SCIENTIFIC NOTE

Hyles wilsoni wilsoni (Rothschild) (Lepidoptera: Sphingidae): Light Trapping in the Olaa Rain Forest, Island of Hawaii

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Abstract. Seasonal fluctuation in relative abundance of the endemic hawk moth *Hyles wilsoni wilsoni* (Rothschild) was determined in its natural habitat, the Olaa rain forest (1200 m elevation, 2157 mm average total precipitation/year), Island of Hawaii, using a light trap (fluorescent black-light tube, 10 watts) operated daily from July 1992 until July 1993. The moth was widespread during August, November, and December of 1992, and from February to April of 1993. Moth catch per night peaked in November (0.41 moth/night, mean temperature 16.5°C), February (0.53 moth/night, 14.1°C), and April (0.38 moth/night, 15.8°C). This study indicates that *H. wilsoni wilsoni* is not as abundant as previously recorded.

The hawk moth, *Hyles wilsoni wilsoni* (Rothschild 1894), is one of five species representing genus *Hyles* in the Hawaiian Islands; four of the species are endemic (Zimmerman 1978). It is known only from the island of Hawaii (Perkins 1913). Except for size and hind wing coloration, this moth is similar to *Hyles wilsoni perkinsi* (Swezey), a rare sphingid endemic to the islands of Oahu and Molokai (Swezey 1920a). However, because of their striking similarities, Zimmerman (1978) considered them to be subspecies of *H. wilsoni.*

The larvae of *H. w. wilsoni* are polyphagous, feeding on many forest trees of different families. Larvae were frequently reared from *Bobea elatior* Gaud. (Rubiaceae) (Swezey 1954). Other host plants endemic to the Hawaiian Islands include *Acacia koa* Hbd. (Leguminosae), *Chamaesyce* spp. (Euphorbiaceae), *Metrosideros polymorpha* Gaud. (Myrtaceae), *Melicope* spp. (Rutaceae), and *Psychotria* spp. (Rubiaceae). A mature larva is 5–6 cm long, with no eyespots on metathorax, and green with pale mid-dorsal and subspiracular longitudinal lines. Adult moths have been reported to visit the flowers of *Metrosideros* and cultivated herbs, including *Canna* spp. (Cannaceae) and *Nasturtium* sp. (Brassicaceae) (Zimmerman 1978). Related Asian species in the tribe Choerocampini, subfamily Macroglossinae, reach greatest development in wet, tropical forests at lower elevations. They cause minor damage to plants, primarily in the families Rubiaceae and Vitaceae (Lin 1987).

No ecological or life history studies have been conducted on *H. w. wilsoni.* Giffard (1919) noticed the great variation in the numbers of this moth attracted to light in Kilauea, Hawaii, at various times of the year. However, no data were presented in his report. Information on distribution was compiled from collection locality data on the Island of Hawaii at elevations ranging from 900 to 1158 m. The specimens were dated from 1919 until 1986, and there was no indication as to when the appearance of this moth might be forecasted.

This study reports on the relative abundance of *H. w. wilsoni*, based on one-year light trapping in its natural habitat, the Olaa rain forest, Island of Hawaii.

Materials and Methods

A universal black-light trap (Bio Quip Products, Gardena, CA) was placed about 3 m above ground at the University of Hawaii Volcano Experimental Station adjacent to Olaa Forest in the Hawaii Volcanoes National Park. The vegetation of the Olaa area is wet tropical forest, consisting predominantly of *Metrosideros polymorpha* and *Cibotium* spp. There are small patches of wet *Acacia koa* and *Metrosideros polymorpha* forest with some stands of introduced trees. Total precipitation is 2157 mm/year and elevation is 1140 m.

The trap was operated daily from July 1992 to July 1993. Because of electric power outages, the trap was not operational on all nights. When operable, it was run from sunset to sunrise. The light source was a 10-watt fluorescent black-light tube, operated by 120 v AC, 60 Hz electric current. No killing agents were used. A large 19-liter polypropylene bucket contained the trapped insects, keeping escapes to a minimum. On cold mornings, some moths were usually found inactive on the edges of trap baffles or on the outside of the trap bucket, and these were also counted. *Hyles wilsoni wilsoni* was recognized using keys and figures in Zimmerman (1978). Live catches were marked on the underside of wings by a fine point permanent marker and released again in the forest, 5 km away from the trap. Average catch per night was calculated as the total number of trapped moths, divided by the number of days the trap was operational during the month. Climatological data during the study period were summarized from the Hawaii Volcanoes National Park Station (Anonymous 1992, 1993), the station closest to the trap.

Results and Discussion

The moth was absent during July 1992, but began to appear in the trap the following month (Fig. 1). No moths were trapped in September or October. They appeared in November at the rate of 0.41 moth/night. Catches declined significantly to 0.13 moth/night in December, and the moth disappeared again during January 1993. The catch rate of moths peaked in February 1993, followed by a decline in March and another resurgence in April. No more moths were collected from May through July 1993, and no marked moths were recaptured. Apparently, there are four generations of *H. w. wilsoni* per year, as indicated by the low population density in August (0.1 moth/night, mean temperature 18.3°C) and three optimal peaks during November (0.41 moth/night, 16.5°C), February (0.53 moth/night, 14.1°C), and April (0.38 moth/night, 15.8°C).

Temperature and rainfall are important factors regulating the appearance and abundance of insects. However, there was no correlation between temperature and the trap catch per day in this study. Mean (± SEM) temperature during the seven months of insect absence (17.4 ± 0.6°C) was not significantly different from temperature when the insects were present (16.1 ± 0.6°C); $t = 1.46$, $df = 11$, $P = 0.172$. Also, the presence or absence of *H. w. wilsoni* was not influenced by increasing or decreasing amounts of precipitation (200.7 ± 43.2 vs. 246.4 ± 78.7 mm/month; $t = 0.51$, $df = 11$, $P = 0.62$).

Since *H. w. wilsoni* is not entirely a nocturnal moth, and night trapping alone may not be sufficient to determine seasonal fluctuation in density with complete accuracy, the above data should be supplemented by determination of peak oviposition or larval abundance. However, this study indicates that *H. w. wilsoni* is not as abundant as previously recorded. Zimmerman (1978) reported swarms of hundreds of *H. w. wilsoni* together in the dense forests near Hilo, Hawaii. Recently, such numbers have never been observed in Olaa or Hilo; the total number of moths trapped during the course of the present study (July 1992 to July 1993) was only 37.

Reduction in native habitat, changes in plant distribution, and the introduction of new predators and parasitoids are all important factors that influence insect populations. The

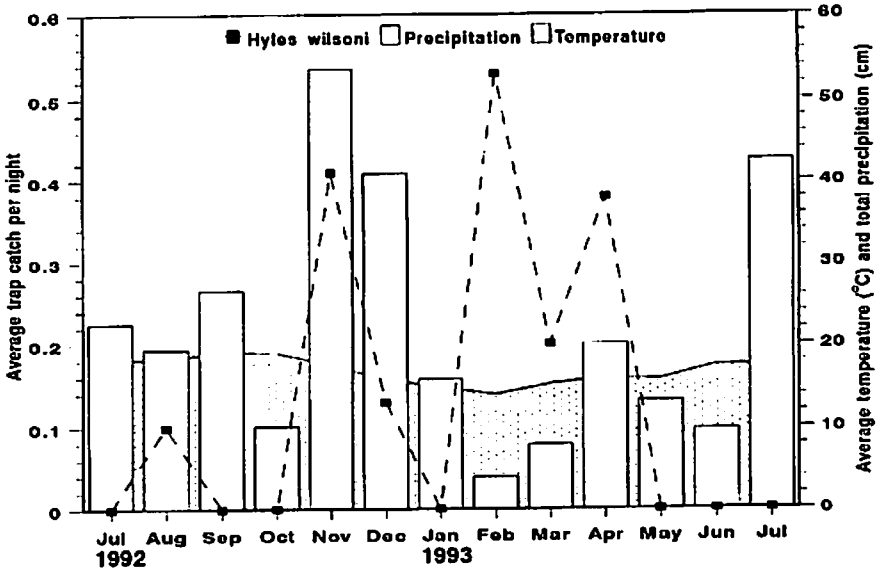

Figure 1: Light trap catch of *Hyles wilsoni wilsoni* and weather data during July 1992–July 1993 in Olaa rain forest, Hawaii Island.

populations of *H. w. wilsoni* may be affected by the abundance of *Trichogramma* spp. (Hymenoptera: Trichogrammatidae), which attack the eggs of several Lepidoptera in the Olaa forest. Swezey (1920b) was the first to report the effect of egg parasitism on the endemic *H. w. perkinsi*. He collected four eggs, and they were all parasitized by *Trichogramma semifumatum* (Perkins), a rare endemic species known only from the islands of Oahu and Hawaii. As many as 22 adult parasitoids emerged from one egg. *Trichogramma chilonis* Ishii also developed in eggs of *H. w. wilsoni*. Two out of five eggs (sub-spherical, diam. = 1.74 ± 0.04 mm) collected from *Psychotria hawaiiensis* (A. Gray) on November 30, 1992, produced 46 adult *T. chilonis*. *Trichogramma chilonis* is the dominant egg parasitoid on all of the major Hawaiian islands, and is reported to develop in eggs of several alternative host species of Lepidoptera of six different families in the Olaa forest (MMR, personal observations; Oatman et al. 1982). This parasitoid was introduced from Australia in 1929 and Taiwan in 1983 for biological control of the Asiatic rice borer, *Chilo suppressalis* (Walker) (Lepidoptera: Crambidae). Furthermore, in an example of predation, Wirth and Howarth (1982) observed females of *Forcipomyia ingrami* Carter (Diptera: Ceratopogonidae) attacking larvae of *H. w. wilsoni* in Hawaii Volcanoes National Park.

Collection labels of 37 *H. w. wilsoni* specimens (from Bishop Museum, Hawaii Department of Agriculture, and private collections) revealed that this sphingid is also present on the island of Maui. Two specimens were collected from the upper Hana forest reserve, 1860 m elevation, on July 7, 1973 (Bishop Museum, unknown collector). On the island of Hawaii, specimens of *H. w. wilsoni* have been collected mostly from Hawaii Volcanoes National Park and the Olaa forest (67.5%, 800–1170 m), north Saddle Road (10.8 %, 1450 m), upper Waikea forest reserve (10.8%, 400–1100 m), Hualalai (2.7%, 915 m), and Hilo (2.7%, 610 m).

Light trapping, distributional data, and field observations indicate that *H. w. wilsoni* is absent during seven months of the year and is not widespread all year around as reported by Zimmerman (1978). Light trap catches in relation to rainfall data do not show a definite pattern. Peaks occurred during rainy months as well as in most dry months of the year (Figure 1). Perhaps the UV light trapping alone is not a good indicator of relative abundance of this moth. Other tropical sphingids (e.g., *Erinnyis ello* [L.] and *Pachylia* spp.) have shown the same erratic occurrence in rainforests of Belize (Meerman 1999) and Costa Rica (Janzen 1984; cited in Meerman 1999).

Further research is needed to determine factors influencing populations of *H. w. wilsoni* in its natural habitats and why this endemic moth is not as abundant as previously reported.

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