Life History of the Ragweed Plume Moth, *Adaina ambrosiae* (Murtfeldt), in Southern California

(Lepidoptera: Pterophoridae)

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Faunistic surveys of California ragweeds (*Ambrosia* spp., Compositae) detected numerous species of phytophagous insects associated with these native plants (Goeden and Ricker, 1974a, 1974b, 1975, 1976, and unpublished data). Many of these insects were little studied species of no economic importance. We have begun life history studies of the more stenophagous species, some for their intrinsic interest, others as candidate agents for the biological control of North American ragweeds accidentally introduced into eastern Europe and elsewhere, where they are becoming important agricultural and hayfever-inducing weeds (Goeden et al., 1974).

Adaina ambrosiae (Murtfeldt) was among the first species selected for more intensive study in the field and laboratory; however, it was found to reproduce readily on sunflower, *Helianthus annuus* L., and thus was rejected as a candidate biological control agent. Our observations on the life history of this heretofore little known plume moth are reported. Unless otherwise indicated, these data were obtained from cultures maintained in the insectary of the Division of Biological Control, Department of Entomology, University of California, Riverside. Insectary conditions were 27 ± 1°C, 40–70% relative humidity, and a 12/12-hr (light/dark) photoperiod.

Taxonomy.—Adaina ambrosiae was described as a species of *Oidamatophorus* by Murtfeldt (1880). She included descriptions of the larva and pupa, which were quoted and amplified by Barnes and Lindsey (1921). The adult was illustrated in Barnes and Lindsey (1921) and Essig (1926).

Distribution and Host Plants.—Essig (1926, p. 714) described its range as ". . . throughout the United States, and in Arizona and along the Pacific Coast in the west." He noted that the larvae feed on "ragweed." Barnes and Lindsey (1921) reported this species from *Ambrosia artemisiifolia* L.

We collected *Adaina ambrosiae* larvae during January–October, 1969–71, from *Ambrosia acanthicarpa* Hooker, *A. chamissonis* (Lessing) Greene, *A. confertiflora* Decandolle, *A. dumosa* (Gray) Payne, *A. erio-*

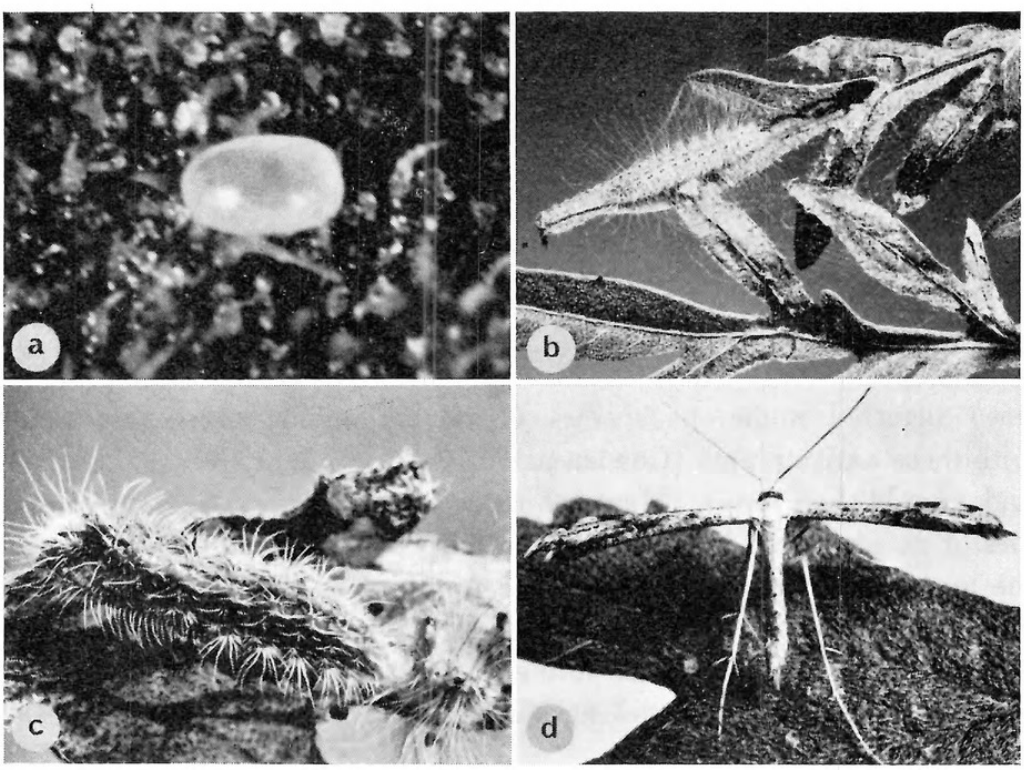

FIG. 1. Life stages of *Adaina ambrosiae*. (a) egg, 50×, (b) fifth instar larva that has fed on leaf of *Ambrosia confertiflora*, 2×, (c) pupa, 7×, (d) adult, 4×.

centra (Gray) Payne, and *A. psilostachya* Decandolle at the following locations in southern California: Los Angeles Co.—Azusa, Llano, South San Gabriel; Orange Co.—Huntington Beach, El Toro, Yorba Linda; Riverside Co.—Banning, Desert Center; San Bernardino Co.—Apple Valley, Bloomington, Cedar Canyon, Hackberry Mountain, Mountain Pass, Twenty-nine Palms; San Diego Co.—Chula Vista, Fallbrook, La Mesa, Piru, and Ventura. *Adaina ambrosiae* was most commonly and widely associated with western ragweed, *Ambrosia psilostachya,* on which it was cultured in the insectary. We also have collected the larvae from cocklebur, *Xanthium strumarium* L., on several occasions and reared them to adults on this weed.

Biology.—Egg.—The egg (Fig. 1a) is ellipsoidal, translucent white to pale yellow, smooth, and lustrous. The mean (±S.E.) length and width of 50 eggs were 0.354 ± 0.002 mm and 0.237 ± 0.001 mm, respectively.

The positions of 220 eggs obtained from 5 moths were recorded. All were attached singly to leaf blades, one to several per leaf, their long axes parallel to the upper and lower leaf surfaces (Fig. 1a). Only 4 (1.8%) of these eggs were laid on the superior epidermis. Fifty-seven

(26%), 121 (56%), and 38 (18%) of the remaining 216 eggs were attached to the basal, middle, and apical thirds of the undersides of leaf laminae, respectively. Of the 220 eggs, 108 (49%) were laid alongside a midrib, 60 (27%) were laid in contact with a primary vein, 25 (11%) were laid next to a secondary vein, and the remaining 27 (12%) touched no veins. The incubation period was about 4 days.

Larva.—Twelve of 15 larvae individually reared from eggs passed through 5 instars in an average of 18 ± 0.8 days. Three larvae apparently molted only 3 times and pupated after 14, 15, and 15 days. The maximum lengths attained by the first to fifth instars were 1.15 ± 0.03 mm, 1.90 ± 0.03 mm, 3.06 ± 0.07 mm, 4.94 ± 0.03 mm, and 7.44 ± 0.07 mm, respectively. Larvae with 5 instars grew in length an average of 60% between each successive molt.

The newly hatched larva is pale yellow. After eclosion, it abandoned the chorion and immediately proceeded to feed on the leaf lamina, gradually assuming the pale green coloration characteristic of subsequent instars. All instars were leaf skeletonizers (Fig. 1b). They consumed the adjacent epidermis and mesophyll, forming irregularly shaped scars, but left intact the opposite epidermis, midrib, primary veins, and at least the bases of the secondary veins. First to third instars evidenced a slight preference for feeding upon the lower leaf surfaces. Fourth and fifth instars tended to feed more upon the upper leaf surfaces. The latter tendency was most pronounced in the last instar (Fig. 1b).

The larvae apparently fed most actively at night. In the field, later instars commonly rested by day in shallow grooves excavated the lengths of their bodies along the midribs on the upper sides of leaves. From these resting niches, in which pupation frequently occurred, the larvae apparently foraged by night to return and rest between feedings by day. Fine silken threads on the foliage marked the course of their movements. In the insectary, one or more stadia, sometimes the entire larval period, was spent on the same leaf. The first to fifth stadia averaged 3 ± 0.2 (range: 2–4) days, 2.6 ± 0.1 (range: 2–3), 2.3 ± 0.1 (range: 2–3), 3.5 ± 0.2 (range: 3–5), and 5.6 ± 0.2 (range: 5–7) days, respectively.

The later instars threw their small, dark, fecal pellets over their heads for distances of several cm by means of rapid upward flips of their terminal abdominal segments. This behavior kept their feeding areas relatively clean (Fig. 1b).

A non-feeding prepupal stage began 2 days prior to pupation, during which time the mature larva contracted slightly in length, took on a

violet hue, and spun a small silken pad upon the leaf surface. The prepupae turned whitish 1 day prior to pupation.

Pupa.—The pupa (Fig. 1c) is slightly angulate, hairy, and naked. It is attached posteriorly by a cremaster to the silken pad spun by the mature larva. When disturbed, the pupa bent its abdomen backward and arched upward anteriorly. The mean length of 118 pupae was 5.73 ± 0.03 mm.

Most pupation occurred atop leaf blades, although a few pupae were attached to the undersides of living or dead, lower cauline leaves. Some mature larvae vacated the plants and pupated on the walls and floors of cages. The pupal periods for 55 individuals averaged 5.5 ± 0.1 (range: 2–8) days.

Adult.—Adults were not commonly encountered in nature. They mostly remained at rest on plants by day, their wings characteristically outstretched (Fig. 1d), flying short distances when disturbed.

When caged with bouquets of freshly excised, vegetative shoots and provided with water, 11 fecund females lived an average of 11.8 ± 1.1 (range: 7–17) days; 15 males averaged 10.7 ± 1.1 (range: 6–22) days. After a preovipositional period that averaged 2.8 ± 0.3 (range: 2–5) days, these 11 females oviposited for an average of 8.5 ± 1.1 (range: 4–15) days. During these ovipositional periods, they laid an average total of 119 ± 26 (range: 38–283) eggs. The daily numbers of eggs produced by these females varied considerably. Based only on days when females oviposited, the daily totals varied from 1 to 67 eggs and averaged 14.4 ± 1.4 eggs. Oviposition rates sharply declined toward the ends of the oviposition periods. Oviposition apparently occurred only at night.

Mating and dispersal normally were nocturnal activities, although 4 instances of mating were observed during daylight hours in the morning and afternoon for protracted, but untimed durations.

Of 109 adults reared from a random sample of insectary-reared F_1 generation pupae derived from field-collected larvae, 52 were females and 57 males.

Seasonal History.—*Adaina ambrosiae* is multivoltine in southern California; however, the number of annual generations is unknown and probably varies considerably with the host plant species and climatic zone involved. In the insectary, the egg to egg cycle was completed in about 30 days.

Natural Enemies.—Field collected larvae commonly were heavily parasitized. *Apanteles* sp. nr. *nemoriae* Ashmead (Hymenoptera: Braconidae) was reared from larvae collected from *Ambrosia confertiflora*

and *A. psilostachya*. *Hyposoter* sp. nr. *nigrolineatus* (Viereck) (Hymenoptera: Ichneumonidae) was reared from larvae collected on *A. confertiflora*, *A. dumosa*, *A. eriocentra*, and *A. psilostachya*. Both were primary, solitary endoparasitoids. A single specimen of *Mesochoris* sp. (Hymenoptera: Ichneumonidae) was reared, probably as a hyperparasitoid, from a larva collected on *Ambrosia psilostachya*.

ACKNOWLEDGMENTS

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