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Report on the scale insect *Icerya imperatae* Rao (Hemiptera: Coccoidea: Margarodidae) seriously infesting grasses in the Republic of Palau

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Abstract—*Icerya imperatae* Rao (Hemiptera: Coccoidea: Margarodidae: Iceryini) is reported as a new pest in the Republic of Palau where it has caused serious damage to grasses used for erosion control. The only previous published record of this scale insect is from the Philippines but here we also document it for the first time on various species of Poaceae in Australia, Brunei and Malaysia. We also discuss the distribution and pest status of five other species of Iceryini recorded from the Pacific region. These are *Icerya aegyptiaca* (Douglas), *I. purchasi* Maskell, *I. seychellarum* (Westwood), *Crypticerya jacobsoni* (Green) and *Steatococcus samaraius* Morrison.

In 2004, the scale insect *Icerya imperatae* Rao was found on the island of Babeldaob, Republic of Palau, severely damaging signal grass, *Brachiaria decumbens* (Poaceae). This grass was imported as seed and planted to control erosion along a new road being built around the island. Subsequent collections on Babeldaob in July 2005 have recorded this insect on at least five other species of grasses, including a native *Ischaemum* species. The scale insect is new to Palau

and may have been introduced accidentally with ornamentals from the Philippines.

Icerya imperatae was first detected in Palau in October 2004, infesting imported grass planted on a road embankment on Babeldaob Island. Damage at this time was not very severe, but chlorotic patches of grass were noticeable. Adults of *I. imperatae* were found feeding within the chlorotic patches and each infested grass blade had characteristic purple blotching and transverse bands, especially below the insect feeding sites (Fig. 1). By July 2005, large patches of signal grass in some areas had been killed by this scale insect, and, in many of these places, the introduced legume *Stylosanthes erecta* (also known by the synonym *S. guianensis)* (Fabaceae) had taken over from the signal grass.

Rao (1951) described *I. imperatae* as new from the Philippines on grasses. It is predominately found as females, which are conspicuous and fairly large, often attaining a length of 7 mm when adult. The body of the adult female is reddish orange in life, its legs are black, and its dorsal surface is covered with white wax which also projects as short, thick filaments at the posterior end (Fig. 1). A white wax ovisac (Fig. 2) is produced ventrally from a band of cuticular pores on the anterior abdomen. Eggs are laid into the ovisac and the first-instar nymphs (crawlers) develop protected by the female's body above and the wax of the ovisac below. The ovisac does not protrude far beyond the end of the abdomen in *I. imperatae,* unlike the prominent, often fluted, ovisac of many other *Icerya* species (Morrison 1928, Miller et al. 2005, Unruh 2005).

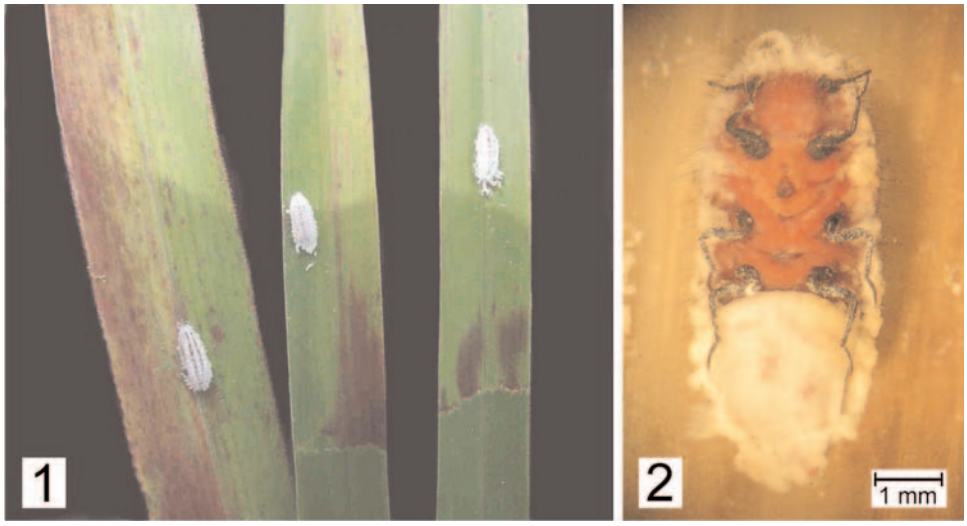
Icerya imperatae has not been reported from other regions since it was described from the Philippines. Our recent studies, however, have revealed that the species has a wider distribution in southern Asia and northern Australia. We have examined specimens from the following institutions: The Australian National Insect Collection, Canberra (ANIC); B. P. Bishop Museum, Honolulu (BPBM); The Bohart Museum of Entomology, University of California, Davis (BME); The Natural History Museum, London (BMNH); Queensland Department of Primary Industries, Indooroopilly (QDPI); Coccoidea Collection of the U.S. National Museum of Natural History, Beltsville (USNM). Specimens of *I. imperatae* have been collected from the following localities, all on Poaceae:

AUSTRALIA: Northern Territory (N.T.), Humpty Doo, on rice *(Oryza sativa)*, 10 May 1974, C. S. Li (ANIC, BMNH); N.T., Humpty Doo, on sorghum, 9 February 1972, N. W. Forrester (ANIC); N.T., Tortilla Flats, on grass, 9 February 1972, S. W. Brown (ANIC); N.T., Darwin, Casuarina, on *Paspalum notatum,* 10 November 1983, A. Allwood (BMNH); Queensland: Eumundi, on *Paspalum,* November 1927, collector unknown (QDPI); Queensland, Brisbane, on grass, January 1900, collector unknown (QDPI).

BRUNEI: Penanjong, under grass blades, 22 March 1989, J. H. Martin (BMNH).

MALAYSIA: Selangor, Prang Besar (now Putrajaya), on *Paspalum conjugatum* and *Ottochloa nodosa,* 5 June 1987, C. T. Ho (BMNH).

PALAU: Babeldaob I., Aimeliik, 7.4028N, 134.509E, on *Brachiaria decumbens,* 12 October 2004, A. Moore (BMNH); Babeldaob I., Aimeliik, on *Brachiaria*



Figures 1, 2. *Icerya imperatae*. Fig. 1. Adult females on blades of signal grass, showing darker blotches and bands on the blades (photograph by K. Englberger). Fig. 2. Ventral surface of an adult female, showing the white ovisac at the posterior of the body (photograph by P. J. Gullan).

sp., 29 April 2005, F. Sengebau (BME); Babeldaob I., Aimeliik, on *Brachiaria* sp., *Chloris barbata, Ischaemum* sp. and *Pennisetum* sp., 19 July 2005, K. Englberger (BME, BPBM); Babeldaob I., Airai, on *Bothriochloa* sp. and *Imperata conferta,* 19 July 2005, K. Englberger (BME, BPBM).

PHILIPPINES: Negros Occidental, Ada Tanao, Sagay, on *Saccharum spontaneum,* 10 October 1928, W. D. Pierce [holotype female] (USNM); Negros Occidental, Victorias, on *Imperata exaltata,* 24 January 1928, W. D. Pierce (USNM); Negros Occidental, Manapla, Hda Cayang, on sugarcane, 6 August 1928, W. D. Pierce (USNM); Hda Salome, 24 April 1928, W. D. Pierce (USNM); Negros Occidental, Manapla, on *Bambusa spinosa,* 11 July 1928, W. D. Pierce (USNM).

There is some variation among all of the material examined. Specimens from Brunei and Malaysia are only about 4 mm long. Moreover, the hind tarsus is only 280-290 µm long in specimens from Palau and Malaysia, whereas in specimens from the Philippines the tarsus is 350-420 µm long. There are intermediate lengths in the other material studied and, in other features, there is as much variation in all the original material examined from the Philippines as there is in the material from the other localities.

The margarodid tribe Iceryini contains six genera, of which three occur in the Pacific region as well as other tropical to sub-temperate areas (Williams & Watson 1990, Foldi 2001, Ben-Dov 2005, Unruh 2005). The genera known from the Pacific region are *Icerya* Signoret, now totalling almost 50 species worldwide, *Crypticerya* Cockerell and *Steatococcus* Ferris. Some species of *Icerya* are known to be biparental and fertilized females produce males and females. Unfertilized females always produce males so that fertilization is required for production of females (Hughes-Schrader 1930). Hughes-Schrader also has shown that *Icerya purchasi* Maskell is hermaphrodite, although males are known. If eggs are fertilized by sperm from males, diploid embryos are produced which always give rise to hermaphrodites. If the eggs remain unfertilized, they develop parthenogenetically into haploid males. Since the hermaphrodite produces ripe sperm in large numbers before any copulation takes place, it is usually impossible to ascertain whether sperm of the male is potent. In addition to *I. purchasi,* a species known to occur in the Pacific region, hermaphroditism is found in the African species *I. bimaculata* De Lotto (Hughes-Schrader 1963) and the South American species *I. zeteki* Cockerell (Hughes-Schrader & Monahan 1966). Although some species of Icerya have proved not to be hermaphroditic, most species, including *I. imperatae,* have not been studied for this method of reproduction. No male specimens were found among the samples from Palau, but male scale insects are short-lived and usually much harder to find than the females, even as nymphs.

Six described species of *Icerya* have been recorded from grasses (Poaceae) (Ben-Dov 2005): the polyphagous *I. aegyptiaca* (Douglas), *I. palmeri* Riley & Howard and *I. seychellarum* (Westwood), and the grass or bamboo specialists *I.*

imperatae, I. paulista Hempel and *I. pilosa* Green. Only two species of *Crypticerya, C. kumari* Rao and *C. nuda* (Green), and one species of *Steatococcus, S. nudatus* (Maskell), have been reported from Poaceae (Ben-Dov 2005). Other than *I. imperatae,* the only species of Iceryini recorded from the Pacific region are *I. aegyptiaca, I. purchasi, I. seychellarum, Crypticerya jacobsoni* (Green) and *Steatococcus samaraius* Morrison. The following brief accounts of these species are included to help in understanding the position of *I. imperatae* in Palau.

Icerya aegyptiaca is a widely distributed, polyphagous species (Ben-Dov 2005), which in the Pacific region has been recorded from numerous localities in the Commonwealth of the Northern Mariana Islands, the Republic of Palau and the Federated States of Micronesia, Guam, and the Republic of the Marshall Islands (Beardsley 1966; Nafus 1996, 1997). Waterhouse (1993) listed parasitoids and predators that have been used to control it throughout its recorded distribution. In atolls where the coccinellids *Rodolia cardinalis* (Mulsant) and *R. pumila* (Weise) have not been successful, Brancatini (1996) has shown that the release of *R. limbata* (Blackburn) in the Federated States of Micronesia (Mokil) and Kiribati (Nikunau) may provide some control.

Icerya purchasi is a common pest throughout the northern Pacific region (Beardsley 1966). Although Waterhouse (1993) mentioned the introduction of the coccinellid *R. cardinalis* to control *I. purchasi* in Palau, Nafus (1997) did not record this scale insect on Palau and we have not seen specimens from there.

Icerya seychellarum is highly polyphagous and widespread throughout the tropics (Ben-Dov 2005). It is common in many Pacific territories where it often infests breadfruit. When discussing this scale insect from Palau, Beardsley (1955) commented that the coccinellid *R. pumila* may control it there but added that there was no recorded evidence for this.

Crypticerya jacobsoni (Green) is known from China, southern Asia and the northern Pacific area (Ben-Dov 2005). Although Takahashi (1939) recorded it from Palau, we have not seen specimens to confirm the record.

Beardsley (1966) reported *S. samaraius* from a few localities and host plants in Palau and stated that *R. pumila* was the main predator there. Nafus (1997) also listed this scale insect from Palau but, apparently, did not regard it as a pest.

Discussion

In the absence of suitable natural enemies, outbreaks of *Icerya* species may be expected, even in areas where a species has been known to occur for long periods. In Kenya, for example, there have been serious outbreaks by *I. pattersoni* Newstead in recent years on coffee, with leaves becoming sclerotic and plants appearing to be covered in snow (Kinuthia and Mwangi 1988; Coffee Research Foundation 1996). There are specimens of *I. pattersoni* collected in Kenya on coffee in 1951 (BMNH) but no damage was reported then. The species may have been in Kenya much earlier because specimens are also at hand from neighbouring Uganda collected on *Castilloa* sp. as early as 1913. *Icerya pattersoni* must be

regarded as an invasive species in Kenya. Similarly, *I. imperatae* is an invasive species in Palau. It is possible that this new pest will be controlled effectively by coccinellid and other predators that are present already on Palau. At least three coccinellid species, *R. cardinalis, R. pumila* and *Cryptolaemus montrouzieri* Mulsant, have been introduced to Palau in the past to control other iceryine species, but probably only *R. pumila* is still present (Waterhouse 1993). *Rodolia pumila* is widespread in Micronesia, including in many parts of Palau (Waterhouse 1993), however, it is not known whether populations of this beetle continue to survive in all places were they have been reported in the past. This coccinellid is known to control *I. aegyptiaca* (Waterhouse 1993) and *S. samaraius* (Beardsley 1966) and also may be effective against *I. imperatae,* although the natural enemies of *I. imperatae* have never been studied.

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