

SCIENTIFIC NOTE

***Dulinius conchatus* Distant (Hemiptera:Tingidae),
Considered and Rejected as a Potential Biological Control
Agent of *Paederia foetida* L. (Rubiaceae),
an Invasive Weed in Hawaii and Florida**

Robert W. Pemberton¹, Kenneth Murai², Paul D. Pratt¹, and Kenneth Teramoto²

¹Invasive Plant Research Laboratory, USDA-ARS, Ft. Lauderdale, Florida, USA

²Biological Control Section, Hawaii Department of Agriculture, Honolulu, Hawaii, USA

Abstract. *Dulinius conchatus* Distant, a potential biological control agent of *Paederia foetida* L., an invasive weed in Hawaii and Florida, was collected in Japan and brought into quarantine for host specificity testing. Testing indicated that this lace bug, which is native to India but introduced to Japan, lacked the needed specificity, thereby eliminating it from further consideration. The lace bug is expanding its geographic range in Japan.

Paederia foetida L. (Rubiaceae), known as *maile pilau* in Hawaii and skunk vine on the U.S. mainland, is an aggressive vine that displaces native vegetation in Hawaii and Florida, and disrupts horticultural practices in Hawaii (Pemberton and Pratt 2002). In Hawaii, the weed is known from the islands of Hawaii, Oahu, and Kauai (Puff 1991), and Maui (D. O'Dowd, personal communication). In Florida, the weed occurs primarily in the central part of the state but was recently reported in the south (Pratt and Pemberton 2001). *Paederia foetida* is native to both temperate and tropical Asia, from India to Japan and Southeast Asia (Puff 1991). In 2002, a cooperative biological control project began between the USDA-ARS and the State of Hawaii Department of Agriculture (DOA), in which USDA-ARS would conduct exploration for natural enemies and the Hawaii DOA would conduct quarantine evaluations of candidate insects. *Paederia foetida* is considered to be a safe target for biological control in Hawaii and Florida because there are no congeneric species in these states. Almost all non-target native plant use in Hawaii and the U.S. mainland by introduced biological control agents have been of congeners of the target weed (Pemberton 2002).

One of the primary insects sought during surveys for natural enemies of *P. foetida* in Japan (June 2002) was the tingid *Dulinius conchatus* Distant. This lace bug, which is native to India and Sri Lanka (Distant 1910), has recently naturalized in Japan around the old Osaka (Itami) airport between Kobe and Osaka, where it was causing considerable damage to the leaves of *P. foetida* (Tomokuni and Saito 1998). We readily found and collected colonies of the lace bug by searching *P. foetida* vines growing a few km east and west of the old airport (June 14 at 34.79980 N x 135.42119 E., elevation ca. 25m; June 17 at 34.77934 N x 135.44995 E.), within the reported area of naturalization. A smaller population of the lace bug was also found near Kiyomizu Temple in Kyoto, ca. 36 km beyond the northeast limit of the 1997 distribution. Detection of the lace bug was aided by the distinctive stipple marks on the leaves, which can become gray-white from the loss of chlorophyll. During the June 14–17 search period, adults, including those mating, and nymphs of various sizes were readily observed on the undersides of the leaves. Eggs were found within the leaves through dissection under a 40X microscope. To obtain an idea of the field host range of the insect, other species of plants growing with *P. foetida* infested by *D. conchatus* were examined for

the lace bug and its characteristic damage, but neither were found. About 400 lace bug adults and nymphs were sent to the Hawaii Department of Agriculture Insect Quarantine Facility in Honolulu for evaluation by Murai and Teramoto.

The primary step in the evaluation to determine the potential utility of this insect as a biological control agent of *P. foetida* was to investigate the validity of an old report (Distant 1910) indicating that it could breed on *Morinda citrifolia* L. This plant, known as “noni” in Hawaii, was a critical test plant for two reasons. First, it is a culturally important plant cultivated for its reputed medicinal properties. Second, *M. citrifolia* belongs to the tribe Morindeae, while *P. foetida* belongs to tribe Paederinae (Bremer 1996). The needed host specificity level for a *P. foetida* biological control agent is the genus *Paederia* or at most the tribe Paederinae (Pemberton and Pratt 2002). Both Hawaii and Florida have many economic and native plants in the Rubiaceae (Wagner et al. 1999, Wunderlin 1998) including rare and legally protected species (U.S. Fish and Wildlife Service 1993), but none of which belong to the tribe Paederinae, which is characterized by foul smelling sulfur compounds. If *D. conchatus* could complete its life cycle on *M. citrifolia*, its host range would be judged unacceptably broad and the insect would be eliminated as a candidate biological control agent for *P. foetida*. The process of investigating the suitability of *M. citrifolia* consisted of tests to see if the insect could breed on the plant, and if so, describing the life cycle of the lace bug on the plant.

Upon receipt of the lace bugs from Japan on June 21, 2002, a propagation colony was established by transferring the insects onto a caged *P. foetida* plant of Hawaiian origin growing in a 1 gallon pot. The insects began feeding on the plant soon after transfer and their characteristic tar-like fecal spots were soon evident. As nymphs appeared in the colony, they were moved to another *P. foetida* plant. When the original stock plants began to deteriorate, new plants were placed in the cages, to which the lace bug transferred. To determine whether *D. conchatus* could develop on *M. citrifolia*, adults were transferred from the propagation colony plants. The first transfer, made 4 days after the lace bugs arrived in quarantine, involved 30 adults to the single available plant. Additional transfers were made within the next 21 days after 4 additional plants were obtained. The numbers of adults transferred ranged between 6 and 30 (Table 1), with fewer numbers going onto plants used later in the study, as it became apparent that 30 adults were too many for a single plant to sustain, and because the later plants were smaller. The *P. foetida* plants, on which the lace bugs produced continuous generations, served as informal controls.

To obtain information on the insect's life cycle when feeding on *M. citrifolia*, a leaf bouquet was made by excising a leaf and inserting the petiole in a water filled 10 dram vial. The leaf was secured with cotton wadding and placed in the cage containing the lace bug colony for 1 day. The exposed leaf was then removed and placed in a gallon glass jar covered with a cloth cover to allow for the hatch of any eggs laid during its exposure to the lace bugs. Upon emergence, of the first three nymphs that hatched from eggs laid in the leaf were moved to a clean leaf and placed in a new jar. The exposed leaf and the transferred nymphs were observed daily with a dissecting microscope to follow the development of the lace bug. All tests were conducted under a 12:12 photoperiod and at ambient quarantine temperature and humidity conditions, which ranged between 24–29°C (mean 26.4, SD 0.37) and 41–73% (mean 54.4%, SD 1.73).

All five exposed *M. citrifolia* plants were readily fed upon by the adult lace bugs and fecal spots were soon evident. Early instar nymphs were present about 13 days after the adult transfers and new F_1 adults began to emerge after 23 days. The F_2 adults began to emerge after 52 days. All 5 plants produced F_2 adults (Table 1). The transfers of 30 adults onto the first 2 test plants caused the plants to deteriorate, resulting in the development of fewer F_2 than F_1 adults. Plants receiving 6 to 15 adults produced more F_2 adults than F_1 adults, and larger numbers of F_2 adults than the plants that received 30 adults. All five plants produced

Table 1. *Dulinius conchatus* performance on *Morinda citrifolia*.

Test plant (height)	No. adults transferred	No. F ₁ adults emerging	No. F ₂ adults emerging
1. (36 cm)	30	86	47
2. (41 cm, variegated)	30	122	63
3. (15 cm)	15	95	109
4. (15 cm)	15	89	103
5. (21 cm)	6	66	76

adults beyond F₂s, but these were not counted because the generations began to overlap.

Nymphs hatched after 13 days from eggs laid in the excised leaves exposed to the lace bug colony. Four nymphal instars, each lasting 2 to 3 days, were determined by observing and counting cast skins. Ten to 12 days are needed from egg hatch to adult, and a total of 23 to 25 days from newly laid egg to adult.

Because *M. citrifolia* proved to be an excellent laboratory host for *D. conchatus*, the insect was dropped from further consideration as a candidate biological control agent for *P. foetida* in Hawaii and Florida. We wonder, however, what the accidental introduction of this damaging insect to Japan may mean for *P. foetida*, especially since our survey indicates that it has spread well beyond the old Osaka airport area where it first established. *Paederia foetida* is a widely distributed, native plant in Japan that occurs commonly in disturbed areas and forest margins. The plant's commonness in the airport area, where attacked by the lace bug for at least five years, may suggest that the lace bug may not dramatically reduce the Japanese populations of the plant.

Literature Cited

- Bremer, B.** 1996. Combined and separate analysis of morphological and molecular data in the plant family Rubiaceae. *Cladistics* 12: 21–40.
- Distant, W.L.** 1910. Rhynchota Vol. V. of the Fauna of British India, including Ceylon and Burma. 362p. Taylor and Francis, London.
- Pemberton, R. W.** 2002. Predictable Risk to Native Plants in Biological Control of Weeds in Hawai'i. Pp. 77–84. In: Smith, C.W., J.E. Denslow and S.D. Hight (eds.) Proceedings, Hawaii Biological Control Workshop. Technical Report #129, Pacific Cooperative Studies Unit, University of Hawaii, Honolulu.
- Pemberton, R.W., and P.D. Pratt.** 2002. Skunk vine (*Paederia foetida*). pp. 343–351. IN: R. Van Driesche, B. Blossey and M. Hoddle, S. Lyon and R. Reardon (eds.) Biological control of invasive plants in the eastern United States. US Forest Service Forest Health Technology Enterprise Team-2002-04, Morgantown, West Virginia.
- Pratt, P.D., and R.W. Pemberton.** 2001. Geographic expansion of the invasive weed *Paederia foetida* into tropical South Florida. *Castanea* 66:3: 307.
- Puff, C.** 1991. The genus *Paederia* L. (Rubiaceae-Paederieae): taxonomic history, revised generic description, and subgeneric division. In: Puff, C. (ed.) The genus *Paederia* L. (Rubiaceae-Paederieae): A multidisciplinary study. *Opera Botanica Belgica* 3: 195-204.
- Tomokuni, M., and T. Saito.** 1998. *Dulinius conchatus* Distant (Heteroptera, Tingidae), presumably a recent invader to Japan. *Rostria* 47: 23–28.
- US Fish and Wildlife Service. 1993. Endangered and threatened wildlife and plants. 50 Code of Federal Regulations 17.11 and 17.12.
- Wagner, W.L., D.R. Herbst, and S.H. Sohmer.** 1999. Manual of the flowering plants of Hawaii. Revised Edition, Vol. 2. Univ. Hawaii Press, Bishop Museum Press, Honolulu.
- Wunderlin, R. P.** 1998. Guide to the vascular plants of Florida. Univ. Press of FL. Gainesville. 806 pp.

