Descriptions and Illustrations of the First Instar Nymphs of the Cardiococcinae (Hemiptera: Coccidae)[1]

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Abstract Taxonomic information on the Cardiococcinae is limited to morphological characters of the adult female. Morphological information on the immature stages has not been accomplished in the past. This work adds to the current knowledge of coccid immatures by providing descriptions and illustrations for the first-instar nymphs of *Ceroplastodes dugesii* (Signoret), *Inglisia patella* Maskell and *Pseudokermes nitens* Cockerell. Examination of the first instars indicated that morphological similarities exist between *C. dugesii* and *P. nitens.* However, *I. patella* differed morphologically from both of those species by lacking a rugose or papillated derm and by having greater than 34 marginal setae.

Key Words *Ceroplastodes dugesii, Inglisia patella, Pseudokermes nitens,* Cardiococcinae, first instar, derm

Scale insects (Hemiptera: Coccoidea) are notorious plant pests in urban landscapes, forests, fruit and nut trees, and greenhouses. The main injury by these pests is caused by the ingestion of plant sap. This can result in a loss of vigor, poor growth, leaf drop, chlorosis, die-back of twigs and branches, and occasionally death of the host plant. World-wide, approximately 7500 scale species have been described in 20 families, many of which are not pest species. Plant inspectors and extension agents receive numerous scale insect samples to identify and determine whether it is a known pest species. Many species superficially resemble one another and species complexes exist in which an expert is necessary for a correct identification. In other cases, identifications cannot be made because an identifiable life stage was not collected.

The most current classification of the Family Coccidae (Hodgson 1994) is based on re-descriptions of adult females and males of all known soft scale genera. It recognizes 10 subfamilies: Cardiococcinae, Ceroplastinae, Cissococcinae, Coccinae, Cyphococcinae, Eulecaniinae, Filippinae, Myzolecaniinae, Pseudopulvinariinae and Pulvinariinae. This classification is the most complete to date but does not incorporate morphological information about immature stages. Of the immature stages, the crawler stage (first instar) is the most studied taxonomically. Unfortunately, the crawler stage is described or illustrated only for approximately 5% of the known

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species of Coccidae (Williams 1997). The crawler stage is the only life stage in which host-induced dimorphism is absent. The addition of morphological characters from the crawler stage to the known database of Coccidae will enhance classification in the future.

Of the ten subfamilies, perhaps the least is known about the crawler stages of the Cardiococcinae, also known as the glassy scales. The adult females of the Cardiococcinae are covered in a thin, hard, waxy (glassy) test. Characteristics common to the adult females of this subfamily include: (1) dorsal setae entirely absent, (2) dorsal pores sparse except in a submarginal band and longitudinal row anterior to the anal plates, (3) dorsal ducts absent, (4) lack long setae anterior to genital opening (replaced with smaller setae in groups), and (5) quadrate anal plates (Hodgson 1994). The first instars of the Cardiococcinae share similar morphologies with other members of the Coccidae but differ in the presence of a rugose or papillate dorsal derm (Williams and Hodges 1997).

Most of the 16 genera within the Cardiococcinae are restricted to the Southern Hemisphere. Only one species, *Inglisia vitrea* Cockerell, is reported to occur in North America north of Mexico. Like most members of the Coccidae, species of the Cardiococcinae can potentially become pests if populations are allowed to attain sufficiently high levels. Only two species have been reported as pests: *Ceroplastodes dugesii* (Signoret) as a pest of legumes in New Zealand, and *Inglisia fagi* Maskell as a pest of beech in Australia (Hodgson 1994). This paper presents morphological descriptions and illustrations of the type species for three genera of the Cardiococcinae (*Ceroplastodes, Inglisia* and *Pseudokermes*).

Materials and Methods

Slide-mounted specimens of first-instar soft scales were borrowed from the following museums: Auburn University Entomological Museum (AUEM); the Florida State Collection of Arthropods (FSCA); and the National Museum of Natural History (USNM). Additional specimens were mounted from previously collected material. Specimens were removed and slide mounted according to procedures of Wilkey (1962) and Williams and Kosztarab (1972). Measurements of slide-mounted specimens were made using an ocular micrometer on a Zeiss RA phase contrast microscope at magnifications from 320 X to 2000 X. All measurements are given in micrometers and are presented as the mean followed by the range in parentheses. Ten specimens were selected (when available) from different hosts and collection dates in an attempt to show an accurate range of variation within the species. The body outline and all illustrations were traced using a Leitz Mikro Promar slide projector. Details and enlargements were made via free-hand drawing while viewing the specimens through a Zeiss RA phase contrast microscope. For each figure, the central illustration is of the first instar with the left half representing the dorsum and the right half representing the venter. Surrounding the central illustration are enlargements of the antennae (upper right), spiracular pores and ventral pore groupings (center right), ventral body setae and ventral ducts (center right), tarsal segments showing modifications (lower right), anal ring (lower center), anal plates (lower left), dorsal pores groupings (center left), spiracular setae (center left), marginal setae and trilocular pores (upper left). Illustrations are not made to the same scale for all species, nor are the enlargements or dermal structures in direct proportion to one another. Morphological terminology is taken from Hamon and Williams (1984). For each species treatment under "speci-

mens studied", the first number indicates the number of slides and the second number (in parentheses) the number of specimens.

Descriptions of First Instar Nymphs

Ceroplastodes dugesii (Signoret) Figure 1

Material studied. *Dalea formosa* 1(1), Fortugas Mt., NM, 1894. Collector unknown, (USNM); *Dalea formosa* 1(12), Las Cruces, NM, 9 December 1895, Collector unknown, (USNM); *Dalea* spp., 1(3), Mexico, Collection data incomplete, (USNM); *Kuhnestria purpurea,* 2(13), Phillips Co., KA, 7 September 1906, G.A. Dean (USNM); *Petalostemon violaciens,* 1(8), Phillips Co., KA, 24 December 1903, G.A. Dean (USNM).

General appearance. Body (Fig. 1-a) oval, 483 (464-507) long, 243 (223-260) wide. Antennae and legs well developed.

Dorsum. Derm membranous, strongly lobed. Marginal setae (Fig. 1-b) 7 (6-8) long, pointed, lanceolate, distribution: 6 anteriorly between eyes, 2 on each side between eyes and anterior spiracular furrow, 2 on each side between anterior and posterior spiracular furrows, 8 located on each side of body posteriorly. Body setae absent. Spiracular setae undifferentiated from marginal setae with 2 present in each furrow. Small bilocular pores (Fig. 1-e) occurring in one submarginal row and one submedial row. Trilocular pore (Fig. 1-f) located at apex of head. Eyes present on margin just above level of antennal scape. Anal plates (Fig. 1-g). Each plate 41 (39-46) long, 21 (20-23) wide, cephalolateral margin 23 (20-24) long, caudolateral margin 30 (28-31). Anal ring (Fig. 1-h) hourglass shaped with 6 setae and 10 pores present.

Venter. Antenna (Fig. 1-i) 127 (117-135) long. Legs (Fig. 1-j) 275 (247-310) long; tarsal digitules 32 (31-36) long, prothoracic set with one digitule setiform and one capitate, mesothoracic and metathoracic sets with both digitules being capitate; claw digitules 15 (12-19) long, each set slightly clubbed; claws 16 (15-19) long, with denticle. Spiracular furrows with quinquelocular porese (Fig. 1-k); each pore band with 2 pores. Ventral body setae (Fig. 1-l) in a row of 6 on each side of the abdomen, 1 between spiracular furrows on each side of body. Two large interantennal setae present. Six pairs of small, posterior, submedian setae present. Ventral microducts absent. Other structures: ventral microspines on posterior abdominal segments.

Inglisia patella Maskell, Figure 2

Material studied. *Elaeocarpus* sp., 1(1), Montueka, New Zealand, 2 February 1938, G. Brittin (USNM).

General appearance. Body (Fig. 2-a) oblong, derm membranous, 402 long, 229 wide. Antennae and legs well developed.

Dorsum. Derm smooth. Marginal setae (Fig. 2-b) clavate, distribution as follows: 30 between eyes, 10 between eyes and anterior spiracular furrow, 8 between anterior and posterior spiracular furrows, 35 on each side posterior of body. Body setae absent. Dorsal ducts (Fig. 2-n) present, distribution: 1 on each side below level of antennal scape, 2 on each side between anterior and posterior spiracular furrows. Spiracular setae not differentiated from marginal setae. Large dark disc pores (Fig. 2-c1) located in submarginal row. Small light disk pores (Fig. 2-c2) located in submedial row. Eyes present on margin just below antennal scape. Anal plates (Fig. 2-g)

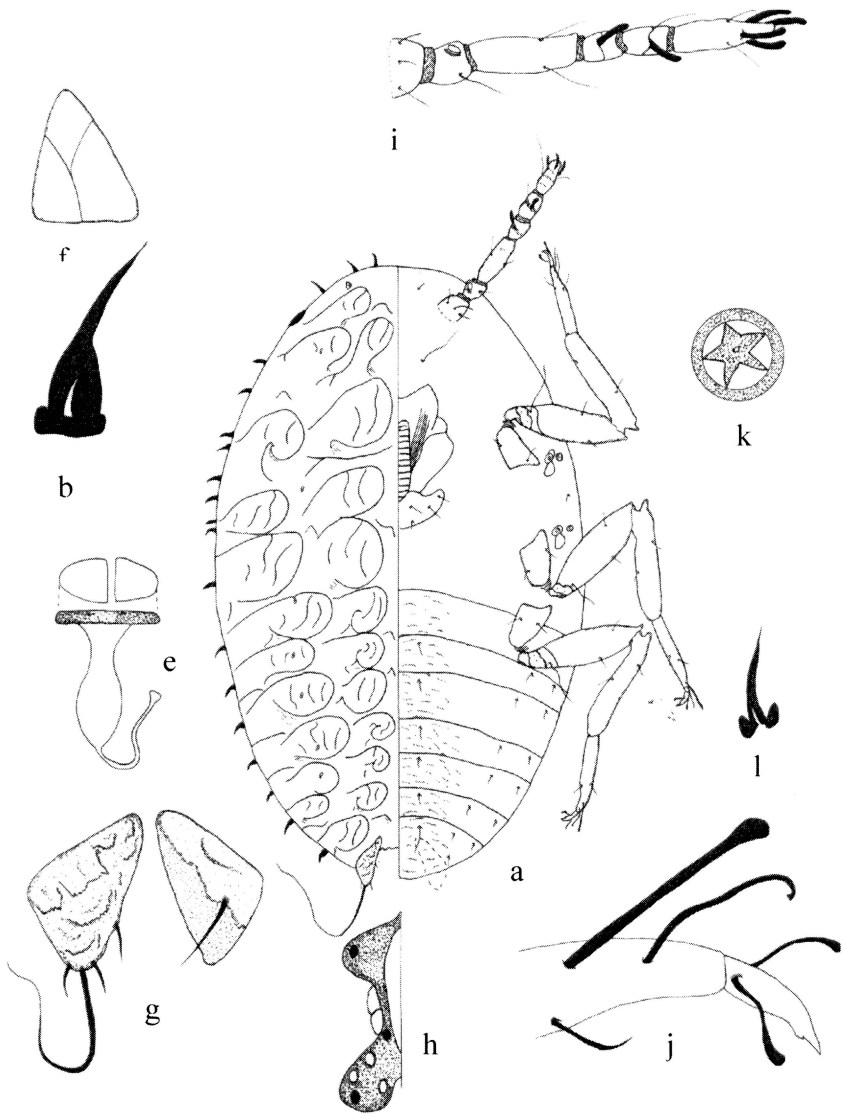

Fig. 1. *Ceroplastodes dugesii* (Signoret). First Instar.

present. Each plate 34 long, 15 wide, cephalolateral margin 19 long, caudolateral margin 24 long. Plates exhibit plate like reticulations on derm. Anal ring (Fig. 2-h) semi-oval with 6 setae and 10 pores.

Venter. Antennae (Fig. 2-i) 111 long. Sensory pore present on second antennal segment. Legs (Fig. 2-j) 168 (159-178) long; tarsal digitules 31 long, prothoracic set with 1 digitule setiform and 1 capitate, mesothoracic and metathoracic sets with both

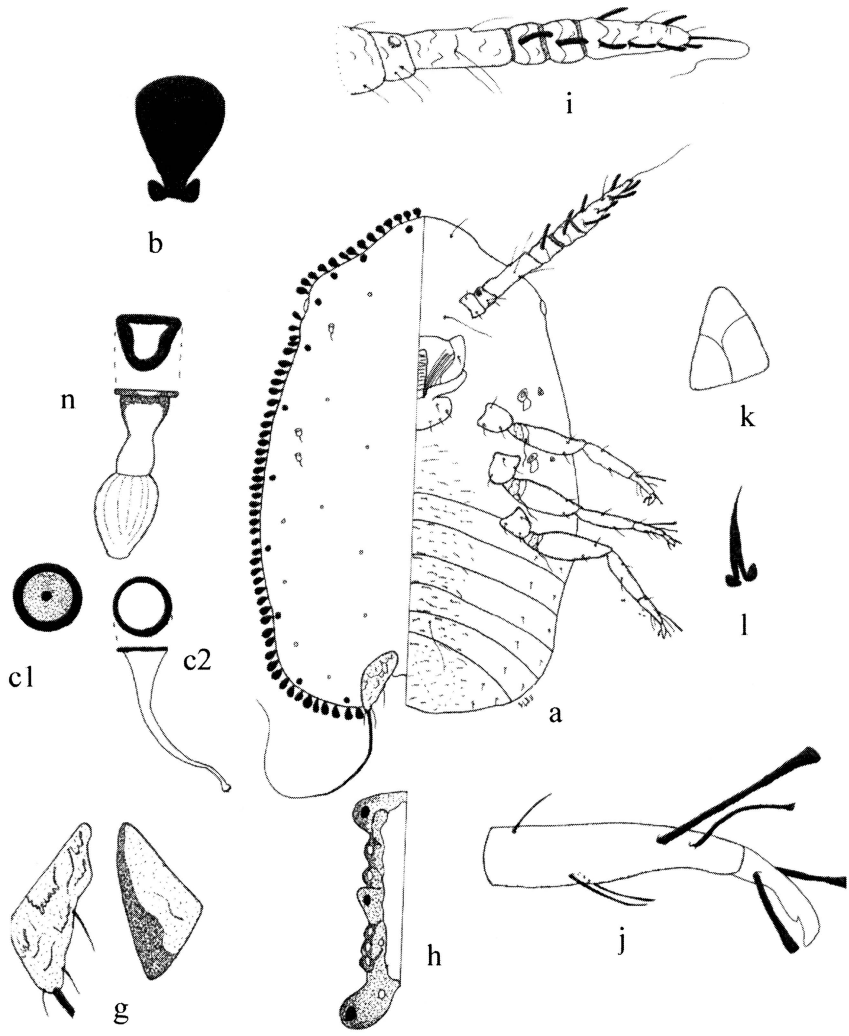

Fig. 2. *Inglisia patella* Maskell. First Instar.

digitules being capitate. Claw digitules 19 long. Claw 12 (10-14) long with a denticle. Two sensory pores occurring on each trochanter. Spiracular furrows with trilocular pores (Fig. 2-k); each pore band with 1-2 pores in each band. Ventral body setate (Fig. 2-l) in 2 rows of 7 on each side of abdomen, 1 between spiracular furrows on each side of body. Two large pair of interantennal setae. One pair of large submedian setae. Ventral microducts (Fig. 2-n) present, distribution; 1 between each of the abdominal ventral body setae. Other structures: ventral microspines present on median of each abdominal segment.

Pseudokermes nitens Cockerell Figure 3

Material studied: *Eugenia uniflora,* 10 (42), Bompland Misiones, Argentina, October 1910, Jorgensen (AUEM).

General appearance. Body (Fig. 3-a) rugose, elongate, oval, 499 (433-566) long, 298 (260-384) wide. Antennae and legs well developed.

Dorsum. Derm rugose. Segmentation somewhat visible. Marginal setae (Fig. 3-b) 7 (5-10) long, pointed, stout, expanded basally, tapering slightly to posterior, distribution: 8 between eyes, 2 on each side between eye and anterior spiracular furrow, 2 on each side between anterior and posterior spiracular furrow, 9 on each side of body posterior of abdomen. Body setae absent. One spiracular setae (Fig. 3-c) 32 (23-39) long, occurring in each spiracular furrow. Dorsal ducts absent. Dorsal pore groupings (Fig. 3-d) consisting of simple disc pores with small bilocular pores (Fig. 3-e) occurring in rows submarginally and submedially. Trilocular pores (Fig. 3-f) located at anterior apex of head. Eyes present on margin at level of antennal scape. Anal plates (Fig. 3-g) 54 (46-57) long, 25 (19-34) wide, cephalolateral margin 35 (31-42) long, caudolateral margin 36 (32-39) long. Plates with finger like projections on dorsum. Anal ring (Fig. 3-h) hexagonal in shape, with 6 setae and 10 pores.

Venter. Antennae (Fig. 3-i) six segmented, 110 (103-118) long. Sensory pore on second antennal segment. Legs (Fig. 3-j) 318 (293-351) long. Tarsal digitules 37 (32-46) long, prothoracic set with 1 digitule setiform and 1 apically knobbed, mesothoracic set and metathoracic set with both digitules apically knobbed. Claw digitules 21 (15-25) long, all sets with 1 digitule slender with slight apical knob and the other being greatly expanded and knobbed. Claws 18 (15-21) long with strong denticle. Two sensory pores on each trochanter. Spiracular furrows (Fig. 3-k) each with 2 quinquelocular pores; occasionally quadrilocular pores occurring in posterior spiracular furrow. Ventral body setae spike shaped (Fig. 3-l) 3 (3-4) long, distribution: 1 at anterior apex of head, 1 on each side between anterior and posterior spiracular furrows, 2 rows of 7 on each side of abdomen. Tow large interantennal setae present. Six pair of posterior median setae with most posterior longest. Ventral microducts absent. Ventral microspines present on median of median of most posterior abdominal segments.

Discussion

Members of the Cardiococcinae are referred to as the glassy scales due to the presence of a glassy membranous derm on the dorsum of the adult females. Characteristics shared by first instars of *C. dugesii, I. patella* and *P. nitens* include six segmented antennae and anal plates with reticulations on the dorsum. Both *P. nitens* and *C. dugesii* also share the following characteristics: legs that are 2/3 the body length, rugose or papillate dorsal derm, bilocular and trilocular pores on the dorsum, quinquelocular pores in the spiracular furrows, and six ventral submedian setae. *Inglisia patella* is unlike *P. nitens* and *C. dugesii* in that the first-instar nymph has the following attributes: legs that are 1/3 body length, smooth dorsal derm, 120 marginal setae instead of 32-34, dorsal pore pattern lacking bilocular pores, trilocular pores present in the spiracular furrows, and only 3 ventral submedian setae.

Although the current classification places all three genera within the Cardiococcinae, Hodgson (1994) did note that morphological characteristics of *I. patella* differed from any other members of the *Inglisia.* Williams and Hodges (1997) also came up

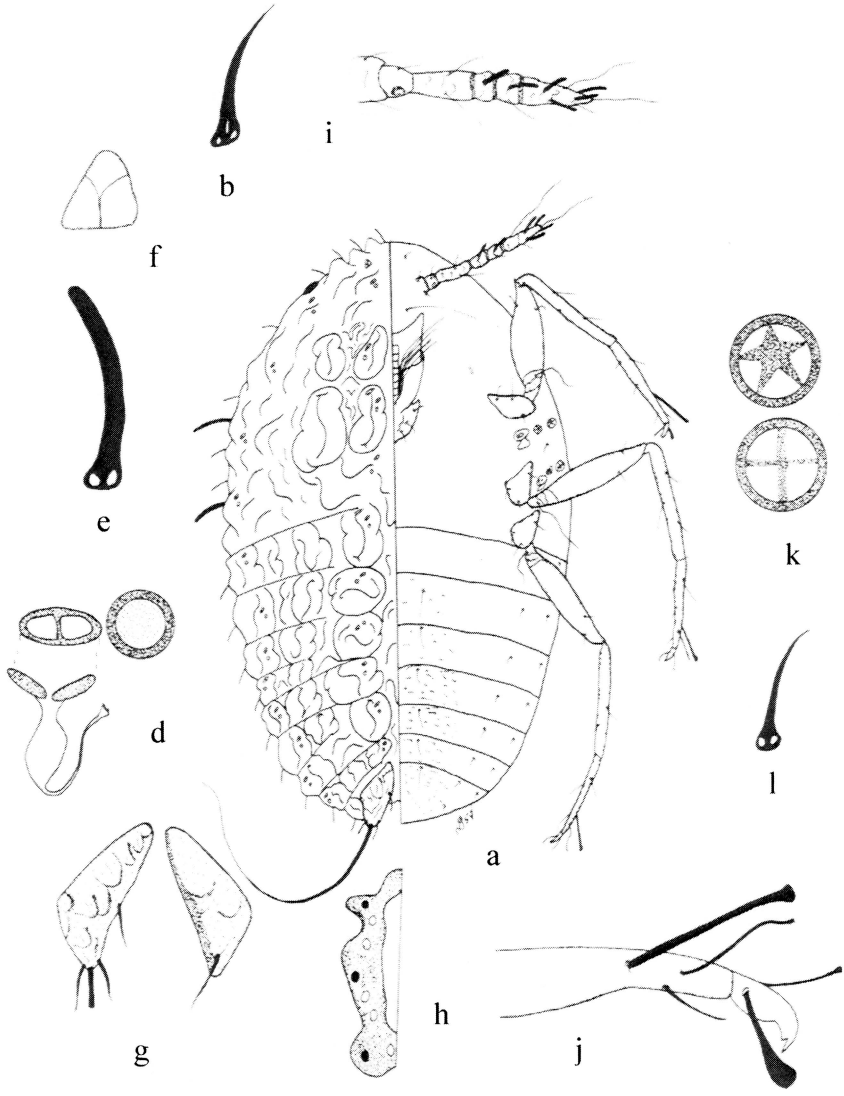

Fig. 3. *Pseudokermes nitens* Cockerell. First Instar.

with the same conclusion based on a compilation of characters of *C. dugesii, P. nitens, I. patella* and *I. vitrea* (Cockerell). *Inglisia vitrea* shared the following characteristics with *C. dugesii* and *P. nitens:* leg length 2/3 body length, rugose dorsum derm, 32 marginal setae, bilocular pores present in the dorsal pore pattern, quinquelocular pores in spiracular furrows, and presence of six ventral submedian setae. The only shared characters between *I. patella* and *I. vitrea* were six segmented antennae and dorsal pores present in dorsal pore pattern.

A better understanding of the Cardiococcinae and proper placement of the individual species within the subfamily can be achieved with further investigation of subsequent life stages such as the first-instar nymphs. This paper has presented comparative descriptions and illustrations of three type species of genera found within the subfamily. Further investigations are needed on other species of *Inglisia* and the other Cardiococcinae taxa.

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