Coccidohystrix insolita (GREEN) (HEMIPTERA: PSEUDOCOCCIDAE) FROM INDONESIA AND ITS NOTE ON THE THREE SOLANACEOUS PLANTS

Dewi Sartiami[1*], Warniyadi Suroto Adisuseno[2], Nada Rachmatika[1], Ruly Anwar[1] & Gillian W Watson[3]
[1]Department of Plant Protection,
Faculty of Agriculture,
IPB University, Kamper Rd., IPB Darmaga Campus,
Wing 7 Level 5, Bogor,
West Java, Indonesia, 16680
[2]Agriculture Quarantine Agency,
the Ministry of Agriculture,
Harsono RM Rd., No. 3,
Head Office of the Ministry of Agriculture,
West Jakarta, DKI Jakarta, Indonesia, 12560
[3]Department of Life Sciences,
Natural History Museum, London,
United Kingdom
*Corresponding Email: *dsartiami@apps.ipb.ac.id*

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ABSTRACT

The presence of eggplant mealybug, *Coccidohystrix insolita* (Green) (Hemiptera: Pseudococcidae) from Indonesia and it infested host plants have been reported in this paper. *It* was collected in 2017 on cassava, *Manihot utilissima* in Central Java; additional samples were collected on Turkey berry, *Solanum torvum* in East and West Java in 2020, and in Aceh (Sumatra) in 2021. In a rearing experiment, the survivorship of *C. insolita* on three host plant species, *Solanum melongena* (eggplant), *Solanum lycopersicon* (tomato), and *Capsicum annuum* (chilli) was tested; based on the non-parametric Dunn's test at a 5% level, the mealybug thrives best on *Solanum melongena*.

Keywords: Sternorrhyncha, Coccomorpha, sap-sucking insect, eggplant mealybug, invasive species, host plants, Solanaceae

ABSTRAK

Kehadiran spesies Koya Terung, *Coccidohystrix insolita* (Green) (Hemiptera: Pseudococcidae), dan pokok perumahnya yang diinfestasi dari Indonesia telah dilaporkan dari Indenesia dalam penerbitan ini. Ia dikumpulkan pada tahun 2017 ke atas ubi kayu, *Manihot utilissima* di Tengah Jawa; sampel tambahan telah dikumpulkan dari beri Turki, *Solanum torvum* di Timur dan Barat Jawa pada 2020 dan dari Aceh (Sumatra) pada 2021. Eksperimen penternakan telah

menentukan jangka hayat *C. insolita* pada tiga perumah, *Solanum melongena* (terung), *Solanum lycopersicon* (tomato) dan *Capsicum annuum* (cili); berdasarkan ujian Dunn tidak-parametrik pada 5%, spesies koya dapat hidup lebih lama pada *S. melongena*.

Kata Kunci: Sternorrhyncha, Coccomorpha, serangga penghisap sap, koya terung, spesies invasif, pokok perumah, Solanaceae

INTRODUCTION

The eggplant mealybug, *Coccidohystrix insolita* (Hemiptera: Pseudococcidae), is a sap-sucking insect with a broad range of host plants, having been recorded on hosts in 50 genera belonging to 21 plant families (García Morales et al. 2016). It is known to be a pest on several important crops, particularly those in the family Solanaceae (Moore et al. 2014; Williams 2004). In the Philippine Islands, *C. insolita* became a serious pest of eggplant in 1997, causing leaf yellowing and killing young plants of wild and cultivated crops (Lit et al. 1998).

Coccidohystrix insolita was described by Green in 1908 (García Morales et al. 2016). Since then, it has become an invasive species, widely distributed in the tropics and subtropics. It has been recorded in the Palearctic region (China in 1954, Saudi Arabia in 1984, Spain in 2015), Ethiopian Region (Rodrigues Island in 1899, Kenya in 1911, South Africa in 1915, Madagascar in 1950, Tanzania in 1964 including Zanzibar Island in 2005), and Oceania (Western Samoa in 1988, Guam in 2014) (García Morales et al. 2016); also in southern Asia (India in 1902, Sri Lanka in 1922, Thailand in 1960, the Philippines in 1972, Laos in 1973, Myanmar in 1989, Pakistan and Bangladesh in 1992, and Vietnam in 1999) (Williams 2004). In 2006, *C. insolita* was intercepted at plant quarantine in Japan on *Alternanthera* sp. (Amaranthaceae) from Singapore (Tokihiro 2006). There is no literature record of it having been recorded previously in Indonesia (García Morales et al. 2016; Zarkani et al. 2021).

According to García Morales et al. (2016), there are 13 species of *Coccidohystrix sensu stricto*, eight of which are found in the Palaearctic (*C. artemisiae* (Kiritchenko), *C. burumandi* Moghaddam, *C. insolita* (Green), *C. katiae* Kaydan & Szita, *C. prionodes* (Wang), C. *samui* Kozár & Konczné Benedicty, *C. splendens* (Goux), and *C. zsuzsannae* Kaydan; two in the Oriental region (*C. eleusines* Williams and *C. insolita*) and five in the Afrotropical region (*C. daedalea* Gavrilov-Zimin, *C. ihoujin* Tanaka, *C. insolita*, *C. madecassa* (Mamet), and *C. primigenia* Gavrilov-Zimin.

Most mealybug species reproduce sexually, although some are parthenogenetic (Downie & Gullan 2004); *C. insolita* was found to produce males in Indonesia, so the species reproduces sexually. On *Solanum melongena*, *C. insolita* feeds on all parts of the plant including the leaf, stem, flower, and fruit, forming heavy infestations that can potentially damage the entire plant (Plant Quarantine Wing 2017). The damage symptoms on *S. melongena* leaves are wrinkling, curling, and yellowing, somewhat similar to those caused by the papaya mealybug, *Paracoccus marginatus*, on papaya leaves (Muniappan et al. 2008; Peña & Johnson 2015). The tropical climate in Indonesia supports the growth of agricultural and horticultural crops, which favors the establishment and development of *C. insolita*. The objectives of this study were to record samples of *C. insolita* in Indonesia and to measure the survivorship of the mealybug on *Solanum melongena* (eggplant), *S. lycopersicon* (tomato), and *Capsicum annuum* (chilli pepper) (Solanaceae).

MATERIALS AND METHODS

Collection of Mealybugs, Preparation of Slide Mounts, and Species Identification

Plant fragments infested with live adult females of *C. insolita* were collected from infested host plants into labeled paper bags: two specimens from *Manihot utilissima* (cassava) and colonies from *Solanum melongena* and the ornamental *S. torvum*. At the Laboratory of Insect Biosystematics, Department of Plant Protection, IPB University, Bogor, Indonesia, the mealybugs were killed and preserved in 70% ethyl alcohol and the stained cuticles of adult females were prepared on microscope slide mounts following the procedure given by Sirisena et al. (2013). Slide-mounted specimens were identified using a compound light microscope with phase contrast illumination with 10x to 40x objectives, and the keys provided by Williams (2004).

Survivorship on Host Plants

The survivorship of *C. insolita* was studied, based on the development of mealybug populations on three solanaceous crops: eggplant, tomato, and chili pepper. Adult female mealybugs were reared on eggplant until they produced the first generation. Using a soft paintbrush, these progenies were gently transferred to plants of each host species to be tested. The test was replicated three times. Each replicate consisted of five plants of each host species, and each plant was infested with 10 third-instar female nymphs; thus, the test required a total of 15 plants of each host and 450 third-instar nymphs. Observations were performed at 10, 20, and 30 days after infestation (DAI). On each occasion, the mealybug population on each host plant was counted.

Data Analysis

The resultant data were first analyzed using the Kruskal-Wallis's test, then with the non-parametric Dunn's test at the 5% level.

RESULTS

Distribution Record

Coccidohystrix insolita was found to be established in four provinces in Indonesia: East Java, Central Java, West Java, and Aceh (Sumatra Island).

Material examined (samples are given in chronological order): INDONESIA: Central Java, Banjarnegara (7°23'11.8"S 109°40'00.9"E), on *M. utilissima*, 17.iii.2017, coll. W.S. Adisuseno; West Java, Bogor (6°33'18.0"S 106°47'31.3"E), on *S. torvum*, 27.xi.2020, coll. D. Sartiami; Sumatra I., Aceh, Aceh Besar (5°28'31.1"N 95°22'57.0"E), on *S. melongena*, 27.ii.2021, coll. N. Rahmatika; Sumatra I., Aceh, Aceh Besar (5°28'07.8"N 95°21'53.9"E), on *S. melongena*, 19.iii.2021, coll. N. Rahmatika; Indonesia, East Java, Sidoarjo (7°22'51.5"S 112°45'21.5"E), on *S. torvum*, 01.i.2022, coll. D. Sartiami; West Java, Bogor (6°33'07.9"S 106°47'35.9"E), on *S. torvum*, 19.iii.2022, coll. D. Sartiami; Sumatra I., Aceh, Aceh Besar (5°28'31.1"N 95°22'57.0"E), on *S. melongena*, 27.ii.2021, coll. N. Rahmatika; and Sumatra I., Aceh, Aceh Besar (5°28'07.8"N 95°21'53.9"E), on *S. melongena*, 19.iii.2021, col. N. Rahmatika.

Mealybug Identification

Characteristics of slide-mounted specimens from all the Indonesian samples matched the description of *C. insolita* by Williams (2004). Characteristics of slide-mounted adult female *C. insolita* (Figure 1-2) are: antenna 9-segmented. **Dorsum** with ostioles present on posterior of

abdomen only; cerarii on margin numbering 17 pairs, each consisting of conical setae on a sclerotized prominence (but no trilocular pores); additional cerarii present on dorsal mid-line and submedial areas; and between medial and submedial cerarii on meso- and metathorax. Hind legs without translucent pores, each claw with a denticle. Circulus absent. Anal lobes present, each with a ventral sclerotized bar. **Venter** with quinquelocular pores numerous; multilocular disc pores numerous on abdominal segments III-IX; oral collar tubular ducts present on abdominal segments V-VIII; oral rim ducts absent.

Figure 1**.** *Coccidohystrix insolita*, slide-mounted adult female

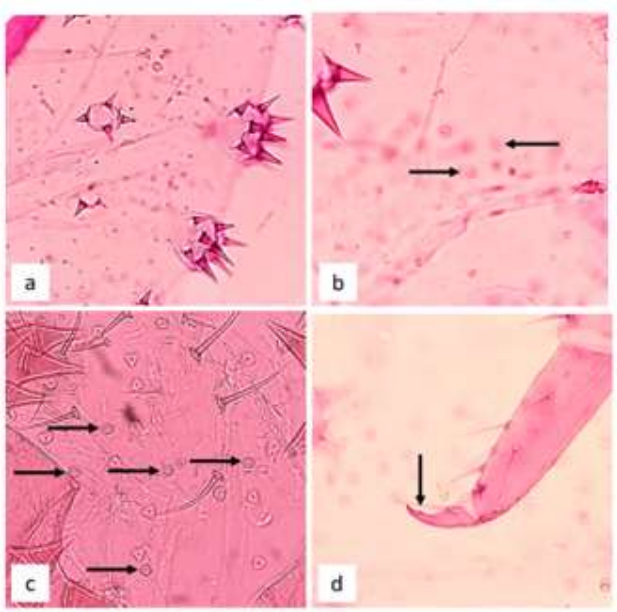

Figure 2**.** Morphological characters of *Coccidohystrix insolita*: (a) cerarii on sclerotized prominences; (b) dorsal multilocular disc pores on metathorax; (c) ventral quinquelocular pores on abdominal segment II; and (d) claw denticle

Appearance of the adult female of *C. insolita* in life: body oval, almost glossy yellowish-green, with a very thin mealy wax coating especially on the dorsum; body 3-4 mm long, with a white waxy ovisac as long as or longer than the body formed at the posterior end from elongate white wax filaments (Figure 3a). Figure 3b shows the adult male of *C. insolita* in life, and Figure 3c shows a colony of the live mealybugs. The live adult female has several dark grey marks on the dorsum of the abdomen and thorax.

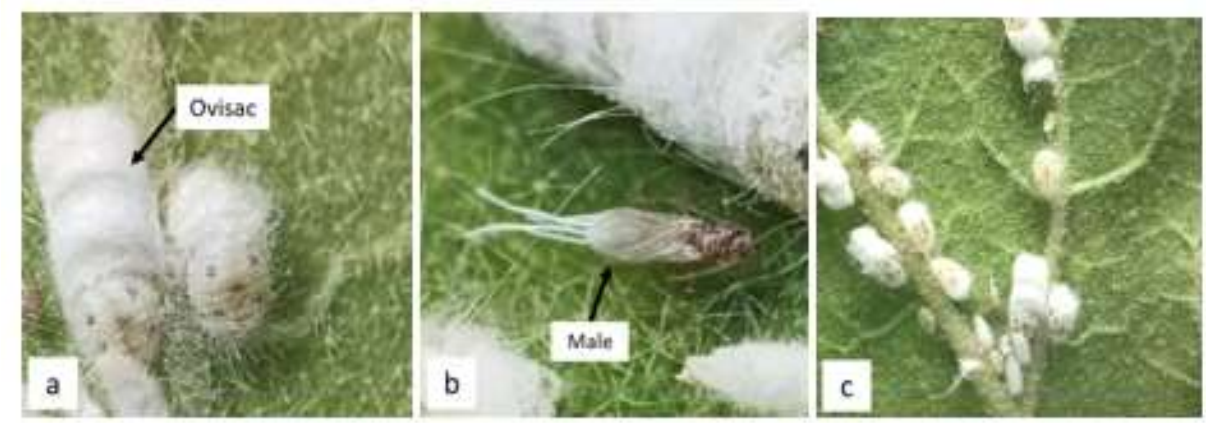

Figure 3. *Coccidohystrix insolita* on *Solanum torvum* leaf undersides: (a) live adult females with ovisacs; (b) live adult male; (c) a colony

Coccidohystrix insolita nymphs and adults were often found living together; colonies commonly occupy the leaf undersides on *S. torvum* (Figure 3 & 4a). In areas surrounding the infested host plants, a frequently encountered ant species visiting the mealybug colonies was *Dolichoderus* sp. (Hymenoptera: Formicidae).

Host Plants and Damage Symptoms

Coccidohystrix insolita was found heavily infesting *S. melongena* at one of the survey sites; it covered almost the entire plant including leaves, flowers, and stems. The mealybug population on a 3-month-old plant was estimated at around 112 individuals.

The survivorship tests of *C. insolita* on three solanaceous plants revealed that the most favourable of the three host species tested was *Solanum melongena.* The host species and time elapsed since initial infestation significantly affected the mealybug population size achieved (Table 1).

Table 1. Population growth of *Coccidohystrix insolita* on three host plant species at different times after initial infestation

Day After Infestation (DAI)	Average Population Growth on Host Plant (±SD)[1]		
	Eggplant	Tomato	Chilli
10	10.00±0.00ab	9.60±0.89ab	0.60±0.55b
20	9.00 ±1.41ab	8.40±1.52ab	0.40±0.55b
30	297.20±141.12a	195.20±64.31a	0.00±0.00b

[1]SD: Sstandard deviation, numbers within a column followed with the same letter are not significantly different, based on the Dunn test at 5%.

Attack by *C. insolita* caused various plant damage symptoms. Chlorotic mottling of the leaves and leaf distortion (Figure 4b-c) were frequently seen in this study, which are very noticeable when compared with an uninfested plant (Figure 4d).

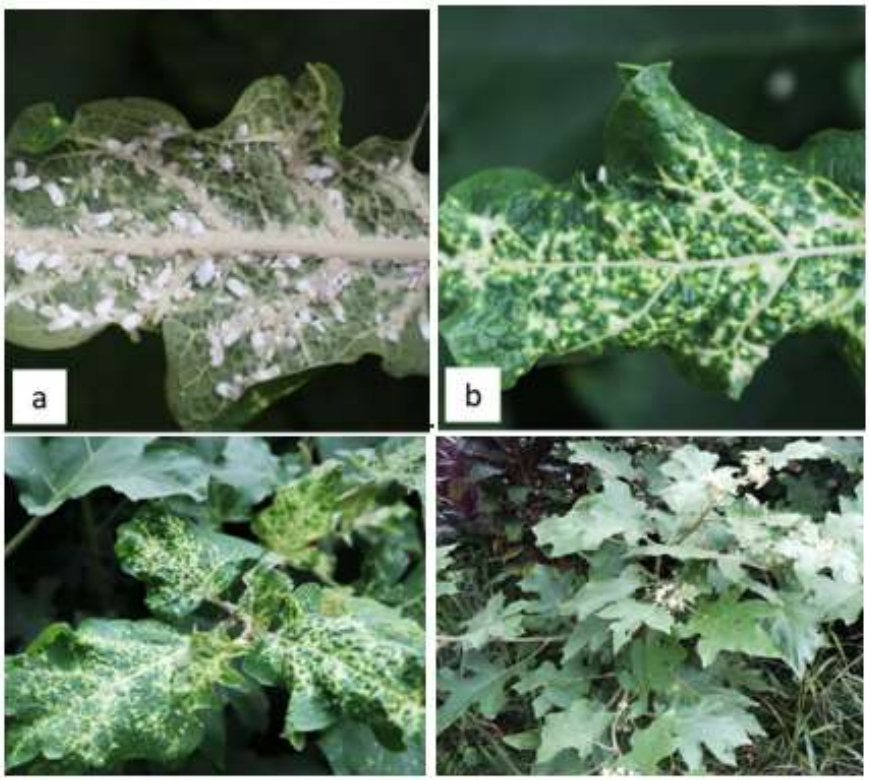

Figure 4. Damage symptoms caused by *Coccidohystrix insolita* on *Solanum torvum*: (a) a colony of *C. insolita* on the underside of the leaf; (b-c) appearance of the upper surface of infested leaves, showing chlorotic mottling; and (d) healthy, uninfested *S. torvum*

DISCUSSION

Distribution Record

The data above are the records of *C. insolita* from Indonesia. The mealybug was collected by the Indonesian Agricultural Quarantine Agency in 2017 (Indonesian Agricultural Quarantine Agency 2018) on cassava in Central Java. Then, in 2020, the species was recorded on a heavily infested *S. torvum* plant in Bogor, West Java. *Solanum torvum* is a new host plant record for *C. insolita*, not listed by García Morales et al. (2016). In the following year, the pest was found on Sumatra I., Aceh Province, feeding on *S. melongena* and single young weed (*Galinsoga parviflora*, Family Asteraceae) growing next to the infested eggplant. The original time of arrival of *C. insolita* in Indonesia is unknown, but it is thought that the mealybug was probably present much earlier than the records above.

Taxonomy

Williams (2004) and García Morales et al. (2016) recorded only two species of *Coccidohystrix* in the Oriental region, *C. eleusine* and *C. insolita*. Adult female *C. insolita* can be distinguished as follows (character states of *C. elusine* given in parentheses): cerarii numbering 17 pairs (18 pairs); dorsum without oral collar tubular ducts (with oral collar tubular ducts); claw with a

denticle (claw without a denticle); and ventral multilocular disc pores present as far forwards as metathorax (multilocular pores confined to venter of abdominal segments VI-IX).

The dark grey marks on the dorsum of the abdomen and thorax of live female *C. insolita* were also mentioned by Mani and Shivaraju (2016) and Sirisena (2022). These spots make the species rather easy to recognize in the field; most other mealybugs lack dark grey dorsal marks. Moore et al. (2014) mentioned that the ovisac can become up to 6 times longer than the body.

Host Plants

Williams and Watson (1988), García Morales et al. (2016) and CABI (2020) list host plants of *C. insolita* that include the following 21 families: Acanthaceae, Amaranthaceae, Apocynaceae, Araceae, Arecaceae, Aristolochiaceae, Asteraceae, Chenopodiaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Malvaceae, Menispermaceae, Moraceae, Poaceae, Rhamnaceae, Rubiaceae, Solanaceae, Sterculiaceae, Tiliaceae, and Zygophyllaceae. In Indonesia, the mealybug was found on a different host plant at each discovery locality in Java and Sumatra. The diversity and abundance of host plants available, as well as a desirable tropical climate in Indonesia, may be substantial drivers in the wider dispersal and establishment of *C. insolita*. Mani and Shivaraju (2016) noted that feeding by both nymphal and adult stages can cause damage symptoms.

Coccidohystrix insolita is known as the eggplant mealybug because *S. melongena* is its preferred host plant, as was shown in this study. The earliest record of the mealybug infesting *S. melongena* is in Green's annotated list of the Coccidae of Ceylon (= Sri Lanka) (Green 1937). In the present study, it survived and reproduced successfully on eggplant and tomato (Table 1), which are its main hosts. It thrived best on eggplant, reaching its highest population at 30 DAI (Table 1), whereas only moderate population growth occurred on tomatoes over the same time period. It is thought that *C. insolita* can develop well on many plant species in the family Solanaceae, including chili peppers. However, *C. insolita* had never been reported on this species plant. And the result of this test in this work showed the establishment and population growth was not achieved; possibly the variety was unpalatable.

Attendant Ants

Several ant species are known to attend *C. insolita* for its copious sugary honeydew (Sirisena 2022), including *Dolichoderus* sp., *Anoplolepis gracilipes* and *Solenopsis geminata* (García Morales et al. 2016; Lit et al. 1998). This study recorded one ant species attending *C. insolita*: *Dolichoderus* sp. The presence of attendant ants on plants sometimes indicates the presence of mealybug colonies.

CONCLUSION

The important mealybug pest on eggplant, *Coccidohystrix insolita*, is reported from Indonesia. Based on its survivorship on three solanaceous host-plant species, *C. insolita* thrives best on *Solanum melongena*.

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CONFLICT OF INTEREST

None.

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