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M. L. WILLIAMS, T. KONDO

Characteristics of First-instar Nymphs in the Soft Scale Insects (Hemiptera: Coccidae): Surprising Indicators of Relationships

Abstract - Recent studies of the adult males and immatures have shown that characteristics of these stages can provide some surprising indications of relationships within the soft scale insect family Coccidae. In this study of the taxonomic characters in first-instar nymphs, characteristics of 120 species of first instars in eight of the ten subfamilies of Coccidae (Cardiococcinae, Ceroplastinae, Coccinae, Eriopeltinae, Eulecaniinae, Filippinae, Myzolecaniinae, and Pseudopulvinariinae) were compared. Emphasis is placed on a comparison of some unusual features of first instars within the subfamily Myzolecaniinae and between the more typical characters seen in other first-instar soft scale insects.

Key words: Coccidae, Scale Insects, Hemiptera, First Instars.

INTRODUCTION

Classification of the Coccidae has been based primarily on morphological characteristics of the adult female, with little attention given to characteristics of the adult male or the immature stages. Hodgson (1994) presented a higher classification of the family Coccidae and classified the family into 12 subfamilies based on morphology of the females and males. Williams and Hodges (1997) completed the most comprehensive study to date of the immature stages (81 species in 33 genera) and determined that characteristics seen in the immature stages were useful in determining relationships between and among taxa. This study focuses on characteristics of the first-instar nymphs in the subfamily Myzolecaniinae, and is part of a comprehensive revision of the Myzolecaniinae being conducted by the junior author.

The subfamily Myzolecaniinae was erected by Hodgson (1994), and currently contains 82 species in 17 genera. First instars for a few species of the included genera in the Myzolecaniinae have previously been described, but most of those included in this study (15 genera, 47 species) are undescribed. Williams and Hodges (1997) included eight genera and ten species of Myzolecaniinae in their study. Sheffer and Williams (1990) described eight first instars in the genus *Toumeyella* and Williams

(1993) added a description for *Toumeyella lignumvitae*. The first instars of *Pseudophilippia quaintancii* and *Neolecanium cornuparvum* were described by Ray and Williams (1980, 1983). Qin and Gullan (1989) provided descriptions for *Cryptostigma endoeucalyptus*, and Gullan and Stewart (1996) described the adult female and first instar of *Torarchus endocanthium*, a monotypic genus found inside hollow stems of plants in the genus *Canthium* in Australia. Two additional descriptions of first instars for two monotypic genera, *Alecanium hirsutum* and *Cyclolecanium hyperbaterum*, were provided by Morrison (1921, 1929).

In this study, characters for 120 species of first-instar nymphs in the subfamilies Cardiococcinae, Ceroplastinae, Coccinae, Eriopeltinae, Eulecaniinae, Filippinae, Myzolecaniinae, and Pseudopulvinariinae were compared. Particular emphasis was placed on characteristics of representative species in the subfamily Myzolecaniinae, and some interesting and surprising relationships were indicated among the species studied, based on their morphological characters.

MATERIALS AND METHODS

Dry material and slide mounted specimens in the Auburn University Coccoidea Collection, as well as material borrowed from the following scale insect collections: British Museum of Natural History, London, UK; United States National Museum, Beltsville, Maryland; Museu de Zoologia, Universidade de Sao Paulo, and the Instituto Biologico, San Paulo, Brazil; Museum Nationale d'Histoire Naturelle, Paris, France; ARC-Plant Protection Research Institute, Pretoria, South Africa; and the Universidade Federal de Parana, Brazil, were utilized in this study. Dry specimens were slide mounted and examined using a Zeiss RA phase contrast microscope. First-instar nymphs for 15 of the 17 genera and 47 species of Myzolecaniinae were utilized in this study. First instars for *Halococcus* and *Paractenochiton* have not been described, and none were available for study.

RESULTS AND DISCUSSION

We were able to see morphological differences sufficient enough to separate all species of first-instar nymphs of Myzolecaniinae included in this study. Several genera and species exhibited morphological characteristics that were unusual or that differed from the normal character states seen in most other first-instar nymphs in the Coccidae.

Following is a discussion of the first instar general morphology as seen in most of the Coccidae, with comments on variations from the norm as seen in characters of first instars in the Myzolecaniinae. Differences in the first instars of the New World and Old World Myzolecaniinae were most apparent.

GENERAL APPEARANCE. The illustration of the first instar of *Megasaissetia inflata* (Fig. 1) is fairly characteristic of most first-instar Coccidae and can be used as a

reference for the general appearance. First instar coccids generally share the following characteristics: eyes present; anal plates each with a long apical seta; antennae well developed, five- or six- segmented; legs well developed, five segmented, tarsi with a pair of knobbed digitules, except for prothoracic tarsi which have one of the digitules

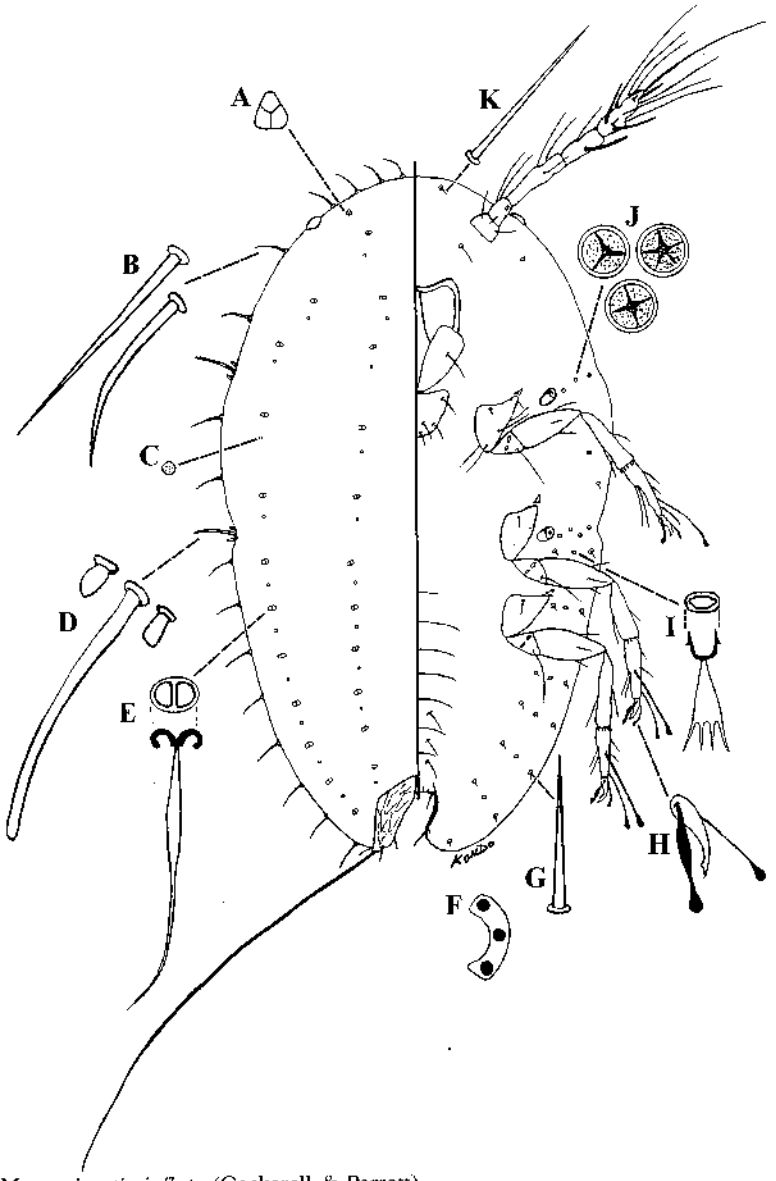

Fig. 1 - *Megasaissetia inflata* (Cockerell & Parrott).

setiform; spiracular setae usually differentiated from marginal setae; anal ring well developed, with six setae; multilocular pores and tubular ducts absent from abdominal region.

BODY. Oval to elongate oval, generally widest in thoracic region (Fig. 1A), derm membranous throughout, usually smooth, but on occasion rugose or papillate. Two basic body types were seen in the Myzolecaniinae, the more general type (Fig. 1A) occurred in most, while a larger body type (Fig. 2A), generally twice as large (0.8-1.8 mm), was seen in the genera, *Cribrolecanium*, *Cryptostigma*, *Houardia*, and *Myzolecanium*.

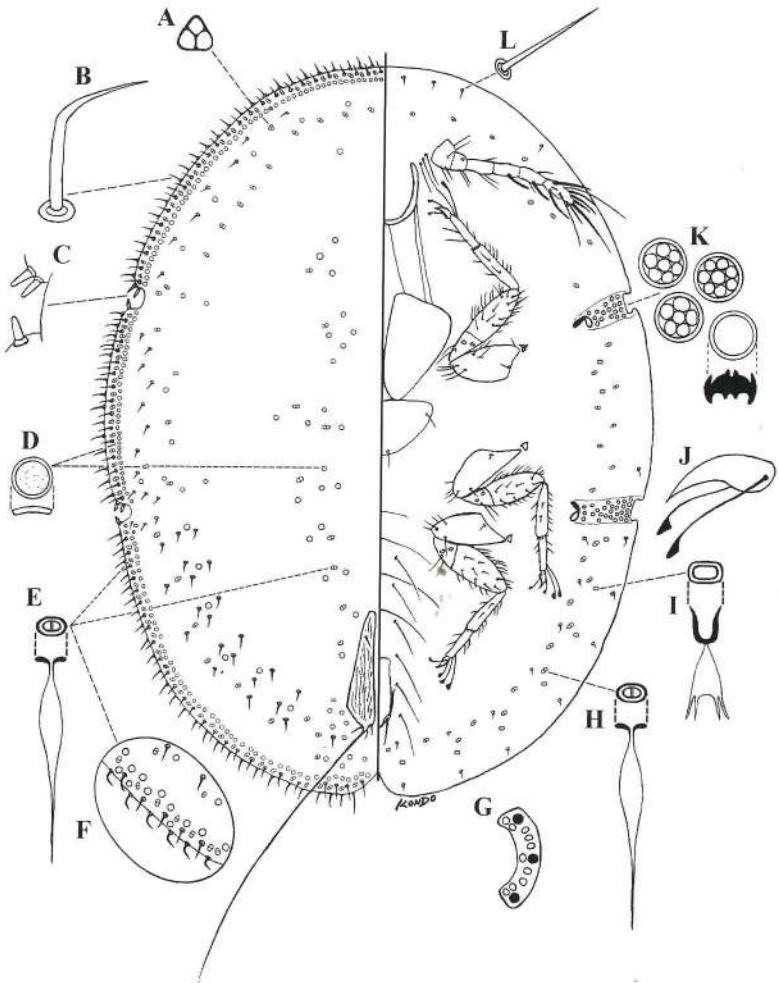

Fig. 2 - *Houardia mozambiquensis* Hodgson.

ANTENNAE. The antennae of most first instars are six segmented. Five segmented antennae are only found in the New World Myzolecaniinae, and were present in most species of *Akermes*, *Neolecanium*, *Toumeyella*, and in *Cryptostigma biorbiculus*, *Cyclolecanium hyperbaterum*, *Megasaissetia inflata*, and *Pseudophilippia quaintancii*.

EYES. Eyes were seen on the margin of the head of all species studied except *Houardia mozambiquensis* (Fig. 2), *Myzolecanium endoeucalyptus,* and *M. robertsi.* The complete absence of eyes is highly unusual in first instars.

LEGS. Well developed, without tibio-tarsal sclerotization or free articulation. Two sensory pores present on each face of trochanters. Various hair-like setae present on each segment. Tarsus with knobbed digitules except for prothoracic tarsus where one digitule is setiform. Tarsal claw simple or with a denticle. The legs of species in *Cribrolecanium*, *Cryptostigma*, *Houardia*, and *Myzolecanium* had many more setae than normally seen (compare legs in Fig. 2 with Fig. 1). Unusual characteristics on the legs were also seen in other species of first instar Myzolecaniinae. In *Alecanopsis grandis*, *Richardiella taiensis*, *Torarchus endocanthium*, and an undescribed species of *Xenolecanium*, all tarsal digitules were knobbed, while in *Cryptostigma inquilina*, *C. quinquepori*, *C. reticulolaminae*, and *Myzolecanium endoeucalyptus*, all tarsal digitules were setiform. *Toumeyella lomagundiae* (which is not congeneric) has an extremely long seta on the femur that extends nearly to the apex of the tarsus. This feature is also seen in the totally unrelated *Etiennea petasus*, *Kilifia americana*, *Milviscutulus mangiferae*, and *Protopulvinaria pyriformis*.

SPIRACLES. All first instars had one pair on each meso- and metathorax. In *Cribrolecanium*, *Cryptostigma*, *Houardia* (Fig. 2), and *Myzolecanium* the spiracular apodeme attaches to the anterior edge of the peritreme. This was only seen in these four genera.

SPIRACULAR SETAE. Generally differing in shape from marginal setae; usually 3 in each group, positioned at the apex of the spiracular furrow, with the median seta of each group longer than the 2 lateral setae (Fig. 1D), rarely subequal. Some notable differences from the norm exhibited in the Myzolecaniinae include: *Toumeyella parvicornis*, where the spiracular setae are undifferentiated from the marginal setae; the genus *Houardia*, which has deep spiracular clefts and spiracular setae that oppose each other and arise from the sides of the spiracular cleft (Fig. 2), a feature also seen in some *Cryptostigma* and in *Cribrolecanium*; *Richardiella taiensis*, which has 3 subequal spiracular setae in each group that are flattened, expanded at the apex, and appear spatulate; and *Akermes scrobiculatus*, in which the spiracular clefts are strongly sclerotized. There was a wide range of variation in numbers of spiracular setae among the Myzolecaniinae, ranging from 0-5 setae per group and the number often varied from anterior group to posterior group, but were generally consistent within a species.

ANAL PLATES. Two anal plates present, these well developed, usually triangular with rounded angles. Each plate with a long apical seta, about 1/3 to 1/2 as long as the body, and 2 or 3 dorsal setae. In *Houardia*, the anal plates are long and slender (Fig. 2). In all species of *Cryptostigma*, there was a sclerotized fold on the dorsum of the

body just anterior to the anal plates. This character seemed to be unique to this genus.

ANAL RING. The anal ring in all species studied had six anal ring setae and a varying number of translucent pores. Nothing unusual was seen in species in the Myzolecaniinae.

PORES AND CRIBRIFORM PLATES. Most commonly, pore groupings on the dorsum are located in rows submarginally, submedially and/or medially. These groupings are made up of simple disc pores (simple pores) (Fig. 1C) and bilocular pores (microductules) (Fig. 1E). A single trilocular pore (Fig. 1A) is present on each side of the head. In *Toumeyella parvicornis* the bilocular pores are grouped into pore clusters submarginally on the dorsum, and in *Pseudophilippia quaintancii* the dorsum is covered with large invaginated tubercles, each containing a pair of quinquelocular pores. Cribriform pore plates are found in only a few species. They occur dorsally in all species of *Hemilecanium* and also in *Etiennea villiersi*. Unique cribriform pore plate-like structures were also seen on both the dorsum and venter of *Cribrolecanium formicarum*. Various types of multilocular disc pores (Figs. 1J and 2K) occur in the spiracular furrows. Generally there are 3-4 pores in each spiracular pore band, but these pores are numerous (Fig. 2K) in the larger bodied first instars seen in *Cribrolecanium*, *Cryptostigma*, *Houardia*, and *Myzolecanium*.

DUCTS. Ventral microducts (Fig. 1I) occur in all first instars studied, with the exception of *Torarchus endocanthium*. They generally are located in a submarginal row between each of the pairs of ventral body setae on the abdomen, one on each side between the anterior and posterior spiracular furrows, and one on each side of the head just below level of antennal scape. In several of the Myzolecaniinae (species of *Criptostigma*, *Myzolecanium*, and in *Houardia troglodytes*) two rows of ventral microducts occurred submarginally.

BODY SETAE. Marginal setae (Fig 1C) in a single row around body, generally distributed as follows: 8 anteriorly around head between eyes, 2 on each side between eyes and anterior spiracular setae, 2 on each side between anterior and posterior spiracular setae, and 8 on each side of abdomen. In *Houardia*, and *Myzolecanium endoeucalyptus* the marginal setae are in a double row (Fig. 2B) and are quite numerous. In *Myzolecanium endoeucalyptus* the marginal setae number about 300-400. Dorsal body setae are slender and bristle-like and generally occur in a submedian row of 4 each on each side of the body, but these setae occur in reduced numbers or are absent in many of the Myzolecaniinae. Exceptions to this can be found in *Cribrolecanium formicarum*, which has numerous dorsal setae (50-60) scattered over the body, *Neolecanium silveirai* has 12 pairs in an irregular median row, and several species of *Cryptostigma* have 5 pairs. Ventral body setae (Fig. 1G,K) are short and bristle-like, located submarginally and generally distributed as follows: 1 pair on head, 1 on each side between anterior and posterior spiracular regions, and 7 pairs on each side of abdomen. *Cribrolecanium formicarum*, all species in the genus *Myzolecanium*, and *Neolecanium silveirai* have 2 pairs of ventral body setae on the head, while species of *Houardia* have 3-5 pairs on the head (Fig. 2L). Most first instars with 3 pairs of

long ventral submedian setae (Fig. 1) on the pregenital segments of abdomen, with the posterior pair being the longest. In several of the Myzolecaniinae more than 3 pairs of ventral submedian setae were seen. Examples are: *Alecanopsis tenuis* and *Richardiella taiensis* – 4 pairs; *Myzolecanium endoeucalyptus*, and *M. robertsi* – 5 pairs; *Alecanium hirsutum*, *Alecanopsis casurinae*, *A. grandis*, *Cribrolecanium formicarum*, *Houardia mozambiquensis* (Fig. 2), and *Torarchus endocanthium* – 6 pairs; and *Myzolecanium magnetinsulae* – 7 pairs.

Morphological characters of the first-instar nymphs of the Myzolecniinae indicate that the New World genera *Cryptostigma* and *Myzolecanium* are closely related to the Old World genera of *Cribrolecanium* and *Houardia*. All first instars in this group are much larger and usually exhibit an increased number of pores, ducts and setae that is normally seen in other coccid first instars.

Two types of first instars were seen in *Akermes riograndensis* and *Cryptostigma biorbiculus*. In both cases there was a difference in the dorsal pore patterns between a number of specimens from the same material. It is not known if these variations are sex linked or not, as we have not found any characters to separate the sexes in first-instar nymphs in the Coccidae.

While comparing characters of first instars in this study, it became apparent that there were several species that were not congeneric and actually belonged in other genera. The following observations can be noted: *Neolecanium silveirai* belongs in *Cryptostigma*; *Alecanopsis casuarinae* belongs in *Myzolecanium*; and *Cribrolecanium andersoni* most likely belongs in the Coccinae: Paralecaniini.

Characteristics of the first-instar nymphs are continuing to prove useful for determining relationships in the Coccidae. As more first-instar nymphs of the Coccidae are studied and described, new and exciting indications of relationships will be forthcoming. We must continue to combine information from all developmental stages to form a more sound classification system for the group.

REFERENCES

GULLAN P. J., STEWART A. C., 1996 - A new genus and species of ant-associated coccid (Hemiptera: Coccidae: Myzolecaniinae) from *Canthium* Lam. (Rubiaceae). - Memoirs of the Queensland Museum, 39(2): 307-314.

HODGSON C. J., 1994 - The scale insect family Coccidae: an identification manual to genera. - CAB International Press. Wallingford. 640 pp.

MORRISON H., 1921 - Some nondiaspine Coccidae from the Malay Peninsula, with descriptions of apparently new species. - Philippine Journal of Science, 18(6): 637-677.

MORRISON H., 1929 - Some neotropical scale insects associated with ants (Hemiptera: Coccidae). - Annals of the Entomological Society of America, 22: 36-60.

QIN T. K., GULLAN P. J., 1989 - *Cryptostigma* Ferris: a coccid genus with a strikingly disjunct distribution (Homoptera: Coccidae). - Systematic Entomology, 14: 221-232.

Ray C. H., Williams M. L., 1980 - Descriptions of the immature stages of *Pseudophilippia quaintancii* (Homoptera: Coccoidea: Coccidae). - Annals of Entomological Society of America, 73: 437-447.

Ray C. H., Williams M. L., 1983 - Description of the immature stages and adult male of *Neolecanium cornuparvum* (Homoptera: Coccidae). - Proceedings of the Entomological Society of Washington, 85: 161-173.

Sheffer B. J., Williams M. L., 1990 - Descriptions, distribution and host-plant records of eight first instars in the genus *Toumeyella* (Homoptera: Coccidae). - Proceedings of the Entomological Society of Washington, 92: 44-57.

Williams M. L., 1993 - *Toumeyella lignumvitae*, a new species of scale insect from the Florida Keys (Homoptera: Coccidae). - Florida Entomologist, 76(4): 566-572.

Williams M. L., Hodges G. S., 1997 - Taxonomic characters: nymphs. Chap. 1.1.3.3, pp. 143-156. In: Ben-Dov, Y. and Hodgson, C. J., Eds., Soft Scale Insects: Their Biology, Natural Enemies and Control [Vol. 7A]. Elsevier, Amsterdam and New York, 452 pp.

Prof. Michael L. Williams - Department of Entomology and Plant Pathology, 301 Funchess Hall, Auburn University, AL 36849-5413, USA. E-mail: mlwillia@acesag.auburn.edu

Takumasa Kondo - Department of Entomology and Plant Pathology, 301 Funchess Hall, Auburn University, AL 36849-5413, USA. E-mail: kondota@auburn.edu