

Pink Wax Scale (*Ceroplastes rubens*) a Growing Threat to Agriculture in Sri Lanka

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ABSTRACT: Wax scale (Hemiptera: Sternorrhyncha: Coccidae), has become an increasingly concerning pest on crop plants and perennials in Sri Lanka. Recent field reports indicate outbreaks of wax scales population and rapid spread on a large number of economically important plants. A methodical study of this species has not been conducted and the identity of the species has not been confirmed yet. A field survey was conducted in three districts: Gampaha, Kalutara and Kandy, from July 2017 to August 2018, to identify the wax scale species causing the recent outbreaks and to record its distribution and host range. The wax scale species was identified as *Ceroplastes rubens* Maskell (pink wax scale) and infestation level of each host plant was presented. The species was prevalent on host-plants belonging to 28 families in all three districts surveyed, among the host-plants families, Araceae (16.9%), Anacardiaceae (16.1%), Myrtaceae (12.7%) and Rubiaceae (10.2%) found to be dominant. It was also found that the significantly higher ($p < 0.05$) infestation level in Gampaha district in compared to Kalutara and Kandy districts. The necessary actions need to be taken to control pink wax scale to prevent further spreading into other areas of the country.

Keywords: Host-plant, pest, Sri Lanka, wax scale

INTRODUCTION

Scale insects refer to a group of sap-sucking insects, classified under the Hemipteran Suborder: Sternorrhyncha, Infraorder: Coccoomorpha and Family: Coccidae. Among them, wax scales, of the genus *Ceroplastes* are an economically important phytophagous insect group. Adult females and nymphs of wax scales cause direct damage through feeding on plant phloem sap. They excrete sugary honeydew, which fouls plant surfaces and provides a medium for the growth of sooty mold fungus on leaves, so reducing the active photosynthetic area (Argov *et al.*, 1987). Heavy infestations of wax scales can cause leaf discoloration and premature drop, branch dieback and even plant death. Sooty mold fouling can lead to a significant reduction in photosynthesis, reducing yield. The scales therefore cause loss of production and reduce the aesthetic value of the crop or the produce (Hodges *et al.*, 2000). In addition, some species of wax scale are virus disease vectors, for example *C. rusci* is known to carry plant viruses (La Notte *et al.*, 1997).

Currently, 144 species and six subspecies of wax scales have been reported worldwide (García Morales *et al.*, 2016). The first and most comprehensive record of the presence of the

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family Coccidae in Sri Lanka was done during the British era, when 71 species in 28 genera were recorded by Green (1937). At present, seven species of subfamily Ceroplastinae, such as *Ceroplastes actiniformis* Green, *Ceroplastes ceriferus* (Fabricius), *Ceroplastes floridensis* (Comstock), *Ceroplastes pseudoceriferus* Green, *Ceroplastes rubens* Maskell, *Ceroplastes sinensis* Del Guercio and *Ceroplastes stellifer* Westwood belonging to ceroplastinae have been recorded in Sri Lanka (Green, 1935; Sirisena, *et al.*, 2016; García Morales *et al.*, 2016). Although these wax scales are spreading at an alarming rate, so far, a methodical study on this scale has not been conducted and the identity of the species has not been confirmed. The present study therefore was conducted to identify the wax scale species causing the recent outbreak and record its distribution and host range.

METHODOLOGY

A field survey was conducted to study the occurrence of a wax scale species. Eleven sites located in three administrative districts, Gampaha, Kalutara and Kandy were surveyed during July 2017 to August 2018. The survey was supported by the extension officers in the districts concerned. The awareness of provincial agricultural extension officers regarding the wax scale threat to horticultural crops was raised in advance. Extension officers were requested to report the presence of the pest on horticultural and non-horticultural crops in their areas of jurisdiction. From the locations reported by the field officers, 3 to 4 in each of the 3 districts were selected randomly for field sampling.

The most severely affected tree/bush identified at each location was georeferenced using a GPS receiver and which was considered as the center point of a transect of having a length of 200 m. Along the transect, all the vegetation, including trees, shrubs and weed species that might carry infestations were examined. Wax scale-infested host-plant samples were collected from vegetation on the transect line. The sampling method varied according to the size of the host plant/tree. In the case of trees, twenty infested leaves per tree and four infested shoots (30 cm in length and 1.0-1.2 mm in diameter) (Hendawy *et al.*, 2013) found nearest to the perimeter of the canopy were sampled. Each tree was sampled from the four cardinal directions (North, East, South and West) as five leaves and one branch per direction, using a sharp knife (Hendawy *et al.*, 2013). In the case of shrubs, five to ten leaves or three 30 cm lengths of infested twigs were sampled. In the case of small plants/weeds, the whole plant was sampled. Each sampled twig/plant was placed in a labeled, mesh fitted plastic jar or paper bag containing a sample number, the locality, date of collection and notes on the host plant and its habitat. Data were recorded on the abundance of wax scale insects per unit area (number of scales/cm²); and the number of live, individual insect life stages (nymphs and adult females) on the leaves. Paper bags containing the specimens were transferred carefully to the Entomology Laboratory at the Horticultural Crops Research and Development Institute, Gannoruwa for further study. Plants and plant parts suspected to be infested by the wax scales were closely examined in the laboratory. The host-plant specimens were identified up to the species level with the collaboration of a Botanist/Taxonomist. Photographs of fresh specimens were taken for the confirmation of the identity. The live appearance of the wax scale insects were recorded using digital photography. The scale insect specimens were prepared for compound light microscopy using the slide-mounting method described by Sirisena *et al.* (2013). Photographs were taken using a high-powered microscopic camera (OPTIKA B5). Slide-mounted adult female specimens were identified under a compound light microscope (Motic BA 300) with objectives between 10 x 20 and 10 x 40, using the keys and illustrations in Green (1896; 1908); Sankaran (1962); Williams and Watson (1990); and Hodgson and Peronti (2012). The abundance and infestation levels were

compared using ANOVA procedure in SAS statistical software and the descriptive statistics were calculated using Microsoft excel program. Voucher specimens were deposited in the insect collection of Horticultural Crops Research and Development Institute (HORDI), Gannoruwa, Peradeniya.

RESULTS AND DISCUSSION

The wax scale spreading an epidemic level in the surveyed areas was identified as *Ceroplastes rubens* Maskell; this identification was confirmed digitally by the Insects Division, Department of Life Sciences, The Natural History Museum, London, U.K. The species was first recorded from Sri Lanka by Green (1896). Two colour forms of *C. rubens*, pink and white were collected. However the white colour form was dominant (Figure 1). Malumphy (2014) also recorded white-waxed individuals of *C. rubens* in Sri Lanka. Some other *Ceroplastes* species like *C. rusci* have also been recorded with white and pink colour forms, which might be induced by different environmental conditions.

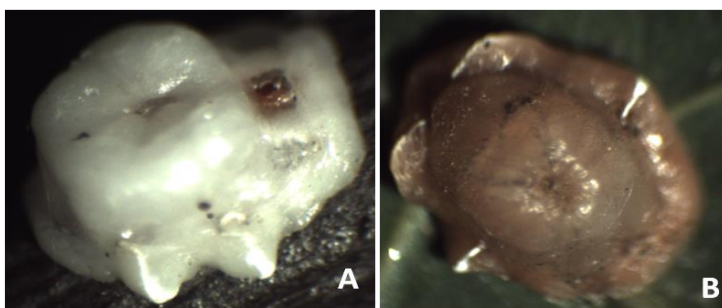


Figure 1. Adult female of *Ceroplastes rubens* A) White colour type B) pink colour type

Live appearance of *C. rubens*

Adult female *C. rubens* are globular and coated with a thick layer of wet pinkish or whitish wax (Figure 1). In dorsal view, they appear sub-rectangular or oval; they may grow to over 3.1 mm in diameter. Adult males are much smaller and have one pair of wings. The pink eggs are laid under the adult female's body, protected by the waxy test. The first-instar crawlers are pink and have functional legs. The second- and third-instar nymphs secrete clumps of wax over themselves, giving them a star-like appearance.

Diagnostic characteristics of slide-mounted specimens

Slide-mounted adult female was broadly oval, anal process was short, heavily sclerotized, stigmatic clefts distinct, each containing about 25-30 stigmatic setae of which three were large and prominent with blunted tips (Figure 2). Antennae were each six segmented and legs were small and poorly developed. Eight area was present in the dorsum, without pores, ducts or setae. Tubular ducts were cylindrical, fine, fairly numerous on cuticle between clear areas. The dorsal setae were few, short and truncate. Marginal setae were short, stiff, acute and slightly curved, sparse. Venter was an inter-antennal setae usually numbering two pairs or absent. Multilocular pores were present around vulva. Spiracular disc pores were present in broad band between each spiracle and corresponding spiracular cleft. Tubular ducts were absent from venter.

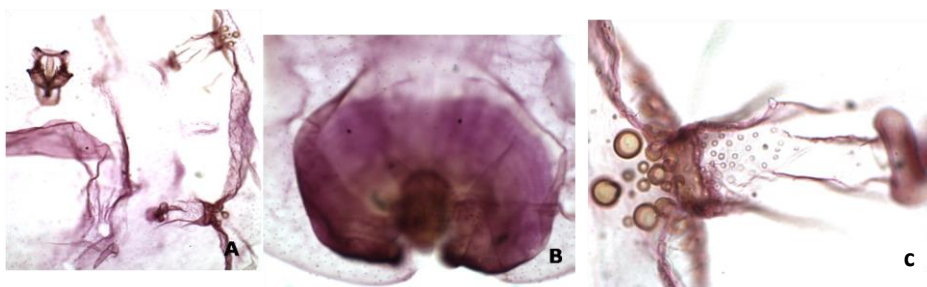


Figure 2. Slide mounted specimens of *Ceroplastes rubens* A) mouth parts and spiracle B) anal plate C) stigmatic furrow and setae

The occurrence (%) of *C. rubens* in different plant families and species

This species was prevalent on hosts belonging to 28 families of plants. However, there was a variation in distribution of species among the districts. It was noted that the scale species has a pronounced preference for *Aglaonema* spp. in Gampaha district (Table 1), *Ixora* spp. and *Mangifera indica* in Kaluthara district (Table 2) and *Mangifera indica* and *Syzygium* varieties in Kandy district (Table 3).



Figure 3. *Ceroplastes rubens* on A) Mango B) Cycas C) Ixora

Table 1. The distribution and host range of *Ceroplastes rubens* in Gampaha District

Host crop		Gampaha District Locations		
Family & species name	Common name	1	2	3
Family: Anacardiaceae				
<i>Mangifera indica</i>	Mango (Gira)	-	H	-
Family: Araceae				
<i>Aglaonema commutatum</i>	<i>Aglaonema</i> Sp 1	H	-	-
<i>A. costatum</i>	<i>Aglaonema</i> Sp 10	-	H	-
<i>Aglaonema</i> Red edge	<i>Aglaonema</i> Sp. 5	H	-	M
<i>A. nitidum</i>	<i>Aglaonema</i> Sp. 7	H	-	-
<i>Aglaonema</i> sp.	<i>Aglaonema</i> Sp. 8	L	-	-
<i>Aglaonema</i> sp.	<i>Aglaonema</i> Sp. 9	H	-	-
<i>Aglaonema</i> sp.	<i>Aglaonema</i> Sp. 11	-	-	H
<i>Aglaonema</i> sp.	<i>Aglaonema</i> Sp. 12	-	-	H
<i>Aglaonema</i> sp.	<i>Aglaonema</i> Sp. 13	-	-	H
Family: Balsaminaceae				
<i>Impatiens balsamina</i>	Kudalu/ Rose Balsom.	L	-	-
Family: Calophyllaceae				
<i>Mesua ferrea</i> L.	Naa / Ceylon Ironwood	M	-	-
Family: Clusiaceae				
<i>Garcinia morella</i>	Goraka	-	H	-
Family: Cycadaceae				
<i>Cycas circinalis</i>	<i>Cycas</i>	-	H	-
Family: Myrtaceae				
<i>S. malaccense</i>	Jambo	-	H	-
<i>Syzygium</i> sp. <i>Kristina</i>		H	-	-
Family: Rubiaceae				
<i>Ixora chinensis</i>	<i>Ixora</i> dwarf	H	H	H
Family: Sapotaceae				
<i>Manilkara zapota</i>	Sapadilla	-	L	-

Locations; 1 – Nittambuwa

2 - Udugampala

3 – Jaela

H - Wax scale presence at high level, M - Wax scale presence at moderate level, L - Wax scale presence at low level

Table 2. The distribution and host range of *Ceroplastes rubens* in Kalutara District

Host crop		Kalutara District Locations			
Family & species name	Common name	1	2	3	4
Family: Amaranthaceae					
<i>Alternanthera dentata</i>	Red Mukunuwenna	-	-	M	-
Family: Anacardiaceae					
<i>Mangifera indica</i>	Mango (<i>Rata</i>)	H	-	H	H
	Mango (Tom EJC)	-	H	-	-
<i>Spondius dulcis</i>	<i>Ambarella</i> dwarf	-	-	H	-
Family: Apocynaceae					
<i>Carissa grandiflorum</i>	Damson	-	-	H	-
Family: Araceae					
<i>A. marantifolium</i>	Aglaonema Sp. 2	-	-	H	-
<i>Aglaonema</i> Red edge	Aglaonema Sp. 5	-	-	-	H
<i>Aglaonema</i> sp. Pink veined	Aglaonema Sp. 6	-	H	-	L
Family: Asteraceae					
<i>Melampodium paludosum</i>		-	-	H	-
Family: Balsaminaceae					
<i>Impatiens balsamina</i>	<i>Kudalu</i> / Rose Balsom.	-	-	H	-
Family: Clusiaceae					
<i>G. mangustana</i>	Mangustin	M	-	-	-
Family: Cycadaceae					
<i>Cycas circinalis</i>	<i>Cycas</i>	-	-	H	-
<i>C. revoluta</i>	<i>Cycas</i>	H	H	-	H
Family: Hydrangeaceae					
<i>Hydrangea</i> sp. (<i>paniculata</i>)	Hydrangea	-	-	L	-
Family: Lauraceae					
<i>Cinnamomum verum</i>	Cinnamon	-	-	M	-
Family: Myrtaceae					
<i>Syzygium samarangense</i>	Small <i>jambu</i>	-	H	-	H
<i>Syzygium</i> sp. <i>Kristina</i>		H	-	-	-
Family: Pinaceae					
<i>Cedrus deodara</i>	<i>Devadara</i>	-	M	-	-
Family: Polypodiaceae					
<i>Asplenium nidus</i>	Birds' Nest Fern	-	-	H	L
Family: Rubiaceae					
<i>Ixora chinensis</i>	<i>Ixora</i> dwarf	-	H	H	-
<i>I. coccinea</i>	<i>Ixora</i>	-	H	H	-
<i>I. lutea</i>	<i>Ixora</i>	-	H	H	-
Family: Rutaceae					
<i>C. sinensis</i>	Orange	-	-	L	-
Family: Santalaceae					
<i>Santalum album</i>	Sandalwood	-	-	M	-
Family: Sapotaceae					
<i>Manilkara zapota</i>	<i>Sapadilla</i>	-	-	H	H
Family: Solanaceae					
<i>Solanum macrocarpon</i>	Brinjal	-	-	H	-
Locations; 1 - Batagoda 2 – Nagoda 3 – Moronthuduwa 4 – Walallawita					

H - Wax scale presence at high level, M - Wax scale presence at moderate level, L - Wax scale presence at low level

Table 3. The distribution and host range of *Ceroplastes rubens* in Kandy District, in the survey during July 2017- August 2018

Host crop		Kandy District Locations			
Family & species name	Common name	1	2	3	4
Family: Acanthaceae-					
<i>Ruellia tuberosa</i>		-	-	H	
Family: Anacardiaceae					
<i>Mangifera indica</i>	Mango (<i>Amarapali</i>)	H	-	-	-
	Mango (<i>Dampara</i>)	H	-	-	-
	Mango (Tom EJC)	H	-	-	-
	Mango (<i>Malwana</i>)	H	-	-	-
	Mango (<i>Karabawa</i>)	H	-	-	-
	Mango (<i>Velleikolomban</i>)	-	-	H	-
	Mango (<i>Karthakolomban</i>)	-	-	H	-
<i>Spondius dulcis</i>	<i>Ambarella</i> dwarf	H	-	-	-
Family: Araceae					
<i>Aglaonema commutatum</i>	<i>Aglaonema</i> Sp 1	-	H	-	-
<i>A. commutatum</i> var. pseudobracteatum	<i>Aglaonema</i> sp 3	-	H	-	-
<i>A. marantifolium</i>	<i>Aglaonema</i> Sp. 2	-	H	-	-
<i>Aglaonema</i> Red edge	<i>Aglaonema</i> Sp. 5	-	-	H	-
Family: Araliaceae					
<i>Schefflera arboricola</i>	<i>Schefflera</i> variegated araliya	-	M	-	-
<i>Polyscias guilfoylei</i> victoriae	Dwarf <i>Koppa kola</i>	-	H	-	-
Family: Celastraceae					
<i>Salacia chinensis</i>	<i>Himbutu</i>	H	-	-	-
Family: Clusiaceae					
<i>Garcinia morella</i>	<i>Goraka</i>	-	-	-	H
Family: Cycadaceae					
<i>Cycas circinalis</i>	<i>Cycas</i>	H	-	-	-
<i>C. media</i>	<i>Cycas</i>	-	H	-	-
Family: Ebenaceae					
<i>Diospyros kaki</i>	Persimmon	H	-	-	-
Family: Euphorbiaceae					
<i>Antidesma bunius</i> L. Spreng	Karawalakabella /Bignay	H	-	-	-
Family: Gesneriaceae					
<i>Saintpaulia ionantha</i>	African violet	-	L	-	-
Family: Iridaceae					
<i>Iris domestica</i>	Leopard lily	-	-	-	L
Family: Lauraceae					
<i>Persea americana</i>	Avocado	-	-	-	L
Family: Malvaceae					
<i>Hibiscus mutabilis</i>	Bengali rose	-	-	-	M

Family: Myrtaceae					
<i>Nephelium lappaceum</i>	Rambutan	H	-	-	-
<i>S. campanulata</i>	Kristina	-	-	H	-
<i>S. cumini</i>	Madan	H	-	-	-
<i>S. cumini</i>	Madan (Black plum)	H	-	-	-
<i>S. malsciensis</i>	Pini Jambu	H	-	-	-
<i>S. samarangense</i>	Small jambu	H	-	-	H
<i>S. samarangense</i>	Green Jambu	H	-	-	-
<i>S. samarangense</i>	Rose Giant	H	-	-	-
Family: Oleandraceae					
<i>Nephrolepis exclatae</i>	Fern	-	M	-	-
Family: Polypodiaceae					
<i>Asplenium nidus</i>	Birds' Nest Fern	-	L	-	-
Family: Rubiaceae					
<i>I. coccinea</i>	<i>Ixora</i>	-	-	-	H
<i>I. hybrida</i>	<i>Ixora</i>	-	-	L	-
<i>I. hybrids</i>	<i>Ixora</i>	-	H	-	-
<i>I. lutea</i>	<i>Ixora</i>	-	L	H	-
Family: Rutaceae					
<i>Citrus maxima</i>	Pumello (Surath)	M	-	-	-
<i>C. sinensis</i>	Orange	-	L	-	-
Family: Sapotaceae					
<i>Chrysophyllum caniot</i>	Kiripalu	L	-	-	-
Locations;	1 – Fruit Plant Nursery, Gannoruwa	2 - Gannoruwa			
	3 - Kahapathwala	4 – Danthure			

H - Wax scale presence at high level, M - Wax scale presence at moderate level, L - Wax scale presence at low level

The highest relative percentage of occurring was recorded in family Araceae (16.9%), followed by Anacardiaceae (16.1%), Myrtaceae (12.7%), Rubiaceae (10.2%) and in other families it was below 10%. The mean infestation was significantly higher ($P<0.05$) in family Araceae (9.74 ± 2.6 insects/10 cm²) and Myrtaceae (9.29 ± 1.5 insects/10 cm²) in compared to other families and the lowest mean infestations (0.02 ± 0.52 insects/10 cm²) was recorded in family Gesneriaceae

The distribution and the mean infestation of *C. rubens* in different ocations

The mean infestation of *C. rubens* was significantly ($P<0.05$) high in the Gampaha district (9.8 ± 2.7 insects/10 cm²) in compared to the Kalutara (5.8 ± 1.1 insects/10 cm²) and Kandy (4.2 ± 0.5 insects/10 cm²) districts.

CONCLUSIONS

The wax scale species which is responsible for the recent outbreaks of wax scale insect on crops and perennial plants in Sri Lanka has been identified as *Ceroplastes rubens* Maskell. In Sri Lanka, there appear to be two distinct forms of this species based on the wax colour (either pink or white wax). Among the host plants, mango, *Garcinia*, *Syzygium* and *Ixora* were found to be the plant species most susceptible to attack by the scale.

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REFERENCES

- Argov, Y., Podoler, H., Bar-Shalom, O. and Rosen, D. (1987). Mass rearing of the Florida wax scale, *Ceroplastes floridensis*, for production of natural enemies. *Phytoparasitica* 15, 277-287.
- García, M., Denno, B.D., Miller, D.R., Miller, G.L., Ben-Dov, Y. and Hardy, N.B. (2016). ScaleNet: a literature-based model of scale insect biology and systematics. Database at <http://scalenet.info>. doi: 10.1093/database/bav118.
- Green, E.E. (1896). Catalogue of Coccidae collected in Ceylon. *Indian Mus. Notes* 4 (1896-1900), 2-10.
- Green, E. E. (1937). An annotated list of the Coccidae of Ceylon, with emendations and additions to date. *Ceylon J. Sci.* 20, 277-341.
- Green, E.E. (1935). On a species of *Ceroplastes* (Hemiptera: Coccidae), hitherto confused with *C. ceriferus* Anders. *Stylops* 4(8), 180.
- Green, E.E. (1908). Remarks on Indian scale insects (Coccidae), Part III. With a catalogue of all species hitherto recorded from the Indian Continent. *Mem. Dept. Agr. Ent. Ser. (India)* 2, 15-46.
- Green, E.E. (1909). The Coccidae of Ceylon. Part IV. Dulau & Co., London, U.K, pp. 268-278.
- Hendawy, A.S., Saad, I.A.I. and Rehab, H.T. (2013). Survey of Scale Insects, Mealy bugs and Associated Natural Enemies on Mulberry Trees in the Nile Delta. *Egypt J. Agric. Res.* 91(4), 1447-1458.
- Hodgson, C.J. and Peronti, A.L.B.G. (2012). A revision of the wax scale insects (Hemiptera: Sternorrhyncha: Coccoidea: Ceroplastinae) of the Afrotropical Region. *Zootaxa* 3372, 1–265.
- Hodges, G.S., Ruter J.R. and Braman S.K. (2000). Susceptibility of *Ilex* species, hybrids and cultivars to Florida wax scale. *J. Environ. Horticulture*. 19: 32–36.

- La Notte P., Buzkan N., Choueiri E., Minafra A., and Martelli G.P. (1997). Acquisition and transmission of grapevine virus A by the mealybug *Pseudococcus longispinus*. J. Plant Pathol. 78, 79-85.
- Malumphy, C. (2014). Pink wax scale, *Ceroplastes rubens*. The Food and Environment Research Agency, Sand Hutton, York, YO 41 1LZ, UK.
- Sankaran, T. (1962). The external characters of the post-larval stages of the wax scale, *Ceroplastes pseudoceriferus* Green (Hemiptera: Coccidae). Indian J. Entomol. 24, 1-18.
- Sirisena, U.G.A.I., Watson, G.W., Hemachandra, K.S., and Wijayagunasekara, H.N.P. (2013). A Modified Technique for the Preparation of Specimens of Sternorrhyncha for Taxonomic Studies. Trop. Agric. Res. 24(2), 139–149.
- Sirisena, U.G.A.I., Watson, G.W., Hemachandra, K.S. and Wijayagunasekara, H.N.P. (2016). Diversity of soft scale insects (Hemiptera, Sternorrhyncha, Coccoidea) in Sri Lanka. Arthropod Diversity and Conservation in the Tropics and Sub-tropics, pp. 285-295.
- Williams D.J. and Watson G.W. (1990). The scale insects of the tropical South Pacific region. Part 3: The soft scales (Coccidae) and other families. CAB International, Wallingford, U.K, pp. 267.