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THE LIFE HISTORY OF *HELIOTHIS OREGONICA* (NOCTUIDAE)

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Heliothis oregonica (Hy. Edwards, 1875) is widespread in montane western North America, occurring from southern British Columbia southward in the Sierra Nevada-Cascade Axis to the Lake Tahoe area of California and in the Rocky Mountain System to southern Colorado. In western America, its altitudinal range is rather wide: in southern British Columbia, for example, it occurs at altitudes between 1500 and 6000 feet. Until recently the species was considered to be confined to the West; however, two specimens were taken in 1956 at Mistassini Post in central Quebec. A single additional specimen in the Canadian National Collection was taken at Lloydminster, Alberta, well to the east of the Cordillera, in the aspen parkland belt of the Prairie Provinces. These records suggest that the species may occur in a series of disjunct populations across central Canada.

In differing areas of the distribution, the species is in flight between the middle of May and the middle of August. The period of adult activity in any area is presumably governed by seasonal development; thus at 1500 ft. in the Vernon area of southern British Columbia it flies during the latter part of May, but at 6000 ft. in the Manning Park area it has not been taken until early August.

Heliothis oregonica has been observed on several occasions ovipositing in the heads of *Castilleja* spp. in both British Columbia and California. The species is obviously not confined to *Castilleja*, however, because partially grown larvae have been found feeding on the seed capsules of *Geranium* sp.

Behaviour

Heliothis oregonica is a day-flying species and has the compound eyes greatly reduced as in other Heliothidinae with an exclusively diurnal period of activity. On warm afternoons in the montane meadowlands that constitute its usual habitat, the little moth flies swiftly and almost invisibily from blossom to blossom. The female, with wings vibrating, moves rapidly over a *Castilleja* head and pauses only momentarily, with wings partially elevated, to deposit an egg.

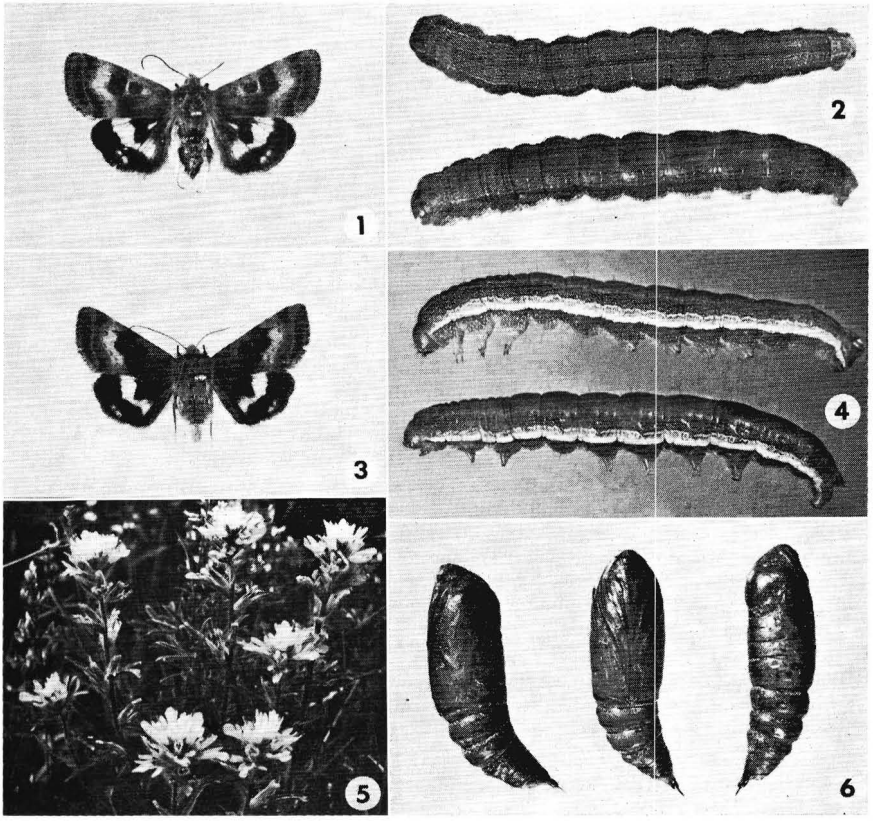
On *Castilleja* the eggs are deposited singly on the bracts, on the lip of the calyx, within the tube of the calyx or on the corolla. Three individually confined wild-caught females deposited a mean of 172 eggs, and the maximum laid by a single female was 202. A few of these eggs hatched on the fourth day after deposition but the majority hatched on the fifth day. The newly hatched larva crawls down the tubular corolla or bores through the calyx and corolla. Within the protective sheath of the corolla, the young larva feeds on the stamens, pistil and developing seed capsule. During the median stadia, the larva may usually be found at the base of a bract, its anterior end buried in the adjacent blossom on which it is feeding. Nearly mature larvae make much less effort to conceal themselves, and may usually be found feeding from a partially exposed position on the stalk. Both green and reddish-brown colour phases of larvae are probably protected from predators by their resemblance to the green stems or to the red bracts and calyxes.

Forty-seven of 58 larvae, reared individually to the pupal stage, matured in six larval stadia, the remainder in five. At the cessation of feeding, the larva tunnels into the ground to form a pupal cell. The species overwinters in the pupal stage. Available data suggest that the species is single-brooded throughout its range.

Descriptions of Stages

The following descriptions of immature stages were based on the progeny of three females taken near Vernon, B. C., and on those of two females taken near Tahoe Valley, Eldorado Co., Calif. The larvae were reared individually at room temperature on the blossoms and seed capsules of *Castilleja* spp. Rearing techniques employed were those outlined by Hardwick (1958). The estimate of variability following the mean for various values is the standard deviation.

Adult (Figs. 1, 3). Head, thorax and abdomen with an inner coat of appressed black scales and an outer coat of olive-grey hair-like vestiture; hair-like vestiture on abdomen shorter and less dense than on head and thorax. Outer vestiture on under-



Figs. 1–6. *Heliothis oregonica* (Hy. Edwards) and its food plants. 1, 3, Adults, Osoyoos, B. C., 3500 ft., and Vernon, B. C., 1200 ft.; 2, 4, dorsal and left lateral aspects of ultimate-stadium larvae, Vernon, B. C.; 5, blossoms of *Castilleja* sp. on which eggs have just been deposited; 6, pupae.

side of body paler than on upper side. *Forewing* olive-grey or olive-brown, variably suffused with reddish-brown. Transverse anterior line sinuous, angling outward between costal and trailing margins; seldom well defined, often completely obliterated. Median space cream, irrorated with olive or brown. Large, dark, usually globular orbicular, claviform and reniform spots present in basal area of median space. Basal space and basal area of median space variably suffused with olive or reddish-brown; basal suffusion often extending outward to incorporate orbicular and claviform spots, less commonly to also incorporate reniform spot. Transverse posterior line broadly excurved around reniform spot, then essentially straight to inner margin. Subterminal and terminal spaces concolorous, usually olive-brown, rarely suffused with reddish-brown; the two spaces separated by a pale-yellow or pale-grey subterminal line. Fringe concolorous with terminal space. *Hind wing* white marked with black; a black basal area, a narrow black inner-marginal band, a broad black outer-marginal band and a black blotch on disc. Black basal area usually extending outward to incorporate at least part of discal blotch. Outer-marginal band with a white median

patch. Fringe white. *Underside* of both wings pale grey marked with dark brown or black, and with pale-grey fringes; outer area of each wing darker grey than inner area. Forewing with prominent claviform, orbicular and reniform spots, and a narrow subterminal band. Hind wing with a prominent discal blotch and a variably expressed inner-marginal band; inner-marginal band forming an irregular patch at anal angle and often produced to form at least a partial outer-submarginal band.

Expanse: 26.8 ± 1.8 mm (48 specimens).

Egg. Light green when deposited. Micropylar area becoming dull red on second day after deposition. Reddish colouring becoming more intense on third day. Whole egg becoming purplish-brown on fourth day after deposition; then turning dark grey with larval head becoming visible through chorion a few hours before hatching.

Dimensions of egg: length, 0.566 ± 0.061 mm; diameter, 0.577 ± 0.023 mm (14 eggs).

First-Stadium Larva. Head and prothoracic shield black. Suranal shield dark blackish-brown. Trunk dirty yellowish-grey in young larva, becoming clear pale yellow in latter part of stadium. Setal bases and thoracic legs black.

Head width: 0.289 ± 0.012 mm (25 larvae).

Duration of stadium: larvae maturing in five stadia, 4.4 ± 0.8 days (11 larvae); larvae maturing in six stadia, 4.2 ± 0.6 days (47 larvae).

Second-Stadium Larva. Head, prothoracic and suranal shields usually dark brown; head concolorous with, darker than or paler than prothoracic shield; head occasionally rather light brown. Trunk dark dirty grey at beginning of stadium, becoming pale yellowish-green as larva increases in size; two pairs of pale dorsal lines in many specimens. Setal bases and thoracic legs black.

Head width: 0.449 ± 0.033 mm (25 larvae).

Duration of stadium: larvae maturing in five stadia, 6.9 ± 1.0 days (11 larvae); larvae maturing in six stadia, 6.4 ± 1.5 days (47 larvae).

Third-Stadium Larva. Head fawn mottled with darker brown. Prothoracic shield varying from green to pale fawn. Suranal shield poorly distinguished from trunk. Trunk varying from dark greyish-green to pale bright green; two or three pairs of rather prominent yellow lines on dorsal surface; midventral area greenish-grey, paler than remainder of trunk. Thoracic legs fawn.

Head width: 0.745 ± 0.069 mm (83 larvae).

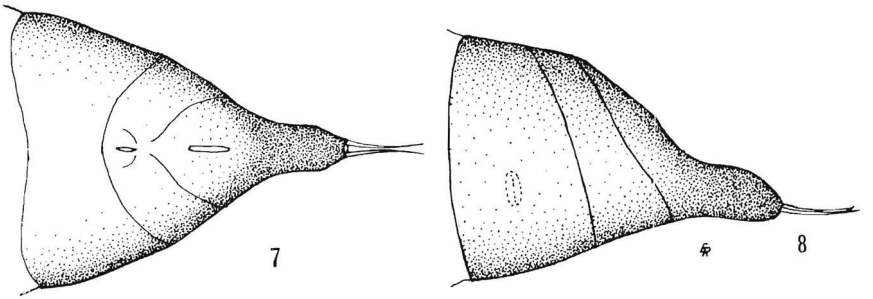
Duration of stadium: larvae maturing in five stadia, 3.3 ± 1.0 days (11 larvae); larvae maturing in six stadia, 3.7 ± 1.2 days (47 larvae).

Antepenultimate-Fourth-Stadium Larva. Head and prothoracic shield varying from yellowish-fawn to greenish-fawn. Suranal shield essentially concolorous with trunk. Trunk medium green, with a pair of dorsal and a pair of subdorsal, usually prominent, yellow lines; three narrow wavy pale lines between dorsal and subdorsal yellow lines. Lateral band prominent, the ventral half pale yellow or white, the dorsal half pale green. Ventral region of trunk greyish-green, paler than dorsal region. Thoracic legs varying from yellowish-fawn to greenish-fawn.

Head width: 1.12 ± 0.07 mm (50 larvae).

Duration of stadium: 4.0 ± 1.4 days (47 larvae).

Penultimate-Stadium Larva. Head varying from green to straw-coloured. Prothoracic shield of similar colouring to head. Suranal shield poorly distinguished from trunk. Trunk shades of green, in some specimens with a dull yellow cast. Middorsal band consisting of two or three narrow, irregular and broken lines. Subdorsal area margined dorsally and laterally by yellow lines; median band of subdorsal area consisting of two or three narrow, irregular and broken, green lines. Supraspiracular area consisting of an irregular scrollwork of narrow green lines. Spiracular band white or cream, stained with green dorsally. Ventral region greyish-green. Thoracic legs translucent green or fawn.



Figs. 7, 8. *Heliothis oregonica* (Hy. Edwards), apical abdominal segments of pupa. 7, Ventral; 8, right lateral.

A reddish-brown colour phase occasionally present among penultimate-stadium larvae.

Head width: fourth-stadium larvae maturing in five stadia, 1.41 ± 0.08 mm (23 larvae); fifth-stadium larvae maturing in six stadia, 1.74 ± 0.10 mm (26 larvae).

Duration of stadium: fourth stadium of larvae maturing in five stadia, 5.8 ± 1.4 days (11 larvae); fifth stadium of larvae maturing in six stadia, 4.6 ± 1.3 days (47 larvae).

Ultimate-Stadium Larva (Figs. 2, 4). Larva occurring in several colour phases; most larvae varying from light to medium green; a few larvae in shades of brown, dull red, or even purple. Maculation in all these colour phases essentially the same.

Head and prothoracic shield green or yellow-fawn in green specimens; brown or orange in brown or reddish specimens. Suranal shield essentially concolorous with trunk. Middorsal band presenting a complex pattern formed by the remnants of three or four narrow, badly broken, longitudinal lines. Subdorsal area similar to middorsal band, flanked on either side by narrow light-yellow lines. Supraspiracular area similar in appearance to middorsal band and subdorsal area. Spiracular band prominent; cream, white or yellow; dorsal half of band suffused with ground colour of body. Suprapodal area green or reddish-brown, mottled with grey. Midventral area varying from greenish-grey to brownish-grey.

Head width: 2.48 ± 0.18 mm (25 specimens).

Duration of feeding phase of ultimate stadium: larvae maturing in five stadia, 6.2 ± 1.1 days (11 larvae); larvae maturing in six stadia, 6.6 ± 1.6 days (47 larvae).

Duration of prepupal phase of ultimate stadium: 4.0 ± 1.0 days (54 larvae).

Pupa (Figs. 6–8). Dark mahogany-brown with a green suffusion on thorax and thoracic appendages. Spiracles on a level with general surface of cuticle; rims of spiracles very weakly projecting. Abdominal segments 5, 6 and 7 extensively and coarsely pitted; segments 4 and 8 less coarsely pitted and dorsum of segments 1, 2 and 3 rather finely pitted. Proboscis terminating between extreme apexes of wings. Cremaster consisting of two long, moderately stout setae borne at the apex of thumb-like prolongation of the tenth abdominal segment.

Length from anterior end to posterior margin of fourth abdominal segment: 9.0 ± 0.8 mm (25 pupae).

Acknowledgments

I appreciate the assistance of my associate, Mr. E. W. Rockburne, who measured the immature stages and drew the cremaster area of the pupa.

Mr. John E. H. Martin of this Institute provided the photographs of larvae and pupae.

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AMERICAN WHITE BUTTERFLIES (PIERIDAE) AND ENGLISH FOOD-PLANTS

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Six years ago (1964), when I offered notes on the rearing of subspecies of *Pieris napi* L., I did so "in spite of their European bias." What I had in mind was the possible non-availability of recommended foodplants in America, rather than their unsuitability for Nearctic subspecies. However, even before the notes appeared, I had run into trouble with *Pieris virginiensis* Edwards.

Most subspecies of the *Pieris napi* species-group will thrive on a variety of cruciferous plants. Even *bryoniae* Ochsenheimer, which in its Alpine habitats feeds almost exclusively on *Biscutella laevigata* L., shows no obvious preference for this plant in captivity, and does quite well on *Alliaria petiolata* Bieb. Other authors (e.g. Hovanitz & Chang 1962) have attempted systematic experiments on the choice of food by *Pieris* larvae (usually *P. rapae* L.), but it is difficult thus to demonstrate the reality of host-species preferences, unless they are sufficiently marked to over-ride possible differences in condition of the plants presented. The experiments and observations now to be described were not systematic in this sense, but by repetition and ruthlessness established certain conclusions.

Pieris virginiensis Edwards

May 1962.—Larvae hatching from Connecticut eggs of *P. virginiensis* (kindly sent by Mr. S. A. Hessel) fed on *Dentaria diphylla* Michx. leaves sent with them, but would do no more than nibble at English *Alliaria*, *Hesperis matronalis* L. and *Cardamine pratensis* L. All died. Later ex-