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from warm temperate forests in Korea

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## Armored scales (Hemiptera: Diaspididae) from warm temperate forests in Korea

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**Abstract.** *Andaspis recurrens* Takagi and Kawai, *Hypaspidotus jordani* (Kuwana), *Lepidosaphes kamakurensis* (Kuwana) and *Selenomphalus distylii* Takagi from warm temperate forests are newly documented in the Korean fauna of armored scale insects (Hemiptera: Diaspididae). Characteristics of these species are briefly given and illustrative photographs and information on their distribution and hosts are provided.

**Key words.** Coccoids, *Andaspis recurrens*, *Hypaspidotus jordani*, *Lepidosaphes kamakurensis*, *Selenomphalus distylii*.

## Introduction

Warm temperate forests occur where summers are warm, winters are mild without extended periods of snow cover or severe frost, and where there is no marked dry season (Walter 1971). The large eastern Asian warm temperate forest zone is dominated by evergreen or semi-deciduous flowering plants. Armored scale insects (Hemiptera: Diaspididae) can occur on leaves, twigs, branches or trunks of these plants. They are often pests of many evergreen and deciduous plants, but it is difficult to recognize them or overlooked by the observer due to their small size. The republic of Korea also has a warm temperate forest (35 degrees latitude south), where shrubs and trees such as *Castanopsis sieboldii* (Makino) Hatus (Fagaceae), *Quercus glauca* Thunb., *Cinnamomum camphora* (L.) J. Presl. (Lauraceae), *Persea thunbergii* (Siebold and Zucc.) Kosterm., and *Camellia japonica* L. (Theaceae), grow naturally. Over the course of surveying of warm temperate forests, some armored insect scales were collected. These were identified as *Andaspis recurrens* Takagi and Kawai, *Hypaspidotus jordani* (Kuwana), *Lepidosaphes kamakurensis* (Kuwana) and *Selenomphalus distylii* Takagi and represent the first records of the occurrence of these species in Korea. Of these, two of the genera, *Hypaspidotus* Takahashi and *Selenomphalus* Mamet are newly reported from the Republic of Korea through this survey.

The genus *Hypaspidotus* characterized by well-developed, upside down U-shaped paraphyses between the median lobes, between median and second lobes, and between the second and third lobes (Fig. 4). This genus contains two species worldwide and among them, *H. jordani* collected on leaves of *Castanopsis cuspidata* and *Quercus glauca* (Fagaceae) is newly added to the catalogue of Korean scale insects.

The other genus *Selenomphalus* described by Mamet (1958) is related to *Metaspidotus* and *Crassaspidotus*, in the arrangement of dorsal macroducts and all pygidial lobes of about same shape and size, but is readily distinguished by the spur-like shape of the third lobe (Fig. 9). Only two species, *S. euryae* (Takahashi) that occurs on evergreen trees in China and Taiwan and *S. distylii* Takagi, found during this survey, which were previously known only from Japan on *Distylium* plant, have been reported from the Asian region. A host plant and distribution of *S. distylii* is updated through this survey.

The remaining other two genera, *Andaspis* MacGillivray and *Lepidosaphes* Shimer, are closely related, which have oyster-shell shaped scale covers; some *Andaspis* species were formerly placed in *Lepidosaphes*. However, the genus *Andaspis* differs from that genus primarily by the shape and position of the median lobes of the pygidium. These are usually exceptionally large, placed close together, with the inner edges short, diverging to the long oblique outer margins, with small gland spines between them (Williams and Watson 1988).

The genus *Andaspis* is comprised of 46 species worldwide (García et al. 2016). In Korea, the first record of *Andaspis* scales began by Suh (2011) with the report of *Andaspis crawii* (Cockerell) and *Andaspis kashicola* (Takahashi). The *Andaspis* species collected on the underside of the leaves of *Quercus*

*glauca* (Fagaceae) during the survey does not have a club-shaped paraphysis arising from the middle basal part of median lobe.

The genus *Lepidosaphes* was described by Shimerin in 1868 and currently contains 168 species known worldwide (García et al. 2016). Of these, 18 species have been documented from the Korean peninsula (Paik 2000). This genus has the following characters: female body elongate, fusiform, lateral lobes of free abdominal segments well developed; median lobes not yoked, separated, with one pair of gland spines between median lobes, the second lobes bilobed; dorsal ducts two-barred, usually six pairs of marginal macroducts, ducts on submargin and submedian abdomen often numerous, with similar ducts also on submargins of anterior abdomen and thorax; dorsal submarginal bosses often present; lateral tubercles or spurs often present between some abdominal segments; perivulvar pores present in 5 groups (Williams and Watson 1988). During a recent survey of the southern area of Korea, which consists predominantly of warm temperate forests that are preferred by armored scales, a species of *Lepidosaphes* occurring on camellia plants (*Camellia japonica*) was collected.

In this paper, the author adds four armored scale insect species to the Korean fauna: *Andaspis recurrens* Takagi and Kawai, *Hypaspidiotus jordani* (Kuwana), *Lepidosaphes kamakurensis* (Kuwana), and *Selenomphalus distylii* Takagi. Illustrations and information on distribution and host plants for each of these species are provided.

## Materials and Methods

All slide-mounted specimens studied for this paper are deposited in the Collection of Plant Quarantine Technology Center, South Korea. The characters provided below for diagnoses are based on specimens of adult females collected on the leaves of their plant hosts. Terminology for morphological structures follows that of Miller and Davidson (2005). Abbreviations of collecting regions are as follows: Gyengsangnamdo (GN), Jeollanamdo (JN) and Jejudo (JJ). Photographs were taken using an AxioCam MRc5 camera mounted on a ZEISS Axio Imager M2 Microscope and a Leica M165C microscope with a Delta pix camera. An asterisk (\*) is used to indicate new host and distribution records.

## Species Diagnoses

### *Andaspis recurrens* Takagi and Kawai (Figures 1–2)

*Andaspis recurrens* Takagi and Kawai, 1966: 106. Type data: Japan, on *Castanopsis* sp.

**Diagnosis.** Adult female cover reddish brown, oyster-shell shaped; shed skins yellowish to brown, marginal. Male not collected by author. Adult female elongate with one pair of lobes, second lobes when present represented by small marginal prominences. Median lobes with paraphyses arising at both basal angles; medial ones slender, divergent; lateral ones with appendage curved outwards, however, not in the specimens collected in Korea. Marginal macroducts of the pygidium, with 1 on abdominal segment 7, 2 on each abdominal segments 6 and 5, 1 on abdominal segment 4. With small macroducts (approximately 2.2 µm in diameter) on dorsum; abundant across abdominal segments 3 to 5; 11–14 in a long submedian row on abdominal segment 6. Ventral microducts forming a transverse row across the metathorax. Gland spines present on submarginal and marginal areas of abdomen. Dorsal boss (pigmented cicatrix) present between abdominal segments 5 and 6. Antenna with 2 or 3 setae. Anterior spiracle with 2 to 3 pores, posterior spiracles without pores. Perivulvar pores in 5 groups, about 24 pores in total.

**Material examined.** Korea. JN: Bogildo, 2 adult females, on *Quercus glauca*, leaf, iv-18-2008 (S.J. Suh).

**Distribution.** Japan (Kawai 1980), \*Korea.

**Hosts.** Fagaceae: *Castanopsis cuspidata*, \**Quercus glauca* (Kawai 1980).

**Remarks.** Takagi has commented that it is not easy to determine whether this specimen collected in Korea represents a variation within *A. recurrens* or a distinct species (Takagi 2011). The morphological differences between the Korean and Japanese forms are usually attributable to host- and feeding-site variations. Japan is separated from the Asian continent, so this geographic isolation may be a critical factor, giving rise to intraspecific diversification of *A. recurrens*. It is difficult to determine which form is more ancestral. In an effort to clarify this problem, a survey should be conducted from a wider area in Asian continent including China.

***Hypaspidiotus jordani* (Kuwana)** (Figures 3–4)

*Aspidiotus jordani* Kuwana, 1902: 69. Type data: Japan, on *Quercus* sp.

**Diagnosis.** Adult female cover white, flat, circular; shed skins yellow to dark, central. Male not collected by the author. Adult female turbinate with three pairs of well-developed lobes. Median lobes rectangular-shaped, separated by half of width of one median lobe; lobe 2 and lobe 3 triangular-shaped. Paraphyses well-developed, arising from basal corners of lobes, 2 paraphyses between the adjacent lobes curved towards each other, forming a reverse U-shaped sclerosis between median lobes, between median and second lobes, and between second and third lobes. Plates fimbriate; 2 in each side of 1<sup>st</sup> space and 2<sup>nd</sup> space; 3 in 3<sup>rd</sup> space. With 1–3 marginal macroducts on abdominal segments 3–4, shorter than pygidial macroducts. Pygidial macroducts usually extending up to base of anus, about 100 µm long, with about 34 on each side of pygidium on abdominal segments 5–8. Antenna with 1 seta. Anterior and posterior spiracles without pores. Perivulvar pores in 4 groups, about 35 pores in total.

**Material examined.** Korea. GN: Oedo, 1 adult female, on *Castanopsis cuspidata*, leaf, xi-5-2008 (S.J. Suh). JN: Bogildo, 8 adult females, on *Castanopsis cuspidata*, leaf, iv-18-2008 (S.J. Suh); Bogildo, 1 adult female, same host, iv-2-2009 (S.J. Suh). JJ: Andeokgyegok, 1 adult female, on *Quercus glauca*, leaf, v-17-2012 (S.J. Suh); Donnaeko, 12 adult females, on *Castanopsis cuspidata*, leaf, v-16-2012 (S.J. Suh); Halla Arboretum, 5 adult females, same host, x-16-2012 (S.J. Suh).

**Distribution.** Japan (Kawai 1980), \*Korea.

**Hosts.** Fagaceae: *Castanopsis cuspidata*, *Castanopsis sieboldii*, \**Quercus glauca*, *Quercus* sp. (Kawai 1980).

***Lepidosaphes kamakurensis* (Kuwana)** (Figures 5–7)

*Lepidosaphes kamakurensis* Kuwana, 1925: 18–19. Type data: Japan, on *Thea japonica*.

**Diagnosis.** Adult female cover pale to dark brown, oyster-shell shaped, slightly convex; shed skins pale to dark brown, marginal. Male cover similar to that of female, shorter, narrower. Adult female elongate fusiform with two definite pairs of lobes; third and fourth lobes represented by a series of small points. Pygidium rather trapezoidal; medial lobes rather small, nearly as long as wide, separated by a space more or less narrower than one of them. Dorsal macroducts slender (about 1.8 µm in diameter), with 7–9 on abdominal segment 6. Gland spines present on metathorax and abdomen. Lateral projections present between abdominal segments 1 to 3. Antenna with 2 setae. Anterior spiracle with 2 pores, posterior spiracles without pores. Perivulvar pores in 5 groups, about 19 pores in total.

**Material examined.** Korea. GN: Dadaepo, 12 adult females, on *Camellia japonica*, leaf, 13-xii-2007 (S.J. Suh); Dongbaekseom, 9 adult females, same host, 14-xiii-2008 (S.J. Suh); Dongbaekgongwon, 5 adult females, same host, 24-ix-2008 (S.J. Suh); Yongdusangongwon, 9 adult females, same host, 15-xii-2011 (S.J. Suh). JN: Wando Arboretum, 8 adult females, on *Camellia japonica*, leaf, 17-vi-2008 (S.J. Suh); Wandosumokwon, 5 adult females, same host, 1-iv-2009 (S.J. Suh); Bogildo, 2 adult females, same host, 2-iv-2009 (S.J. Suh).

**Distribution.** Japan, Taiwan (Kawai 1980; Hua 2000), \*Korea.

**Hosts.** Smilacaceae: *Heterosmilax japonica*. Theaceae: *Camellia japonica*, *Camellia* sp. (Kawai 1980; Hua 2000).

***Selenomphalus distylii* Takagi** (Figures 8–9)

*Selenomphalus distylii* Takagi, 1959: 112. Type data: Japan, on *Distylium racemosum*.

**Diagnosis.** Adult female cover brown, slightly convex, subcircular (Takagi 1959). Adult female turbinate with three pairs of lobes. Median lobes broad, flatly rounded along the apical margin, separated by a space slightly narrower than 1/3 width of one median lobe; lobe 2 smaller than the median lobes; lobe 3 spur-shaped, heavily sclerotized. Paraphyses present, small, slender from basal corners of each lobe. Plates fimbriate; 2 in 1<sup>st</sup> space and 2<sup>nd</sup> space respectively, slender; 3 in 3<sup>rd</sup> space, outer two broad; 7 laterad of lobe 3, broad. Pygidial macroducts elongate, with two to three longitudinal rows on each side, eight to ten ducts in rows each. Antenna with 1 seta. Anterior and posterior spiracles without pores. Perivulvar pores in 4 groups, about 23 pores in total.

**Material examined.** Korea. JJ: Andeokgyegok, 2 adult females, on *Neolitsea sericea*, leaf, x-4-2001 (S.M. Oh).

**Distribution.** Japan (Kawai 1980), \*Korea.

**Hosts.** Hamamelidaceae: *Distylium racemosum* (Kawai 1980). Lauraceae: \**Neolitsea sericea*.

## Discussion

This updated list of the armored scales known to occur in Korea, including *Andaspis recurrens* Takagi and Kawai, *Hypaspidiotus jordani* (Kuwana), *Lepidosaphes kamakurensis* (Kuwana), and *Selenomphalus distylii* Takagi, which are newly recorded in Korea, adds to our understanding of the Korean fauna of armored scales. All of these species were collected on leaves of their host plants and all have a restricted host range. No economic damage to these host plants was observed during the survey although *L. kamakurensis* is fairly common on camellia plants. Armored scales received much attention throughout the world due to their sudden appearance in large numbers on economically important crops and ornamental plants. This information is essential to assessing the economic impact that a given species poses. Therefore, constant collecting trips and taxonomic studies are required to deal with pest issues concerning armored scales.

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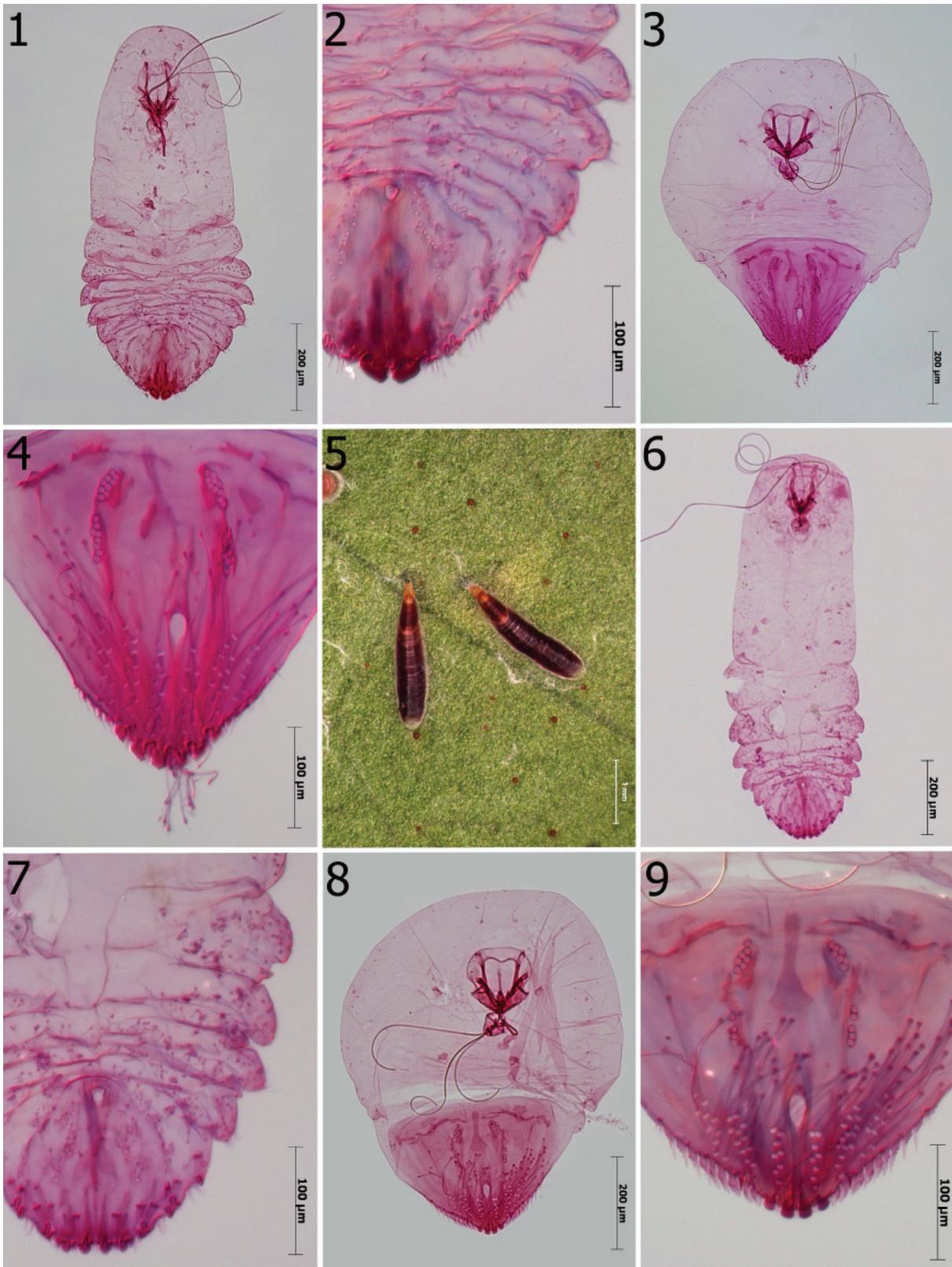
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**Figures 1–9.** Species of armored scales new to Korea. 1–2: *Andaspis recurrens*, 1) female, 2) pygidium. 3–4: *Hypaspidiotus jordani*, 3) female, 4) pygidium. 5–7: *Lepidosaphes kamakurensis*, 5) habitus, 6) female, 7) pygidium. 8–9: *Selenomphalus distylii*, 8) female, 9) pygidium.