

1984, a single population was rediscovered on Maui (Riotte 1986), and subsequently, populations on two other islands were rediscovered. Currently, the moth is known only from populations on Maui, Kahoolawe, and Hawaii. Moth population numbers are known to be small based upon past sampling results; however, no reasonably accurate estimate of population sizes has been determinable at this point because of the adult moth's wide-ranging behavior and overall rarity (Arthur Medeiros, U.S. Geological Survey-Biological Resources Division (USGS-BRD), pers. comm. 1998; Van Gelder and Conant 1998). Before humans arrived, dry and mesic shrubland and forest covered about 823,283 hectares (ha) (2,034,369 acres (ac)) on all the main islands (Hawaii Natural Heritage Program (HNP) 2000), and it is likely that the Blackburn's sphinx moth inhabited much of that area (Riotte 1986). Reports by early naturalists indicate the species was once widespread and abundant, at least during early European settlement on nearly all the main Hawaiian islands (Riotte 1986).

The moth has been recorded from the islands of Kauai, Kahoolawe, Oahu, Molokai, Maui, and Hawaii, and has been observed from sea level to 1,525 m (5,000 ft) elevation. Most historical records were from coastal or lowland dry forest habitats in areas receiving less than 127 cm (50 in) of annual rainfall. On the island of Kauai, the moth was recorded only from the coastal area of Nawiliwili. Populations were known from Honolulu, Honouliuli, and Makua on leeward Oahu, and Kamalo, Mapulehu, and Keopu on Molokai. On Hawaii, it was known from Hilo, Pahala, Kalaoa, Kona, and Hamakua. It appears that this moth was historically most common on Maui, where it was recorded on Kahului, Spreckelsville, Makena, Wailuku, Kula, Lahaina, and West Maui.

Blackburn's sphinx moth larvae feed on plants in the nightshade family (Solanaceae). The natural host plants are native trees within the genus *Nothocestrum* (aiea), on which the larvae consume leaves, stems, flowers, and buds. However, many of the plants recorded for this species are not native to the Hawaiian Islands, and include *Nicotiana tabacum* (commercial tobacco), *Nicotiana glauca* (tree tobacco), *Solanum melongena* (eggplant), *Lycopersicon esculentum* (tomato), and possibly *Datura stramonium* (Jimson weed). Sphingid moths are known to exploit nutritious but low-density, low-apparency host plants such as vines and sapling trees.

Development from egg to adult can take as little as 56 days, but pupae may remain in a state of torpor (inactivity) in the soil for up to a year. The growth rates of larvae for many closely related sphingid species are reported to decrease when their host plants lack suitable water content. In fact, suitable host plant water content can improve the later fecundity of the adult stage (Murugan and George 1992).

Adult moths have been found throughout the year, and have been observed feeding on nectar from *Ipomoea indica* (koaliawa). Other likely native nectar-providing plants for the moth are other *Ipomoea* species (spp.), *Capparis sandwichiana* (maiapilo), and *Plubago zeylancia* (iliee). Many sphingid studies have shown that air temperature restricts adult feeding activity above a certain temperature (usually 30 degrees Celsius (86 degrees Fahrenheit)) (Herrera 1992). During Van Gelder and Conant's captive-rearing study (1998), adult moth feeding was not observed and captive-reared adult moths lived no longer than 12 days. In general, sphingids are known to live longer than most moths because of their ability to feed and take in water from a variety of sources, rather than relying only upon stored fat reserves. Because they live longer than most moths, female sphingid moths have less time pressure to mate and lay eggs, and often will take more time in locating the best host plants for egg laying (B. Gagné, pers. comm. 1994; David Hopper, Service, *in litt.* 2000, 2002; Williams 1931, 1947; Riotte 1986; Van Gelder and Conant 1998; Kitching and Cadiou 2000). Because there are no studies showing any sphingid-species adults being short-lived, we believe that some unknown factor contributed to the brief adulthood of the Blackburn's sphinx moths observed during Van Gelder and Conant's (1998) study.

Blackburn's Sphinx Moth Habitat and Range

Plant species composition in the moth's habitat varies considerably depending on location and elevation, but some of the most common native plants in areas where the moth occurs are the trees *Diospyros sandwicensis* (lama), *Rauvolfia sandwicensis* (hao), *Reynoldsia sandwicensis* (ohe), *Pouteria sandwicensis* (alaa), the shrubs *Erythrina sandwicensis* (wiliwili), *Dodonaea viscosa* (aalii), and *Myoporum sandwicense* (naio) (Roderick and Gillespie 1997; Van Gelder and Conant 1998; Wagner *et al.* 1999; Cabin *et al.* 2000; Wood 2001a, 2001b).

The largest populations of Blackburn's sphinx moths, on Maui and Hawaii, are associated with trees in the genus *Nothocestrum* (Van Gelder and Conant 1998). For example, the large stand of *Nothocestrum* trees within the Ka naio Natural Area Reserve (NAR), Maui, is likely the largest in the State (Medeiros *et al.* 1993), and this fact may explain why the moth occurs with such regularity in the Ka naio area (A. Medeiros, pers. comm. 1994). *Nothocestrum* is a genus of four species endemic to the Hawaiian Islands (Simon 1999) which currently occur on Kauai, Oahu, Molokai, Lanai, Hawaii, and Maui. One species, *N. longifolium*, primarily occurs in wet forests, but can occur in mesic forests as well. Three species, *N. latifolium*, *N. brevifolium*, and *N. peltatum*, occur in dry to mesic forests, the habitat in which the moth has been most frequently recorded. Moth larvae have been documented feeding on two *Nothocestrum* spp., *N. latifolium*, and *N. brevifolium*; it is likely that *N. peltatum* and *N. longifolium* are suitable host plants for larval moths as well. This is supported not only by the fact that these two species are closely related to known larval hosts, but also because past historical records document the moth as occurring on the islands of Kauai and Oahu, where *N. latifolium* is not abundant and *N. brevifolium* does not occur. Furthermore, the species is known to feed on a variety of native and nonnative Solanaceae.

On Molokai, moth habitat includes vegetation consisting primarily of mixed-species mesic and dry forest communities composed of native and introduced plants (HNP 2000). Although Molokai is not known to currently contain a moth population, past moth sightings on Molokai have been reported. The island does contain native *Nothocestrum* larval host plants, including *N. longifolium* and *N. latifolium*, as well as adult host plants and restorable, manageable areas associated with these existing host plants (Wood 2001a). Because of its proximity to Maui (currently and historically home to the most persistent and largest population) and the fact that Molokai has in the past and presently supports *N. latifolium*, many researchers believe the moth could re-establish itself on the island and become a viable population(s) in the future (Frank Howarth, Bishop Museum, pers. comm. 2001).

The endangered larval host plant, *Nothocestrum brevifolium*, as well as adult host plants, occur in the areas on Hawaii Island that support populations of the moth (Marie Brueggemann, Service,