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SCHEDORHINOTERMES LONGIROSTRIS (ISOPTERA: RHINOTERMITIDAE) ON GUAM ADDS TO ASSAULT ON THE ENDEMIC *CYCAS MICRONESICA*

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We provide the first report of *Schedorhinotermes* termites in the Mariana Islands, and note the infestations are constrained to one small locality and restricted to live *Cycas micronesica* K.D. Hill plants. This cycad is a prominent tree in the forests of the several islands within the western Caroline Islands and Mariana Islands. It is the only native gymnosperm in the region, and like all *Cycas* species exhibits primitive features reminiscent of early spermatophytes. Although this plant species is highly resilient to tropical cyclone damage (Hirsh & Marler 2002), biomechanical failure can occur during cyclones wherever tissues exhibit prior damage. We noticed trees being snapped near ground level on several occasions, and because we had never seen this occur in the absence of a tropical cyclone we examined the damaged trees. Browsing behavior of feral deer (*Cervus mariannus* Desmarest) was clearly causing the toppling. This deer species was introduced to Guam from the Philippines in the 1770s (Rogers 1995), and it has caused copious ecological damage in recent years (Wiles et al. 1999). The snapped *C. micronesica* stems consistently exhibited pre-existing internal stem tissue damage where the trees failed biomechanically.

The cause of these internal cavities became apparent when we discovered established termite colonies within the cavities. The majority of arboreal termites found in the forests of the Mariana Islands belong to the genus *Nasutitermes* (*N. luzonicus* Oshima plus at least one other undetermined congeneric species) (Yudin 2002; Mankin & Moore 2010). The termites within toppled *C. micronesica* stems did not match this genus, and were identified as *Schedorhinotermes longirostris* (Brauer) by N. Y. Su of the University of Florida. In one case the chambers were shared by *S. longirostris* and *Nasutitermes* sp. On another occasion we observed termites excavating galleries in the megasporophyll and seed sarcotesta tissues of a female *C. micronesica* tree. We had never observed termites feeding on any cycad reproductive structures, so collections were made and confirmed as *Schedorhinotermes* by T. G. Miles of the University of Toronto. The center of origin for *Schedorhinotermes* is the Indo-Malayan region (Emerson 1955). As with most *Schedorhinotermes* species, little is known about the native range of *S. longirostris* other than type locality, which is the Nicobar Islands in the Andaman Sea. However, termite collections in the early 1900s in the Philippines were identified as *S. longirostris* (Oshima 1916).

Our observations with *Schedorhinotermes* have been constricted to locations adjacent to the Andersen Air Force Base airport (13°35.591'N 144°54.197'E). In contrast, we have observed *Nasutitermes* chambers on *C. micronesica* plants throughout Guam and the island of Rota. This highly constricted range lends support to a recent invasion of *Schedorhinotermes*. Similarly, the leaf miner *Erechthias* sp. and scale *Aulacaspis yasumatsui* Takagi were initially discovered in 2003 (Marler & Muniappan 2006) when infestations were highly constricted. Moreover, the *Cycas*-specific butterfly *Chilades pandava* Horsfield was discovered in 2005 when it was constricted to northern Guam (Moore et al. 2005). In these invasion examples the pest populations rapidly spread throughout the island.

Geological history within the endemic range of this cycad is restricted to volcanic action and tectonic uplifting. Therefore, the termite fauna originated by rafting or anthropogenic introductions. *Cycas micronesica* was Guam's most abundant tree species in 2002 (Donnegan et al. 2004). In some habitats the stem density exceeded 3,500 plants per hectare, but mortality was so vast within 2 years of the scale invasion that the taxa was Red-listed as endangered (Marler et al. 2006). The *A. yasumatsui* invasion initiated an invasional meltdown (see Simberloff 2010). For example, the subsequent invasion of *C. pandava* (Moore et al. 2005) and an increase in damage by other pre-existing pests (Marler & Muniappan 2006) created complex interactions that were unforeseeable. The cycad is approaching extirpation from Guam habitats, and ongoing *S. longirostris* attack is adding to the threat within the infested area.

The columnar stem of arborescent cycad species contains concentric cylinders of vascular tissue comprised of soft, parenchymatous xylem tissue and little lignified tissue (Marler et al. 2010). Persistent parenchymatous pith and cortex are not replaced by wood or phloem as in more typical woody plants. The termites consumed the plant's vascular cylinders starting at the ground level and avoided the central pith and peripheral cortex as they worked up the stems. The affinity for 2 alien termite species to attack living trees of an endemic *Cycas* species was unexpected considering the lack of true wood found in cycad stems.

The most intriguing part of this correspondence is that these termites consumed living tissue in the cycad megastrobili. The affected megasporophylls and seed integuments were 22 months of age. Most reproductive structures on

spermatophyte species are ephemeral, which precludes any opportunity for termites to consume the structures. The longevity of seed development on Guam's *C. micronesica* trees, exceeding 30 months (Marler & Shaw 2009), may explain why ample time is afforded to exploit the tissue.

We do not consider this a benign academic note documenting a new invasion. Firstly, we are unaware of any other report of termites consuming living reproductive structures from any other cycad species. Secondly, *C. micronesica* was the most abundant tree on Guam in 2002, but is now approaching extirpation due to the combined attack of several invasive species. This termite is one more addition to the assault. Thirdly, the biological resources of Guam have been struggling to cope with centuries of disturbances associated with the sequential invasions of exploitative humans. But at no time in history has the population and health status of a native plant changed on such a grand scale and with such velocity. Within just 2 yr, extensive populations of healthy cycads were killed and damaged by a coalition of invasive species. *C. micronesica* declined from being listed as the most abundant tree (Donnegan et al. 2004) to paltry populations of declining individuals deserving of endangered status (Marler et al. 2006). The looming extirpation of this biological resource illuminates clear signs of extensive negative cascading impacts on Guam's environment, considering the obligate associations between *C. micronesica* and other native organisms. We thank N. Y. Su, R. Scheffrahn, Ja. Krecek and T. Myles for identifications.

Summary

This is a first report of *Schedorhinotermes* termites in the Mariana Islands where the termite is constrained to one small locality and restricted to live cycad trees. The host was the most abundant tree species as recently as 2002, but is now highly threatened due to this termite species and several other pest invasions. This is also the first known report of termites consuming reproductive structures for any cycad taxa.

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