INSECTA MUNDI A Journal of World Insect Systematics

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Date of Issue: May 10, 2013

CENTER FOR SYSTEMATIC ENTOMOLOGY, INC., Gainesville, FL

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Insecta Mundi 0295: 1-8

ZooBank Registered: urn:lsid:zoobank.org:pub:44E7641E-7908-4362-AEC1-3C33F8812616

Published in 2013 by
Center for Systematic Entomology, Inc.
P. O. Box 141874
Gainesville, FL 32614-1874 USA
http://www.centerforsystematicentomology.org/

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INSECTA MUNDI 0295: 1-8 2013

On the armored scales, genus *Aulacaspis* Cockerell (Hemiptera: Diaspididae), of Korea

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Abstract: *Aulacaspis difficilis* (Cockerell) and *Aulacaspis latissima* (Cockerell), occurring on *Elaeagnus glabra* Thunb. and *Distylium racemosum* Siebold and Zucc. (Elaeagnaceae), are newly recorded in the Korean fauna of armored scales (Hemiptera: Diaspididae). The characters of these species are here redescribed with illustrative photographs and information on distribution and hosts. Also a key to species of *Aulacaspis* Cockerell is provided for correct species identification.

Key words : *Aulacaspis difficilis*, *Aulacaspis latissima*, New Record, Diaspididae, Korea

Introduction

The genus *Aulacaspis* Cockerell (Diapspididae) occurs in almost all zoogeographical regions except Antarctica. This is a large genus with 96 species known worldwide; of these, 85 species and 29 species have been reported in Oriental and Palaearctic regions, respectively (Ben-Dov et al. 2012). Species of *Aulacaspis* occur on various host plants including woody and herbaceous plants and some species such as *A. rosae* Bouché, *A. yasumatsui* Takagi and *A. marina* Takagi and Williams are considered to be serious pests of roses, cycads and mangroves (Hodges et al. 2005; Miller and Davidson 2005; S. Takagi 2007, 2008).

The knowledge of the *Aulacaspis* scales in Korea began with Nakayama (1933) with the record of *A. rosae* Bouché. After that, the following four species were added to the Korean armored scale fauna; *A. distylii* Takahashi, *A. yabunikkei* Kuwana, *A. rosarum* Borchsenius, and *A. spinosa* (Maskell) (Paik and Kwon 1977; Paik 1978; Han et al. 2002; Kwon et al. 2003). I recently reviewed papers published in Korea and carefully examined specimens collected by the Animal and Plant Quarantine Agency (QIA) and the National Academy of Agricultural Science (NAAS) to update information on the genus *Aulacaspis* in Korea.

As a result of re-examination of *Aulacaspis* specimens housed at National Academy of Agricultural Science (NAAS), two specimens that had been identified as *A. distylii* Takahashi based upon the paper published by Paik and Kwon (1977) were found to be *Aulacaspis latissima* (Cockerell) (Figure 2G1). Therefore, it is considered that the species Paik (1978) and Paik (2000) documented as *A. distylii* to be a misidentification of *A. latissima*. In addition, *A. latissima* was misidentified as *A. distylii* by Kwon et al. (2003), and the mention of *A. distylii* in the checklist of Korean insects (Lee 2010), probably represents a misidentification of *A. latissima*.

An additional *Aulacaspis* species occurring on *Elaeagnus glabra* Thunb. and *E. umbellata* Thunb. (Elaeagnaceae) was found while conducting this project. This species was identified as *Aulacaspis difficilis* (Cockerell) and represents the first record of this species in Korea.

In this paper, a dichotomous key to species of *Aulacaspis* known in the Republic of Korea is presented and diagnoses, photographs, host plants and distribution of *Aulacaspis difficilis* (Cockerell) and *Aulacaspis latissima* (Cockerell) are provided for accurate species identification.

Materials and Methods

All slide mounted specimens used for this paper are deposited in the collection of Yeongnam Regional Office, Animal and Plant Quarantine Agency, Busan, South Korea. Some *Aulacaspis* specimens housed at National Academy of Agricultural Science, Suwon, South Korea were not in good condition for identi-

fications. These were remounted on microscope slides with the minimum damage. The dichotomous key mentioned below was based only on leaf-associated specimens of adult females. Terminology for morphological structures used in descriptions and an identification key follows that of Miller and Davidson (2005). Photographs were taken using an AxioCam MRc5 camera through ZEISS Axio Imager M2 Microscope and a Leica M165C microscope with Delta pix camera. An asterisk(*) is used to indicate a new distribution record. The following *Aulacaspis* species: *A. rosae*, *A. rosarum*, *A. spinosa* and *A. yabunikkei* were well described in the paper of Kwon et al. (2003), and are not addressed here.

Results and Discussion
Description

Aulacaspis difficilis (Cockerell)
(Figures 1A-I)

Chionaspis difficilis Cockerell, 1896 [Japan].

Field Characters. Adult female cover convex, circular white; shed skins usually subcentral, yellowish orange. Male cover smaller, felted, white, elongate, with slight median carina; shed skin yellowish (Figures 1A-B).

Slide-mounted Characters. Adult female with 3 pairs of well-developed lobes, fourth lobes with lateral lobule represented by series of low points. Median lobes broadly rounded usually more than 2 times width of 2nd lobes, separated by space 0.2 times width of median lobes, with strongly sclerotized yoke, medial margin parallel sided one-third to one-half length of lobe then strongly divergent to apices, projecting or somewhat sunken into apex of pygidium; second and third lobes bilobed, significantly smaller than median lobes. Gland spine formula usually 1-2-3(4), with about 28 gland spines near each body margin anterior of fourth lobe area, medial lobes without gland spines between them. Macroducts on pygidium about same size, without duct between medial lobes; submedial ducts on segments 2 to 5, with 9 to 15 ducts each; submarginal ducts on segments 2 to 5, with 9 to 15 ducts each; marginal ducts on segments 5 to 7 with 1 to 2 ducts each. Perivulvar pores in 5 groups; approximately 82 pores on each side of body. Anterior spiracles with 46 to 50 pores, posterior spiracles with 11 to 20. Antennae each with 1 conspicuous seta. Body stout, dark purple, cephalothorax roundish expanded.

Material examined. Korea. Jeollanamdo (JN): Gugyedeung, 9 adult females (leaf), on *Elaeagnus glabra* (Elaeagnaceae), 1-iv-2009 (S.J. Suh); Songho-ri, 5 adult females, same host, 2-iv-2009 (S.J. Suh); Wando arboretum, 5 adult females, same host, 10-v-2007 (S.J. Suh); Yesong-ri, 6 adult females, same host, 24-vii-2012 (S.J. Suh). Gyeongsangnamdo (GN): Dangri-dong, 8 adult females (leaf), on *Elaeagnus umbellata* (Elaeagnaceae), 4-v-2012 (Y.H. Lee).

Hosts. Elaeagnaceae: *Elaeagnus glabra* Thunb., *Elaeagnus pungens* Thunb., *Elaeagnus umbellata* Thunb., *Elaeagnus* sp., *Hippophae rhamnoides* L.(Ben-Dov et al. 2012).

Distribution. China, Japan and Korea* (Ben-Dov et al. 2012).

Aulacaspis latissima (Cockerell)
(Figures 2A-F)

Chionaspis latissima Cockerell, 1897 [Japan].
Aulacaspis distylii Takahashi: Paik and Kwon 1977, 1978; Kwon et al. 2003 (misidentifications).

Field Characters. Adult female cover flat, circular, opaque white, slightly convex; shed skins marginal, yellow, with brown median line (Figure 2A). Male cover elongate, parallel sided, white, with a median ridge; shed skin marginal, yellow or brown.

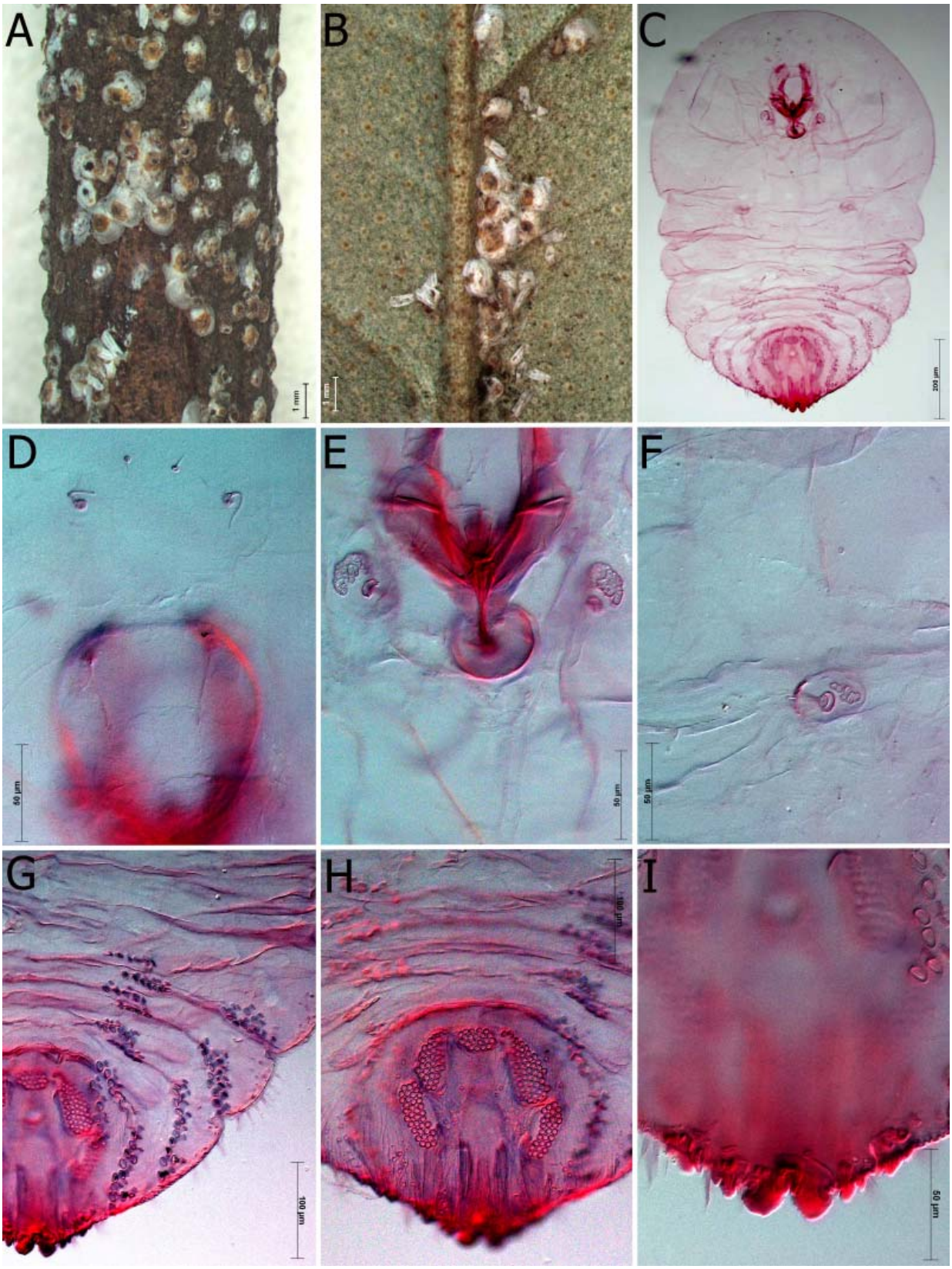

Figure 1. *Aulacaspis difficilis* (Cockerell); A-B. habitus, C. female, D. antennae, E. anterior spiracle, F. posterior spiracle, G. abdomen, H. perivulvar pores, I. median lobes.

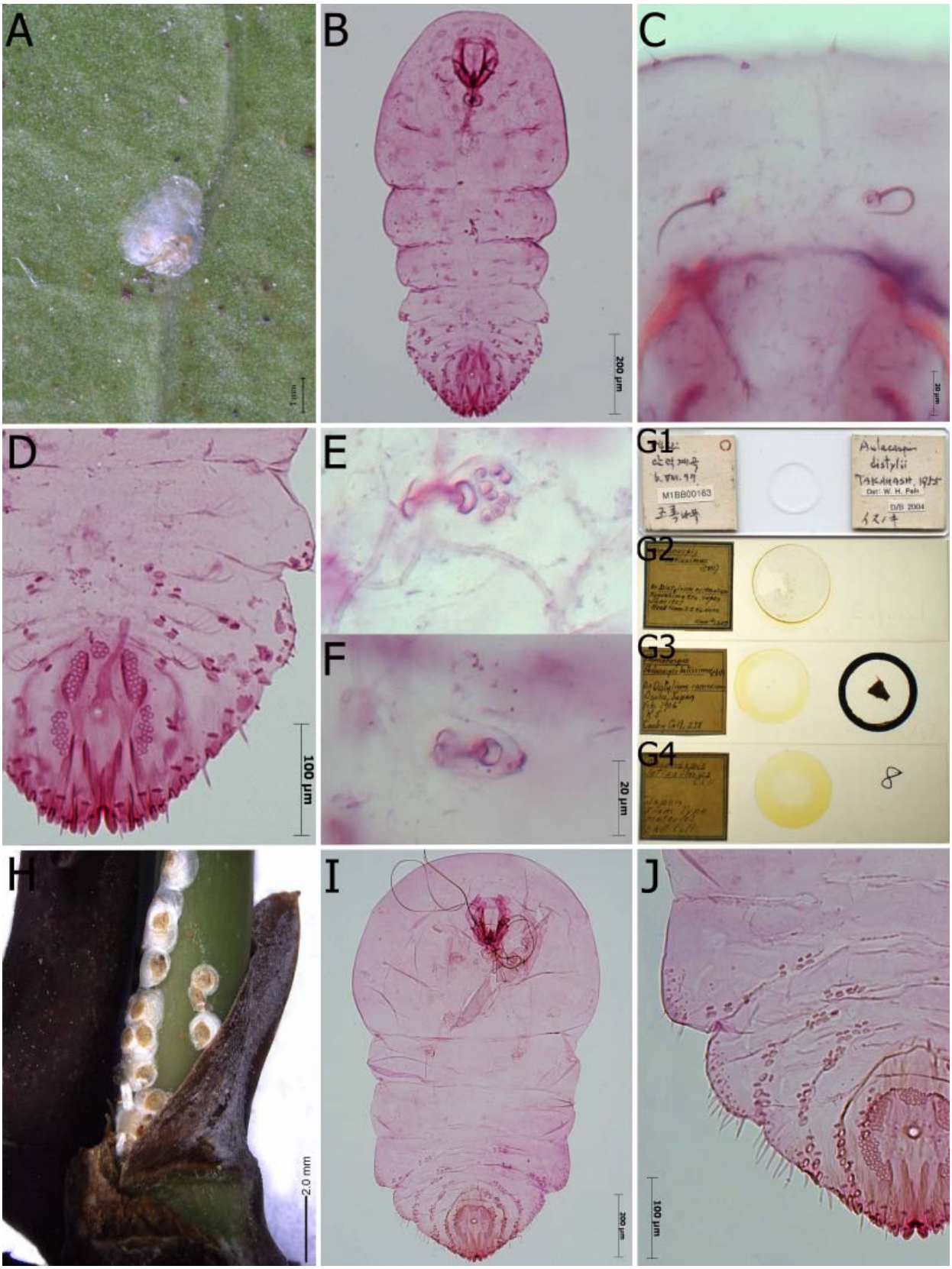

Figure 2. *Aulacaspis latissima* (Cockerell), A-G; A. habitus, B. female, C. antennae, D. abdomen, E. anterior spiracle, F. posterior spiracle, G1-4. specimens. *A. spinosa* (Maskell), H-J; H. habitus, I. female, J. abdomen.

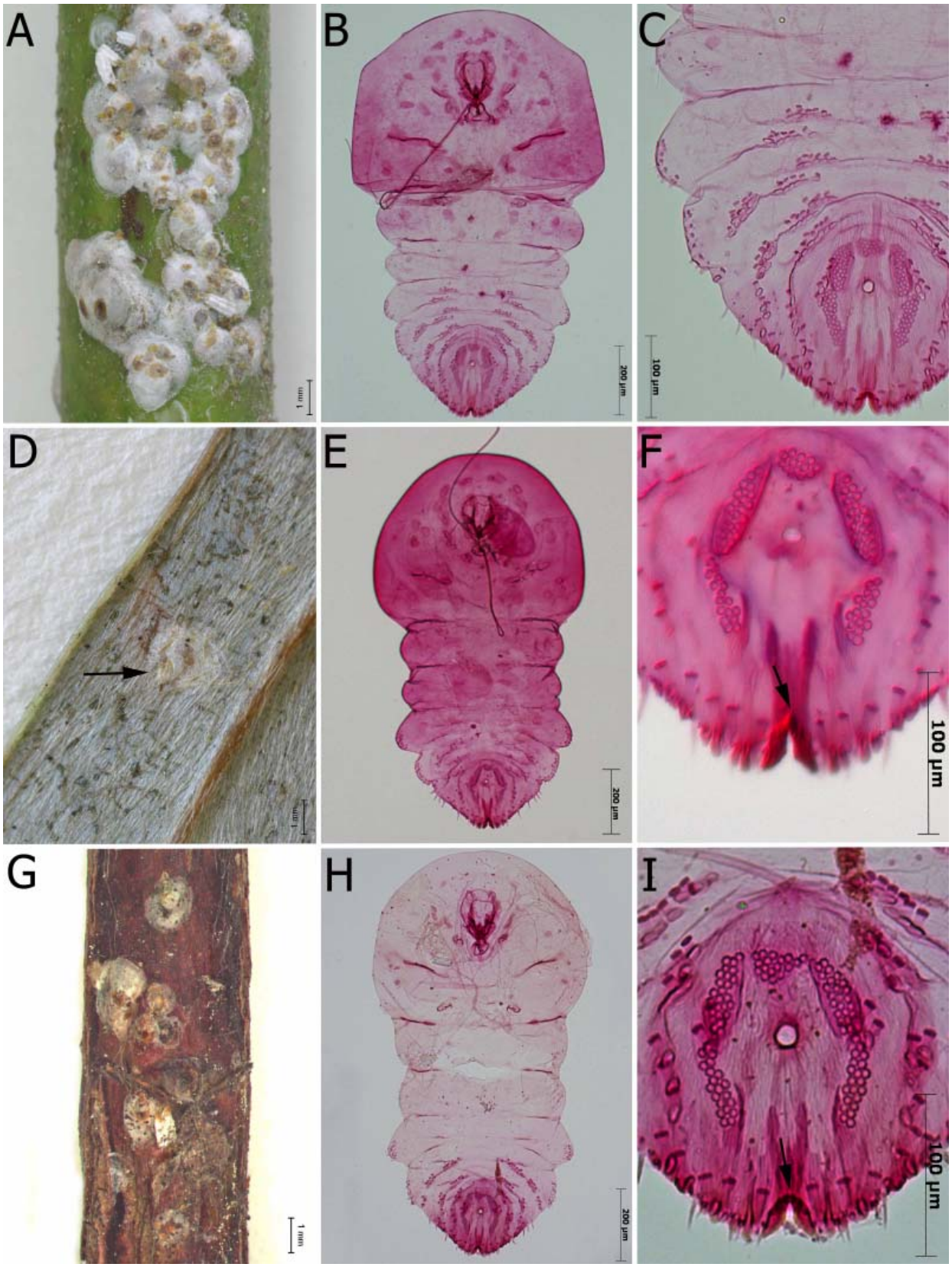

Figure 3. *Aulacaspis rosarum* Borchsenius, A-C; A. habitus, B. female, C. abdomen. *Aulacaspis yabunikkei* Kuwana, D-F; D. habitus, E. female, F. abdomen. *Aulacaspis rosae* (Bouché), G-I; G. habitus, H. female, I. abdomen.

Slide-mounted Characters. Adult female with 3 pairs of well-developed lobes, fourth lobes with lateral lobule represented by series of low points. Median lobes separated by space 0.3 times width of median lobes, with yoke, medial margin parallel sided one-third to one-half length of lobe then strongly divergent to apices, lateral margins diverging slightly, with 0-2 lateral notches, medial margins serrate with 6-12 notches; second lobes bilobed, smaller than median lobes; third lobes bilobed, usually slightly smaller than second lobes. Gland spine formula 1-1-1, with about 11 gland spines near each body margin anterior of fourth lobe area, medial lobes without gland spines between them. Macroducts on pygidium about same size, without duct between medial lobes; submedial ducts on segments 3 to 5, with 1 to 2 ducts each; submarginal ducts on segments 3 to 5, with 1 to 2 ducts each; marginal ducts on segments 5 to 7 with 1 to 2 ducts each. Perivulvar pores in 5 groups; approximately 39 pores on each side of body. Anterior spiracles with 5 to 7 pores, posterior spiracles with 2 to 3. Antennae each with 1 conspicuous seta. Body elongate, pale yellow, cephalothorax roundish expanded, abdominal segments narrow.

Material examined. Korea. Jejudo (JJ): Andeokgyegok, 2 adult females, on *Distylium racemosum* (Hamamelidaceae), 6-viii-1977 (W.H. Paik); same data, except for 5 adult females, 8-v-2008 (S.M. Oh); same data, except for 19 adult females (leaf), 23-vii-2008 (S.J. Suh); Hawon-dong, 13 adult females, same host, 11-iv-2007 (S.M. Oh); Topyeong-dong, 3 adult females, same host, 17-x-2001 (S.M. Oh).

Hosts. Hamamelidaceae: *Distylium racemosum* Siebold and Zucc. (Ben-Dov et al. 2012).

Distribution. China, Japan and Korea* (Ben-Dov et al. 2012).

Remarks. Korean *A. latissima* specimens have a relatively robust yoke between the median lobes and slightly more numerous macroducts on dorsum, compared to the Japanese specimens (Figures 2G2-4).

Key to species of *Aulacaspis* in Korea
(slide mounted adult female)

1. With ducts on dorsum of 2nd abdominal segment **2**
— Without ducts on dorsum of 2nd abdominal segment **4**

2(1). Spines more than 10 on ventral margins of 2nd and 3rd abdominal segments. **3**
— Spines less than 10 on ventral margins of 2nd and 3rd abdominal segments. (Figures 3A-C) ..... ***A. rosarum* Borchsenius**

3(2). Only found on *Elaeagnus*. Median lobes broadly rounded, usually more than 2 times width of 2nd lobes. (Figures 1A-I) ..... ***A. difficilis* (Cockerell)**
— Only found on *Smilax*. Median lobes round, usually less than 1.5 times width of 2nd lobes. (Figures 2H-J) ..... ***A. spinosa* (Maskell)**

4(1). Normal body shape, not as described below, head and thorax enlarged distinctly. With usually ducts on dorsum of 6th abdominal segment **5**
— Body slender, anterior portion not distinctly enlarged. Without ducts on dorsum of 6th abdominal segment. (Figures 2A-F) ..... ***A. latissima* (Cockerell)**

5(4). Median lobes narrowly rounded. Yoke between median lobes produced anteriorly. (Figures 3D-F) ..... ***A. yabunikkei* Kuwana**
— Median lobes broadly rounded. Yoke between median lobes, not produced anteriorly. (Figures 3G-I) ..... ***A. rosae* (Bouché)**

Discussion

Aulacaspis difficilis and *A. latissima* are added to Korean armored scale fauna through the project recently conducted. Additional information provided in this paper should be helpful to understand the genus *Aulacaspis* in Korea.

While writing a manuscript on the *Aulacaspis* armored scales of Korea, considerable effort was spent sorting out the identity of *A. yabunikkei* that occur on *Neolitsea* plants (Lauraceae) due to multiple described forms and published records. This species has been recorded from a broad region of eastern Asia occurring on various Lauraceae and other hosts (Ben-Dov et al. 2012). *Aulacaspis yabunikkei* was first reported on *Cinnamomum pedunculatum* Nees (Lauraceae) from Japan and *Cinnamomum camphora* (L.) J. Presl (Lauraceae) from Taiwan by Kuwana (1926) who described and illustrated two forms. Although there were some differences between them, Kuwana concluded they were the same species. With respect to Korea, this species was first collected on *Neolitsea sericea* (Blume) Koidz. (Lauraceae) in 1977 (Paik 1978). However, these specimens are different from *A. yabunikkei* as described by Kuwana (1926) and Takagi (1969, 2012) by having a broad cephalothorax, robust head tubercles, elongated second lobes and the yoke between median lobes is produced anteriorly. It is recommended that these specimens be treated as a new species due to the distinct characters mentioned above. However, morphological differences observed between these Korean specimens may be attributable to the host- and site-caused variations and developmental conditions of adult females such as full-grown versus young adult females.

Acknowledgments

I am grateful to Greg Evans (USDA/APHIS/NIS, Washington, DC, USA), Greg Hodges (FDACS-DPI, Florida, USA) and Julieta Brambila (USDA/APHIS/PPQ, Florida, USA) for their useful editorial contributions to this draft manuscript.

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Received March 18, 2013; Accepted April 14, 2013.