Bodenheimer 1943, Ben-Dov 1990); Egypt (Hall 1923, 1925, 1926); and Morocco (Nakahara 1975). *Chaetococcus phragmitis* was first reported established in the USA at New Jersey (Nakahara 1975); however, a well-known parasitoid wasp (*Platencyrtus parkeri* Ferrier) specific to this mealybug was identified at a New York City collection earlier in 1955 (P.W. Oman, USDA-ARS Insect Pest Survey, 1955). It has since become established in the states listed above in "Material Examined".

On reeds, *C. phragmitis* can be found below the leaf-sheaths, often at the base of nodes. Specimens were also observed near the succeeding nodes. The body is surrounded by white wax, mainly around the margins, and a wax tube projects from the anal tube. Long, coiled tubes of wax, produced by the cylindrical ducts, were distinct along the margin of studied specimens. This species has also been taken from

Phragmites australis (Kozár 1985). Tranfaglia (1976) observed specimens from material questionably labeled as *Dactylon* sp. Little attention should be given to this host, as well as to the identification of "breadfruit" under "Other Material Examined".

On many occasions, the marginal ultrastructures of older individuals were transposed to the venter. This was due either to the body's lateral expansion during maturation or to the mounting techniques employed. In these specimens, it appeared that no multilocular or cylindrical ducts were present dorsally. Although multilocular pores typically possessed 9-10 locules, some had as few as six present. Variability was also seen in the anal ring setae among several specimens from Maryland. In these particular specimens, at least one seta was bifid. Nonetheless, these aberrations were not prevalent.

Diagnosis. *Chaetococcus phragmitis* most resembles *Chaetococcus turanicus*, but can be distinguished from *C. turanicus* by having a complete anal ring at the end of an invaginated tube and cylindrical ducts along the entire margin of the body. The distribution of cylindrical ducts and multilocular pores along the margin of the body and the absence of lateral vulvar apodemes separates *C. phragmitis* from *Chaetococcus bambusae*.

Chaetococcus sulci (Green)
Plate 5

Antonina sulcii Green, 1934: 510-511; Borchsenius, 1937a: 61; Schmutterer, 1955: 101; Danzig & Kozár, 1974: 10.

Antonina sulci Green; Goux, 1935: 94-95.

Antoninella sulci (Green) Sulc, 1944: 150-167.

Chaetococcus sulcii (Green) Borchsenius, 1949a: 316-317; 1950: 114; Danzig, 1964: 626; 1967: 813; Tereznikova, 1975: 172.

Chaetococcus sulci (Green) Kosztarab & Kozár, 1978: 38; 1988: 82-83.

Antonina purpurea Signoret (misidentified); Kiritshenko, 1931: 315. [error corrected in Kiritshenko, 1940: 125]

GENERAL DESCRIPTION

Body of the Adult Female. Unmounted individuals are oval to circular; dorsum convex, strongly at times; position of mouthparts varies, typically at some point between anterior spiracles and anterior margin of body, sometimes midway between both spiracular pairs;

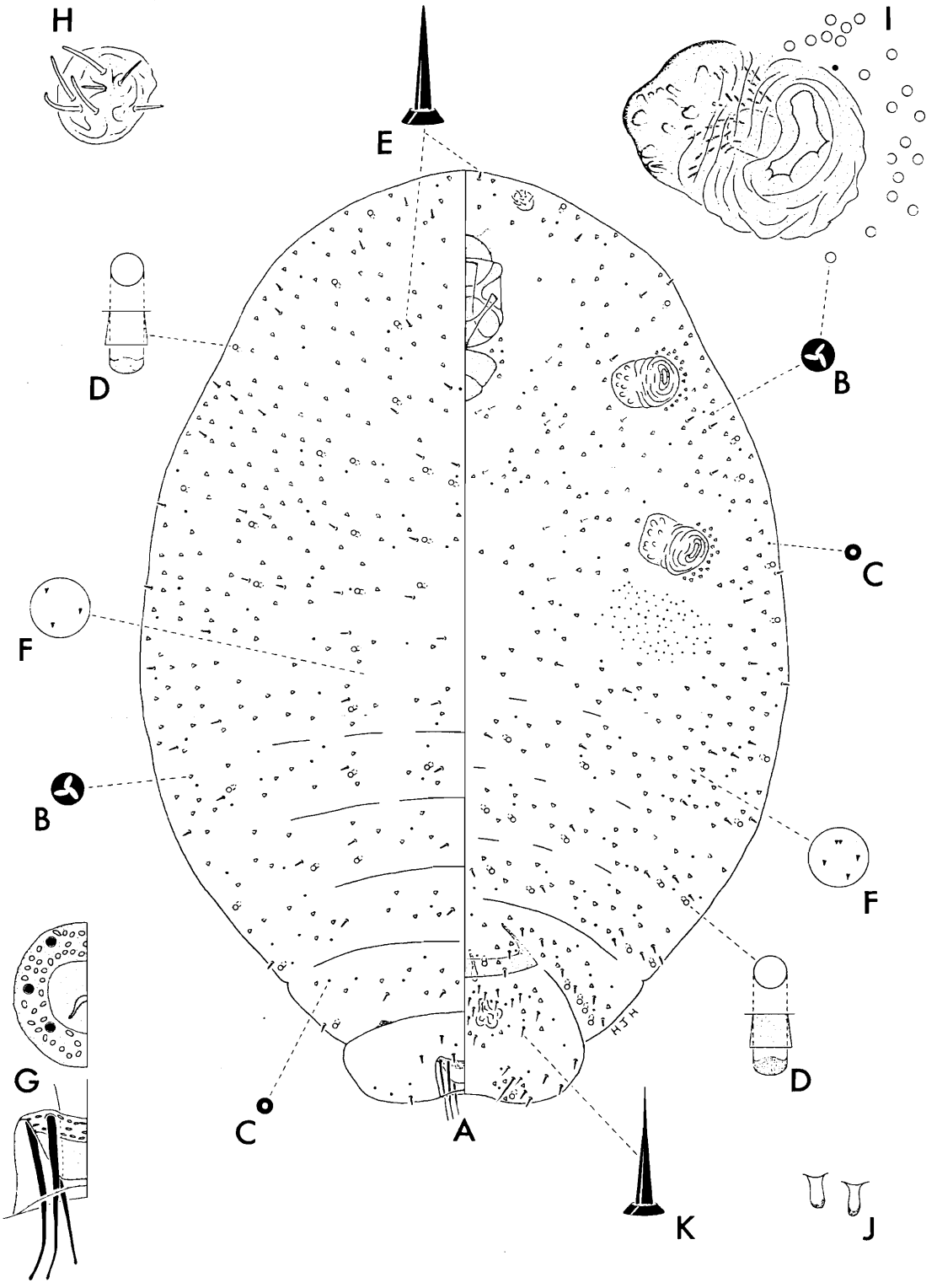

Plate 5. ***Chaetococcus sulci*** **(Green), Adult Female.**

abdominal segmentation distinct in young individuals, vague otherwise; last abdominal segment well-defined and expanded laterally with distinct constriction between segments VII-VIII, segment VII well-defined laterally in young individuals; anterior end rounded, caudal end truncate or concave, often dependent on location of anal tube opening; color yellow-brown to dark brown depending on age of individual.

On microscope slide (fig. A): 1531μm (1217-1879) long, 1244μm (879-1740) wide; body outline as mentioned above, caudal end becomes rounded at times with mounting.

Dorsal Surface

Trilocular Pores (fig. B). 5.12μm (4.75-6.65) in diameter, rim triangular to circular; distributed over entire surface of body except none on abdominal segment VIII.

Simple Disc Pores (fig. C). 2.57μm (1.90-3.80) in diameter, with circular rim; distributed over entire surface of body.

Cylindrical Ducts (fig. D). 4.58μm (3.80-5.70) in diameter, 10.6μm (8.55-12.4) long, with collar approximately one-half length of tube; sporadically distributed over entire surface of body except none on abdominal segment VIII, fewer present medially on posterior segments, sometimes appearing in longitudinal rows.

Setae (fig. E). Conical, slender, 6.65-20.9μm long; distributed over entire surface. (see "Remarks")

Spicules (fig. F). Minute, 0.95-1.90μm long, either solitary or in groups of two or more; located on medio-submedial region of mesothorax, metathorax, and abdomen.

Anal Ring (fig. G). Circular, 93.5μm (70.0-125) in diameter, with numerous pores 2.81μm (1.90-3.80) in diameter; with 6 setae 87.5-128μm long, setae knobbed at end; ring at end of tube, tube 40.5μm (20.0-55.0) long, tube opening terminal or slightly dorsad.

Other Structures. Small, vague apodemes located submarginally between abdominal segments VII-VIII.

Ventral Surface

Antennae (fig. H). Unsegmented, slightly convex, 11.5μm (7.50-15.0) long, diameter at base 28.4μm (17.5-37.5); often recessed and appearing plate-like.

Clypeolabral Shield. Approximately 1.2X longer than broad, 121μm (92.5-135) long, 105μm (95.0-125) wide; anterior projection nearly one-third length of shield, 35.3μm (27.5-47.5) long, projection slightly tapered and rounded, muscle remnants often appear as horns.

Labium. Approximately 1.3X broader than long, 60.7μm (50.0-70.0) long, 76.8μm (67.5-87.5) wide at base, two-segmented.

Legs. Absent, but group of duct-like pores behind posterior spiracles in area typically occupied by metathoracic legs.

Spiracles (fig. I). Anterior: spiracular arm 69.4μm (62.5-87.5) long, as broad as long, with sclerotized peritreme; atrium 45.5μm (37.5-60.0) wide; with 15-40 trilocular pores grouped around peritreme, occasionally with a simple disc pore among group. Posterior: similar to anterior pair but slightly larger; arm 72.7μm (55.0-92.5) long, atrium 49.0μm (35.0-57.5) wide; associated pores same.

Trilocular Pores (fig. B). Structure as that on dorsum, 5.23μm (4.75-5.70) in diameter; distributed over entire venter, in marginal group with setae and cylindrical ducts on segment VIII, clustered between clypeolabral shield and labium.

Simple Disc Pores (fig. C). Structure as that on dorsum, 2.61μm (1.90-3.80) in diameter; located over entire surface of body, clustered with trilocular pores at mouthparts.

Duct-like Pores (fig. J). 2.02μm (1.90-2.85) in diameter, 7.35μm (4.75-9.50) long, occasionally with vague collar at base; grouped immediately posterior to metathoracic spiracles in area typically occupied by metathoracic legs (fig. A); few trilocular pores often found dispersed within pore group.

Cylindrical Ducts (fig. D). Structure as that on dorsum, 4.80μm (3.80-5.70) in diameter, 11.4μm (9.50-14.3) long; few distributed along margin of head, thorax, abdominal segments II-III, and segment VIII; those on segment VIII in group with trilocular pores and setae; more found distributed over entire surface of segments IV-VII, those on segments VI-VII found primarily along latero-posterior region of segments.

Setae. Of two types. Conical (fig. E): structure as that on dorsum, 6.65-19.0μm long; distributed on submargino-marginal region of head, thorax and lateral portion of abdominal segment VIII; also found over entire surface of segments II-VII. Flagellate (fig. K): broad, 5.70-32.3μm long; distributed on medio-submedial region of head and thorax, and over entire surface of abdominal segment VIII; grouped with trilocular pores and cylindrical ducts along margin of VIII; apical setae present, 38.0-57.0μm long, located within marginal grouping of ultrastructures of segment VIII.

Spicules (fig. F). Structure as that on dorsum, 0.95-1.90μm long; located on medio-submedial region of the last two thoracic segments, medio-submarginal region of abdominal segments II-VI, and submargino-marginal region of segments VII-VIII.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four associated apophyses, posterior pair of apophyses partially arise from segment VIII.

Other Structures. Meso- and metathoracic sternal apophyses vaguely evident at times; segment VIII with submedial pair of dermal depressions near vulva, depressions devoid of ultrastructures.

Type Material Examined. None available for examination.

Other Material Examined. ***Brachypodium ramosum*: FRANCE**, Remoulins, Gard, Nov. 1953, coll. H.L. Parker, no. 5499-2, 1(6) USNM. ***Festuca ovina*: GERMANY**, Bad Münster a. St., UMS, 18 May 1955, coll. H. Schmutterer, 1(1) HS; Hohentwil, 31 Oct. 1953, coll. H. Zwölfer, 1(1) HS; **UKRAINE**, Odessa, "Russia", 20 Jun. 1930, coll. A. Kirichenko, E.E. Green #23/33, no. 2-a, 1(3) BM, 3(3) VPI. ***Festuca pallens*: POLAND**, Ojcow, dist. Olkusz, 7 Sep. 1967, coll. J. Koteja, no. 2171 1(1) VPI; Ojcow, p. Olkusz, 26 Sep. 1966, coll. B. Ogaza & J. Koteja, no. 3728 1(2) VPI. ***Festuca pseudodalmatica*: HUNGARY**, Velencefürdö, 15 Jun. 1982, coll. Kozár & B. Walter, no. 1847, 1(2) VPI. ***Festuca rupicola*: HUNGARY**, Budaörs, 23 May 1981, coll. Kozár, no. 1494, 1(2) VPI. ***Festuca vaginata*: HUNGARY**, Csévharaszt, 30 Oct. 1964, coll. G. Szelényi, no. 69=73, 1(3) VPI. ***Festuca valesiaca*: CZECHOSLOVAKIA**, no collection date, coll. K. Sulc, EEG 2/34, 1(1) BM; **HUNGARY**, Apajpuszta, 8 Jun. 1982, coll. Kozár, no. 1833, 1(2) VPI; Szársomlyó, 8 Jul. 1975, coll. M. Kosztarab/F. Kozár/G. Ördögh, no. 444, 1(1) VPI. ***Festuca* sp.: CZECHOSLOVAKIA**, Stránská Skála, Kreslit, coll. Sulc, 8 Aug. 1937, 2(7) MM; **KAZAKHSTAN**, Aktjubinskaja Oblast, 5 Aug. 1936, coll. N. Borchsenius, 2(2) VPI; **HUNGARY**, Hortobágy, 29 Jun. 1975, coll. M. Kosztarab/F. Kozár/G. Ördögh, no. 422, 1(1) VPI; Obánya, 8 Jul. 1975, coll. M. Kosztarab/F. Kozár/G. Ördögh, no. 431, 1(1) VPI, Szabadszállás Kisrét, 24 Jun. 1975, coll. M. Kosztarab/F. Kozár/G. Ördögh, no. 383, 1(1) VPI; Szársomlyó, 26 Aug. 1981, coll. F. Kozár & B. Nagy, no. 1657, 1(1) BM. ***Poa nemoralis*: RUSSIA**, Tatarskaja, Bugulma, 5 Aug. 1981, coll. Kozár, no. 1620, 1(1) VPI. ***Poa pratensis*:** Tatarskaja, Tat Tombarly, 8 Aug. 1981, coll. Kozár, no. 1623, 1(1) VPI; **UKRAINE**, Zakarpatske, 29 Jun. 1956, coll. N. Borchsenius, VPI SP044, 5(5) VPI. **Undetermined Grass: FRANCE**, Aix en Province, Bouche du Rhône, 8 Apr. 1954, coll. H.L. Parker, no. 5499-2, 1(4) USNM.

Remarks. *Chaetococcus sulci* is found on various grasses in warm steppe habitats of the western Palearctic Region. In addition to the above localities, this species has been reported from the French Departments of Eure, Rhône, and Savoie (Goux 1935); along

the Moldau River, Brno, and Kobyla Mountains, Slovensko, Czechoslovakia (Sulc 1944); Gorá, Koronna, Panienskie and Skaly, Ojców National Park, Poland (Koteja & Zak-Ogaza 1983); Orgeev, Moldavia (Kozár & Ostafichuk 1987); Ukrainian Provinces of Doneckaja, Vorosilovgradskaja, Zaporozskaja and Crimea (Borchsenius 1936, Tereznikova 1975); Krasnodarski Kraj, Russia (Tereznikova 1975); and the Caucasus Mountains in Georgia and Russia (Borchsenius 1936, Tereznikova 1975).

Enclosed in a white "ovisac", this species can be found in the culm or around the root crown of its host (Sulc 1944, Kosztarab & Kozár 1988). Kiritshenko (1931) reported *C. sulci* from *Festuca sulcata* under the name *Antonina purpurea* Signoret. It has also been taken on *Poa trivialis* (Kozár & Ostafichuk 1987). The collection of this species on *Sedum* sp. (Danzig & Kozár 1974) is questionable. *Chaetococcus sulci* was found in mixed infestations with *Antoninella inaudita* Kiritshenko (Kiritshenko 1938) and *Ripersia wuenni* Reyne (= *Euripersia europea* (Newstead)) (Reyne 1953).

A gradient was often seen between conical setae and flagellate setae. This similarity between the two types obscured their diagnosis and hindered the definition of their distribution. For example, the setae immediately posterior to the vulva are characteristically flagellate in *Chaetococcus* spp.; however, in some examined *C. sulci* they appeared conical. Although not seen in examined material of this study, the middle and hind legs may be represented by small tubercles with claws (Borchsenius 1949a, Kosztarab & Kozár 1988).

Diagnosis. *Chaetococcus sulci* can easily be recognized by the absence of multilocular pores and the presence of cylindrical ducts over much of the body. Multilocular pores were also not seen in immatures available for examination.

Chaetococcus turanicus Borchsenius
Plate 6

Chaetococcus turanicus Borchsenius, 1949a: 317-318; 1950: 114; Tang, 1992: 29.

Antonina turanica (Borchsenius) Danzig, 1972: 337.

Antonina phragmitis Marchal (misidentified); Archangelskaya, 1937: 128. [corrected by Borchsenius, 1949a: 318]

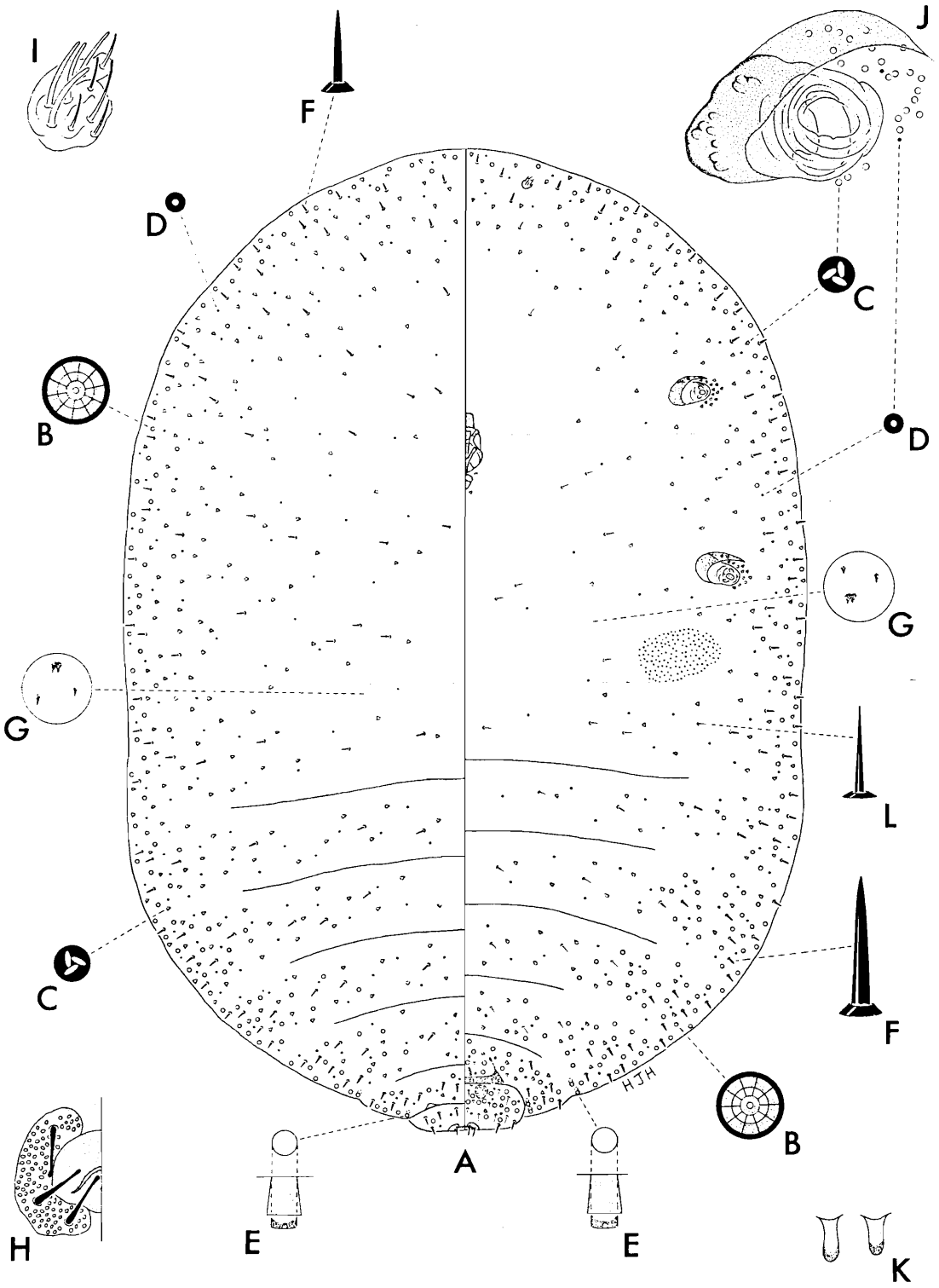

Plate 6. ***Chaetococcus turanicus*** **Borchsenius, Adult Female.**

GENERAL DESCRIPTION

Body of Adult Female. Unmounted individuals are elliptical with parallel sides to broadly oval, slightly convex dorso-ventrally; anterior end rounded, caudal end truncate; abdominal segmentation vague; lateral constriction between segments VII-VIII strong, VIII slightly expanded laterally, lateral constriction between VI-VII variable, sometimes obsolete; anal ring terminal or slightly dorsad; mouthparts located at some point between spiracular pairs; color yellow to brown.

On microscope slide (fig. A): 3718µm (2295-4774) long, 2314µm (1263-2895) wide; broadly oval to circular, dorso-posterior area of segment VIII often transposed to venter (as illustrated).

Dorsal Surface

Multilocular Pores (fig. B). 9.03µm (8.55-9.50) in diameter, 9-11 locules; distributed along margin of head, thorax and abdominal segments III, occasionally on submargin; also located on the submargino-marginal region of segment IV, submedio-marginal region of segments V-VI, entire surface of segment VII, and lateral margin of segment VIII.

Trilocular Pores (fig. C). 6.12µm (5.70-7.60) in diameter, rim triangular to circular; distributed over entire surface of head, thorax, and abdominal segments II-VII, fewer are found medially on head and thorax.

Simple Disc Pores (fig. D). 2.79µm (1.90-3.80) in diameter, with circular rim; distributed over entire surface.

Cylindrical Ducts (fig. E). 3.48µm (2.85-3.80) in diameter, 8.08µm (7.60-8.55) long, with collar approximately two-thirds length of tube; located on latero-posterior margin of abdominal segments VI-VII, but few in number.

Setae (fig. F). Conical, slender, 8.55-22.8µm long; distributed over entire surface, found primarily along margin of body.

Spicules (fig. G). Minute, 0.95-1.90µm long, most are solitary; located on medio-submedial region of mesothorax, metathorax, and abdominal segments II-V; also found over entire surface of segments VII-VIII.

Anal Ring (fig. H). 130µm (125-133) in diameter, separated dorsally and ventrally, thus forming 2 C-shaped halves; with numerous pores 2.42µm (1.90-2.85) in diameter, pores in 3-4 erratic rows; ring with 6 setae 37.5-55.0µm long, length approximately one-third ring diameter, tips of setae are knobbed; ring flush with derm or slightly recessed dorsally.

Other Structures. Small apodemes located submarginally between abdominal segments VII-VIII.

Ventral Surface

Antennae (fig. I). Unsegmented, plate-like to slightly convex, diameter 26.8μm (25.0-30.0).

Clypeolabral Shield. Approximately 1.5X longer than broad, 158μm (150-165) long, 105μm (100-113) wide; anterior projection approximately one-third length of shield, 55.0μm (50.0-62.5) long, projection more or less parallel-sided.

Labium. Nearly as broad as long, 64.2μm (57.5-70.0) long, 70.0μm (57.5-87.5) wide at base, two-segmented.

Legs. Absent; group of duct-like pores behind posterior spiracles in area typically occupied by metathoracic legs.

Spiracles (fig. J). Anterior: spiracular arm 78.0μm (75.0-80.0) long, as broad as long, with sclerotized peritreme; atrium 45.8μm (37.5-50.0) wide, with 15-35 trilocular pores grouped around peritreme, occasionally with 1-2 simple disc pores among group. Posterior: similar to anterior pair but larger; arm 87.1μm (82.5-95.0) long, atrium 57.9μm (52.5-62.5) wide; associated pores same.

Multilocular Pores (fig. B). Structure as that on dorsum, 9.14μm (8.55-9.50) in diameter; distributed along submargino-marginal region of head, thorax and abdominal segments II-V, occasionally on submedian; also found over entire surface of segments VI-VIII with fewer located laterally on VIII.

Trilocular Pores (fig. C). Structure as that on dorsum, 6.20μm (5.70-7.60) in diameter; distributed over entire venter with fewer located medially on head and thorax, few are also present around labium.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.00μm (1.90-3.80) in diameter; located over entire venter.

Duct-like Pores (fig. K). 2.38μm (1.90-2.85) in diameter, 5.70μm (4.75-6.65) long; grouped posterior to metathoracic spiracles in area typically occupied by metathoracic legs (fig.); often with some trilocular and multilocular pores dispersed within pore group.

Cylindrical Ducts (fig. E). Structure as that on dorsum, 3.33μm (2.85-3.80) in diameter, 9.03μm (8.55-9.50) long; located on latero-posterior margin of abdominal segments VI-VII, but few in number.

Setae. Of two types. Conical (fig. F): structure as that on dorsum, 9.50-28.5μm long; distributed on submargino-marginal region of head, thorax, and abdominal segments II-VII; also located on lateral margin of segment VIII. Flagellate (fig. L): 7.60-27.6μm long; distributed on medio-submedial region of head, thorax, and abdominal segments II-VII, and on medio-submarginal region of segment VIII.

Spicules (fig. G). Structure as that on dorsum, 0.95-1.90μm long; located on the medio-submedial region of thorax, medio-submarginal region of abdominal segments II-V, and entire surface of segments VI-VIII.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four associated apophyses, posterior pair of apophyses arise from segment VIII near vulva.

Other Structures. Mesothoracic sternal apophyses vaguely evident at times; segment VIII with submedial pair of small dermal depressions near vulva, depressions devoid of ultrastructures.

Type Material Examined. None available for study.

Other Material Examined. ***Calamagrostis phragmititorum***: **TADZHIKISTAN**, South Pamir, 4 Aug. 1970, collector not given, VPI SP045, 4(4) VPI. ***Phragmites communis***: **UZBEKISTAN**, Buhara, 11 Dec. 1982, coll. Kozár, no. 2104, 1(2) HAS. **Undetermined Host: UZBEKISTAN**, Tashkent, 9 Nov. 1981, coll. Kozár, no. 1706, 1(2) VPI.

Remarks. Borchsenius (1949a) described *C. turanicus* from material collected on reed, *Phragmites* sp., at Samarkand, Uzbekistan, and at Shaartuz and Ayvadzh, Tadzhikistan. Material from Uzbekistan had formerly been identified as *Antonina* (= *Chaetococcus*) *phragmitis* Marchal by Archangelskaya (1937). This species is apparently restricted to reed in the mountainous regions of central Asia (fig. 1). In addition to the above localities, it was reported near various waterways at Golbi-Altai and Bayan-Khongorskii, Mongolia (Danzig 1972). It can be found under the leaf-sheaths of its host without a perceptible wax covering (Borchsenius 1949a).

Unfortunately, all but one of the observed specimens were mature individuals that exhibited little variation. Borchsenius (1949a) observed specimens as long as 10,000μm. Although confident in the description provided, the body shape and distribution of ultrastructures should be reevaluated with the examination of additional material, especially of teneral adult females.

As seen with *Chaetococcus phragmitis*, the marginal ultrastructures in *C. turanicus* were transposed to the venter. Much of abdominal segment VIII's dorsum was also

transposed to the venter causing the anal ring to appear ventral in location. The constriction between segments VII-VIII in unmounted material was more evident than that illustrated.

Diagnosis. *Chaetococcus turanicus* most resembles *Chaetococcus phragmitis*, but can be distinguished from this species by having cylindrical ducts restricted to the latero-posterior margin of abdominal segments VI-VII. Unlike any other *Chaetococcus* spp., the anal ring is split in halves and is not located at the end of an invaginated tube.

Idiococcus Takahashi & Kanda

Type Species: *Idiococcus bambusae* Takahashi & Kanda (1939), by original designation and monotypy.

Takahashi & Kanda, 1939: 52; Ferris, 1957: 86; Hoy, 1963: 10; Morrison & Morrison, 1966: 95; Kawai, 1980: 124; Tang, 1984a: 394-395; 1984b: 100, 117-118; 1992: 35-36.

Takahashi and Kanda (1939) established the genus *Idiococcus* for a single species, *Idiococcus bambusae*, collected on bamboo in Yokohama, Japan. Ferris (1957) suggested the monotypic genus may be a representative of the Eriococcidae; however, Hoy (1963) rebutted this possibility and noted apparent associations with *Antonina* Signoret. Morrison & Morrison (1966) furthered this placement by assigning the genus to the subfamily Antonininae, Pseudococcidae. Kawai (1980) noted similarities with *Serrolecanium* species, especially *Serrolecanium sasae* which also possesses bag-like metathoracic legs. Tang & Wu (Tang 1984a) described as new from Maanshan, China, the species *Idiococcus maanshanensis*. *Idiococcus maanshanensis* is treated here as a synonym of *I. bambusae*.

Idiococcus bambusae, like *Porisaccus* species, possesses bag-like metathoracic legs with duct-like pores. Although both genera lack cylindrical ducts as adult females, immatures of *Porisaccus* species possess these glandular structures. The monotypic genus *Tangicoccus* Kozár & Walter lacks cylindrical ducts and conical setae, and possesses an incomplete anal ring as does *I. bambusae*. *Tangicoccus elongatus* (Tang), however, lacks multilocular pores and its duct-like pores form a marginal band along much of the abdomen. *Idiococcus* is easily distinguished from either genus by the presence of large, bag-like metathoracic legs and a terminal cleft on the abdomen.

DEFINITION

General. Body of adult female oval to elliptical, abdominal segmentation distinct, lateral constriction between abdominal segments VII-VIII visible, constrictions between segments II-VII vague, last 4-5 segments with lateral lobes slightly pronounced; posterior end with apical cleft or split, anal lobes absent.

Dorsal Surface. Ostioles absent; cerarii absent; anal ring semicircular with numerous pores and 6 short setae, located medially and slightly recessed on segment VIII; large sclerotized apodemes submedially between abdominal segments VII-VIII; segment VIII with pair of dermal depressions on submedial-submarginal region, depressions devoid of ultrastructures; trilocular pores distributed over submargino-marginal region, simple disc pores and flagellate setae distributed over entire surface.

Ventral Surface: Antennae reduced to 1-2 segments; eyes absent; clypeolabral shield with prominent anterior projection; labium broader than long, 2-segmented; spiracles heavily sclerotized, as broad as long, atria partially surrounded by sclerotized peritreme, numerous trilocular and simple disc pores associated with atria; prothoracic and mesothoracic legs absent or represented by small evaginated pouches, metathoracic legs represented by large evaginated pouches, pouch flattened and densely covered with duct-like pores; vulva distinct and slit-like, directed caudally, with four slender apophyses; segment VIII with submedial pair of dermal depressions, each depression devoid of ultrastructures.

Trilocular pores are found on submargino-marginal region of venter, simple disc pores and flagellate setae over entire surface, multilocular pores present on submargino-marginal region of abdomen; apical setae absent; circuli absent.

Idiococcus bambusae Takahashi & Kanda
Plate 7

Idiococcus bambusae Takahashi & Kanda, 1939: 52-55; Kawai, 1972: 7; 1980: 124; Tang, 1992: 36. **LECTOTYPE**, adult female, JAPAN, Yokohama, on bamboo (OMNH), examined and here designated.

Idiococcus maanshanensis Tang & Wu, *in* Tang 1984a: 395; 1984b: 101, 118-119; 1992: 36-37. **syn. n.**

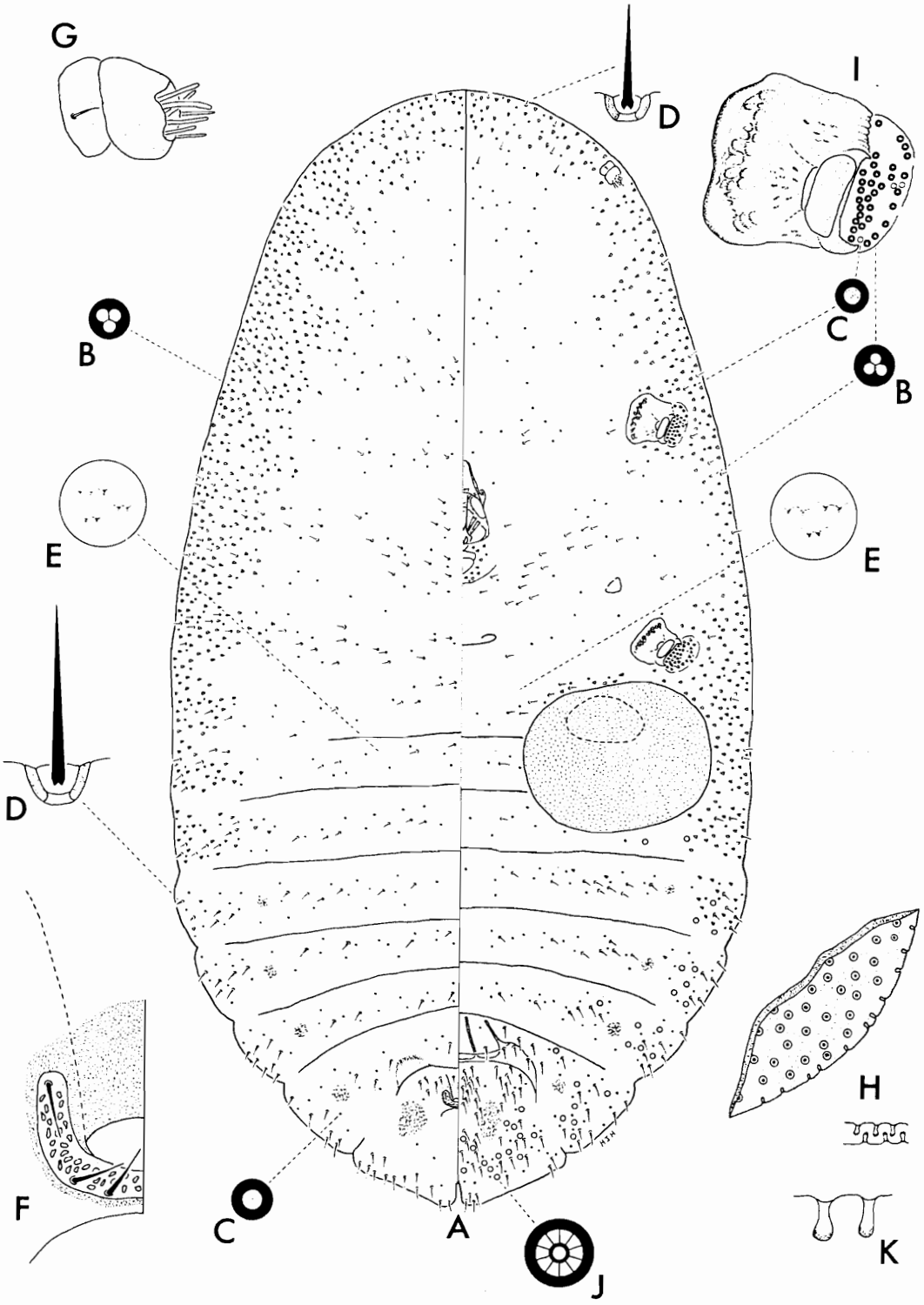

Plate 7. ***Idiococcus bambusae*** **Takahashi & Kanda, Adult Female.**

GENERAL DESCRIPTION

Body of Adult Female. Takahashi and Kanda (1939) described the unmounted body as "reddish brown or dark pinkish red, partly covered with white cottony secretions, ... chitinised over the whole surface in old females, but paler on the thorax, very long, narrow, parallel on the sides."

On microscope slide (fig. A): body oval to elongate slender, 5081μm (2178-9568) long, 1564μm (1071-2071) wide; anterior end rounded, posterior end with apical split or cleft yet anal lobes indistinct; mouthparts typically between anterior spiracles; large, flattened bags or pouches posterior to metathoracic spiracles (see "Legs"); abdominal segmentation between segments II-VIII distinct dorsoventrally, last 4-5 segments with lateral lobes slightly pronounced, lateral constriction between abdominal segments VII-VIII sometimes evident; elongate-slender specimens with lateral margins nearly parallel and with mouthparts transposed to location between anterior and posterior pairs of spiracles (as illustrated).

Dorsal Surface

Trilocular Pores (fig. B). 5.09μm (3.80-6.65) in diameter, with circular outer rim; located on submargino-marginal region of head, thorax, and abdominal segments II-V; at times submedially.

Simple Disc Pores (fig. C). 3.21μm (2.85-4.75) in diameter, distributed over entire surface.

Setae (figs. D). Flagellate, 6.65-34.2μm long, those located on abdominal segments are the longest and thickest; distributed over entire surface, forming group anterior to anal ring on abdominal segment VIII.

Spicules (fig. E). Minute, length $\leq$ 0.95μm, in groups of two or more; located on medio-submarginal region of two posterior thoracic segments and abdominal segments II-IV.

Anal Ring (fig. F). 90.3μm (77.5-100) in diameter, located medially on segment VIII or near segment VII, slightly recessed but not at end of anal tube, semi-circular with open end cephalad, derm at open end sclerotized, dermal fold present immediately posterior to ring; anal ring pores 2.53μm (0.95-4.75) in diameter, in staggered rows 2-3 pores across; with six anal ring setae 19.0-28.5μm long, setal length approximately one-fourth diameter of ring.

Other Structures. Large, sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with pair of dermal depressions devoid of

ultrastructures on submedio-submarginal region, similar but smaller depressions may be seen submarginally on additional segments in old, sclerotized individuals.

Ventral Surface

Antennae (fig. G). One to two segmented, 47.1μm (39.0-55.1) long with 42.8μm (31.4-54.1) base diameter.

Clypeolabral Shield. Slightly longer than broad, 144μm (126-166) long, 129μm (121-138) wide; anterior projection tapered, nearly two-thirds length of shield, 83.8μm (71.4-95.2) long.

Labium. Approximately 1.3X wider than long, 54.7μm (47.6-59.5) long, 70.8μm (57.1-90.4) wide at base; two-segmented.

Legs. Prothoracic legs usually absent, represented by small evaginated pouch when present; mesothoracic legs usually represented by small evaginated pouch; metathoracic legs represented by large, flat, circular pouch or bag-like structure (fig. H), pouch nearly 5X larger than spiracle, pouch with duct-like pores located on dorsal and ventral surfaces.

Spiracles (fig. I). Anterior: spiracular arm 97.4μm (80.9-110) long, very broad, apparently with partial peritreme; atrium 58.8μm (50.0-71.4) wide; 30-80 trilocular pores and 1-5 simple disc pores form a band at the atrium and a ring along the outer boundary of the depression leading to the atrium. Posterior: similar to anterior pair, but atrium slightly larger; arm 97.9μm (80.9-114) long; atrium 65.5μm (52.4-78.5) wide; with 40-100 trilocular pores and 1-5 simple disc pores associated with atrium.

Multilocular Pores (fig. J). 7.28μm (5.70-8.55) in diameter, typically with 10 locules; located on submedio-submarginal region of abdominal segment III and submargino-marginal region of segments IV-VIII, at times found submedially, occasionally absent from segments III-V.

Trilocular Pores (fig. B). Structure as that on dorsum, 5.23μm (4.75-6.65) in diameter; located on submargino-marginal region of head, thorax and abdominal segments II-VI, at times submedially, also grouped around labium.

Simple Disc Pores (fig. C). Structure and distribution as that on dorsum, 3.25μm (1.90-4.75) in diameter.

Duct-like Pores (fig. K). Minute, 2.05μm (1.90-2.85) in diameter, 5.37μm (3.80-7.60) long; located on dorsal and ventral surfaces of bag-like metathoracic legs.

Setae (figs. D). Flagellate, 6.65-36.1μm long; distribution similar to that on dorsum, also grouped medially and submedially just posterior to vulva; apical setae absent.
Spicules (fig. E). Structure and length as that on dorsum, those along margin often solitary; distributed on medio-submedial region of metathorax, medio-submarginal region of abdominal segments II-V, entire surface of segment VI, submedio-marginal region of segment VII, and marginal region of segment VIII.
Vulva. Distinct, smooth, with opening directed toward caudal end; with four long apophyses.
Other Structures. Mesothoracic apophyses usually evident; segment VIII with pair of dermal depressions devoid of ultrastructures on submedio-submarginal region, similar but smaller depressions may be seen submarginally on additional segments in old, sclerotized individuals.
Type Material Examined. *Idiococcus bambusae* Takahashi & Kanda. Lectotype on undetermined bamboo, JAPAN, Yokohama, coll. S. Kanda, 21 May 1935, 1(1) OMNH. Slide labeled "*Idiococcus bambusae* Takah. et Kanda, 1935-V-21, YOKOHAMA, Bamboo (under sheath)" [examined and here designated].

Idiococcus maanshanensis Tang & Wu. On *Indocalamus migoi*, Maanshan City, Anhui, CHINA, 18 Sep. 1979, coll. F.-t. Tang, VPI SP025, 9(9) VPI, subsequent slides made from dry type material (see Remarks).
Other Material Examined. ***Arundinaria pygmaea*: JAPAN**, Shikoku, Matsuyama, 20 Oct. 1962, coll. T. Tachikawa, 3(14) FAHU. ***Bambusa metake*: USA**, New Jersey, Riverton, 18 May 1916, coll. H.B. Weiss, 1(1) USNM. ***Bambusa* sp.: JAPAN**, Yokohama, 20 Apr. 1953, coll. R. Takahashi, no. 53-1079, 1(1) USNM. ***Sasa palmata*: JAPAN**, Hokkaido, Simamatu, (69m-34a'), 9 Sep. 1969, coll. S. Takagi, 2(5) FAHU. *Sasa* sp.: **JAPAN**, Honsyu {= Honshu}, Toyama, Kamidaki, 28 Dec. 1954, coll. S. Takagi, 2(2) FAHU. **Undetermined Bamboo: JAPAN**, "Mitsuyama", 10 Oct. 1962, coll. T. Tachikawa, 1(2) UCD, 1(3) VPI; Tokyo, Mt. Takao, 30 Jul. 1949, coll. R. Takahashi, 1(1) FAHU; Tokyo, 16 Apr. 1950, coll. R. Takahashi, 1(1) FAHU; Matsuyama, 12 Jul. 1955, coll. T. Tachikawa, 1(5) FAHU; Matsuyama, 20 Jul. 1955, coll. T. Tachikawa, 5(21) FAHU.
Remarks. *Idiococcus bambusae* is apparently restricted to bamboo in eastern China and Japan (fig. 2). The observed specimen from Riverton, New Jersey, is probably an accidental introduction or interception in quarantine. In addition to the hosts listed

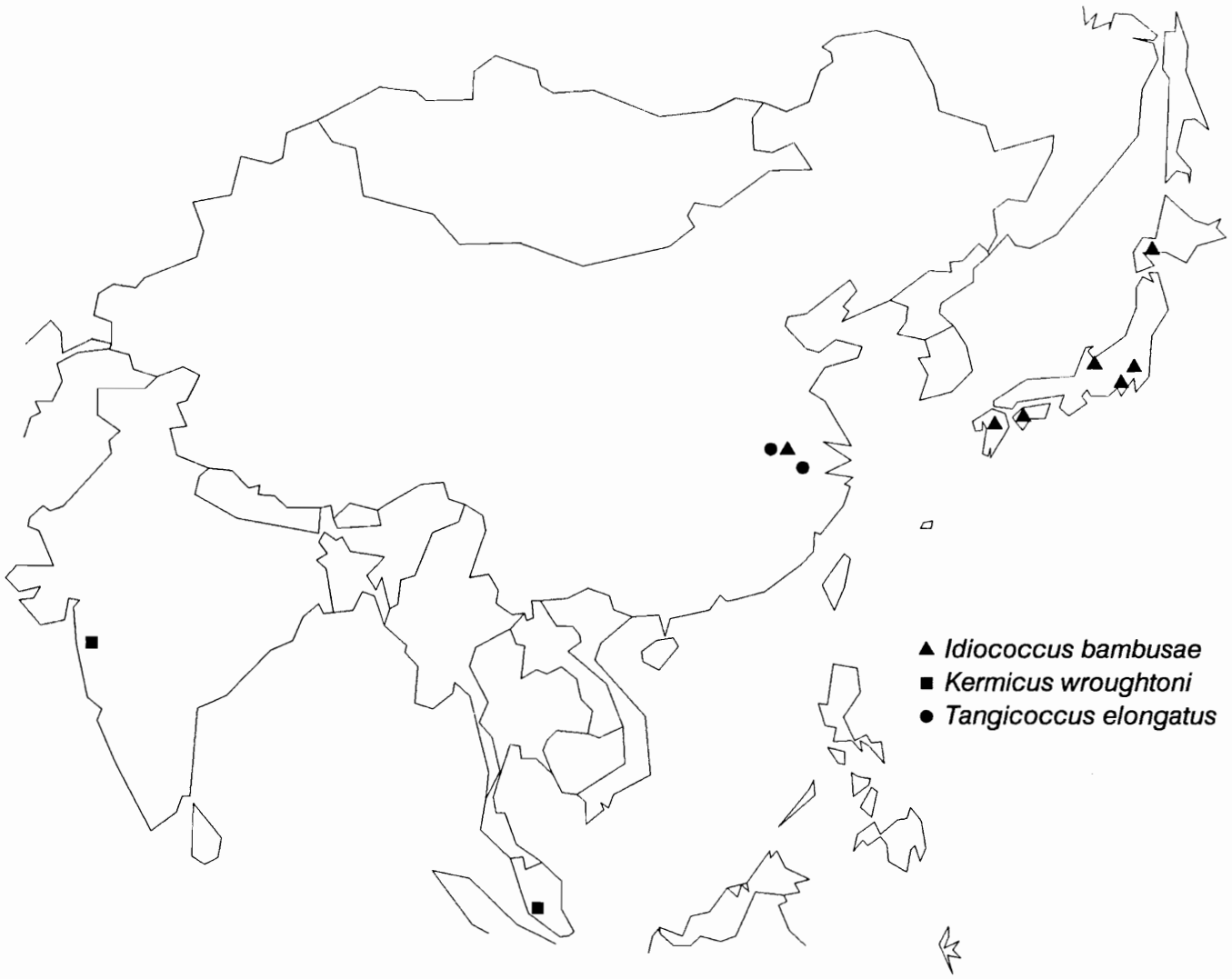

Figure 2. Distribution of monotypic genera (Serrolecaniini).

above, this species has also been collected on *Pleioblastus variegatus* (Takahashi & Tachikawa 1956).

As in many Coccinea, *Idiococcus bambusae* exhibits much plasticity in body outline and form. A few specimens possess an anal cleft that is as wide as the diameter of the anal ring, while others lack the cleft altogether. The absence of an anal cleft was predominantly observed in material from Maanshan City, China; moreover, one specimen from this lot possesses a single, central "lobe". The marginal separation between abdominal segments VII-VIII also displays much variation in this species. This separation, described as a "marginal notch" on the "anal abdominal segment" by Tang & Wu (Tang 1984a, 1984b), is sometimes well defined; however, it was obscure to obsolete in most examined specimens, particularly in those collected from Maanshan City.

Variation was also observed in body shape and size. For instance, the lot collected on *Arundinaria pygmea* in Matsuyama contained individuals that were either approximately 3 mm long and oval in shape (fig. A), or approximately 8 mm long and elliptical. This extreme difference in size and shape among individuals of the same population may be due to the level of maturation in the respective individuals or may be host induced; however, it was not possible to determine the exact causes. Despite these variations, the presence of characters which define the group were constant.

As indicated in Chapter I, dermal depressions or "rosettes" on the body surface are points for muscle attachment between dorsal and ventral surfaces. Muscles attached between these points were observed in specimens not completely cleared before mounting. Tang (1984a, b) used the distributional pattern of these depressions to help separate the genera *Serrolecanium* and *Idiococcus*.

A single specimen remains of Takahashi & Kanda's type series for *Idiococcus bambusae*. Their slide material was apparently divided and preserved in both authors' personal collections (Takahashi & Kanda 1939). No type specimens are present in Dr. Ryôichi Takahashi's collection which is currently housed in the Entomological Institute, Hokkaido University. The one specimen which remains in Dr. Sigeo Kanda's collection was graciously made available by the Osaka Museum of Natural History and is designated here as the lectotype. The type series of *Idiococcus maanshanensis* was not available for study, but Dr. Tang Fang-teh graciously loaned dry type material from which nine specimens were mounted.

Idiococcus maanshanensis (Tang 1984a, 1984b) was distinguished from *I. bambusae* on the basis of having dermal spines, an anal ring with pores but no setae, and no "marginal notch" or distinct separation between abdominal segments VII and VIII. *Idiococcus bambusae*, on the other hand, was thought not to have anal ring pores, anal ring setae, nor dermal spines. Anal ring pores and setae were observed with difficulty under oil immersion at 1000X magnification in specimens from all lots examined, and there is also no apparent difference in the dermal setae of *I. maanshanensis* and *I. bambusae*. The variability in the condition of the last abdominal segments is discussed above. There is no doubt that *I. maanshanensis* is the same species as Takahashi & Kanda's *I. bambusae*, although there is a greater frequency in variability of the terminal segments and fewer multilocular pores on the ventral surface of the former species.

It should be noted that *I. maanshanensis* was twice described as a new species (Tang 1984a, 1984b). This was obviously an oversight by the authors. The first published description by Tang & Wu (Tang 1984a) was contained in an obscure published proceedings of a symposium; nonetheless, it maintains priority.

Kermicus Newstead

Type Species: *Kermicus wroughtoni* Newstead (1897); by monotypy.

Newstead, 1897: 170-171; Ali, 1970: 109; Avasthi & Shafee, 1987: 22; Tang, 1992: 38.

The affinities of this little-known genus to other serrolecaniines, particularly *Chaetococcus*, was recently brought to my attention by Penny Gullan (ANIC) and Gillian Watson (CIE). Newstead (1897) established *Kermicus* for a single species collected from an undetermined host in the Bombay District of India. No other descriptions have been given for the genus or its single species, *Kermicus wroughtoni*, to date. A definition for the monotypic genus can be found within the brief species description below.

Kermicus wroughtoni Newstead
(not illustrated)

Kermicus wroughtoni Newstead, 1897: 170-171; Ali, 1970: 109-110; Avasthi & Shafee, 1987: 22; Tang, 1992: 38.

GENERAL DESCRIPTION

Body of Adult Female. Newstead described unmounted adult females as "hemispherical, shining, piceous" (black with reddish tinge).

On microscope slide: 3063μm (2500-3750) long, 2750μm (2500-3500) wide; broadly oval to circular; body segmentation very distinct, but lateral constrictions between segments absent; anal lobes absent; sternum heavily sclerotized in older individuals.

Dorsal Surface

Trilocular Pores. With thick, circular rim and often recessed to depth subequal to pore diameter; distributed over entire surface.

Simple Disc Pores. Slightly smaller than trilocular pore in diameter, with circular rim, distributed over entire surface.

Setae. Flagellate, long and thick, densely covering entire surface.

Spicules. Minute, solitary; sparsely distributed on abdomen.

Anal Ring. Located centrally on abdominal segment VIII, slightly recessed into derm; anal ring pores numerous; with 26 anal ring setae, setal length subequal to ring diameter.

Other Structures. None apparent.

Ventral Surface

Antennae. Greatly reduced, unsegmented, almost plate-like.

Clypeolabral Shield. As long as broad, length of anterior projection subequal to that of shield.

Labium. As broad as long, two-segmented.

Legs. Prothoracic and mesothoracic legs greatly reduced to small evaginated pouches with pleural vestiges; mesothoracic legs modified into evaginated pouch densely covered with duct-like pores, pouch flattened and almost plate-like, oval to circular, diameter approximately 2X larger than spiracles.

Spiracles. Spiracular arm long and slender, with sclerotized peritreme; atria without associated pores.

Multilocular Pores. Approximately 2X larger than trilocular pores, 10-locular; distributed on submargino-marginal region of head, thorax, and abdominal segments II-VI; also found over entire surface of segments VII-VIII.

Trilocular Pores. Structure and distribution as that on dorsum.

Simple Disc Pores. Structure and distribution as that on dorsum.

Duct-like Pores. Large, diameter subequal to that of simple disc pores, length subequal to diameter of multilocular pores, collar at base similar to that found in other Serolecaniini; located on modified metathoracic legs (see "Legs" above).
Setae. Of two types. Conical: shorter than flagellate setae on dorsum; distributed along margin of body. Flagellate: length subequal to diameter of multilocular pores; distributed on medio-submarginal region of body; no distinct apical setae.
Spicules. In groups of two or more; located on medio-submarginal region of abdominal segments II-VII.
Vulva. Distinct, smooth, with opening directed toward caudal end; with associated four apophyses.
Other Structures. Mesothoracic and metathoracic sternal apophyses evident; sclerotized depression located submedially on anterior half of abdominal segment VIII, depression devoid of ultrastructures.
Type Material Examined. None examined. The type material is currently housed in BM, but is in unsatisfactory condition (pers. comm., Gillian Watson, CIE, London).
Other Material Examined. All from **MALAYSIA**. ***Gigantichloa scortechinii*:** West Malaysia, Ulu Gombak Field Res. Stat., ca. 30 km NE Kuala Lumpur, nr. Gombak River, 11 Mar. 1992, U. Maschwitz, PSW-80, 3(3) ANIC. ***Gigantichloa* sp.:** Selangor, Ulu Gombak, 18 Aug. 1991, R.W. Klein, Tep 4, PSW-80, 2(2) ANIC. **Undetermined Bamboo:** Selangor, Ulu Gombak, 15 Mar. 1991, D. Kovac, PSW-80, 1(1) ANIC
Remarks. It is unfortunate that adequate equipment was not at hand to make complete measurements when the above material was made available; nevertheless, a brief description of the species is provided because of its significance to this study. A thorough description of *K. wroughtoni* is to be given in a current study of Southeast Asian mealybugs (pers. comm., Douglas J. Williams, Dept. of Entomol., The Natural History Museum).

The body outline of *K. wroughtoni* is atypical for the tribe, but other structures which are present, such as the anterior projection and caudally directed vulva, undoubtedly places this species among the others included. Occasionally seen on the body in the area surrounding the modified metathoracic legs were dermal ultrastructures similar to bilocular pores. In other related genera, simple disc pores were often observed fused to another, thus giving the appearance of bilocular pores. Further examination is needed to confirm this observation.

There is an apparent close relationship between this species and ants. The type material was described (Newstead 1897) as attended by *Pecophylla smaragdrina* in the Bombay District of India (Fig. 2). The material observed in this study was attended by ants of the genus *Tetraponera*.

Diagnosis. As in *Idiococcus bambusae*, large cylindrical ducts characteristic of the tribe are not present in any of the developmental stages. Otherwise, this species is distinct in appearance and is easily distinguished by the numerous anal setae, dense coat of dorsal setae, and the absence of lateral constrictions on the abdomen.

Porisaccus Hendricks & Kosztarab, gen. n.

Type Species: *Serrolecanium jiuhuaensis* Wu (1984).

Adult females of *Serrolecanium jiuhuaensis* Wu and *Serrolecanium sasae* (Siraiwa) show many striking differences from other recognized species of *Serrolecanium*. For example, cylindrical ducts are absent, although present in second and third instars; the metathoracic legs are modified into bag-like structures densely covered with duct-like pores; several abdominal segments are expanded and well-defined laterally, but only the last possesses latero-posterior lobes; and the dorsal dermal depressions are not clothed with setae and do not have posterior vulvar apophyses arising from them. For these reasons the genus *Porisaccus* is established for the inclusion of *S. jiuhuaensis* and *S. sasae*.

Etymology. The Latin *pori* (a pore, small opening) and *saccus* (a sack) refer to the porous bag-like modification of the metathoracic leg. The gender is masculine.

DEFINITION

General. Body of adult females ovate to obovate, flattened dorso-ventrally or slightly convex dorsally; last four abdominal segments well-defined and expanded laterally, last segment with latero-posterior lobes, expansions and lobes armed with many conical setae.

Dorsal Surface. Ostioles absent; cerarii absent; anal ring incomplete dorsally, with numerous pores and 6 setae, ring located at end of invaginated tube, tube opening located between bases of latero-posterior lobes; at times with pair of sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with pair of dermal depressions located submarginally, depression devoid of ultrastructures; trilocular

pores and simple disc pores distributed over much of surface; conical and flagellate setae present, conical setae located primarily along margin; segment VIII including lobes occasionally with squamate cuticle similar to but not as defined as that seen in *Serrolecanium* species.

Ventral surface: Antennae reduced to unsegmented stub; eyes absent or represented by small invaginated pits; clypeolabral shield with an anterior projection, sides of projection slightly tapered or parallel; labium broader than long, 2-segmented; spiracles heavily sclerotized, as broad as long, with peritreme and numerous pores associated with atria; prothoracic and mesothoracic legs typically absent, at times represented by small evaginated pouches, metathoracic legs modified into bag-like structures densely covered by duct-like pores, bag-like legs 2-3.5X larger than spiracles; vulva distinct and slit-like, directed caudally, with four slender apophyses and two lateral apodemes, posterior or inner pair of vulvar apophyses arise from segment VIII near vulva; segment VIII with pair of dermal depressions located submedially near vulva, depressed area devoid of ultrastructures.

Trilocular and simple disc pores distributed over much of surface; conical and flagellate setae present, conical setae found primarily along margin of body; apical setae present, located medially on latero-posterior lobes; margin of abdominal segments IV-VIII including expansions and lobes occasionally with squamate cuticle; circuli absent.

Key to Species of Genus *Porisaccus*

Pores associated with spiracular opening trilocular (Plate 8, fig. B); bag-like metathoracic leg ca. 2X larger than spiracle..... ***jiuhuaensis***, p. 68

Pores associated with spiracular opening quadrilocular (Plate 9, fig. K); bag-like metathoracic leg ca. 3.5X larger than spiracle..... ***sasae***, p. 74

Porisaccus jiuhuaensis (Wu), comb. n.
Plate 8

Serrolecanium jiuhuaensis Wu, 1984: 226-228.

GENERAL DESCRIPTION

Body of Adult Female. Alcohol-preserved individuals are elliptical with parallel sides to obovate, flattened dorso-ventrally to slightly convex dorsally; the position of

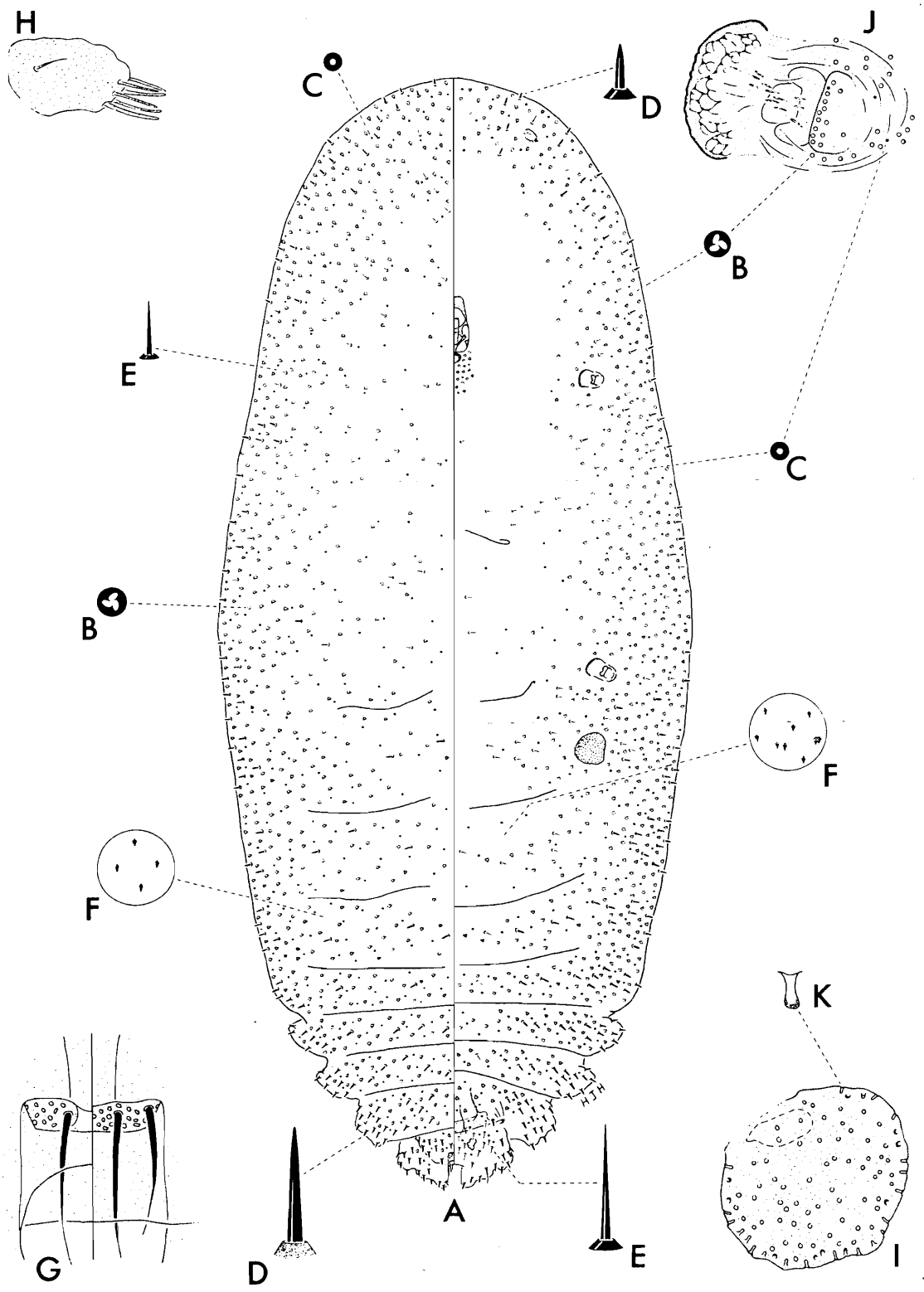

Plate 8. ***Porisaccus jiuhuaensis*** **(Wu), Adult Female.**

mouthparts varies, typically at some point between anterior spiracles and anterior margin of body, otherwise midway between spiracular pairs; last four abdominal segments well-defined and expanded laterally, expansions on segments V-VI pronounced anteriorly and appear as small latero-anterior lobes; segment VIII with distinct latero-posterior lobes, these lobes with rounded apex and strongly incised outer margin; color yellow-brown with abdominal expansions dark brown, entire body dark brown in older individuals.

On microscope slide (fig. A): 5352μm (3557-7515) long, 2429μm (1201-3080) wide; body outline as mentioned above, expansions and lobes of abdomen armed with conical setae, anterior expansions also with glandular structures; all of segment VIII's dorsum including lobes with squamate derm similar to that seen in *Serrolecanium* species, ventrally the squamate derm is found on margin of abdominal segments IV-VIII, including expansions and lobes.

Dorsal Surface

Trilocular Pores (fig. B). 4.17μm (3.80-4.75) in diameter, typically with circular rim; distributed over entire surface of body except latero-posterior lobes of segment VIII.

Simple Disc Pores (fig. C). 2.10μm (1.90-2.85) in diameter, with circular rim; distributed over entire surface of body except latero-posterior lobes of segment VIII.

Setae. Of two types. Conical (fig. D): 6.65-30.4μm long, somewhat slender; distributed over entire surface of body, found primarily along margin especially on abdominal expansions and lobes; few found on medio-submedial region of thorax and first two thoracic segments. Flagellate (fig. E): 5.70-8.55μm long, sporadically distributed over entire surface of head and first two thoracic segments.

Spicules (fig. F). Minute, 0.95-1.90μm long, most solitary but some in groups of two or more; located on medio-submedial region of abdominal segments II-III, medio-submarginal region of segment IV, and entire surface of segments V-VII.

Anal Ring (fig. G). 82.5μm (75.0-87.5) in diameter, incomplete dorsally, with numerous pores 2.69μm (1.90-3.80) in diameter, with 6 setae 110-140μm long; located at end of asymmetrical tube, length of tube 53.8μm (42.5-67.5) along lateral wall, opening of tube at end of body between lobe bases (both dorsal and ventral aspects are illustrated).

Other Structures. Occasionally with small sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with slender dermal depressions

located near aforementioned apodemes, each depression continues as crevice toward inner base of latero-posterior lobes.

Ventral Surface

Eyes. Typically absent, occasionally represented by invaginated pit, 9.28μm (7.50-12.5) in diameter.

Antennae (fig. H). Unsegmented but at times partially separated, 64.1μm (50.0-82.5) long, diameter at base 45.0μm (37.5-57.5).

Clypeolabral Shield. Nearly 1.5X longer than broad, 199μm (178-218) long, 136μm (120-153) wide; with anterior projection approximately one-third length of shield, 61.3μm (50.0-70.0) long, projection tapers slightly at times.

Labium. Approximately 1.4X broader than long, 49.1μm (35.0-55.0) long, 66.8μm (62.5-70.0) wide at base, two-segmented.

Legs. Prothoracic and mesothoracic pairs absent; metathoracic pair represented by bag-like structure (fig. I) approximately 2X larger than spiracles, bag circular to pentagonal, with duct-like pores located on dorsal and ventral surfaces, at times with claw or digitules present.

Spiracles (fig. J). Anterior: spiracular arm 93.3μm (82.5-110) long, nearly as broad as long, with sclerotized peritreme; atrium 58.1μm (52.5-65.0) wide; with 35-80 trilocular and 1-6 simple disc pores associated with atrium. Posterior: similar to anterior pair but slightly larger; arm 101μm (87.5-113) long, atrium 61.7μm (55.0-67.5) wide; 30-90 trilocular and 1-6 simple disc pores associated with atrium.

Trilocular Pores (fig. B). Structure as that on dorsum, 4.13μm (3.80-5.70) in diameter; distributed on submargino-marginal region of head and thorax, sometimes submedially, clustered around labium; also located over entire surface of abdominal segments II-VI except for lateral expansions, and on medio-submarginal region of segment VII.

Simple Disc Pores (fig. C). Structure as that on dorsum, 2.19μm (1.90-3.80) in diameter; distribution as that on dorsum except few on medio-submedial region of head and prothorax, also clustered around labium.

Duct-like Pores (fig. K). 1.78μm (0.95-1.90) in diameter, 5.82μm (4.75-7.60) long, apparently without collar; located on dorsal and ventral surfaces of bag-like metathoracic legs.

Setae. Of two types. Conical (fig. D): structure as that on dorsum, 7.60-29.5μm long; distributed on submargino-marginal region of head, thorax and abdominal segments II-

VII including expansions, at times located submedially; also found on outer margins of segment VIII's latero-posterior lobes. Flagellate (fig. E): structure as that on dorsum, 5.70-20.0μm long, distributed over entire surface of head, thorax and abdominal segment VIII except lobes; also located on medio-submedial region of segments II-VII, those on segment VII found only along the posterior half near the vulva; apical setae present, 51.3-52.3μm long, located medially on latero-posterior lobes.

Spicules (fig. F). 0.95-1.90μm long, either solitary or in groups of two or more; distributed on medio-submedial region of metathorax and abdominal segments II-IV, medio-submarginal region of segment V, entire surface except expansions of segment VI, submedio-marginal region of segment VII, and margin of segment VIII.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four long associated apophyses and two small lateral apodemes, posterior pair of apophyses often seen arising from segment VIII.

Other Structures. Meso- and metathoracic sternal apophyses vaguely evident at times; segment VIII with submedial pair of dermal depressions near vulva, depressions devoid of ultrastructures.

Type Material Examined. None available from China for examination.

Other Material Examined. All available material from the Ryukyu Islands of **JAPAN**. ***Pleioblastus linearis*:** Okinawa-Shoto, Kume Is., 22 Nov. 1970, coll. S. Kawai, TUA 3325, 1(2) TUA; Okinawa-Shoto, Kume Is., 23 Nov. 1970, coll. S. Kawai, TUA 3336, 3(3) TUA; Okinawa-Shoto, Yona, Kunigami, 16 Dec. 1989, coll. S. Kawai, TUA 13112, VPI SP035, 4(4) TUA, 2(2) VPI; Amami-Oshima, Tatsugo T., 30 Jan. 1990, coll. S. Kawai, TUA 13184, VPI SP031, 1(1) TUA; Okinawa-Shoto, Kume Is., 1 Mar. 1991, coll. S. Kawai, TUA 13596, VPI SPO37, 1(1) TUA.

Remarks. Wu (1984) described *Serrolecanium jiuhuaensis* from material collected on *Indocalamus migoi* at Jiuhua Mountain in the Anhui Province of China (Fig. 3). Although no type material was available for study, there was little doubt that the material examined was the same as that described by Wu. Wu (1984) observed ventral multilocular pores on the last abdominal segment and "chrysanthemum-shaped hardened skin spots". The later observation and the amount of sclerotization drawn in the original illustration would suggest that Wu made his description using old, sclerotized individuals. The significance of this in relation to the observation of multilocular pores is given in more detail under the redescription of *Serrolecanium indocalamus* Wu.

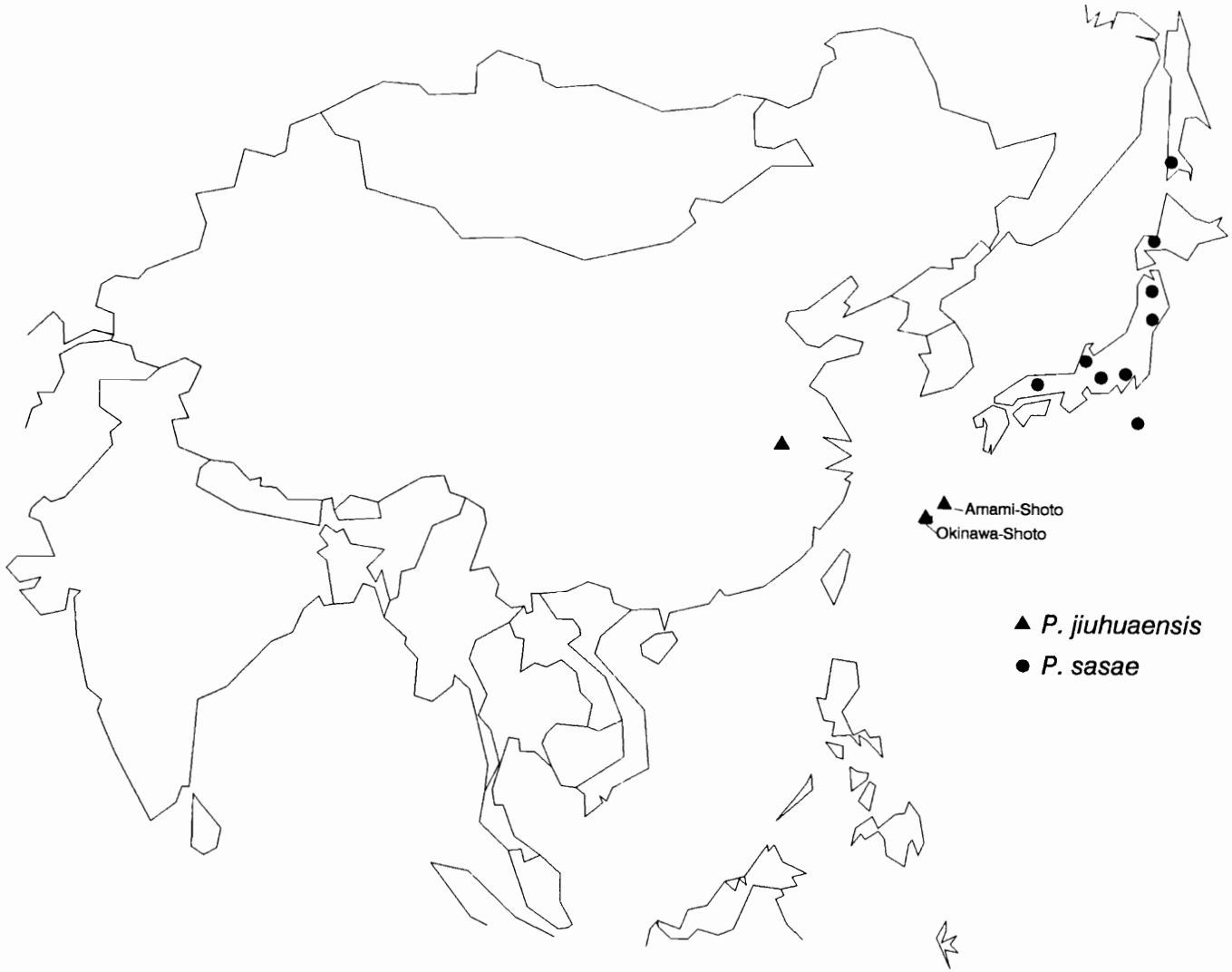

Figure 3. Distribution of *Porisaccus* species.

A specimen examined from lot TUA 3336 lateral constrictions between abdominal segments III-IV, but segment IV did not appear expanded laterally. Interestingly, another specimen of the same lot had 1-2 quadrilocular pores among the trilocular pores associated with the spiracles. A distinguishing characteristic of *Porisaccus sasae* (Siraiwa) are the quadrilocular pores associated with its atria. This same specimen of *P. jiuhuaensis* also had what appeared to be a quinquelocular pore as well as about three pairs of fused trilocular pores elsewhere on the body.

Diagnosis. *Porisaccus jiuhuaensis* may easily be confused with *Porisaccus sasae* which has a similar general appearance. Characteristics useful in distinguishing this species from the later include the following: pores associated with spiracular opening trilocular; bag-like modification of metathoracic leg approximately 2X larger than spiracle; distance between vulvar lateral apodeme to angle at base of latero-posterior lobe subequal to length of lobe's outer margin, segment VIII including lobes more or less quadrate ventrally.

Porisaccus sasae (Siraiwa), comb. n.
Plate 9

Antonina sasae Siraiwa, 1939: 68.

Serrolecanium sasae (Siraiwa) Kawai, 1972: 9; Danzig, 1978: 11; 1980: 203; Kawai, 1980: 123-124; Danzig, 1986: 236-238; Tang, 1992: 41.

GENERAL DESCRIPTION

Body of Adult Female. Dry and alcohol-preserved individuals ovate to obovate, flattened dorso-ventrally to slightly convex dorsally; much wax encircles body but very little found dorso-ventrally; position of mouthparts varies, typically at some point between anterior spiracles and near anterior margin of body, at times located midway between spiracular pairs; last four abdominal segments well-defined and expanded laterally, last segment with latero-posterior lobes, lobes with rounded apex, outer margin of lobes straight to slightly sinuate; color yellow-brown with abdominal expansions dark brown, older individuals with entire body dark brown.

On microscope slide (fig. A): 3212µm (1617-5698) long, 1267µm (770-1694) wide; body outline as mentioned above, expansions and lobes of abdomen armed with conical setae, anterior expansions also with glandular structures dorsally.

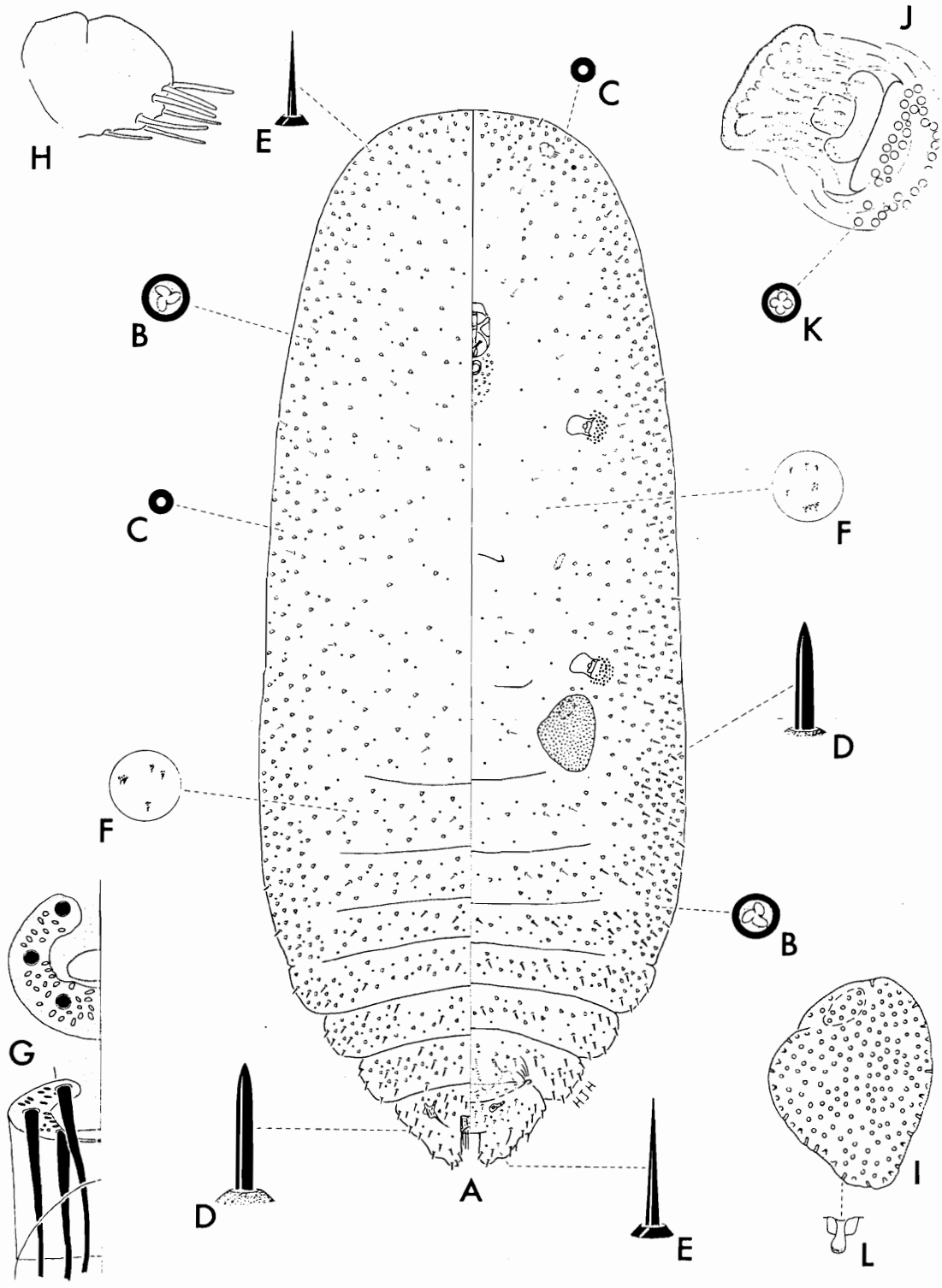

Plate 9. ***Porisaccus sasae*** **(Siraiwa), Adult Female.**

Dorsal Surface

Trilocular Pores (fig. B). 5.81μm (4.75-7.60) in diameter, typically with circular rim; distributed over entire surface of body except latero-posterior lobes of segment VIII, found primarily along margin.

Simple Disc Pores (fig. C). 2.96μm (1.90-3.80) in diameter, with circular rim; distributed over entire surface of body except latero-posterior lobes of segment VIII.

Setae. Of two types. Conical (fig. D): 7.60-21.9μm long; located on margin of abdominal segment II, submargino-marginal region of segment III, and entire surface of remaining abdominal segments; few occasionally found along margin of head and thorax. Flagellate (fig. E): 5.70-9.50μm long, sporadically distributed over entire surface of head, thorax, and abdominal segment II.

Spicules (fig. F). Minute, 0.95-1.90μm long, solitary or in groups of two or more; located on medio-submedial region of mesothorax, medio-submarginal region of metathorax and abdominal segments II-IV, and entire surface of segments V-VII.

Anal Ring (fig. G). 77.8μm (72.5-87.5) in diameter, incomplete dorsally, with numerous pores 2.76μm (1.90-4.75) in diameter, with 6 setae 98.8-144μm long; located at end of asymmetrical tube, length of tube 38.4μm (25.0-48.8) along lateral wall, tube opening at end of body between lobe bases.

Other Structures. Occasionally with small sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with pair of submarginal dermal depressions, each depression continues as crevice toward inner base of latero-posterior lobes.

Ventral Surface

Eyes. Absent or represented by small invaginated pit 9.00μm (2.50-12.5) in diameter.

Antennae (fig. H). Unsegmented, at times partially separation, 51.3μm (38.0-66.5) long, diameter at base 35.0μm (24.7-51.3).

Clypeolabral Shield. Approximately 1.4X longer than broad, 168μm (138-183) long, 120μm (100-140) wide; anterior projection approximately two-fifths length of shield, 40.8μm (37.5-50.0) long, projection slightly tapered.

Labium. Approximately 1.2X broader than long, 57.1μm (50.0-62.5) long, 67.9μm (57.5-77.5) wide at base, two-segmented.

Legs. Prothoracic legs typically absent but at times represented by small evaginated pouch; mesothoracic legs often represented by small evaginated pouch; metathoracic pair represented by large bag-like structure (fig. I) approximately 3.5X larger than spiracles,

shape of bag varies but typically triangular, bag with duct-like pores located on dorsal and ventral surfaces.

Spiracles (fig. J). Anterior: spiracular arm 69.7μm (52.5-87.5) long, as broad as long, with lightly sclerotized peritreme; atrium 37.2μm (30.0-42.5) wide; with 30-55 quadrilocular (fig. K) and 1-4 simple disc pores located near atrial opening, quadrilocular pores 3.95μm (2.85-4.75) in diameter. Posterior: similar to anterior pair but slightly larger; arm 75.9μm (67.5-92.5) long, atrium 43.3μm (35.0-50.0) wide; 45-70 quadrilocular and 1-7 simple disc pores associated with atrium.

Trilocular Pores (fig. B). Structure as that on dorsum, 5.58μm (4.75-7.60) in diameter; located on submedio-marginal region of head and thorax, sometimes medially, clustered around labium; also distributed over entire surface of abdominal segments II-VI except lateral expansions, and on medio-submarginal region of segment VII, those on segment VII are found only along anterior half of segment.

Simple Disc Pores (fig. C). Structure as that on dorsum, 2.91μm (1.90-3.80) in diameter; distributed over entire surface of body, clustered around labium.

Duct-like Pores (fig. L). 1.68μm (0.95-1.90) in diameter, 5.87μm (3.80-11.4) long, with collar at base; located on dorsal and ventral surfaces of bag-like metathoracic legs.

Setae. Of two types. Conical (fig. D): structure as that on dorsum, 6.65-18.1μm long; sparsely distributed along margin of head, thorax, and abdominal segment II; more are found distributed on submargino-marginal region of abdominal segments III and VII, entire surface of segments IV-VI, and along outer margin of segment VIII's latero-posterior lobes. Flagellate (fig. E): structure as that on dorsum, 6.65-18.1μm long; distributed over entire surface of head, thorax, abdominal segment VIII; also found on medio-submedial region of segments II-III and VII, those on segment VII found primarily along posterior half near vulva; apical setae present, 33.3-57.0μm long, located medially on latero-posterior lobes.

Spicules (fig. F). Structure as that on dorsum, 0.95-1.90μm long; located on submedian of prothorax, medio-submedial region of last two thoracic segments, medio-submarginal region of abdominal segments II-IV, entire surface of segments V-VI, and submargino-marginal region of segments VII-VIII.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four long associated apophyses and two lateral apodemes, posterior pair of apophyses arise from segment VIII.

Other Structures. Meso- and metathoracic sternal apophyses vaguely evident at times; segment VIII with submedial pair of dermal depressions near vulva, depressions devoid of ultrastructures.

Type Material Examined. None available for examination. Presumably dispersed and lost with the rest of Siraiwa's collection (pers. comm., Dr. Shozo Kawai, Tokyo University of Agriculture, Japan).

Other Material Examined. All material from **JAPAN**. ***Pleioblastus simonii*:** Akigawa C., nr Tokyo, 16 Oct. 1965, coll. S. Kawai, TUA 1395, 1(4) TUA; Hachioji, Tokyo, 17 Apr. 1966, coll. S. Kawai, TUA 1536, 1(4) TUA; Mt. Jimba, nr Tokyo, 29 Oct. 1974, coll. S. Kawai, TUA 4399, 4(11) TUA. ***Pleioblastus* sp.:** Mt. Amagi, Izu, 3 Nov. 1965, coll. S. Kawai, TUA 1432, 1(1) TUA; Mt. Mutsuishi, Okutama, Tokyo, 23 Nov. 1965, coll. S. Kawai, TUA 1469, 1(8) TUA. ***Sasa borealis*:** Okayama, Tomata, Okutsu, Woodland Park, 23 Aug. 1978, coll. S. Kawai, TUA 1501, VPI SP038, 1(1) TUA, 1(1) VPI; Ishikawa-ken, Yamanaka Spa., 27 Sep. 1980, coll. S. Kawai, TUA 1635, VPI SP040, 1(1) VPI. ***Sasa kurilensis*:** Aomari-ken, Lake Towada, 1 Jun. 1977, coll. S. Kawai, TUA 1318, VPI SP039, 1(1) TUA, 1(1) VPI; Hokkaido, {intercepted} at D.C., 31 Jan. 1950, coll. H.Y. Gouldman, EQ 16407, 1(3) USNM. ***Sasa palmata*:** Hokkaido, Simamatu, 16 Sep. 1969, coll. S. Takagi, 2(4) FAHU 9(17) VPI; Hokkaido, Simamatu, 30 Jul. 1971, coll. S. Takagi, 2(5) VPI. ***Sasa paniculata*:** Nagano-ken, Mt. Togakusi, 13 Sep. 1967, coll. S. Kawai, TUA 1756, 1(4) TUA. ***Sasa* sp.:** Mt. Mutsuishi, Okutama, Tokyo, 23 Nov. 1965, coll. S. Kawai, TUA 1469, 5(40) TUA. **Undetermined Host:** Yokohama, "Quar. D.C.", 19 Feb. 1919, coll. H.L. Sanford, "in packing with cherry scions", 1(1) USNM.

Remarks. *Porisaccus sasae* is apparently restricted to Sakhalin, now part of the Republic of Russia, and the northern islands of Japan (Fig. 3). In these regions it can be found under the leaf-sheaths of various bamboos. Although no type material was available for study, there is no doubt that the examined material is the same as the material described by Siraiwa (1939) from Honto (= Nevelsk, Sakhalin). This species occurs primarily in mountainous regions (Kawai 1980) and is often found in mixed infestations with either *Antonina crawi* or *Serrolecanium tobai*.

In addition to having the cylindrical ducts characteristic of serrolecaniines, second and third instars also possess quadrilocular pores around the atrial opening as seen in the adult female developmental stage.

Diagnosis. Despite what is drawn in the illustrations for *Porisaccus jiuhuaensis* and this species, the last four abdominal segments are not always distinct in their specific outline. A more distinguishing feature for *P. sasae* is the presence of quadrilocular pores at the spiracular opening; however, the observation of these pores may be obscured by sclerotization or folds of derm in the immediate area. Also, the bag-like modification of the metathoracic legs in this species is approximately 3.5X larger than the spiracles. Abdominal segment VIII's general outline is another useful characteristic. Ventrally this segment including latero-posterior lobes appears more or less triangular; the distance between the lateral vulvar apodeme to the angle found at the base of a latero-posterior lobe is approximately one-half the length of the lobe's outer margin.

Serrolecanium Shinji

Type Species: *Serrolecanium bambusae* Shinji (1935), by monotypy, synonym of *Antonina tobai* Kuwana (1932).

Shinji, 1935a: 106-107; 1935b: 770; Ferris, 1950a: 71-72; Ali, 1970: 122; Danzig, 1980: 202-203; Kawai, 1980: 123; Tang, 1984a: 393; 1984b: 99-100, 117; Danzig, 1986: 235-236; Tang, 1992: 39-40.

Members of *Serrolecanium* Shinji infest various bamboos in China and the islands of Japan (fig. 4); however, the known distribution of this genus will most likely increase with future collecting. *Serrolecanium* was established for *Serrolecanium bambusae* Shinji (Shinji 1935a) which was found to be a junior synonym of *Antonina tobai* Kuwana (Siraiwa 1939).

Although based on a misidentification, Ferris (1950a) correctly recognized that *Antonina tobai* shared few affinities with other members of this genus and returned it to Shinji's *Serrolecanium*. Ferris' *Serrolecanium tobai* is here referred to *Serrolecanium indocalamus* Wu. Kawai (1972) placed another *Antonina* species, *Antonina sasae* Siraiwa, in *Serrolecanium*, but this species is transferred herein to the newly established and closely related genus *Porisaccus*. Danzig (1978) repeated the transfer of *Antonina sasae*, not knowing about Kawai's previous treatment. Wu described the new Chinese species *Serrolecanium jiuhuaensis* (1984) and *Serrolecanium indocalamus* (1988), both of which were collected on the bamboo *Indocalamus migoi*. The former is also

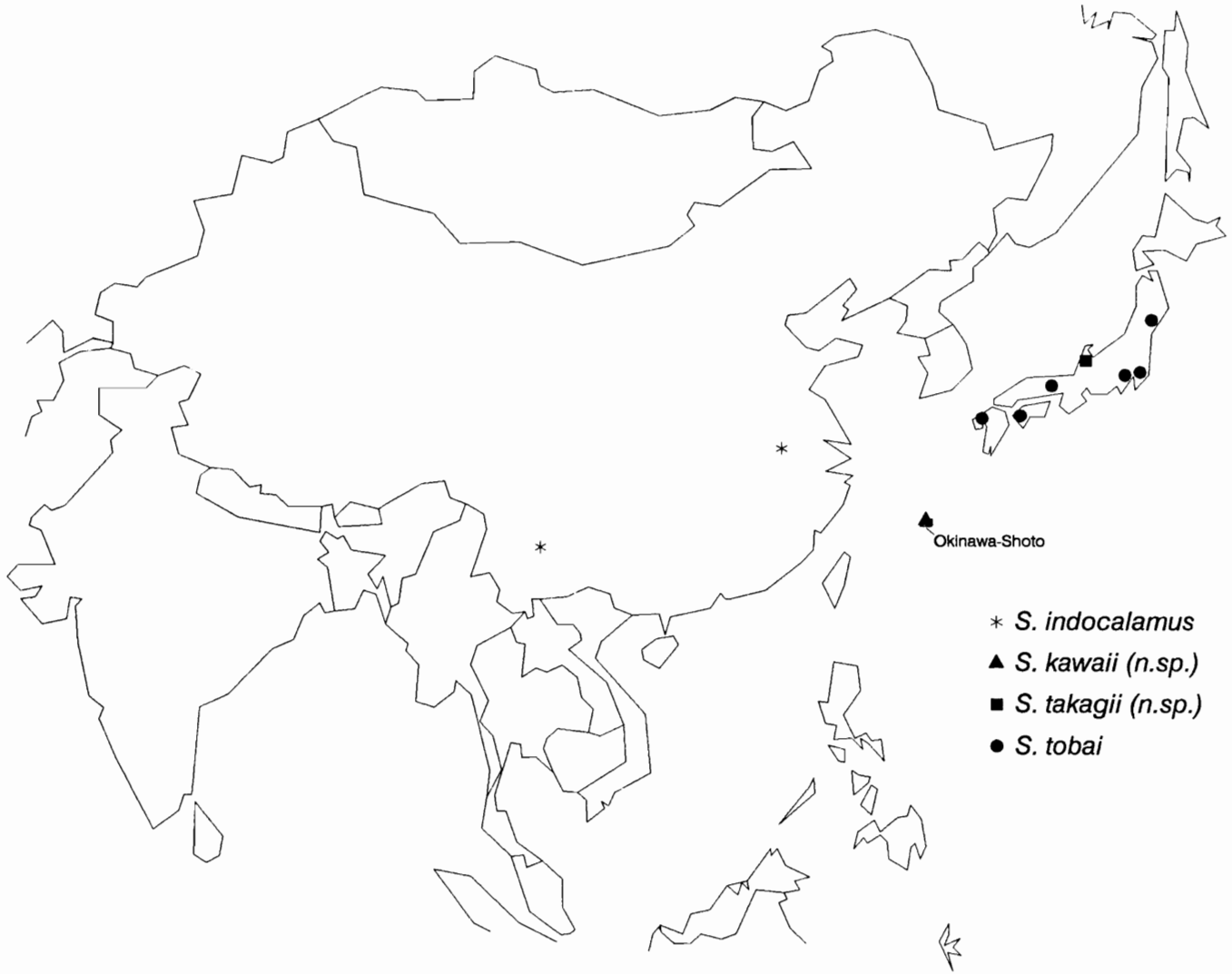

Figure 4. Distribution of *Serrolecanium* species.

transferred herein to *Porisaccus*. Four species are here recognized as belonging to *Serrolecanium* with two described as new.

Serrolecanium appears similar to *Porisaccus* which also possesses latero-posterior lobes on abdominal segment VIII. *Serrolecanium* species, however, also possess latero-posterior lobes on at least segment VII and their duct-like pores located posterior to the metathoracic spiracles are flush with the derm. Members of this genus also have the posterior or inner pair of vulvar apophyses arising from a dermal depression or plate on segment VIII (Plate 13, fig. A), and all but one species (*Serrolecanium kawaii*) possess cylindrical ducts as adult females.

DEFINITION

General. Body of adult females are obovate to elliptical with parallel sides, flattened dorso-ventrally or slightly convex dorsally; last 4-6 abdominal segments well-defined and expanded laterally, last 5-7 segments with latero-posterior lobes, lobes armed with many setae.

Dorsal Surface. Ostioles absent; cerarii absent; anal ring with numerous pores and 6 setae, ring located at end of invaginated tube, tube opening located between bases of latero-posterior lobes or slightly dorsad; sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with pair of dermal depressions located on submedial-submarginal region; trilocular pores and simple disc pores distributed over much of surface, cylindrical ducts with long collars occasionally present; conical setae present, located primarily along margin; flagellate setae occasionally present; marginal region of posterior abdominal segments including expansions and lobes with squamate cuticle (Plate 10, fig. B), gradient often seen between spicules and squamate derm.

Ventral surface: Antennae reduced to 1-2 segments; eyes absent or represented by small invaginated pits; clypeolabral shield with an anterior projection, projection typically prominent and slightly tapered, but nearly obsolete in *S. kawaii*; labium broader than long, 2-segmented; spiracles heavily sclerotized, as broad as long, with peritreme, numerous trilocular and simple disc pores associated with atria, atrial pores often divided into anterior and posterior groups; legs absent but with compact group of duct-like pores behind posterior spiracles in area typically occupied by metathoracic legs; vulva distinct and slit-like, directed caudally, with four slender apophyses and two lateral apodemes,

posterior or inner pair of vulvar apophyses arise from dermal depression located on segment VIII, dermal depression or plate clothed with flagellate setae.

Trilocular and simple disc pores distributed over much of venter, cylindrical ducts with long collars occasionally present; conical and flagellate setae present, conical found primarily along margin of body; apical setae present at base of or near outer margin of latero-posterior lobes; marginal region of posterior abdominal segments including expansions and lobes with squamate cuticle; circuli absent.

Key to Species of Genus *Serrolecanium*

1. Last six abdominal segments well-defined and expanded laterally; anterior projection of clypeolabral shield small, length ≤10% that of shield; antennae plate-like (Plate 11, fig. I); vulvar apophysal plates contiguous (Plate 11, fig. A); cylindrical ducts absent ..... ***kawaii***, p. 87

   Last four abdominal segments well-defined and expanded laterally; anterior projection of clypeolabral shield prominent, length ≥25% that of shield; antennae not plate-like; vulvar apophysal plates separate; cylindrical ducts present **2**

2. Latero-posterior lobes only on last two abdominal segments (Plate 12, fig. A); anal ring with four porous cones, anal ring setae within apex of cones (Plate 12, fig. G) ..... ***takagii***, p. 92

   Latero-posterior lobes on last five abdominal segments (Plate 13, fig. A); anal ring occasionally flared anteriorly but never with four porous cones **3**

3. Tip of latero-posterior lobes with conical seta (Plate 10, fig. B); apical setae at base of latero-posterior lobes (Plate 10, fig. A); abdomen without cylindrical ducts dorsally ..... ***indocalamus***, p. 82

   Tip of latero-posterior lobes without conical seta (Plate 13, fig. B); apical setae midway along outer margin of latero-posterior lobes (Plate 13, fig. A); abdomen with cylindrical ducts dorsally ..... ***tobai***, p. 96

Serrolecanium indocalamus Wu
Plate 10

Serrolecanium indocalamus Wu, 1988: 77.

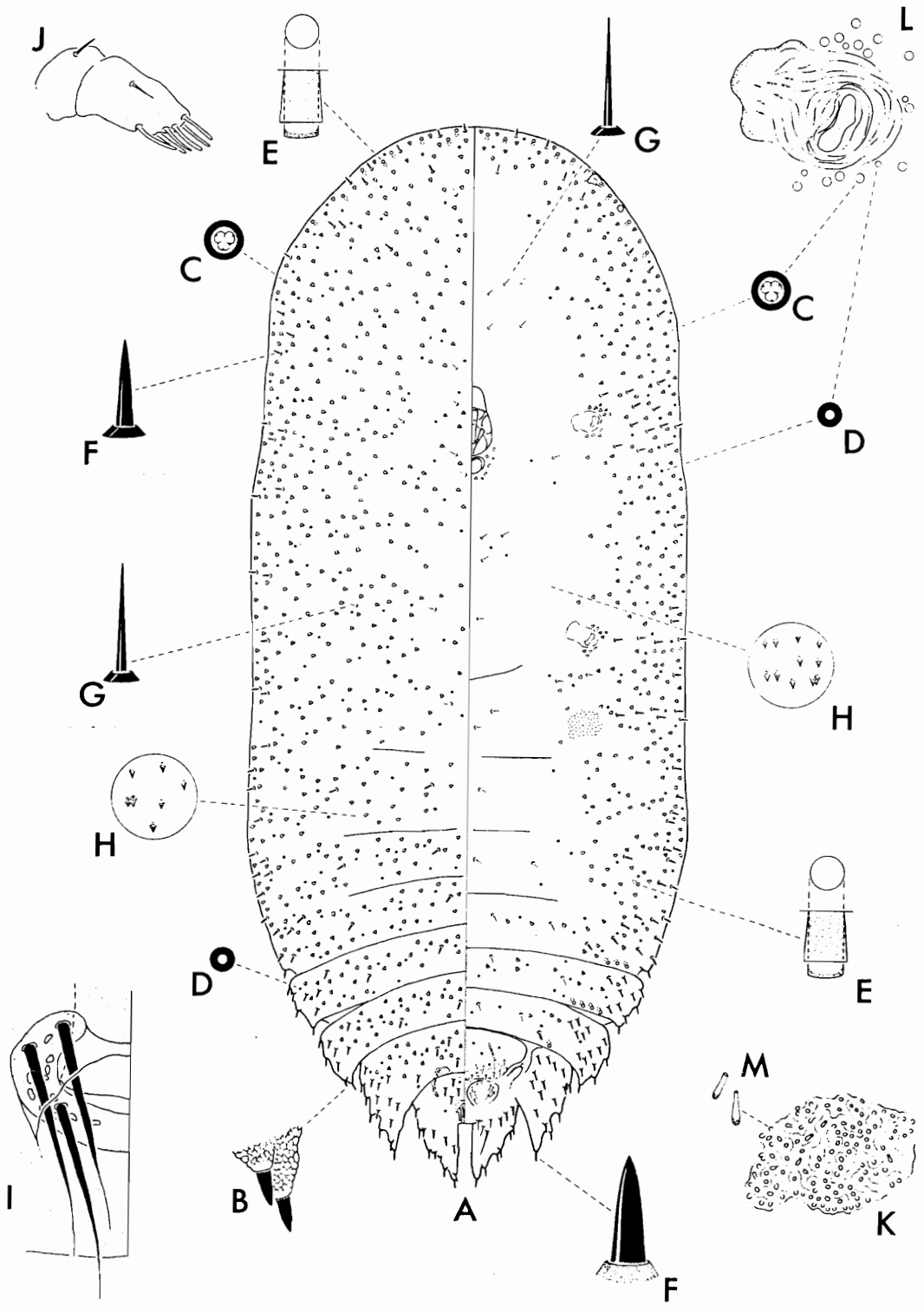

Plate 10. ***Serrolecanium indocalamus*** **Wu, Adult Female.**

Serrolecanium tobai (Kuwana) misidentified: Ferris, 1950a: 72; Ali, 1970: 122; Yang, 1982: 96.

GENERAL DESCRIPTION

Body of Adult Female. Dry, unmounted specimens elliptical with parallel sides to obovate, flattened dorso-ventrally to slightly convex dorsally; surrounded by white wax, with little to no wax on dorsum and venter; mouthparts typically positioned between anterior spiracles or just cephalad, sometimes located further posteriad; abdominal segmentation distinct, last four abdominal segments well-defined and expanded laterally, last five segments with latero-posterior lobes, lobe with pointed apex, length of lobe increases posteriorly with each segment; color yellow-brown, entire body of mature individuals dark brown with heavy sclerotization.

On microscope slide (fig. A): 4203µm (3570-5426) long, 1714µm (1392-2110) wide; body as mentioned above, latero-posterior lobes armed with conical setae but devoid of glandular structures, tip of lobes terminates with conical seta (fig. B), seta similar in size and structure to others found on lobes; squamate derm present dorsally and ventrally on lobes of segments IV-VIII, most of segment VII, and all of segment VIII.

Dorsal Surface

Trilocular Pores (fig. C). 5.82µm (4.75-6.65) in diameter, rim triangular to circular; distributed over entire surface except none present on abdominal segment VIII nor on latero-posterior lobes, fewer found medially on head and thorax.

Simple Disc Pores (fig. D). 3.54µm (2.85-4.75) in diameter, with circular rim; distributed over entire surface except none present on latero-posterior lobes.

Cylindrical Ducts (fig. E). 7.00µm (5.70-7.60) in diameter, 14.3µm (12.4-16.2) long, with collar approximately two-thirds length of tube; found along margin of head and occasionally on prothorax.

Setae. Of two types. Conical (fig. F): 6.65-21.9µm long, stout; distributed on submargino-marginal region of head and thorax, and over entire surface of abdomen, those located on abdomen found predominantly on latero-posterior lobes, those setae found on abdominal segments VII-VIII and on lobes broader and longer than others. Flagellate (fig. G): 8.55-10.5µm long; sparsely distributed on medio-submedial region of head and thorax.

Spicules (fig. H). Minute, 0.95-2.85μm long, solitary or in groups of two or more; located on medio-submarginal region of mesothorax, metathorax, and abdominal segments II-VI.

Anal Ring (fig. I). 72.9μm (66.6-83.3) in diameter, incomplete dorsally, directed caudally, slightly recessed or at end of short tube 13.5μm (7.14-21.4) long, removed from end of body at distance subequal to diameter of ring; anal ring pores numerous, 2.38μm (1.90-2.85) in diameter, distributed over entire ring except for medial section on ventral side; with six anal ring setae, 48.5-76.0μm long.

Other Structures. Sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with dermal depression located near aforementioned apodemes, depressed area without ultrastructures.

Ventral Surface

Eyes. Reduced, sometimes with central invagination, diameter 19.3μm (11.9-30.9).

Antennae (fig. J). Two-segmented, some not completely segmented, 77.0μm (60.8-112) long, diameter at base 41.9μm (33.3-52.3).

Clypeolabral Shield. Approximately 1.2X longer than broad, 172μm (153-188) long, 145μm (131-164) wide; anterior projection nearly two-fifths length of shield, 59.7μm (50.0-75.0) long, sides of projection more or less parallel.

Labium. Approximately 1.2X broader than long, 56.3μm (52.5-64.3) long, 69.5μm (45.2-85.7) wide at base, two-segmented.

Legs. Absent; compact group of duct-like pores (fig. K) behind posterior spiracles in area typically occupied by metathoracic legs.

Spiracles (fig. L). Anterior: spiracular arm 78.3μm (71.4-85.7) long, as broad as long, with peritreme; atrium 49.9μm (38.1-59.5) wide; with two groups of trilocular pores associated with atrium, anterior group with 10-25 trilocular pores, posterior group with 4-10 trilocular pores, 1-4 simple disc pores sometimes present in groups. Posterior: similar to anterior pair, but slightly larger and with fewer pores associated with atrium; arm 90.0μm (83.3-100) long, atrium 57.0μm (45.2-65.0) wide; 4-15 trilocular pores in anterior group and 4-7 in posterior group, simple disc pores same as above.

Trilocular Pores (fig. C). Structure as that on dorsum, 5.80μm (4.75-6.65) in diameter; located on submargino-marginal region of head, thorax, and abdominal segments II-VI; few occasionally distributed on medio-submedial region of segments II-VI; clustered around labium.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.42μm (2.85-4.75) in diameter; distributed over entire surface of head, thorax and abdominal segments II-VI, with fewer found medio-submedially; also located on medio-submedial region of segment VII; clustered around labium.

Duct-like Pores (fig. M). Slender and long, 1.43μm (0.95-1.90) in diameter, 5.70μm (4.75-6.65) long, collar sometimes evident near orifice; grouped in area typically occupied by metathoracic legs (fig. A), grouping typically circular, elongate oval at times.

Cylindrical Ducts (fig. E). Structure as those on dorsum, 7.03μm (6.65-7.60) in diameter, 14.3μm (12.4-15.2) long; located along margin of head and prothorax, 1-4 ducts are also found in the submargino-marginal region of abdominal segments III-VI along the posterior edge of each segment.

Setae. Of two types. Conical (fig. F): structure as that on dorsum, 7.60-21.9μm long; distributed on submargino-marginal region of body and on latero-posterior lobes. Flagellate (fig. G): 10.5-39.0μm long, distributed on medio-submedial region of head, thorax and abdominal segments II-VII, those on segment VII located near vulva; also located on entire surface of segment VIII, and grouped on depressed plate associated with posterior vulvar apophyses; those setae of greatest length found on posterior segments of body; apical setae present but not prominent, 66.5-76.0μm long, centrally located on base of latero-posterior lobes.

Spicules (fig. H). 0.95-1.90μm long, structure and distribution as on dorsum.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four long associated apophyses and two lateral apodemes, posterior apophyses arise from dermal depressions or plates located on segment VIII.

Other Structures. Mesothoracic apophyses sometimes evident but vague.

Type Material Examined. None available for study.

Other Material Examined. All material from **CHINA**. ***Arundinaria* sp.(?):** Yunnan, Si-shan, nr Kunming, "*Serrolecanium tobai*", 8 May 1949, coll. G.F. Ferris, China coll. no. 812, 2(3) UCD; Yunnan, Si-shan, nr Kunming, "*Serrolecanium tobai*", 10 May 1949, coll. G.F. Ferris, China coll. no. 829, 2(2) UCD, 1(1) VPI; Yunnan, Si-shan, nr Kunming, "*Serrolecanium tobai*", 12 May 1949, coll. G.F. Ferris, China coll. no. 849, 4(5) UCD, 4(4) VPI.

Remarks. Many redescriptions and treatments of *Serrolecanium* and its type species, *Serrolecanium tobai*, have been based on a misidentification made by Ferris (1950a) and

on the material that he collected in the Yunnan Province of China. Ferris' material shows striking differences with other lots of *S. tobai*, and is here treated as *S. indocalamus* Wu. Yet this material does not completely match Wu's (1988) definition and may actually represent a separate species. This possibility can not be affirmed until Wu's type material or topotypic material is made available for examination. Repeated attempts to borrow type material were unsuccessful.

Wu (1988) described *S. indocalamus* from material collected underneath the leaf-sheath of *Indocalamus migoi* on Jiuhua Mountain in the Anhui Province. The specimens used for the description of this species were probably old, heavily-sclerotized individuals. This presumption is based on statements made within the original description and on the illustration provided. For example, "chrysanthemum-shaped skin spots" observed by Wu (1988) are dermal depressions or points for muscle attachment and become evident only in heavily-sclerotized individuals. The use of old, sclerotized specimens would explain the dissimilarities between observed material and Wu's definition of *S. indocalamus*.

As experienced in this study, most dermal ultrastructures, especially the wax-producing glands, are often obscured from observation or difficult to properly distinguish in individuals heavily sclerotized. This condition of the integument would explain Wu's identification of deeply-recessed trilocular pores as "small tube glands", and why cylindrical ducts were not observed on the abdominal venter. As noted by Ferris (1950a), the cylindrical duct is unusual in that its inner lining is wavy and gives the impression of having faint septa. This would account for Wu's observation of "multilocular pores" along the margin of the body instead of cylindrical ducts.

Diagnosis. *Serrolecanium indocalamus* is easily be distinguished from *S. tobai* and *S. takagii* by having a conical seta at the tip of its latero-posterior lobes, and by having its apical setae at the base of segment VIII's latero-posterior lobes rather than midway along the lobes' outer margin. *Serrolecanium kawaii* also possesses these aforementioned characters, but it lacks cylindrical ducts and has the last six abdominal segments well-defined laterally.

Serrolecanium kawaii Hendricks & Kosztarab, sp. n.
Plate 11

GENERAL DESCRIPTION

Body of Adult Female. Alcohol-preserved individuals are flat to slightly convex dorsally, broadly obovate to elliptical with parallel sides; covered with white wax, with

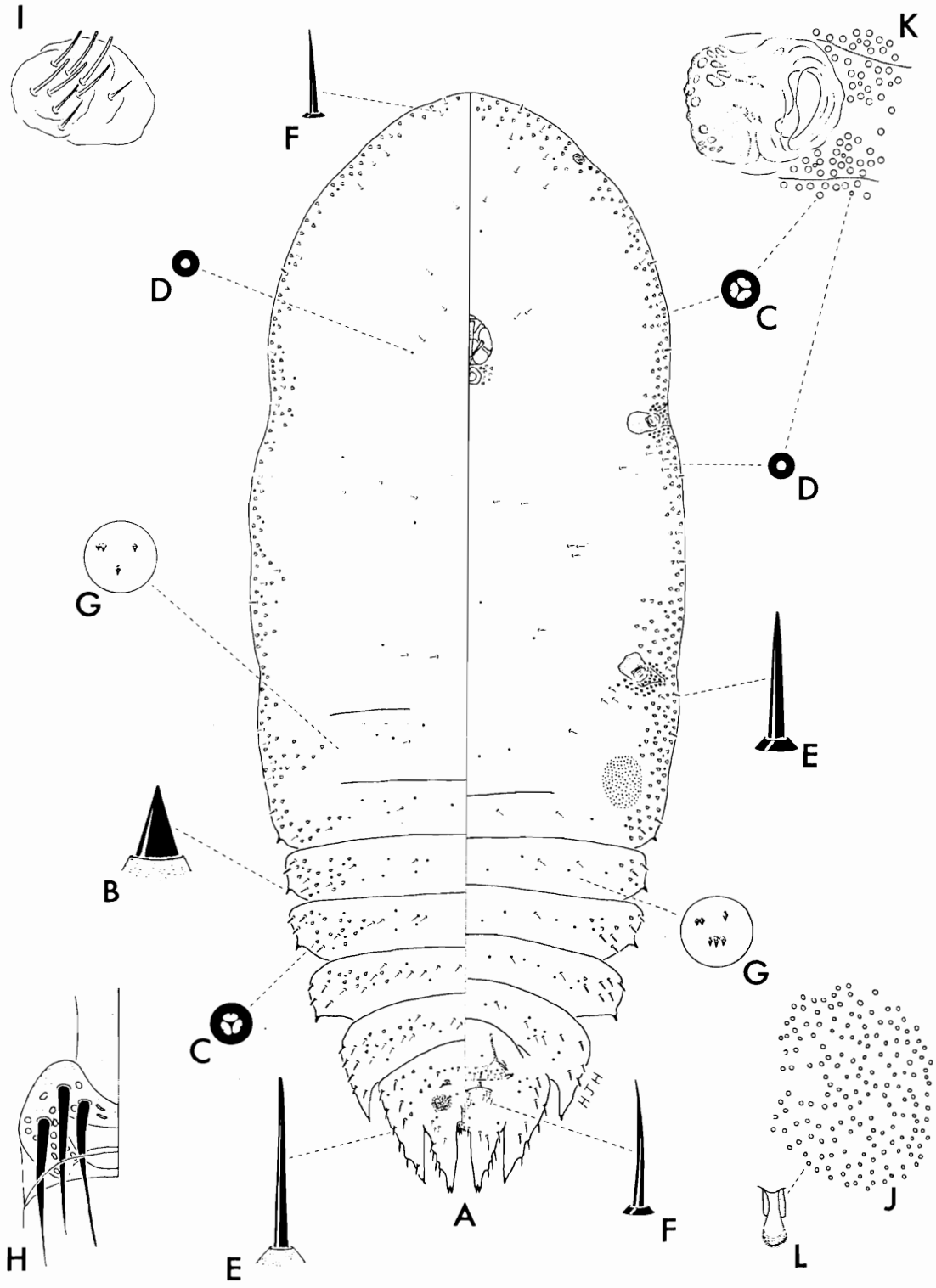

Plate 11. ***Serrolecanium kawaii*** **Hendricks & Kosztarab, Adult Female.**

little or no wax dorsally and ventrally; location of mouthparts varies, positioned at some point between anterior spiracles and anterior margin of body; spiracles located near lateral margin of body; last six abdominal segments well-defined and expanded laterally, each abdominal segment with latero-posterior lobes, lobes with pointed apex, length of lobes increases caudally; color yellow-brown, expansions and lobes of abdomen heavily sclerotized, margin of thorax sclerotized in some individuals.

On microscope slide (fig. A): 3608μm (3280-4081) long, 1975μm (1109-2510) wide; body as mentioned above, latero-posterior lobes of abdomen devoid of glandular structures, last three pairs of lobes armed with slender conical setae along outer margin (fig. E), tip of each lobe terminates with broad conical seta 9.5-18.1μm long (fig. B), lobes of last abdominal segment often terminate with two broad conical setae; margin of VII and all of segment VIII with squamate derm dorsally.

Dorsal Surface

Trilocular Pores (fig. C). 5.37μm (4.75-5.70) in diameter, rim triangular to circular; located on margin of head, submargino-marginal region of abdominal segments II-V, and submedio-marginal region of segments VI-VII; occasionally found on segment VIII.

Simple Disc Pores (fig. D). 3.15μm (1.90-3.80) in diameter, with circular rim; distributed over entire dorsum with fewer found on medio-submarginal region of head and thorax.

Setae. Of two types. Conical (fig. E): 7.60-33.3μm long, as slender as flagellate setae; found along margin of head and thorax, more found along margin of abdomen and outer margin of lobes. Flagellate (fig. F): 4.75-25.5μm long; distributed over entire surface of head and thorax, primarily along margin, also located on medio-submarginal region of abdominal segments II-VII and on base of segment VIII's lobes.

Spicules (fig. G). Minute, 0.95-2.85μm long, solitary or in groups of two or more; located on medio-submarginal region of metathorax and abdominal segments II-VI, and entire surface of segment VII.

Anal Ring (fig. H). 52.5μm (51.3-54.1) in diameter, apparently incomplete ventrally, at end of body between lobe bases, directed caudally, slightly recessed or at end of short tube approximately 19μm long; with 30-50 pores, diameter of pores 2.38μm (1.90-2.85); with six anal ring setae 32.3-53.2μm long.

Other Structures. Sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with dermal depression located posterior to aforementioned apodemes, depressed area without ultrastructures.

Ventral Surface

Eyes. Typically absent; sometimes represented by an invaginated pit, diameter 8.33μm (7.50-10.0).

Antennae (fig. I). Unsegmented and plate-like, diameter 32.9μm (20.0-40.0), with 6-8 setae.

Clypeolabral Shield. Length and width subequal, 162μm (145-175) long, 161μm (150-183) wide; with small anterior projection approximately one-tenth length of shield, 21.3μm (10.0-27.5) long, width of projection subequal to that of apodeme associated with salivary pump (Koteja, 1976).

Labium. Approximately 1.5X broader than long, 59.2μm (50.0-70.0) long, 88.6μm (77.5-100) wide at base, two-segmented.

Legs. Absent; group of duct-like pores (fig. J) behind posterior spiracles in area typically occupied by metathoracic legs.

Spiracles (fig. K). Adjacent to lateral margin and with spiracular furrow. Anterior: spiracular arm 94.7μm (80.0-105) long, as broad as long, with sclerotized peritreme; atrium 46.4μm (35.0-52.5) wide; with group of 65-85 trilocular pores and 3-12 simple disc pores associated with atrium, trilocular pores smaller than those located on rest of body, 4.24μm (3.80-4.75). Posterior: similar to anterior pair, but slightly larger; arm 103μm (82.5-118) long, atrium 50.8μm (45.0-55.0) wide; 75-95 trilocular and 4-12 simple disc pores associated with atrium.

Trilocular Pores (fig. C). Structure as that on dorsum, 5.57μm (4.75-5.70) in diameter; distributed along margin of head, thorax, and abdominal segments II-V; occasionally found submarginally; clustered in lateral area between clypeolabral shield and labium.

Simple Disc Pores (fig. D). Structure and distribution as that on dorsum, 3.00μm (1.90-3.80) in diameter; clustered in lateral area between clypeolabral shield and labium.

Duct-like Pores (fig. L). 2.22μm (1.90-2.85) in diameter, 7.60μm (5.70-9.50) long, collar evident near orifice; within compact group in submargino-marginal region of metathorax posterior to metathoracic spiracle.

Setae. Of two types. Conical (fig. E): structure and distribution as that on dorsum, 6.65-30.4μm long. Flagellate (fig. F): structure as that on dorsum, 3.80-28.5μm long,

those of greatest length distributed along margin and on posterior segments of body; distribution as that on dorsum except those found on segment VII align vulva, also grouped on depressed plate associated with posterior vulvar apophyses; apical setae present but not prominent, 48.5-57.0μm long, centrally located on base of latero-posterior lobes.

Spicules (fig. G). Minute, 0.95-2.85μm long, primarily in groups of two or more, distributed on medio-submarginal region of metathorax and abdominal segment II, and entire surface of segments III-VII except for their lobes.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four long associated apophyses and two lateral apodemes, posterior apophyses arise from dermal depressions or plates located on segment VIII, pair of apophysal plates contiguous and clothed with flagellate setae.

Other Structures. Apparently none.

Type Material Examined. HOLOTYPE, adult female, on *Pleioblastus linearis*, JAPAN, Ryukyu Islands, Okinawa-Shoto, Kume Island, 1 Mar. 1991, coll. S. Kawai, #13573, SP033b, 1(1) TUA. **PARATYPES**. Adult females, data same as holotype, SP033a/c-e, 1(1) FAHU, 3(3) TUA; adult females, on *Pleioblastus linearis*, JAPAN, Ryukyu Islands, Okinawa-Shoto, Yona, Kumigami, 16 Dec. 1989, coll. S. Kawai, #13113, SP032a-d, 2(2) FAHU, 2(2) TUA.

Immatures: second and third instars, SP033f, 1(2) TUA; embryos, SP032e, 1(3) TUA.

Remarks. According to Dr. Shozo Kawai, Tokyo University of Agriculture, each specimen of this new species was collected alone underneath the buds of *Pleioblastus linearis* at Okinawa-Shoto. This solitary behavior is most unusual among the bamboo-infesting mealybugs which are typically gregarious under leaf sheaths. *Serrolecanium kawaii* is also unique among the known *Serrolecanium* species in that cylindrical ducts are absent in the adult female stage, but is present in second and third instar developmental stages.

The degree of sclerotization present in the available specimens around the anal ring and on the lobes made the observation of certain structures very difficult. Described characteristics of the anal ring were based on a conglomeration of partial observations from each specimen. The distribution provided for squamate derm may also be incomplete. It was also challenging to distinguish conical setae from flagellate setae on

the terminal abdominal segments. Despite being as slender as the flagellate setae, conical setae tend to have rounded tips and are not whip-like.

Etymology. This species was named in honor of Dr. Shozo Kawai for his contributions to the knowledge of Japanese scale insects and for providing much assistance to this research project.

Diagnosis. *Serrolecanium kawaii* is very distinct among the known species of *Serrolecanium* and should not be difficult to distinguish. Among its many unique characteristics in the adult female stage are plate-like antennae, slight anterior projection on clypeolabral shield, absence of cylindrical ducts, lateral expansions on all but first abdominal segment, and contiguous vulvar apophysal plates. Although its uniqueness makes determining relationships difficult, it appears most similar to *S. indocalamus* as described herein. Both species have each latero-posterior lobe terminating with a conical seta, and their apical setae are positioned at the base of lobes rather than midway along outer margin.

Serrolecanium takagii Hendricks & Kosztarab, sp. n.
Plate 12

GENERAL DESCRIPTION

Body of Adult Female. Alcohol-preserved individuals are flattened dorso-ventrally to slightly convex dorsally, obovate to broadly turbinate; mouthparts positioned at some point between anterior spiracles and point midway between spiracular pairs; last four abdominal segments well-defined and expanded laterally, last two segments with latero-posterior lobes, apex of lobes rounded, last pair of lobes longer than preceding pair; color yellow-brown.

On microscope slide (fig. A): 2961μm (2310-3696) long, 1821μm (1232-2048) wide; body as mentioned above, latero-posterior lobes of abdomen armed with conical setae, trilocular pores on lobes ventrally, tip of lobes without terminal seta; squamate derm present on margin of abdominal segments V-VI, submargino-marginal region and lobes of segment VII, and entire surface and lobes of segment VIII.

Dorsal Surface

Trilocular Pores (fig. B). 5.20μm (4.75-5.70) in diameter, typically with circular rim; distributed over entire surface of cephalothorax and abdominal segments II-VI, also located on medio-submarginal region of segment VII.

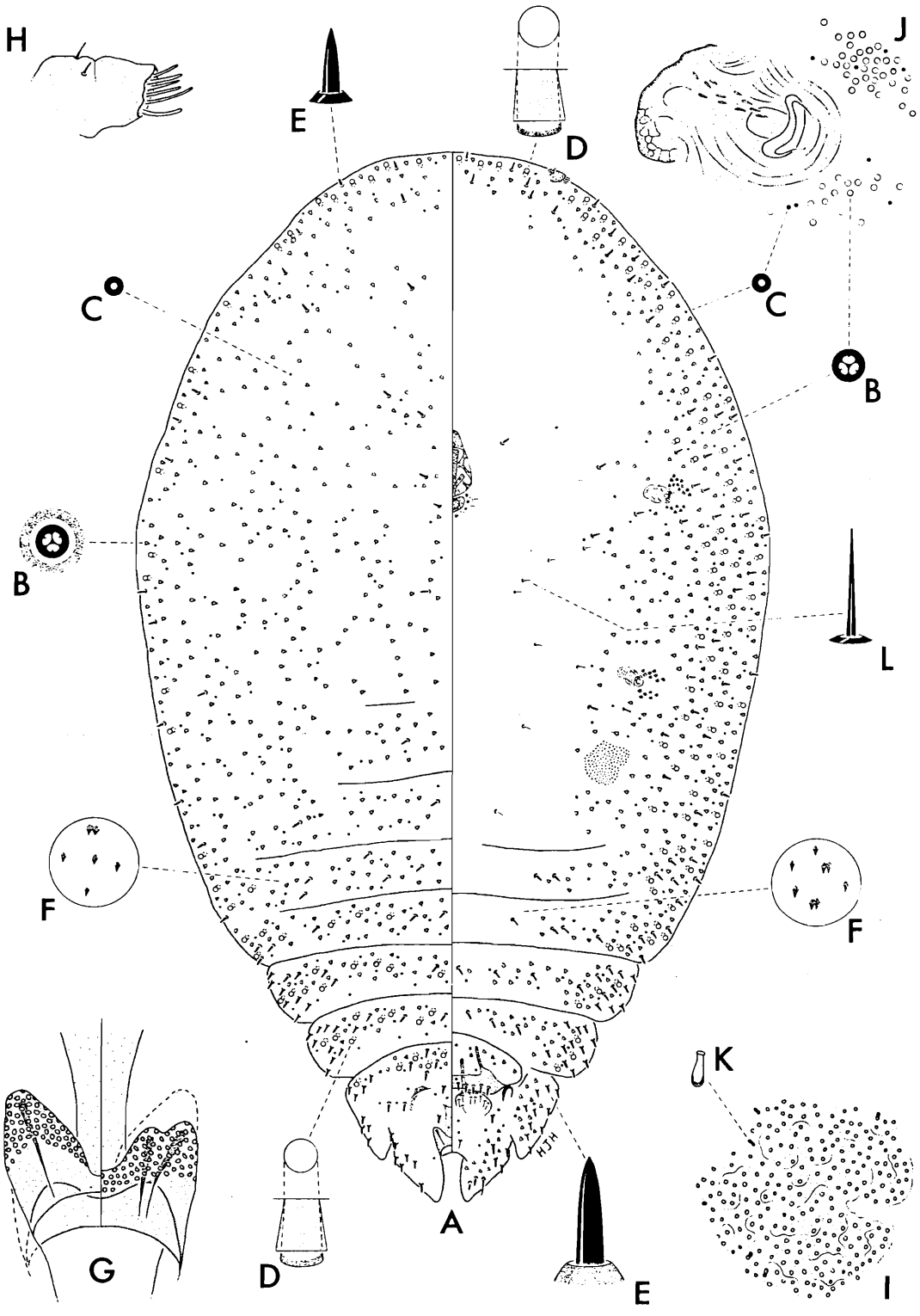

Plate 12. ***Serrolecanium takagii*** **Hendricks & Kosztarab, Adult Female.**

Simple Disc Pores (fig. C). 2.38μm (1.90-3.80) in diameter, with circular rim; distributed over entire dorsum with fewer found on abdominal segment VIII.
Cylindrical Ducts (fig. D). 7.38μm (6.65-7.60) in diameter, 11.7μm (10.5-13.3) long, with collar approximately 3/4 length of tube; distributed on margin of cephalothorax and abdominal segments II-III, and over entire surface of segments IV-VII.
Setae. Conical (fig. E): 6.65-20.0μm long, stout; distributed over entire dorsum, found primarily on margin of body and latero-posterior lobes.
Spicules (fig. F). Minute, 0.95-1.90μm long, solitary or in groups of two or more; located on medio-submedial region of thorax and medio-submarginal region of abdominal segments II-VII.
Anal Ring (fig. G). 151μm (138-160) in diameter, with numerous pores 2.72μm (1.90-3.80) in diameter; ring conformed into crown of four conical horns, dorsal pair of cones each with seta within apex, ventral pair each with two setae, setae 62.7-80.8μm long; ring located at end of asymmetrical tube 85μm (75.0-103) long at greatest length, tube opening at end of body between lobe bases.
Other Structures. Small, sclerotized apodemes located submedially between abdominal segments VII-VIII; segment VIII with slender dermal depression located near aforementioned apodemes.

Ventral Surface

Eyes. Absent.
Antennae (fig. H). Two-segmented, but some only partially divided, 55.8μm (42.5-60.0) long, diameter at base 37.2μm (25.0-52.5).
Clypeolabral Shield. Approximately 1.3X longer than broad, 169μm (155-180) long, 134μm (125-150) wide; anterior projection approximately one-third length of shield, 58.1μm (47.5-65.0) long, projection slightly tapered.
Labium. Approximately 1.5X broader than long, 48.8μm (40.0-57.5) long, 76.3μm (75.0-77.5) wide at base, two-segmented.
Legs. Absent; group of duct-like pores (fig. I) behind posterior spiracles in area typically occupied by metathoracic legs.
Spiracles (fig. J). Anterior: spiracular arm 91.9μm (77.5-100) long, as broad as long, with sclerotized peritreme; atrium 37.5μm (35.0-40.0) wide; with two groups of pores associated with atrium, anterior group with 30-45 trilocular and 3-10 simple disc pores, posterior group with 20-30 trilocular and 4-8 simple disc pores; trilocular pores smaller

than those located elsewhere, 3.68μm (2.85-4.75) in diameter. Posterior: similar to anterior pair, but slightly larger and generally with fewer pores associated with atrium; arm 98.3μm (87.5-108) long, atrium 36.7μm (30.0-40.0) wide; 30-40 trilocular and 1-8 simple disc pores in anterior group, 10-25 trilocular and 2-6 simple disc pores in posterior group.

Trilocular Pores (fig. B). Structure as that on dorsum, 4.91μm (4.75-5.70) in diameter; distributed on submargino-marginal region of head and prothorax, submedio-marginal region of remaining thoracic segments and abdominal segments II-IV, entire surface of segments V-VII, margin of segment VIII, and both pairs of latero-posterior lobes; those on medio-submedial area of segment VII found only on anterior half of region; clustered around labium.

Simple Disc Pores (fig. C). Structure as that on dorsum, 2.45μm (1.90-2.85) in diameter; located on submargino-marginal region of head and prothorax, submedio-marginal region of remaining thoracic segments and abdominal segments II-IV, entire surface of segments V-VIII, but none on lobes or apophysal plates; clustered around labium.

Duct-like Pores (fig. K). 2.16μm (1.90-2.85) in diameter, 6.18μm (4.75-7.60) long, collar not evident; within compact group posterior to metathoracic spiracle in area typically occupied by metathoracic legs.

Cylindrical Ducts (fig. D). Structure as that on dorsum, 7.44μm (6.65-7.60) in diameter, 11.8μm (9.50-14.3) long; located on margin of head, thorax, and abdominal segments II-VI; occasionally found submarginally.

Setae. Of two types. Conical (fig. E): structure as that on dorsum, 4.75-19.0μm long; distributed over entire venter with fewer found on medio-submedial region of head and thorax, those on medio-submedial region of segment VII align vulva, those on segment VIII located marginally and along outer margin of lobes. Flagellate (fig. L): those distributed on thorax and grouped around labium 7.60-10.5μm long, those located on segment VIII and its apophysal plates 14.3-19.0μm long; apical setae present, 29.5-45.6μm long, located midway down outer margin of latero-posterior lobes.

Spicules (fig. F). Structure and distribution as that on dorsum, 0.95-1.90μm long.

Vulva. Distinct, smooth, with opening directed toward caudal end; with four long associated apophyses and two lateral apodemes, posterior apophyses arise from dermal depressions or plates located on segment VIII, apophysal plates clothed with flagellate setae.

Other Structures. None.

Type Material Examined. **HOLOTYPE**, adult female, on *Sasa palmata*, JAPAN, Ishikawa-ken, Mt. Hakusan, (s.l. 1000m), 28 Sep. 1980, coll. S. Kawai, #1608, SP034a, 1(1) TUA. **PARATYPES**. Adult females, data same as holotype, SP034b-e, 1(1) FAHU, 3(3) TUA.

Remarks. One of the more unique characters of this new species is the formation of the anal ring into a crown of four, porous cones. Although other species examined during this study possessed an anal ring that flared anteriorly, *S. takagii* was the only species observed with cones. Both dorsal and ventral habitus of the ring are provided in the illustration (fig. G), with the facing surfaces highlighted.

As in most species examined, glandular structures such as the trilocular pores in this species were often recessed in the derm. The area surrounding the base of these depressions was often sclerotized and gave the impression of a second outer rim (fig. B).

Etymology. This species was named in honor of Dr. Sadao Takagi, Hokkaido University, for his contributions to the knowledge of the scale insects of Southeast Asia and to this research project.

Diagnosis. *Serrolecanium takagii* can easily be distinguished from other *Serrolecanium* species by its unique anal ring, by having many cylindrical ducts distributed over much of the body's margin, and by possessing latero-posterior lobes on the last two abdominal segments only.

Serrolecanium tobai (Kuwana)
Plate 13

Antonina tobai Kuwana, 1932: 216, 218-219; Siraiwa, 1939: 68. [types probably lost or destroyed]

Serrolecanium bambusae Shinji, 1935a: 107-108; 1935b: 770.

Serrolecanium tobai (Kuwana) Kawai, 1972: 9; 1980: 124; Tang, 1992: 40.

GENERAL DESCRIPTION

Body of Adult Female. Kuwana (1932) reported specimens as being found beneath leaf sheaths of the host, partially covered with cottony wax, dark brown in color. Observed alcohol-preserved specimens were obovate to elliptical with parallel sides, flattened to slightly concave ventrally, flattened to slightly convex dorsally; mouthparts typically

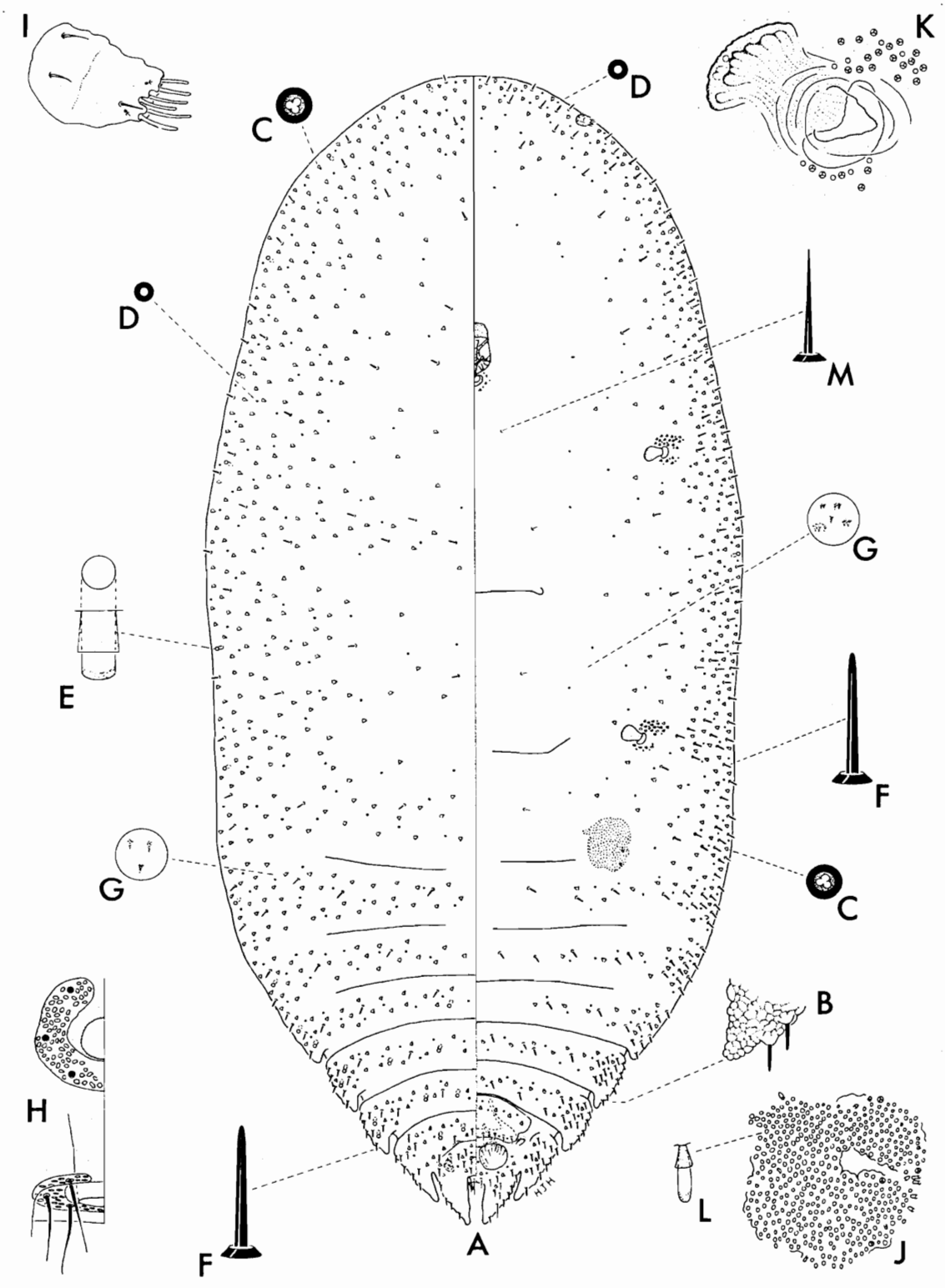

Plate 13. ***Serrolecanium tobai*** **(Kuwana), Adult Female.**

positioned between anterior spiracles or just cephalad, sometimes located further posteriad; last four abdominal segments well-defined and expanded laterally, last five segments with latero-posterior lobes, length of lobes increases caudally; color yellow-brown, abdominal expansions and lobes sclerotized, posterior abdominal segments and margin of thorax darkened in some individuals, entire body of mature individuals heavily sclerotized.

On microscope slide (fig. A): 3252μm (2249-5891) long, 1542μm (1107-2785) wide; body as mentioned above, latero-posterior lobes beset with conical setae but devoid of glandular structures (fig. B, venter), tip of lobes not terminating with seta; squamate derm present on both surfaces of latero-posterior lobes, dorso-posterior half of abdominal segment VII, and entire dorsal surface of segment VIII.

Dorsal Surface

Trilocular Pores (fig. C). 6.05μm (4.75-7.60) in diameter, rim triangular to circular; distributed over entire dorsum, fewer located medially on head and thorax.

Simple Disc Pores (fig. D). 3.74μm (2.85-4.75) in diameter, with circular rim, distributed over entire dorsum.

Cylindrical Ducts (fig. E). 5.52μm (4.75-6.65) in diameter, 12.9μm (11.4-15.2) long, with collar approximately 2/3 length of tube; typically distributed on margin of head, thorax, and abdominal segments II-VI, and medio-submedial region of segments VI-VII. Occasionally found elsewhere, but never on segment VIII.

Setae. Conical (fig. F), 7.60-33.3μm long, stout, greatest lengths found on posterior segments of body; distributed over entire dorsum, primarily marginal, those on latero-posterior lobes found only along outer margin.

Spicules (fig. G). Minute, 0.95-2.85μm long, most solitary; located on medio-submarginal region of metathorax and abdominal segment VIII, and entire surface of segments II-VII.

Anal Ring (fig. H). 90.4μm (85.7-97.6) in diameter, incomplete dorsally; directed caudally, slightly recessed or at end of short tube 27.2μm (25.0-37.5) long, ring or tube opening at end of body between lobes; anal ring pores numerous, 2.49μm (1.90-2.85) in diameter, distributed over entire ring except for medial section on ventral side; with six anal ring setae, 47.5-72.2μm long.

Other Structures. Pair of sclerotized apodemes submedially between abdominal segments VII-VIII; segment VIII with pair of dermal depressions near aforementioned apodemes, depressed areas without ultrastructures.

Ventral Surface

Eyes. Absent or reduced when present, sometimes represented by an invagination, diameter 9.52μm (7.14-14.3).

Antennae (fig. I). Unsegmented or two-segmented, some antennae with incomplete segmentation, 54.6μm (33.3-72.2) long, diameter at base 48.0μm (36.1-62.7).

Clypeolabral Shield. Approximately 1.2X longer than broad, 180μm (170-200) long, 149μm (138-157) wide; with short anterior projection approximately one-fourth length of shield, 46.9μm (32.5-50.0) long.

Labium. Approximately 1.4X broader than long, 58.7μm (52.4-64.3) long, 83.3μm (57.1-107) wide at base, two-segmented.

Legs. Typically absent (see Remarks); compact group of duct-like pores (fig. J) behind posterior spiracles in area typically occupied by metathoracic legs.

Spiracles (fig. K). Anterior: spiracular arm 86.1μm (78.5-92.8) long, nearly as broad as long, with peritreme; atrium 52.4μm (47.6-54.7) wide; with two groups of trilocular and simple disc pores associated with atrium, anterior group with 20-35 trilocular and 5-17 simple disc pores, posterior group with 4-11 trilocular and 4-10 simple disc pores; trilocular pores smaller than those located elsewhere, 4.32μm (3.80-4.75). Posterior: similar to anterior pair, but slightly larger; arm 92.8μm (85.7-100) long, atrium 58.7μm (52.4-61.8) wide; 20-40 trilocular and 1-15 simple disc pores in anterior group, 5-15 trilocular and 4-10 simple disc pores in posterior group.

Trilocular Pores (fig. C). Structure as that on dorsum, 6.18μm (4.75-6.65) in diameter; distributed on submedio-marginal region of head and thorax, and over entire abdominal venter; those on medio-submedial region of segment VII found only on anterior half in more or less transverse row, none found on apophysal plates of segment VIII; grouped around labium and spiracular opening.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.52μm (2.85-4.75) in diameter; distribution similar to that of trilocular pore except found primarily along margin and on posterior half of segment VII's medio-submedial region.

Duct-like Pores (fig. L). Slender but long, 2.51μm (1.90-3.80) in diameter, 9.16μm (6.65-12.4) long, with collar at base; grouped posterior to metathoracic spiracles in area typically occupied by metathoracic legs.

Cylindrical Ducts. Rarely present, dimensions and structure as those on dorsum, few along extreme margin of body from head to abdominal segment IV when present, presence probably due to mounting.

Setae. Of two types. Conical (fig. F): 12.4-25.7μm long, stout; distributed on submargino-marginal region of head, thorax and abdominal segments VII-VIII, also located on entire surface of abdominal segments II-VI, primarily marginal, those on latero-posterior lobes found only along outer margin. Flagellate (fig. M): distributed on medio-submedial region of thorax and abdominal segment VII, those of segment VII located near vulva; also located on entire surface of segment VIII, including the depressed plate from which posterior vulvar apophyses arise; those on thorax 7.60-14.3μm long, those on segments VII-VIII 19.0-29.5μm long; apical setae present but not prominent, 33.6-57.0μm long, located midway along outer margin of terminal lobes.

Spicules (fig. G). 0.95-1.90μm long, usually in groups of two or more; distributed on medio-submedial region of meso- and metathorax, medio-submarginal region of abdominal segments II-VI, and entire surface of segments VII-VIII except for dermal depressions.

Vulva. Distinct, smooth, opening directed caudally; with four long associated apophyses and two lateral apodemes, posterior apophyses arise from dermal depressions or plates located on segment VIII, depressed area clothed with flagellate setae.

Other Structures. Mesothoracic apophyses sometimes evident but vague.

Type Material Examined. None available for study. Dr. Inokichi Kuwana's scale collection is currently housed in the National Institute of Agro-Environmental Sciences (NIAS), Ibaraki, Japan; however, his type series of *Antonina tobai* is presumably lost or destroyed (pers. comm., Dr. Takeshi Matsumura, NIAS; Dr. Shozo Kawai, Tokyo University of Agriculture, Japan).

Other Material Examined. All material from **JAPAN**. ***Pleioblastus simonii*:** Akigawa C., nr Tokyo, 16 Oct. 1965, coll. S. Kawai, 1(3) TUA; Ehime-ken, Matsuyama, 27 Apr. 1985, coll. T. Tachikawa, #1989, 1(1) TUA; Kanagawa-ken, Mt. Tanzawa, 30 Jul. 1965, coll. S. Kawai, #1272, 8(64) TUA; Takao, nr Tokyo, 17 Apr. 1966, coll. S. Kawai, #1541, 1(7) TUA. ***Pleioblastus* sp.:** Mt. Mitake, Ohme, Tokyo, 12 May 1965, coll. S. Kawai, #1131, 3(23) TUA; Kyushu, Saga-ken, Mt. Tara-dake, 15 Apr. 1976,

coll. S. Kawai, #K-107, 2(2) TUA. ***Sasa borealis*:** Miyagi-ken, Sendai C., 6 Apr. 1978, #1446, 2(2) TUA; Okayama, Tomata, Okutsu, Woodland Park, 23 Aug. 1978, coll. S. Kawai, 1(1) TUA. ***Sasa* sp.:** Miyagi-ken, Sendai (Aoba-y.), 10 Feb. 1971, coll. S. Takagi, #71-6b, 2(4) FAHU. **Undetermined Bamboo:** Yokohama, "at Quar. Wash. D.C.", "Antonina tobai Kuw.", 27 Apr. 1916, A.D. Borden, 1(2) USNM.

Remarks. Apparently this species is confined to bamboo on the islands of Japan (Fig. 4). In addition to the host plants listed above, *S. tobai* has also been collected on *Sasa nipponica* and *S. veitchii* (Shinji 1935b). Kuwana (1932) described *S. tobai* from material collected by G. Toba on *Pleioblastus nebulosa* in Iwate-ken, Honshu. Shinji's description (1935a, b), under the synonym *S. bambusae*, was of material collected on *P. simonii* in Shizuoka-ken, Honshu. Although no type material was examined, there is no doubt that the material examined in this study was *S. tobai*.

Many redescriptions of *S. tobai* since 1950, other than those cited above, have been based on Ferris' (1950a) treatment and the material he collected in southwest China on *Arundinaria*. This particular material was misidentified and is here referred to *Serrolecanium indocalamus* Wu. Though no other material of *S. indocalamus* was available for examination, Ferris' material more closely resembled the description and illustration provided by Wu (1988) and showed striking differences from *S. tobai*.

Among the many specimens observed, some possessed structures that closely resemble bilocular pores, particularly in region surrounding the spiracular openings. These ultrastructures were actually simple disc pores partially fused to one another, and were frequently misidentified at first glimpse. A few simple disc pores were also observed partially fused with trilocular pores. Specimens from Mt. Tanzawa, Kanagawa-ken, were initially thought to represent an undescribed species. These individuals are small, have broad lobes, and possess leg remnants (pleural vestiges). These differences were merely geographic variations and not sufficient to consider the lot as a separate species.

Diagnosis. The presence of cylindrical ducts on the abdomen's dorsal surface, absence of terminal setae on latero-posterior lobes, and the location of apical setae midway along outer margin of latero-posterior lobes distinguishes this species from *S. indocalamus* which looks very similar in general appearance. *Serrolecanium takagii* also lacks a terminal seta on the lobes and has its apical setae in same the location as *S. tobai*; however, it has latero-posterior lobes only on the last two abdominal segments and possesses a distinct but unusual anal ring.

Tangicoccus Kozár & Walter

Type species: *Longicoccus elongatus* Tang (1977), by original designation and monotypy.

Longicoccus Tang, 1977: 26; Wang, 1982: 167-168. [homonym of *Longicoccus* Danzig, 1975]

Tangicoccus Kozár & Walter, 1985: 73; Tang, 1992: 30-31. [replacement name for *Longicoccus* Tang]

Longicoccus Tang (1977) was established for the bamboo-infesting *Longicoccus elongatus* of China. Kozár & Walter (1985) recognized that this name was preoccupied by *Longicoccus* Danzig (1975) and replaced it with the patronymic *Tangicoccus*. Tang (1977) felt this genus was similar to *Chaetococcus* Maskell and distinguished the later from the former simply by the presence of pores and setae on the anal ring, structures subsequently observed in *Tangicoccus* during this study. *Tangicoccus* superficially resembles another monotypic genus, *Paludicoccus* Ferris, a non-serrolecaniine, but is easily separated by having a marginal band of duct-like pores present on the abdominal venter (Plate 14, fig. A).

DEFINITION

General. Body of adult female elliptical to ovate; abdominal segmentation vague, lateral constriction between abdominal segments VII-VIII distinct, segment VIII appears expanded laterally, constriction sometimes present between segments VI-VII; caudal end truncate.

Dorsal Surface. Ostioles absent; cerarii absent; anal ring semicircular, with numerous pores and 6 short setae, ring slightly recessed, centrally located on segment VIII; pair of sclerotized apodemes submarginally between abdominal segments VII-VIII; trilocular pores, simple disc pores, and flagellate setae distributed over entire dorsum.

Ventral Surface: Antennae reduced to 1-2 segments; eyes absent; clypeolabral shield longer than broad, with prominent anterior projection; labium broader than long, 2-segmented; spiracles heavily sclerotized, as broad as long, with numerous trilocular pores located within furrow-like peritreme; legs absent; caudally directed vulva slit-like and with four slender apophyses.

Marginal band of duct-like pores extend from point near metathoracic spiracles to abdominal segment VI; trilocular, simple disc pores, and flagellate setae distributed over entire venter; apical setae absent; circuli absent.

Tangicoccus elongatus (Tang)
Plate 14

Longicoccus elongatus Tang, 1977: 26-27; Wang, 1982: 168.
Tangicoccus elongatus (Tang) Kozár & Walter, 1985: 73; Tang, 1992: 31-32.

GENERAL DESCRIPTION

Body of Adult Female. Tang (1977) described the body as "thin with parallel sides, flat, ... length three times greater than width; sclerotization with maturation, yellow brown in color. Several of last abdominal segments hardest, no wax layer."

On microscope slide (fig. A): body long, elliptical to ovate, 6553µm (4998-8768) long, 1868µm (1714-2142) wide; mouthparts positioned between two spiracular pairs; abdominal segmentation vague, lateral constriction between segments VII-VIII distinct, last abdominal segment pronounced laterally, segments VI-VII pronounced somewhat laterally; caudal end truncate, apical setae absent.

Dorsal Surface

Trilocular Pores (fig. B). 5.13µm (4.75-5.70) in diameter, rim triangular to circular; distributed over entire dorsum except none on abdominal segment VIII, fewer found medially on head and thorax.

Simple Disc Pores (fig. C). 3.48µm (2.85-3.80) in diameter, with circular rim; distributed over entire dorsum, fewer found medially on head and thorax.

Setae (fig. D). Flagellate, 6.65-13.3µm long, distributed over entire dorsum, fewer found medially on head; thickness of setae increases caudally.

Spicules (fig. E). Minute, 0.95-1.90µm long, solitary; complete distribution indeterminable with available specimens, some observed on margin of abdominal segment VIII.

Anal Ring (fig. F). 72.5µm (71.3-73.2) in diameter, centrally located on segment VIII or near segment VII, slightly recessed posteriorly but not at end of anal tube, semi-circular with open end cephalad; anal ring pores 3.17µm (1.90-3.80) in diameter,

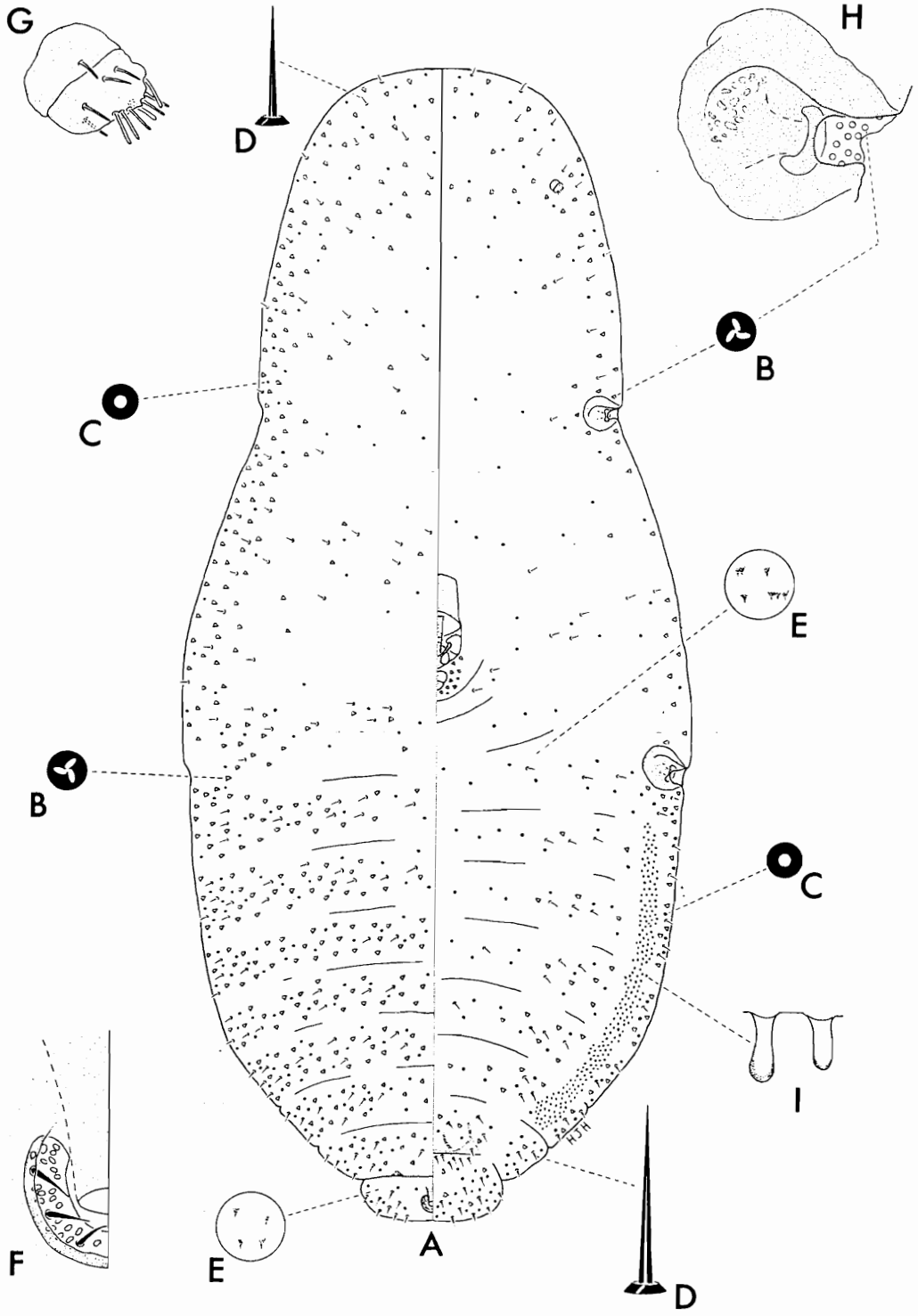

Plate 14. ***Tangicoccus elongatus*** **(Tang), Adult Female.**

numerous, more or less in two rows; six anal ring setae, 14.3-20.9μm long, length approximately one-fourth diameter of ring.

Other Structures. Sclerotized apodemes located submarginally between abdominal segments VII-VIII.

Ventral Surface

Antennae (fig. G). One to two segments, 51.9μm (38.0-57.0) long, diameter at base 37.8μm (33.3-42.0).

Clypeolabral Shield. Approximately 1.3X longer than broad, 170μm (167-174) long, 135μm (126-143) wide; with long anterior projection, projection length subequal to width of shield, 138μm (129-143) long.

Labium. Approximately 1.3X wider than long, 53.6μm (47.6-59.5) long, 69.0μm (66.6-71.4) wide at base; two-segmented.

Spiracles (fig. H). Located at body margin. Anterior: spiracular arm heavily sclerotized, broad, 106μm (85.7-120) long; atrium 50.1μm (42.8-53.2) wide; furrow-like peritreme extends from atrium to margin of body, with 10-20 trilocular pores located within furrow. Posterior: similar to anterior pair, but slightly larger; arm 123μm (119-132) long; atrium 52.1μm (47.6-54.7) wide, associated pores same.

Trilocular Pores (fig. B). 5.07μm (4.75-5.70) in diameter, structure as that on dorsum; distributed over entire venter, few to none medially, grouped around labium and posterior end of clypeolabral shield.

Simple Disc Pores (fig. C). Structure and distribution as that on dorsum, 3.17μm (2.85-3.80) in diameter; grouped with trilocular pores at mouthparts.

Duct-like Pores (fig. I). Large, 3.04μm (2.85-3.80) in diameter, 9.18μm (7.6-10.5) long; distributed in marginal band on abdominal segments II-VI, with approximately four pores across width of band.

Setae (fig. D). Flagellate, 7.60-16.2μm long, distribution and structure as that on dorsum, also grouped on abdominal segment VIII at vulva; no distinct apical setae.

Spicules (fig. E). Structure as that on dorsal surface, 0.95-1.90μm long; difficult to determine distribution but observed on medio-submedial region of metathorax, medio-submarginal region of abdominal segments II-VI and submargino-marginal region of segments VII-VIII.

Vulva. Distinct, smooth, opening directed caudally; with four associated apophyses.

Other Structures. None.

Type Material Examined. None available for study. Repeated attempts to obtain type material from China were unsuccesful.

Other Material Examined. All from **CHINA**. ***Bambusa puberula*:** Anhui, 24 Mar. 1979, coll. F.t. Tang, 2(2) VPI. **Undetermined Bamboo:** locality not translated, 10 Oct. 1979, coll. F.t. Tang, no. 2991, 1(2) AUS.

Remarks. *Tangicoccus elongatus* is considered a serious pest of bamboo in China (Fig. 2), where it may be found feeding beneath the leaf sheaths of its host (Tang 1977). In addition to the host and locality listed above, it has been recorded on *Indocalamus* sp. in Hangzhou, China (Tang 1977).

This mealybug, like many of the other bamboo-infesting species under study, is long and slender. Tang (1977) recorded an attained length of 10.0mm in observed specimens. Relative to its width, the specimen shown in Plate 14 should be approximately 30% longer.

Tang (1977) recorded this species as having multilocular pores distributed over the venter of the last four abdominal segments; however, none were observed in the specimens at hand. The inability to observe a collar on the duct-like pore as described by Tang (1977) may be due to a difference of total sclerotization among observed specimens. Characteristics of the anal ring were also very difficult to see because of heavy sclerotization in the surrounding area; nevertheless, six setae and numerous pores were observed on the anal ring. The anal ring was previously described as having only two setae and no pores (Tang 1977). Tang also assumed that the apodemes located submarginally between abdominal segments VII-VIII are "posterior dorsal ostioles".

CHAPTER III
PHYLOGENETIC ANAYLYSIS OF THE TRIBE SERROLECANIINI

The evolution of Coccinea at the familial and subfamilial levels have been discussed by several workers (Koteja 1974b, Danzig 1980), but few investigations have been undertaken below these levels for mealybug species. Afifi (1968) conducted a comparative analysis of adult male morphology and applied phenetic methods to propose a phylogeny; however, none of the mealybug species covered in this study were used.

Tang provided an interesting discussion on the evolution of a few species recognized here as belonging to the tribe Serrolecaniini. A sequence of character transformations were proposed in the following specific order: *Serrolecanium tobai* (Kuwana) -- *S.* (= *Porisaccus*) *sasae* (Siraiwa) -- *Idiococcus maanshanensis* Tang & Wu (= *I. bambusae*) -- *I. bambusae* Takahashi & Kanda. The sequence of character states were an elongation in body form; an enlargement in the area containing duct-like pores from a small "plate-like" group in *S. tobai* to the large, flattened pouch of *I. bambusae*; and a reduction in serrate appearance of the posterior abdomen (i.e., the number and size of latero-posterior lobes). The last two series were hypothesized as adaptations to attach to the host.

An analysis of the tribe Serrolecaniini was conducted to study the phylogeny of its species on the basis of adult female morphology. This analysis is far from complete and to fully justify the phylogeny proposed will require the inclusion of data from other developmental stages. Nevertheless, this is a preliminary step toward understanding the interspecific relationships of the tribe.

Methods

Coded character states for 13 serrolecaniine species were analyzed with the microcomputer program Hennig86 (Farris 1988). Cladograms or trees were constructed using the implicit enumeration option (ie*), which finds all the most parsimonious trees (i.e., the least number of character state changes). Relationships agreed on by multiple trees were determined by employing the Nelson consensus option (nelsen). Character polarity was determined through outgroup comparison.

Characters. The 17 characters used in the cladistic analysis and their coding are summarized in Table II, while coded character data for the 13 ingroup and 1 outgroup species are given in Table III. The employed characters include 14 binary and 3 multistate transformations. Multistate transformations series 2, 3, and 13 were treated as nonadditive (unordered) because there was no evidence of a linear character relationship.

Table II. Characters and coding for Serrolecaniini species and one outgroup.

No.	Character	States
	ABDOMEN	
0	Constriction between VII-VIII	0, absent; 1, well-defined
1	Constriction between V-VII	0, absent; 1, well-defined
■ 2	Segment VIII latero-posterior lobes	0, absent; 1, naked tip; 2, setal tip
■ 3	Segment VII latero-posterior lobes	0, absent; 1, naked tip; 2, setal tip
	VULVA	
4	Direction	0, ventrally; 1, caudally
5	Lateral apodemes	0, absent; 1, present
6	Origin of posterior apophyses	0, vulvar wall or near; 1, dermal depressions
	ANAL RING	
7	Location ring or tube orifice	0, terminal; 1, dorsum
8	Design	0, complete; 1, U-shaped
9	Setal tips	0, acute; 1, knobbed
	SPIRACLES	
10	Arm design	0, narrow; 1, width ≈ length
11	Atrial pores	0, absent; 1, present
	MOUTHPARTS	
12	Anterior projection on clypeolabral shield	0, absent; 1, present
	LEGS	
■13	Metathoracic coxae	0, normal; 1, absent; 2, as expanded pouch
	DERMAL ULTRASTRUCTURES	
14	Conical Body Setae	0, absent; 1, present
15	Dorsal Apodeme between VII-VIII	0, absent; 1, present
16	Dorsal Depression on VIII	0, absent; 1, present

■Transformation series treated as non-additive.

Table III. Character state matrix for thirteen ingroup species and one outgroup (*).

Taxon	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
*B. takahashii**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
C. bambusae	1	1	0	0	1	1	0	0	0	1	1	1	1	1	1	0	1
C. phragmitis	1	1	0	0	1	0	0	0	0	1	1	1	1	1	1	1	1
C. sulci	1	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0
C. turanicus	1	0	0	0	1	0	0	0	0	1	1	1	1	1	1	1	0
I. bambusae	0	0	0	0	1	0	0	1	1	0	1	1	1	2	0	1	1
K. wroughtoni	0	0	0	0	1	0	0	1	0	0	0	0	1	2	1	0	0
P. jiuhuaensis	1	1	1	0	1	1	0	0	0	0	1	1	1	2	1	1	1
P. sasae	1	1	1	0	1	1	0	0	0	0	1	1	1	2	1	1	1
S. indocalamus	1	1	2	2	1	1	1	0	0	0	1	1	1	1	1	1	1
S. kawaii	1	1	2	2	1	1	1	0	0	0	1	1	1	1	1	1	1
S. takagii	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1
S. tobai	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	1
T. elongatus	1	0	0	0	1	0	0	1	1	0	1	1	1	1	0	1	0

Plesiomorphic character states are coded "0", and derived states are coded "1-2". Descriptive information on the characters selected for analysis may be found in Chapter I and in the various species descriptions (Chapter II).

Limitations in selecting characters for analysis were twofold. Many structures, such as legs and antennae, are lost or reduced in the adult females of serrolecaniine species, and features of these particular appendages are often used to classify mealybugs at the genus-level or below. Secondly, structural regressions in "legless" mealybugs have resulted from a transition to life under the protective leaf sheaths of grasses and bamboo. Regressive characters generally do not provide evidence of shared common ancestry because their simplification may have occurred within independent lineages that were under similar environmental conditions; therefore, they are of low taxonomic weight (Mayr & Ashlock 1991) and were omitted from the data matrix.

Other potentially regressive characteristics not used in this analysis included cylindrical ducts and multilocular pores. It was difficult to ascertain whether these structures were acquired, lost, or absent in the adult female without knowing the ontogenetic condition, thus complicating the coding of these characters. Species-specific autapomorphic characters, such as the anal cleft in *I. bambusae* or 26 anal ring setae in *Kermicus wroughtoni* Newstead were also omitted because they do not provide evidence for shared common ancestry.

Outgroup. The selection of outgroups was also very difficult. Convention would have other "legless" forms serve as outgroups; however, the morphologies of adult females for these non-serrolecaniine species indicate no similarities (see Chapter IV). The legged *Balanococcus takahashii* McKenzie was selected as outgroup based on shared affinities with the tribe. These characteristics include: multilocular pores with 9-10 locules; oral-collared cylindrical ducts, duct ca. 2X longer than broad, collar approximately 1/2 the length of duct and non-flaring; short, broad labium; duct-like pores on the metathoracic coxae and surrounding area. This species was also selected because of its host group and general locality are similar. Determinations of character states for the outgroup were taken from the original description (McKenzie 1964) and observed material [Paratype female on *Zoysia matrella*, Japan, Hiratsuka, Kanagawa, 16 Oct. 1963, coll. N. Oho, 1(1) USNM].

All species of *Balanococcus* Williams were not included because the genus is apparently unresolved and heterogeneous. This assertion is made on the basis of

available species descriptions (Koteja 1988) and on observed material for *B. poae* (Maskell) and *B. orientalis* Danzig & Ivanova.

Results and Discussion

Two equally parsimonious trees were produced by the Hennig86 analysis, each having a length of 28 steps, a consistency index (CI) of 0.74, and a retention index (RI) of 0.82. The Nelson consensus tree, identical to one of the original cladograms, is presented in Figure 5. Lineages are identified by the letter present at the nodes in the figure and the preferred optimization of character states (i.e., where changes occurred) are mapped directly onto the illustrated tree. The original topologies differed only in their resolution of *Serrolecanium takagii* Hendricks & Kosztarab and *S. tobai*. The tree that is not illustrated identified these two species as a distinct clade. The single autapomorphic character for this clade was latero-posterior lobes without setal tips on abdominal segment VII, thus suggesting that latero-posterior lobes on this segment may have developed independently with setal tips in the clade containing *S. indocalamus* Wu and *S. kawaii* Hendricks & Kosztarab.

The results presented in the cladogram are logically consistent with the classification proposed in Chapter II, except for the genus *Chaetococcus* Maskell which is identified as paraphyletic. The inability of the analysis to recognize this genus as monophyletic and to resolve the polytomies at nodes D and H was due to the lack of synapomorphies present in adult females. *Chaetococcus* will be retained as a distinct morphological group until additional analyses propose otherwise.

Special attention needs to be given to some of the characters employed in the analysis, as well as to certain character transformations proposed in the cladograms. Two optimizations were given in the analysis for the anal ring design (character 8). In the optimization not mapped, a reduction to a U-shaped structure appeared in lineage B followed by a reversal back to a more or less complete ring in lineage D. This optimization was not preferred to the one mapped because of the likelihood of it not occurring.

A transposition of the anal ring to the dorsum (character 7) is identified as apomorphic in the serrolecaniine lineage (node A), but it is followed by a reversal back to a position at the end of the abdomen in lineage D. Dorsal anal rings are present in several non-serrolecaniine species, so it is possible that the dorsal transposition of the anal ring is actually convergent within the tribe. Additional data from other stages of

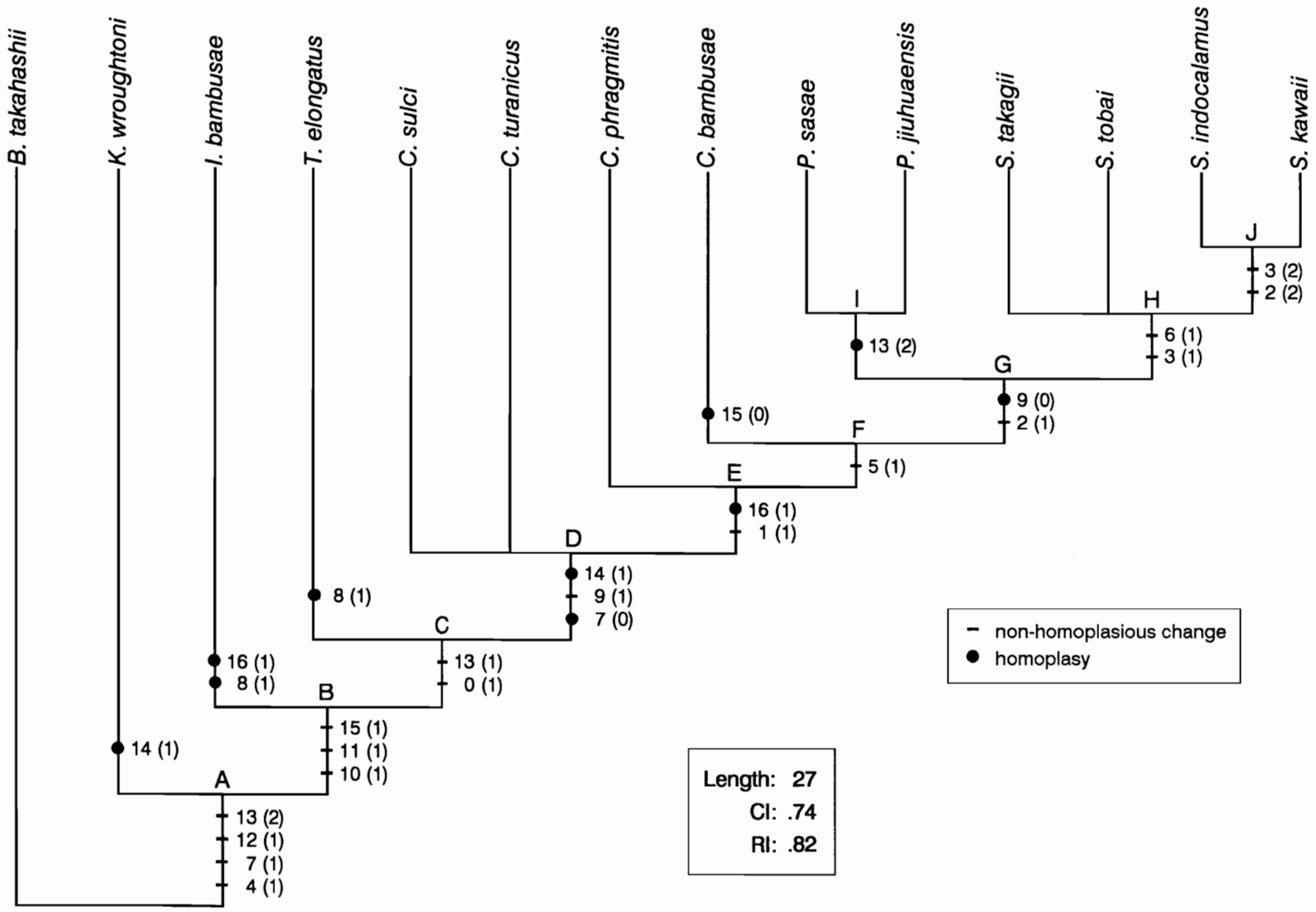

Figure 5. Strict consensus tree of two equally parsimonious cladograms for the tribe Serrolecaniini.

development are needed for confirmation. Knobbed anal ring setae (character 9) may also be interpreted differently with future analyses. They first appear in lineage D and reverse back to acute-tipped setae in lineage G (i.e., in branches which include *Chaetococcus* spp.). This structural characteristic of the anal ring setae is present in non-serrolecaniine genera (e.g., *Antonina*); therefore, future studies may change the polarity of this character in addition to finding it autapomorphic, yet convergent, for the genus.

Characters 14 (conical body setae) and 15 (dorsal apodeme) were very difficult to code. *Balanococcus takahashii* has a pair of cerarii on the last abdominal segment which contain conical setae. Those ingroup species that possess conical body setae do not have them limited to a small cerarian-like groups, but they are found predominantly along the posterior margins of the body. With available data, it is impossible to determine if conical body setae originated from cerarii and spread to other regions of the body, or if they arose independently, perhaps from flagellate setae. The pair of dorsal apodemes present between abdominal segments VII-VIII probably should have not been employed because of intraspecific variation seen in some species. At times these apodemes were very difficult to discern, apparently absent, in some species in which these structures were small, particularly *Chaetococcus* spp. The individual deactivation of either of these characters in the analysis did not alter the topology of the resulting trees, but did reduce the length to 25 steps and increased the CI to 0.76.

The results of this analysis are converse to the aforementioned phylogeny proposed by Tang (1984a, 1984b). The abdomen shows an increase in intersegmental constrictions, and in the number and size of latero-posterior lobes. These adaptations would allow the individual to maneuver the end of the abdomen, yet provide protection against parasitoids. Facing toward the base of the leaf sheath in the confines of its microhabitat, individuals would be most vulnerable to attack from the rear, especially at the softer intersegmental membrane. The latero-posterior lobes are heavily sclerotized and often armed with numerous conical setae; therefore, the ability to telescope the abdomen and overlap these armored lobes may provide protection to this region of the body.

Tang also proposed that the expanded coxae with duct-like pores were adhesive organs that developed independently of the legs and showed an adaptive increase in size. The podal origin of this enlarged structure has been reconfirmed in Chapters I and II. The suggested function of these appendages is also questioned, but the adaptive increase in size is supported to here. According to Tang, the adhesive organ would accommodate

the body during elongation. The stylets of the mouthparts indirectly anchor the body to its host; therefore, an apposing anchor would cause the elongating body to contort between these two areas unless the leg adhesion areas can release and reattach. Moreover, the duct-like pores which secrete the adhesive under this hypothesis are also found on the dorsal surface of the expanded coxae, between the appendage and body.

Duct-like pores are homologous to translucent pores present in mealybug species that possess well-developed legs, and empirical evidence suggests that these glands most likely emit sex pheromones (Williams 1985). If these structures do emit some type of pheromone, an adaptive advantage for individuals restricted to the confines of their microhabitat would be to increase the surface area of these glands. This could be accomplished either through an increase in structural size, number, or distribution. Expanded coxae, which are densely clothed with duct-like pores, would thus increase the surface area of these glands. According to the analysis, expanded coxae appear early in the tribal lineage (node A), are lost in lineage C, but reappear in the *Porisaccus* clade.

An increase in the surface area of duct-like pores is also seen in those groups without expanded coxae. In *Tangicoccus elongatus* (Tang), these glands form a marginal band on the ventral surface of the abdomen. In *Chaetococcus* and *Serrolecanium* Shinji, the grouping of duct-like pores behind the metathoracic spiracles often covers an area 2-3X greater in diameter than a typical mealybug coxa. Similar distributions are also seen in the duct-like and disc-like pores of non-serrolecaniine species (see Chapter IV).

CHAPTER IV
REVISION OF VARIOUS GENERA OF SPHAEROCOCCINAE, THE "LEGLESS MEALYBUGS"

This chapter is a revision of various genera often considered related or belonging to the subfamily Sphaerococcinae on the basis of having regressive antennae and legs. Not included are genera treated in Chapter II as the tribe Serrolecaniini. The relationships of these genera among the Psuedococcidae are uncertain, and to determine their phylogeny will probably require the inclusion of morphological data for adult males and preadult stages of development. Inferences, however, are sometimes made.

Provided under each genus is a key to species and a redescription with illustration of the type species. Discussions and brief descriptions are given for all other species. A key to all legless mealybug genera contained in this work can be found at the end of Chapter I.

Acinococcus Williams

Type Species: *Acinococcus triodiae* Williams (1985); by original designation.

Williams, 1985: 40.

Williams (1985) established the genus *Acinococcus* for two species collected on grass in South Australia. Members are characterized by having the following: body broadly ovate, posterior abdominal segments tapered and heavily sclerotized; abdominal segmentation distinct; body setae flagellate; trilocular pores present and simple disc pores present; cylindrical ducts also present, with oral collar one-fourth to one-half length of tube; dorsal ostioles absent or represented by reduced posterior pair; dorsal pair of apodemes between abdominal segments VII-VIII present or absent; anal ring with 6-8 setae, setae with small knob at tip; antennae present but reduced to 4-6 segments; eyes present; clypeolabral shield apparently with short anterior projection; labium two-segmented; spiracles heavily sclerotized, with broad arm and peritreme, trilocular pores present on peritreme near atrium; legs present but greatly reduced; group of small disc-like pores grouped around metathoracic legs and on abdominal segments II-III; circuli present or absent; vulva directed caudally, with smooth walls and four associated apophyses.

Williams (1985) included *Acinococcus* among several genera related to the genus *Antonina* Signoret, but did not consider it a close relative. As in serrolecaniine genera, members of *Acinococcus* possess a vulva that is directed caudally and has four associated apophyses, and there appears to be an anterior projection on the clypeolabral shield. *Acinococcus stipae* Williams possesses oral collar ducts of two sizes, the largest of which resembles those found in *Chaetococcus* and related genera; however, adult females of serrolecaniines have duct-like pores behind the metathoracic spiracles. Most of these genera also have conical setae present, and abdominal segment VIII is often pronounced laterally. Future attention should be directed toward incorporating a comparative analysis of first instars and adult males to determine if *Acinococcus* should be included in the Serrolecaniini.

Key to Species of Genus *Acinococcus*

Circuli numbering 4-5 (Pl. 15, fig. A); anal ring dorsad at end of segment VIII, with eight setae; ostioles absent ..... ***triodiae***, p. 117

Circuli numbering one or absent; anal ring central on dorsum of segment VIII, with six setae; posterior dorsal ostioles present, but greatly reduced..... ***stipae***, p. 116

Acinococcus stipae Williams

Williams, 1985: 42.

The original description and illustration of Williams (1985) are very adequate for diagnosing this species; however, to his description should be added these emendations: cylindrical ducts of two sizes as in *Acinococcus triodiae*, but collar one-half length of tube; circulus occasionally present on abdominal segment IV. The following description of unmounted adult females is based on illustrative notes provided by Helen Brookes (formerly of WARI). Body of unmounted females oval, flattened ventrally, convex dorsally; pink with posterior abdominal segments slightly sclerotized; margin of body concealed by waxy "pads", dorsum exposed centrally.

Acinococcus stipae is easily distinguished from *A. triodiae* by the having only six anal ring setae and less than two circuli on the abdominal venter. As with *A. triodiae*,

part of the lot from which *A. stipae* was described was not available to Williams because it was on loan to VPI. This material, listed below, has data identical to the type series.
Material Examined. AUSTRALIA, South Australia, nr Warooka, *Stipa* sp., on base of leaf sheaths and crowns, 20 May 1962, coll. D.E. Symon or E.D. Carter, Spec. Index No. 22/62, 8(17) WARI

Acinococcus triodiae Williams
Plate 15

Acinococcus triodiae Williams, 1985: 42-44.

GENERAL DESCRIPTION

Body of Adult Female. Williams (1985) described the body of alcohol-preserved specimens as "hemispherical (except for abdomen)" and "deep brown".

On microscope slide (fig. A): body pyriform, 3802μm (3713-3891) long, 2761μm (2570-2892) wide; mouthparts located near anterior margin, abdominal segmentation well defined, anal lobes undeveloped, last 4-5 abdominal segments tapered and sclerotized, posterior end rounded.

Dorsal Surface

Trilocular Pores (fig. B). 5.96μm (5.70-6.65) in diameter; distributed over entire dorsum, concentration apparently greater on tapered abdominal segments, those on abdominal segments VI-VIII found primarily along anterior half of each segment.
Simple Disc Pores (fig. C). 3.46μm (2.85-3.80) in diameter, rim circular to oval; distributed over entire surface, concentrated on abdominal segment VIII.
Cylindrical Ducts. Of two sizes, both subequal in length and with sclerotized collar, but one approximately 2X wider, collar approximately one-fourth length of tube. Larger duct (fig. D): 4.99μm (3.80-5.70) in diameter, 10.1μm (9.50-10.5) long; sparsely distributed along margin of head. Smaller duct (fig. E): 2.77μm (1.90-3.80) in diameter, 11.5μm (10.5-12.4) long; distributed over entire dorsum except none on abdominal segment VIII; concentration apparently greater on tapered abdominal segments, also concentrated along margin of head.

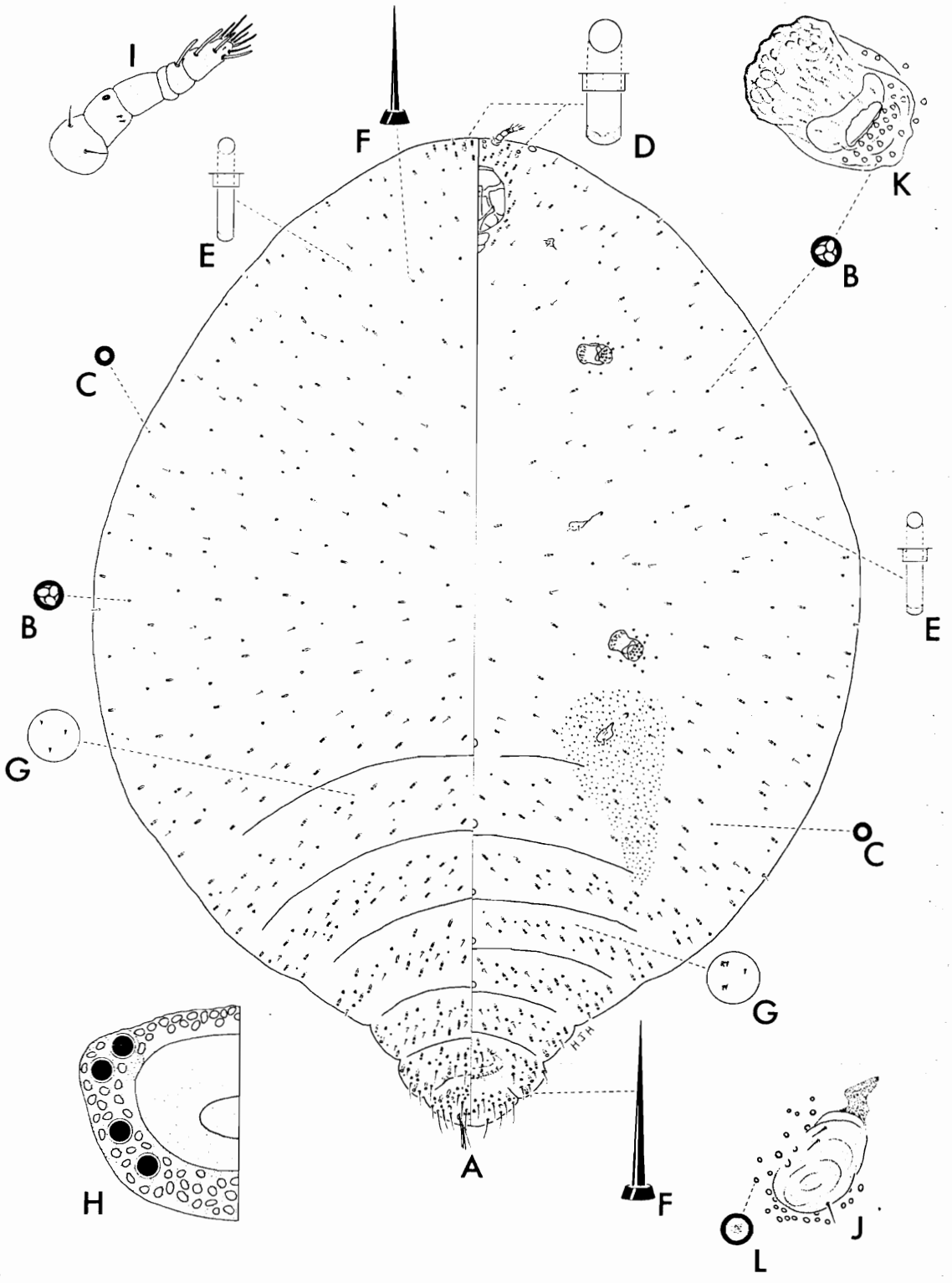

Plate 15. ***Acinococcus triodiae*** **Williams, Adult Female.**

Setae (fig. F). Flagellate, distributed over entire dorsum; length of those on head, thorax, and abdominal segments II-VI relatively uniform, 11.4-17.1μm long; those on segments VII-VIII longer and thicker, 20.0-102μm long.

Spicules (fig. G). Minute, 0.95-2.85μm long, usually solitary; located on medio-submedial region of metathorax and all of abdomen.

Anal Ring (fig. H). 89.9μm (82.7-94.1) in diameter, directed caudally, dorsal section flush with derm, ventral section slightly recessed; anal ring pores 2.47μm (1.90-2.85) in diameter, numerous, in 2-3 rows; with 8 setae, 128-143μm long, tips slightly knobbed at times.

Other Structures. Sclerotized apodemes located submedially between abdominal segments VII-VIII; pair of apodemes marginally on segment VIII.

Ventral Surface

Eyes. Base diameter 19.7μm (14.3-23.8).

Antennae (fig. I). Segmentation varied, 3-6 segments, 129μm (107-151) long and with base diameter of 42.0μm (33.3-54.1).

Clypeolabral Shield. Approximately 1.4X longer than wide, 231μm (207-255) long, 164μm (162-167) wide, apparently with a small projection anteriorly.

Labium. Approximately 1.2X broader than long, 74.6μm (71.4-76.2) long, 85.7μm wide at base, two-segmented.

Legs. Present, but greatly reduced, with vague apophysis located laterad of each leg, remnants of claws visible at times. Prothoracic leg stub-like, 44.7μm (28.5-66.7) long, apophysis absent at times; mesothoracic leg stub-like, 35.6μm (14.3-48.5) long; metathoracic leg stub-like (fig. J), 43.1μm (26.6-64.6) long, sometimes recessed, occasionally with disc-like pores on base.

Spiracles (fig. K). Anterior: spiracular arm 86.7μm (85.7-90.4) long, broad, with peritreme; atrium 62.2μm (57.1-66.6) wide; 15-25 trilocular pores form band at atrium, located on peritreme. Posterior: similar to anterior pair, but slightly larger; arm 89.9μm (83.3-97.6) long; atrium 69.6μm (66.6-76.2) wide; 15-30 trilocular pores comprise band.

Trilocular Pores (fig. B). Structure as that on dorsum, 5.79μm (4.75-6.65) in diameter; distributed over entire venter, few to none medially on head, thorax, and abdominal segments II-VI, concentration apparently greater on tapered abdominal segments and near spiracles, those on segments VII-VIII found primarily along anterior half of each segment.

Simple Disc Pores (fig. C). Structure and distribution as that on dorsum, 3.33μm (1.90-4.75) in diameter.

Disc-like Pores (fig. L). 4.00μm (1.90-5.70) in diameter, locule granular and concave; located on submedio-submarginal region from posterior border of metathorax to anterior border of abdominal segment III, concentrated around vestigial metathoracic leg, occasionally on base of metathoracic leg.

Cylindrical Ducts. Structures and distributions as that on dorsum. Larger duct (fig. D): 5.46μm (4.75-6.65) in diameter, 11.4μm (9.50-12.35) long. Smaller duct (fig. E): 2.56μm (1.90-3.80) in diameter, 10.7μm (9.50-12.4) long, many around mouthparts.

Setae (fig. F). Flagellate, structure and distribution as that on dorsum, also present at entrance to vulva on segment VII; those found on head, thorax and abdominal segments II-VI 11.4-20.9μm long, those on segments VII-VIII 23.8-102μm long; no apical setae present.

Spicules (fig. G). 0.95-3.80μm long, solitary or in groups of 2 or more; located on medio-submedial region of metathorax and abdominal segments II-III, medio-submarginal region of segment IV, and over entire surface of segments V-VIII.

Vulva. Distinct, smooth, with opening directed caudally; with 4 associated apophyses, posterior pair small and sometimes vaguely evident.

Other Structures. Mesothoracic sternal apophyses occasionally present but vague; 4-5 circuli distributed on posterior half of metathorax and on abdominal segments II-V, each circulus positioned near posterior border of respective segments; pair of small apodemes located submedially on segment VII and marginally on segment VIII.

Type Material Examined. Holotype from leaves of *Triodia irritans*, **AUSTRALIA**, South Australia, Gawler Ranges, Oct. 1957, coll. D. C. Swan, Specimen Index no. 206/57, 1(1) ANIC. Paratype data same as holotype except collector listed as D.E. Symons {possibly a misprint}, 1(1) BM. [see Remarks]

Other Material Examined. Data same as holotype, here listed as topotypes, 2(2) WARI. [see Remarks]

Remarks. Swan's original material (Specimen Index No. 206/57, WARI) was divided into alcohol vials and a series of at least 17 slide-mounts. Unfortunately one-half of this material was on loan to VPI and was not available to Dr. D. J. Williams when describing this unique mealybug. Two of these non-paratypic slides are listed here as topotypes. Five of Williams' six paratypes, as well as many of the other specimens from the same lot did not agree with the holotype and definition of *A. triodiae*. These specimens were old,

heavily sclerotized, and broken, and prevented their treatment as a new species at this time. It is possible that these specimens are not representative of *Acinococcus* altogether; therefore, the collection of fresh material is needed to clarify this and to describe as new.

Although the anal ring in observed material was obscured by heavy sclerotization of the abdomen, the characteristics given above were perceivable in specimens at hand. The presence of eight anal ring setae instead of the typical six is not unique among mealybugs, but is uncommon nonetheless (Ferris 1953). In three of the observed specimens, one of the eight setae was broken off.

Williams (1985) described this species as having cylindrical ducts of 3 sizes on the venter; however, ducts of only two general sizes were observed in available material. These were similar to those found on the dorsal surface. The examination of additional material is needed to determine if there is a third size duct present.

The disc-like pore associated with the metathoracic leg looks similar to the simple disc pore that is distributed over the entire derm. It differs from the simple disc pore by the characteristics of its locule and by its greater range in diameter. The locule of the disc-like pore is concave and appears more granular, whereas that of the simple disc pore is convex.

Diagnosis. *Acinococcus triodiae* can easily be distinguished from *Acinococcus stipae* by the presence of eight anal ring setae and 4-5 circuli on the venter.

Antonina Signoret

Type species: *Antonia purpurea* Signoret, by monotypy.

Antonia Signoret, 1872: 35-36; MacGillivray, 1921: 145-147; Morrison & Morrison, 1966: 12. [homonym of *Antonia* Loew, 1856]

Antonina Signoret, 1875: 24-25; Lichtenstein 1879: 45-46; Ferris 1918b: 76; Froggatt, 1921a: 112; Green, 1922: 394-395; Kuwana, 1932: 213-214; Goux, 1935: 95-96; 1937: 94; Zimmerman, 1948: 149-150; Borchsenius, 1949a: 311-312; Ferris, 1953: 289; Gomez-Menor Ortega, 1954: 137-138; Morrison & Morrison, 1966: 12; Afifi & Kosztarab, 1967: 12-14; McKenzie, 1967: 73-74; Yang & Kosztarab, 1967: 7-10; Ali, 1970: 100; Kosztarab & Kozár, 1978: 22; Danzig, 1980: 199; Kawai, 1980: 122; Wang, 1982: 124; Williams, 1985: 44; Danzig, 1986: 233; Kosztarab & Kozár,

1988: 66; Williams & Watson, 1988: 20; Williams & Granara de Willink, 1992: 54. [replacement name for *Antonia* Signoret]

Laboulbenia Lichtenstein, 1877: 299-300, 302; Ben-Dov & Matile-Ferrero, 1989: 168-169. [synonymized by Lichtenstein 1879; see Remarks under *Antonina purpurea*]

The genus *Antonina* is the oldest and most renown among those in this study. Signoret (1872) originally proposed the name *Antonia* for the inclusion of a single species considered unusual at that time because it lacked well-developed legs and antennae. Recognizing *Antonia* as preoccupied, Signoret (1875) provided the replacement name *Antonina* in a supplemental description of its type species, *Antonina purpurea*. This is the genus to which other "legless" mealybugs have often been compared.

Antonina species are found on a variety of bamboo, grass and reeds (Poaceae), except for the questionable *A. australis* which is known only from sedges (Cyperaceae). Most members of the genus have local distributions around the eastern hemisphere; however, *A. graminis* has been reported from many countries between the 40° north and south latitudes. *Antonina crawi* and *A. pretiosa* are presumably native to eastern Asia, but have become established elsewhere at the same latitudes north of the equator.

The genus is defined as follows: body oval to circular, often globular, abdominal segmentation often vague and without lateral constrictions, caudal end rounded or slightly concave, posterior abdominal segments often sclerotized. Posterior dorsal ostioles reduced or absent, at times with pair of dorsal apodemes located between abdominal segments VII-VIII. Anal ring with numerous pores and six ring setae, setal tips often knobbed; typically located at end of an invaginated tube, tube orifice at end of abdomen or slightly dorsad and encircled by numerous glandular pores.

Antennae reduced, 1-3 segmented, eyes reduced or absent. Legs greatly reduced or absent, represented by pleural vestiges, setal groupings, or podal apophyses, when present; rarely stub-like. Sternal apophyses typically absent, but mesosternal pair occasionally vague. Vulva simple, directed ventrally, with at least one pair of vulvar apophyses evident, often transposed 1-2 segments anteriorly on abdominal venter. Clypeolabral shield approximately 1.2X longer than broad; labium approximately 1.2X broader than long, 2-segmented; spiracles heavily sclerotized, spiracular arm often as broad as long, atria typically with band of multilocular or trilocular pores.

Dermal ultrastructures numerous. Multilocular, trilocular, and simple disc pores present; multilocular pore typically with 10-locules. Cylindrical ducts of distinct design present except in *A. australis*; duct long, slender, and with flange near inner end (Pl. 16, fig. F), inner end strongly rounded; those distributed in sclerotized regions of body appear larger and with collar between flange and orifice. Disc-like pores (Pl. 16, fig. E) present on except in *A. vera*; rim of pore vague or obsolete, locule granular and typically concave, size of pores on individual frequently not uniform; distribution varies among species but typically on submargin of abdominal venter near metathoracic spiracles. Conical setae present or absent; flagellate setae present; apical setae present or absent.

Antonina has long been regarded as related to the genus *Chaetococcus* based on regressive similarities in morphology. Granted some species, such as *A. crawi* and *C. bambusae*, do resemble another in body form, have knobbed anal setae, and possess both flagellate and conical setae. Despite these affinities, *Antonina* may be distinguished from other similar genera by the presence of cylindrical ducts as described above, disc-like pores on the venter posterior to the metathoracic spiracles, and a ventrally-directed vulva.

This is the largest genus with 16 species treated but not completely recognized as belonging. No material was made available and examined for *A. bambusae* Khalid & Shafee, *A. elongatus* Tang, *A. meghalayaensis* Khalid & Shafee, or *A. transcaucasicus* Borchsenius. The study of this material will likely find synonymy and reduce the number of species assignable to the genus. *Antonina boutelouae* and *A. nortoni* are transferred to *Antoninoides* Ferris. *Antonina dakotensis* is transferred to the eriococcid genus *Apezococcus* Ferris (see Other Taxonomic Changes at end of chapter). *Antonina australis* is returned with skepticism from *Chaetococcus*, and *A. anceps* is synonymized with *A. graminis*.

Key to Species of Genus *Antonina**

1. Cylindrical ducts absent; disc-like pores small, uniform in size, on modified plate-like metathoracic legs; anal lobes present but only slightly developed ..... ***australis***, p. 125

   Slender cylindrical ducts with flange near inner end present (Pl. 16, fig. F); disc-like pores not on plate-like metathoracic legs, or absent; anal lobes absent **2**

2. Disc-like pores absent from abdominal venter; multilocular pores on lateral margin of two distinct types, 10-loculars and larger 9-loculars ..... ***vera***, p. 165

Disc-like pores present on abdominal venter; only 1 type multilocular pore on lateral margin of body **3**

3. Abdominal segments plate-like with sclerotization, well-defined; trilocular pores on margin of head and thorax of two distinct sizes, one type 1.5X larger than other; anal tube with inner band of trilocular pores near orifice and band of multilocular pores encircling opening ..... ***pretiosa***, p. 148

Abdominal segments never appear to have separate sclerotized plates; trilocular pores on margin of head and thorax of 1 size; anal tube without band of trilocular pores..... **4**

4. Disc-like pores present on submargin between anterior and posterior spiracles; anal tube length ≥ 2X anal ring diameter, length of anal ring setae ≤ 0.5X length of anal tube ..... ***thaiensis***, p. 160

Disc-like pores not present between spiracular pairs; anal tube length ≤ 1.7X anal ring diameter; anal ring setae as long or longer than anal tube **5**

5. Multilocular pores dorsally found only at anal tube orifice; multilocular pores absent from margin of abdominal venter; multilocular pores never closely associated with spiracular atria **6**

Multilocular pores dorsally not confined to region around anal tube orifice; multilocular pores present on margin of abdominal venter; multilocular pores present or absent at spiracular atria **9**

6. Disc-like pores on abdominal venter present on submedio-submarginal region posterior to segment III; conical setae present over entire dorsum of at least abdominal segments VII-VIII **7**

Disc-like pores on abdominal venter absent posterior to segment III; conical setae confined to margin of posterior abdominal segments **8**

7. Apical setae absent; multilocular pores in longitudinal band between vulva and anal tube orifice ..... ***graminis***, p. 133

Apical setae present; multilocular pores not in longitudinal band between vulva and anal tube orifice, at most in ventro-marginal group immediately anterior to tube orifice ..... ***transvaalensis***, p. 163

8. Anal tube length ca. 1.5X ring diameter; legs absent except for podal apophyses; multilocular pores absent from venter anterior to metathoracic spiracles ..... ***zonata***, p. 166

Anal tube length subequal to ring diameter; legs stub-like with podal apophyses; multilocular pores on venter present anterior to metathoracic spiracles ..... ***tesquorum***, p. 159

9. Pore band at spiracular opening multilocular, occasionally with few trilocular pores; legs represented by pleural vestiges or setal grouping, and podal apophyses; multilocular pores absent from margin of head **10**

Pore band at spiracular opening trilocular, few multilocular rarely present; leg remnants absent, podal apophyses sometimes present; multilocular pores ventrally present on margin of head **11**

10. Disc-like pores numerous on venter, distributed on submargino-marginal region from metathoracic spiracle to abdominal segment III; posterior dorsal ostioles usually present, but reduced; anal tube length ca. 1.4X ring diameter ..... ***purpurea***, p. 152

Disc-like pores few, in submarginal band from abdominal segments III to area laterad of vulva; posterior dorsal ostioles absent; anal tube length ca. 1.2X ring diameter ..... ***natalensis***, p. 146

11. Posterior dorsal ostioles present, but reduced; apical setae distinct; multilocular pores present along entire margin of head and thorax; dorsal conical setae only on margin of head and thorax ..... ***crawi***, p. 129

Posterior dorsal ostioles absent; apical setae absent or indistinct; multilocular pores absent from entire margin of head and thorax, except present in area around antennae; dorsal conical setae over entire of head and thorax surface ..... ***maritima***, p. 143

**Antonina bambusae* Khalid & Shafee, *A. elongata* Tang, *A. meghalayaensis* Khalid & Shafee, and *A. transcaucasica* Borchsenius are not included; specimens were not available for examination and current descriptions are inadequate.

Antonina australis Froggatt

Antonina australis Froggatt, 1904: 407-410.

Antonina australis Green, 1904: 463-465; Froggatt, 1917: 140; 1921a: 112; Yang & Kosztarab, 1967: 13-15. [lectotype designated by Williams 1985]

Kuwanina hilli Laing, 1925: 55; Hoy, 1963: 164. [synonymized by Brimblecombe, 1966]
[lectotype designated by Williams, 1985]
Antonina (*Chaetococcus*) *australis* Green; Goux, 1935: 95-96.
Kuwanina australis (Green) Brimblecombe, 1966: 5.
Chaetococcus australis (Froggatt) Williams, 1985: 69-71.

Antonina australis is seemingly restricted to the sedge, *Cyperus rotundus*, in eastern Australia, although other hosts of question have been reported (Williams 1985). In addition to the localities provided below under "Examined Material", it has been collected at Atherton, Townsville, Bowen, Bundaber, Brisbane, and Inglewood, Queensland in Australia (Williams 1985). On its host, *A. australis* can be found underneath leaf sheaths with the body enclosed in a white, waxy sac. Dry-preserved bodies are broadly oval to circular, convex dorsally, dark burgundy in color.

Williams' (1985) excellent illustration of a slide-mounted female should be referred to in conjunction with the following description. On microscope slide: body more or less circular, 2600-5500μm long; posterior abdominal segmentation well-defined, lateral constriction between segments VII-VIII sometimes present, constriction between VI-VII even less, caudal end concave with anal lobes slightly developed, appearing truncate when lobes moved during mounting.

Dorsal surface with multilocular pores, trilocular pores, and simple disc pores; multilocular pores with 10-locules, distributed along margin of abdominal segments VI-VIII, at times submarginally; numerous trilocular and simple disc pores distributed over entire dorsum, trilocular pores with elongate septa, appearing somewhat tritubular. Flagellate setae numerous, distributed over entire dorsum, those along margin closely approach slender conical. Posterior dorsal ostioles present, reduced. Anal ring complete, with numerous pores and six setae, located dorsally on abdominal segment VIII, flush with derm or slightly recessed, setae knobbed at tip and at length ca. 2X diameter of ring.

Ventral surface with similar glandular ultrastructures. Multilocular pores structurally as those on dorsum, located on submargino-marginal region of abdomen and surrounding spiracles at same region. Trilocular pores structurally as those on dorsum but of two sizes; diameter of larger size approximately 1.5X smaller type; larger size located over entire venter; smaller size found at spiracular openings. Structure and distribution of simple disc pores and flagellate setae as that on dorsum; distinct apical setae present.

Antennae 1-2 segmented. Eyes present. Clypeolabral shield with short anterior projection, length of projection 1/8 that of shield, not elongate as drawn by Williams (1985); labium 1.3X longer than broad. Prothoracic and mesothoracic legs absent but podal apophyses evident; metathoracic legs represented by plate-like structure with numerous small disc-like pores, plate-like structure slightly convex, diameter subequal to length of spiracle, found on metathorax and anterior part of abdominal segment II; disc-like pores with thick rim, diameter similar to that of simple disc pores. Spiracles heavily sclerotized, somewhat broad, with numerous trilocular pores in a crescentic band around atria and numerous multilocular pores surrounding entire spiracle, trilocular pores 0.5X diameter of those found elsewhere on the body. Vulva distinct, slit-like but directed ventrally, located between segments VII-VIII, with pair of small apophyses on segment VIII posterior to vulva. Mesothoracic sternal apophyses vaguely evident.

The generic placement of *Antonina australis* remains questionable. Goux (1935) grouped *A. australis* with *A. phragmitis*, *A. bambusae*, and *A. sulci* into the subgenus *Chaetococcus* based on several characteristics including the presence of tubular pores behind the spiracle and a well-marked vulva. Williams (1985) transferred this species to *Chaetococcus* because it had specialized pores grouped behind the metathoracic spiracles similar to *Chaetococcus bambusae*. *Antonina australis*, however, lacks cylindrical ducts, a caudally-directed vulva, and duct-like pores characteristic of *Chaetococcus*. Instead of duct-like pores it has disc-like pores on modified metathoracic legs. The invaginated pit as seen in first instars of serrolecaniine genera is also lacking; therefore, this species is returned to *Antonina*.

This transfer is not without reservations for several reasons. As in *Chaetococcus* and several other genera, an anterior projection is present on the clypeolabral shield. The disc-like pores are structurally similar to those seen in *Peridiococcus* and *Sphaerococcus* (Pl. 21, fig. M), and the long slender ducts characteristic of *Antonina* (Pl. 16, fig. F) are absent. These glandular ultrastructures were also not observed in a third instar available for study. A detailed comparative analysis of other developmental stages including genera with species having well-developed legs is needed to determine the exact placement of this peculiar species. Nevertheless, this species is easily distinguished from other *Antonina* species by having anal lobes and small disc-like pores located on modified hind legs, and by lacking cylindrical ducts.

Williams (1985) discussed discrepancies in authorship for *Antonina australis*, and credited Froggatt (1904) as naming the species over Green (1904). A statement was also

made by Williams that Froggatt's syntype material was probably lost. Froggatt (1904, 1917) collected this species at Singleton District, New South Wales; therefore, the specimens listed below from Singleton may very well be considered syntypes of *Antonina australis* Froggatt. A single syntype specimen of *Antonina australis* Green which is housed in the USNM was not available to Williams (1985) when designating lectotype and paralectotypes for the species. This specimen as well as several subsequent slides from Green's dry type material were also available for examination, as were subsequent slides from dry type material of *Kuwanina hilli* Laing.

Type Material Examined. *Antonina australis* Froggatt. Syntype females on *Cyperus rotundus*, **AUSTRALIA**, New South Wales, Singleton, 5 Jul. 1903, coll. W.W. Froggatt, no. 103, 1(2) USNM.

Antonina australis Green. Subsequent slides, on *Cyperus rotundus*, **AUSTRALIA**, New South Wales, Hunter River Flats, no date given, coll. W.W. Froggatt, 4(4) BM, 1(1) USNM, 4(7) VPI.

Kuwanina hilli Laing. Subsequent slides, on *Cyperus rotundus* (as "onion weed"), **AUSTRALIA**, Queensland, Homehill, Mar. 1921, coll. G.F. Hill, 3(3) BM, 1(1) VPI.

Other Material Examined. ***Cyperus rotundus*: AUSTRALIA**, Queensland, Gatton, on "nut grass", no date given, coll. W.A.T. Summerville, no. H-134, 1(1) BM; Queensland, Manly, on "nut grass", no date given, coll. W.A.T. Summerville, no. H-137, 1(3) BM.

Antonina bambusae Khalid & Shafee

Antonina bambusae Khalid & Shafee, 1988: 49-50.

This species was described from material collected on *Bambusa* sp. in the northeastern district of Assam in India. No information was given of material *in situ* but a brief description and illustration of mounted females was provided. Distinguishing characteristics given were that the body was heavily sclerotized and the anal ring was not located at the end of an invaginated tube. This species was also reported as having a circulus. No description of the vulva was given; therefore, the observance of a circulus may actually have been the genital orifice which is often transposed anteriorly in *Antonina* species. Unfortunately, no discussion was made on disc-like and quinquelocular pores which were included in the drawing. The description and

illustration alone do not provide critical information needed to distinguish this species from among the world *Antonina*.

Antonina crawi Cockerell

Antonina crawi Cockerell, 1900: 70-71; Kuwana, 1902a: 57; Ferris 1918b: 77; Kuwana, 1932: 215-216; Zimmerman, 1948: 151-156; Borchsenius, 1949a: 313-314; 1949b: 137; 1950: 113; Ferris, 1953: 292-293; Williams, 1962: 8; Afifi & Kosztarab, 1967: 15-18; McKenzie, 1967: 74-76; Yang & Kosztarab, 1967: 18-20, 51-53; Ali, 1970: 100-101; Tereznikova, 1975: 160-162; Tang, 1977: 22-23; Danzig, 1978: 7; 1980: 201-202; Kawai, 1980: 122; Wang, 1982: 125-126; Williams, 1985: 44-46; Danzig, 1986: 235. **LECTOTYPE**, adult female, **JAPAN**, intercepted at San Francisco, on bamboo, USNM, examined and here designated.

Antonina socialis Newstead, 1901: 84-85 [synonymized by Williams, 1962; lectotype designated by Williams, 1985]

Antonina crawi is most prevalent on various bamboos in eastern Asia, but has been introduced to coastal regions throughout the world. In addition to the localities provided below with the examined material, it has been collected at Cannes, France (Goux 1937); southern Crimea, Ukraine, and the Caucasus at Black Sea (Borchsenius 1949a, 1949b, Tereznikova 1975); Southern Sakhalin and Kunashir (Siraiwa 1939, Danzig 1978, 1980, 1986); and possibly Queensland, Australia (Williams 1985).

On its host, *A. crawi* can be found underneath the leaf sheaths enclosed in a white, waxy sac, its body purple-red to black. In addition to the hosts listed below, it has been taken on *Arundinaria simoni*, *Phyllostachys quilioi* (Kuwana 1902), and *Sasa kurilensis* (Danzig 1978). Its collection on *Ixora stricta*, a rubiaceous shrub, is questionable (see below). The poorly stained specimen examined from this host possessed most structures which define the species; however, no disc-like pores were perceivable.

The illustration of Ferris (Zimmerman 1948) agrees most with the material observed in this study and should serve as an adequate reference. A description of the adult female is as follows: body elongate oval to obovate, 2000-6000μm long; posterior abdominal segmentation well-defined, lateral constriction between segments VII-VIII distinct, constriction between VI-VII variable, caudal end concave, often strongly, but anal lobes undeveloped.

Dorsal surface with numerous glandular structures; multilocular pores with 10-locules, distributed along margin of entire dorsum; trilocular pores of one size distributed over entire dorsum with fewer on posterior abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum; simple disc pores also distributed over entire dorsum. Conical setae present, few located along margin of head, thorax, and anterior abdominal segments; more found over entire surface of posterior abdominal segments. Flagellate setae are distributed over entire dorsum with fewer on posterior abdominal segments.

Posterior dorsal ostioles present, reduced; dorsum with distinct submedial apodemes between segments VII-VIII. Anal ring at end of invaginated tube, tube length approximately 1.2X ring diameter, numerous multilocular pores and cylindrical ducts form band inside tube orifice; anal ring pores numerous, six anal ring setae extend beyond tube opening, tips of setae are slightly knobbed.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; located primarily on submargino-marginal region of head, thorax and abdomen; occasionally found on other regions of abdomen. Trilocular pores of two sizes, smaller type similar to those on dorsum, diameter of larger size approximately 1.5X smaller type; larger size located around spiracular opening and surrounding area; smaller size distributed over entire venter with fewer located on posterior abdominal segments. Structure and distribution of cylindrical ducts, conical setae, and flagellate setae as that on dorsum; apical setae present. Many disc-like pores of various sizes form band from abdominal segment II to point near vulva, posterior end of band to segment VIII at times; region of band varies, typically submarginal; locules convex or concave.

Antennae 2-3 segmented. Eyes present. Legs absent, but metathoracic podal apophyses sometimes evident. Spiracles heavily sclerotized, somewhat broad, with numerous trilocular pores grouped at atria. Vulva distinct, oval, directed ventrally, with 2 lateral apophyses, apparently located on abdominal segment VI.

Antonina crawi has a similar body shape to *Antonina thaiensis* Takahashi and *Antonina purpurea* Signoret. Like the former of these two species, *A. crawi* possesses a band of multilocular pores and cylindrical ducts at the anal tube orifice and a band of disc-like pores that extends from near the metathoracic spiracle to the vulva. *Antonina thaiensis*, however, also has disc-like pores between the anterior and posterior spiracles, the length of its anal tube is 2X or more than the ring diameter, and its ring setae are approximately 0.5X as long as the tube. *Antonina crawi* can easily be distinguished from

Antonina purpurea, which also has reduced posterior dorsal ostioles, by the presence of trilocular pores at the spiracular opening instead of multilocular pores.

Cockerell's three syntype females were available for study. This type series was located on a single slide but was remounted here onto two slides. One female is here selected as lectotype with the other two as paralectotypes.

Type Material Examined. *Antonina crawi* Cockerell. Lectotype on bamboo, **JAPAN**, intercepted at San Francisco, coll. A. Craw, 1(1) USNM (slide stamped "TYPE" and labeled as follows in at least two handwritings: "*Antonina crawi* Ckll., bamboo, Japan (Craw), Ckll. coll., 1900"). [examined and here designated]. Paralectotypes with same data, 1(2) USNM.

Antonina socialis Newstead. Lectotype on *Arundinaria japonica*, **ENGLAND**, Broxbourne, Herts, 26 Jan. 1899, coll. Masters, 1(1) BM. Paralectotypes on same slide, 1(2) BM.

Other Material Examined. *Antonina crawi* Cockerell. ***Arundinaria fastuosa*: JAPAN**, nr Tokyo, 18 Mar. 1917, USNH No. 1395284, 1(1) USNM. ***Arundinaria graminea*: JAPAN**, 2 Aug. 1921, coll. A.S. Hitchcock, USNH no. 1106992, 1(1) USNM. ***Arundinaria hindsii*: JAPAN**, Yokohama, A.S. Hitchcock, USNH no. 1107004, 1(1) USNM; from China to Botanical Garden, plants of Japan, 13-14 Jul. 1921, A.S. Hitchcock, USNH no. 1107005, 1(1) VPI. ***Arundinaria variegata pygmea*: JAPAN**, Yokohama, 11 Jul. 1911, USNH no. 1064745, 1(1) USNM. ***Arundinaria* sp.: BERMUDA**, 7 May 1955, coll. F.J. Simmons, 1(4) USNM. ***Bambusa* sp.: CHINA**, 1 Sep. 1936, coll. F.C. Chen, no. 188, 1(1) BM; **FRANCE**, Antibes, Alpes Maritimes, Botanical Garden, Aug. 1958, coll. Kaussari, no. 2745, 5(5) MNHNE; **HONG KONG**, Botanical Gardens, coll. A.S. Hitchcock, 21 Oct. 1921, USNH no. 1107095, 1(1) USNM; **SPAIN**, Barcelona, Aug. 1935, coll. A. Balachowsky, 3(5) VPI; Barcelona, 2 Sep. 1935, coll. Bodenheimer, no. 4724, 4(11) MNHNE; **USA**, Louisiana, New Orleans, 9 Apr. 1945, coll. Mayer, 1(2) USNM. ***Brachypodium ramon*: SPAIN**, Santa Pola, 6 Jun. 1978, coll. Kozár, no. 1421, 3(6) HAS 1(2) VPI. ***Indocalamus herklotsii*: HONG KONG**, at D.C., 30 Jan. 1941, coll. W.B. Wood, E.Q. 074557, 1(1) USNM. ***Ixora stricta*: HONG KONG**, botanical garden, 1 Aug. 1936, coll R.H. Le Pelley, no. 133, 1(1) USNM. ***Phyllostachys aurea*: CHINA**, Kwangtung {= Guangdong Sheng}, Koolong Ue, Pukien, 26 Jul. 1930, coll. F.A. McClure, no. 20374, 1(2) USNM. ***Phyllostachys nigra*: CHINA**, Kwangtung {= Guangdong Sheng}, Canton {= Guangzhou}, no coll. date, coll. F.A. McClure, no. 20319, 1(1) USNM. ***Pleioblastus***

***chino*: JAPAN**, Hondo: Koishikawa, Tokyo, at Herbarium of N.Y. Botanical Garden, 11 Apr. 1952, coll. M. Asano & M. Togasi, 1(1) VPI. ***Pleioblastus linearis*: JAPAN**, Ryukyu, Amami-Oshima, Tatsugo T., 30 Jan. 1990, coll. S. Kawai, TUA 13184, 1(1) TUA. ***Sasa* sp.: JAPAN**, Hokkaido, Sapporo, 30 Sep. 1954, coll. S. Takagi, 2(2) FAHU. **Undetermined Bamboo: BERMUDA**, Paget, Botanical Garden, on stems, 13 Apr. 1988, coll. C.J. Hodgson, no. 203, 1(1) BM; 1961, C.I.E. 6363A-17961, 3(5) BM; **CHINA**, Kwangtung {= Guangdong Sheng}, Yeung Kong, 4 Apr. 1949, coll. G.F. Ferris, no. 701, 2(4) UCD, 1(4) VPI; Canton {= Guangzhou}, Lingnan University, 7 Nov. 1948, coll. G.F. Ferris, no. 47, 4(4) VPI; **JAPAN**, Kiushiu {= Kyushu}, Hikosan, no coll. date, no. 181, 1(1) UCD; Hikosan, 1900, coll. Kuwana & G.A. Coleman, 3(3) VPI; Osaka, 13 Sep. 1956, coll. R. Takahashi, 1(4) FAHU; Takao, Tokyo Pref., Jul. 1949, coll. R. Takahashi, 1(4) FAHU; Tokyo, 2 Dec. 1949, coll. R. Takahashi, 1(5) FAHU; Tokyo, Nishigahara, no. 26, 3(7) UCD; Honshu, Toyama, Oct. 1962, coll. S. Takagi, 2(4) FAHU; Yokohama, "Imperial Plant Quar.", 24 Jul. 1918, coll. S.I. Kuwana, 3(3) VPI; Yokohama, no coll. date, coll. Kuwana, 1(1) UCD; Yokohama, at Wash. D.C., on "seeds", Jan. 1918, 1(3) UCD; at Phila., 2 Aug. 1934, coll. W.J. Ehinger, no. 23688, 1(3) USNM; no other locality data, 24 Jul. 1918, coll. S.I. Kuwana, 2(4) VPI; **TAIWAN**, Lo-liu-shan, nr. Arisan, alt. 2660m, 29 Sep. 1949, coll. G.F. Ferris, no. 28, 3(6) UCD, 3(6) VPI; as "Formosa", Taihoku, 20 Nov. 1915, coll. M. Maki, 1(2) UCD; as "Formosa", Taipei, 23 Jan. 1949, coll. G.F. Ferris, no. 310, 1(1) VPI; as "Formosa", Taiping-shan, west of Lo-tung, 22 Feb. 1949, coll. G.F. Ferris, no. 560, 2(4) VPI; **USA**, California, Ventura, Nov. 1900, coll. E.O. Essig, no. 598, 1(1) BRI; California, Ventura, 12 Jan. 1913, coll. E.O. Essig, 2(3) UCD; California, no other locality, no collection date, coll. Essig, 2(4) VPI; Hawaii, Honolulu, no collection date, coll. E.M. Ehrhorn, 1(2) UCD; Hawaii, Oahu, Pearl City, 4 Apr. 1961, coll. J.W. Beardsley, 2(4) USNM; Hawaii, Oahu, Pearl City, 9 Jan. 1962, coll. J.W. Beardsley, 1(4) JWB; Louisiana, New Orleans, coll. W. Bradley, no. 53, 2(3) LSU, 1(2) UCD. **Undetermined Host: JAPAN**, at quarantine, Feb. 1912, coll. not given, 1(3) UCD; Kukuokea, Dec. 1903, coll. S.I. Kuwana, 2(4) VPI; **USA**, California, no other locality data, 1913, coll. not given, 4(6) VPI; California, no other locality data, 1913, coll. not given, 1(3) VPI.

Antonina socialis Newstead: *Arundinaria japonica*, **ENGLAND**, Herts, coll. R. Newstead, 1(1) BM.

Antonina elongata Tang

Antonina elongatus Tang, 1992: 663, 692.

Tang (1992) vaguely described this species within an appendix or English summary to his book on Chinese mealybugs. His description was based on two adult females collected in an ant nest at Fujian Province and consisted only of body dimensions and a statement of relatedness to *Antonina purpurea* Signoret and *A. vera* Borchsenius. *Antonina elongata* differed from the former by having trilocular pores at the spiracular opening, and from the later by possessing three-segmented antennae.

It is possible that the two type specimens were not adult females. Tang's illustration does not depict the presence of a vulva nor disc-like pores on the venter. Among the characters drawn were: multilocular pores on the submargino-marginal region of both surfaces, a reduced pair of posterior dorsal ostioles, three-segmented antennae, eyes, sclerotized spiracle with slender arm and trilocular pores associated with the atria, leg remnants, and a curled stylet loop that would extend close to end of abdomen if straightened. The drawn figure appears very similar to observed preadult *Antonina crawi* Cockerell; however, the examination of the type series is needed to confirm this possible oversight.

Antonina graminis (Maskell)

Sphaerococcus graminis Maskell, 1897b: 244. [lectotype designated in Williams, 1985]
Chaetococcus graminis (Maskell) Maskell, 1898: 250-251.
Kermicus (*Chaetococcus*) *graminis* (Maskell) Cockerell, 1899a: 392.
Antonina graminis (Maskell) Fernald, 1903: 121; Zimmerman, 1948: 156-157; Ferris, 1953: 294-295; Williams, 1958a: 206; Chada & Wood, 1960: 5-9; Beardsley, 1966: 406; McKenzie, 1967: 76-78; Yang & Kosztarab, 1967: 20-23, 53-55, 66-68; Ali, 1970: 101; Kawai, 1980: 122; Wang, 1982: 127; Williams, 1985: 45; Williams & Watson, 1988: 20-24; Williams & Granara de Willink, 1992: 55-58; Varshney, 1992: 64.
Antonina indica Green, 1908: 27; 1922: 395-396; Kuwana, 1932: 215; Takahashi, 1951: 21; Wang, 1982: 127-128. [synonymized by Zimmerman, 1948; lectotype designated in Williams, 1985]

Antonina littoralis Cockerell & Buecker, 1930: 1-3; Laing, 1933: 676. [synonymized by Williams & Watson, 1988]

Antonina anceps Green *in* Kasargode, 1914: 136; Varshney, 1992: 64. (*nomen nudum*) **syn. n.**

Unlike most "legless" mealybugs, *A. graminis* is world-wide in distribution and has usually broad host range. In addition to the locations listed under "Material Examined", this well known pest of cultivated grasses has been reported from: Italy (Marotta 1992); Kenya, Libya, Nigeria, Somalia, Uganda, Zimbabwe (Williams 1970); Coromo Islands and Madagascar (Mamet 1954, 1960); Mauritius (Chada & Wood 1960); Kuwait (Williams 1970); Saudi Arabia (Matile-Ferrero 1984); Israel & Egypt (Ben-Dov 1990); Bangladesh & Pakistan (Williams 1970, Varshney 1992); Japan Archipelago (Kuwana 1932, Williams 1970, Kawai 1980); Vietnam (Danzig & Konstantinova 1990); Thailand (Williams 1970); Malaysia (Takahashi 1951); Java & Sumatra (Chada & Wood 1960, Williams 1970); Johnston Island (Chada & Wood 1960, Beardsley 1966); Islands of Melanesia, Micronesia, and Polynesia (Chada & Wood 1960, Beardsley 1966, Williams & Watson 1988); El Salvador (Chada & Wood 1960, Williams & Granara de Willink 1992); Guatemala (Chada & Wood 1960, Williams & Granara de Willink 1992); Nicaragua (Chada & Wood 1960); Louisiana, Mississippi, and New Mexico in USA (Chada & Wood 1960); Islands of Antigua, Curacao, Nevis, Puerto Rico, Trinidad, and Virgin Islands (Chada & Wood 1960, Williams 1970, Williams & Granara de Willink 1992); Bermuda (Williams 1970, Hodgson & Hilburn 1990, 1991, Williams & Granara de Willink 1992); Argentina, Ecuador, French Guiana, Peru, Surinam (Williams 1970, Williams & Granara de Willink 1992); and South Australia (Williams 1985)

Also unlike most "legless" species, *A. graminis* is a polyphagous pest of numerous grass and bamboo species. This well known pest of cultivated grasses has a host range of over 40 genera. Chada & Wood (1960) reported 69 species of Poaceae being attacked in the United States alone. Additional host species not listed here can be found in Chada & Wood (1960), Brimblecombe (1966), and Hodgson & Hilburn (1990). Little attention should be paid to the probable misidentifications of *Croton* and "a fagaceous tree" on the slides listed below.

This species is often located at the base of culms and on rhizomes of its host, but may also be found on aerial roots (Zimmerman 1948) and roots (Jayanthi 1986). Adult females are deep red to purple in color, oval to ovate, flattened ventrally, convex

dorsally; older individuals are more globular is shape. The body is surrounded by wax except for a small region at the posterior end; a prominent wax tube emanates from the anal area.

The illustration of Williams & Watson (1988) agrees most with the material observed in this study and should serve as an adequate reference. Those by Ferris (*in* Zimmerman 1948, Ferris 1953) are also sufficient. A description of the adult female is as follows: body broadly oval to circular, 1000-3900μm long; segmentation poorly defined, abdominal segments VII-VIII heavily sclerotized, caudal end truncate or concave, dependent on location of anal tube.

Dorsal surface with multilocular pores, trilocular pores, simple disc pores, and cylindrical ducts; multilocular pores with 10 locules, found outside anal tube orifice; trilocular pores numerous, distributed over entire dorsum with fewer on posterior abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, those in sclerotized region of abdomen concentrated into transverse band, sclerotization around duct gives impression of collar between orifice and flange; simple disc pores also distributed over entire dorsum. Conical setae present, distributed over entire surface, those located on sclerotized region of abdomen longer and more numerous than rest of surface.

Posterior dorsal ostioles absent; pair of submedial apodemes vaguely present at times between segments VII-VIII. Anal ring at end of invaginated tube, tube length subequal to ring diameter, numerous multilocular pores surround tube orifice; anal ring pores numerous, six anal ring setae extend just beyond tube opening.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; located on medio-submarginal region of thorax and abdominal segments II-VI with those on thorax found primarily in area surrounding spiracles, also found in medial band between vulva and anal tube orifice, occasionally found at margin of head near antennae. Structure and distribution of trilocular pores and cylindrical ducts same as those on dorsum. Conical setae structurally similar to those on dorsum, but distributed only on marginal region of venter. Flagellate setae also present, located on medio-submarginal region of ventral surface; apical setae lacking. Many disc-like pores with convex locule and of various sizes form band from abdominal segment II to area near vulva, posterior end of band extends to segment VIII at times; region of band varies, but typically submedio-submarginal.

Antennae 1-2 segmented. Eyes present. Legs absent, but podal apophyses typically present. Spiracles heavily sclerotized with narrow arm, numerous trilocular pores form crescentic band at atrium. Vulva distinct, oval, directed ventrally and encircled by flagellate setae, with lateral and caudal pairs of apophyses, apparently located between abdominal segment VI-VII.

Antonina graminis may be confused with *Antonina maritima* which closely resembles it in overall body design and structural organization. *Antonina maritima* is distinguishable in having multilocular and trilocular pores associated with spiracular atria, numerous multilocular pores along the margin of head and prothorax, and multilocular pores present dorsally on medio-submedial region of abdominal segments VII-VIII. *Antonina graminis* may also be confused with *Antonina transvaalensis*, but this species has a less distinct band of disc-like pores on the abdominal venter. Its disc-like pores are few in number and are restricted to a submedial band on abdominal segments III-V.

According to Kasargode (1914), E.E. Green provisionally named material collected by the former in western India *Antonina anceps*, but only host data was provided. No description of this species has ever been given. The observed material of *A. anceps* showed no morphological differences from *A. graminis* and is here treated as a synonym.

Type Material Examined. *Sphaerococcus graminis* Maskell was not available for study. *Antonina littoralis* Cockerell & Buecker: two syntype females on grass, **NEW CALEDONIA**, 1(2) AMNH (slide labeled "on grass, New Caledonia, nr coast, May 26, TYPE, (Ckll)")

Other Material Examined. *Antonina graminis* (Maskell). ***Agropyron repens*: AUSTRALIA**, Queensland, Camooweal, "couch grass", 6 Mar. 1958, coll. C.A. Paine, no. 75/58, 2(4) VPI, 1(3) WARI; Western Australia, Kununurra, "couch grass", 27 Dec. 1968, coll. D.G. Shedley, 1(2) WARI. ***Andropogon* sp.: USA**, Georgia, Echols Co., 4 May 1968, coll. R. Beshear, 1(1) UGES; Georgia, Early Co., 26 Apr. 1972, coll. R. Beshear, 1(1) UGES. ***Aristida spiciformis*: USA**, Florida, Port St. Lucie, 30 Sep.. 1983, coll. K. Hibbard, 2(2) FSCA. ***Aristida stricta*: USA**, Florida, Ft. Pierce, 12 Jan. 1983, coll. S.P. Beidler, 3(3) FSCA. ***Aristida* sp.: SOUTH AFRICA**, Transvaal, Pretoria, 2 Feb. 1970, coll. H.K. Munro, 1(1) PPRI. ***Brachiaria mutica*: PAPUA NEW GUINEA**, Erap, 5 Feb. 1969, coll. H. Shottler, DASF no. 12, 1(3), DASF 1(3) VPI. ***Chloris gayana*: BOTSWANA**, Gaberones, "Rhodes grass", 15 Oct. 1969, coll. N.S. Irving, 2(2) PPRI, 1(1) VPI; **BRAZIL**, Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A.

Dickason, 1(6) VPI; **USA**, Texas, Kingsville, "Rhodes grass", 6 Oct. 1948, coll. E.O. Essig, 1(1) UCD. ***Chloris* sp.: USA**, Florida, Key West, 27 Feb. 1947, coll. P.E. Frierson, 3(9) FSCA. ***Croton* sp.: BURMA**, Rangoon, Jan. 1911, coll. R.S. Woglum, no. 121, 1(4) USNM. ***Cynodon dactylon*: AUSTRALIA**, Queensland, Brisbane, 9 Aug. 1972, coll. M. Kosztarab & W.A. Smith, 1(3) VPI; Western Australia, Perth, 2 Sep. 1959, coll. D. Shedley, no. 215/59, 1(2) WARI; **BRAZIL**, Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A. Dickason, 2(6) VPI; **FIJI**, Viti Levu, 12 Jan. 1977, coll. M.F. Kirby, 1(1) VPI; **LEBANON**, Beirut, Nov. 1968, coll. Talhouk, no. 3672, 1(3) MNHNE; Beirut, Nov. 1968, coll. Talhouk, no. 3674, 1(2) MNHNE; **MEXICO**, Tamaulipas, 28 Apr. 1950, coll. A.M. Vance & H.L. Chada, 4(6) USNM; Yucatan, Tulum, 26 Mar. 1987, coll. M. Kosztarab, 1(2) VPI; **USA**, Arizona, Tucson, 19 Jun. 1980, 1(1) FSCA; California, Lakewood, "Bermuda grass", 1 Nov. 1967, coll. Wood, 4(8) CLA; California, Los Angeles, "Bermuda grass", 26 Sep. 1967; coll. L.E. Meyers, 2(2) CLA; California, San Diego, 10 Aug. 1964, coll. G.L. Hill, 1(3) VPI; Florida, Brooksville, 12 Jun. 1980, coll. A.L. Bentley, 2(2) FSCA; Florida, Gainesville, 8 Oct. 1976, coll. R.L. Crocker, 1(1) FSCA; Florida, Key West, "Bermuda grass", 2 Jul. 1954, coll. O.D. Link, 3(18) FSCA; Florida, Largo, 3 Sep. 1964, coll. B. Allen, 1(1) FSCA; Florida, Long Key St. Park, 20 Mar. 1978, coll. M. & M. Kosztarab, 2(2) VPI; Florida, Miami, 4 Mar. 1965, coll. C.E. Stegmaier, 3(3) FSCA; Florida, Miami, "Bermuda grass", 5 Nov. 1951, coll. not given, 2(9) FSCA; Florida, Miami Beach, "Bermuda grass", 29 Dec. 1953, coll. G.W. Dekle & P.E. Frierson, 1(1) FSCA; Georgia, Echols Co., "Bermuda grass", 4 Oct. 1969, coll. R. Beshear, 2(2) UGES; Hawaii, Oahu, Honolulu, 1 Jun. 1957, coll. not given, 1(1) JWB; South Carolina, Pawleys Island, "Bermuda grass", 16 Oct. 1974, coll. R. Beshear, 2(2) UGES; Texas, Bay City, "Bermuda grass", 20 Dec. 1987, coll. M. Schuster, 4(7) VPI; Texas, Bexar Co., San Antonio, 10 Dec. 1989, coll. M. & M. Kosztarab, 1(1) VPI; Texas, Guadalupo Co., 3 May 1950, coll. E. Wood, 1(4) USNM; Texas, Frio Co., 26 Apr. 1950, coll. E.A. Wood, 1(3) USNM. ***Cynodon plectostachus*: BRAZIL**, Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A. Dickason, 1(3) VPI. ***Cynodon* sp.: IRAN**, Ahwaz (Khuzestan), no coll. date, 2(5) VPI. ***Dactyloctenium aegyptium*: MEXICO**, Yucatan, Tulum, 26 Mar. 1987, coll. M. Kosztarab, 1(2) VPI; **USA**, Florida, Hialeah, 9 Feb. 1965, co.. C.E. Stegmaier, 3(3) FSCA. ***Digitaria decumbens*: BRAZIL**, Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A. Dickason, 1(3) VPI; **JAMAICA**, "pangola grass", Jul. 1966, coll. W. Dvell, 2(7) VPI; **USA**, Florida, Lake Wales, 21 Nov. 1983, coll. R.R. Snell, 4(4) FSCA; Florida, Orange Lake, 7 Jul. 1981, coll. A. Chavez, 3(3)

FSCA; **VENEZUELA**, Ara Ure, Portuguesa, "pangola grass", 10 Jul. 1968, coll. J.V. Aguero, 1(2) VPI; Perija-Zulia, "pangola grass", 17 Oct. 1966, coll. C.J. Rosales & A. D'Ascoli, 1(1) VPI. ***Digitaria didactyla*: PAPUA NEW GUINEA**, Aiyura, "potted plant", 7 Jan. 1962, coll. J.H. Barrett, 2(7) VPI. ***Digitaria pentzii*: BRAZIL**, Itapetinga, Bahia, 28 Apr. 1966, coll. E.A. Dickason, 1(3) VPI; Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A. Dickason, 1(5) VPI; Jul. 1966, coll. R.W. Dvell, 3(3) FSCA. ***Digitaria sanguinalis*: USA**, Florida, Miami, 6 Feb. 1965, coll. C.E. Stegmaier, 4(4) FSCA; Florida, Patrick Air Force Base, 28 Jun. 1982, coll. F.A. Smith, 3(3) FSCA. ***Digitaria swazilandensis*: GUYANA**, Montjoly, 11 Oct. 1980, coll. not given, no. 8574, 1(1) MNHNE. ***Digitaria* sp.: PAPUA NEW GUINEA**, Goroka, 28 May 1963, coll. J.H. Barrett, 1(2) VPI. ***Distichlis spicata*: BAHAMAS**, Berry Islands, 22 Mar. 1987, coll. M. Kosztarab & M. Kosztarab, 4(8) VPI. ***Echinochloa colonum*: CUBA**, Santiago, de las Vegas, 1 Feb. 1937, coll. S.C. Bruner, 1(5) USNM. ***Elyonurus hirsutus munro*: BRAZIL**, Reccife, Pernambuco, 1 Dec. 1967, coll. M.F. Schuster, 2(2) VPI. ***Eragrostis* sp.: USA**, Georgia, Emmanuel Co., 13 Sep. 1971, R. Beshear, 1(1) UGES. ***Eremochloa ophiuroides*: USA**, Alabama, Mobile Co., 24 Aug. 1973, coll. Ball, 12(12) AU; Georgia, Clinch Co., "centipede grass", 4 Mar. 1972, coll. R. Beshear, 1(1) UGES. ***Melinis minutiflora*: HONDURAS**, Tatumbla, 13 Jul. 1989, coll. M.W. Williams, 2(3) VPI; **BRAZIL**, Rio de Janeiro, Guanabara, 14 Jun. 1966, coll. E.A. Dickason, 1(3) VPI. ***Panicum adspersum*: USA**, Florida, Miami, 4 Mar. 1965, coll. C.E. Stegmaier, 2(2) FSCA. ***Panicum barbinode*: HONDURAS**, La Lima, C.A., 3 Aug. 1967, coll. C. Evers, 8(8) FSCA. ***Panicum hemitomon*: USA**, Florida, Lake Wales, 21 Nov. 1983, coll. R.R. Snell, 2(2) FSCA. ***Panicum purpurascens*: BRAZIL**, Porto Alegre, Rio Grande, 6 Nov. 1967, coll. M.F. Schuster, 3(6) VPI; **COLOMBIA**, Boyaca State, Chiquinquira, Pertuguesa, 12 Jan. 1978, coll. J. Guttierrez, 3(3) FSCA; **USA**, Florida, Hobe Sound, 31 May 1978, coll. E.W. Campbell, 3(3) FSCA; Florida, Hypoluxo, "para grass", 25 Jan. 1951, coll. M.U. Mounts, 1(2) FSCA; Florida, Lake Worth, "para grass", 26 May 1949, coll. O.D. Link, 6(26) FSCA; Florida, Loxahatchee, "para grass", 9 Jan. 1952, coll. O.D. Link, 3(13) FSCA; Florida, Miami, "para grass", 22 Jun. 1944, coll. Henderson, 3(9) FSCA; Florida, Miami, "para grass", 5 Jan. 1949, coll. O.W. Calkins, 2(5) FSCA; Florida, Okeechobee, "para grass", 31 Mar. 1953, coll. O.D. Link, 2(11) FSCA; Florida, Oslo, "para grass", 21 Sep. 1949, coll. R.R. Nixon, 2(5) FSCA; Florida, Palm Springs, 21 Sep. 1983, coll. R.I. Sailer, 5(5) FSCA, Florida, Truckland, 7 Jan. 1987, coll Z. Smith, 3(3) FSCA; **VENEZUELA**, El Limon-Aragua, "para grass", 25 Jun.

1956, coll. R. Torres, 2(4) VPI; El Limon-Aragua, "para grass", 6 Dec. 1964, coll. F. Fernandez-Yepez & D. Villasmil, 2(3) VPI. ***Panicum trichoides*: VENEZUELA**, El Limon-Aragua, 5 May 1955, coll. F. Fernandez-Yepez, 4(5) VPI. ***Panicum* sp.: USA**, Florida, Ft. Pierce, 8 Jan. 1982, coll. K. Hubbard, 4(4) FSCA. ***Paspalum notatum*: USA**, Florida, Arcadia, 14 Aug. 1986, coll. Z. Smith, 5(5) FSCA. ***Paspalum* sp.: BRAZIL**, Goienia Goias, 18 Nov. 1967, coll. M.F. Schuster, 3(6) VPI; **MARTINIQUE**, Ste. Marie, 18 Apr. 1957, coll. not given, no. 2531, 1(1) MNHNE. ***Pennisetum purpureum*: USA**, Florida, Homestead, 30 May 1979, coll. not given, 4(4) FSCA. ***Phragmites* sp: USA**, Florida, nr. Everglades, 30 Mar. 1959, coll. M. Kosztarab, 1(2) VPI. ***Rhynchelytrum roseum*: USA**, Florida, Clermont, 10 Nov. 1980, coll. H.L. Morrison, 3(3) FSCA; Florida, Miami, 13 Feb. 1965, coll. C.E. Stegmaier, 4(4) FSCA; Florida, Miami, 6 Feb. 1965, coll. C.E. Stegmaier, 4(4) FSCA; Florida, Miami, 13 Feb. 1965, coll. C.E. Stegmaier, 3(3) FSCA; Florida, Miami, 17 Feb. 1965, coll. C.E. Bingman, 2(2) FSCA; Florida, Miami, 18 Feb. 1965, coll. C.E. Stegmaier, 1(1) FSCA. ***Rhynchelytrum repens*: USA**, Florida, West Palm Beach, 14 Feb. 1979, coll. W.C. Churchill, 1(1) FSCA. ***Saccharum officinarum*: NETHERLAND ANTILLES**, as "Dutch Indies", "sugar cane", 29 Aug. 1935, coll. Limber et al., 1(1) USNM; **USA**, Florida, Homestead, 13 Oct. 1980, coll. W.E. Wyles, 1(1) FSCA. ***Setaria geniculata*: USA**, Florida, Miami, 12 Feb. 1965, C.E. Stegmaier, 1(1) FSCA. ***Setaria verticillata*: SOUTH AFRICA**, Transvaal, Zebediela, 12 Apr. 1966, coll. H. Bass, 2(2) PPRI. ***Sorghum halepense*: USA**, Arizona, Tucson, Sabina Canyon, 16 Nov. 1970, coll. E.J. Hambleton, 2(3) USNM; Florida, Alachua Co., Bevins Arms, 15 Sep. 1964, coll. A.E. Graham, 2(2) FSCA; Georgia, Spalding Co., "Johnson grass", 13 Feb. 1968, coll. R. Beshear, 1(1) UGES. ***Spartina patens*: USA**, Florida, Estero Island, 2 Nov. 1981, coll. Z. Smith, 3(3) FSCA; Florida, Hobe Sound, 26 Nov. 1978, coll. E.W. Campbell, 1(1) FSCA; Florida, Nr. Vero Beach, 22 Aug. 1985, coll. E.W. Campbell, 3(3) FSCA; Georgia, Glynn Co., 16 Mar. 1972, 3(3) UGES; South Carolina, Pawleys Island, 16 Oct. 1974, coll. R.J. Beshear, 2(2) UGES. ***Spartina* sp.: USA**, Florida, Bayport, 4 Feb. 1974, coll. R. Beshear, 2(2) UGES; Florida, Bayport, 7 Jul. 1971, coll. R. Beshear, 1(1) UGES; Florida, Gulf Port, 8 Aug. 1970, coll. H.H. Tippins, 1(1) UGES; Georgia, Glynn Co., 11 Jan. 1983, coll. R. Beshear, 2(2) UGES. ***Sporobolus poiretii*: USA**, Florida, Miami, 12 Feb. 1965, coll. C.E. Stegmaier, 3(3) FSCA. ***Stenotaphrum secundatum*: USA**, California, El Centro, Imperial Co., 13 Oct. 1957, coll. C. Staab, 1(2) UCD; California, El Centro, "St. Augustine grass", 14 Nov. 1957, coll. R. Hawthorne, 1(3)

CLA; California, Gardena, "St. Augustine grass", 17 Oct. 1967, coll. Edwards, 1(2) CLA; Florida, Ft. Lauderdale, "St. Augustine grass", 20 Jun. 1952, coll. B. Foster, 2(8) FSCA; Florida, Miami, "St. Augustine grass", 5 Nov. 1957, coll. F.G. Butcher, 2(7) FSCA; Florida, Miami, Dade Co., 15 Nov. 1988, coll. D. Storch, 1(4) VPI; Florida, Miami Beach, 5 Feb. 1965, coll. C.E. Stegmaier, 4(4) FSCA; Florida, Miami, 8 Sep. 1977, coll. C.H. Ray, 17(17) AU; Florida, Miami, 30 Aug. 1978, coll. P. Chobrda, 2(2) FSCA; Florida, Naranja, 30 Aug. 1978, coll. P. Chobrda, 1(1) FSCA; Georgia, Spalding Co., "St. Augustine grass", 5 Oct. 1970, coll. H.H. Tippins, 1(1) UGES; Texas, Live Oak Co., "St. Augustine grass", no date, coll. M.V. Meisch, 2(3) UCD; date & locality not given, presumably Florida, "St. Augustine grass", coll. D.O. Wolfenbarger, 1(1) FSCA. ***Uniola paniculata*: USA**, Florida, Ft. Pierce, 16 Jun. 1978, coll. E.W. Campbell, 1(1) FSCA. **Undetermined Grass: ANGOLA**, NE Luanda, 26 Aug. 1967, coll. A. Balachowsky, no. 3373, 5(9) MNHNE; **AUSTRALIA**, Brisbane, 1899, coll. G. Compere, no. 1167-8, 2(7) USNM; Northern Territory, nr. Katherine, Aug. 1968, coll. not given, 1(5) WARI; **BOLIVIA**, Santa Cruz, Gul Saavedre, 29 Mar. 1988, coll. F.D. Bennett, 5(5) FSCA; **CHINA**, Canton {= Guangzhou}, Lingnan Univ., 22 Nov. 1948, coll. G.F. Ferris, no. 108, 2(3) VPI; Deng-wu-shan, on West River, west of Canton, 13 Dec. 1948, coll. G.F. Ferris, no. 211, 2(4) VPI; Lingnan, 18 Nov. {1948}, {coll. G.F. Ferris}, no. 98, 1(2) UCD; Lingnan, 22 Nov. {1948}, {coll. G.F. Ferris}, no. 108, 2(7) UCD; Lingnan, 21 Dec. {1948}, {coll. G.F. Ferris}, no. 252, 1(1) UCD; Lo-Kong-tung, NE of Canton, {coll. G.F. Ferris}, no. 120, 1(1) UCD, 2(4) VPI; nr. Lo-Kong-tung, NE of Canton, {coll. G.F. Ferris}, no. 266, 2(4) UCD, 1(2) VPI; **COLOMBIA**, Palmira Valle, 21 Feb. 1956, coll. M. Benavides & P. Para, 1(4) VPI; Palmira Moyo, 1942, coll. B. Losadas, 2(4) VPI; Johny Cay Island, San Andres, 28 Feb. 1970, coll. M. & M. Kosztarab, 3(6) VPI; S. of San Lois, San Andres, 27 Feb. 1970, coll. M. & M. Kosztarab, 3(6) VPI; **CUBA**, Havana, 28 Dec. 1954, coll. Dekle & Acuna, 3(6) FSCA; **GABON**, Makokou, Apr. 1978, coll. J. Legrand, no. 7325, 4(8) MNHNE; **GUADELOUPE**, Lamentin, 29 Jun. 1957, coll. A. Balachowsky, No. 2546, 1(1) MNHNE; **HONG KONG**, date not given, coll. O.E. Bremner, 1(1) UCD; Taipo, New Territories, 27 May 1949, coll. G.F. Ferris, no. 874, 1(1) UCD, 1(3) VPI; **INDIA**, Tiruchirapalli, Tamilnadu, 2 Oct. 1967, coll. S.A. Shafee, 1(2) USNM; **NAMIBIA**, Etosha Nat. Park, no other data, H.C. no. 6290, 3(3) PPRI; **PANAMA**, Chiriqui Province, 1938, coll. G.F. Ferris, no. 219, 2(3) UCD; **SAO TOME**, Savane de, 16 Aug. 1967, coll. A.S. Balachowsky, no. 3369, 2(3) MNHNE; **SOUTH AFRICA**, Durban, 17

Mar. 1949, coll. P. Theron, 9(11) UST; Transvaal, Ellisras, 28 Mar. 1970, coll. A.A. Barnard, 2(2) PPRI; Transvaal, Kruger National Park, Olifants River, 23 Feb. 1990, coll. M. Kosztarab, 1(2) VPI; Transvaal, Pretoria, 10 Apr. 1976, coll. H.K. Munro, 2(2) PPRI; Transvaal, Pretoria, 24 Feb. 1969, coll. H.K. Munro, 1(1) PPRI; Transvaal, Pretoria, 29 Dec. 1970, coll. G. DeLotto, 1(1) PPRI; Stellenbosch, Cape Province, 27 Feb. 1990, coll. J. Giliomee & M. Kosztarab, 1(1) UST, 1(1) VPI; **TAIWAN**, Chia-I (= Kagi), 27 Oct. 1949, coll. T. Maa, Ferris Coll. no. 289, 1(2) UCD; as "Formosa", Chi-pen, nr. Taitung, 16 Feb. 1949, coll. G.F. Ferris, no. 531, 1(2) VPI; as "Formosa", Ken-ting, nr Cape Garambi, 5 Feb. 1949, coll. G.F. Ferris, no. 413, 2(5) VPI; as "Formosa", Ken-ting, nr Cape Garambi, 6 Feb. 1949, coll. G.F. Ferris, no. 434/435, 4(9) VPI; as "Formosa", Taipeh, 1949, {coll. G.F. Ferris}, no. 287, 2(4) VPI; as "Formosa", Taipeh, 1 Feb. 1949, coll. G.F. Ferris, no. 376/377, 15(25) VPI; Taipeh, 4 Nov. 1949, coll. C.T. Lin, Ferris Coll. no. 91, 1(2) UCD; as "Formosa", Wulai, nr Taipeh, 27 Feb. 1949, coll. G.F. Ferris, no. 605, 2(5) VPI; **TONGA**, Tongatapu, 9 Mar. 1975. coll. W.H. Price, 5(5) FSCA; **USA**, California, Spring Valley, San Diego, 7 Nov. 1965, coll. J.R. Hohimer, 1(1) VPI; Florida, Avon Park, 14 Apr. 1973, coll. R. Beshear, 1(1) UGES; Florida, Bayport, 7 Jul. 1971, coll. R. Beshear, 1(1) UGES; Florida, Bayport, 27 Nov. 1970, coll. R. Beshear, 1(1) UGES; Florida, Bayport, 4 Feb. 1972, coll. R. Beshear, 2(2) UGES; Florida, Ft. Lauderdale, 1 Jun. 1952, coll. K. Peck, 1(1) FSCA; Florida, Ft. Ogden, 15 Jan. 1952, coll. Bickner & Dekle, 2(6) FSCA; Florida, Gainesville, 8 Oct. 1954, coll. S.H. Kerr, 1(1) FSCA; Florida, Gifford, 16 Nov. 1949, coll. K.E. Bragdon, 4(8) FSCA; Florida, Hobe Sound, 16 Sep. 1977, coll. E.W. Campbell, 1(1) FSCA; Florida, Hobe Sound, 15 Jun. 1978, coll. E.W. Campbell, 1(1) AU; Florida, Homestead, 7 Oct. 1949, coll. J.V. McConnell, 2(3) FSCA; Florida, Homestead, 15 Feb. 1978, coll. H. von Wald, 8(8) FSCA; Florida, Indian Rocks, 15 Dec. 1952, coll. L.B. Hill, 1(5) FSCA; Florida, Key West, 5 May 1950, coll. J.C. Bell, 2(8) FSCA; Florida, Lady Lake, 14 Feb. 1952, coll. J.C. Bell, 2(6) FSCA; Florida, Lee Co., Sanibel, 8 Apr. 1975, coll. W.F. Gimpel, 6(11) MDA; Florida, Leon Co., 24 Feb. 1972, coll. H.H. Tippins, 1(1) UGES; Florida, Montverde, 8 Feb. 1951, coll. J.C. Bell, 2(8) FSCA; Florida, Orlando, 2 Mar. 1948, coll. O.D. Link, 4(16) FSCA; Florida, Panama City, 6 Sep. 1970, coll. R. Beshear, 1(1) UGES; Florida, Pine Island, 10 Jul. 1970, coll. R. Beshear, 1(1) UGES; Florida, Plant City, 29 Jan. 1987, coll. L. Kavouras, 5(5) FSCA; Florida, Port Salerno, 29 Nov. 1978, coll. E.W. Campbell, 4(4) FSCA; Florida, Ruskin, 13 Dec. 1982, coll. J.R. McFarlin, 5(5) FSCA; Florida, St. Petersburg, 16 Sep. 1952, coll. L.B. Hill, 2(11) FSCA; Georgia,

Cambden Co., 1 Sep. 1970, coll. R. Beshear, 1(1) UGES; Georgia, Cambden Co., Cumberland Island, 21 Mar. 1969, coll. R. Beshear, 4(4) UGES; Georgia, Echols Co., 27 Jan. 1968, coll. R. Beshear, 3(3) UGES; Georgia, Glynn Co., 16 Mar. 1972, coll. J.O. Howell, 2(2) UGES; Georgia, Irwin Co., 27 Nov. 1973, coll. R. Beshear, 1(1) UGES; Georgia, McIntosh Co., 9 Jan. 1972, coll. R. Beshear, 1(1) UGES; Hawaii, Halawa Kahala, no date given, coll. Koebele, no. F 1961, 1(1) UCD; Hawaii, Honolulu, Aug. 1958, coll. W.C. Look, 1(2) JWB; Hawaii, Iao Valley, 28 Nov. 1976, coll. M. Kosztarab, 1(1) VPI; Hawaii, Kahului, Maui, 16 Aug. 1965, coll. C.S. Koreo, 1(1) VPI; Hawaii, Oahu, 20 May 1953, coll. H.N. Androus, 1(4) USNM; Hawaii, Waipouli, Kauai, 24 Nov. 1976, coll. M. Kosztarab, 1(1) VPI; Hawaii, Opaekea Falls, Kauai, 24 Nov. 1976, coll. W. Dekle, 1(1) VPI; Hawaii, Waimea Canyon, Kauai, 24 Nov. 1976, coll. M. Kosztarab, 1(1) VPI; Texas, Kingsville, King Ranch, 1949, coll. not given, 1(2) UCD; Texas, Nueces Co., Corpus Cristi, 2 Oct. 1990, R.D. Parker, 2(5) VPI; no other locality given, 13 Apr. 1960, coll. R.H. Beamer, 2(5) VPI. **Undetermined Bamboo(?): TAHITI**, Papeete, 19 Sep. 1972, coll. M. Kosztarab, 2(4) VPI. **Undetermined Host: COLOMBIA**, Barranquilla, Feb. 1961, coll. Gibler, 3(6) VPI; Cucuta, 15 Nov. 1960, coll. L. Pasada, 3(6) VPI; Melambo (Ant.), 8 Mar. 1961, coll. Hopp, 3(6) VPI; Tasmalameque, 10 Jul. 1961, coll. I. Vega, 3(7) VPI; Villavicencio (M.), Apr. 1960, coll. H. Chaverra, 5(8) VPI; Tropical Cali, Valle, 27 Apr. 1939, coll. B. Losada, 2(4) USNM; no other data, 4(16) VPI; **HONG KONG**, no other data, "*Chaetococcus graminis* Mask.", Mask. Coll. no. 574, 2(2) USNM; **MEXICO**, SW of Jalapa, V. Cruz, 13 Jul. 1967, coll. D.R. Miller & J. Villanueva, 1(1) VPI; **PANAMA**, Chiriqui Province., 1938, coll. G.F. Ferris, no. 231, 1(1) UCD; **TAIWAN**, Taipeh, 22 Nov. 1949, coll. T. Maa & C.T., Ferris Coll. no. 90, on "fagaceous tree", 1(1) UCD; **USA**, Florida, Eustis, 7 Oct. 1980, coll. H. Morrison, 3(3) FSCA; Georgia, Echols Co., 4 Oct. 1969, coll. R. Beshear, 1(1) UGES; **VENEZUELA**, Ranch, Chiquinguira, on "*Acarigual portugues*", 12 Jan. 1978, D.J. Gutierrez, no. 5, 5(5) FSCA.

Antonina indica Green. ***Cynodon dactylon*: INDIA**, Cuttack, "manienie grass", Aug. 1911, coll. Green, 1(2) VPI; **SRI LANKA**, as "Ceylon", Pundaluoya, "manienie grass", no coll. date, coll. E.E. Green, 1(2) UCD; **USA**, Hawaii, Oahu, Kahala, "manienie grass", 4 Apr. 1920, coll. Stickney, 3(9) USNM, no other locality given, "Bermuda grass", 1918, coll. Ehrhorn, 1(2) UCD; Hawaii, Oahu, Makaka, "Bermuda grass", Sep. 1917, coll. E.M. Ehrhorn, 2(3) UCD. ***Digitaria* sp.: PHILIPPINES**, Manila,

intercepted at Honolulu, 31 Oct. 1938, coll. not given, 1(2) USNM. ***Panicum barbinode*: CUBA**, Santa Clara Prov., 8 Apr. 1937, coll. A. Jordan, 1(5) USNM.

Antonina anceps Green. **Undetermined Bamboo: INDIA**, Poona, no date given, coll. H.H. Mann, no. 22, 2(2) BM.

Antonina maritima Ayyar

Antonina maritima, Green 1917: 86. (*nomen nudum*)

Antonina maritima Ayyar, 1919: 45.

Antonina maritima Green, 1922: 396; 1917: 86; Ayyar, 1921: 345; 1930: 64; Green, 1937: 295; Yang & Kosztarab, 1967: 55-57; Ali, 1970: 101; Varshney, 1992: 64. **syn. n.**

Green (1917) first used the name *Antonina maritima* in a host-list for various scale insects, but did so without providing an author or description for this new name. Although giving credit to Green for the name, Ayyar (1919) provided the first, although vague, description of the species. Green's detailed description of the species did not occur until 1922. For this reason, Ayyar is credited with the authorship of this species. Although none of Ayyar's material was examined, it can be assumed that it was in fact *A. maritima* because Green provided identifications for Ayyar (1919, p. 7) and included Ayyar's material in his description. The specimens listed under "Other Material Examined" from Coimbatore may be the material of Ayyar used by Green. It is labeled in Green's handwriting, and the name given for the collector, Ramakrishna, is part of Ayyar's name. This particular slide includes the posterior half of three additional females.

Antonina maritima is known only from Sri Lanka and southern India. It has been taken from *Panicum* sp. (Ali 1967), in addition to the hosts listed below. Individuals are found on the roots and rhizomes of its host (Varshney 1992), contained within a pink or white waxy sac (Green 1922). When near water, populations may become submerged during high tides (Ali 1967). Green described unmounted adult females as broadly oval to sub-circular, sclerotized at the posterior end.

This species closely resembles *A. graminis*; therefore, the illustrations of Ferris (*in* Zimmerman 1948) or Williams & Watson (1988) should be used as a template for the following description of *A. maritima*. On microscope slide: body broadly oval to

circular, 1600-3100μm long; segmentation vaguely defined, lateral constriction between abdominal segments VII-VIII somewhat pronounced; caudal end truncate or concave, dependent on location of anal tube, segments VII-VIII heavily sclerotized.

Dorsal surface with multilocular pores, trilocular pores, simple disc pores, and cylindrical ducts. Multilocular pores with 10 locules, few found along margin of head, more located over entire surface of abdominal segments VII-VIII, also outside anal tube orifice; trilocular pores numerous, distributed over entire dorsum; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, ducts in sclerotized section of abdomen seemingly with collar between orifice and flange; simple disc pores also distributed over entire dorsum. Conical setae present, distributed over entire surface, those located on sclerotized region of abdomen longer and more numerous than rest of surface.

Posterior dorsal ostioles absent; pair of submedial apodemes vaguely present at times between segments VII-VIII. Anal ring at end of invaginated tube, tube length approximately 1.2X ring diameter, numerous multilocular pores and few cylindrical ducts surround tube orifice; anal ring pores numerous, six anal ring setae extend to tube opening.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; many often on margin of head, also located on medio-submarginal region of thorax and abdominal segments II-VI with those on thorax found primarily in area surrounding spiracles, likewise found over entire surface of segments VII-VIII, occasionally seen elsewhere on abdomen. Structure and distribution of trilocular pores same as those on dorsum. Structure and distribution of cylindrical ducts same as those on dorsum, but loosely concentrated into transverse band in sclerotized region at caudal end. Conical setae structurally similar to those on dorsum, but distributed only on marginal region of venter. Flagellate setae also present, located on entire surface of head and abdominal segment VIII, and on medio-submarginal region of thorax and segments II-VII; no distinct apical setae among flagellate setae. Many disc-like pores with concave locules and of various sizes form band from abdominal segment II to point near vulva, posterior end of band extends to segment VIII at times; region of band varies, typically submedio-submarginal.

Antennae 1-2 segmented; eyes absent or represented by small invaginated pit. Legs absent, but podal apophyses typically present. Spiracles heavily sclerotized with narrow arm, numerous trilocular pores form crescentic band at atrium, few multilocular pores at

times associated with outer margin of pore band. Vulva distinct, oval, directed ventrally and encircled by flagellate setae, with lateral pair of apophyses, apparently located between abdominal segment VI-VII.

Antonina maritima is strikingly similar to *Antonina graminis*. *Antonina maritima* is distinguishable in having multilocular and trilocular pores associated with spiracular atria, numerous multilocular pores along the margin of head and prothorax, and multilocular pores present dorsally on medio-submedial region of abdominal segments VII-VIII. It also does not have a distinct submedial band of multilocular pores between vulva and anal tube orifice. *Antonina maritima*, like *A. graminis*, may also be confused with *Antonina transvaalensis*, but this particular species has few disc-like pores which are restricted to a submedial band on abdominal segments III-V.

Type Material Examined. *Antonina maritima* Ayyar. None examined; on roots of *Cynodon* sp., Coimbatore, **INDIA**, coll. T.V.R. Ayyar.

Antonina maritima Green. Syntype females on *Cyperus* sp., **SRI LANKA**, Colombo, 2(10) BM (slides labeled "*Antonina maritima* Green, from *Cyperus* sp., seashore, Colombo, Ceylon, coll. E.E. Green, Jul. 1911"). Also examined were subsequent slides from Green's dry type material, 2(4) VPI.

Other Material Examined. ***Cyperus* sp.: INDIA**, Coimbatore, date not provided, coll. Ramakrishna, 38, 1(2) BM; **SRI LANKA**, as "Ceylon" Colombo, coll. E.E. Green, Sep. 1911, 1(1) UCD, 1(2) USNM.

Antonina meghalayaensis Khalid & Shafee

Antonina meghalayaensis Khalid & Shafee, 1988: 50-52.

This species was described from material collected on *Bambusa* sp. in the northeastern district of Meghalaya in India. No information was given of material *in situ*, but a brief description and illustration of mounted females was provided. This species was distinguished from *A. graminis* by lacking abdominal sclerotization, and by possessing pairs of rod-like structures laterally on the anal tube and on the margin of the abdomen near the anal tube. The rod-like structures observed by Khalid & Shafee on the anal tube are actually muscle remnants, and may be seen in several species of *Antonina*. The pair seen on the margin of the body is actually lateral constrictions between

abdominal segments VII-VIII which appear "rod-like" with heavy sclerotization. These too are present in other *Antonina* species, particularly *A. crawi*.

This species was also reported as having a circulus, but this structure may have been the vulva of which no description was given. Based on the description provided, a venturesome guess would view this species and *A. crawi* as conspecific; however, in *A. meghalayaensis* the disc-like pores were reported as few and confined to the posterior abdominal region. No material was observed in this study, and the original description and illustration alone are not sufficient to distinguish *A. meghalayaensis* from other species with certainty.

Antonina natalensis Brain

Antonina natalensis Brain, 1915: 86-87; DeLotto, 1958: 80-81; Ezzat, 1962: 159; Almeida, 1974: 60-61.

Antonina indica var. *panica* Hall, 1925: 6-7; 1926: 33; 1937: 125-126; Williams, 1958b: 4. [synonymized by DeLotto, 1958]

Antonina natalensis is found predominantly in the Ethiopian Region at the base of grasses. It has been recorded from Mozambique (Almeida 1974) and Israel (Ben-Dov 1990); in addition material was examined from the localities listed below.

Brain (1915) described live adult females as obovate, flattened ventrally, rounded dorsally, purplish black, enclosed in yellow-white to buff ovisac. Hall (1925) further indicated that the body is exposed at the mouthparts and around the posterior extremities. DeLotto (1958) provided the latest illustration of this species; however, that of *Antonina graminis* by Ferris (1953) may also be used as a template. A description of slide-mounted adult females is as follows: body broadly oval to circular, 2800-4200µm long; abdominal segmentation poorly defined, last two abdominal segments membranous to lightly sclerotized, caudal end rounded or concave, dependent on location of anal tube.

Dorsal surface with multilocular pores, trilocular pores, simple disc pores, and cylindrical ducts. Multilocular pores with 10 locules, occasionally 11, located on margin of abdominal segments VII-VIII, on margin of pro- and mesothorax of young individuals; trilocular pores numerous, distributed over entire dorsum with fewer on last two abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum; simple disc pores also distributed over entire dorsum.

Conical setae few, limited to posterior abdominal segments, each of these segments with 1-2 setae along margin; flagellate setae numerous, distributed over entire dorsum, those located on posterior segments longer than those on rest of surface.

Posterior dorsal ostioles absent; pair of submedial apodemes vaguely present at times between segments VII-VIII. Anal ring at end of invaginated tube, tube length approximately 1.2X ring diameter, numerous multilocular pores form band around tube orifice, cylindrical ducts occasionally present in the same band; anal ring pores numerous, six anal ring setae extend to end of tube, setal tips slightly knobbed.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; located in region surrounding anterior spiracle and sparsely distributed laterad of anterior spiracle to margin of body; also found on medio-submarginal region of metathorax and abdominal segments II-V, and over entire surface of segments VI-VIII; occasionally found in area between anterior and posterior spiracles. Structure and distribution of trilocular pores, simple disc pores, cylindrical ducts, and flagellate setae same as those on dorsum. Apical setae present but nearly indistinct among long flagellate setae. Few disc-like pores of various sizes form submedio-submarginal band from abdominal segment III to point near vulva.

Antennae 2-3 segmented; eyes present. Leg remnants present, typically represented by setal group and pleural vestiges, sometimes by stub-like protrusion, podal apophyses present. Spiracles heavily sclerotized with broad arm, multilocular pores form crescentic band at atrium, band sometimes with few trilocular pores. Vulva distinct, oval, directed ventrally and encircled by flagellate setae, apparently located on abdominal segment VI, with lateral and caudal pairs of apophyses, lateral pair inflated and sausage-like.

Antonina natalensis is distinguishable from other species by its inflated vulvar apophyses, band of multilocular pores at the spiracular openings, small band of disc-like pores, and by the sparseness of conical setae.

DeLotto (1958) also considered *Antonina transvaalensis* Brain as a junior synonym of *A. natalensis*, but I am in agreement with Yang & Kosztarab (1967) that these are two separate species. In the repositories of the BM and VPI are several slides of specimens collected on grass at Drappa and Durgaput, India, in 1911 by J.H. Gravely (see below). On these slides is written "*Antonina antennata*"; however, no descriptions are available for this name. After examining this material, no morphological differences were observed in adult females that would justify its separation from *A. natalensis*.

Type Material Examined. *Antonina natalensis*. Syntype females on grass, **SOUTH AFRICA**, Natal, Pietermaritzburg, coll. A. Kelley, 2(2) USNM (slides labeled "*Antonina natalensis* Br., grass, Pietermaritzburg, Natal, 15 Nov. 1914, 33 C.K.B."; one slide marked "Type" and the other "Chas. K. Brain").

Antonina indica panica. Syntype females on *Panicum turgidum*, **EGYPT**, Hamet el Abeed, coll. T.W. Kirkpatrick, 2(3) BM (slides labeled "*Antonina indica* var. *panica* Hall, *Panicum turgidum*, Hamet el Abeed, 16 Nov. 1923, W.J.H.") and **EGYPT**, Wadi Nouega, coll. W.J. Hall, 1(2) USNM (slide labeled "*Antonina indica* var. *panica* Hall, *Panicum turgidum*, Wadi Nouega, Eastern Desert, 2 May 1925, W.J.H.").

Other Material Examined. *Antonina natalensis*. ***Panicum turgidum*: ALGERIA**, Oued Amais, Tassili N'Ajjers, Sahara Central, Apr. 1949, coll. A.S. Balachowsky, no. 69, 3(5) MNHNE; Oued Amais, Tassili N'Ajjers, Sahara Central, Apr. 1949, coll. A.S. Balachowsky, no. 767, 1(1) MNHNE. ***Pennisetum* sp.: CAMEROON**, Dehang, 25 Mar. 1951, coll. A. Balachowsky, no. 438, 3(3) MNHNE. **Undetermined Grass: INDIA**, Drappa, nr. Calcutta, Jan. 1911, J.H. Gravely, Ind. Mus. 105, 2(3) BM, 6(6) VPI; Durgaput, nr. Calcutta, Dec. 1911, coll. J.H. Gravely, Ind. Mus. 116, 3(3) BM.

Antonina indica panica. ***Eragrostis* sp.: ZIMBABWE**, as "Rhodesia", 27 Mar. 1928, coll. W.J. Hall., no. 299 2(2) USNM. ***Panicum turgidum*: EGYPT**, Abu Sueir, 7 Nov. 1925, coll. W.J. Hall, 1(2) MNHNE; Eastern Desert, 2 May 1925, coll. W.J. Hall, 4(4) VPI; Suez Road, 27 Apr. 1924, coll. W.J. Hall 3(5) VPI.

Antonina pretiosa Ferris

Antonina pretiosa Ferris, 1953: 298-299; McKenzie, 1967: 78-80; Yang & Kosztarab, 1967: 30-33, 57-59; Tippins & Beshear, 1972: 287; Wang, 1982: 126-127; Johnson & Lyon, 1988: 330-331; Li et al., 1988: 17; Williams & Granara de Willink, 1992: 58.

Structurally this is the most unusual species of *Antonina*, and surprisingly not among those transferred to the genus *Chaetococcus* in the past. Superficially it resembles members of *Chaetococcus* more than any other *Antonina* species shifted between the genera. Only *Antonina crawi* resembles *Chaetococcus* species more. Apparently indigenous to southeast Asia, *Antonina pretiosa* is found enclosed in copious wax under the sheaths and bracts of bamboo (Ferris 1953). It has also become established in various

regions of southern North America. In addition to the hosts and localities listed below, *A. pretiosa* has been taken from *Sasa tessellata* in Inner Mongolia (Li et al. 1988).

The illustration of Ferris (1953) is the most adequate to date and may be used in conjunction with the following description. Mounted adult females are broadly oval to obovate, 1100-4200μm; abdominal segmentation well-defined, lateral constrictions between abdominal segments distinct, caudal end round or concave, but anal lobes undeveloped; most or all abdominal segments sclerotized, often described as having "plates".

Dorsal surface with numerous glandular structures. Multilocular pores with 10-locules, found encircling anal tube orifice only. Trilocular pores of two sizes; larger type ca. 9μm in diameter, distributed along margin of head, thorax, and abdominal segment II; smaller pore ca. 6μm in diameter, distributed over entire surface of head, thorax and abdominal segment II, and on medio-submarginal region of segments III-IV and medio-submedial region of segments V-VII, also forms band within anal tube near orifice. Simple disc pores found over entire dorsum. Cylindrical ducts long and slender with flange near tip, located on submargino-marginal region of head and thorax, and over entire abdominal venter, but predominant along entire margin. Conical setae slender, similar to flagellate setae in appearance, few located along margin of head, thorax, and abdominal segments II-III, more over entire surface of remaining abdominal segments. Flagellate setae distributed over entire surface of head, thorax and abdominal segment II, and on medio-submarginal region of segments III-IV.

Posterior dorsal ostioles greatly reduced or absent, sometimes appearing on segment VI. Anal ring at end of invaginated tube, tube length approximately 1.7X ring diameter, tube opening removed from end of abdomen at distance subequal to ring diameter, multilocular and trilocular pores form separate bands at orifice; anal ring pores numerous, six anal ring setae extend to end of tube or beyond, tips of setae are slightly knobbed.

Ventral surface also with many pores and ducts. Multilocular pores lacking, but cylindrical ducts with structure and distribution as those on dorsum. Trilocular pores of two sizes similar to those on dorsum; larger size distributed on margin of head, thorax, and abdominal segments II-III; smaller size located over entire venter, also in a crescentic band at spiracular opening. Conical and flagellate setae structurally similar to those on dorsum, but with slightly different distributions; conical setae located only along margin of venter, flagellate setae located over entire venter; apical setae lacking.

Many disc-like pores of various sizes form submarginal band on abdominal segments II-VII, occasionally on metathorax and segment VIII, often difficult to distinguish because recessed and in sclerotized area.

Antennae 2-segmented, eyes typically absent, legs completely lacking. Spiracles heavily sclerotized, with numerous trilocular pores grouped at atria. Vulva distinct, oval, directed ventrally but at times appearing caudally, with lateral and caudal pairs of apophyses, apophyses slender and long.

Antonina pretiosa is easily distinguished from other *Antonina* species by the condition of the abdomen, the double band of pores at the anal tube orifice, and the two sizes of trilocular pores distributed on the body. The submarginal band on the abdominal venter has long been considered to be made up of cylindrical ducts, and justifiably so. The recessed nature of the disc-like pores in this sclerotized region of the abdomen portrays an image of cylindrical ducts.

This species is not without variation. A specimen from Delray Beach, Florida, had multilocular pores anterior to vulva. Some specimens from Guangzhou, China (Ferris Coll. 97), and Taipei, Taiwan (Ferris Coll. 331), had disc-like pores only on abdominal segment II. Li et al. (1988) reported quadrilocular pores along margin of head and thorax. These glandular structures were infrequently seen in some specimens during this study, but their presence was inconsistent and at different locations of the body among specimens.

According to Ferris (1953), the type was taken from "giant bamboo" at Montebello, California; therefore, the material listed below may be syntype material even though not marked as such. Written on this slide as well as several others from localities mentioned by Ferris is "*Antonina speciosa* n. sp."

Type Material Examined. See remarks above.

Other Material Examined. ***Bambusa balcooa*(?): USA**, Illinois, Chicago, Garfield Park Conserv., date not given, coll. E.E. Green, 2(7) USNM. ***Bambusa disticha*: CUBA**, Stga. de les Vagas, "Letter" 4 Nov. 1940, coll. J. Acuña & S.C. Bruner, no. 11092, 1(2) USNM. ***Bambusa multiplex*: CHINA**, Canton {= Guangzhou}, Lingnan Univ., 18 Nov. 1948, coll. G.F. Ferris, no. 97, 5(11) VPI; **USA**, Florida, Homestead, 1 Nov. 1990, coll. C. Lichkai, no. SP012, 1(1) VPI; Florida, Gainesville, 6 Jun. 1987, coll. F.D. Bennett, 2(2) FSCA; Florida, Alachua Co., Gainesville, 28 Aug. 1988, coll. F.D. Bennett, 2(2) FSCA; Florida, New Smyrna Beach, 18 Sep. 1980, coll. A.L. Bentley, 2(2) FSCA; Maryland, Baltimore Co., Monkton, 1 Dec. 1977, coll. C.L. Staines, 5(19) MDA.

***Bambusa nana*: MALAYSIA**, Kuala Lumpur, 16 Mar. 1929, coll. "Entomol. Div.", no. 5928, 1(3) BM. ***Bambusa vulgaris*: USA**, Florida, New Smyrna Beach, 15 Jun. 1984, coll. J.N. Pott, "Aureo-variegata", 1(1) FSCA. ***Bambusa* sp.: HONG KONG**, Hong Kong Island, 11 Jun. 1988, coll. F.D. Bennett, 3(3) VPI; **TAIWAN**, Taipei, 9 Oct. 1950, coll. T. Maa, Ferris coll. no. 331, 3(5) UCD, 1(3) VPI; **USA**, California, Contra Costa Co., Brentwood, 4 Mar. 1964, coll. F.J. Brucato, 3(6) VPI; California, San Gabriel, 22 Nov. 1967, coll. White, 2(3) CLA; Florida, Bushnell, 5 Dec. 1977, coll. G.T. Smith, no. K-802, 1(1) FSCA; Florida, Delray Beach, 21 May 1979, coll. K. Stolley & M. Sander, no. L-223, 2(2) FSCA; Florida, Ft. Myers, 23 Feb. 1961, coll. W.T. Walsh, 2(2) FSCA; Florida, Ft. Pierce, 22 Jan. 1987, coll. B. Gillis & Z. Smith, 1(1) FSCA; Florida, Gainesville, 21 Feb. 1979, coll. D. Culbert, 3(3) FSCA; Florida, Jacksonville, 30 Mar. 1978, coll. L.S. Woodford, 1(1) FSCA; Florida, Lakeland, 5 Jan. 1978, coll. "Training class, #33", 3(3) FSCA; Florida, Miami, 8 Mar. 1965, coll. P.S. Herrmann, 3(3) FSCA; Florida, Miami, 3 Apr. 1978, coll. H. von Wald, 4(4) FSCA; Florida, Milton, 10 Nov. 1980, coll. D. Reese, 2(2) FSCA; Florida, Oneco, 6 Apr. 1959, coll. C. Bickner, 1(5) FSCA; Florida, Palatka, 16 Jun. 1980, coll. K. Elliott, 1(1) FSCA; Florida, Sarasota, 1 Apr. 1959, coll. M. Kosztarab, 10(51) VPI; Florida, Stuart, 24 Aug. 1977, coll. E.W. Campbell, no. K-737, 6(6) FSCA; Florida, Winter Haven, 25 Jan. 1979, coll. "Training class, #34", no. L-147, 2(2) FSCA. ***Phyllostachys aurea*: USA**, Florida, Delray Beach, 26 Jan. 1983, coll. C. Terwilliger, 3(3) FSCA; Florida, Ormond Beach, 4 Aug. 1980, coll. J.N. Pott, 1(1) FSCA. ***Pleioblastus distichus*: USA**, California, Los Angeles Co., San Fernando, 9 Jul. 1964, coll. R. Howell, 3(3) VPI. ***Yushania aztecorum*:** Florida, Lake Buena Vista, at California, 22 Jan. 1982, coll. F.L. Ware, 2(2) FSCA. ***Zuexine* sp.:** Florida, Ft. Pierce, 12 Dec. 1978, coll. E.W. Campbell, 1(1) FSCA. **Undetermined Bamboo: CHINA**, {Guangzhou}, 20 Oct. 1948, {coll. G.F. Ferris}, no. 1, 2(4) UCD; Canton {= Guangzhou}, Lingnan Univ., Oct. 1948, coll. G.F. Ferris, no. 2, 1(1) VPI; Canton {= Guangzhou}, Lingnan Univ., 27 Oct. 1948, coll. G.F. Ferris, no. 21, 2(5) UCD 3(5) VPI; Canton {= Guangzhou}, Lingnan Univ., 26 Oct. 1948, coll. G.F. Ferris, no. 22, 1(2) VPI; Canton {= Guangzhou}, Lingnan Univ., 5 Dec. 1948, {coll. G.F. Ferris}, no. 152, 3(6) VPI; **HONG KONG**, Fanling, New Territories, 28 May 1949, coll. G.F. Ferris, no. 887, 2(3) UCD, 1(3) VPI; **MALAYSIA**, Johore, 3 Aug. 1972, coll. M. Kosztarab, 2(4) VPI; **USA**, California, Los Angeles, 27 Jan. 1936, coll. L.E. Myers, 3(4) CLA, 1(1) UCD; California, Los Angeles, 1928, coll. not given, 2(2) VPI; California, West Los Angeles, 9 May 1940, coll. J. Caldwell, 1(2) CLA; California, Los Angeles, 16

Nov. 1944, coll. Wagner, 2(2) CLA; California, Los Angeles Co., Huntington Park, 11 Apr. 1960, coll. U. Nur, 1(3) UCD; California, Montebello, 5 Dec. 1938, coll. L.E. Myers, "Japanese bamboo", 1(2) UCD; California, Montebello, 20 Jun. 1952, coll. not given, "giant bamboo", 1(2) UCD; California, Newmark, 27 Jan. 1921, coll. Zeluff & Potter, 2(4) FSCA; California, Ontario, 20 Jul. 1915, coll. C.P. Clausen, on "spies", 1(4) UCD; California, S. Pasadena, 23 Dec. 1925, coll. L.E. Myers, 1(1) UCD; California, Pasadena, 14 Jan. 1933, coll. L.E. Myers, 1(2) CLA; California, San Gabriel, 31 Jul. 1936, coll. L.E. Myers, "giant bamboo", 1(1) UCD; California, San Leandro, 15 Nov. 1932, coll. Whitney, 1(4) VPI; Florida, Brooksville, 7 Jul. 1971, coll. R. Beshear, 1(1) UGES; Florida, Gainesville, 26 Apr. 1946, coll. G.B. Merrill, 1(1) UCD; Florida, Hillsb. Co., Tampa, 18 Mar. 1979, coll. W.F. Gimpel, 1(1) MDA; Florida, Mountain Lake, 13 Jun. 1920, coll. C.M. Hunt, 1(2) UCD; Florida, St. Augustine, 9 Sep. 1951, coll. F.D. Bennett, 1(5) USNM; Georgia, Camden Co., Cumberland Island, 1 Sep. 1970, coll. R. Beshear, 1(1) UGES; Georgia, Camden Co., Cumberland Island, 20 Mar. 1971, coll. R. Beshear, 1(1) UGES; Georgia, Camden Co., 20 Mar. 1972, coll. R. Beshear, 1(1) UGES; Georgia, Camden Co., 24 Sep. 1980, coll. R. Beshear, 1(1) UGES; Georgia, Chatham Co., 2 May 1968, coll. H.H. Tippins, 1(1) UGES; Georgia, Glynn Co., 12 Oct. 1973, coll. H.H. Tippins, 1(1) UGES; Georgia, Lowndes Co., 20 Oct. 1971, coll. H.H. Tippins, 1(1) UGES; Georgia, Savannah, 21 Jun. 1945, coll. Rau, 1(3) USNM; Louisiana, Baton Rouge, 6 May 1945, coll. Rau, 1(3) USNM. **Undetermined Host: CHINA**, Foochow {= Fuzhou}, date not given, coll. M.S. Yang, 2(6) BM.

Antonina purpurea Signoret
Plate 16

Antonia purpurea Signoret, 1872: 35-36.

Antonina purpurea Signoret, 1875: 323-325; Lichtenstein, 1879: 45-46; Parrott, 1900: 138-139; Lindinger, 1912: 60; Green, 1934: 509-510; Goux, 1935: 94: Borchsenius, 1949a: 312-313; Gomez-Menor Ortega, 1954: 138-141; Afifi & Kosztarab, 1967: 24-26; Yang & Kosztarab, 1967: 33-35; Kosztarab & Kozár, 1978: 31; Kosztarab & Kozár, 1988: 67. **LECTOTYPE**, adult female, FRANCE, Cannes, on *Agropyron* (NHMV), examined and here designated.

Laboulbenia brachypodii Lichtenstein, 1877: 299-300, 302; Ben-Dov & Matile-Ferrero, 1989: 168-169. [synonymized by Lichtenstein 1879: 45-46; see Remarks]

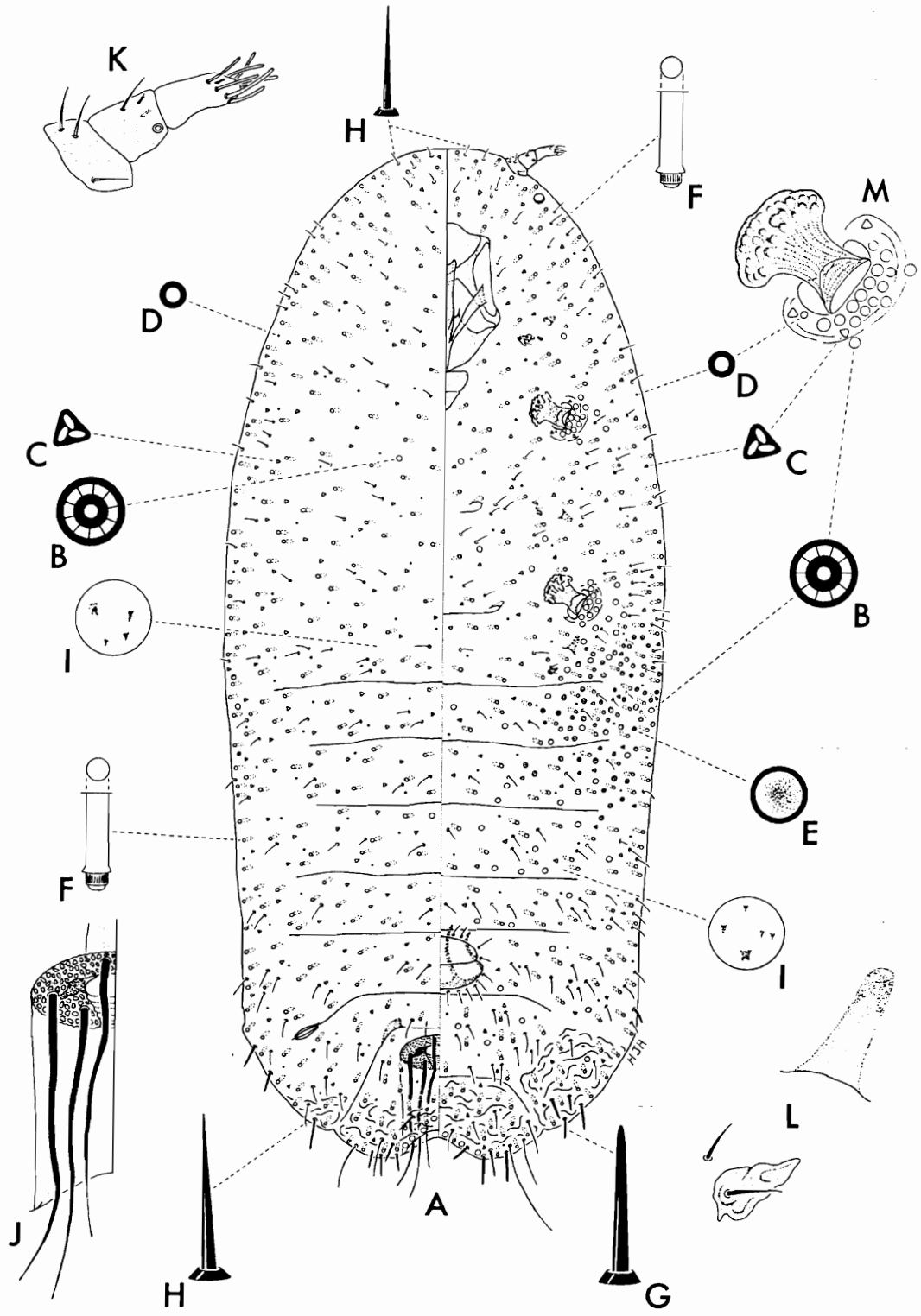

Plate 16. ***Antonina purpurea*** **Signoret, Adult Female.**

Antonina brachypodii (Lichtenstein) Cockerell, 1896a: 324.

GENERAL DESCRIPTION

Body of Adult Female. Specimens preserved in alcohol ovate to obovate, posterior end slightly tapered, flattened ventrally, convex dorsally, deep purple-red to brown, enclosed in mass of waxy threads with posterior end exposed, located at base of culm with cephalic end toward base. Signoret (1875) described the body "as a mass, of an elongated cylindrical form, blackish, which, crushed, tints the fingers with dark red" (translation in Parrott, 1900).

On microscope slide (fig. A): 2279μm (1163-3624) long, 1170μm (544-2069) wide; body outline as above, posterior abdominal segments sclerotized; in young individuals constriction between abdominal segments VII-VIII slightly evident, abdominal segmentation well-defined, caudal end somewhat concave but anal lobes absent.

Dorsal Surface

Multilocular Pores (fig. B). 7.32μm (6.65-8.55) in diameter, with 10 locules; located around anal tube orifice and along margin of abdominal segment VIII, few occasionally found elsewhere on thorax and abdomen.

Trilocular Pores (fig. C). 5.05μm (4.75-6.65) in diameter, rim triangular to circular; distributed over entire surface with few to none found on abdominal segment VIII.

Simple Disc Pores (fig. D). 2.98μm (1.90-4.75) in diameter, with circular rim, distributed over entire surface.

Disc-like Pores (fig. E, venter). Few occasionally found along extreme margin of metathorax and abdominal segments II-III; 5.21μm (2.85-8.55) in diameter, locule granular and concave.

Cylindrical Ducts (fig. F). Long and slender, 3.40μm (2.85-4.75) in diameter, 12.4μm (9.50-16.2) long, with small flange near end of duct; distributed over entire surface.

Setae. Of two types. Conical (fig. G, venter): 15.2-53.2μm long, slender; located on margin of abdominal segments VI-VIII. Flagellate (fig. H): 9.50-116μm long, those with greatest lengths on posterior abdominal segments; distributed over dorsum.

Spicules (fig. I). Minute, 0.95-3.80 long, solitary or in groups of two or more; distributed on medio-submedial region of metathorax, medio-submarginal region of abdominal segments II-V, medio-submedial region of abdominal segment VI, and medial as well as marginal region of segments VII-VIII.

Dorsal Ostioles. Posterior pair usually present, but poorly developed.

Anal Ring (fig. J). 98.2μm (81.2-109) in diameter; at base of invaginated tube, tube 135μm (104-169) long, orifice at end of segment; anal ring pores numerous, 2.49μm (1.90-2.85) in diameter, distributed over entire ring except for medial section on the ventral side where the ring is separated; with six anal ring setae 160-241μm long, tips of setae knobbed, setae extend beyond length of anal tube.

Other Structures. Sclerotized apodemes located submedially between abdominal segments VII-VIII, apodemes vague in older individuals.

Ventral Surface

Eyes. Base diameter 15.1μm (11.6-18.6).

Antennae (fig. K). Typically 3-segmented, occasionally with 2 or 4 segments, 59.5μm (41.8-77.0) long, diameter at base 44.2μm (37.1-66.5).

Clypeolabral Shield. Approximately 1.2X longer than broad, 215μm (176-284) long, 181μm (162-199) wide.

Labium. Approximately 1.2X broader than long, 77.4μm (65.0-104) long, 96.5μm (78.9-130) wide at base, two-segmented.

Legs (fig. L). Greatly reduced, represented by remnants of pleural vestiges and grouping of 1-7 flagellate setae, at times with claw; with an apophysis located laterad of each leg, apophyses associated with prothoracic legs often vague; remnants of some legs lacking at times.

Spiracles (fig. M). Anterior: spiracular arm 72.4μm (51.0-92.8) long, sometimes as broad as long; atrium 46.8μm (34.8-58.0) wide; 6-44 multilocular pores form a crescentic band around atrium, band may also contain 1-17 trilocular pores and 1-6 simple disc pores. Posterior: similar to anterior pair, but slightly larger; arm 82.9μm (62.6-104) long; atrium 52.9μm (41.8-65.0) wide; band with 7-50 multilocular pores, presence and number of other pores same as before.

Multilocular Pores (fig. B). Structure as that on dorsum, 7.10μm (5.70-7.60) in diameter; sparsely distributed on entire thorax, predominantly around spiracles; more found on entire surface of abdominal segments II-VII and along margin of segment VIII, sometimes concentrated along latero-posterior margin of segments VI-VII.

Trilocular Pores (fig. C). Structure and distribution as those on dorsum, 5.14μm (3.80-6.65) in diameter.

Simple Disc Pores (fig. D). Structure and distribution as those on dorsum, 3.18μm (1.90-4.75) in diameter.

Disc-like Pores (fig. E). Structure as that on dorsum, 5.36μm (3.80-9.50) in diameter; located on submargino-marginal region of abdominal segments II-III and metathorax posterior to spiracles, distribution may extend to anterior half of segment IV.

Cylindrical Ducts (fig. F). Structure and distribution as those on dorsum, 3.30μm (2.85-3.80) in diameter, 12.9μm (9.50-16.2) long.

Setae. Structures and distributions as those on dorsum. Conical (fig. G): 14.3-51.3μm long. Flagellate (fig. H): 9.50-119μm long; apical seta distinct, 143-151μm long.

Spicules (fig. I). Structure as that on dorsum, 1.85μm (0.95-2.85) long, usually in groups of two or more; located on medio-submedial region of mesothorax and metathorax, medio-submarginal region of abdominal segments II-IV, and submedio-submarginal region of segment V; sometimes found on medial region of segment V and submedial region of segment VI.

Vulva. Distinct, smooth or wrinkled, with opening directed ventrally toward surface, encircled by flagellate setae; apparently located on abdominal segment VI; with 4 long apophyses.

Other Structures. Mesothoracic apophyses usually evident; metathoracic apophyses occasionally evident.

Type Material Examined. Lectotype on *Agropyron* sp., FRANCE, Cannes, date unknown, collector unknown, 1(1) NHMV (slide labeled "*Antonina purpurea* Sign., 'auf *Agropyrum*', France, (Cannes), det. Signoret, from type material, ex coll. Wien Mus.") [examined, here designated]. Paralectotype data same as lectotype, 2(2) NHMV (slide label same as lectotype).

Other Material Examined. ***Agropyron intermedium*: ITALY**, site unknown and date unknown, coll. Otto Jaap, BM 1940/180, 1(4) BM, 2(3) VPI; Pegli, 18 Jan. 1913, coll. O. Jaap, coll. no. 134, 1(2) USNM, 1(2) VPI. ***Agropyron* sp.: FRANCE**, Alpes-Maritimes, Cap d'-Antibes, 5 Oct. 1929, coll. A. Balachowsky, no. 4733, 2(2) MNHNE; Alpes-Maritimes, Gourdon, 750m, 5 Oct. 1950, coll. A. Balachowsky, 2(3) VPI; Gourdon (A.M.), 5 Oct. 1930, coll. A. Balachowsky, 29/30 no. 10, 1(1) BM; Gourdon (A.M.), 700m, 5 Oct. 1930, coll. A. Balachowsky, no. 4734, 2(2) MNHNE; **YUGOSLAVIA**, Portoroz, 25 Jun. 1981, coll. F. Kozár, no. 1555, 1(1) VPI. ***Brachypodium phoenicoides*: FRANCE**, Alpes-Maritimes, Valbonne, 22 Jul. 1966, coll. C. Louis, 2(3) VPI; "St. Martin de L.", 25 Aug. 1966, coll. C. Louis, 1(1) VPI. ***Brachypodium***

***ramosum*: FRANCE**, Bouches-du-Rhône, no other locality data, Aug. 1913, coll. P. Marchal, 1(2) BM, 1(2) VPI; Bouches-du-Rhône, no other collection data, coll. P. Marchal, 1(2) BM; **SPAIN**, Santa Pola, 6 Jun. 1978, coll. D. Matile, no. 7389-1, 1(1) HAS. ***Brachypodium* sp.: FRANCE**, Bouches-du-Rhône, no other locality data, 31 May 1914, coll. P. Vaysiére, 1(2) VPI; Serres, coll. Canard, May 1961, 1(1) VPI; Serres, coll. Canard, May 1963, 1(4) VPI. ***Bromus inermis*: FRANCE**, Vence, 25 Oct. 1980, coll. F. Kozár & C. Benassy, no. 1385, 1(2) VPI. ***Phyllostachys aurea*: FRANCE**, Antibes, 18 Oct. 1980, coll. F. Kozár, no. 1350, 1(2) VPI. **Undetermined Grass: FRANCE**, Alpes-Maritimes, Juan-les-Pins, Jan. 1931, coll. A. Balachowsky, 1(1) VPI; Antibes, 12 Oct. 1980, coll. F. Kozár, no. 1326, 1(2) VPI; Bouches-du-Rhône, "Aix-en-Rhône", 8 Apr. 1954, coll. H. L. Parker, no. 54-0982-A, 1(1) USNM; Bouches-du-Rhône, Carry-le-Rouet, 1918, coll. P. Vaysiére, no. 4732, 1(1) MNHNE; Bouches-du-Rhône, Le Cannet, "Garrique grass", 25 Mar. 1952, coll. H. L. Parker, no. 52-463, 1(2) USNM; Bouches-du-Rhône, Le Cannet, Mar. 1955, coll. H. L. Parker, Parker Coll. 5415, 1(6) USNM; Gard, Nimes, 28 Feb. 1955, coll. H. L. Parker, no. 5568, 4(10) USNM; Remoulins, Jul. 1954, coll. H. L. Parker, no. 5499, 1(3) USNM; Valbonne, 15 Oct. 1980, coll. F. Kozár, no. 1336, 2(4) VPI; Valbonne, 21 Oct. 1980, coll. F. Kozár, no. 1361, 1(1) VPI. **Undetermined Host: FRANCE**, Aix-en-Provence, 8 Jul. 1954, coll. H. L. Parker, no. 5511-6, 1(4) USNM; Gard, Remoulins, May-Jun. 1954, coll. H. L. Parker, no. 54-940, 1(4) USNM; Gard, Remoulins, Jul. 1954, coll. H. L. Parker, no. 5516, 2(6) USNM; Carry-le-Rouet, Jul. 1936, coll. P. Vaysiére, no. 10724, 1(1) MNHNE.

Remarks. Although the title of Green's 1934 paper alluded to a discussion on the type of *A. purpurea*, this work was no more than a redescription. He did, however, prepare slide-mounts of three females from Signoret's dry type material. Through the courtesy of the Vienna Museum, these three specimens were available for examination, one of which was selected and here designated lectotype.

Until now, the relationship between *Laboulbenia brachypodii* Lichtenstein and *A. purpurea* was unclear. Lichtenstein (1877) erected *Laboulbenia* for a species collected on *Brachypodium pinnatum* in southern France and named this species *L. brachypodii*. Most of Lichtenstein's "description" (pp. 209-300) was a discussion on the development and behavior of males and immature stages. In a postscript (p. 302), Lichtenstein indicated that his *L. brachypodii* may be *A. purpurea*, and he would "*réserve la création*" of *Laboulbenia* until after consultation with Signoret. Many workers, including Parrott (1900), Morrison and Morrison (1966), Borchsenius (1949a), and Kosztarab & Kozár

(1988), accepted *L. brachypodii* as a synonym of *A. purpurea* based solely on Lichtenstein's postscript. Without discussion, Cockerell (1896a) transferred this species to the genus *Antonina.*

Ben-Dov and Matile-Ferrero (1989) examined Lichtenstein's scale insect collection and his original collection book and found no specimens or records of *L. brachypodii.* However, they found specimens of *A. purpurea* labeled in Lichtenstein's handwriting in the collection and entries for this species in the register. Simplistic in its significance, yet understandably overlooked by previous coccid workers is a subsequent paper by Lichtenstein (1879). In this paper (p. 45), Lichtenstein repeats his discussion on the behavior and development of the insect in question under the name *A. purpurea*; therefore, he had himself determined that the two species were conspecific.

Although disc-like pores were occasionally found on the dorso-lateral margins of the body, their presence here was probably the result of mounting. The illustration of a disc-like pore (fig.) shows a heavy sclerotized, circular rim; however, the rim of this pore is not always as distinct as that presented. As indicated above, the locule of the disc-like pore is concave. The curvature of the locule is usually shallow, but in some instances it was observed reaching a depth subequal to the width of the pore.

Antonina purpurea occurs at the base of the roots or within the culm of its hosts in the Mediterranean Region. In addition to the above hosts, it has been collected on *Milium* (Signoret 1875) and *Brachypodium pinnatum* (Lichtenstein 1877). The collection of this species on *Phyllostachys aurea* by Kozár (material examined) is most peculiar because *A. purpurea* typically does not infest bamboo. The examined specimens from this cultivated bamboo were unquestionably *A. purpurea*, but there were fewer disc-like pores than that usually found on specimens from grasses. Additional intraspecific variation was observed. Some specimens, such as the last one listed under "Other Material Examined" lacked ostioles and had few multilocular pores on the body. Others, such as the those observed from *Agropyron intermedium*, were densely covered with multilocular pores.

Diagnosis. This species most resembles *Antonina crawi* Cockerell in body form and with the presence of reduced posterior dorsal ostioles. *Antonina purpurea* can easily be separated from *A. crawi* and most other species by the presence of multilocular pores at the spiracular opening and the absence of disc-like pores on abdominal segments IV-VI. This species can be separated from *Antonina natalensis* Brain, which also possesses

many multilocular pores at the atria, by the presence of ostioles and the absence of disc-like pores on abdominal segments IV-VI.

Antonina tesquorum Danzig

Antonina tesquorum Danzig, 1971: 390-391; 1972: 337; 1974: 69; 1980: 200; 1984: 33; 1986: 234-235.

This species is found within dirty-white ovisacs on roots of grasses near the base (Danzig 1971) in the far eastern section of the Palearctic Region. *Antonina tesquorum* has been reported from Chernyatino and Pokrovka within Razdol'na River Valley, Southern Primorye, (Danzig 1971); Delger-Khagai-Uli City, Central-Gobi Aimak, and Vostochnyi, Mongolia (Danzig 1971, 1974); and the locations listed below. It has also been taken from *Cleistogenes sinensis* (Danzig 1971, 1980, 1986), *Leymus chinensis* (Danzig 1974), and *Stipa grandis* (Danzig 1984).

Adult females are cherry red (Danzig 1986), oval to broadly oval, flattened ventrally, convex dorsally, sometimes strongly arched, abdominal segmentation vague laterally, anterior end rounded, posterior end truncate to slightly concave, margin of posterior segments heavily sclerotized. To Danzig's (1971) description and illustration should be added the following emendations: body of mounted females as described above, 1800-2700μm long; abdominal segmentation vague, lateral constrictions between abdominal segments vague.

Dorsal surface with few multilocular pores around anal tube orifice, pore with 10 locules; trilocular and simple disc pores numerous, distributed over entire dorsum, fewer trilocular pores found on posterior abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, those in sclerotized region at end of abdomen concentrated somewhat into a transverse band as seen in *Antonina graminis*, sclerotization around ducts gives impression of a collar between orifice and flange. Conical setae few, located on margin of posterior abdominal segments; flagellate setae numerous, located over entire dorsum, those on posterior abdominal segments longer than those elsewhere.

Posterior dorsal ostioles absent; pair of submedial apodemes vaguely present between segments VII-VIII. Anal ring at end of invaginated tube, tube length subequal

to ring diameter; anal ring pores numerous, six anal ring setae extend just beyond tube opening, tips of setae with small knob.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; located on medio-submarginal region of thorax and abdomen, those on thorax found primarily in area surrounding spiracles, few occasionally found at margin of head near antennae and eyes. Structures and distributions of trilocular pores, simple disc pores, cylindrical ducts, conical setae, and flagellate setae same as those on dorsum; apical setae not evident among long flagellate setae. Many disc-like pores of various sizes form submedio-submarginal band from metathorax to abdominal segment III; inner section of band sometimes medial, but bands never contiguous.

Antennae 1-2 segmented; eyes present but reduced. Legs present but greatly reduced, stub-like with podal apophyses; mesosternal apophyses evident, prothoracic sternal apophyses vague. Spiracles heavily sclerotized, with numerous trilocular pores grouped at atrium. Vulva distinct, oval, directed ventrally, apparently located between abdominal segment VI-VII, with lateral and caudal pairs of apophyses.

Danzig (1971) described two sizes of trilocular pores and cylindrical ducts. In the specimens available, only one size of both structures were discernible. The trilocular pores had some variation in diameter, but this was the case with all species. Intraspecifically, the cylindrical ducts of *Antonina* are of one size, but those found in heavily sclerotized regions appear to be much larger and with a collar. The diameter of the inner bore is the same.

Antonina graminis most resembles this species in general appearance and structural distribution. *Antonina tesquorum* can be distinguished from this similar species by having stub-like legs present, few conical setae limited to the margin of the posterior abdominal segments, and no disc-like pores posterior to abdominal segment III.

Type Material Examined. Paratypes on *Cleistogenes squarrosa*, **RUSSIA**, Irkutsk Region, Elantsy, 4 Aug. 1970, coll. E. Danzig, 1(2) USNM.

Other Material Examined. ***Cleistogenes squarrosa*: MONGOLIA**, Suche-Batoz Aimak, Tumentsogt, 28 Aug. 1982, coll. not given, 5(5) VPI.

Antonina thaiensis Takahashi

Antonina thaiensis Takahashi, 1942: 14-15; 1951: 21; Ali, 1970: 101.

This little known species is known only from bamboo in southeast Asia, where it is presumably found under the leaf sheaths of its host. According to Takahashi (1942), the live adult female is brownish black when heavily sclerotized and covered with wax. There is no adequate illustration for *Antonina thaiensis*. One may want to use the drawing of *Antonina crawi* Cockerell by Ferris (1953) as a template with the following description of slide-mounted specimens.

Body of adult female elliptical to broadly ovate, 1400-6600μm long; posterior abdominal segmentation somewhat distinct, lateral constriction between segments VII-VIII somewhat distinct, caudal end truncate to slightly concave, anal lobes undeveloped; margins of posterior abdominal segments sclerotized.

Dorsal surface with numerous glandular structures; few multilocular pores with 9-10 locules present, distributed along margin of head and first two thoracic segments, and entire surface of remaining segments; trilocular pores of one size distributed over entire surface of head, thorax and abdominal segments II-IV, and on medio-submarginal region of segment V; simple disc pores located over entire dorsum; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, predominantly along margin, also forming band at anal tube orifice. Few conical setae present, stout, located on margin of abdominal segments V-VIII, one seta per segment, sometimes on margin of additional abdominal segments; flagellate setae located over entire dorsum with greatest lengths found on posterior abdominal segments.

Posterior dorsal ostioles absent, reduced; dorsum with distinct submedial apodemes between segments VII-VIII. Anal ring at end of invaginated tube, tube approximately 2X as long as ring diameter, numerous cylindrical ducts form band just inside tube orifice, band at times with multilocular pores; anal ring pores numerous; six anal ring setae, setae sword-shaped and approximately one-half as long as tube.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; found on margin of head and entire surface of thorax and abdomen, those on thorax primarily around spiracles. Trilocular pores of two sizes, larger size similar to those on dorsum, diameter of larger size approximately 1.5X smaller type; larger size distributed over entire surface, clustered around labium; smaller type forms band at spiracular opening only. Structure and distribution of simple disc pores, cylindrical ducts, conical setae, and flagellate setae as that on dorsum; apical setae lacking. Disc-like pores of various sizes form submarginal band on metathorax posterior to spiracles and abdominal segments II-III; also grouped submarginally between

spiracular pairs in area where mesothoracic legs are typically found, both bands on margin at times, groupings occasionally small and difficult to locate in older individuals.

Antennae 1-2 segmented; eyes and legs completely absent. Spiracles heavily sclerotized, with small trilocular pores grouped at atria in a crescentic band. Vulva distinct, oval, directed ventrally, apparently located between abdominal segments V-VI, with lateral and caudal pairs of long apophyses.

This species may be confused with *Antonina crawi* which has a similar general outline. *Antonina thaiensis* is distinguishable from this and other species by the presence of disc-like pores on mesothorax in area where legs are usually found, an anal tube approximately two-fold the ring diameter, anal ring setae one-half the length of the anal tube, band of cylindrical ducts around the anal tube orifice, and the absence of posterior dorsal ostioles.

Type Material Examined. Species described from bamboo, Bangkok, Thailand, 27 Mar. 1940. The type material for this species is possibly lost or destroyed. None of the type series is present in FAHU or TUA, the repositories which currently house Takahashi's scale insect collections.

Other Material Examined. ***Bambusa vulgaris*: THAILAND**, Bangkhen, Bangkok, 23 Jul. 1971, coll. Prasertphon, 15(24) VPI; Dhonburi, Bangkoknoi, 16 Sep. 1971, coll. Chanchai, 2(2) VPI; no other locality, 12 Oct. 1960, coll. A. Manjikal, 2(2) BM. ***Phragmites* sp.: MALAYSIA**, Kuala Lumpur, 20 Mar. 1943, coll. R. Takahashi, 1(4) BM. **Undetermined Bamboo: MALAYSIA**, Kuala Lumpur, 23 Jul. 1944, coll. R Takahashi, 1(5) BM; Kuala Lumpur, Lake Gardens, 11 Feb. 1985, coll. J.H. Martin, 2(2) BM.

Antonina transcaucasica (Borchsenius), comb. n.

Chaetococcus transcaucasicus Borchsenius, 1949a: 318-319; 1949b: 139; 1950: 115; Ter-Grigoryan, 1966: 91; 1973: 229-230.

The observation of material is preferable for any taxonomic change; nonetheless, the descriptions of this species suggest it is a member of *Antonina*. Borchsenius (1949a) discussed the absence of duct-like pores in this species, but the presence of irregular pores (= disc-like pores) posterior to the metathoracic spiracle. The cylindrical ducts described were not similar to other *Chaetococcus* species reported on, but were to those

provided for *Antonina crawi* Cockerell which was also included. The disc-like pores were also of similar size to those in *A. crawi*.

The primary character which separated *Antonina* and *Chaetococcus* species in Borchsenius' work was the presence and length of the anal tube. According to Borchsenius, in *Chaetococcus* species the anal tube ring was flush with the derm or in a short tube. Another character used in his generic key to diagnose *Antonina* was the absence of disc-like pores behind the metathoracic spiracle, yet these were present in both species included, *A. crawi* and *A. purpurea* Signoret.

Antonina transcaucasica was described from material collected 7 August 1932, on *Agropyron* grass in Nahichevanskaja ASSR, Azerbaidzhan. It has also been reported from Armenia (Ter-Grigoryan 1966, 1973). Borchsenius (1949a) and Ter-Grigoryan (1973) describe adult females as also having 3-segmented antennae, leg remnants with claw, and an anal ring slightly recessed or at the end of a very short tube.

The illustration of Ter-Grigoryan (1973) is the only complete illustration to date, but is not satisfactory enough to distinguish it from other *Antonina* species. In this illustration, the disc-like pores are located in the medio-submedial region of metathorax, but the two groupings are not contiguous. Multilocular pores are drawn along the dorsal margin and over entire venter, and their enlargement depicts 10 locules. Trilocular pores, cylindrical ducts, and setae are distributed over the entire body. The description and distribution of structures would suggest that this species resembles *Antonina tesquorum* Danzig.

Antonina transvaalensis Brain

Antonina transvaalensis Brain, 1915: 87-88; DeLotto, 1958: 82; Yang & Kosztarab, 1967: 38-40.

DeLotto (1958) designated this species as synonym of *Antonina natalensis* Brain, but I am in agreement with Yang & Kosztarab (1967) that these two species are structurally different. Nonetheless, *A. transvaalensis* and other *Antonina* species may be conspecific with *Antonina graminis* (Maskell). Detailed studies of all developmental stages will be needed to clarify the relationships of these three species.

No adequate illustrations of this species exist; therefore, that of *A. graminis* (Ferris 1953) may be used in conjunction with the following description of slide-mounted

specimens. Body of adult female broadly oval to circular, 1900-2700μm long; segmentation poorly defined; caudal end heavily sclerotized, rounded or often concave.

Dorsal surface with few multilocular pores found outside anal tube orifice only, pores with 10 locules; trilocular and simple disc pores numerous, distributed over entire dorsum with fewer on posterior abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, those in sclerotized region at end of abdomen concentrated into transverse band, sclerotization around duct gives impression of a collar between orifice and flange. Conical and flagellate setae present, conical setae distributed over entire surface of abdominal segments IV-VIII, flagellate ones located on entire surface of head, thorax, and segments II-III..

Posterior dorsal ostioles absent; pair of submedial apodemes present between segments VII-VIII. Anal ring at end of invaginated tube, tube length subequal to ring diameter, numerous multilocular surround tube orifice, trilocular pores occasionally present in group; anal ring pores numerous; six, thick anal ring setae extend to tube orifice.

Ventral surface also with many pores and ducts. Multilocular pores structurally as those on dorsum; located on medio-submarginal region of two posterior thoracic segments and abdominal segments II-VI, also found in a ventro-marginal group on segment VIII, just anterior to anal tube orifice. Structures and distributions of trilocular pores simple disc pores, and cylindrical ducts same as those on dorsum. Conical setae structurally similar to those on dorsum, but located only on marginal region of segments VI-VIII. Flagellate setae structurally similar to those on dorsum, distributed over entire venter; apical setae distinctly present. Few disc-like pores of various sizes form submedial band on abdominal segments III-V.

Antennae 1-2 segmented; eyes represented by invaginated pits. Legs absent, but metapodal apophyses present; mesosternal apophyses vaguely evident. Spiracles heavily sclerotized with narrow arm, numerous trilocular pores form crescentic band at atrium. Vulva distinct, oval, directed ventrally, apparently located between abdominal segment V-VI, with lateral and caudal pairs of apophyses.

Antonina transvaalensis greatly resembles *A. graminis*, but can be distinguished from this similar species by having many multilocular pores present on medial region of thorax, conical setae limited to posterior abdominal segments, small band of few disc-like pores on segments III-V only, and without complete medial band of multilocular pores extending from vulva to anal tube orifice. *Antonina natalensis* also has a short

band of disc-like pores and conical setae restricted to posterior abdominal segments, but this species has inflated vulvar apophyses, multilocular pores surrounding the spiracular opening, multilocular pores on the ventral thoracic margin, and also lacks multilocular pores on the medial region of the thorax.

Type Material Examined. Syntype females on grass, **SOUTH AFRICA**, Pretoria, Daspoort, coll. C.K. Brain, 11 Oct. 1914, no. 70, 2(4) USNM. [One slide with incorrect date of "11 Oct. 1939" on label; see DeLotto, 1958]

Antonina vera Borchsenius

Antonina vera Borchsenius, 1956: 675-676; Danzig, 1974: 70.

This species is found on stems of grass in northeastern Palearctic Region. In addition to the material examined, *Antonina vera* has been taken from *Cleistogenes* sp. at Vostochnyi and Vostochno-Gobi, Mongolia (Danzig 1974). Alcohol-preserved specimens are oval, slightly convex dorso-ventrally, and yellow-brown. No complete illustration exists for this species, so those drawn for *Antonina graminis* (Maskell) by Ferris (*in* Zimmerman 1948, Ferris 1953) can be used as a template. On microscope slide, adult female body broadly oval, 1100-1500μm long; segmentation poorly defined, posterior abdominal segments sclerotized, caudal end rounded.

Dorsal surface with numerous wax glands and setae. Multilocular pores of 2 designs; larger size with 9 locules found on margin of thorax and abdominal segments II-VI; smaller size with 10 locules located on margin of head, thorax, and abdominal segments II-VI, few also found near anal tube orifice. Trilocular and simple disc pores distributed over entire surface; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum, those in sclerotized region at end of abdomen concentrated somewhat into transverse band, sclerotization around duct gives impression of collar between orifice and flange. Few conical setae found on margin of last four abdominal segments, 1-2 per segment; flagellate setae distributed over entire dorsum, longest ones found on posterior abdominal segments.

Posterior dorsal ostioles absent; submedial apodemes lacking. Anal ring at end of invaginated tube, tube length subequal to ring diameter, few multilocular pores surround tube orifice; anal ring pores numerous; six anal ring setae extend beyond tube orifice, setal tips knobbed.

Ventral surface also with many dermal ultrastructures. Multilocular pores structurally as those on dorsum; larger size with similar distribution as that on dorsum; smaller size found on margin of head, submedio-marginal region of thorax, and entire surface of abdomen; these on venter located predominantly along margin and around spiracles. Structures and distributions of trilocular pores, simple disc pores, cylindrical ducts, conical setae, and flagellate setae same as those on dorsum; apical setae distinctly present. Disc-like pores lacking.

Antennae 2-segmented; eyes present. Legs stub-like, with podal apophyses; mesosternal apophyses evident. Spiracles heavily sclerotized with narrow arm, numerous trilocular pores form crescentic band at atrium. Vulva simple and indistinct, directed ventrally, apparently located between abdominal segments VI-VII, with vague lateral pair of apophyses.

Antonina vera is easily distinguished from other *Antonina* species by possessing two types of multilocular pores along the body margin and by lacking disc-like pores on the venter. Although this species lacks the characteristic disc-like pores, it does possess cylindrical ducts representative of *Antonina*.

Type Material Examined. Subsequent slides from type material, females on stem of grass, **KOREA**, North Province, Phen'yan, coll. N. Borchsenius, 11 Jul. 1950, 1(1) VPI, 1(2) ZIL.

Antonina zonata Green

Antonina zonata Green, 1919: 175-176; Morrison, 1920: 177; Green, 1922: 399-400; 1937: 295; Takahashi, 1951: 21; Afifi & Kosztarab, 1967: 26-29; Yang & Kosztarab, 1967: 40-43, 59-61; Ali, 1967: 32; 1970: 101; Wang, 1982: 127.
Chaetococcus zonatus (Green) Tang, 1992: 29-30.

Antonina zonata is found clustered at the axils (Green 1919) of various bamboo in the Oriental Region. In addition to the locations listed below, this species has been taken from *Bambusa* sp. at Bulacan Province, Baliuag, Philippines (Morrison 1920), and at Muzaffarpur, India (Ali 1967). It is uncertain whether the examined material from *Bambusa* at the Philippines is the same from which Morrison (1920) made his report. This material was poorly mounted and is questionably *A. zonata*.

According to Green (1919), live adult females are pyriform, strongly convex, olive green with dark brown blotches dorsally, completely brown in older specimens, and rest

in a mat of white wax. As with most *Antonina* species, no adequate illustration of this species exists and those of other species must serve as a reference. For this species, one may want to use those of *Antonina graminis* (Maskell) by Ferris (*in* Zimmerman 1948, Ferris 1953). A description of slide-mounted adult females is as follows: body pyriform to circular, 1300-3700μm long; abdominal segmentation poorly defined except dorsally between abdominal segments VII-VIII, lateral constriction between segments VII-VIII vague when present, segment VIII sclerotized dorsally, caudal end rounded.

Dorsal surface with few multilocular pores surrounding anal tube orifice, pores with 10 locules; trilocular and simple disc pores numerous, distributed over entire dorsum with fewer on posterior abdominal segments; cylindrical ducts long and slender with flange near tip, distributed over entire dorsum except segment VIII. Conical setae few, limited to last 4-5 abdominal segments, each of these segments with 1-2 setae along margin; flagellate setae numerous, distributed over entire dorsum, those located on posterior segments longer than those on rest of dorsum.

Posterior dorsal ostioles absent; pair of submedial apodemes between segments VII-VIII present, vague at times. Anal ring at end of invaginated tube, tube length approximately 1.5X ring diameter, with multilocular pores at orifice; anal ring pores numerous; six anal ring setae extend beyond end of tube, setal tips slightly knobbed.

Ventral surface also with many glands and setae. Multilocular pores structurally as those on dorsum; absent from venter anterior to metathoracic spiracles, located on submedian of abdominal segments II-III and metathorax posterior to spiracle, and on medio-submedial region of segments IV-VIII, occasionally present on median of metathorax and segments II-III. Structure and distribution of trilocular and simple disc pores same as those on dorsum. Structure and distribution of cylindrical ducts same as those on dorsum, but also found on segment VIII. Structure and distribution of setae as those on dorsum; apical setae present.

Disc-like pores of various sizes located in small group just posterior to metathoracic spiracle, group about same size as spiracle and often recessed. Yang & Kosztarab (1967) described second instar females as having sieve-like (disc-like) pores; yet, these pores were not seen in third instars made available for this study. The 2 specimens observed by Yang & Kosztarab (1967) may have been teneral adult females, which are much smaller than mature females; however, to verify this possible oversight will require the examination of these 2 specimens.

Antennae reduced to 1-2 segments; eyes absent. Legs absent but podal apophyses present; mesosternal and metasternal apophyses evident in young individuals. Spiracles heavily sclerotized with broad arm, trilocular pores form crescentic band at atrium. Vulva distinct, oval, directed ventrally, located between segments VII-VIII, with lateral pair of apophyses.

Antonina zonata is distinguished from other species by the following combination of characters: multilocular pores lacking on thoracic venter; vulva positioned between segments VII-VIII; and disc-like pores present in small group posterior to metathoracic spiracle.

Green (1919) described *Antonina zonata* from specimens collected on *Teinostachyum attenuatum* at Pundaluoya, Ceylon (= Sri Lanka). This type host species was reported again by Green (1922). Two slides housed in the BM have "Type" and "Cotype" labels; however, their collection labels, written in Green's handwriting, have *Arundinaria* sp. indicated as the host. The host provided is possibly the result of a pen slip. The status of this material as syntype material remains uncertain at this time.

Material Examined. ***Arundinaria* sp.: SRI LANKA**, as "Ceylon", Pundaluoya, date not given, coll. not given, 2(9) BM. ***Bambusa blumeana*: PHILIPPINES**, Manila, 20 May 1916, coll. B. Arce, no. 2598, 2(5) USNM. ***Indocalamus nanunicus*: CHINA**, at {Washington} D.C., 30 Jan. 1941, coll. Gouldman, EQ 074558, 1(1) USNM. ***Semiarundinaria venusta*: CHINA**, Canton {= Guangzhou}, at {Washington} D.C., 30 Jan. 1941, coll. W.B. Wood, EQ 074567, 1(1) USNM. ***Teinostachyum attenuatum*: SRI LANKA**, as "Ceylon", Pundaluoya, date not given, coll. E.E. Green, 1(1) UCD; as "Ceylon", Pundaluoya, 30 Dec. 1922, coll. E.E. Green, 1(1) BM. **Undetermined Bamboo: CHINA**, Canton {= Guangzhou}, Lingnan University, 26 Oct. 1948, coll. G.F. Ferris, no. 25, 10(15) VPI; Canton {= Guangzhou}, Lingnan University, 7 Nov. 1948, coll. G.F. Ferris, no. 47, 12(13) VPI; **INDIA**, Coimbatore, 15 Feb. 1932, coll. E.E. Green, 5(8) VPI; Pusa, date not given, coll. not given, BM 1963 3, 1(1) BM; **MALAYSIA**, Selangor, Ulu Gombak, 18 Jul. 1944, coll. R. Takahashi, 1(7) BM; **PHILIPPINES**, Manila, date not given, coll. G. Compere, 1(1) USNM. **Undetermined Host:** Hwangyen(?), 9 Jan. 1936, coll. not given, no. 188, 1(1) USNM.

Antoninoides Ferris

Type species: *Antonina parrotti* Cockerell, by monotypy and original designation.

Ferris, 1953: 300; Morrison & Morrison, 1966: 12; Williams & Granara de Willink, 1992: 58-60.

In his original description of *Antonina graminis* (= *Antonina parrotti*), Parrott (1900) discussed similarities with *Antonina nortoni* Parrott & Cockerell, but considered establishing a separate genus for the single species because of the presence of legs. Ferris (1953) established the genus *Antoninoides* for *A. parrotti* and considered adding *A. nortoni* if not for the presence of legs in the type species. *Antoninoides boutelouae* Parrott and *A. nortoni* are transferred here to the genus *Antoninoides*.

Members of *Antoninoides* are indigenous to the USA and Mexico where they are found enclosed in ovisacs at the base of grass culms. Adult females are cream-colored and oval in shape; abdominal segmentation often vague and without lateral constrictions, caudal end rounded or slightly concave, posterior abdominal segments often sclerotized. Posterior dorsal ostioles present or absent; pair of dorsal apodemes present between abdominal segments VII-VIII, often vague. Anal ring with numerous pores and six setae, setal tips often knobbed; flush with derm or typically located at end of a short invaginated tube, tube orifice at end of abdomen or slightly dorsad.

Antennae 2-6 segmented, eyes present. Legs reduced, sometimes represented merely by pleural vestiges or setal grouping; podal apophyses present. Sternal apophyses typically absent, mesosternal pair vague when present. Clypeolabral shield and labium each as long as broad, labium 2-segmented; spiracles heavily sclerotized, spiracular arm as broad as long, multilocular pores and trilocular pores form a crescentic band around atrium, trilocular pores found along inner margin of band. Vulva distinct, directed ventrally, with distinct lateral pair and vague caudal pair of apophyses.

Body with numerous dermal ultrastructures including trilocular pores, simple disc pores, and flagellate setae. Multilocular pores present, with 9-10 locules, most typically found on abdominal venter. Cylindrical ducts of two distinct designs present (Pl. 17, figs. E, F); both subequal in length and with collar at base, but one duct approximately 2X wider; collar extends 1/3 length of tube and flares outward, difficult to see in some specimens; only smaller size duct present in *A. nortoni*.

Duct-like pores present on venter (Pl. 17, fig. M), often difficult to observe even at 1000X magnification; diameter $\leq$0.5X that of trilocular pore; length of pore varies, sometimes subequal to pore diameter and giving the appearance of being disc-like;

distribution different among species but typically in submarginal band that extends from area posterior to metathoracic spiracles to about abdominal segment IV.

Antoninoides has long been regarded as related to the genus *Antonina* (Ferris 1953, Williams & Granara de Willink 1992). Despite the translation of its name, this genus is not similar to *Antonina* except that both show reduction in the antennae and legs. The members of *Antoninoides* possess duct-like pores instead of granular disk-like pores and their cylindrical ducts are of a different form. *Antoninoides* species do share affinities with the distinctly legged *Trionymus penium* (Williams). This species was also observed to have cylindrical ducts of two sizes, often with a collar 1/3 the length of the duct and flaring; it also possesses duct-like pores on the ventral submargin around the metathoracic legs and on abdominal segment II. Further studies should investigate this potential relationship.

Key to Species of Genus *Antoninoides*

1. Legs partially reduced (Pl. 17, fig. K); antennae with 4-6 segments (Pl. 17, fig. J); length of duct-like pores on abdominal venter 3X pore diameter; posterior dorsal ostioles well-developed ..... ***parrotti***, p. 175

   Legs absent or reduced to pleural vestiges; antennae with 3 or fewer segments; length of duct-like pores on abdominal venter ≤ pore diameter; dorsal ostioles absent or represented by a vague posterior pair **2**

2. Dorsum without multilocular pores; body with two types of cylindrical ducts (Pl. 17, figs. E, F), diameter of one type 2X wider than second type; anal ring located at end of invaginated tube, tube length approximately 0.7X ring diameter ..... ***boutelouae***, p. 170

   Dorsum with multilocular pores on posterior abdominal segments; body with one type of cylindrical ducts; anal ring located dorsally on abdominal segment VIII, not at end of invaginated tube ..... ***nortoni***, p. 172

Antoninoides boutelouae (Parrott), comb. n.

Antonina boutelouae Parrott, 1900: 138; Dean, 1909: 266; Ferris, 1953: 290-291; Yang & Kosztarab, 1967: 15-18; Kosztarab & McDaniel, 1969: 114.

Antoninoides boutelouae is found at the base of grasses in the Great Plains and southwest regions of the USA. Unmounted adult females are oval, cream-colored, and contained within a white ovisac (Parrott 1900). Ferris' (1953) illustration should be referred to with the following definition of slide-mounted individuals. Adult females are oval to subcircular with posterior abdominal segments lightly sclerotized, 1000-2600μm long; caudal end rounded to truncate, without anal lobes.

Dorsal surface with trilocular pores, simple disc pores, and flagellate setae distributed over entire surface; longest setae located on posterior abdominal segments. Cylindrical ducts of two types similar to those described under *A. parrotti* (Cockerell); those found on posterior abdominal segments with an evident collar; larger type ducts distributed over entire dorsal surface of head, thorax, and abdominal segments II-VII; smaller type duct found over entire surface of segments VII-VIII. Anal ring with numerous pores and six setae, setae about 1.3X tube length and with knobbed tips; located at end of invaginated tube, tube length approximately 3/4 ring diameter, tube orifice at end of abdomen or slightly dorsad. Pair of dorsal apodemes vaguely apparent submedially between segments VII-VIII.

Ventral surface with similar glandular ultrastructures in addition to multilocular pores and duct-like pores. Multilocular pores with 9-10 locules, few found on thorax encircling spiracles, many found on medio-submarginal region of abdominal segments IV-VIII, few occasionally present on same region of segments II-III. Structures and distributions of trilocular pores, simple disc pores, and flagellate setae as those on dorsum; no distinct apical setae. Structures of cylindrical ducts as those on dorsum, but distributions slightly different; larger type duct distributed over entire venter; smaller type duct on margin of VII and over entire surface of VIII. Shallow duct-like pores located in submarginal band on abdominal segments II-IV; often difficult to locate pores because of their minute size and light sclerotization; diameter of pore ≥ length, the shallowness of pores sometimes gives them the appearance of small disc-like pores.

Antennae 3-segmented. Eyes present. Clypeolabral shield nearly as long as broad; labium as long as broad, two-segmented. Legs absent or represented by pleural vestiges, small evagination, or setal grouping; podal apophyses evident. Spiracles heavily sclerotized, somewhat broad, with group of trilocular and multilocular pores at atria as described in *A. parrotti*. Vulva distinct, directed ventrally, with lateral and caudal pairs of apophyses, caudal pair vague.

Antoninoides boutelouae is easily distinguished from *A. nortoni* (Parrott & Cock.) and *A. parrotti* by lacking multilocular pores on the dorsal abdomen. Unlike *A. nortoni* (Parrott & Cock.), which also has shallow duct-like pores and legs absent or greatly reduced, this species has two distinct types of cylindrical ducts on the body and an anal tube.

Type Material Examined. Syntype females on *Bouteloua hirsuta*, **KANSAS**, south of Manhattan, May 1899, coll. Kempton, 1(2) USNM.

Other Material Examined. All material from **USA**. ***Bahia dissecta*: ARIZONA**, Coconino Co., Williams, 1 Sep. 1968, coll. D.R. Miller & J.E. Lauck, 1(1) VPI. ***Bouteloua gracilis*: SOUTH DAKOTA**, Gary, "blue grama", 6 Sep. 1967, coll. B. McDaniel, 1(1) CBM. ***Bouteloua havardii*: TEXAS**, Limpin Canyon, 1889, coll. G.C. Neally, 1(1) KSU. ***Bouteloua* sp.: TEXAS**, Point Isabel {probably Port Isabel}, 1921, coll. G.F. Ferris, no. T287, 1(1) UCD. **Undetermined Grass: KANSAS**, Clay Center, sand hills, 4 Jul. 1899, coll. P.J. Parrott, 1(3) VPI; south of Manhattan, sand hills, no date given, coll. Kempton, 2(2) KSU; no other locality given, Jun. 1899, coll. Kempton, 10(13) VPI.

Antoninoides nortoni (Parrott & Cockerell), comb. n.

Antonina nortoni Parrott & Cockerell, *in* Parrott, 1899: 280-281; 1900: 140; Dean, 1909: 266; Ferris, 1953: 296-297; Merrill, 1953: 112; Afifi & Kosztarab, 1967: 18-21; Yang & Kosztarab, 1967: 25-28; Tippins & Beshear, 1972: 286; Williams & Granara de Willink, 1992: 58.

Antoninoides nortoni is found at the base of grasses in the southern USA and Mexico. In addition to the hosts listed below, this species has been reported on *Andropogon* sp. (Tippins & Beshear 1972). Unmounted adult females are oval, cream-colored, and contained within a white ovisac (Parrott 1899). Ferris' (1953) illustration should be referred to in conjunction with the following definition of slide-mounted individuals. Adult females are oval to subcircular with posterior abdominal segments lightly sclerotized, 1100-3100µm long; caudal end rounded, without anal lobes.

Dorsal surface with trilocular pores, simple disc pores, and flagellate setae distributed over entire surface; longest setae located on posterior abdominal segments. Multilocular pores with 9-10 locules, distributed on margin of abdominal segment V and

over entire surface of segments VI-VIII, sometimes present medio-submedially on segments IV-V. Cylindrical ducts similar to small type described under *A. parrotti* (Cockerell), distributed over entire dorsum except none on abdominal segment VIII, collar not evident on those found anteriorly, duct often recessed and appearing to have a double rim when looking down tube orifice. Anal ring with numerous pores and six setae, setal tips knobbed, ring located dorsally just anterior to end of body, slightly recessed cephally. Pair of dorsal apodemes present submedially between segments VII-VIII; posterior dorsal ostioles absent or vaguely present.

Ventral surface with similar glandular ultrastructures. Structure of multilocular pores as those found on dorsum, few located on thorax around spiracles and on medio-submarginal region of abdominal segments II-V, more found distributed over entire surface of segments VI-VIII, few occasionally present on margin of segments II-V. Structures and distributions of trilocular pores, simple disc pores, and flagellate setae as those on dorsum; no distinct apical setae. Structure of cylindrical ducts same as that on dorsum, found over entire venter. Duct-like pore also present, located in submarginal band from metathorax just posterior to spiracle and extending to abdominal segment V, pore diameter 0.5X pore length, their shallowness gives appearance of small disc-like pores, difficult to discern at times.

Antennae 2-3 segmented; eyes present; clypeolabral shield nearly as long as broad; labium as long as broad, two-segmented. Legs absent or represented by pleural vestiges or setal grouping; podal apophyses evident. Spiracles heavily sclerotized, somewhat broad, with group of trilocular and multilocular pores at atria as described in *A. parrotti*. Vulva distinct, directed ventrally, with lateral and caudal pairs of apophyses, caudal pair vague.

Some variation was seen in the distribution of duct-like pores among individuals. The grouping of duct-like pores in most individuals extends posteriorly as far down as segment V; however, the grouping in others was located only on the metathorax and segment II. Specimens from the Quitaque lot exhibited both distributions. Furthermore, the grouping or band of these structures in specimens from Colorado was wide and extended into the submedian.

Antoninoides nortoni is easily distinguished from *A. boutelouae* (Parrott) and *A. parrotti* by possessing a single type of cylindrical duct, similar to the small type found in these other two species. Unlike *A. boutelouae*, which also has legs absent or greatly

reduced and shallow duct-like pores, this species multilocular pores present on the abdominal dorsum and lacks an anal tube.

Much discrepancy exists among the data labels of "type" slides for *A. nortoni*, and assessing this material is confusing. The original description (Parrott 1899) indicated that the material was collected 25 Apr. 1899 on *Bouteloua racemosa* by J.B. Norton at Blue Mont, Manhattan, Kansas. A single specimen, evidently a syntype, is housed in the BM repository, but included on its label in Parrott's handwriting is "*Eriopeltis nortoni* Ckll. & Parrott". In addition to the author's names being reversed, "*Eriopeltis*" is crossed out and *Antonina* added in another handwriting.

Another indubitable syntype is housed in the USNM collections. Written entirely by Parrott's hand on this slide is the appropriate data and "pt. of type", but the date provided is 27 May 1899. Yet a third slide with a single specimen in the USNM has all the correct data and "Cotype" on its label, but was written entirely in Parrott's handwriting. Another specimen housed in the USNM is obviously a subsequent slide of type material. On this slide is written in one penmanship "*Antonina nortoni* P. & C., Type, Ckll. coll.", and in another "*Bouteloua racemosa*, Kansas, 1899."

Type Material Examined. Syntype females on *Bouteloua racemosa*, **KANSAS**, Blue Mont, Manhattan, coll. Norton, 1(1) BM, 2(2) USNM.

Subsequent slides: data same as above, 1(1) BM, 1(1) USNM, 1(4) VPI.

Other Material Examined. All material from **USA**. ***Aristida stricta*: FLORIDA**, Archer, 9 May 1986, coll. F.D. Bennett, 8(9) FSCA; Hobe Sound, 24 May 1978, coll. E.W. Campbell, 3(3) FSCA; **NORTH CAROLINA**, Cameron, 31 Jul. 1928, coll. C.H. Brannon, 1(1) USNM. ***Aristida* sp.: FLORIDA**, Clay Co., 28 May 1976, coll. R. Beshear, 1(1) UGES; **GEORGIA**, Charlton Co., 23 Jul. 1973, coll. R. Beshear, 1(1) UGES; Charlton Co., 9 Feb. 1983, coll. R. Beshear, 1(1) UGES; Echols Co. 24 Sep. 1980, coll. R. Beshear, 1(1) UGES; Seminole Co., 27 Apr. 1972, coll. R. Beshear, 1(1) UGES; Tattnall Co., 14 Feb. 1976, coll. R. Beshear, 1(1) UGES; **TEXAS**, nr. Quitaque, 1921, coll. G.F. Ferris, no. T762, 6(10) UCD. ***Bouteloua curtipendula*: ARIZONA**, Huachuca Mts., 26 Jun. 1940, {coll. L.P. Wehrle}, 3(5) UCD. ***Bouteloua* sp.: ARIZONA**, Sonoita, 13 Jul. 1940, {coll. I.L. Wiggins}, "G.F.F.", 2(7) UCD; **TEXAS**, Decatur, 1921, coll. G.F. Ferris, no. T897, 2(3) UCD. ***Cynodon dactylon*: FLORIDA**, Lake Gem, as "wire grass", 31 Aug. 1923, coll. H.W. Fogg, 5(8) FSCA. ***Eragrostis secundiflora*: TEXAS**, Decatur-Alvord, 1921, coll. G.F. Ferris, no. T277, 1(1) UCD. **Undetermined Grass: COLORADO**, Prowers Co., east of Lamar, 29 Jun. 1970, coll.

D.R. Miller, no. 1545, 3(5) USNM; **FLORIDA**, Clay Co., 28 May 1976, coll. R. Beshear, 1(1) UGES; Sorrento, 19 Aug. 1949, coll. J.C. Bell, 4(13) FSCA; **GEORGIA**, Loundes Co., Twin Lakes, 16 Nov. 1955, coll. B.A. App, 1(2) USNM; Walker Co., 27 Sep. 1976, coll. R. Beshear, 1(1) UGES; **KANSAS**, Blue Mont, Manhattan, no date given, coll. Norton, 1(1) VPI; Woodside Co., west of Piqua, 27 Jun. 1970, coll. D.R. Miller, no. 1512, 2(2) USNM; **OKLAHOMA**, Seminole Co., "triple lawn grass", 29 Jun. 1956, coll F.A. Fenton, 2(6) USNM; **TEXAS**, Panhandle, 4 Jun. 1978, coll. R. Beshear, 1(1) UGES; Wheeler, 5 Jul. 1972, coll. R. Beshear, 1(1) UGES; no additional locality given, no date given, {coll. G.F. Ferris}, no. "T?", 1(2) UCD. **Undetermined Host: TEXAS**, Stephenville, 14 Apr. 1952, coll. P.T. Riherd, 1(5) USNM.

Antoninoides parrotti (Cockerell)
Plate 17

Antonina graminis Parrott, 1900: 140-141; Cockerell 1901: 333; Ferris 1918b: 77. [secondary homonym of *Antonina graminis* (Maskell)] **LECTOTYPE**, adult female, KANSAS, south of Hutchinson, on *Eragrostis trichodes* (USNM), examined and here designated.

Antonina parrotti Cockerell, *in* Fernald 1903: 122; Dean, 1909: 267; Merrill 1953: 112. [replacement name for *Antonina graminis* Parrott]

Antoninoides parrotti (Cockerell) Ferris, 1953: 301; Williams & Granara de Willink, 1992: 61.

GENERAL DESCRIPTION

Body of Adult Female. Parrott (1900) described the waxy sac as "globular" and "dirty white"; the encased body as oval, light brown, and "slightly pollinose".

On microscope slide (fig. A): body broadly oval to circular, 1635µm (1179-2280) long, 1174µm (831-1857) wide; abdominal segments VII-VIII slightly sclerotized along margin, posterior end blunt, anal lobes indistinct, opening to anal tube located near end of segment VIII.

Dorsal Surface

Multilocular Pores (fig. B). 6.72µm (5.70-8.55) in diameter, with 10 locules; distributed on submargino-marginal region of abdominal segments II-III, submedio-

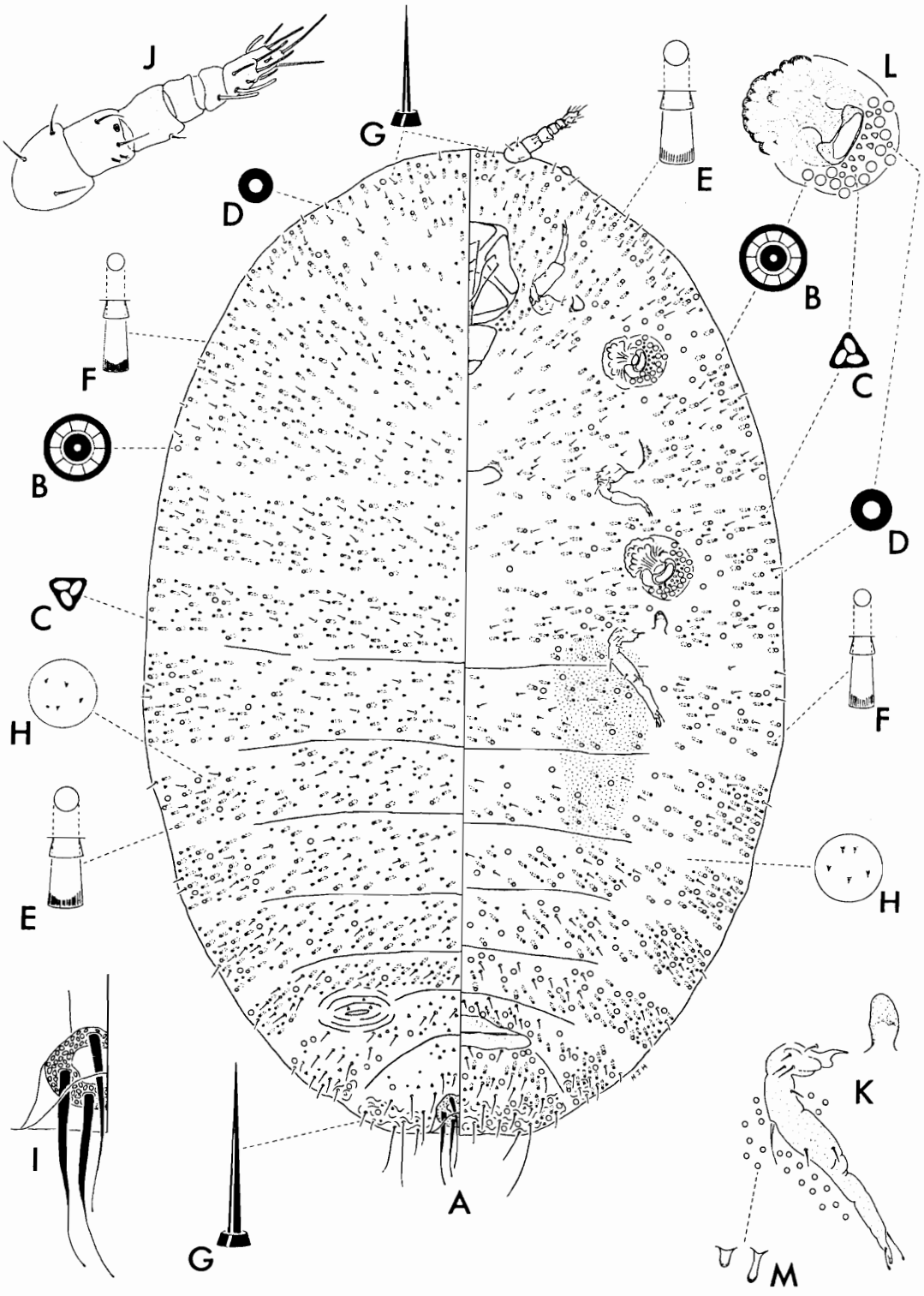

Plate 17. ***Antoninoides parrotti*** **(Cockerell), Adult Female.**

marginal region of segments IV-V, and over entire surface of segments VI-VIII with fewer found medially; few may occasionally be found on submargino-marginal region of head and thorax.

Trilocular Pores (fig. C). 4.69μm (3.80-5.70) in diameter, with triangular to circular rim; located over entire dorsum, but fewer found on head, margin, and abdominal segment VIII.

Simple Disc Pores (fig. D). 3.61μm (2.85-4.75) in diameter; distributed over entire dorsum, with fewer found on head.

Cylindrical Ducts. Of two types, both subequal in length and with collar at base, but one duct approximately 2X wider; collar extends ca. 1/3 length of duct and flares out, difficult to see when lightly sclerotized or stained. Larger duct (fig. E): 4.41μm (3.80-5.70) in diameter, 9.94μm (8.55-12.4) long; distributed over entire surface from head to abdominal segment V, occasionally found on abdominal segments VI-VII. Smaller duct (fig. F): 2.24μm (1.90-2.85) in diameter, 9.81μm (7.60-11.4) long; distributed over entire surface of head, thorax, and abdominal segments II-VI, with fewer medially; occasionally found on submargino-marginal region of abdominal segment VII.

Setae (fig. G). Flagellate, 7.60-133μm long; distributed over entire dorsum, those of greatest length found caudally.

Spicules (fig. H). Minute, 0.95-2.85μm long, usually in groups of two or more; located on medio-submarginal region from mesothorax to abdominal segment V, on medio-submedial region of segment VI, and over entire surface of segments VII-VIII; occasionally found on submedio-submarginal region of prothorax.

Dorsal Ostioles. Posterior pair present, usually well developed, sometimes with 2-4 trilocular pores on lips.

Anal Ring (fig. I). 82.1μm (74.2-88.2) in diameter; at base of a very short anal tube, 22.3μm (11.6-30.2) long; anal ring pores numerous, 2.51μm (1.90-3.80) in diameter; with six setae, 95.1-204μm long, knobbed, extending well beyond length of anal tube.

Other Structures. Pair of submedial apodemes vaguely apparent between abdominal segments VII-VIII at times.

Ventral Surface

Eyes. Base diameter 15.6μm (11.6-18.6).

Antennae (fig. J). Four- to six-segmented, 120μm(94.1-146) long; base diameter 38.6μm (28.5-47.5).

Clypeolabral Shield. Nearly as long as broad, 161μm (139-186) long, 167μm (158-181) wide.

Labium. Nearly as long as broad, 82.0μm(74.2-92.8) long, 87.8μm (76.6-99.8) wide at base, two-segmented.

Legs. Present with various degrees of reduction and fusion, at times broken off or represented by short stub; with an apophysis located laterad of each leg, apophysis associated with prothoracic leg usually vague. Prothoracic leg 149μm (80.8-200) long, mesothoracic leg 106μm (26.6-165) long, metathoracic leg (fig. K) 122μm (33.35-201) long.

Spiracles (fig. L). Anterior: spiracular arm 63.6μm (51.0-67.3) long, as broad as long, with slender peritreme; atrium 41.6μm (34.8-46.4) wide; 11-35 multilocular pores, 4-15 trilocular pores, and 1-6 simple disc pores form a crescentic band around atrium; trilocular pores predominant type along inner margin of band. Posterior: similar to anterior pair, but slightly larger; arm 68.6μm (55.7-76.6) long; atrium 47.7μm (39.4-55.7) wide; 15-48 multilocular pores, 8-20 trilocular pores, and 2-7 simple disc pores comprise band.

Multilocular Pores (fig. B). Structure as that on dorsum, 6.62μm (5.70-7.60) in diameter; sparsely distributed on submargino-marginal region of head and thorax, and occasionally medio-submedial region of metathorax; more found distributed over entire surface of abdomen with fewer located medially, grouped around vulva.

Trilocular Pores (fig. C). Structure as that on dorsum, 4.54μm (3.80-5.70) in diameter; sparsely distributed over entire venter, primarily found along lateral margins, small cluster of pores found at junction of clypeolabral shield and labium.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.58μm (2.85-4.75) in diameter, distributed over entire venter, fewer located on head and medial region.

Duct-like Pores (fig. M). Minute, 1.12μm (0.95-1.90) in diameter, 3.31μm (1.9-4.75) long, smaller diameters often as broad as deep, difficult to view entire structure at times; located on submedio-submarginal region from posterior half of metathorax near leg to anterior half of abdominal segment IV.

Cylindrical Ducts. Structures as that on dorsum. Larger duct (fig. E): 4.28μm (3.80-5.70) in diameter, 10.3μm (9.50-11.4) long; located primarily on margin of body and posterior half of each body segment, with fewer found on last three abdominal segments; few also found on remaining regions of head, thorax and abdominal segment II. Smaller duct (fig. F) 2.24μm (1.90-2.85) in diameter, 10.2μm (8.55-11.4) long, distributed over

entire surface of head, thorax, and abdominal segments II-VII; few present along anterior half of segment VIII.

Setae (fig. G). Structure and distribution as that on dorsum, 8.55-152µm long; no distinct apical setae among long flagellate setae.

Spicules (fig. H). Structure as that on dorsum, 0.95-2.85µm long; located on medio-submedial region of mesothorax and metathorax anterior to spiracle, medio-submarginal region of metathorax posterior to spiracle, and over entire surface from abdominal segment II to anterior half of segment VIII.

Vulva. Distinct, wrinkled, opening directed ventrally and surrounded by thick flagellate setae; lateral and caudal pair of apophyses present, caudal pair short and vague.

Other Structures. Mesothoracic apophyses usually present, metathoracic apophyses seldom evident.

Type Material Examined. Lectotype on *Eragrostis trichodes*, **KANSAS**, sand hills south of Hutchinson, Aug. 1899, H.B. Kempton 1(1) USNM (slide labeled as "*Antonina graminis* Parrott, type on *Eragrostis trichodes*, S. of Hutchinson, Aug. 1899, (Kempton)"; in another handwriting is "Pseud., *parrotti* (Ckll.)") [examined, here designated]; Paper envelope with data of slide, also with "TYPE" stamped on outside and "Remounted Jan. 1932 L.M.R." written on inside of flap.

Several subsequent slides. ***Bulbilis dactyloides*: KANSAS**, Manhattan, Aug. 1899, coll. Kempton, "*Antonina graminis* Parrott", 6(9) VPI. ***Eragrostis pectinacea*: KANSAS**, Hutchinson, Aug. 1899, coll. Kempton, "*Antonina graminis* Parrott", 1(1) VPI. ***Eragrostis trichodes*: KANSAS**, Nickerson, Aug. 1899, coll. Kempton, "*Antonina graminis* Parrott", 2(2) VPI; Nickerson, Aug. 1899, coll. P.J. Parrott, 2(3) VPI. The last lot is mislabelled because Parrott did not collect material for his species description (See Remarks below).

Other Material Examined. All material from **USA**. ***Andropogon scoparius*(?): OKLAHOMA**, Ellis Co., no other locality data, 22 Oct. 1958, coll. unknown, no. 128, "*Antonina parrotti* Ckll.", 1(7) USNM. ***Bouteloua trifida*: TEXAS**, LaPryor, 14 Apr. 1966, coll. M.F. Schuster, 1(2) VPI; Zapata Co., no other locality data, 13 Jun. 1966, coll. M.F. Schuster, 1(3) VPI. ***Bouteloua* sp.: TEXAS**, west of Georgetown, 28 Jul. 1899, coll. Kempton, 2(2) KSU. ***Bulbilis dactyloides*: TEXAS**, Chillicothe, 16 Nov. 1907, coll. B.P.I., "*Antonina parrotti* Ckll.", 1(2) USNM. ***Chloris ciliata*: TEXAS**, Webb Co., no other locality data, 11 Jan. 1950, coll. Chada & Wood, no. 5, "*Antonina parrotti* Ckll.", 1(4) USNM. ***Chloris cucullata*: TEXAS**, Brooks Co., no other locality

data, 21 Jun. 1966, coll. M.F. Schuster, 1(2) VPI. ***Chloris* sp.: TEXAS**, Brownsville, 1921, coll. Ferris, Ferris Texas Coll. T264, "*Antonina parrotti* Ckll.", 1(1) UCD. ***Dactylis glomerata*: MISSISSIPPI**, A & M College, as "orchard grass", 28 Nov. 1927, coll. M.R. Smith & W.A. Douglas, "Pseudantonina parrotti (Ckll.)", 1(1) BM, 1(1) MNHNE. ***Eragrostis trichodes*: KANSAS**, Rice Co., south of Raymond, Jul. 1910, coll. Dickens, 1(2) VPI. ***Holcus halepenis*: MISSISSIPPI**, Starkville, "Johnson grass", 4 Jun. 1927, coll. J.N. Roney, 1(4) MNHNE. ***Sporobolus argutus*: TEXAS**, nr Brownsville, date unknown, coll. unknown, Ferris Texas Coll. T-772, "*Antonina parrotti* Ckll.", 1(2) UCD. ***Sporobolus junceus*: FLORIDA**, Gainesville, 2 May 1979, coll. D. Culbert, 6(6) FSCA. ***Sporobolus* sp.: TEXAS**, north of Linton {probably Linden}, date unknown, coll. unknown, Ferris Texas Coll. T-764, "*Antonina parrotti* Ckll.", 1(2) UCD. ***Triodia pilosa*: TEXAS**, west of Eagle Pass, 1921, coll. G.F. Ferris, no. T693, 1(1) UCD. **Undetermined Grass: KANSAS**, sand-hills south of Hutchinson, Aug. 1899, coll. Kempton, "*Antonina ~~nortoni~~ graminis* Parrott", 3(3) KSU; Nickerson, Aug. 1899, coll. "Correll", "*Antonina ~~nortoni~~ graminis* Parrott", 1(1) KSU; Riley Co., "Spuhr Bottom", 29 Jul. 1899, coll. Kempton, "*Antonina ~~nortoni~~ graminis* Parrott", 1(1) KSU; Sumner Co., South Haven, 28 Jun. 1970, coll. D.R. Miller, no. 1519, 3(6) USNM; Kansas, no other collection data, 2(4) VPI; Aug. 1899, coll. Kempton, Bx. 5, 1(1) USNM; no other locality data, Aug. 1899, Bx. 5, coll. Kempton, "*~~Ripersia~~ Antonina parrotti* (Ckll.)", "COTYPE", 1(1) USNM; **OKLAHOMA**, Grant Co., 5 mi west of Medford, 28 Jun. 1970, coll. D.R. Miller, no. 1520, 3(6) USNM; Cimarron Co., north of Boise City at state line, 30 Jun. 1970, coll. D.R. Miller, no. 1555, 1(1) USNM; **TEXAS**, Kingsville, at King Ranch, 10 Feb. 1949, coll. unknown, Ferris Coll., 5(6) UCD; Point Isabel {probably Port Isabel}, no collection date, coll. unknown, Ferris Texas Coll. T-773, "*Antonina parrotti* Ckll.", 2(3) UCD. **Host Unknown: KANSAS**, Nickerson, Aug. 1899, coll. Kempton, 3(3) KSU; **TEXAS**, Kleberg Co., no other locality data, 2 Jul. 1966, coll. J.C. Boling, 1(2) VPI.

Remarks. *Antoninoides parrotti* occurs at the base of culms of various grasses in southern USA and northern Mexico. In addition to the above localities, *A. parrotti* has been reported from Las Vegas, New Mexico (Cockerell 1901) and Montemorelos, Mexico (Williams & Granara de Willink 1992). It has also been collected on *Dasychloa pulchella*, *Eragrostis secundiflora* (Ferris 1953), and *Paspalum ciliatifolium* (Parrott 1900).

Parrott's (1900) description of *Antonina graminis* was made using specimens collected by J.B. Norton and H.B. Kempton on five host species from four localities in Kansas. However, Parrott did not provide a specific designation of type host and locality, nor information on the type material in his description. An original slide which contains one adult female was available for study and it is here designated lectotype (see Type Material Examined above). The handwriting on the slide's label matches that with the original dry material housed in KSU repository. The data label included with dry material collected by Kempton on *Paspalum ciliatifolium* from south of Hutchinson (KSU) also has "type" written on it. For this reason it is assumed that the examined type slide is among a syntype series and it has been treated as such; however, attempts to locate other slides has been unsuccessful.

T.D.A. Cockerell (Fernald 1903) recognized that Parrott's *Antonina graminis* was preoccupied by *Antonina graminis* (Maskell), a combination which itself occurred in Fernald's Catalogue, and provided this species with the patronym, *Antonina parrotti*. Unfortunately, no taxonomic discussion was given. A slide housed in the USNM repository has "COTYPE" written on it (see Other Material Examined); however, the only handwriting on this slide's label that matches the type material is "*Ripersia*, on grass, Aug. 1899, Bx 5, Kempton. "COTYPE, Pseud. *Antonina parrotti* (Ckll.), [Kansas]" was added later in at least two other handwritings, one which may have been Cockerell. This slide is probably not from the type series because Parrott explicitly listed host species from which he based his description and he made no reference to *Ripersia*.

At times, the very short anal tube of this species is folded on itself and may appear absent; moreover, some specimens were observed to have their anal ring only slightly recessed into the derm. Unlike most observed specimens, those from Gainesville, Florida, had numerous multilocular pores dorsally on abdominal segment VIII.

Diagnosis. *Antoninoides parrotti* is distinguished from *A. boutelouae* (Parrott) and *A. nortoni* (Parrott & Cock.) by possessing legs that are only partially reduced and duct-like pores that are typically 1.3X longer than wide. Individuals that have their legs broken off may be confused with *A. nortoni* which may also have dorsal ostioles. *Antoninoides nortoni*, however, has only one type of cylindrical duct on its body which is similar to the small type seen in this species.

Cypericoccus Williams

Type Species: *Cypericoccus multipori* Williams (1985); by original designation and monotypy.

Williams, 1985: 103.

Williams (1985) questioned a possible relationship between this genus and the genera *Antonina* Signoret and *Sphaerococcus* Maskell, and indicated studies of male morphology would be needed for verification. Adult females of this monotypic genus show no resemblances to either of these genera.

Five genera which also lack trilocular pores and possess fairly developed legs were discussed by Williams (1985). Those listed were *Annulococcus* James, *Asphodelococcus* Morrison, *Boreococcus* Danzig, *Metadenopsis* Matesova, and *Metadenopus* Sulc. *Metadenopsis* (Matesova 1966) appears the most similar among those covered. This genus, particularly its type species, possesses anal ring pores and setae, but no sclerotized ring. Cerarii and circuli are absent, but dorsal ostioles and cylindrical ducts are present. *Cypericoccus* differs from *Metadenopsis* by having two distinct size groups of multilocular pores, legs and antennae reduced, and only the posterior pair of dorsal ostioles present.

Cypericoccus multipori Williams
Plate 18

Cypericoccus multipori Williams, 1985: 103-105.

GENERAL DESCRIPTION

Body of Adult Female (fig. A). Description of unmounted adult females unknown. On microscope slide, body oval to slender elongate, 4123µm (2499-5391) long, 1889µm (785-2535) wide; both ends rounded but anterior end may taper, sides reasonably parallel; abdominal segmentation poorly defined, anal lobes undeveloped.

Dorsal Surface

Multilocular Pores. Of two general sizes. Larger pore (fig. B): 7.97µm (7.60-9.50) in diameter, with 9 or 11 locules, the "hub" of the pore has a single translucent spot positioned near septum; distributed over entire dorsum, found predominantly on submargino-marginal region of head, thorax and abdominal segments II-VII, and all of

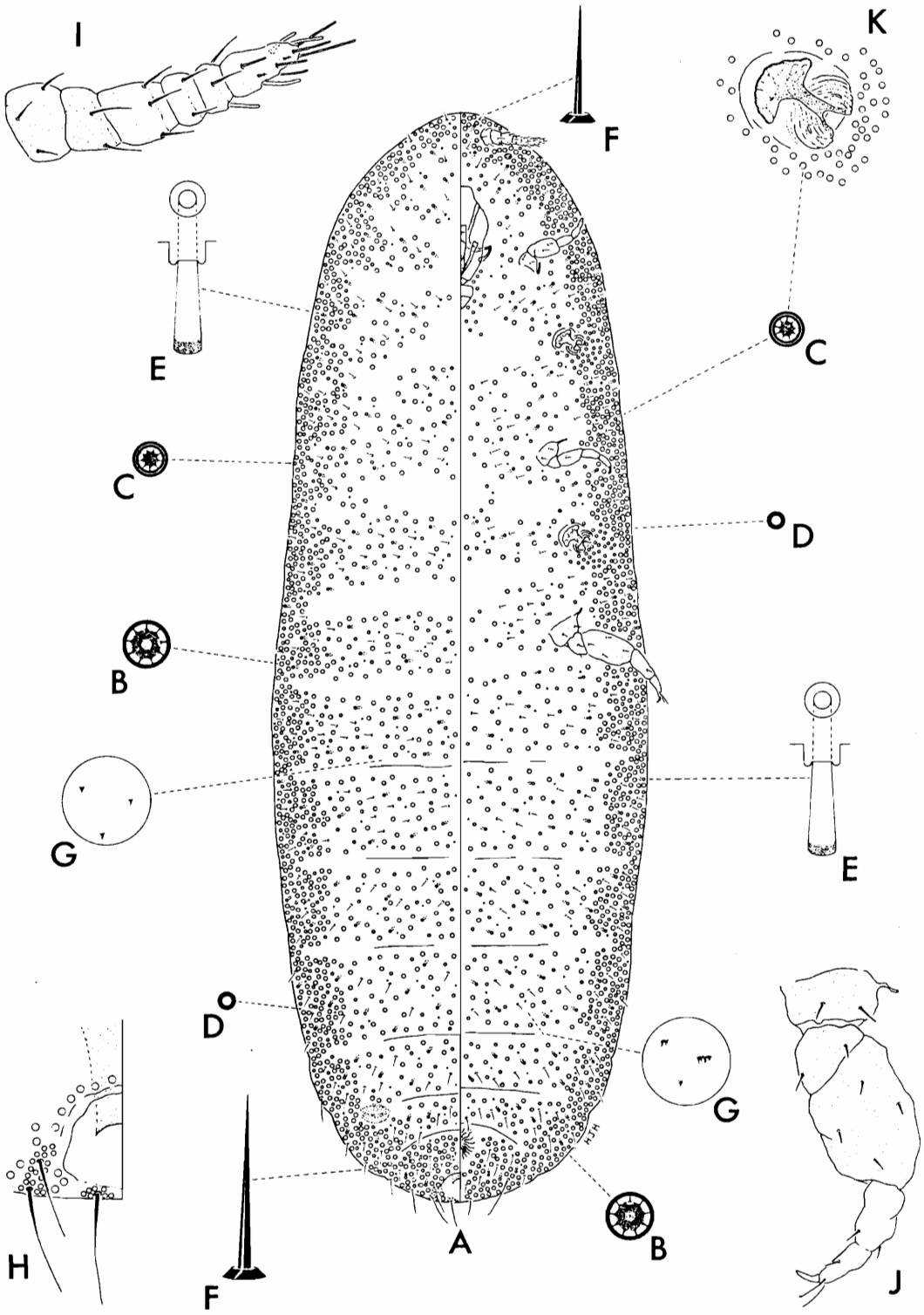

Plate 18. ***Cypericoccus multipori*** **Williams, Adult Female.**

segment VIII. Smaller pore (fig. C): 6.28μm (5.70-6.65) in diameter, with 9 or 11 locules; many distributed over entire dorsum.

Simple Disc Pores (fig. D). 2.88μm (1.90-3.80) in diameter, sparsely distributed over entire dorsum.

Cylindrical Ducts (fig. E). 2.24μm (1.90-2.85) in diameter, 9.06μm (8.55-10.5) long; orifice typically at bottom of a dermal invagination or pit, this depression may be mistaken as an oral rim when viewed at certain angles; distributed over entire dorsum.

Setae (figs. F). Flagellate, 8.55-78.0μm long, scattered over entire dorsum; cephalic setae long, but those with greatest lengths found on posterior abdominal segments.

Spicules (fig. G). Minute, 0.95-1.90μm long, usually solitary; sparsely distributed on medio-submedial region of metathorax and abdominal segments II-V, medial region of segment VI, and anterior half of segment VIII.

Dorsal Ostioles. Posterior pair present, but poorly developed.

Anal Ring. Sclerotized ring not present, anal opening located at posterior end of segment VIII and within an area devoid of wax glands (fig. H). Four groups of setae and small glandular pores adjacent to posterior margin of clear area are probably remnants of an anal ring, area devoid of ultrastructures may be a membranous zone between anal ring and anus of other species; lateral pair has two flagellate setae and 22-28 glandular pores per grouping, medial pair has one seta and 9-12 pores per grouping; pore diameter 3.80-4.75μm, setae approximately 90μm long or equivalent to longest abdominal setae.

Other Structures. Apparently none.

Ventral Surface

Eyes. Base diameter 15.6μm (14.3-19.0).

Antennae (fig. I). Typically 6-segmented, 141μm (124-159) long with base diameter of 40.5μm (31.4-44.7); one specimen possessed an antenna of three segments and another possessed one of four segments.

Clypeolabral Shield. Approximately 1.7X longer than wide, 218μm (195-238) long, 130μm (112-145) wide.

Labium. Slightly broader than long, 55.3μm (52.4-59.5) long, 59.8μm (54.7-64.3) wide at base, 2-segmented.

Legs (fig. J). Present, with various degrees of reduction and fusion, sometimes broken off; metathoracic legs usually much larger than others. Prothoracic leg 190μm (57.0.-

248) long, mesothoracic leg 191μm (56.1-271) long, metathoracic leg 274μm (86.5-400) long.

Spiracles (fig. K). Anterior: spiracular arm 58.7μm (50.0-64.3) long; atrium 28.8μm (23.8-33.3) wide. Posterior: similar to anterior pair but slightly larger; arm 64.5μm (54.7-78.5) long; atrium 32.8μm (26.2-35.7) wide.

Multilocular Pores. Structurally identical to those found on dorsum. Larger pore (fig. B): 7.92μm (7.60-8.55) in diameter, distribution as that on dorsum except absent from medial region of prothorax. Smaller pore (fig. C): 6.22μm (4.75-6.65) in diameter, distribution as that on dorsum, concentrated around labium and spiracles.

Simple Disc Pores (fig. D). Structure and distribution as that on dorsum, 2.85μm (1.90-3.80) in diameter.

Cylindrical Ducts (fig. E). Structure and distribution as that on dorsum, 2.33μm (1.90-2.85) in diameter, 9.16μm (8.55-9.50) long.

Setae (figs. F). Structure and distribution as that on dorsum, generally longer than those on dorsum, 9.50-102μm long; apical seta undifferentiated from other setae on last abdominal segment.

Spicules (fig. G). 0.95-2.85μm long, most in groups of two or more; sparsely distributed on medio-submedial region of thorax, medio-submarginal region of abdominal segments II-VII, and entire surface of segment VIII.

Vulva. Distinct, circular, wrinkled, with opening directed ventrally; four small, vague apophyses present.

Other Structures. Apparently none.

Type Material Examined. Holotype from inflorescence [spikelet] of nut-grass [*Cyperus rotundus*], **AUSTRALIA**, Western Australia, Midland Junction, near Perth, 4 Mar. 1964, coll. S. W. Brown, 1(1) ANIC.

Paratypes: same data as holotype, 1(1) BM; on *Mesomelaena tetragona*, **AUSTRALIA**, Western Australia, Forrestfield, Specimen Index No. 18/65, 25 Jun. 1965, coll. G. D. Rimes, 2(7) BM, 1(4) WARI; Western Australia, Wattle Grove, in spikelet, Specimen Index No. 214/59, 23 Aug. 1959, coll. H. M. Brookes, 1(1) BM.

Other Material Examined. All from **AUSTRALIA**. ***Mesomelaena tetragona*:** Western Australia, Forrestfield, Specimen Index No. 18/65, 25 Jun. 1965, coll. G. D. Rimes, 4(7) ANIC, 2(3) WARI; Western Australia, Wattle Grove, Specimen Index No. 214/59, 23 Aug. 1959, coll. H. M. Brookes, 3(3) WARI. [see Remarks]

Remarks. In his original description, Williams (1985) described the "anus as indistinct but at the base of a tube" and used this characteristic as one to separate this monotypic genus from closely related genera. What may have been mistaken as an anal tube is the sclerotized rectum which was seen in other species of this study. Although insignificant to the diagnosis of this species, it was determined in this study that this species does possess vestigial eyes.

The minute, translucent spot seen on the large-type multilocular pore was described by Williams (1985) as an enlarged locule rather than an anomaly at the base of a septum, and as not always present. This transparent spot could be seen with careful focusing on all large-type multilocular pores unobscured by wax. Apparently some of the small-type multilocular pores may possess this transparent spot; however, the small size of these pores prevents a positive description using a conventional compound microscope. Histological studies or scanning electron microscopy of both types of multilocular pores should provide a better description of this aberration.

Future workers should note that only 13 of the designated 19 paratypes are accountable. The remaining 6 may be among the 13 specimens listed under "Other Material Examined", but it is likely impossible to determine which, if any, of these are paratypes. The data labels on these additional slides are identical to those on the slides with paratype designations, and there are no distinguishing marks. This discrepancy should not cause any problems for future studies, and was reported only to inform those seeking type material that there appears to be fewer paratypes than that reported in the original description.

Nesticoccus Tang

Type species: *Nesticoccus sinensis* Tang, by original designation and monotypy.

Tang, 1977: 28-29; Tang, 1992: 33-34.

Nesticoccus Tang (1977) was established for a single species collected on bamboo, *Arundinaria* sp., at Hangzhou, Zhejiang, China. Tang (1977) first indicated its relatedness to *Paludicoccus* Ferris and the cryptococcid genus *Kuwanina* Cockerell. He later (Tang 1992) placed *Nesticoccus* near *Kuwanina* within the subtribe Serrolecaniina Shinji. Other genera included in the subtribe were *Idiococcus* Takahashi & Kanda, *Kermicus* Newstead, and *Serrolecanium* Shinji. It was assigned to this subtribe on the

assumption that there was a sclerotized plate or sac posterior to the metathoracic spiracle. As indicated below in the type species description, this sclerotized region is not a separate plate and does not contain duct-like pores as seen in the three serrolecaniine genera listed above.

The taxonomic placement of *Nesticoccus* is very difficult to diagnose merely on adult female morphology, at least among the genera covered in this study. Its correct placement among the Pseudococcidae will most likely require global generic revisions which incorporate legged species and other developmental stages. A definition of this monotypic genus can be found below in the brief description of *Nesticoccus sinensis*.

Nesticoccus sinensis Tang
(not illustrated)

Nesticoccus sinensis Tang, 1977: 28-29; 1992: 34-35.

Nesticoccus sinensis is found on bamboo, particularly *Arundinaria amabilis*, in eastern China. It is found at the base of leaf sheaths, the body covered by wax and resting in a waxy mass shaped like a bird nest (Tang 1977). The body of slide-mounted females is more or less circular, ca. 2500μm long; abdominal segmentation vague to obsolete, anal lobes lacking; lateral margins of abdomen heavily sclerotized; sclerotized region sometimes produced posteriorly and extending beyond end of abdomen.

Dorsal surface with few glandular structures. Few multilocular pores ca. 7.50μm in diameter, with 10 locules, located along margin of head and thorax, more found on sclerotized region of abdomen. Very few simple disc pores, ca. 2.20μm in diameter, located along margin. Few cylindrical ducts ca. 2.20μm in diameter, ca. 11.0μm long, with flange-like collar that extends almost entire length of duct; located along margin of head and thorax, more found on sclerotized region of abdomen. Body setae flagellate, short, distributed over entire dorsum. Anal ring absent, anus at times surrounded by sclerotized region posteriorly. Dorsal ostioles and cerarii lacking.

Ventral surface with more glandular structures. Multilocular pores same as those on dorsum, distributed on margin of head and sclerotized region of abdomen, also located over entire surface of thorax but predominant along margin. Trilocular pores ca. 5.50μm in diameter, located on medio-submedial region of head and thorax and concentrated around spiracles. Simple disc pores structurally as those on dorsum, few

found over entire surface of head and thorax, and on margin of abdomen. Cylindrical ducts similar to those on dorsum; few found on margin of head and thorax, more found on sclerotized region of abdomen. Disc-like pores small, 3.00-5.50μm in diameter; distribution difficult to assess in available specimens, observed on abdominal venter between anus and posterior end of sclerotized region of abdomen. Structure and distribution of body setae same as that on dorsum; apical setae present; few spicules seen on median of thorax.

Eyes absent; antennae 1-2 segmented; clypeolabral shield as long as broad; labium as long as broad, two-segmented. Legs absent or represented by pleural vestiges, podal apophyses evident; spiracles heavily sclerotized with broad spiracular arm, numerous trilocular pores associated with atria and surrounding arm. Vulva wrinkled, vague, directed ventrally, associated apophyses not evident. Sternal apophyses wanting, circulus present on abdomen, shape somewhat hourglass-like.

Type Material Examined. Paratypes, possibly syntypes on *Arundinaria* sp., from Hangzhou, **CHINA**, coll. not given, 1(12) AUS (data on red labels as follows: "*Nesticoccus sasae*, n.g. & sp., Hangzhou, bamboo, 69.3.31, no. 334"). Possible subsequent slides from dry type material; data "*Nesticoccus*, Hangzhou, bamboo, 69.3.31, no. 125" 2(2) VPI.

Remarks. Through the courtesy of Professor Tang Fang-teh and Agricultural University of Shanxi, I was able to view what is presumed to be type material. Due to inconsistencies in labeled data and difficulties in translating, it was not determined whether the material was paratype or syntype material. Tang's (1977) description did not provide information on type series. Described plate and two short setae on anal ring. Added obstacles surfaced in the observance of specimens, particularly in determining distributions of the various dermal ultrastructures. All of the specimens were old, postreproductive females, most of which were halved dorso-ventrally.

Although not seen in available specimens, Tang reported a single pair of anal ring setae. Tang (1977, 1992) described and illustrated the sclerotized region on the abdomen as plate-like. In none of the observed specimens was this region demarcated as a separate plate. Instead, the edges of the sclerotized region faded into the membranous regions. An examination of young, prereproductive females of this species is much needed to determine the nature of its structures and their true distributions.

Paludicoccus Ferris

Type species: *Pseudolecanium disticlium* Kuwana, by original designation and monotypy.

Ferris, 1918a: 327; 1953: 392; McKenzie 1967: 211; Morrison & Morrison 1966: 143; Williams & Granara de Willink, 1992: 292.

Ferris (1918a) established *Paludicoccus* for *Pseudolecanium disticlium* Kuwana which was erroneously placed in the aberrant and heterogeneous *Sphaerococcus* Maskell (Fernald 1903). Morrison & Morrison (1966) suggested its placement in Antonininae. At present, the genus contains only one species, *Paludicoccus distichlium*.

Paludicoccus is very obscure in that it shares characteristics with several genera, including members of the tribe Serrolecaniini. The posterior abdominal segments of *P. distichlium* look very similar in general form to the monotypic *Tangicoccus* Kozár & Walter, but this similarity is highly superficial. Both have the anal ring positioned centrally on segment VIII and not at the end of an invaginated tube; the vulva is directed caudally and has four associated apophyses, but no lateral apodemes; and there are no sclerotized dermal depressions on segment VIII. Both genera also have duct-like pores and spiracular arms that are nearly circular with a peritreme, and they lack conical setae.

Paludicoccus distichlium, however, has a complete anal ring and possesses cylindrical ducts and multilocular pores. Although the structure of the multilocular pore is different, that of the cylindrical duct is very similar to that found in other serrolecaniine genera. Structurally the mouthparts are more like that of *Antoninoides* Ferris; moreover, the clypeolabral shield lacks an anterior projection as seen in Serrolecaniini. Lastly, the invaginated pit seen in first instars of serrolecaniines was not observed in those available for *P. distichlium*.

Only this genus, among all those examined in this study, was hesitantly omitted from the tribe Serrolecaniini based on adult female morphology. A thorough comparative analysis of other developmental stages, particularly first instars, is needed to determine if this omission was warranted.

Paludicoccus distichlium (Kuwana)
Plate 19

Pseudolecanium disticlium Kuwana, 1902b: 134-135. **LECTOTYPE**, adult female, USA, California, Palo Alto, on *Distichlis maritima* (= *D. spicata*) (UCD), examined and here designated.

Sphaerococcus disticlium (Kuwana) Fernald, 1903: 85.

Paludicoccus disticlium (Kuwana) Ferris, 1918a: 327-328; Williams & Granara de Willink, 1992: 292.

Paludicoccus distichlium (Kuwana) Ferris, 1953: 393; McKenzie, 1967: 211-213.

GENERAL DESCRIPTION

Body of Adult Female. Unmounted specimens were described as "ellipsoidal in form, usually flat, pinkish brown in color, shiny, the posterior segment darker color, thinly coated with white cottony wax" (Kuwana 1902).

On microscope slide (fig. A): body elongate to broadly oval, 2820µm (1821-4106) long, 1167µm (714-1749) wide; anterior end rounded, posterior end round to truncate; abdominal segmentation more or less distinct, separation between segments VII-VIII well-defined marginally, somewhat constricted; without anal lobes, posterior abdominal segments sometimes sclerotized marginally.

Dorsal Surface

Multilocular Pores (fig. B). 7.52µm (6.65-9.50) in diameter, with 5-10 locules, normally with 7; sparsely distributed along submargino-marginal region, at times submedially.

Trilocular Pores (fig. C). 6.39µm (4.75-8.55) in diameter, with triangular or circular rim; distributed over entire surface of head, thorax and abdominal segments II-VII; fewer found on head and along margin of body, occasionally absent from anterior half of head and sometimes present along anterior border of abdominal segment VIII.

Simple Disc Pores (fig. D). 3.96µm (1.90-6.65) in diameter; located on submargino-marginal region of head, two anterior thoracic segments, and abdominal segment VIII; also distributed over entire surface of metathorax and remaining abdominal segments.

Cylindrical Ducts (fig. E). 4.80µm (3.80-5.70) in diameter, 13.1µm (9.50-17.1) long, with collar approximately one-half length of duct, collar sometimes difficult to see; sparsely

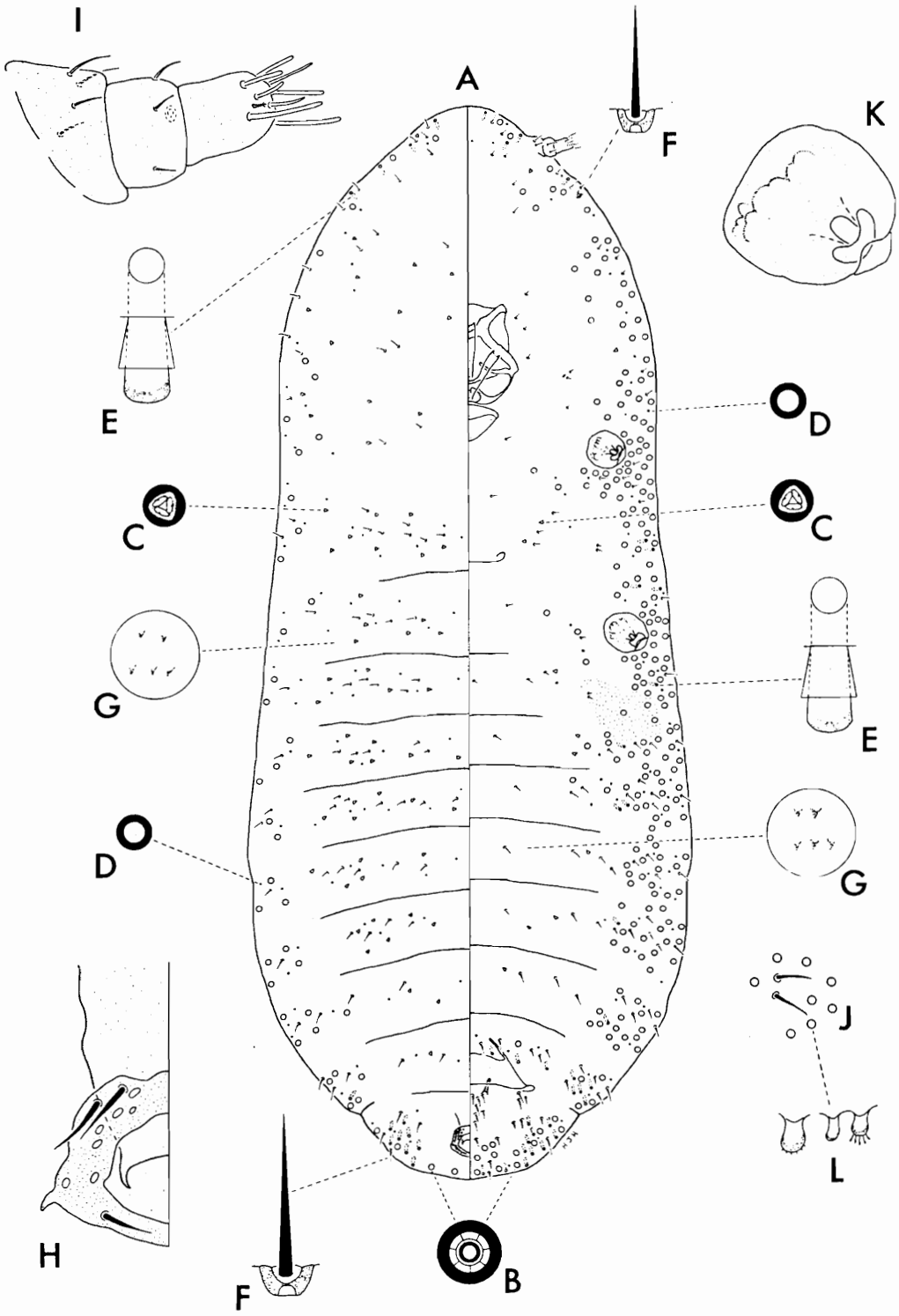

Plate 19. ***Paludicoccus distichlium*** **(Kuwana), Adult Female.**

distributed on margin of head and abdominal segments VI-VII, grouped laterally on submargino-marginal region of abdominal segment VIII.

Setae (fig. F). Flagellate, 4.75-28.5μm long, greater lengths located on posterior segments; distributed over entire dorsum except abdominal segment VIII, located laterally on segment VIII in submargino-marginal region, one pair occasionally present between anal ring and segment VII.

Spicules (fig. G). Minute, 0.95-3.80μm long, solitary or in groups of two or more; located on medio-submarginal region from mesothorax to anterior half of abdominal segment VIII.

Anal Ring (fig. H). 69.0μm (61.9-78.5) in diameter, centrally located on abdominal segment VIII; anal ring pores few, 2-9 on each side, 2.72μm (1.90-3.80) in diameter; six anal ring setae, 11.9-23.8μm long, length approximately one-fourth that of ring diameter.

Other Structures. Apparently none.

Ventral Surface

Eyes. Reduced, often with central depression or represented by an invaginated pit; diameter 9.12μm (7.14-11.9).

Antennae (fig. I). Three to four segmented, 63.7μm (48.5-78.9) long; diameter 45.0μm (38.0-54.1) at base.

Clypeolabral Shield. As long as broad, 163μm (152-176) long, 165μm (148-188) wide.

Labium. Approximately 1.5X broader than long, 61.4μm (47.6-71.4) long, 96.3μm (83.3-107) wide at base; two-segmented.

Legs. Absent or represented by remnants of pleural vestiges and group of 2-4 flagellate setae (fig. J), setae 4.75-6.65μm long.

Spiracles (fig. K). Anterior: spiracular arm 60.0μm (50.0-76.2) long, as broad as long, shape almost circular; peritreme present; atrium 25.9μm (23.8-28.6) wide. Posterior: similar to anterior pair, but slightly larger; arm 65.0μm (57.1-76.2) long; atrium 29.6μm (23.8-35.7) wide.

Multilocular Pores (fig. B). Structure as that on dorsum, 7.21μm (5.70-8.55) in diameter; located on submargino-marginal region of body, concentrated around spiracles, at times submedially.

Trilocular Pores (fig. C). Structure as that on dorsum, 6.30μm (4.75-7.60) in diameter; sparsely distributed on submargino-marginal region of head and prothorax, submedio-submarginal region of mesothorax and abdominal segments II-V, and medial region of

segment VI; sometimes found on medial and marginal regions of mesothorax and segments II-V.

Simple Disc Pores (fig. D). Structure as that on dorsum, 3.71μm (1.90-5.70) in diameter; distributed on submargino-marginal region of entire body except abdominal segment VII, located over entire surface of VII.

Duct-like Pores (fig. L). Minute, 1.77μm (0.95-2.85) in diameter, 3.63μm (2.85-4.75) long, often difficult to view entire structure; located on submargino-marginal region of metathorax and anterior half abdominal segment II, group of pores partially or entirely surrounds leg remnants.

Cylindrical Ducts (fig. E). Structure as that on dorsum; 4.64μm (3.80-5.70) in diameter, 13.7μm (9.50-17.1) long; sparsely distributed on margin of head and thorax, and few on submargin of abdominal segments II-VI in what appears to be longitudinal band; more found over entire surface of abdominal segment VII and on submargino-marginal region of abdominal segments VII-VIII.

Setae (figs. F). Structure as that on dorsum, 6.65-27.6μm long; distribution similar to that on dorsum except for abdominal segment VIII; setae on segment VIII found along entire margin, and in medial and submedial groups just posterior to vulva; apical setae absent.

Spicules (fig. G). Structure as that on dorsum, 0.95-2.85μm long, usually in groups of two or more; distributed on medio-submedial region of mesothorax, metathorax, and abdominal segments II-VII, sometimes located submarginally on segments II-VII.

Vulva. Distinct, smooth, opening is directed toward caudal end; with four associated apophyses, posterior pair of apophyses shorter than anterior pair and arise from segment VIII near vulva.

Other Structures. Mesothoracic apophyses usually evident.

Type Material Examined. Lectotype on *Distichlis spicata*, **USA,** California, Palo Alto, coll. S.I. Kuwana, 1(1) UCD (slide labeled "*Pseudolecanium disticlium*, Type, *Distichlis maritima*, Palo Alto, Cal., 18 Dec. 1901, S.I.K., Kuwana") [examined and here designated] Paralectotype data same as lectotype (data label same) 1(1) UCD. Lectotype and paralectotype were originally on one slide, but separated upon remounting.

Other Material Examined. ***Distichlis spicata*: ARGENTINA**, Mendoza Province, San Martin, 1950, coll. Rosas Costas, 2(4) UCD; **USA**, California, Alameda Co., Oakland, 5 Mar. 1968, coll. T.R. Haig, 1(1) VPI; C. Costa Co., Martinez, 6 Mar. 1968, coll. T.R. Haig, Calif. Dept. Agr. 68C11-33, 2(3) VPI; Palo Alto, salt marshes, 19 Aug. 1917, coll.

G.F. Ferris, "*Sphaerococcus disticlium* Kuw.", **TOPOTYPE**, 1(3) BM, 1(1) UCD; Palo Alto, salt marshes, 1 Feb. 1918, coll. G.F. Ferris, "*Sphaerococcus disticlium* Kuw.", 1(2) BM, 1(1) UCD; **USA**, Texas, nr El Paso, Jun. 1921, coll. Ferris, no. T122, 3(5) CBM, 4(7) UCD; Red River, nr Quanah, 1921, coll. Ferris, no. T279, 3(4) CBM, 2(2) UCD. ***Distichlis* sp.: USA**, California, San Diego Co., San Felipe Creek, 1939, Coll. Ferris, 1(3) UCD. **Undetermined Grass: USA**, Texas, Vernon, Pease River Bottom, date unknown, collector not given {probably G.F. Ferris}, "C.C.", no. T692, 1(1) CBM, 1(1) UCD.

Remarks. *Paludicoccus distichlium* apparently is restricted to saltgrass, *Distichlis* sp, in the southwestern United States and Argentina. On its host it can be found feeding under leaf sheaths of the culm and rhizomes (Ferris 1953). Although the etymology of the specific epithet for this species was not given by Kuwana (1902), it can be assumed it was derived from the host genus *Distichlis*. The original spelling of *disticlium*, either a *lapsus calami* or printer's error, was emended by Ferris (1953). The Bohart Museum, University of California at Davis, graciously loaned much of the above material, including two syntypes of *Pseudolecanium disticlium*. One of the two females of this series is selected as lectotype.

Ferris (1953) alluded that specimens from Argentina may represent a separate species. The slight degree of variation among specimens from all localities, especially in the distribution of cylindrical ducts, might initially compel one to separate them. Some specimens observed from California have few to no cylindrical ducts located ventrally between the prothorax and abdominal segment VII, nor caudally on segment VIII. This structure, however, is quite abundant on these areas in individuals observed from Texas and Argentina. Also observed was a difference between the number of antennal segments and the amount of reduction in the eye. North American specimens have three antennal segments and pit-like eyes, whereas those from Argentina have four antennal segments and convex eyes. No consistent variation, however, was observed to consider these specimens as separate species. The examination of adult males and immature stages should help clarify this possibility.

Duct-like pores on the specimen observed from Oakland, Alameda Co., California, exhibited an unusual aberration which may be of evolutionary importance. The diameter of some of these pores was approximately 2X larger than most others present. Superficially, these aberrant pores looked very similar to the concave disc-like pores of *Antonina* Signoret. Even if no direct phylogenetic transition from the duct-like pores of

Paludicoccus to the disc-like pores of *Antonina* exists, this phenomenon provides insight to the possible origin of disc-like pores seen in several genera.

Parapaludicoccus Mamet

Type species: *Parapaludicoccus isaloensis* Mamet, by original designation and monotypy.

Mamet, 1962: 179-180.

Mamet (1962) established this genus for a peculiar species collected in Madagascar; however, some doubt revolves around the type species. The two specimens from which Mamet based his description are the only ones known to exist and may not be adult females. Furthermore, host data was not provided by the collector, thus encumbering future collecting of additional material.

Despite the misleading name, *Parapaludicoccus* Mamet shares few characteristics other than regressive appendages with *Paludicoccus* Ferris. In the absence of synapomorphic characteristics such as specialized glands on the abdominal venter, the affinities and lineage of this genus are difficult to assess.

Parapaludicoccus isaloensis Mamet
Plate 20

Parapaludicoccus isaloensis Mamet, 1962: 180-182.

GENERAL DESCRIPTION

Body of Adult Female (fig. A). Appearance of unmounted adult females not known. On microscope slide: body oval, 926μm (916-935) long, 458μm (437-480) wide; abdominal segmentation poorly defined, segment VII partially or entirely concealed underneath segment VIII on dorsal surface; segment VIII circular to ovate and heavily sclerotized dorsally, anal ring located sub-centrally on segment, segment may also be sclerotized along its ventral margin; anal lobes undeveloped.

Dorsal Surface

Cylindrical Ducts. Of two types. Large ducts (fig. B): 3.42μm (2.85-3.80) in diameter, 14.6μm (14.3-15.2) long, with a sclerotized collar 1/4 length of tube; several encircle anal ring on abdominal segment VIII, few may also be present along margin of head.

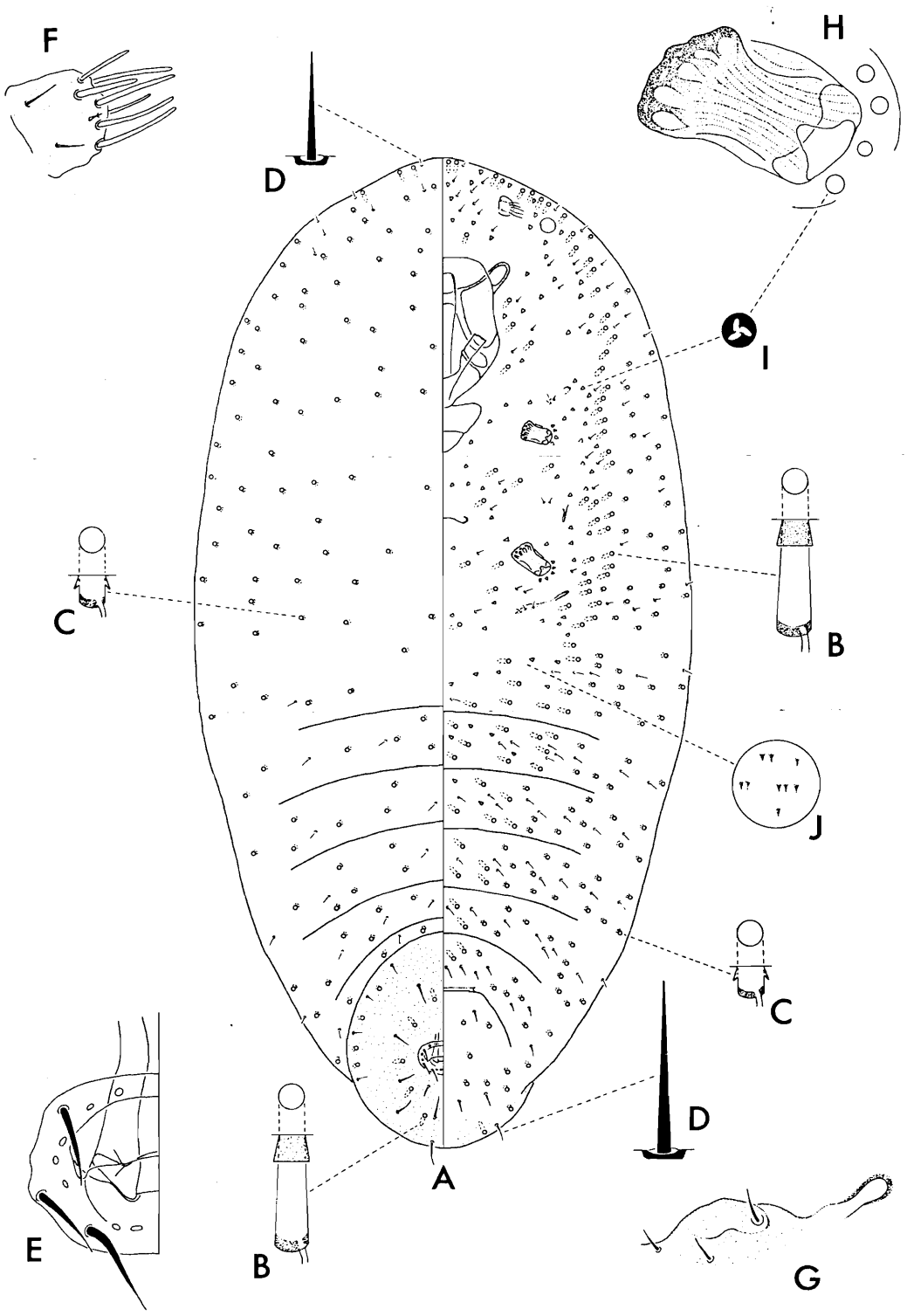

Plate 20. ***Parapaludicoccus isaloensis*** **Mamet, Adult Female.**

Small ducts (fig. C): 2.44μm (1.90-2.85) in diameter, 2.99μm (2.85-3.80) long, with a flanged collar 1/2 to 1/4 length of tube; distributed over entire dorsum except within circle of large ducts on segment VIII.

Setae (fig. D). Flagellate, sparsely distributed on submargino-marginal region of head and over entire surface of abdomen; length of those on head and abdominal segments II-VII relatively uniform, 5.70-8.55μm long; those on segment VIII longer and thicker, 16.2-32.3μm long.

Anal Ring (fig. E). 50.4μm (48.5-52.3) in diameter, possibly recessed in derm; anal ring pores few, in a single row, 1.43μm (0.95-1.90) in diameter; with six anal ring setae, 12.4-16.2μm long, approximately 3X shorter than ring's diameter.

Other Structures. Apparently none.

Ventral Surface

Eyes. Circular, base diameter 16.9μm (15.2-18.1).

Antennae (fig. F). Typically unsegmented, 17.8μm (12.4-23.8) long, base diameter 20.4μm (19.0-21.9).

Clypeolabral Shield. Length and width subequal, 155μm (143-167) long, 145μm (119-171) wide.

Labium. Approximately 1.5X broader than long, 50.0μm (47.6-52.4) long, 76.2μm (69.0-83.3) wide at base, two-segmented.

Legs (fig. G). Greatly reduced, represented by group of 2-3 flagellate setae and occasionally by small dermal protrusion; each leg remnant with vague lateral apophysis.

Spiracles (fig. H). Anterior: spiracular arm 34.9μm (33.3-35.7) long; atrium 19.0μm (16.7-21.9) wide; atrium with 2-8 trilocular pores around opening. Posterior: similar to anterior pair, but slightly larger; arm 38.9μm (35.7-40.5) long; atrium 22.2μm (21.4-23.8) wide; 4-8 trilocular pores associated with atrial opening.

Trilocular Pores (fig. I). 3.80μm (2.85-4.75) in diameter, with triangular to circular rim; distributed from head to abdominal segment V on area within band of large cylindrical ducts.

Cylindrical Ducts. Of two types, structures as those on dorsum. Large ducts (fig. B): 4.12μm (2.85-5.70) in diameter, 14.1μm (13.3-15.2) long; distinctively concentrated into an irregular band, band marginal on head and moves gradually mediad from point near eyes to abdominal segment VII, also found distributed in area between these bands, a single pair of ducts also located along segment VIII's margin. Small ducts (fig. C):

2.69μm (1.90-2.85) in diameter, 2.22μm (1.90-2.85) long; distributed from head to abdominal segment VII outside area occupied by large-type ducts and over entire surface of segment VIII.

Setae (fig. D). Flagellate, distributed over entire venter; length of those outside area occupied by large cylindrical ducts relatively uniform, 4.75-5.70μm long; those on remaining surfaces and on segment VIII longer and thicker, 8.55-20.9μm long; no apical setae present.

Spicules (fig. J). Approximately 0.95μm long, usually in groups of two or more; distributed on medio-submedial region of thorax and on area of abdominal segments II-VII occupied by large cylindrical ducts.

Vulva. Indistinct, see "Remarks".

Other Structures. Mesothoracic sternal apophyses evident.

Type Material Examined. Holotype on undetermined host, **MADAGASCAR**, Isalo, Mar. 1956, coll. A. Robinson, RM no. 746, 1(1) MNHNE (slide labeled with above information). Paratype data same as holotype, 1(1) MNHNE (slide label same as holotype).

Other Material Examined. None available for study.

Remarks. This is a most unusual mealybug, even among the legless species. Mamet described this species from material sent to him by Dr. Renaud Paulian, then deputy director of the Institut de Recherche Scientifique de Madagascar. Unfortunately these are the only two specimens currently known to exist and there is no host record to facilitate the collection of additional material.

Many structures were difficult to view because of the sclerotization of segment VIII and the deformation of the slide-mounted specimens. This was particularly a problem when examining the anal ring and vulva. Although a characteristic vulva was not observed, these specimens are being treated as adult females based on Mamet's original designation, the abundance of ultrastructures, and the presence of unusual dermal folds in the area typically occupied by the vulva.

The smaller cylindrical duct was described "as having a small adventitious cell adjoining the orifice." This so-called accessory cell is actually the appearance given by the ductule as it enters the sclerotized end of the duct. When viewed at certain angles, this area appears as a translucent spot, and could be mistaken for a cell.

Although the appearance of live forms is not known, a few observations were made with these two slide-mounted specimens that may shed light on its habitus. Dorsally,

abdominal segment VIII is probably concave and directed caudally at an angle. The curvature is assumed because there is a split in the derm on each side of the anal ring that extends laterally to the margin of the segment. Also, the majority of ducts and setae are aligned toward the anal ring. The angle is assumed because segment VII is folded on itself in both specimens, and it possesses many ultrastructures.

A concentration of ultrastructures (e.g., cylindrical ducts) into a band is frequently found along the margin of the body in Coccinea. The proximity of the band to structures found on the venter and the band's ventral location in the observed specimens would suggest it is located along the ventral surface of this species. Hypothetically, the body would take on somewhat of a wedge shape with head at apex if it was inflated and the ventral area within the aforementioned band remained anchored to a substrate. The collection of live material is needed to verify these assumptions.

***Peridiococcus* Williams**

Type species: *Sphaerococcus stypheliae* Maskell, by original designation.

Williams, 1985: 259-260.

Peridiococcus Williams (1985) was established for two species found in Australia and unsurprisingly assigned to the catch-all genus *Sphaerococcus* Maskell. Members are characterized by having the following: body more or less circular, abdominal segmentation typically indistinct, anal lobes lacking, posterior end of abdomen often transposed dorsally; body setae flagellate and distributed over entire body, apical setae absent, cerarii absent; trilocular pores present but few, primarily found on venter of head and thorax; simple disc pores present over entire body; multilocular pores few or absent; cylindrical ducts numerous, with flange-like collar on middle one-half to two-thirds of tube (Pl. 21, fig. E), two distinct sizes present in *Peridiococcus ethelae* (Fuller).

Dorsal ostioles absent; anal ring absent, anal opening removed from end of body because of transposition of abdomen; eyes present or absent; antennae unsegmented; clypeolabral shield as long as broad; labium two-segmented, ca. 1.3X longer than broad; spiracles heavily sclerotized, with broad arm, trilocular or quadrilocular pores present peritreme near atrium. Prothoracic and mesothoracic legs stub-like or absent; metathoracic legs modified into an enlarged flattened pouch, surface of pouch covered with disc-like pores; disc-like pores smaller than trilocular pores, locule granular and

concave, rim vague and irregular; circulus present or absent; vulva directed ventrally, often transposed to end of body or dorsally, associated apophyses vague or absent.

As noted by Williams (1985), the relationship of this genus among the Pseudococcidae is difficult to assess based on adult female morphology alone. Although grossly distinct from one another, the type species of *Peridiococcus* (Pl. 21) and *Sphaerococcus* Maskell (Pl. 23) share some characteristics in addition to reduced appendages and host species. The mouthparts are very similar in that the cross tentorial arm is located near the anterior end of the clypeolabral shield and the two-segmented labium is about 1.3X longer than broad. The rim of the trilocular pore has a translucent area separating circular outer region and triangular inner region. Small, irregular-shaped disc-like pores are present on modified metathoracic legs which appear to be enlarged coxae.

Key to Species of Genus *Peridiococcus*

Circulus present (Pl. 21, fig. A); eyes present; pores at spiracular opening quadrilocular (Pl. 21, fig. L); cylindrical ducts of one size on venter..... ***stypheliae***, p. 202

Circulus absent; eyes absent; pores at spiracular opening trilocular; two sizes of cylindrical ducts on venter, diameter of one type ca. 2X greater than other .....***ethelae***, p. 200

Peridiococcus ethelae (Fuller)

Sphaerococcus ethelae Fuller, 1897a: 1346; 1897b: 9; 1899: 449-450; Froggatt, 1921b: 9. **LECTOTYPE**, adult female, **AUSTRALIA**, Western Australia, Swan River, on *Casuarina* sp., USNM, examined and here designated.

Peridiococcus ethelae (Fuller) Williams, 1985: 260-263.

This species is found throughout Australia where it aggregates on twigs (Froggatt 1921b) of various casuarinas. It has been taken from *Casuarina glauca*, *C. luehmannii*, *C. cristata* (Williams 1985), and those species listed below. In addition to those locations listed below, it has been reported at Euston and Triangie, New South Wales; Cleveland, Yarraman, and Marmor, Queensland; Old Koomooloo and Middleback, South Australia; and Mildura, Victoria.

According to Fuller (1897a), adult females are globular, green, and enclosed by small white flecks of wax. To accompany Williams' (1985) superb illustration of mounted specimens is the following description: body subcircular to circular, abdominal segmentation absent dorsally, distinct ventrally, end of abdomen sometimes transposed slightly to dorsum.

Dorsal surface with simple disc pores and flagellate setae distributed over entire surface. Cylindrical ducts with flaring collar located on middle one-half to two-thirds of duct, ca. 5.0μm in diameter and ca. 7.5μm long; distributed over entire dorsum but predominantly found on margin of head and thorax. Anal ring absent, anal opening located about one-fourth total body length from posterior end of body, without setal rows between it and vulva. No other structures evident on dorsum.

Ventral surface also with simple disc pores and flagellate setae distributed over entire surface; apical setae lacking. Trilocular pores numerous but confined to area surrounding spiracles. Cylindrical ducts of two sizes; larger size similar to those described on dorsum, located on submargino-marginal region of body except posterior abdominal segments; smaller size similar to larger size duct but diameter ca. 2.5μm, structurally identical to those described in *P. stypheliae* (Maskell), located on medio-submedial region of venter except posterior abdominal segments, occasionally on submargin.

Eyes absent; antennae unsegmented, plate-like; clypeolabral shield slightly longer than broad; labium ca. 1.3X longer than broad, two-segmented. Spiracles heavily sclerotized, broad, with band of trilocular pores at atrium. Vulva distinct, wrinkled, directed ventrally. Mesosternal apophyses present, metasternal apophyses occasionally present. Prothoracic legs, mesothoracic legs, and podal apophyses entirely lacking; metathoracic legs modified into an enlarged flattened pouch, oval to triangular in shape, surface reticulate with disc-like pores; disc-like pores ca. 2.5μm in diameter, locule granular and concave, rim vague. No other structures evident on venter.

Peridiococcus ethelae is distinguishable from *P. stypheliae* by possessing two distinct sizes of cylindrical ducts on the body and trilocular pores at the spiracular opening, and by lacking eyes, circuli, and multilocular pores. As noted by Williams (1985), Fuller redescribed this species as new three times. Available for study were eight syntype females located on a single slide. These females were remounted onto five slides, and one was selected as lectotype with the other seven as paralectotypes.

Type Material Examined. Lectotype on *Casuarina* sp., **AUSTRALIA**, Western Australia, Swan River, coll. C. Fuller, 1(1) USNM. Original slide with 2 labels, one labeled "*Sphaero*: *ethelae*" in one handwriting and the other label with "on Casuarina sp., Swan R., W. Aust., Fuller Type" by another person; paper envelope with aforementioned data and Brain Coll. #404. [here designated]. Paralectotypes with same data, 4(7) USNM.

Other Material Examined. ***Casuarina cumagei*: AUSTRALIA**, New South Wales, Tranya, no date given, coll. Froggatt, no. 1650, 2(4) USNM, 2(2) VPI.

Peridiococcus stypheliae (Maskell)
Plate 21

Sphaerococcus stypheliae Maskell, 1895a: 27 [*nomen nudum*, Williams 1985: 263].
Sphaerococcus stypheliae Maskell, 1895b: 67-68; Fernald, 1903: 87.
Peridiococcus stypheliae (Maskell) Williams, 1985: 263-265 [lectotype designated].

GENERAL DESCRIPTION

Body of Adult Female. Maskell (1895b) described unmounted adult females as "covered by a semi-globular test of wax, which is yellow or with a faint pink tinge, though the general appearance on a twig is blackish, on account of the unusual fungus growths". The body is "dark purple or dark-brown, filling the test; the dorsal region convex, the ventral flat or slightly concave". The test is also lined inside with white wax.

On microscope slide (fig. A): body broadly oval to circular, 781µm (643-964) long, 789µm (607-964) wide, sclerotization at times along margins of older specimens; abdominal segmentation absent dorsally, vague ventrally; anal lobes lacking; abdominal venter approximately one-fifth total body length, end of abdomen often transposed to dorsum, thus vulva located terminally or more frequently dorsad.

Dorsal Surface

Multilocular Pores (fig. B). Occasionally present (see Remarks), 1-2 located on abdominal segment VIII when present; 6.18 (5.70-6.65) in diameter, pore apparently with 10 locules surrounding inner rim.

Trilocular Pores (fig. C). Occasionally present along margin of head and thorax; 4.87µm (4.75-5.70) in diameter, rim of pore with translucent area separating circular outer region and triangular inner region.

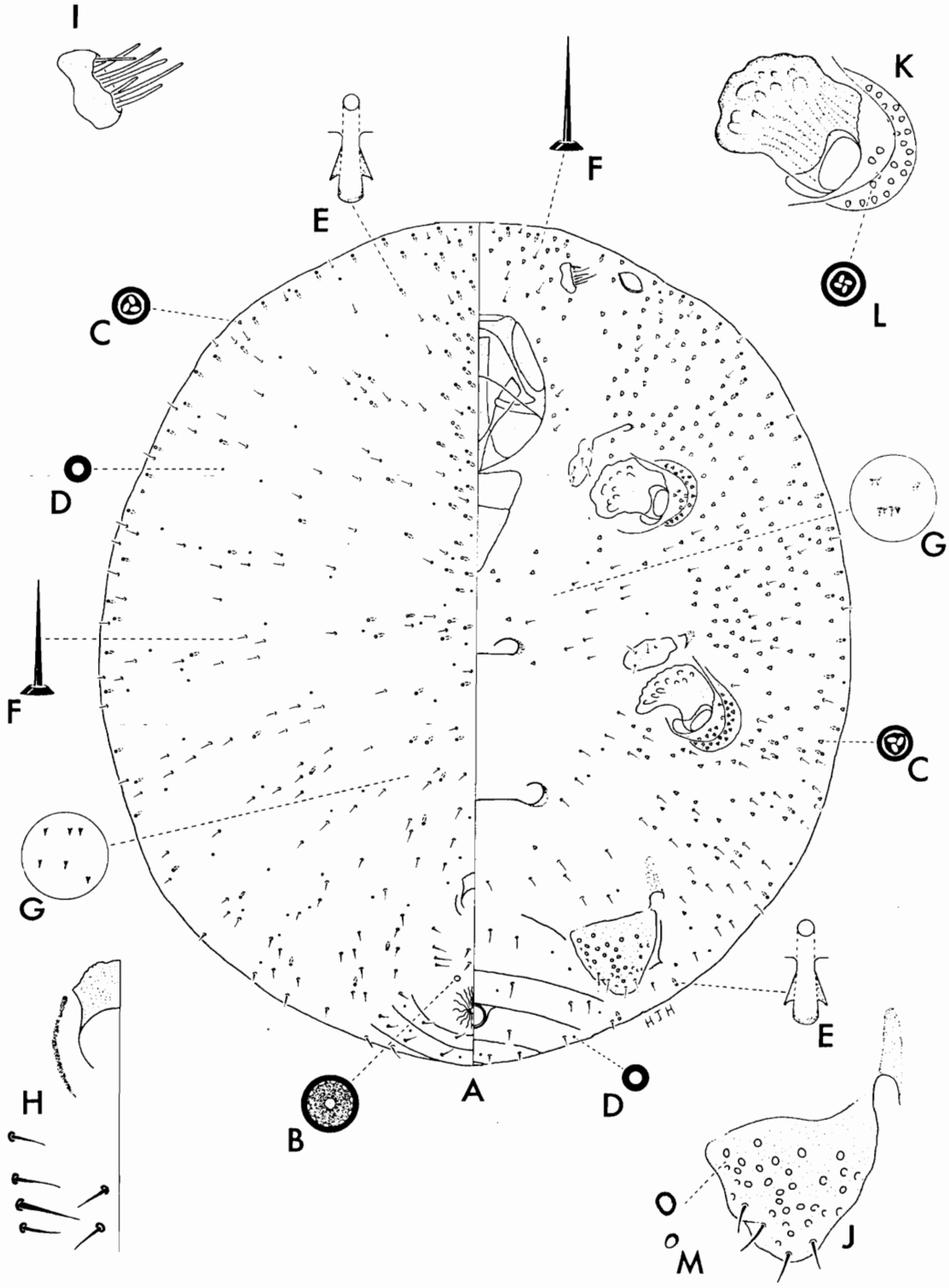

Plate 21. ***Peridiococcus stypheliae*** **(Maskell), Adult Female.**

Simple Disc Pores (fig. D). 2.61μm (1.90-3.80) in diameter, rim heavily sclerotized; distributed over entire dorsum.

Cylindrical Ducts (fig. E). 2.46μm (1.90-2.85) in diameter, 9.61μm (7.60-11.4) long; with flaring collar located on middle one-half to two-thirds of tube, collar may appear as an oral rim when looking down the tube orifice; distributed over entire dorsum, but found predominantly along margin and in longitudinal band from margin of head to metathorax; fewer present on abdomen.

Setae (fig. F). Flagellate, 6.65-19.0μm long, those setae located on abdominal segments thicker than others; distributed over entire dorsum; in four longitudinal rows between anal opening and vulva, inner rows with two setae each, outer pair with 4-5 setae each.

Spicules (fig. G). Minute, 0.95-1.90μm long, usually solitary; found on medio-submedial region of abdominal segments IV-VII.

Anal Ring (fig. H). Absent, sclerotization laterad to anal opening may be remnants of anal ring; anal opening 23.8μm (21.4-26.2) in diameter, located one-fifth to one-eighth of total body length from posterior end of body.

Other Structures. None apparent.

Ventral Surface

Eyes. Base diameter 18.0μm (11.9-21.4); approximately same size as antennae.

Antennae (fig. I). Unsegmented, 17.0μm (10.5-25.7) long and base diameter of 27.0μm (19.0-33.3).

Clypeolabral Shield. Slightly longer than wide, 127μm (124-136) long, 117μm (114-121) wide.

Labium. Approximately 1.4X longer than wide; 79.8μm (71.0-88.1) long, 56.4μm (47.6-71.4) wide at base; two-segmented.

Legs. Present, but greatly reduced, with an apophysis located laterad of each leg; prothoracic and mesothoracic legs set close to spiracles, metathoracic legs near end of body. Prothoracic leg stub-like, 10.9μm (7.14-14.3) long, apophysis vague at times; mesothoracic leg stub-like, 13.4μm (7.14-21.4) long; metathoracic leg (fig. J) an enlarged pouch, shape quadrate or triangular and moderately flattened, slightly recessed in groove, 67.4μm (40.5-88.1) long, 80.0μm (57.1-107) wide at base, covered with disc-like pores.

Spiracles (fig. K). Anterior: spiracular arm 53.2μm (47.6-59.5) long, broad; atrium 31.1μm (26.2-35.7) wide; 25-40 quadrilocular pores (fig. L) form a crescentic band

around atrium, band often obscured under dermal fold and by sclerotization, pore diameter 4.12μm (3.80-4.75), approximately same size as trilocular pores. Posterior: similar to anterior pair, but slightly larger; arm 57.1μm (54.7-61.9) long; atrium 33.1μm (28.6-35.7) wide; 20-35 quadrilocular pores comprise band.

Trilocular Pores (fig. C). Structure as that on dorsum, 5.05μm (4.75-5.70) in diameter; distributed over entire surface of head and thorax, predominantly on submargino-marginal region.

Simple Disc Pores (fig. D). Structure and distribution as that on dorsum, 2.94μm (1.90-3.80) in diameter.

Disc-like Pores (fig. M). Locule granular and concave, rim not precisely circular as seen in simple disc pores, 3.50μm (1.90-4.75) in diameter; located on expanded coxae of metathoracic legs.

Cylindrical Ducts (fig. E). Structure as that on dorsum, 2.35μm (1.90-2.85) in diameter, 9.17μm (7.60-11.4) long; sparsely distributed along margin of venter.

Setae (fig. F). Structure and distribution as that on dorsum, 7.60-20.9 long; no apical setae present.

Spicules (fig. G). 0.95-2.85μm long, typically in groups of two or more; found on medio-submedial region of thorax and abdominal segments II-VI.

Vulva. Distinct, wrinkled, directed ventrally; with two small apophyses, apophyses usually imperceptible.

Other Structures. Mesothoracic and metathoracic sternal apophyses present, prothoracic sternal apophyses vague if present; circulus present between abdominal segments III-IV, may be misinterpreted as the anal ring due to its location on shifted abdomen.

Type Material Examined. Lectotype from *Monotoca* (or *Styphelia*) *elliptica*, **AUSTRALIA**, New South Wales, Vaucluse, near Sydney, date unknown, coll. W. W. Froggatt, 1(1) NZAC (slide labeled as "*Sphaerococcus stypheliae*, adult female, 1894, W.M.M."). Paralectotype data same as lectotype, 1(1) NZAC (slide label same as lectotype).

Other Material Examined. All material from **AUSTRALIA**. ***Acacia* sp.:** Melbourne, no date given, coll. G. Compere, no. 348, "*Sphaerococcus stypheliae* Mask.", 2(6) USNM. ***Leptospermum* sp.:** N.S. Wales, Sydney, seashore, 20 Dec. 1905, coll. A. Koebele, no. 2025, Kotinsky coll. no. 249, "*Sphaerococcus stypheliae* Mask.", 4(6) USNM. **Undetermined Host**: Sydney, no date given, "on wild bush", coll. G.

Compere, no. 1063, "*Sphaerococcus stypheliae* Mask.", 2(9) USNM; Sidney, Watson's Bay, no date given, "on wild plant", coll. G. Compere, no. 348, "*Sphaerococcus stypheliae* Mask.", 1(4) USNM; "*Sphaerococcus stypheliae* Mask.", mounted from Maskell's type material (see Remarks), 3(4) NZAC, 7(10) USNM, 2(4) VPI.

Remarks. The last lot of material listed above was mounted from what is presumed to be Maskell's type material held in two boxes located at NZAC. These boxes are labeled "*Sphaerococcus stypheliae* Mask., Australia, Mask. Coll. #407" and "*Sphaerococcus stypheliae* Mask., Australia". Deitz and Tocker (1980) indicated that Maskell sometimes included subsequent lots of the 'same species' to his original dry material; nonetheless, these slide-mounted specimens match those of Maskell's original slides. There are seven additional slides mounted from Maskell's material and housed in the USNM. Two of these slides contain no specimens, one contains a male specimen which may either be *P. stypheliae* or an eriococcid, and the remaining four slides contain eriococcid specimens.

When this species is slide-mounted, the dorsum tends to fold on itself because of its convex shape, especially along the margins. This folding is often one-sided, thus the medial band of cylindrical ducts may appear to be submarginal or marginal to one side. Although a prothoracic or mesothoracic leg may be absent, its associated apophyses marks its true position.

What is believed to be a multilocular pore is structurally different from that of other species. Only four total were observed in three of the 45 examined specimens. Yet only one of these so-called multilocular pores possessed what resembled locules; moreover, these locules were very vague. Whether or not it is a true multilocular pore is uncertain; however, it will be classified as such based on Williams' (1985) observations and on structural resemblances seen here. The illustrated multilocular pore is an interpretation made from what was observed.

As in other species (e.g., *Acinococcus triodiae*), the disc-like pore associated with the metathoracic leg looks similar to the simple disc pore that is distributed over the entire derm. It differs from the simple disc pore by the characteristics of its locule and rim. The locule of the disc-like pore is concave and appears more granular, whereas that of the simple disc pore is convex. Third instars also possess vestigial appendages, but are without disc-like pores on the metathoracic legs.

In addition to the hosts listed above, *P. stypheliae* has been collected on *Melaleuca* sp. and *Agonis elliptica* (Williams 1985).

Diagnosis. This species is easily distinguished from *Peridiococcus ethelae* (Fuller) by having quadrilocular pores associated with spiracular opening, a circulus, and well-developed eyes.

Pseudantonina Green

Type Species: *Pseudantonina bambusae* Green by original designation and monotypy.

Green 1922: 363-364; Ferris 1953: 411; Borchsenius 1960: 923-926; McKenzie, 1967: 285-286; Ali, 1970: 114-115; Williams & Granara de Willink, 1992: 419-421; Tang, 1992: 116-117.

Pseudantonina, like *Sphaerococcus* Maskell, appears to be a crossroads for several species in their journey to correct taxonomic placement. *Pseudantonina spirapuncta* Lobdell, *P. lingnani* Ferris, *P. caudata* Borchsenius, *P. fushanensis* Borchsenius, *P. guandunensis* Borchsenius, *P. magnotubulata* Borchsenius, *P. ostiolata* Borchsenius, *P. poae* (Maskell), *P. junci* De Boer, and *P. raouliae* De Boer have been transferred to other genera. These transferences or their summarizations may be found in Ferris (1953), Borchsenius (1960), Cox (1987), Koteja (1989), and Tang (1992). *Pseudantonina agaves* Chiaromonte was found to be conspecific with the eriococcid *Ovaticoccus agavium* Doug. (Borchsenius 1958). None of the remaining four species (*P. aeria* Williams & Granara de Willink, *P. arundinariae* McConnell, *P. giganticoxa* Lobdell, *P. texana* Ferris) bear any resemblance to the type species, a sentiment expressed also by Borchsenius (1960). Most of these species were placed in *Pseudantonina*, not based on the morphology of the type species, but on Ferris' (1953) description of enlarged and flattened hind coxae beset with pores, and reduced antennae and legs in North American species.

Varshney (1992) reported two species, *Pseudantonina imperata* Green and *Pseudantonina rigida* Green as *nomen nudum*, but these species were not treated because of the unavailability of material. *Pseudantonina aeria*, *P. arundinariae*, *P. giganticoxa*, and *P. texana* are treated under "Species of Uncertain Placement" at the end of this chapter. A definition of *Pseudantonina* may be found in the description of its type species below.

Pseudantonina bambusae Green
Plate 22

Pseudantonina bambusae Green, 1922: 363-364; Green, 1937: 295; Ali, 1970: 115.

LECTOTYPE, adult female, SRI LANKA, Nuwara Eliya, on *Teinostachyum attenuatum* (BM), examined and here designated.

GENERAL DESCRIPTION

Body of Adult Female. Green (1922) described the unmounted body as elliptical, flattened dorso-ventrally, and occasionally covered by loose white wax.

On microscope slide (fig. A): body elliptical to ovate, 3084μm (1540-4998) long, 1296μm (714-1821) wide; both ends rounded although posterior end at times concave in younger individuals, anal lobes absent; abdominal segmentation more or less distinct, lateral segmentation between abdominal segments VII-VIII slightly constricted in younger individuals; anal ring usually transposed to venter.

Dorsal Surface

Multilocular Pores (fig. B). 6.96μm (5.70-8.55) in diameter, with 10 locules; few located along margin of head; also located on margin of segment V and over entire surface of segments VI-VIII with most of these found marginally; occasionally seen along margin of thorax and segments II-IV.

Trilocular Pores (fig. C). 4.94μm (3.80-5.70) in diameter, rim triangular to circular; distributed over entire dorsum except none found on abdominal segment VIII, fewer located in areas occupied by multilocular pores.

Simple Disc Pores (fig. D). 3.35μm (1.90-4.75) in diameter; few present, sparsely distributed along margin of head, thorax, and abdominal segments II-IV, and over entire surface of segments V-VII.

Cylindrical Ducts (fig. E). 5.70μm (4.75-6.65) in diameter, 14.8μm (11.4-17.1) long; with thin collar that extends approximately 2/3 length of tube, collar not evident in poorly stained individuals; few present on margin of head, prothorax, and abdominal segments IV-VII; those found on abdominal segments located on posterior half of each segment.

Setae (fig. F). Flagellate, 8.55-28.5μm long; distributed over entire dorsum; in general, those found medially are small and those found on posterior segments appear slightly thicker.

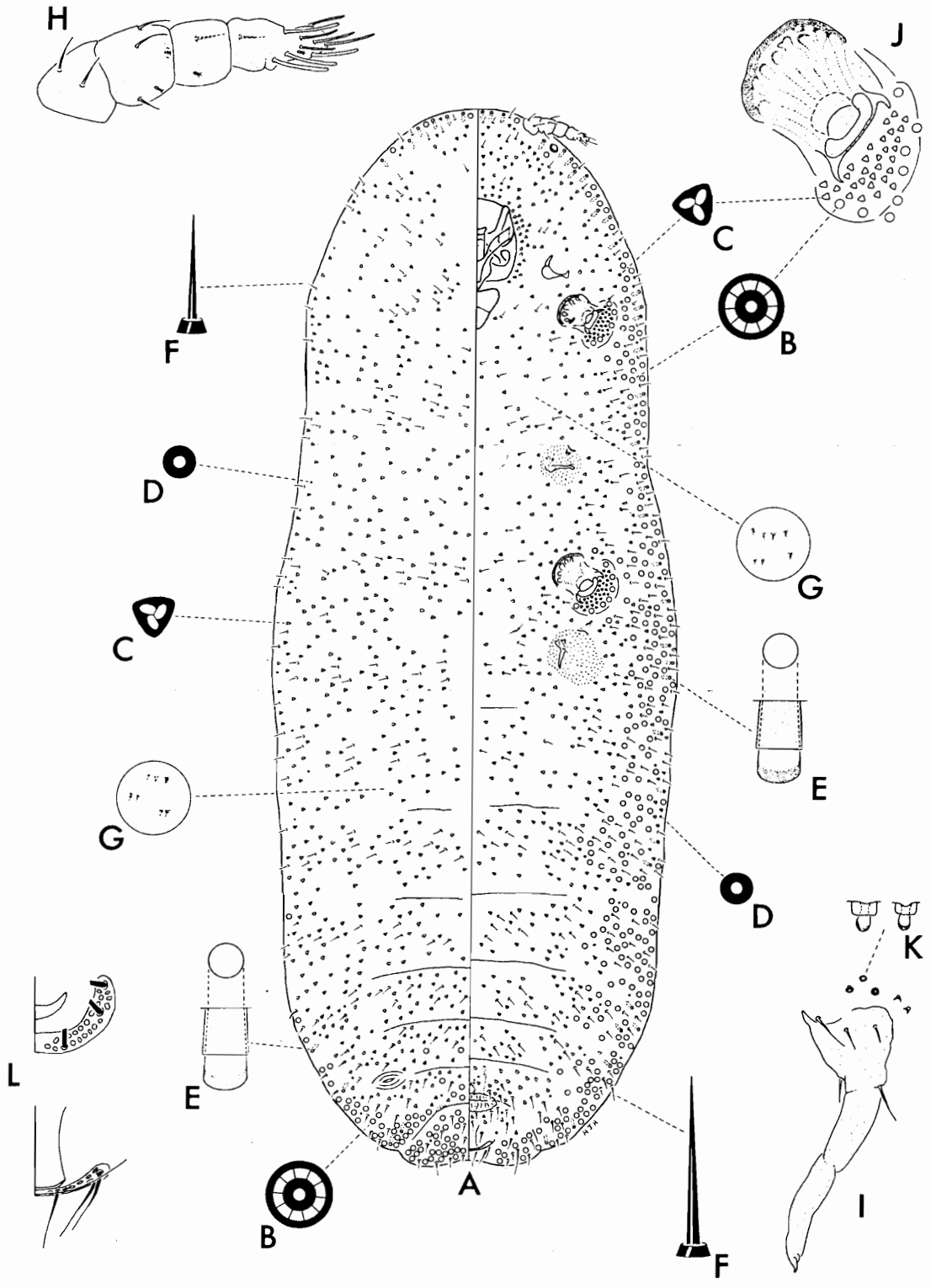

Plate 22. ***Pseudantonina bambusae*** **Green, Adult Female.**

Spicules (fig. G). Minute, 0.95-1.90μm long, in groups of two or more; located on medio-submedial region of thorax and abdomen, occasionally on submargin.

Dorsal Ostioles. Posterior pair present, poorly developed at times.

Other Structures. Small sclerotized apodemes located submedially between abdominal segments VII-VIII.

Ventral Surface

Eyes. Well-developed, diameter 13.4μm (11.9-15.0).

Antennae (fig. H). With 3-6 segments, typically five, 122μm (105-157) long; base diameter 39.0μm (28.5-47.5).

Clypeolabral Shield. As long as broad, 159μm (150-168) long, 156μm (145-163) wide.

Labium. Length and width subequal, 77.1μm (70.0-82.5) long, 79.4μm (71.4-85.0) wide at base, two-segmented.

Legs. Present, with various degrees of reduction and fusion, at times broken off or mere stubs. Prothoracic leg 12.5-170μm long, often with small apophysis; mesothoracic leg 19.0-158μm long, with small apophysis and group of duct-like pores surrounding base; metathoracic leg (fig. I) 20.9-173μm long, with small apophysis and group of duct-like pores surrounding base.

Spiracles (fig. J). Anterior: spiracular arm 65.5μm (55.0-76.2) long, nearly as broad as long; atrium 37.5μm (32.5-45.2) wide; apparently with incomplete peritreme; 1-9 multilocular pores and 20-40 trilocular pores form a crescentic band around atrium, trilocular pores form inner margin of band. Posterior: similar to anterior pair, but larger; arm 80.5μm (70.0-100) long; atrium 46.7μm (40.0-52.4) wide; atrial band with 1-20 multilocular pores and 30-60 trilocular pores.

Multilocular Pores (fig. B). Structure as that on dorsum, 6.39μm (5.70-7.60) in diameter; located along margin of head and prothorax, and on submargino-marginal region of remaining body segments.

Trilocular Pores (fig. C). Structure as that on dorsum, 4.82μm (3.80-5.70) in diameter; distributed over entire venter, fewer located in areas occupied by multilocular pores, grouped along lateral margins of clypeolabral shield and around vulva.

Simple Disc Pores (fig. D). Structure as that on dorsum, 2.85μm (1.90-3.80) in diameter; located on submedio-marginal region of head, thorax and abdominal segments II-VI, and over entire surface of segments VII-VIII.

Duct-like Pores (fig. K). Minute, 2.38μm (1.90-2.85) in diameter, 4.43μm (2.85-5.70) long; collar present but difficult to view at times; located in compact group around mesothoracic and metathoracic legs, group demarcated in young individuals and appearing plate-like.

Cylindrical Ducts (fig. E). Structure as that on dorsum, 5.38μm (3.80-7.60) in diameter, 14.0μm (9.50-19.0) long; distributed along entire margin of venter with fewer found on first two to three abdominal segments.

Setae (fig. F). Structure as that on dorsum, 10.5-33.3μm long; distribution similar to that of dorsum, grouped around vulva; apical setae present, 42.8-76.0μm long.

Spicules (fig. G). Structure and distribution as that on dorsum, 0.95-1.90μm long.

Vulva. Distinct, wrinkled, directed ventrally and surrounded by thick flagellate setae; with four long apophyses.

Anal Ring (fig. L). Semi-circular, 84.3μm (75.0-95.2) in diameter, located near end of segment VIII, anus directed caudally (fig. A) or ventrally; anal ring pores 3.29μm (1.90-4.75) in diameter, 20-50 present in two rows that are separate medially; six anal ring setae, 33.3-62.7μm long.

Other Structures. Thoracic sternal apophyses at most vaguely evident.

Type Material Examined. Lectotype on *Teinostachyum attenuatum*, **SRI LANKA**, Nuwara Eliya, Mar. 1898, coll. E.E. Green, 1(1) BM (slide labeled "*Pseudantonina bambusae* Green, on small bamboo, Nuera Eliya, Ceylon") [examined, here designated]. Paralectotype data same as lectotype, 2(9) BM; two paralectotype specimens are located on slide containing lectotype.

Other Material Examined. Remaining specimens examined [4(8) BM 3(3) VPI] were subsequent slides mounted from Green's dry type material. Data same as type series and with "BM 1940, 180".

Remarks. Through the courtesy of the British Museum, I have been able to examine E. Ernest Green's syntype series as well as his dry type material. His slide series comprises 10 adult females and a few immature stages on two slides. An adult female located on a slide of three has been designated as lectotype. Although the body is broken in half, it best represents the structures present and their distribution. The two remaining females on this slide as well as the seven located on the other slide are designated paralectotypes.

The presence of duct-like pores around the mesothoracic leg complicates the hypothesis that the specialized pores (e.g., duct-like) found in many of the legless mealybugs evolved from translucent pores which are found on metathoracic legs. A

similar condition with disc-like pores is seen in *Antonina thaiensis* Takahashi. *Pseudantonina bambusae* is also unusual in that the anal ring is transposed to the venter. In only one specimen was it located on the dorsum, but this was likely due to the mounting. It appears that the ring is directed caudally, but the compression from mounting forces the ring in most specimens to appear flush with the derm.

As with *Antoninoides parrotti* (Cockerell) and *Paludicoccus distichlium* (Kuwana), some duct-like pores found on specimens of *P. bambusae* were as wide as deep. Superficially, these particular pores resemble small versions of disc-like pores found in *Antonina* Signoret and others. It is suggested to see the Remarks section under the *Paludicoccus distichlium* description for the significance of this observation.

Diagnosis. This species is easily distinguished by having a semi-circular anal ring transposed to the venter and duct-like pores associated with the mesothoracic legs.

Sphaerococcus Maskell

Type species: *Sphaerococcus casuarinae* Maskell, by monotypy.

Maskell, 1892: 39; 1893: 237; 1895a: 26-27; Cockerell, 1896b: 49; 1899a: 392; 1899b: 262; 1899c: 277; Fernald 1903: 85-87; Ferris 1918a: 323-324; 1919: 249; Froggatt 1921b: 7; Morrison & Morrison 1922: 35-38; Hoy 1963: 14; DeLotto 1969: 23; Beardsley 1974a: 325, 328; 1984a: 100; Williams 1985: 359.

As Ferris (1918a) so aptly put it, *Sphaerococcus* Maskell has been nothing more than a "convenient dumping-place for a considerable number of species that are but little understood -- or it were entirely truthful to say not understood at all." Many previous workers (Morrison & Morrison 1922, Hoy 1963, Beardsley 1974a, Beardsley 1984a, Williams 1985) have considered the genus a heterogeneous group; moreover, some have indicated that it was probably monotypic. To date, 38 species (Table IV) have been assigned to it since its establishment, with only one by transference. Maskell himself described half of these species.

Twenty-two of these 38 species have been reassigned to other genera by previous workers. Of the 16 currently assigned to *Sphaerococcus*, only one, *Sphaerococcus durus* DeLotto, appears to share affinities with the type. Further studies are necessary to provide a definite placement for the 14 remaining species (see Species of Uncertain

Table IV. Species assigned to the genus *Sphaerococcus*.

Species	Current Placement	
	Genus[a]	Family[b]
Sphaerococcus acaciae Mask., 1893	*Callococcus* (Morrison & Morrison 1927)	Asterolecaniidae (Beardsley 1984a)
Sphaerococcus africanus Brain, 1915	*Lenania* (DeLotto 1979)	Pseudococcidae (DeLotto 1979)
Sphaerococcus bambusae Mask., 1893	*Chaetococcus* (Maskell 1898)	Pseudococcidae
Sphaerococcus cantentulatus Froggatt, 1921	*Celaticoccus* (Lambdin & Kosztarab 1976)	Lecanodiaspididae (Lamb. & Krb. 1976)
Sphaerococcus casuarinae Mask., 1892	*Sphaerococcus*	Pseudococcidae (Williams 1985)
Sphaerococcus cupressi Ehrhorn, 1911	*Ehrhornia* (Ferris 1918a)	Pseudococcidae (Ferris 1953)
Sphaerococcus diaspidiformis Green, 1916	*Mycococcus* (Ferris 1952)	Asterolecaniidae (Ferris 1952)
Pseudolecanium disticlium Kuwana, 1902[c]	*Paludicoccus* (Ferris 1918a)	Pseudococcidae (Ferris 1953)
Sphaerococcus durus DeLotto, 1969	*Sphaerococcus*	Pseudococcidae (DeLotto 1969)
Sphaerococcus elevans Mask., 1895	*Floracoccus* (Beardsley 1974a)	Eriococcidae (Beardsley 1984a)
Sphaerococcus ethelae Fuller, 1897	*Peridiococcus* (Williams 1985)	Pseudococcidae (Williams 1985)
Sphaerococcus ferrugineus Froggatt, 1898	uncertain	uncertain
Sphaerococcus floccosus (*nomen nudum*)[d]	uncertain	uncertain
Sphaerococcus froggatti Mask., 1894	uncertain	uncertain
Sphaerococcus graminis Mask., 1897	*Antonina* (Fernald 1903)	Pseudococcidae (Williams 1985)
Sphaerococcus inflatipes Mask., 1893	*Sphaerococcopsis* (Cockerell 1899b)	Eriococcidae (Hoy 1963)
Sphaerococcus inflatipes simplicior Mask., 1896	*Sphaerococcopsis* (Beardsley 1974b)	Eriococcidae (Hoy 1963)
Sphaerococcus leaii Fuller, 1897	*Casuarinaloma* (Froggatt 1933)	Eriococcidae (Beardsley 1984a)
Sphaerococcus leptospermi Mask., 1894	*Callococcus* (Morrison & Morrison 1927)	Asterolecaniidae (Beardsley 1984a)
Sphaerococcus melaleucae Mask., 1894	uncertain	uncertain
Sphaerococcus morrisoni Fuller, 1897	uncertain	uncertain
Sphaerococcus morrisoni elongatus Fuller, 1899	uncertain	uncertain
Sphaerococcus newmanni Froggatt, 1921	uncertain	uncertain
Sphaerococcus obscuratus Mask., 1896	*Kuwanina* (Ferris 1919)	Eriococcidae (Hoy 1963)

Table IV. Species assigned to the genus *Sphaerococcus* (Continued).

Species	Current Placement	
	Genus[a]	Family[b]
Sphaerococcus parvus Mask., 1897	*Kuwanina* (Fernald 1903)	Cryptococcidae (Kosztarab 1968)
Sphaerococcus pirogallis Mask., 1894	*Eremococcus* (Ferris 1919)	Asterolecaniidae (Beardsley 1984a)
Sphaerococcus populi Mask., 1898	*Doraphis* (Eastop & Lambers 1976)	Aphididae (Ferris 1936)
Sphaerococcus pulchellus Mask., 1897	*Callococcus* (Ferris 1918a)	Asterolecaniidae (Beardsley 1984a)
Sphaerococcus pustulans Green, 1905	uncertain	uncertain
Sphaerococcus rugosus Mask., 1897	uncertain	uncertain
Sphaerococcus rugosus elongatus Mask., 1897	uncertain	uncertain
Sphaerococcus socialis Mask., 1897	uncertain	uncertain
Sphaerococcus stypheliae Mask., 1895	*Peridiococcus* (Williams 1985)	Pseudococcidae (Williams 1985)
Sphaerococcus sylvestris Ckll. & King, 1898	*Kermes* (Bullington & Kosztarab 1985)	Kermesidae (Bull. & Krb. 1985)
Sphaerococcus tepperi Fuller, 1897	uncertain	uncertain
Sphaerococcus tokionis Ckll., 1896	*Aclerda* (McConnell 1953)	Aclerdidae (McConnell 1953)
Sphaerococcus tomentosus Fuller, 1899	uncertain	Eriococcidae (Afifi & Kosztarab 1967)
Sphaerococcus turbinata Froggatt, 1921	uncertain	

[a]Major reference of new combination.
[b]Major reference of familial placement.
[c]Transferred to *Sphaerococcus* by Fernald (1903).
[d]Name used by Green (1917).

Placement at end of chapter). These studies will not only require the examination of type specimens, but also fresh material including males and nymphal females.

Members of *Sphaerococcus* can be defined as broadly oval to circular; abdominal segmentation distinct but reduced ventrally, surface area of last abdominal segment at least 1/3 of total area of abdominal venter; vulva transposed cephally near center of abdomen; anal lobes lacking; posterior abdominal segments sclerotized, margin of anterior segments occasionally sclerotized.

Trilocular pores and simple disc pores present dorsally and ventrally; cylindrical ducts occasionally present on venter of *S. casuarinae*; body setae flagellate and conical, apical setae present. Posterior dorsal ostioles present, at times poorly developed. Cerarii absent or present only on posterior abdominal segments. Anal ring at base of an asymmetrical tube, tube orifice slightly dorsad and removed a short distance from end of body. Sclerotized apodemes present or absent between abdominal segments VII-VIII.

Eyes present but reduced; antennae reduced, with 2-5 segments; clypeolabral shield slightly longer than broad; labium at least 1.3X longer than broad, two-segmented. Spiracles heavily sclerotized, numerous trilocular pores clustered at atrium. Legs present with various degrees of reduction and fusion, podal apophyses present; surface of expanded metathoracic coxae covered with disc-like pores, pore at times with deep locule and approaching duct-like status. Vulva distinct, wrinkled, directed ventrally, with four vague apophyses. Thoracic sternal apophyses present or absent.

Based on this comparative analysis of adult female morphology, no other genus covered appears related to *Sphaerococcus*, although some characteristics are shared. Most notable is the similarity in design of the trilocular pore and labium between this genus and *Peridiococcus* Williams. As noted earlier, the similarities between these two genera are few. Hopefully, comparative analyses of other developmental stages will shed light on the taxonomic placement of this renown genus.

Key to Species of Genus *Sphaerococcus*

Posterior dorsal ostioles well-developed, anterior lip distinct (Pl. 23, fig. A); cerarii present on posterior abdominal segments (Pl. 23, fig. D); labium ca. 1.7X longer than broad; trilocular pores present on dorsum of abdominal segments VII-VIII ..... ***casuarinae***, p. 215

Posterior dorsal ostioles poorly developed, nearly obsolete; cerarii absent; labium ca. 1.3X longer than broad; trilocular pores absent from dorsum of segments VII-VIII ..... ***durus***, p. 220

Sphaerococcus casuarinae Maskell
Plate 23

Sphaerococcus casuarinae Maskell 1892: 39-41; Ferris 1919: 249-250; Froggatt 1921b: 8-9; Morrison & Morrison 1922: 35-37; Williams 1985: 359-361 (lectotype designated by Williams, 1985).

GENERAL DESCRIPTION

Body of Adult Female. Froggatt (1921b) described the unmounted body as "resting upon a felted cotton pad on the bract of the host gall; dark reddish brown; naked when exposed, but under the cover of the bracts often more or less covered with white cotton; broadly oval, very convex".

On microscope slide (fig. A): body broadly oval to circular, 1581μm (1142-2321) long, 1491μm (1071-2106) wide; abdominal segmentation distinct but reduced ventrally, surface area of last abdominal segment ca. 1/2 total area of abdominal venter, vulva located ca. 1/3 length of body from posterior end; posterior end rounded to slightly truncate and sclerotized, anal lobes lacking; sclerotization may be found along anterior margins of older specimens.

Dorsal Surface

Trilocular Pores (fig. B). 5.97μm (4.75-7.60) in diameter, rim of pore with translucent area separating circular outer region and triangular inner region; distributed over entire dorsum.

Simple Disc Pores (fig. C). 3.31μm (1.90-4.75) in diameter; distributed over entire dorsum.

Setae. Of two types. Conical: stout, 14.3-20.9μm long, associated with cerarii (fig. D). Flagellate (fig. E): 9.50-42.2μm long; distributed over entire dorsum, greatest lengths found along entire margin and on abdominal segments.

Spicules (fig. F). Minute, ≤1.90μm, usually solitary; located on medio-submarginal region of abdominal segments III-VII.

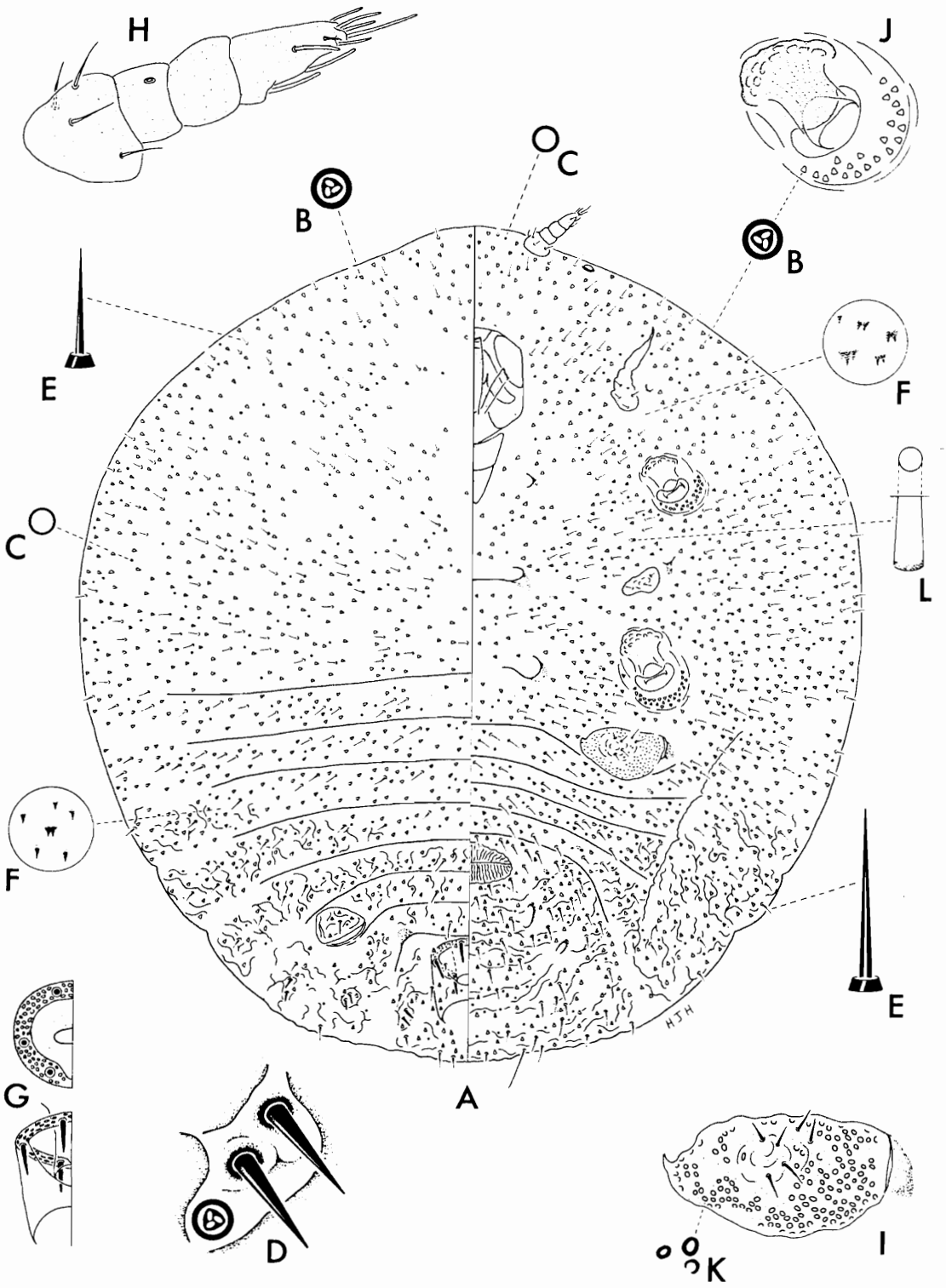

Plate 23. ***Sphaerococcus casuarinae*** **Maskell, Adult Female.**

Dorsal Ostioles. Posterior pair present; anterior lip well-developed, with 1-3 flagellate setae and 4-6 trilocular pores; posterior lip poorly developed.

Anal Ring (fig. G). 107μm (88.1-117) in diameter, at base of asymmetrical tube; anal ring pores numerous, 2.69μm (0.95-3.80) in diameter; six anal ring setae, stout, 20.9-31.5μm long, length approximately one-sixth diameter of ring; anal tube 87.5μm (71.4-114) long, opening located slightly dorsad at end of body.

Other Structures. Sclerotized apodemes located submedially between abdominal segments VII-VIII; cerarii composed of 2 stout setae and 1-3 associated trilocular pores located on last three abdominal segments, recessed within dermal folds and often difficult to observe.

Ventral Surface

Eyes. Base diameter 16.3μm (11.9-19.0).

Antennae (fig. H). Reduced to 3-5 segments, typically 4-segmented, 84.1μm (60.8-106) long; base diameter 40.1μm (34.2-47.5).

Clypeolabral Shield. Approximately 1.2X longer than broad, 168μm (155-179) long, 142μm (131-150) wide.

Labium. Approximately 1.7X longer than broad, 112μm (95.2-121) long, 67.3μm (50.0-78.5) wide at base, two-segmented.

Legs. Present with various degrees of reduction and fusion, at times broken off or stub-like, with an apophysis located laterad to each leg. Prothoracic leg 92.8μm (23.8-190) long; mesothoracic leg 44.2μm (11.9-95.2) long; metathoracic leg (fig. I) 39.1μm (11.9.-119) long, coxal base expanded, with group of disc-like pores found on and around expanded area.

Spiracles (fig. J). Anterior: spiracular arm 70.1μm (52.4-85.7) long; atrium 48.9μm (40.5-52.4) wide; 20-40 trilocular pores form a crescentic band around atrium. Posterior: similar to anterior pair, but slightly larger; arm 84.7μm (71.4-100) long; atrium 56.9μm (45.2-64.3) wide; 25-45 trilocular pores comprise band.

Trilocular Pores (fig. B). Structure and distribution as that on dorsum, 5.90μm (4.75-7.60) in diameter.

Simple Disc Pores (fig. C). Structure and distribution as that on dorsum, 3.22μm (1.90-4.75) in diameter.

Disc-like Pores (fig. K). 3.54μm (1.90-4.75) in diameter, similar to simple disc pores but with thicker rim; distributed on surface of and around expanded base of metathoracic legs.

Cylindrical Ducts (fig. L). Occasionally present, sparsely distributed on medio-submarginal region of thorax and abdomen; small, 2.58μm (1.90-2.85) in diameter, 6.18μm (4.75-7.60) long.

Setae (fig. E). Flagellate only, 8.55-29.5μm long; distribution similar to that of dorsum; apical setae present, 40.9-65.6μm long.

Spicules (fig. F). Small, ≤2.85μm, typically in groups of two or more; located on medio-submarginal region of head, thorax, and abdominal segments II-V.

Vulva. Distinct, oval, wrinkled, directed ventrally; with four small apophyses, apophyses frequently imperceptible.

Other Structures. Thoracic sternal apophyses present, prosternal apophyses often vague; 1-2 pairs of sclerotized apodemes located submedially posterior to vulva.

Type Material Examined. Paralectotype on *Casuarina quadrivalvis*, **AUSTRALIA**, Victoria, no other location data known, date not given, coll. C. French, 1(1) NZAC (data labeled as "*Sphaerococcus casuarinae*, adult female, 1891, W.M.M.").

Other Material Examined. All material from **AUSTRALIA**. ***Casuarina quadrivalvis*:** Label partially missing, "Lidgett", "Mym...", "971.?", 1(2) UCD. ***Casuarina* sp.:** South Australia, Blackwood, 9 Apr. 1960, coll. N. Lanthois, spec. index 37/60, 4(6) VPI, 1(2) WARI. **Host Unknown:** No other collection data, 1(2) VPI.

Remarks. *Sphaerococcus casuarinae* apparently is restricted to *Casuarina* in Australia. It has also been taken from *C. glauca*, *C. luehmannii*, *C. stricta*, and *C. verticillata* (Williams 1985). In addition to the above localities, *S. casuarinae* has been recorded from Geelong and Wyperfield National Park, Victoria (Williams 1985); Toranga Park, Sydney, (Williams 1985) and Newport (Froggatt 1921b), New South Wales; Eidsvold and Marmor, Queensland (Williams 1985). Its distribution probably extends into adjoining Pacific Islands where this host genus is native.

Sphaerococcus casuarinae appears to have a close association with galls formed by the eriococcid *Cylindrococcus casuarinae* Maskell. The galls of this eriococcid, found on the same host species as *S. casuarinae*, is conical to fusiform with basal bracts (Gullan 1984). Maskell (1892) and Froggatt (1921b) reported *S. casuarinae* as feeding at the base of these galls, sometimes under the bracts.

The structures of this species are often distorted when the globular body is compressed under coverslip. The posterior end of several slide-mounted specimens was folded on itself ventrally, thus distorting the terminal segments and frequently obscuring the presence and location of the vulva. The cerarii are often difficult to detect because of their recessed location and the sclerotization of the derm. Through the courtesy of the Waite Agricultural Research Institute, I was able to prepare favorable slide-mounts of young adult females collected in Blackwood. These slides (see above) were suitable for determining the normal condition of problematic morphological characteristics.

Cylindrical ducts were not present in some examined specimens, a condition also observed by Williams (1985). Although not seen in available material, Williams indicated that these ducts may be present along the margin of the cephalothorax. The difference between our observed distributions may be due variation in the definition of the marginal area. The distribution reported here corresponds to that observed in immature females available for examination.

Diagnosis. This species is distinguished from *Sphaerococcus durus* DeLotto by having well-developed posterior dorsal ostioles and cerarii present on the posterior abdominal segments. *Sphaerococcus casuarinae* also has a much longer labium. In this species it is ca. 1.7X longer than broad, whereas in *Sphaerococcus durus* it is ca. 1.3X.

Sphaerococcus durus DeLotto

DeLotto, 1969: 23-24.

Sphaerococcus durus was described from material collected under the bark of branches of *Leucosidea sericea* (Rosaceae) at Golden Gate, South Africa. Live adult females are dorso-ventrally flat when young, and become highly convex at maturity (DeLotto 1969). DeLotto's description and illustration are suitable for diagnosis of this species, but the following additions and corrections are provided to follow the format of this study. Slide-mounted females are broadly elliptic; abdominal segmentation distinct but reduced ventrally, surface area of last abdominal segment ca. 1/3 total area of abdominal venter, vulva located ca. 1/4 length of body from posterior end; posterior end rounded, anal lobes lacking; the derm wrinkled and sclerotized both dorsally and ventrally on margin of head, thorax and abdominal segments II-III, and entire surface of segments IV-VIII.

Dorsal surface with simple disc pores and short conical setae, ca. 6.00μm long, distributed over entire surface. Trilocular pores located on submargino-marginal region of head and thorax, and submargin of abdomen; those anteriorly found primarily along margin; occasionally found on submedian of thorax. Posterior dorsal ostioles present but poorly developed. Anal ring at base of asymmetrical tube, tube orifice removed from end of body at distance subequal to tube diameter; six anal ring setae present, but other characteristics obscured by sclerotization. Sclerotized apodemes between abdominal segments VII-VIII and cerarii lacking.

Ventral surface with similar dermal ultrastructures. Trilocular pores structurally as those on dorsum, distributed over entire venter except margin of abdominal segments VI-VIII, fewer found medially. Structure and distribution of simple disc as that on dorsum. Cylindrical ducts lacking. Setae of two types; conical similar to those on dorsum, found on margin of head and submargino-marginal region of remaining segments; flagellate setae stiff, almost conical, distributed over entire surface of head and medio-submedial region of remaining segments; apical setae present.

Eyes reduced and recessed; antennae with 2-3 segments; clypeolabral shield slightly longer than broad; labium ca. 1.3X longer than broad, two-segmented. Spiracles heavily sclerotized, spiracular arm with incomplete peritreme, numerous trilocular pores clustered at atrium. Legs greatly reduced and with associated apophyses; prothoracic and mesothoracic pairs conical; metathoracic legs conical to globular, almost bag-like, with dorsal and ventral surfaces covered by setae and deep disc-like pores; disc-like pores ca. 1.9μm in diameter and 1.9μm deep, pores could be classified as shallow duct-like pores. Vulva distinct, wrinkled, directed ventrally, with four vague apophyses. No other structures evident on venter.

Sphaerococcus durus is distinguished from *Sphaerococcus casuarinae* Maskell by lacking cerarii, dorsal apodemes, sternal apophyses, and well-developed posterior dorsal ostioles. This species also has conical setae distributed over the entire dorsum and a shorter labium.

Type Material Examined. Holotype female on *Leucosidea sericea*, **SOUTH AFRICA**, Orange Free State, Golden Gate, 11 Nov. 1966, coll. G. DeLotto, H.C. no. 2568, 1(1) PPRI. Paratype females with same data, 3(3) PPRI.

ADDITIONAL TAXONOMIC CHANGES

Apezococcus dakotensis (Kosztarab & McDaniel) comb. n.

Antonina dakotensis Kosztarab & McDaniel, 1969: 111-114.

Antonina dakotensis Kosztarab & McDaniel (1969) was described from a single specimen collected on *Bouteloua hirsuta* in South Dakota. Dr. Douglas R. Miller (Systematic Entomology Laboratory, USDA, Beltsville, Maryland) long questioned the placement of this species in *Antonina* and noted resemblances to the eriococcid genus *Apezococcus* Ferris. The holotype, itself poorly mounted, was available for examination through the courtesy of the USNM. The morphological structures visible in the holotype agreed with Ferris' (1955) definition of the monotypic *Apezococcus*; however, no material of *Apezococcus idiastes* Ferris was available to determine if the two were conspecific.

Type Material Examined. Holotype on *Bouteloua hirsuta*, **USA**, South Dakota, Custer Co., Custer St. Park, 5 Aug. 1967, coll. B. McDaniel, 1(1) USNM.

SPECIES OF UNCERTAIN PLACEMENT

Pseudantonina aeria Williams & Granara de Willink (*incertae sedis*)

Williams & Granara de Willink, 1992: 421-423.

Pseudantonina aeria was described from material collected on a bromeliad, *Tillandsia* sp. The authors justifiably noted that a redescription of the type species was needed, and assigned this unusual species to *Pseudantonina* because of its resemblance to North American species.

This species was defined (Williams & Granara de Willink, 1992) as having large cylindrical ducts on dorsal and ventral surfaces, ducts with oral collars and with diameter subequal to that of multilocular pore; multilocular pores few, found predominantly on posterior abdominal segments; few trilocular pores present on median of thorax and anterior abdominal segments; anterior and posterior dorsal ostioles poorly developed; cerarii present on last abdominal segment; spiracles of typical pseudococcid form; legs

well-developed but small, metathoracic coxae expanded and beset with numerous translucent pores.

Williams & Granara de Willink (1992) suggested the relationship of this species to other North American species, in particular *Pseudantonina texana* Ferris. This species bears no resemblance to *P. bambusae* based on description, but its proper placement among the Pseudococcidae can not inferred without further generic revisions of the family on a global scale. Additional characters, particularly from preadult stages, may be needed to assign this species.

Pseudantonina arundinariae McConnell
(*incertae sedis*)

McConnell, 1941: 93-95; Ferris, 1953: 412-413; McKenzie, 1967: 286-287.

In addition to the type host and locality, *Pseudantonina arundinariae* has also been recorded from California on 'dwarf bamboo' (McKenzie 1967). According to McConnell (1941), live adult females are found between leaf sheaths of its host. The description and illustration of McConnell are very adequate for diagnostic purposes. Some of the following characteristics are repeated, while others are supplementary or additions.

Adult females, mounted, elliptical; dorsal ostioles represented by reduced posterior pair; anal ring complete, slightly dorsad on abdominal segment VIII, with six setae and two discontinuous rows of pores; with a single pair of cerarii on last abdominal segment; antennae 6-segmented; eyes present; vulva directed ventrally, with lateral and caudal pairs of apophyses; legs reduced, segmentation evident.

Multilocular pores with 9-10 locules, distributed on dorsal margin of posterior abdominal segments, on venter distributed on margin of thorax and anterior abdominal segments, most numerous over entire ventral surface of posterior abdominal segments. Trilocular pores, simple disc pores, and flagellate setae numerous over entire body. Apical setae small but distinct. Cylindrical ducts few and small, ca. 2.5μm in diameter and 5.0μm long, diameter ca. 0.5X that of trilocular pore, with oral collar extending 1/2 length of duct, inner end of duct which is not surrounded by collar bulbous; sparsely distributed on dorsal margin of abdominal segments IV-VIII, also sparsely found over entire venter of abdominal segments VI-VIII. Duct-like pores without collars present around base of metathoracic legs.

This species shows no affinities with *P. bambusae* other than the reduced antennae to 5-6 segments, reduced legs, and the presence of duct-like pores in the area surrounding the metathoracic legs. Other than the presence of duct-like pores around the base of mesothoracic legs in the type species, major differences between these two species are the structure and location of the anal ring, and the size and design of cylindrical ducts. *Pseudantonina arundinariae* may be found to belong to *Kiritshenkella* Borchsenius or *Balanococcus* Williams, but its true placement remains questionable until the assemblages of these two genera are resolved.

Type Material Examined. Paratypes on *Arundinaria* sp., **USA**, South Carolina, Anderson, 18 & 25 Aug. 1939, coll. H.S. McConnell, 1(1) UCD, 2(2) USNM.

***Pseudantonina giganticoxa* Lobdell**
(*incertae sedis*)

Lobdell, 1930: 211-212; Ferris, 1953: 414-415.

This species was originally described from *Cyperus ovularis* or *echinatus* at A. & M. College, Mississippi. Although no type material was observed, the viewed specimen from *Aristida* at Georgia is undoubtedly *Pseudantonina giganticoxa*. Ferris (1953) erroneously gave as author the name Hoke, which was the married name of the author at the time of Ferris' redescription.

The original description and illustration of this species are preferable over those of Ferris (1953), but are only satisfactory for diagnosis. To the original description should be added the following changes and additions. Slide-mounted adult female broadly oval, anal lobes slightly produced; anterior and posterior dorsal ostioles present, reduced; cerarii lacking; anal ring complete, centrally positioned on dorsum of abdominal segment VIII, with six setae and numerous pores. Antennae 6-segmented; eyes present; spiracles broad, with distinct peritreme, numerous trilocular and multilocular pores grouped at peritreme (as illustrated); legs reduced with podal apophyses vague, metathoracic coxae greatly enlarged and covered with numerous disc-like pores; vulva directed ventrally with lateral and caudal pairs of apophyses.

Body setae predominantly conical, distributed over most of body; flagellate setae thick, located ventrally on abdominal segment VIII; apical setae short. Multilocular pores with 10 locules, distributed over entire body; trilocular pores also found over entire

body. Cylindrical ducts small, ca. 2.5μm in diameter and 5.0μm long, diameter subequal to that of trilocular pore, with oral collar that extends the entire length of duct and flares at inner end, orifice appears to protrude from body integument (as illustrated); distributed over entire body.

This species shows no affinities with *P. bambusae*, but is similar to *Pseudantonina texana*. It is distinguished from *P. texana* by possessing disc-like pores rather than duct-like pores on expanded coxae, conical setae of entire body, and by lacking cerarii. Both of these species may be found with future studies to belong to *Kiritshenkella*, *Balanococcus*, or related genus.

Material Examined. Single female on *Aristida* sp., **USA**, Georgia, Emanuel Co., 16 Mar. 1976, coll. H.H. Tippins, 1(1) AU.

***Pseudantonina texana* Ferris**
(*incertae sedis*)

Ferris, 1953: 416-417; Williams & Granara de Willink, 1992: 423.

Ferris (1953) described *Pseudantonina texana* from a single specimen collected on *Panicum obtusum* near Quitique, Texas. As governed by Article 73(a)ii of the Code of Zoological Nomenclature, this specimen is the holotype due to monotypy. This species has also been recorded on an undetermined grass at Texcoco, Mexico (Williams & Granara de Willink 1992). The description and illustration of Ferris (1953) is adequate for diagnostic purposes.

Slide-mounted adult female broadly oval, anal lobes undeveloped; dorsal ostioles represented by reduced anterior and posterior pairs; cerarii represented by single pair on abdominal segment VIII; anal ring complete with numerous pores and six setae, centrally located on dorsum of segment VIII; antennae 6-segmented; eyes present; spiracles broad, with thin peritreme, numerous trilocular pores grouped at peritreme; legs reduced, podal apophyses evident, metathoracic coxae greatly enlarged and covered with numerous duct-like pores; vulva directed ventrally with lateral and caudal pairs of apophyses.

Body setae predominantly flagellate, thick, distributed over entire body, apical setae present; conical setae represented only by those associated with cerarii. Multilocular pores with 10 locules, located only on venter, grouped around metathoracic coxae and metathoracic spiracle (as illustrated), also found over entire venter of abdominal

segments VI-VIII. Trilocular pores numerous, distributed over entire body. Cylindrical ducts small, ca. 2.5μm in diameter and 5.0μm long, diameter subequal to that of trilocular pore, with oral collar that extends the entire length of duct and flares at inner end; distributed over entire body.

This species also shows no affinities with *P. bambusae*, but is very similar to *P. giganticoxa*. *Pseudantonina texana* is distinguished from this species by having duct-like rather than disc-like pores on the enlarged metathoracic coxae, multilocular pores only on the venter, and a single pair of cerarii on the last abdominal segment. These two species appear to represent a common genus.

Type Material Examined. Holotype on *Panicum obtusum*, **USA**, Texas, Briscoe Co., nr. Quitique, 1(1) UCD. Slide labeled as "*Pseudantonina texensis*, TYPE, on *Panicum obtusum*, escarpment near Quitique, Ferris, 1921."

Sphaerococcus ferrugineus Froggatt
(*incertae sedis*)

Froggatt, 1898: 378; Froggatt, 1921b: 10; Beardsley, 1984a: 85-88.

Sphaerococcus ferrugineus is found within ornate galls on *Melaleuca* in Queensland and New South Wales, Australia. Unmounted adult females preserved in alcohol were conical, heavily sclerotized, with mouthparts located at base of cone-shaped body and end of abdomen end at the apex. Individuals are embedded into the gall tissue with the pointed posterior section of the body exposed. Froggatt (1898) provided line drawings of the gall and specimen habitus with his description.

Although poor slide-mounts of this species were prepared from available dry material, the following observations were made. The caudal end is invaginated. This invagination, which is membranous, contains the vulva and anal opening. Eyes, antennae, legs, and anal lobes are lacking. The labium appears unsegmented and hairless. There are not many ultrastructures located on the body. Quinquelocular pores surround the spiracles, and within the caudal invagination are found many disc-like pores. The later are circular to oval, with a thick rim, and a single locule that is granular in appearance. Small, flagellate setae are sparsely distributed over the entire body. The anal opening is simple, without a sclerotized rim but with six setae.

This species has no affinities with *Sphaerococcus*, and may prove not to be a pseudococcid. Froggatt (1898) listed *S. ferrugineus* under the gall-forming Brachyselinae of Maskell's (1897a) classificatory scheme, not under the unavailable group-name Idiococcinae as were previous *Sphaerococcus* species.

Material Examined. AUSTRALIA, Queensland, Brisbane, on *Melaleuca*, 9 Aug. 1972, coll. M. Kosztarab and W.A. Millen, VPI SP011, 4(8) VPI.

Sphaerococcus floccosus (nomen nudum) (*incertae sedis*)

A description of *Sphaerococcus floccosus* has not been located to date; however, Green (1917) reported that this species, without author and description, was found on *Correa alba*. Based on specimen labels, it is found on the roots of this rutaceous shrub.

As this is an unavailable name, a definition will not be given until such time that it may be done thoroughly and with illustration. It was observed, however, that this species has no affinities with *Sphaerococcus*, and is probably referable to the family Eriococcidae or related to these.

Material Examined. AUSTRALIA, Victoria, Cape Schank, on *Correa alba*, rec. Jun. 1905, coll. C. French, "*Sphaerococcus floccosus*", 1(2) USNM, 3(8) VPI. The later was mounted from dry material housed in the British Museum ("B.M. 1940, 180"). Additional dry material is also housed in SAM.

Sphaerococcus froggatti Maskell (*incertae sedis*)

Maskell, 1894: 94-95; Froggatt, 1921b: 10; Beardsley, 1984a: 85-88.

Sphaerococcus froggatti was described from material collected in galls on *Melaleuca linariifolia* at Flemington, New South Wales, Australia. Observed galls were made up of clusters of aborted leaves. The dry adult female mounted in this study was blood-red, more or less circular with the caudal end concave, and located within a central, felt-lined chamber. The slit-like opening to the chamber was found at the top of the gall. When placed in KOH, its color turned to lignin pink.

Slide-mounted, the body was as follows: circular, ca. 1600μm in diameter; derm posterior abdominal segments roughened with small, raised protrusions. Antennae reduced, unsegmented; eyes present; labium as broad as long, 1/2 as long as clypeolabral shield; legs and podal apophyses lacking; spiracles heavily sclerotized and broad, with peritreme; no distinct anal ring; vulva distinct and directed ventrally.

Entire body covered with long, stiff flagellate setae. Quinquelocular pores numerous; located over entire dorsum; ventrally found on margin of head and thorax, and over entire surface of abdomen, also grouped at spiracles. Disc-like pores present in large group on submedio-submarginal region of metathorax posterior to spiracle and abdominal segment II.

This species has no affinities with *Sphaerococcus*, but is very similar to *Sphaerococcus morrisoni* Fuller described below. Both are probably referable to the family Eriococcidae.

Material Examined. AUSTRALIA, New South Wales, Flemington, nr. Sydney, in galls on *Melaleuca linariifolia*, "K1510", collector and date not given, 1(1) AM. Additional dry material is also housed in SAM.

Sphaerococcus melaleucae Maskell
(*incertae sedis*)

Maskell, 1894: 94; Cockerell, 1899a: 392; Fernald, 1903: 85; Froggatt, 1921b: 12.

Sphaerococcus melaleucae was described from material collected by Walter Froggatt on *Melaleuca linariifolia* at Penhurst, New South Wales, Australia. Although no gall is formed, this species covers itself with "small masses of roughened black waxy secretions, from which project smaller conical processes" (Froggatt 1921b). Cockerell (1899a), without explanation listed this as a variant of *Sphaerococcus acaciae* Maskell and incorrectly gave Fuller authorship. This combination was also listed in Fernald's Catalogue (1903), but given authorship to Cockerell.

A single specimen was excised from a test identical to that described above. Although the individual was parasitized and distorted, the following observations were made. Adult female circular but posterior end tapered to small point, flattened ventrally, strongly convex dorsally. Body of female when slide-mounted circular, 1000μm in

diameter, last abdominal segment with anal cleft or closely appressed lobes; dorsum of posterior abdominal segments with transverse convolutions and sclerotization.

Eyes, antennae, and legs absent. Clypeolabral shield destroyed during mounting; labium two-segmented and slightly longer than broad; spiracles small with narrow arm. Anal opening at base of "lobes" but characteristics not discernible because of sclerotization; vulva small and wrinkled. Short, thick, flagellate setae present over entire body, fewer found ventrally, "apical setae" located medially on "lobes". Quinquelocular pores few on dorsum, distributed over entire surface except for segments with convolutions, confined to area near spiracular opening on venter.

Possible familial placement will not be inferred because the few structures that are present in the adult female stage may place it among several families; nonetheless, this species shares no affinities with *Sphaerococcus*.

Material Examined. AUSTRALIA, New South Wales, host, date and collector not given, 1(1) SAM. Collector probably C. French, Jr. and host appeared to be *Melaleuca* sp.

Sphaerococcus morrisoni Fuller
(*incertae sedis*)

Fuller, 1897a: 1346; 1897b: 9; 1899: 450-451; Froggatt, 1921b: 12-14; Beardsley, 1984a: 85-88.

Sphaerococcus morrisoni was described from material collected in obovate galls on *Melaleuca* at Pinjarrah, Western Australia. Slide-mounted adult females are circular without anal lobes. Eyes and legs are absent; antennae are absent or represented by an unsegmented stub. Neither anal ring nor vulva were discernible in the observed material. Quinquelocular pores of two sizes and stiff flagellate setae are found over the entire body. An unusual large group of disc-like pores is found in the medio-submedial region of the venter just posterior to the metathoracic spiracles.

The morphology of immatures suggest that this species is an eriococcid. In first instars and embryos, the antennae are 6-segmented. Each spiracle has one quinquelocular pore associated with it, no other glandular structures present on body. The anal opening is simple, without ring or setae. Dorsally, there are six longitudinal rows of large conical setae with one pair marginally. Second instars retain six-segmented

antennae and legs, but both are reduced. Quinquelocular pores are sparsely distributed over the entire body, and conical setae are replaced with flagellate setae. Also present are cylindrical ducts with cupped ends. This species has no affinities with *Sphaerococcus*.

Type Material Examined. Syntype adult females with embryos: **AUSTRALIA**, Western Australia, "Pinyarrah", on *Melaleuca*, TYPE, Brain #407, 1(5) USNM. Nymphs: data same, 1(13) USNM.

Sphaerococcus morrisoni var. *elongatus* Fuller
(*incertae sedis*)

Fuller 1899: 451.

Fuller (1899) briefly described *Sphaerococcus morrisoni* var. *elongatus* from material collected at Swan River, Western Australia. This variant was distinguished from *S. morrisoni* by characteristics of the gall which was produced. The gall was slender, often longer than that produced by *S. morrisoni*, and grey-green in color versus red.

The only morphological difference provided in the poor description was that the adult female was "but a little smaller." Interestingly, Froggatt (1921b) did not recognize this variation in his catalogue of Australian scale insects. A determination of its correct placement can not be provided without examining specimens of this species; however, there is little doubt that it shares no affinities with *Sphaerococcus*.

Sphaerococcus newmanni Froggatt
(*incertae sedis*)

Froggatt, 1921b: 14.

Described from material collected on *Melaleuca* at Busseltown, Western Australia, *Sphaerococcus newmanni* does not produce galls but secretes a yellow-brown "puparium" of wax, best described and illustrated by Froggatt (1921b).

Mounted females are broadly oval, ca. 4200μm long and 2800μm wide; entirely membranous except for a dorsal median band of sclerotization, without anal lobes. Eyes

and legs absent; antennae small and unsegmented; spiracles lightly sclerotized and broad. Clypeolabral shield with anterior pair of sclerotized horns; labium two-segmented, as broad as long, length 1/3 that of shield. Anal opening simple, without sclerotized ring or setae; vulva small and indistinct.

Flagellate setae cover the entire body with fewer found ventrally. A narrow median band of microtubular ducts extends the entire dorsum and terminates ventrally near end of body, short transverse bands intersect median band near both ends of dorsum, distribution corresponds to test pattern; ductule at inner end of duct bifurcate at times, tube orifice with oval rim which appears partially biloculate at times.

Large quinquelocular pores with pentagonal rim present on both surfaces, more numerous on dorsum, concentrated along median band, pore often recessed in derm and appearing to be at base of tube; smaller quinquelocular pores with circular rim distributed between spiracle and margin of body. Long cylindrical ducts with cupped end present on both surfaces, more numerous on dorsum, concentrated along median band.

Sphaerococcus melaleucae shows no affinities with *Sphaerococcus*; however, its observed test and morphology is similar in general appearance to that described (Ferris 1918a, Froggatt 1921b) for *Callococcus pulchellus* (Maskell), itself originally assigned to *Sphaerococcus*.

Material Examined. AUSTRALIA, Western Australia, "Busselton", host not given, date not given, coll. C. French, 1(2) SAM. Host appeared to be *Melaleuca* sp.

Sphaerococcus pustulans Green
(*incertae sedis*)

Green, 1905: 7-8; Beardsley, 1974a: 328; 1984a: 85-88.

Green (1905) described *Sphaerococcus pustulans* from material collected at Victoria, Australia, on *Eucalyptus* sp. The insect forms blister-like galls on the surface of the bark. The gall is flat and nearly circular with a small central pore (Green 1905). Body of adult females circular, ca. 2000µm in diameter, without anal lobes, dorsum with a central sclerotized patch.

Antennae with 4-6 segments, greatly reduced and stub-like; eyes absent; legs reduced, with stout segments, dorsal surface of metathoracic pair with numerous translucent pores. Anal ring at end of body, greatly reduced and fragmented, with six

short setae and few pores; vulva small, oval and wrinkled, vaguely apparent. Dermal ultrastructures consist of quinquelocular and thick flagellate setae, both distributed over entire body.

Green (1905) reported similarities between *S. pustulans* and *S. elevans* Maskell (= *Floracoccus elevans*). *Sphaerococcus elevans* differed by possessing a distinguishable rosette pattern centrally on the dorsum and by lacking legs. Beardsley (1974a) noted affinities in gall formation between this species and the eriococcid genera *Floracoccus* Beardsley and *Sphaerococcopsis* Cockerell, both which also attack *Eucalyptus*. *Sphaerococcopsis* species, like *S. pustulans*, are described as having distinguishable central patterns on their dorsum. Froggatt (1921b) surprisingly did not include *S. pustulans* in his catalogue of Australian scale insects.

Type Material Examined. Syntype females on *Eucalyptus gonicalyx*, **AUSTRALIA**, Victoria, Myrinong, no date given, coll. J. Lidgett, no. 52, 1(6) BM.

Sphaerococcus rugosus Maskell
(*incertae sedis*)

Maskell, 1897a: 322-323; Froggatt, 1921b: 17; Hoy, 1959: 10-11; Beardsley, 1984a: 85-88.

Sphaerococcus rugosus was collected within galls on *Leptospermum* at Western Australia. Although no material was observed, this species apparently is the same as the varietal form *Sphaerococcus rugosus* var. *elongatus* Maskell discussed below.

According to Maskell (1897a), the only organs evident on *S. rugosus* are the mouthparts and spiracles. Of the ultrastructures present, he observed "small circular spinnerets" and setae, "which are most numerous near the abdominal extremity..." He indicated in his description of *S. rugosus* var. *elongatus* that the only difference between the two was the shape of the gall produced. Both form galls which are wrinkled all over and without a visible opening, but the gall of *S. rugosus* is sub-globular with pointed apex whereas that of *S. rugosus* var. *elongatus* is fusiform (Maskell 1897a). Maskell also noted that the adult female and larva of the two were identical. Hoy (1959) and Beardsley (1984a) listed this species as of uncertain familial status.

Sphaerococcus rugosus var. *elongatus* Maskell
(*incertae sedis*)

Maskell, 1897a: 323-324; Froggatt, 1921b: 17.

As discussed above, *Sphaerococcus rugosus* and *S. rugosus* var. *elongatus* are probably conspecific; however, material of the former was not available for verification. *Sphaerococcus rugosus* var. *elongatus* was described from material collected on an undetermined host at Albany, Western Australia. Slide-mounted adult females are described as follows: body circular without anal lobes; antennae unsegmented, plate-like; eyes and legs lacking; anal opening simple, without ring or setae, at bottom of small invagination. Bilocular pores the only glandular structure present, found primarily on caudal segments around vulva and anal opening, few also distributed over rest of body. Body setae flagellate, with similar distribution as bilocular pores.

First instars without anal lobes; last four abdominal segments each with one long, curved conical seta on margin, apical setae as long as body, remaining setae on body small and flagellate. Legs long, derm of segments "scaly". Antennae with three segments, terminal segment 2X longer than first two combined, derm similar to legs. Spiracles without associated pores; anal opening simple, without ring or setae. Single pair of 8-shaped cylindrical ducts similar to those found in Phoenicococcidae; the only glandular structures present, found dorsally on abdominal segment II.

This varietal form has no affinities with *Sphaerococcus*. Although the cylindrical ducts found in first instars are characteristic of the family Phoenicococcidae, the bilocular pores present in adult females are found in other families, including Kermesidae and Eriococcidae. The proper familial placement of this species can not be inferred without additional data from other developmental stages.

Material Examined. Adult female with embryos: **AUSTRALIA**, "*Sphaerococcus rugosus elongatus* Mask.", Mask. Coll. No. 537, 1(2) USNM. First Instars: data same, 2(27) USNM.

Sphaerococcus socialis Maskell
(*incertae sedis*)

Maskell, 1897a: 325-326; Froggatt, 1921b: 18 (misspelled as *socilis*); Beardsley, 1984a: 85-88.

Sphaerococcus socialis forms globular galls with imbricated scales on myrtaceous plants in Western Australia; live adult females are globular, approximately 1.5mm in diameter (Maskell 1897a). Slide-mounted adult females are circular and without legs; eyes and antennae present, the later represented by an unsegmented stub; labium appears unsegmented; an anal opening was not perceivable in available specimens. Numerous quinquelocular pores and long flagellate setae cover the entire body. This species has no affinities with *Sphaerococcus*.

Material Examined. AUSTRALIA, "*Sphaerococcus socialis* Mask.", Mask. Coll. No. 510, 1(2) USNM.

Sphaerococcus tepperi Fuller
(*incertae sedis*)

Fuller, 1897a: 1346; 1897b: 9; 1899: 449; Froggatt, 1921b: 18; Beardsley, 1984a: 85-88.

Fuller (1897a, 1897b) briefly described *Sphaerococcus tepperi* from material collected on *Melaleuca* from Western Australia. Again he used characteristics of the formed galls as the primary diagnostic feature. Fuller (1899) later provided more details to his original description, particularly in relation to adult female morphology. Unfortunately, Fuller did not indicate the location of specimens on or within the gall.

Fuller (1899) described and illustrated the galls as spherical but flattened at base and apex, composed of aborted leaves of which the points protruded from the gall. Adult females were defined as yellow, elongate pyriform with head pointed and end of abdomen widely rounded; abdominal segments chitinous; anal opening simple; prothoracic & mesothoracic legs absent, metathoracic legs atrophied, with circular pores, resembling those found in *Sphaerococcus* (= Peridiococcus) *stypheliae* Maskell.

A gall matching the description of Fuller was made available by the South Australian Museum and was partially dissected. Within a basal cavity of the gall was found the pupal remains of a lepidopteran, but no mealybugs. At the inner base of aborted leaves were found several eriococcids similar to those found present with the type series of *Sphaerococcus stypheliae* (see *Peridiococcus stypheliae* description). Based on this information, Fuller's *Sphaerococcus tepperi* possibly may have been *S. stypheliae*, which has also been reported on *Melaleuca* at New South Wales (Williams 1985). The gall described by Fuller (1897a, 1897b, 1899) was reported similar to that

formed by *Sphaerococcus socialis* Maskell. Although data indicate that this species does not belong to *Sphaerococcus*, the poor descriptions of Fuller alone are independently insufficient to determine the placement of this species.

Sphaerococcus tomentosus Fuller
(*incertae sedis*)

Fuller, 1899: 450; Afifi & Kosztarab, 1967: 29-32.

Sphaerococcus tomentosus was described by Fuller (1899) from material collected on *Melaleuca* from Swan River, Western Australia. Live adult females are convex dorsally, flattened ventrally, within a sub-globular mealy test, and often in aggregations (Fuller 1899). Neither Fernald (1903) nor Froggatt (1921b) listed this species in their catalogues of scale insects.

Afifi and Kosztarab (1967) examined males of *S. tomentosus* and considered it to belong to the Eriococcidae. Available for study was one slide from Fuller's syntype series. This slide contained one adult male and several first instars which were not properly cleared before mounting. Although a complete examination of first instars was not possible, the condition of the material was adequate enough to make general observations. First instars have prominent anal lobes with conical setae. An anal ring is present with six setae and there are four longitudinal rows of conical setae (excluding marginal pair) on the dorsum. These few observations of first instars supports the conclusions of Afifi & Kosztarab that this species is an eriococcid.

Also available for study was one slide containing adult females collected from *Leptospermum* at New South Wales; therefore, this material may be misidentified as *S. tomentosus*. Afifi & Kosztarab (1967) noted discrepancies between males of this same lot of material with that of the type series. Slide-mounted adult females of this lot were circular with no anal lobes. Dorsum with many bilocular pores, quinquelocular pores, and large cylindrical ducts with cupped ends; fewer of all three found ventrally. Body setae flagellate, distributed over entire body. Eyes and legs absent; antennae represented by unsegmented stub; anal opening simple, without ring or setae. Whether a correct identification or not, this lot of material also appears to represent an eriococcid or related family.

There is disagreement between the specific epithet "*tomentosus*" provided with Fuller's type material listed below and "*tormentosus*" given in the original description. The Latin *tomentos* means "dense hair, stuffing" and could refer to the "congregating together and secreting quantities of white, woolly matter" (Fuller 1899). Fuller made no statements in his description that would suggest the selection of the Latin *torment*, meaning "a twisted rope" or "a missile." The misspelling of multilocular pore as "multiocular" in the original description may also suggest that "*tormentosus*" represents a printer's error in spelling.

Material Examined. Adult Female: **AUSTRALIA**, New South Wales, Canberra, on *Leptospermum*, coll. Froggatt, no. 1632, 1(4) BM. First Instars and Adult Male: **AUSTRALIA**, Western Australia, Swan River, on *Melaleuca*, TYPE, Brain #405, 1(6) USNM.

Sphaerococcus turbinata Froggatt
(*incertae sedis*)

Froggatt, 1921b: 19; Beardsley, 1984a: 85-88.

Froggatt probably surpassed Maskell in inadequate species descriptions with his treatment of *Sphaerococcus turbinata*. His description of this species is based merely on the gall formed by this insect because the "adult female coccids had been so badly damaged by hymenopterous parasites as to render their description impossible." This description represents rather well the problem stated by Ferris (1918a) about *Sphaerococcus*.

Sphaerococcus turbinata was described from turbinate galls collected on *Melaleuca* near Launceston, Tasmania. In his description, Froggatt (1921b) indicated similarities in the gall formed with that of *Sphaerococcus pirogallis* Maskell, which is currently included in the asterolecaniid genus *Eremococcus* Ferris. In that *S. turbinata* forms galls would suggest that it is not a member of *Sphaerococcus*, but the examination of fresh material is required to determine its correct placement.

CONCLUSIONS

The quotation of La Rochefoucauld which opens this study states, "Affected simplicity is a subtle form of imposture." This statement adequately reflects a problem that has existed in Pseudococcidae systematics for many decades. Previous workers frequently contemplated relationships among several mealybug genera (Table I) simply because they share reduced or lost features, rather than derived characters. Moreover, these taxa have typically been separated into their own group (e.g., Sphaerococcinae Cockerell) because of these delusive similarities, especially degenerative legs, and have assumed the misleading title -- legless mealybugs. The results of this comparative morphological analysis of adult females suggests that some, if not most, of these "legless" taxa are not related and have developed regressive features convergently under similar microhabitats or food specializations. However, homoplasy in vestigial legs has not been supported by a phylogenetic analysis of all the "legless" forms.

Despite the probable heterogeneity of the entire "legless" group, six genera (Table V) representing the tribe Serrolecaniini Shinji appear to form a natural group. These species share the following characteristics as adult females: duct-like pores present on modified metathoracic coxae or immediate area of body, clypeolabral shield with anterior projection, vulva directed caudally and with four prominent apophyses; and prominent pair of dermal depressions present on venter of abdominal segment VIII. An invaginated pit of unknown function was also observed latero-posterior to each metathoracic leg in first instars and embryos made available for examination. This structure was not seen in first instars of other "legless" forms that were also made available for study, and is possibly synapomorphic for the tribe Serrolecaniini.

Uncertainty remains to the proper placement of Serrolecaniini among the family Pseudococcidae. Shared affinities with *Balanococcus takahashii* McKenzie would place the tribe in the subfamily Pseudococcinae Cockerell of most current classifications (Danzig 1986, Tang 1992), but this placement awaits revisionary support and phylogenetic analyses of the family. The phylogeny proposed for the tribe Serrolecaniini (Chapter III) defines this taxon on the basis of having a ventrally directed vulva, dorsally positioned anal ring or anal tube orifice, an anterior projection on the clypeolabral shield, and expanded metathoracic coxae. These characteristics define the tribe relative to the outgroup *B. takahashii* only. If future phylogenetic analyses include all "legless" forms

Table V. Genera of "Legless" Mealybugs

Acinicoccus Williams	2[a]
Antonina Signoret	16
Antoninoides Ferris	3
Chaetococcus Maskell[b]	4
Cypericoccus Williams	1
Idiococcus Takahashi & Kanda[b]	1
Kermicus Newstead[b]	1
Nesticoccus Tang	1
Paludicoccus Ferris	1
Parapaludicoccus Mamet	1
Peridiococcus Williams	2
Porisaccus Hendricks & Kosztarab[b]	2
Pseudantonina Green	1
Serrolecanium Shinji[b]	4
Sphaerococcus Maskell	2
Tangicoccus Kozár & Walter[b]	1

[a]Number of species recognized following this study.
[b]Members of the tribe Serrolecaniini.

and support the monophyly of Serrolecaniini, the characters which define the group may change.

Results from the revision (Chapter II) and phylogenetic analysis (Chapter III) of the tribe suggests that while structural reduction has occurred to various appendages, converse transformations have taken place in other features to accommodate a sessile life under leaf sheaths. Most obvious among these changes is the dorsoventral flattening of the body and an elongation along the longitudinal plane; however, these features are widespread among grass-infesting Coccinea. Other adaptations, however, have evolved that apparently facilitate both reproduction and survivability in the Serrolecaniini.

Bands of muscle generally extend between the dorsum and venter to serve dorsoventral contractions of the body. Their points of attachment occasionally may be seen on the body integument in the form of small dermal depressions, particularly on the abdomen. In Serrolecaniini these depressions are very large on the last abdominal segment, especially on the venter just posterior to the vulva (Pl. 5, fig. A). The dimensional increase of these dermal depressions is probably correlated to an increase in muscle development at these points. Within proximity of these dermal depressions, the vulva of Serrolecaniini has four well-developed apophyses for muscle attachment and has its orifice directed caudally (Pl. 2), with the genital walls having shifted to the longitudinal plane.

Contraction of muscles attached to these particular dermal depressions and the vulvar apophyses would allow the individual to raise the end of the abdomen and open the vulva, thus facilitating copulation or egg deposition in otherwise confined habitats. It is currently not known if any of these species are ovoviviparous. Similar modifications to the vulva are seen in a few non-serrolecaniine species that infest grasses, such as *Paludicoccus distichlium* (Kuwana), but there are no dermal depressions evident and the vulvar apophyses are not well-developed. Nonetheless, similar adaptations to the vulva have developed along separate lineages.

Also seen in advanced species of Serrolecaniini is the development of lateral vulvar apodemes (Pl.. 3, fig. A). Muscles attached to these structures are probably used to close the vulva. Lateral vulvar apodemes are present in the genera *Porisaccus* Hendricks & Kosztarab and *Serrolecanium* Shinji (Fig. 5), as well as in *Chaetococcus bambusae* (Maskell). Further changes to the vulvar region are seen in *Serrolecanium*. In this genus the posterior pair of vulvar apophyses have moved caudally and arise from the dermal depression on segment VIII (Pl.. 13, fig. A). Although no empirical evidence is

available, all of the aforementioned adaptations evidently promote the reproductive success of the species.

Additional modifications that may be adaptations to reduce mortality are present on the abdomen of serrolecaniine species. Most of the "legless" species under study have heavy sclerotization along the margins of the body, particularly on the posterior abdominal segments. These regions of sclerotization are sometimes complimented with numerous conical setae. In addition to having these characteristics of the body, the abdomen of most serrolecaniine genera show a directional increase in intersegmental constrictions and in number of latero-posterior lobes (Fig. 5) beginning at the last abdominal segment. The latero-posterior lobes are heavily sclerotized and often armed with numerous conical setae; therefore, the ability to telescope the abdomen and overlap these armored lobes could protect this region of the body against parasitism without limiting maneuverability.

In all "legless" groups, characteristics of the disc-like and duct-like pores are one of the most intriguing adaptations to a sessile life and evidently promote reproductive success. These glandular structures are homologous to the translucent pores which are strongly believed to emit sex pheromones (Williams 1985). Primitively, these pores and their derivatives are found on well-developed metathoracic legs of various Pseudococcidae and Eriococcidae, particularly on the coxa, and occasionally surround the base of the legs (e.g., *B. takahashii*). The degeneration of legs and subsequent immobility of individuals would seemingly limit the use of pheromone producing glands, but several modifications have obviously been selected to overcome this problem.

Some species, such as the displaced *Pseudantonina giganticoxa* Lobdell, have a distributional and numerical increase of glands through an enlargement of their metathoracic coxae, while the remaining leg segments are atrophied or lost. Yet an increase in surface area is also seen in species without expanded coxae. The glands in several genera (e.g., *Antoninoides* Ferris) are found on the body in the immediate area of metathoracic legs, whether present or lost, and often encompass an area much larger than a typical mealybug coxa. The glands of *Tangicoccus elongatus* (Tang) form a marginal band nearly the entire length of the abdominal venter. Similar longitudinal bands are seen in several species of *Antonina* Signoret; moreover, the glands of this genus also show a magnification in surface area through an increase in structural size. The disc-like pores of this genus typically obtain maximum diameters subequal to those of multilocular pores.

Probably the most unusual transformation is the appearance of these glands at the region of the mesothoracic legs in *Pseudantonina bambusae* Green and *Antonina thaiensis* Takahashi. Unsurprisingly, modifications to these specialized glands are not confined to the Pseudococcidae, and occur in displaced species probably assignable to the family Eriococcidae. Disc-like pores form large groups posterior to each metathoracic spiracle in *Sphaerococcus froggatti* Maskell and *S. morrisoni* Fuller. The gall-forming *S. ferrugineus* Froggatt has its disc-like pores positioned near the vulva at the tip of the abdomen, which is the only region of the body not contained within the gall.

Another apparently convergent character that has developed in response to a sessile life is the formation of an anal wax tube. Wax tube formation is often seen in *Antonina graminis* (Maskell), *Chaetococcus bambusae*, *C. phragmitis* (Marchal), and the margarodid genera *Xylococculus* Morrison and *Xylococcus* Loew. Wax produced by the anal ring is molded by the anal tube into an elongate, hollow structure that may attain a length over five-fold the specimen's body length. This unique adaptation expels honeydew away from the body, thus preventing contamination in the immediate area.

As suspected, the simplification of various structures has occurred convergently through different lineages in the family Pseudococcidae (and possibly Eriococcidae), and does not reflect homogeneity as some previous workers (Varshney 1985, Tang 1992) have suggested. The resulting selective pressures of immobility and habitat confinement have apparently selected for enhancements or modifications to various other features that promote both survivorship and reproductive success. Although confident in the revisions undertaken in this study, comparative analyses of other developmental stages are needed to further justify the classifications presented and to resolve the placement of these peculiar mealybugs among the Pseudococcidae. Nonetheless, this study is a step toward understanding their relationships to other taxa and reclassifying the entire family.

INDEX TO HOST PLANTS

This index is not comprehensive and does not provide current usage of botanical names, but includes data as reported on examined material and within cited references. The works of Kelsey & Dayton (1942), Hitchcock (1950), Bailey & Bailey (1976), Radford et al. (1981), and Tsvelev (1984) were used to correct spellings. Names followed by an asterisk (*) were not found in any of these sources.

INDEX TO SCALE INSECT TAXA

Valid names in Roman type; synonyms, homonyms, nomen nuda, misidentifications, and questionable spellings in *italics*. Page numbers of taxa descriptions in **boldface**.

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VITA

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