

Behavior of the Hawaiian Dancing Moth, *Dryadula terpsichorella* (Tineidae: Dryadulinae)

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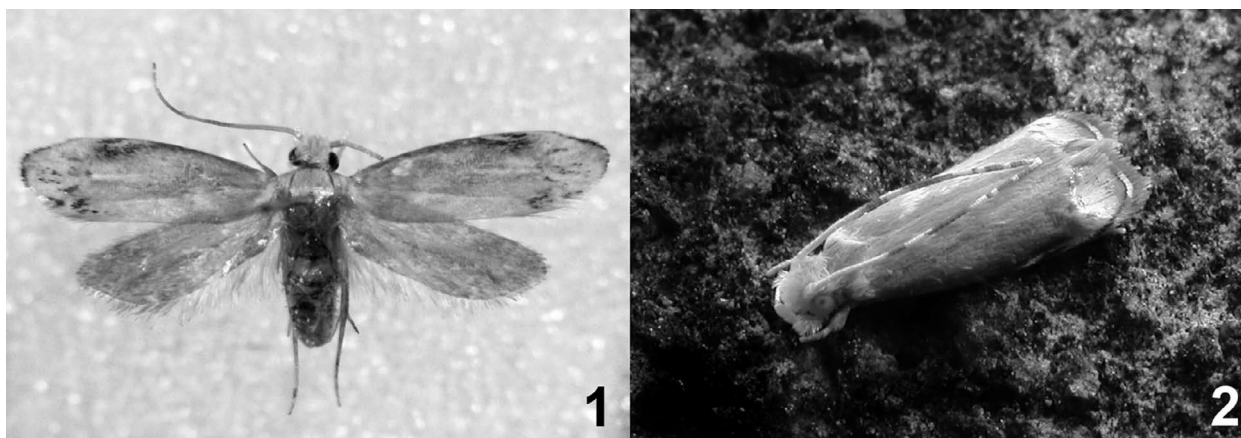
BEHAVIOR OF THE HAWAIIAN DANCING MOTH, *DRYADAULA TERPSICHORELLA*
(TINEIDAE: DRYADULINAE)

The Hawaiian Dancing Moth, *Dryadula terpsichorella* (Busck, 1910) (Figs. 1, 2) is an invasive tineid first collected in Hawaii around 1900 (Busck 1910; Swezey 1909; Zimmerman 1978). The origin of the moth is unknown, but it has been recorded from Fiji (Meyrick 1920), Rapa Island (Clarke 1971), French Polynesia, Samoa, and Central America (Zimmerman 1978). It was recently discovered in California (Powell 1999) and Florida (Heppner & Davis 2008). In Hawaii, it was recorded from the islands of Hawaii, Maui, Molokai, Oahu (Zimmerman 1978) and is likely also on Kauai. All known larval hosts for *D. terpsichorella* in Hawaii are the dead leaves of monocots, including banana (*Musa*, Musaceae), pineapple (*Ananas*, Bromeliaceae), screw-pine (*Pandanus*, Pandanaceae) and sugarcane (*Saccharum officinarum*, Poaceae) (Swezey 1909). Zimmerman (1978) reported ferns and *Costus spicatus* (Costaceae) as possible hosts, but these records have not been confirmed.

Dryadula terpsichorella is peculiar because the adult rapidly “dances” on the upper (adaxial) surface of leaves (e.g., Powell 1999; Swezey 1909; Zimmerman 1978). While this moth has been reported to dance, neither its behavior nor that of any other dancing tineid has been described in detail. We provide the first description of the dancing pattern of *D. terpsichorella* and present videos of its behavior. We also synthesize the published hypotheses on dancing in microlepidoptera, and postulate that the behavior is a strategy allowing the moth to simultaneously forage and avoid predation.

Sixteen adults of *D. terpsichorella* were observed on the islands of Hawaii and Oahu during August – December 2010. Dancing was observed on *Gardenia brighamii* (Rutaceae) and *Alpinia* sp. (Zingiberaceae) at the University of Hawaii Lyon Arboretum in Manoa, and on *Chrysophyllum oliviforme* (Sapotaceae) at Pupukea-Paumalu Forest Reserve on Oahu. All specimens were collected after observations of dancing were recorded. We took video footage of seven individuals using a Nikon Coolpix 4500 digital camera during August 3–7 2010. Two QuickTime® video files of *D. terpsichorella* recorded by the first author are available as supplementary material and can be downloaded from the Rubinoff Lab website: <http://www.ctahr.hawaii.edu/rubinoffd/>. Specimens collected are deposited in the University of Hawaii Insect Museum, Honolulu, HI.

The dancing movement of *D. terpsichorella* (Fig. 3; Supplementary Movie 1, 2) is smooth and rapid with frequent concentrated areas of spinning. The movement is similar to the dancing behavior found in Gelechioidea (Forbes 1923; Kawahara & Adamski 2006; Koster 2010; Morrison 1968; Nishida 2007; Plant 1980; Robinson 1988), but differs significantly from the jerky movements of the choreutid genus *Brenthia* (Aiello & Becker 2004; Rota & Wagner 2006). Moths of *D. terpsichorella* danced on the adaxial surface of leaves by shifting their legs back and forth and ran both sideways and, at times, rapidly forward, covering most of the adaxial leaf surface (Fig. 3). Compared to the dancing movement of *Belthea oni* Kawahara & Adamski, the



FIGS. 1, 2. *Dryadula terpsichorella* (Busck). 1) Pinned male, collected 07-viii-2010, UH Manoa Botanical Garden, Honolulu, Hawaii; A. Kawahara and K. Nishida leg. 2) Adult resting on shaded side of a concrete seawall in downtown Hilo, Hilo, Hawaii; photo K. Nishida. Scale bar = 1 mm.

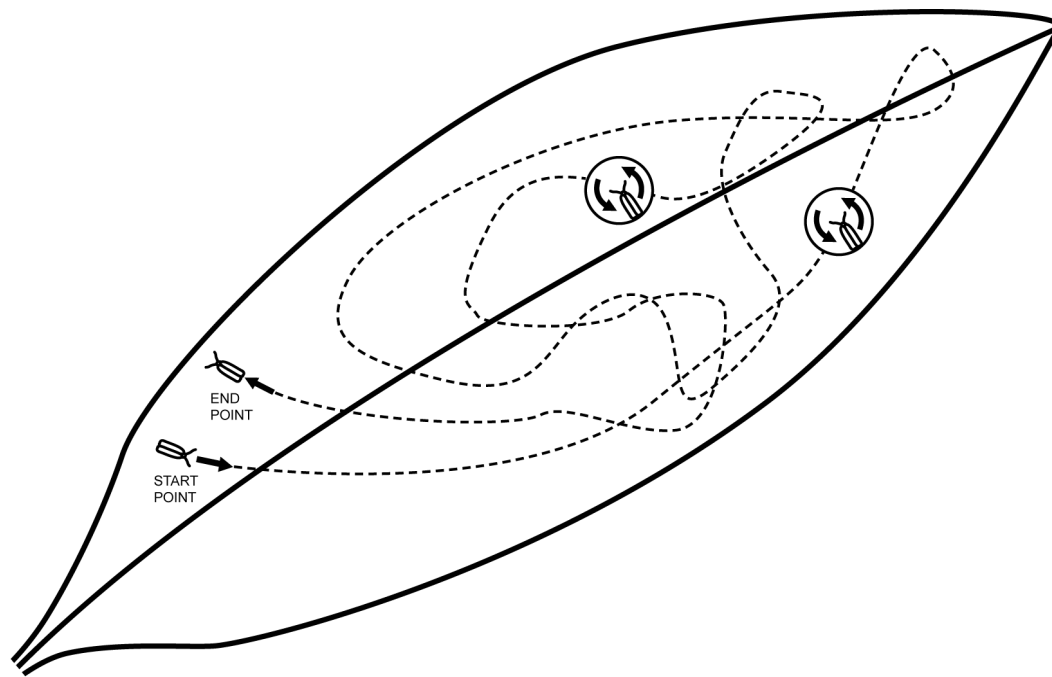


FIG. 3. Illustration of a typical dancing path of *D. terpsichorella* (Busck). Circles indicate areas where the moth spins (and pivots) while running sideways around a particular point on the leaf.

dancing movement was more linear. While *B. oni* appears to be more active in direct sunlight (Kawahara & Adamski 2006), *D. terpsichorella* was most active in shaded microhabitats. When the wind was strong, moths would stop dancing and rest. Moths occasionally ran to the abaxial surface of a leaf and rested or flew to another plant and continued to dance. In four cases we observed two individuals on the same leaf. In two of the four cases, the individuals were both male and in the other two cases there was one male and one female. No mating was observed, nor did we find any mated pairs on the leaves. In all cases, the behavior of moths did not change when they were in close proximity. Dancing behavior was most commonly observed on broad-leaved plants with smooth surfaces, as was observed in the gelechiid, *Belthea oni* in Costa Rica (Kawahara & Adamski 2006). The average time of dancing was 45.3 seconds (± 22.7 seconds; $n = 12$).

The purpose of the dancing behavior seen in *D. terpsichorella* and other dancing microlepidoptera remains unknown. Two hypotheses have been proposed, which we here call the “mate search” and “aggregation” hypotheses. Morrison (1968) observed *Dryadula pactolia* Meyrick dancing and hypothesized that dancing is a behavior associated with mating. Initial observations of *B. oni* also suggested that dancing might be associated with mating (Kawahara & Adamski 2006). Under this “mate search” hypothesis,

we would expect greater dancing at times when a moth is in close proximity with the opposite sex, and the behavior should change when a male and female are in close proximity. We did not observe any change in behavior of *D. terpsichorella* during the few instances of observing a male and female on the same leaf. In both *D. terpsichorella* and previously in *Belthea oni* (Kawahara & Adamski 2006), we rarely observed two moths circling on one leaf together.

Davis & Sinev (2008) proposed an alternative explanation that we here call the “aggregation hypothesis”. They described the dancing behavior of *Cosmopterix victor* Stringer and wrote, “dancing behavior ... can be a special adaptation of monophagous and strictly oligophagous forms providing the aggregation of adults on the host plants for mating and subsequent oviposition. It allows uniting of two different life activities, the searching for a sexual partner and the searching for appropriate host plant, which leads to the economy of energy and to the success of reproduction” (p. 208). They believed that adult moths dance primarily on the surface of their hosts, attracting additional individuals for mating which leads to eventual oviposition. Under their hypothesis, moths would be expected to spend more time on their host than on a non-host and engage in greater dancing activity on their host. From our observations of *D. terpsichorella*, dancing occurrence

is equally common on monocots known to be larval hosts and those that are not.

Given our observations, we hypothesize that this type of rapid dancing behavior in microlepidoptera is neither associated with mate searching nor an aggregatory behavior that is used to attract mates to their larval host plant. Instead, we hypothesize that this type of dancing is associated with foraging and a defense against predatory arthropods such as salticid jumping spiders that attack small insects on leaves. This “foraging” hypothesis, first mentioned briefly in Kawahara & Adamski (2006) and later by Koster (2010) is supported by the fact that the moth makes very concentrated circles at particular areas on the leaf. In *Belthea oni*, moths were seen drinking from a drop of water while dancing, and the proboscis is extended while the moth runs across the leaf surface (A. Y. Kawahara & K. Nishida, unpublished). By moving swiftly and running in concentrated circles with an extended proboscis, the moth can search for nutrients on the leaf surface and at the same time avoid potential attack by predators that use a fixed search image for hunting. However, we could not measure the composition or quantity of nutrients on the leaf nor were we able to determine whether nutrient availability was the primary factor that triggered the moth's movement from one leaf to another. Thus, additional field observations are clearly necessary to test our hypothesis. We hope that our ongoing ecological experiments and additional observations will expand on this initial report.

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