

New records of three armored scale insect species from Sri Lanka (Hemiptera: Diaspididae)

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ABSTRACT

Armored scale insects have become a severe threat as a plant pest in many parts of the world, and their mysterious features empowered them to high impact on yield loss and exportation of planting materials. However, they have not acquired significant attention so far in research studies of Sri Lanka. Thus it is crucial to be aware of available native species, potential threat species and their host range to predict potential risks in Sri Lanka. At present, 181 armored scale species have been reported in Sri Lanka. In 2020, a field survey was carried out to update information by visual inspection of the vegetation in randomly selected 190 home gardens in Galle district, a southern province of Sri Lanka. Three armored scale insects (Hemiptera: Diaspididae) were recorded from Sri Lanka for the first time. These species were slide mounted, microscopically identified using taxonomic keys and described as *Aspidiella hartii* infesting Ginger tubers (*Zingiber officinale*), *Lepidosaphes esakii* from Pleomele plant (*Pleomele thaliodes*) and *Pseudaulacaspis leverii* from Cycas plant species. Among them, *Aspidiella hartii* have been recorded as a common pest of yams, ginger, turmeric and other root crops in other countries, and that might be a potential epidemic in Sri Lanka. Information related to the diagnosis, distribution and hosts of these newly recorded species is updated.

Keywords: Armored scale, *Aspidiella hartii*, *Lepidosaphes esakii*, *Pseudaulacaspis leverii*.

INTRODUCTION

The armored scales are plant sap-feeding insects considered among the most destructive and economically important agricultural pests. They belong to the largest family of scale insects: family Diaspididae (Order Hemiptera, superfamily Coccoidea) (Miller et al., 2005). Nearly 2,650 species in about 400 genera are distributed worldwide (Garcia et al., 2016). They are highly polyphagous that grow on 1,380 plant species belong to 182 genera, and survive for more than a single year. Further, they can appear on most of the plant parts (aerial and underground parts) (Miller and Davidson 2005; Ben-Dov, 2008; Kondo et al., 2008; Miller and Gimpel 2008; Rouhani et al., 2018). Specialized adaptation and behaviour enable them to survive easily, transmit worldwide, and become severe quarantine pests.

Usually, members of the family Diaspididae are very small. The female insect is covered by a non-attached, hardened, protective, waxy scale cover that makes it difficult to control. The body can be exposed by lifting off this armour (Rouhani et al., 2018). They possess three female instars that have no pupal stages, and in case of the males, winged adult males occur after completing two feeding nymphal instar stages followed by two non-feeding stages (pre-pupa and pupa) (Watson, 2005). Among them, only first instar 'crawlers' and winged adult males are mobile, have legs, and crawl (Williams and Watson, 1988). A number of armored scale species show parthenogenesis in addition to sexual reproduction.

According to the literature, 181 armored scale species belong to 57 genera have already been recorded from Sri Lanka (Garcia et al., 2016). Although there is the inadequacy of taxonomic studies on armored scale insects in the recent past, there was significant progress in discovering scale insect fauna in the island, mainly by Edward Ernest Green as far back as the nineteenth century. This study aims to update the armored scale insects in Sri Lanka and provide a comprehensive taxonomic and diagnostic description of these new species. This work is aimed to fill the knowledge gap by a sampling of armored scales from the Galle district, which has not been done before.

METHODOLOGY

A field survey on armored scale insects was carried out in randomly selected 190 home gardens in Galle district, a southern province of Sri Lanka, during January-April 2020 by visual inspection of the vegetation in home gardens, including trees, shrubs and weed species that might carry infestations. Infested host-plant parts, including fruits, leaves, bark pieces and branches, were collected and placed in labelled Ziplock polythene bags (15 cm × 20 cm). The adult females were preserved in 70% alcohol with the small pieces of infested plant materials in labelled and sealed screw-topped Nalgene vials (3-5 mL). The preserved samples were taken to the laboratory for the identification of collected species. Permanent slide mounts of armored scales were prepared according to Sirisena et al. (2012). Medium-sized adult females were slide-mounted and examined using a Zeiss compound microscope (Olympus SZH52, China). Species were identified using keys based on Williams and Watson (1988). The prepared slides were stored in the Entomology Laboratory, Department of Plant Sciences, Faculty

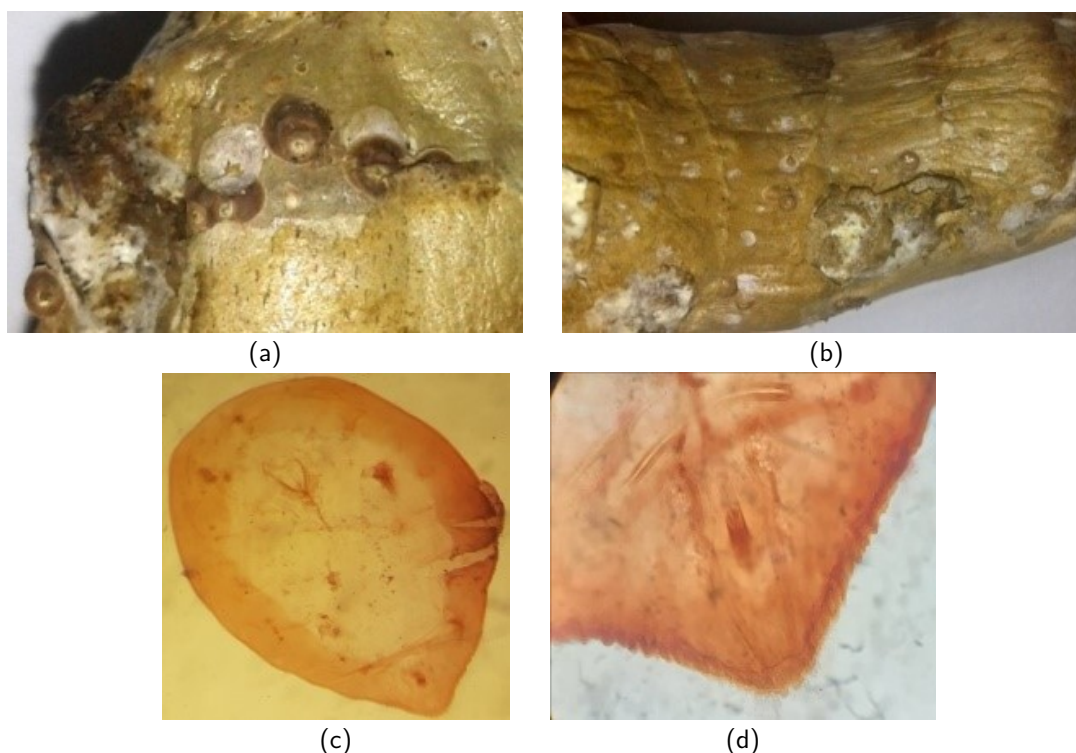


Figure 1: (a) Colony of *A. hartii* on ginger corm, (b) *A. hartii* infected ginger corm, (c) Slide-mounted adult female of *A. hartii*, and (d) Pygidium of slide-mounted *A. hartii*

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RESULTS AND DISCUSSIONS

Aspidiella hartii, *Lepidosaphes esakii*, and *Pseudaulacaspis leverii* were reported in Sri Lanka for the first time.

Genus *Aspidiella* (Leonardi), 1898

This genus was raised by Leonardi (1898) with *Aspidiotus sacchari* as the type species (*Aspidiotus sacchari* is now known as *Aspidiella sacchari*). *Aspidiella* is worldwide in distribution and consists of 8 species at present. In Sri Lanka, two species have been previously recorded; *A. panici* (Rutherford, 1915) and *A. sacchari* (Cockerell, 1893). In addition to this, the present study recorded *A. hartii* to the list.

Diagnosis (mounted material): Possesses 1-barred ducts and plates but differs in having only two pairs of well-developed lobes, while the third pair is represented as short points. The pygidial margin is crenulate and lacks paraphyses. There is a marginal zone of ducts on the dorsal and ventral margins of the pygidium. These ducts are more or less of equal size.

Aspidiella hartii (Cockerell), 1895

External appearance (unmounted material): Occurring on the tubers, the scale of the female is brown to brownish-grey with slightly paler, circular, relatively flat

and the rest of the dorsal shield is darker than subcentral to submarginal exuviae. Adult females are faint membranous yellow in colour and live inside these scale covers (Figure 1(a)). The male scale is smaller and more elongated but similar in color with marginal exuvia.

Diagnosis (mounted material): The slide-mounted adult female body is membranous and pyriform to elongate-pyriform shape. Two pairs of sclerotized lobes present and each third lobe represented by a short unsclerotized point; weak parallel scleroses present at bases of median lobes. Plates are fimbriate, between lobes and lateral to third lobes. Dorsal and ventral ducts are present in a submarginal zone as far forward as the second abdominal segment; ventral ducts are slightly smaller than dorsal ducts. Perivulvar pores are in four groups (Figure 1(c)).

Identification key: Sri Lanka: one colony, Imaduwa, 8.iii.2020.

Distribution: This species has a worldwide distribution, including 31 countries as Ivory Coast, Dominican Republic, Ecuador, Federated States of Micronesia, Fiji, Galapagos Islands, Gana, Guadeloupe, Haiti, Honduras, Hong Kong, India, Malaysia, Martinique, Mauritius, New Caledonia, New Zealand, Nigeria, Panama, Papua New Guinea, Philippines, Puerto Rico and Vieques Island, Saint Croix, Sierra Leone, Solomon Islands, Thailand, Tonga, Trinidad and Tobago, U.S. Virgin Islands, Vanuatu and Zambia (Garcia et al., 2016).

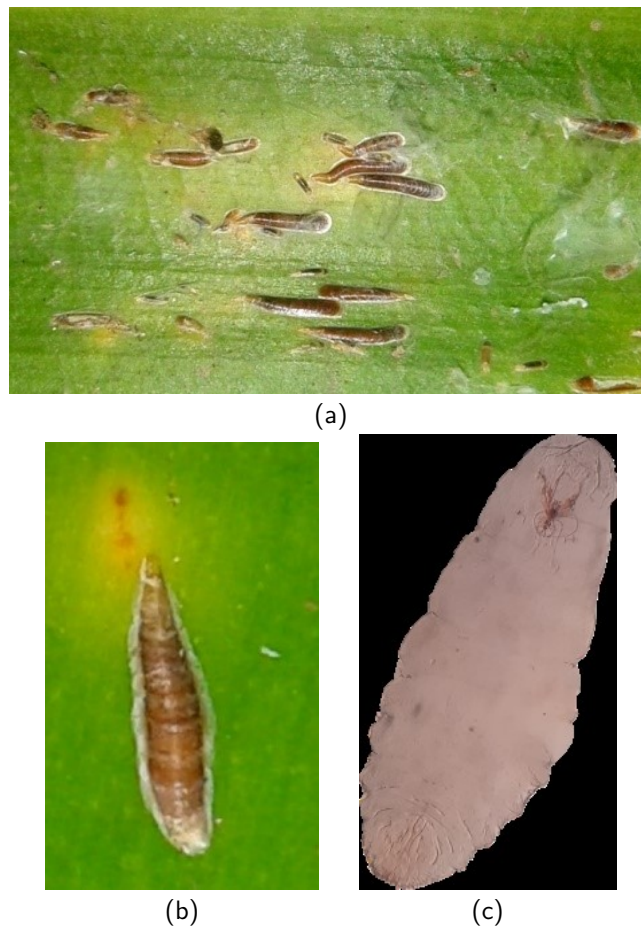


Figure 2: (a) Colony of *L. esakii* on Pleomele leaf, (b) Adult female of *L. esakii*, and (c) Slide-mounted adult female of *L. esakii*

Host plants: *A. hartii* has been previously recorded on hosts from Araceae, Convolvulaceae, Cyperaceae, Dioscoreaceae, Melastomataceae, Poaceae, Portulacaceae and Zingiberaceae plant families, including 10 Genera (Garcia et al., 2016). During the current study, this species was collected from ginger tubers (Zingiberaceae: *Zingiber officinale*).

Economic importance: *Aspidiella hartii* is a common pest of yams and a tropicopolitan species that cover the tubers in stores after completing reproduction. Genus *Dioscorea*, is known to be badly affected in the field (Williams and Watson, 1988). Mainly yams are attacked in storage (Chua and Wood, 1990; Morse et al., 2000; Schmutterer et al., 1957; Williams and Watson, 1988). It is considered that *A. hartii* is a potential field and storage pest of ginger and turmeric plants (Zingiberaceae) and other tropical roots/rhizome crops such as taro and dasheen stored before consumption. Kotikal and Kulkarni (2000) mentioned *Aspidiotus curcumae* (now known as *Aspidiella hartii*) as a major pest of turmeric (*Curcuma longa*) in India (Karnataka). Due to the infestation, stored tubers become fibrous and unpalatable and prevent germination. Further, *A. hartii* is badly influenced by these products viability, quality, and mar-

ketable value. There is a phytosanitary risk with importation as planting materials. The yam cultivation should not be carried out followed by ginger or turmeric. It prevents the population build-up of *A. hartii* in the field.

Genus *Lepidosaphes* (Shimer), 1868

This genus was raised by Shimer (1868) with *Mytilococcus communis* Amerling (*Lepidosaphes ulmi*, Linnaeus) as the type species. *Lepidosaphes* is worldwide in distribution and is comprised of 195 species at present. In Sri Lanka, twelve species have been recorded previously under this genus (Garcia et al., 2016), and the present study added *L. esakii* to the list.

Diagnosis (mounted material): Adult female body is elongate, fusiform, and usually membranous except for pygidium. Lateral abdominal lobes are well-developed and have marginal gland spines or gland tubercles. Unyoked separated median lobes with one pair of gland spines in medial region, Bilobated 2nd lobe with paraphyses short if present, the third lobe is insignificant. Macroducts exhibit a tendency towards a reduction in number, size, or shape. Six pairs of marginal macroducts and 2-barred dorsal ducts occur on the pygidium.

Numerous submargin and submedian abdominal ducts, similar ducts occur on submargins of anterior thorax and abdomen. Bosses present on dorsal submarginal region. Lateral spurs or tubercles occur between some abdominal segments. Anus locates near the base of pygidium and perivulvar pores occur in 5 groups.

***Lepidosaphes esakii* (Takahashi), 1939**

External appearance (unmounted material): Adult female 1.75 mm long, tending to be broadly oval, widest at mesothorax; head and pygidium rounded, reddish-brown colour scale (Figure 2(a))

Diagnosis (mounted material): Slide-mounted adult female is 1.75 mm long, tending to be broadly oval, widest at mesothorax; lateral lobes of abdominal segments only moderately developed; head and pygidium rounded. Other important characters are the rather narrow diverging median lobes, the space between as wide as or wider than a single lobe. The second lobes are narrow. Gland spines are slightly longer than lobes. Present in pairs on pygidium, but three or four present on margins of third and fourth segments. Six marginal macroducts are on each side. Dorsal ducts are small, smaller than half-width and length of a marginal macroduct; the sixth segment usually with a single submarginal duct and 2-3 submedian ducts; anteriorly, forming groups on margins of the abdomen, and occurring sparsely on margins of thorax; submedian groups present as far forward as segment 3. The antenna has two long setae. Each anterior spiracle has 5-8 disc pores (Figure 2(c))

Identification key: Sri Lanka: one colony, Ambalangoda, 16.ii.2020; one colony, Balapitiya, 26.i.2020; two colonies, Bope-poddala, 22.i.2020; one colony, Gonapinuwa, 20.ii.2020; one colony, Imaduwa, 19.ii.2020; one colony, Niyagama, 4.ii.2020.

Distribution: This species has been distributed in six countries as Federated States of Micronesia, Guam, Kiribati, Marshall Islands, Northern Mariana Islands and the Philippines (Garcia et al., 2016).

Host plants: This species has been recorded on hosts from 2 plant families, including 2 Genera (Garcia et al., 2016). During the current study, this species was collected from Pleomele (*Pleomele thalioides* – Asparagaceae).

Genus *Pseudaulacaspis* (MacGillivray), 1921

This genus was raised by MacGillivray (1921) with *Disaspis pentagona* Targioni Tozzetti as the type species. *Pseudaulacaspis* is worldwide in distribution and is comprised of 64 species at present. In Sri Lanka, twelve species had been recorded previously under this genus, and during this study, *P. leverii* was collected.

***Pseudaulacaspis leverii* (Williams and Watson), 1988**

External appearance (unmounted material): Adult female scale is white in colour, elongate, pyriform, terminal exuviae. The male scale is also elongated and white (Figure 3)

Diagnosis (mounted material): Elongated adult female is about 0.9 mm long; head and pygidium rounded; membranous body pygidium not membranous; lateral lobes of free abdominal segments only moderately developed. Median lobes prominent but recessed into the apex of the pygidium, forming a notch, the inner edges longer than outer edges, each lobe rounded distally. Bilobed second lobes are much smaller than median lobes. Serrate margins represent third lobes. Gland spines more numerous on third and fourth segments and arranged singly on each side of fifth and posterior segments; Wider dorsal ducts present on pygidial margins; shorter ones, present in submarginal rows on fourth and fifth segments on each side, and as a small marginal group on the third segment. Single submedian ducts are present on the fourth and fifth segments on each side, only rarely two ducts are rarely present instead of one. Microducts sparse in submarginal areas forward to prothorax. One submarginal boss presents on each side of the first segment. The anus is situated towards the base of the pygidium. Ventral surface with numerous perivulvar pores present in five elongate groups. Microducts on pygidium present in a group anterior to the vulva, in arrow above each second lobe to the vulva, and submargins. Microducts are sparsely present on free abdominal segments and near spiracles; each antenna has one long seta and each anterior spiracle has a group of 23-30 disc pores (Williams and Watson, 1988).

Identification key: Sri Lanka: one colony, Ambalangoda, 16.ii.2020; one colony, Karandeniya, 31.i.2020.

Distribution: This species has been distributed in Fiji (Garcia et al., 2016).

Host plants: *P. leverii* has been recorded on host plants of the Pandanaceae family (Garcia et al., 2016). During the current study, this species was collected from Cycas plant species.

The list of armoured scale insect fauna in Sri Lanka is updated with these newly recorded species, which aids in the correct identification of species. Appropriate identification is essential for an effective quarantine inspection in the export and import of plant commodities. Further, it avoids misidentification of closely related species. Armored scale pest outbreaks can occur due to potential causes, including climate changes, availability of host resources and pesticides. Numerous severe attacks by armored scales have been recorded from different neighbouring countries (Varshney, 2015). Thus, it is advisable to be aware of native species and potential armored scale insect pests threats to predict future risks. Therefore, managing such severe attacks and developing pest control strategies requires ecological and biological information about these pests.

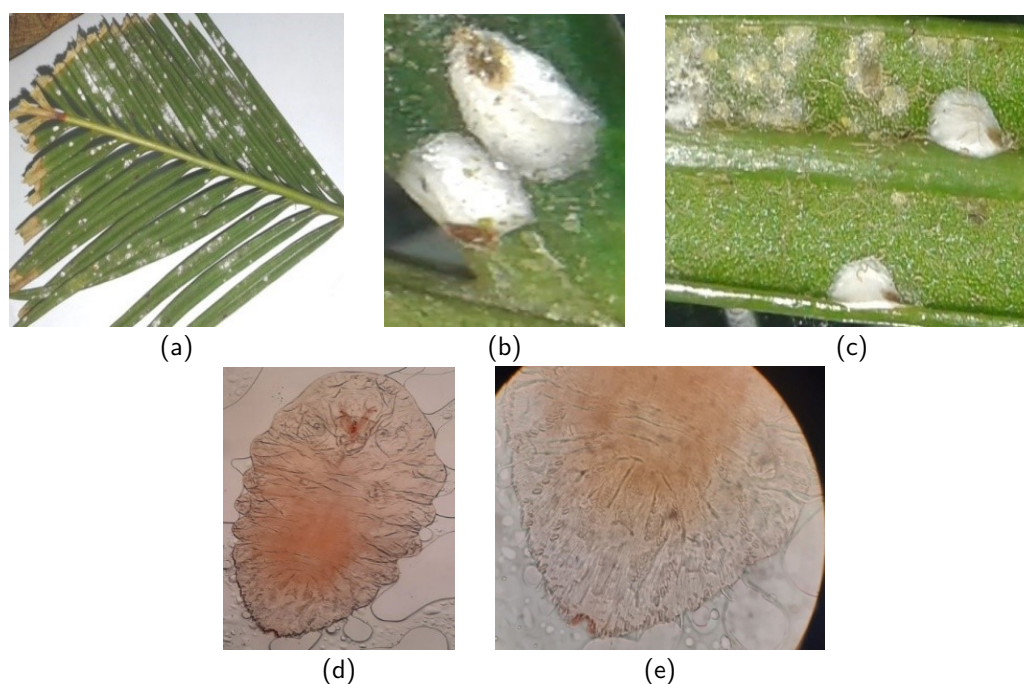


Figure 3: (a) *P. leveri* infected cycas leaf, (b) Adult females of *P. leveri* on cycas leaf, (c) Colony of *P. leveri* on cycas leaf, (d) Slide-mounted adult female of *P. leveri*, and (e) Pygidium of slide-mounted adult female of *P. leveri*

CONCLUSION

The list of armored scale insects in Sri Lanka was updated by discovering the three new species: *Aspidiella hartii* infesting Ginger tubers (*Zingiber officinale*), *Lepidosaphes esakii* from Pleomele plant (*Pleomele thaliodes*) and *Pseudaulacaspis leveri* from Cycas plant species from Galle district in Sri Lanka.

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