

Project Summary

FIELD RELEASE OF *APROSTOCETUS NITENS* PRINSLOO & KELLY (HYMENOPTERA: EULOPHIDAE: TETRASTICHINAE) FOR BIOLOGICAL CONTROL OF THE ERYTHRINA GALL WASP, *QUADRASTICHUS ERYTHRINAE* KIM (HYMENOPTERA: EULOPHIDAE)



Flowering wiliwili (*Erythrina sandwicensis*);
Photo by Forest & Kim Starr.

Background

Erythrina gall wasp (*Quadrastichus erythrinae*) was first detected in Hawai'i on the island of O'ahu in 2005. This non-native species quickly spread to *Erythrina* species throughout the state, including wiliwili (*Erythrina sandwicensis*), a highly valued keystone endemic species of Hawai'i lowland dry forests. The invasion of Hawai'i by Erythrina gall wasp (EGW) resulted in the defoliation and mortality of thousands of *Erythrina* trees throughout the state, and it was not until the approval and release in 2008 of *Eurytoma erythrinae* Gates & Delvare, 2008 (Hymenoptera: Eurytomidae), a wasp parasitoid of EGW, that wiliwili populations began to show signs of increased survival (Kaufman et al. 2020). Ongoing monitoring of wiliwili has shown that while trees are now able to produce copious foliage, inflorescences and seed pods are still being heavily impacted by the EGW, with the result that seed set is low, and recruitment of *E. sandwicensis* is minimal. A potential second

biocontrol agent, *Aprostocetus nitens*, has been studied as a natural enemy complementary to *E. erythrinae*, and it is hoped that this species will further reduce the EGW's negative impacts on the trees.

Purpose and Need for the Proposed Action

Despite the success of the release of *Eurytoma erythrinae* in terms of preventing trees from dying because of EGW infestations and damage, it has been proposed that a second parasitoid species, *A. nitens*, would need to be released to augment the beneficial impacts of *E. erythrinae*. By releasing a second biocontrol agent, an additional non-chemical form of control will complement the suppression of EGW populations (Yalemar and Bautista 2011). Because *E. erythrinae* functions more as a predator than a typical parasitoid, with its larvae feeding in EGW galls and tunneling to feed on additional larvae in adjacent galls, they prefer larger galls with many individual EGW for oviposition, likely to maximize fitness of progeny. This feeding behavior leaves young *Erythrina* seedlings as well as reproductive parts (flowers and fruits)—where smaller galls tend to form—still vulnerable to attack by EGW and with little impact from *E. erythrinae* (Yalemar et al. 2016).

The Hawai'i Department of Agriculture, with support from the Hawai'i Department of Land and Natural Resources, proposes to release *Aprostocetus nitens* from its Insect Containment Facility [quarantine containment] into the natural environment of the state of Hawai'i as a biological control agent. Unlike *E. erythrinae*, this parasitoid utilizes only one host individual to complete its development, and, therefore, it can live on much smaller galls, such as those found on flowers, seed pods, and young seedlings. This release is expected to supplement the effects of *E. erythrinae* in suppressing infestations of EGW. As *A. nitens* is effective at low gall insect density, it is expected to protect reproductive structures on *E. sandwicensis*, and increase survival and likelihood of recruitment of wiliwili, an ecologically and culturally important endemic Hawaiian tree species.

Target Organism: *Quadrastichus erythrinae* (Erythrina Gall Wasp)

The Erythrina gall wasp was first detected in 2005 when galls were observed on *Erythrina variegata* on the University of Hawai'i campus on O'ahu. Emerging adult wasps were subsequently identified as *Quadrastichus erythrinae*, a gall-forming eulophid wasp native to Africa. The current distribution of the EGW as an invasive species encompasses American Samoa, Florida, Guam, India, mainland China, Puerto Rico, Singapore, and Taiwan (Rubinoff et al. 2010). Like other gall-forming wasps, the EGW inserts its eggs inside young leaf and stem tissue. Wasp larvae develop inside the tissue, causing a gall to form. As the infestation progresses, leaves and stems become deformed, which results in reduced levels of photosynthesis, and galled material eventually dies and drops from the tree severely reducing photosynthetic area. The plant quickly loses vigor and may eventually die (Yang et al. 2004). Generation time for EGW is short: in Hawai'i, the full life cycle from egg to adult has been observed to be approximately 20 days (HDOA Plant Pest and Control Branch

2008). Once the wasp has established, it is dispersed via wind and through human activities such as hiking and shipping (Centre for Agricultural Bioscience International [CABI] Invasive Species Specialist Group 2015).

Organism Proposed to Be Released: *Aprostocetus nitens*

Aprostocetus nitens was first described by Prinsloo and Kelly (2009) after it was collected during exploratory surveys for natural enemies of EGW in South Africa, Tanzania, and Kenya between 2005-2006. This species is quite small (1.1–1.7 mm long), and shiny black in color with a dark metallic green tinge and yellow gaster, antennae, and legs. The wings are transparent with brown venation (see Prinsloo and Kelly, 2009, for full description).

Biological studies of *A. nitens* were performed at the HDOA Insect Containment Facility. This species exhibits female parthenogenesis or thelytoky under laboratory conditions, which means that the eggs do not need to be fertilized by a male to be viable and produce female offspring. The entire life cycle for this species from egg to adult takes approximately 20 days, and newly emerged adult females contain one or two mature eggs in their ovaries (Yalemar et al. 2016). Females are synovigenic, which means they continue to produce mature eggs, laying an average of 139 eggs throughout their lifespan. The adults can survive 4 days without food and are long-lived, reportedly up to 120 days (Yalemar 2016).

Host Specificity Trials

Host specificity studies were performed at the HDOA Insect Containment Facility. The non-target gall-forming insects tested were the same as those used in trials of *Eurytoma erythrinae* (Yalemar et al. 2016): banyan gall wasp (*Josephiella microcarpae*), a scale insect (*Tectococcus ovatus*) on strawberry guava (*Psidium cattleianum*), a eulophid wasp (*Ophelimus* sp.) on eucalyptus, a native psyllid, (*Pariaconus* sp.) on 'ōhi'a lehua (*Metrosideros polymorpha*), lantana gall fly (*Eutreta xanthochaeta*) (Diptera: Tephritidae), Hamakua pamakani gall fly (*Procecidochares alani*), and Maui pamakani gall fly (*Procecidochares utilis*). Results of the host specificity trials indicate that *A. nitens* is host specific to *Quadrastichus erythrinae* and has no preference for any of the seven non-target gall forming species studied. In addition, even if *A. nitens* were to parasitize these non-target species, it would be unable to produce any offspring because none of these species were shown to be suitable for supporting *A. nitens* development.

Impact of *Aprostocetus nitens* on *Eurytoma erythrinae*

Results of the multiparasitism trials showed that there was no significant difference in the ratio of the two parasitoids emerging when either is released first on the host. When the two parasitoids were released concurrently, the proportion of *E. erythrinae* emerging from galls was found to be significantly higher than that of *A. nitens*. No significant difference was found in EGW suppression levels when parasitoids were combined, compared to the effects of *E. erythrinae* alone. Significantly, *A. nitens* and *E. erythrinae* were shown to have distinct different preferences for utilizing galls on

different parts of the plant, with *A. nitens* preferring galls on foliage and *E. erythrinae* showing a preference for galls on stems and petioles, which supports observations of these species' behavior in their native range (Ramadan pers comm.).

These results show that the two parasitoid species are very unlikely to compete with each other in the field, as they utilize different niche space in the way of host gall locations on the plant to a large extent.

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