

SCIENTIFIC NOTE

**Association of *Trupanea dubautiae* (Diptera: Tephritidae)
with *Dubautia laxa* (Asteraceae) in
Mt. Kaala National Area Reserve on Oahu**Andrei V. Alyokhin^{1,3} and Russell H. Messing²¹Dept. of Plant and Environmental Protection Sciences, College of Tropical Agriculture and Human Resources, University of Hawaii, 3050 Maile Way, Honolulu, HI 96822, USA²Kauai Agricultural Research Center, College of Tropical Agriculture and Human Resources, University of Hawaii, 7370 Kuamoo Rd., Kapaa, HI 96746, USA³Present address: Dept. of Biological Sciences, University of Maine, Orono, ME 04469-5722, USA

Trupanea dubautiae (Bryan) is a tephritid fruit fly endemic to the islands of Oahu, Kauai, and Maui (Hardy and Delfinado 1980). The larvae of this species reside in flowerheads of native composite plants and feed on their seeds. So far, *T. dubautiae* has been recorded from the flowers of *Dubautia plantaginina* Gaudichaud, *D. arborea* (Gray) (Hardy and Delfinado 1980), *D. raillardoides* Hillebrand (Duan et al. 1996), and *Bidens* sp. (Bryan 1921). However, its host range is likely to also include other *Dubautia* species growing on the islands.

Native Hawaiian tephritids are potentially at risk of being attacked by hymenopterous parasitoids introduced to control fruit-infesting exotic tephritids (Howarth 1991; Duan et al. 1996; Follett et al. 2000). Therefore, having baseline information on their current abundance and distribution is important for evaluating possible nontarget effects of biological control programs in Hawaii. Little attempt has ever been made to quantify *T. dubautiae* populations previously.

We surveyed *T. dubautiae* populations infesting *Dubautia laxa* Hooker & Arnott (*na'ena'ena*) flowerheads at the Mt. Kaala Natural Area Reserve on the island of Oahu (1200 m elevation, 2000 mm mean annual precipitation). *D. laxa* is a shrub 0.5–5 m tall with opposite leaves and numerous heads in erect, simple to somewhat glomerate-congested, corymbose inflorescences 2–17 cm long, 3–27 cm wide (Wagner et al. 1999). This species usually occurs in wet forests, bogs, and on fog-swept ridges. On Oahu, Mt. Kaala Natural Area Reserve supports one of the very few remaining populations of this plant.

Randomly selected *D. laxa* inflorescences were excised at approximately weekly intervals during October 1999 and brought to the laboratory, where the number of flowerheads was counted. Five flowerheads were selected at random from each inflorescence, dissected under a microscope, and the number of *T. dubautiae* larvae and pupae infesting each of them was recorded. The relationship among the number of flowerheads per inflorescence, the percentage of infested flowerheads collected from individual plants, and the mean numbers of fly immatures per infested flowerhead were tested using Spearman's rank correlations (PROC CORR, SAS Institute 1999). Flies were reared to adulthood as described by Duan et al. (1996), and then identified using the keys developed by Hardy and Delfinado (1980). Identifications were confirmed by Dr. Elmo Hardy at the University of Hawaii at Manoa. Voucher specimens of *T. dubautiae* are stored in the Entomology Museum of the University of Hawaii at Manoa.

A total of 51 *D. laxa* inflorescences were collected during the study. On average, each individual inflorescence consisted of 57.4 flowerheads (SEM = 3.4, range 16–115). Fly immatures inhabited approximately 65.0% of the dissected flowerheads (SE = 4.2, range 0–

100%), with *T. dubautiae* being the only species recovered during our survey. Infested flowerheads contained as many as 5 flies (mean = 1.4, SE = 0.1). Duan and Messing (1997) reported finding 35 ± 3.3 *T. dubautiae* per 100 *D. raillardioides* flowerheads dissected in February 1996 in the Kokee area on the island of Kauai. Expressing our findings in the same units, we obtain a population density of 98 ± 13.6 *T. dubautiae* per 100 *D. laxa* flowerheads, which is almost three times as high as the density observed by Duan and Messing (1997). Therefore, it is possible that *D. laxa* is a preferred host for this fly species when compared to *D. raillardioides*. Alternatively, it is also possible that the Mt. Kaala area provided a more favorable environment for *T. dubautiae* than the Kokee area, or that fly density was affected by a difference in environmental conditions between the 1996 and 1999 collecting seasons.

There were no significant correlations between the number of flowerheads per sampled inflorescence and the percentage of infested flowerheads (Spearman's rank correlation, $r = -0.11$, $P = 0.4649$), nor between the numbers of flowerheads per sampled inflorescence and the mean numbers of flies per infested flowerhead (Spearman's rank correlation, $r = 0.13$, $P = 0.3750$). In other words, flies did not show any preference towards ovipositing on larger inflorescences. This might indicate that gravid *T. dubautiae* females foraging for oviposition sites did not display a density-dependent functional response to the abundance of their hosts. However, the data are insufficient to prove that this was indeed the case. Many Diptera are capable of evaluating substrate quality prior to oviposition and prefer to lay their eggs on flowerheads most suitable for larval development (Zimmerman 1980; Straw 1989a; Brody 1992; Lalonde and Roitberg 1992, 1994). Little is known about developmental requirements of *T. dubautiae*; it is possible that females responded specifically to flowerhead quality, not just to the number of flowerheads comprising an inflorescence.

The mean number of immature flies per infested flowerhead was positively correlated with the percent of infested flowerheads (Spearman's rank correlation, $r = 0.41$, $P = 0.0027$). Little is known about the oviposition behavior of *T. dubautiae*. However, many other tephritid species have been reported to mark flowerheads where they deposit their eggs with an oviposition-detering pheromone (Straw 1989b; Pittara and Katsoyanos 1990; Lalonde and Roitberg 1992). Since conspecific females usually avoid laying eggs into the marked flowerheads, such a behavior reduces intraspecific larval competition. However, when fly populations are high, and uninfested hosts become scarce, rejecting previously attacked hosts substantially elevates the search time costs for gravid females (Lalonde and Roitberg 1994). Flies may compensate for such an increase by either increasing clutch size when an uninfested host is found, or by allocating eggs to previously attacked marked flowerheads (Lalonde and Roitberg 1994). Both strategies result in a positive correlation between fly density per infested flowerhead and the percent of flowerheads infested, comparable to the positive correlation observed in the present study. Similar compensatory mechanisms have been also reported for a number of other insect species (Roitberg and Prokopy 1983; Charnov and Skinner 1985; Roitberg and Mangel 1988; Rosenheim and Rosen 1992).

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