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Biology, Management, and Updated Host Range of the Lobate Lac Scale (*Paratachardina pseudolobata*) in Hawai'i's Urban Landscapes

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Introduction

Hawai'i's urban landscapes are under a severe threat posed by a recently introduced invasive insect pest, the lobate lac scale, *Paratachardina pseudolobata* (Kerriidae: Coccoidea: Sternorrhyncha: Hemiptera). This plant parasite, native to India and Sri Lanka, was first discovered on a weeping banyan tree (*Ficus benjamina*) on O'ahu in October 2012 by arborists participating in a tree-climbing competition at Moanalua Gardens. Since then, it has become one of the most severe plant pests in O'ahu's urban landscapes, attacking a wide range of plant species, including some that are endemic and endangered. This pest also poses threats to the natural areas and forests. It has not been reported on any other Hawaiian islands to date.

Mature lobate lac scales, about 2 mm long and 2 mm wide, have an x-shaped appearance and a deep maroon color. They have a hard, resinous protective armor covering their soft body underneath. The first instar measures approximately 0.4 mm in length and has a deep red color. The second instar molts to the adult stage. Development to adult from instar requires 15–19 weeks, 8–11 weeks for the first instar stage and 7–8 weeks for the second. The adults are wingless, immobile, and attached tightly on twigs. These insects disperse at the crawler stage (either first or second instar) via air currents or birds and other animals or by movement of infested plants by humans. They reproduce by parthenogenesis (no mating required), as do many other scale insects, and no male has been observed (Howard et al. 2010). The lobate lac scale has a wide range of hosts, consisting of more than 300 mainly woody dicotyledonous plant species in Florida (Howard et al. 2010). The Hawai'i Department of Agriculture (HDOA) determined in 2013 that this insect had infested at least 21 native and non-native plant species on O'ahu, but the number of affected plant species in Hawai'i is increasing: Our recent survey on UH-Mānoa campus found over 80 infested plant species.

Weeping banyan branch with lobate lac scales.

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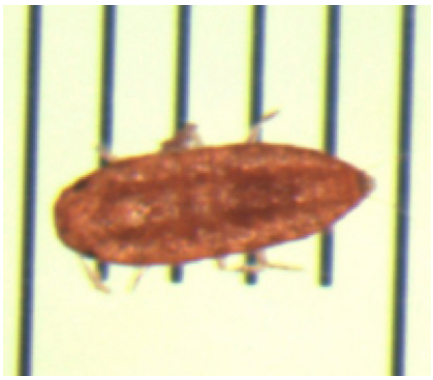

First instar of lobate lac scale (length 0.4 mm).

Mature female lobate lac scales (Photo: HDOA).

Sooty mold formation on twigs and leaves.

The lobate lac scale infests the woody tissues of small, young twigs and branches around the thickness of a pencil and less frequently the main, older branches. Major effects on hosts include the formation of sooty molds, causing an unhealthy appearance; the dieback of twigs and branches; the thinning of foliage; and eventually the death of entire plants of some species. Infestation has not been observed on the plant leaves, petioles, or flowers. Although the lobate lac scale has a wide host range, ficus trees and hibiscus plants are highly prone to severe infestation in Hawai‘i.

Updated Host Range in Hawai‘i’s Urban Landscapes

We started a survey of plants serving as hosts of the lobate lac scale at the UH-Mānoa campus in April 2014. To date, we have recorded in excess of 80 host plant species belonging to 34 families. The list includes 15 plant species native to Hawai‘i and four endangered plant species. Some of the plant families, such as Moraceae, Fabaceae, Malvaceae, and Myrtaceae, are more susceptible, as indicated by the high number of infested species in these families. In our survey, a plant species was considered a host of lobate lac scale if at least one mature female were present on the plant (Howard et al. 2006). In reality, we always observed multiple adults and crawlers on the host plants identified in our survey. To identify plants to genus and species, we mainly referred to the interactive online plant map tool maintained by UH Landscaping (http://manoa.hawaii.edu/landscaping/plantmap.html). We also consulted UH Landscaping personnel and other experts as needed. Table 1 provides a list of the landscape and ornamental plant species on the UH-Mānoa campus found to be infested by the lobate lac scale. As we surveyed only the UH-Mānoa campus, it is reasonable to expect the inclusion of additional host plant species within the broader urban landscape of the Honolulu metro area.

Management

Information on the biology and control of lobate lac scale is limited. Research conducted at University of Florida showed that systemic insecticide imidacloprid (1-[(6-chloro-3-pyridinyl) methyl]-N-nitro-2-imidazolidinimine) was effective to some extent in controlling lobate lac scale on Indian laurel trees (*Ficus retusa*) when applied via soil drenching (Howard et al. 2005).

In December 2013, we started a project at UH-Mānoa to test the efficacy and longevity of imidacloprid against lobate lac scale on weeping banyans (*Ficus benjamina*), one of the most severely infested plant species in Hawai‘i, using a trunk-injection method. Our data to date showed that imidacloprid via trunk injection, at the dose specified on the label (5% imidacloprid at 8 ml per inch diameter at breast height), was highly effective against lobate lac scale, with the longevity of control at least one year. We intend to continue monitoring the infestation for up to two years after treatment to assess the long-term efficacy. Pesticides residue analysis from the young twigs of treated trees is underway. In addition, we observed that moderate irrigation as a cultural practice provided benefits to

Table 1. Host Plants of Lobate Lac Scale on UH-Manoa Campus

	Scientific Name	Common Name	Family	Remarks
1	*Graptophyllum pictum*	Caricature plant	Acanthaceae	
2	*Sanchezia speciosa*	Sanchezia	Acanthaceae	
3	*Pseuderanthemum carruthersii*	False eranthemum	Acanthaceae	
4	*Mangifera indica*	Mango	Anacardiaceae	
5	*Schinus terebinthifolius*	Christmasberry	Anacardiaceae	
6	*Annona muricata*	Soursop	Annonaceae	
7	*Annona squamosa*	Custard apple	Annonaceae	
8	*Podranea ricasoliana*	Port John’s creeper	Bignoniaceae	
9	*Tabebuia impetiginosa*	Amapa	Bignoniaceae	
10	*Spathodea campanulata*	African tulip tree	Bignoniaceae	
11	*Cordia lutea*	Yellow geiger	Boraginaceae	
12	*Cordia dichotoma*	Fragrant manjack	Boraginaceae	
13	*Bursera simaruba*	Copperwood	Burseraceae	
14	*Casuarina equisetifolia*	Ironwood	Casuarinaceae	
15	*Elaeodendron orientale*	False olive	Celastraceae	
16	*Terminalia melanocarpa*	Moo-jee, Brown damson	Combretaceae	
17	*Terminalia* spp.	Black terminalia	Combretaceae	
18	*Diospyros sandwicensis*	Lama	Ebenaceae	Native to Hawai‘i
19	*Euphorbia celastroides*, formerly *Chamaesyce celastroides*	‘Akoko	Euphorbiaceae	Native to Hawai‘i
20	*Acacia koa*	Koa tree	Fabaceae	Native to Hawai‘i
21	*Acacia confusa*	Formosa koa	Fabaceae	
22	*Millettia pinnata*	Pongamia, Indian beech	Fabaceae	
23	*Sesbania tomentosa*	‘Ohai	Fabaceae	Endangered, native to Hawai‘i
24	*Caesalpinia pulcherrima*	Dwarf poinciana	Fabaceae	
25	*Brownia coccinea*	Scarlet flame bean	Fabaceae	
26	*Tipuana tipu*	Rosewood	Faboideae	
27	*Ocimum basilicum*	Basil	Lamiaceae	
28	*Persea americana*	Avocado	Lauraceae	
30	*Cinnamomum burmannii*	Korintji cassia	Lauraceae	

Table 1. Host Plants of Lobate Lac Scale on UH-Manoa Campus, cont'd.

	Scientific Name	Common Name	Family	Remarks
29	*Lecythis minor*	Monkeypot nut	Lecythidaceae	
31	*Lagerstroemia speciosa*	Banaba	Lythraceae	
32	*Michelia champaca*, syn. *Magnolia champaca*	Champak, Joy perfume tree	Magnoliaceae	
33	*Hibiscus arnottianus*	Hawaiian white hibiscus	Malvaceae	Native to Hawai‘i
34	*Hibiscus clayi*	Koki‘o ‘ula	Malvaceae	Endangered, native to Hawai‘i
35	*Hibiscus rosa-sinensis*	Chinese hibiscus	Malvaceae	
36	*Hibiscus waimeae*	Koki‘o ke‘oke‘o	Malvaceae	Native to Hawai‘i
37	*Hibiscus kokio ssp. kokio*	Hawaiian red hibiscus	Malvaceae	Native to Hawai‘i
38	*Hibiscus* spp.	Hibiscus	Malvaceae	
39	*Hibiscus kokio* ssp. *saintjohnianus*	Koki‘o	Malvaceae	Native to Hawai‘i
40	*Thespesia grandiflora*	Maga	Malvaceae	
41	*Malvaviscus penduliflorus*	Turk's cap	Malvaceae	
42	*Lebronnecia kokioides*		Malvaceae	Endangered
43	*Ficus benjamina*	Weeping banyan	Moraceae	
44	*Ficus microcarpa*	Chinese banyan	Moraceae	
45	*Ficus petiolaris*	Mary's tree	Moraceae	
46	*Ficus binnendykii*	Narrow-leaf ficus	Moraceae	
47	*Ficus rumphii*	Rumpf's fig tree	Moraceae	
48	*Ficus rubiginosa*	Port Jackson fig	Moraceae	
49	*Ficus spp.*		Moraceae	
50	*Ficus religiosa*	Bo tree, Sacred fig	Moraceae	
51	*Ficus celebensis*	Willow fig	Moraceae	
52	*Ficus elastic*	Indian rubber tree	Moraceae	
53	*Ficus calophylloides*	Kamani-leaved fig	Moraceae	
54	*Psidium guajava*	Guava	Myrtaceae	
55	*Pimenta dioica*	Allspice	Myrtaceae	
56	*Eugenia uniflora*	Surinam cherry	Myrtaceae	
57	*Syzygium cumini*	Java plum	Myrtaceae	
58	*Metrosideros polymorpha*	‘Öhi‘a lehua	Myrtaceae	Native to Hawai‘i

Table 1. Host Plants of Lobate Lac Scale on UH-Manoa Campus, cont'd.

	Scientific Name	Common Name	Family	Remarks
59	*Lophostemon confertus*	Vinegar tree	Myrtaceae	
60	*Melaleuca quinquenervia*	Broad-leaved paperbark	Myrtaceae	
61	*Callistemon viminalis*	Weeping bottlebrush	Myrtaceae	
62	*Pisonia umbellifera*	Pāpala kēpau	Nyctaginaceae	Native to Hawai‘i
63	*Jasminum multiflorum*	Pïkake hökü, Star jasmine	Oleaceae	
64	*Averrhoa carambola*	Starfruit	Oxalidaceae	
65	*Plumbago auriculata*	Plumbago	Plumbaginaceae	
66	*Macadamia integrifolia*	Macadamia nut	Proteaceae	
67	*Morinda citrifolia*	Noni, Indian mulberry	Rubiaceae	
68	*Gardenia taitensis*	Tiare, Tahitian gardenia	Rubiaceae	
69	*Gardenia brighamii*	Hawaiian gardenia	Rubiaceae	Endangered, native to Hawai‘i
70	*Gardenia sootepensis*	Golden gardenia	Rubiaceae	
71	*Hamelia patens*	Firebush	Rubiaceae	
72	*Mussaenda erythrophylla*	Red flag bush	Rubiaceae	
73	*Psydrax odorata*	Alahe‘e	Rubiaceae	Native to Hawai‘i
74	*Santalum ellipticum*	Coast sandalwood	Santalaceae	Native to Hawai‘i
75	*Blighia sapida*	Akee	Sapindaceae	
76	*Litchi chinensis*	Lychee	Sapindaceae	
77	*Koelreuteria formosana*	Golden-rain tree	Sapindaceae	
78	*Chrysophyllum oliviforme*	Satin leaf	Sapotaceae	
79	*Manilkara zapota*	Chicle tree, Sapodilla	Sapotaceae	
80	*Solanum melongena*	Eggplant	Solanaceae	
81	*Pipturus albidus*	Waimea nettle, Māmaki	Urticaceae	Native to Hawai‘i
82	*Leea guineensis*	Leea	Vitaceae	
83	*Guaiacum officinale*	Lignum vitae	Zygophyllaceae	

trees infested with lobate lac scales. Biological control methods could be considered as management options, but no potential biological control agents have been identified.

Trunk injection is a way to efficiently manage many different insect and disease problems, as well as nutrient deficiencies, in a manner that limits environmental exposure. Trunk injection involves using a special injection tool that places and seals the chemical directly into the trunk, where it is quickly taken up by the vascular system and distributed throughout the tree. It therefore limits the direct, negative impact to an applicator, to other people, and to the environment. In addition, the trunk-injection method typically uses relatively lesser quantities of pesticides compared to conventional treatment methods, such as soil drenching and foliar sprays, which reduces pesticide health concerns and environmental impacts. A study showed that the dose of pesticides required to control certain pests in a tree applied via trunk injection is $^{1}/_{10}$th to $^{1}/_{5}$th of that required in the soil-drenching application (Norris 1965). Reduced safety concerns using the trunk-injection method are of particular importance and interest for landscape pest management in urban areas, where human population density is high and environmental concern from the public is usually significant. In summary, our ongoing research indicates that imidacloprid via trunk injection could be a viable option to manage the lobate lac scale in Hawai'i's urban landscapes. For smaller plant species for which injection is not feasible, imidacloprid via soil drenching could be a viable management option.

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