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NOTES ON THE BIOLOGY AND PARASITOIDS OF THE SWEET FERN UNDERWING (LEPIDOPTERA: NOCTUIDAE) IN MICHIGAN

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INTRODUCTION

The sweet fern underwing, *Catocala antinympha* (Hübner), sometimes called "the wayward nymph" (Holland, 1968), is one of several lepidopterous defoliators of sweet fern, *Comptonia peregrina* (L.) Coult. Investigators have dealt only briefly with this insect because it is difficult to collect and rear in quantity and consequently, its biology is poorly known. The early works are basically taxonomic treatises. Barnes and McDunnough (1918b) updated the synonomy which remains intact to date. They placed *antinympha* as belonging to their Group IV (*Catabapta* Hulst), a group comprising *Myrica* (=*Comptonia*) feeders. Their treatise presents excellent color reproductions of the adult and mature larva. Previously, Beutenmüller (1902) described the six larval instars.

The present paper adds a little more to the distribution, biology, and habits of the sweet fern underwing, with emphasis on Michigan, and includes the known parasitoids and the effect of some of them on the size of the larval head capsule.

METHODS AND MATERIALS

Underwing moth larvae in various stages of development were collected by sweep-netting from sweet fern in Alcona, Wexford, Lake, and Grand Traverse counties, Michigan, during the summers of 1971 and 1972. Specimens not injured or preserved in alcohol were reared in petri dishes in a small unheated laboratory trailer near Fife Lake, Wexford County. Fresh foliage was supplied daily, and head capsule widths were measured after each ecdysis. A total of 175 larvae were collected, and of these, 139 were reared. These yielded 52 adult moths, 67 hymenopterous parasitoids, 6 dipterous parasitoids, and 14 mortalities due to injuries and unknown causes. Braconid and ichneumonid parasitoids that matured were sent to W. R. M. Mason at the Canadian Biosystematic Research Institute and H. K. Townes at the American Entomological Institute for identification.

Fourteen of the reared larvae, during their last instar, were placed outdoors on a sweet fern plant enclosed by a cage so we could observe pupation. Other specimens that pupated in their rearing dishes were allowed to emerge into a small cage. They were then captured, transferred to a larger cage in the field and placed over a cluster of sweet fern plants. Protective hiding places (short pine bolts) and food (a mixture of beer, molasses, and bananas) were provided. All sweet fern plants were removed in mid-October each year and examined carefully for eggs. Those found were placed in vials and stored overwinter in a garage.

DISTRIBUTION

C. antinympha occurs in southern Canada from Ontario eastward through Quebec to Nova Scotia, and in the northern United States from New England west to the Mississippi River. Specifically, it has been recorded in the literature from Maine, New Hampshire, Massachusetts, New York, Maryland, Pennsylvania, and Wisconsin (Forbes, 1948; Barnes and McDunnough, 1918a; Cary, 1928; Darlington, 1949; Holland, 1968; Schaffner and Griswold, 1934). In Michigan it is common in the northern part of the lower peninsula (Fig. 1), but it has been collected in Allegan, St. Clair, Livingston, and Wayne Counties which are southern and not particularly abundant in sweet fern which appears to be its only host.

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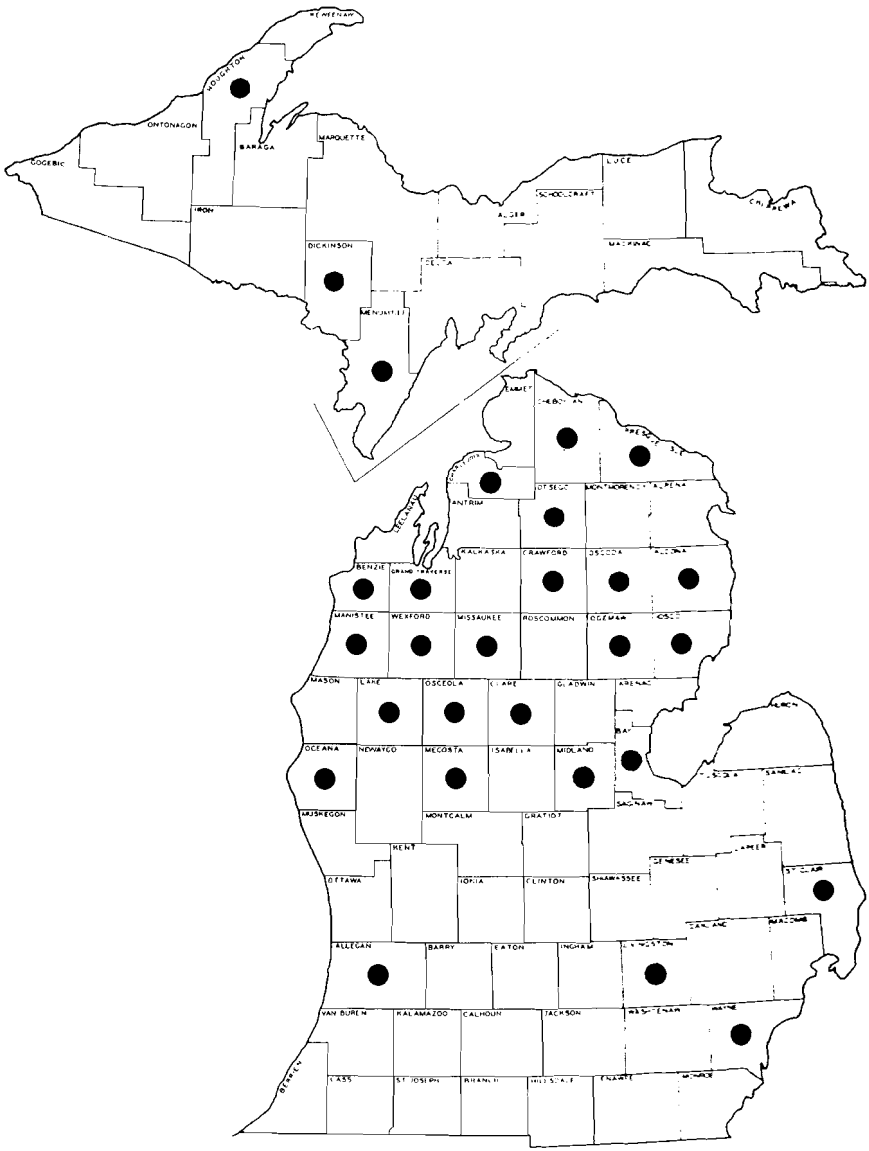

Fig. 1. Michigan counties where the sweet fern underwing has been collected.

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BIOLOGY

Catocala antinympha is univoltine and overwinters in the egg stage–typical traits of the genus. Insufficient numbers were collected to accurately define all the life stages. However, it is possible to outline a generalized life cycle from the insects observed and from the scattered records in the literature.

The light brown eggs are deposited on the host in early August several days after adult emergence. This delay is probably owing to a shortage of mature ova as dissections of freshly emerged adults show. Most eggs are found singly on the flower stem within two inches of the litter. They are somewhat hemispherical in shape with an oval base; the sides have 20-25 vertical ribs about half of which reach the micropylar area at the top. Some ribs are branched. Numerous faint transverse ribs occur in the matrix between the vertical ribs. Seven eggs averaged 0.99 mm long, 0.71 mm wide, and 0.71 mm high.

After the eggs overwinter, larval eclosion begins about mid- to late May. The larvae migrate up the stems of the host and feed on the edges of the young sweet fern leaves. The larvae are day feeders in contrast to many *Catocala* that rest or hide until evening. Even so, they are difficult to detect because of their mottled markings and their habit of stretching out parallel to the foliage and twigs while feeding and resting. They are not easily captured because they twist violently and drop to the ground when either they or their host plant are touched. Only once did I see one rear up and sway from side to side instead of dropping off the host. The larvae are generally solitary (Fig. 2); three or more larvae per plant is uncommon.

There are six larval instars–all were described fully by Beutenmüller (1902), but he did not give head capsule measurements. He segrated *antinympha* larvae into a group designated as those "without processes or elevation on the eighth abdominal segment." Head capsule width measurements of non-parasitized larvae from Michigan for the various inst :rs were:

Instar	No. measured	Mean width (mm)
I	0	0.40 (est)
II	4	0.58
III	17	0.82
IV	15	1.25
V	36	1.77
VI	21	2.53

The first two instars passed quickly, probably averaging about three or four days and probably not exceeding seven to eight each. Instars III-VI increased progressively, reaching an average of 14 days for the 6th (last) instar. Beutenmüller (1902) observed ecdysis at only two-day intervals for instars I to IV, but this likely occurred under warm laboratory conditions.

When ready to pupate, mature larvae migrate to the soil and spin a thinly webbed cocoon (Fig. 3) in the leaf litter adjacent to the soil. Darlington (1949) recorded the pupa as occurring in the soil and "trash" (i.e. litter). Pupae are nearly an inch long, brown, and dusted with a pale blue coating. I found the pupal stage to vary from 15 to 23 days, beginning in early July and ending in late August, about an eight-week period. Brower (1994) gave the pupal period as 20-30 days and Schaffner and Griswold (1934) stated the pupal period occurred from July to early August. Darlington (1949), however, found larvae alive as late as October 20 in southern New Jersey, but did not say whether the larvae were healthy or capable of pupation. Adults (Fig. 4) are gone by this time as attested by most collectors.

Adult capture dates outside of Michigan include: July and August (Schaffner and Griswold, 1934), August (Holland, 1968), and August-September (Cary, 1928). Capture dates in Michigan varied from July 12 to September 18.[2] My rearing records show adults

[2]Data from collections at Michigan State University, The University of Michigan, J. H. Newman (entomologist) (MSU), and M. C. Nielsen (lepidopterist), Lansing, Michigan.

Fig. 2. Larva of the sweet fern underwing on sweet fern plant.

emerging from July 29 to August 29 and several were still alive in cages in the field on September 13, 1972, when the tests were terminated.

LARVAL PARASITIZATION

PARASITOIDS.–In Michigan, five species of parasitoids were reared from *Catocala antinympha* larvae: an ichneumonid, *Zele mellea* Cresson, an unidentified dipteran, and several braconids including *Hyposoter annulipes* Cresson. The other braconids of the

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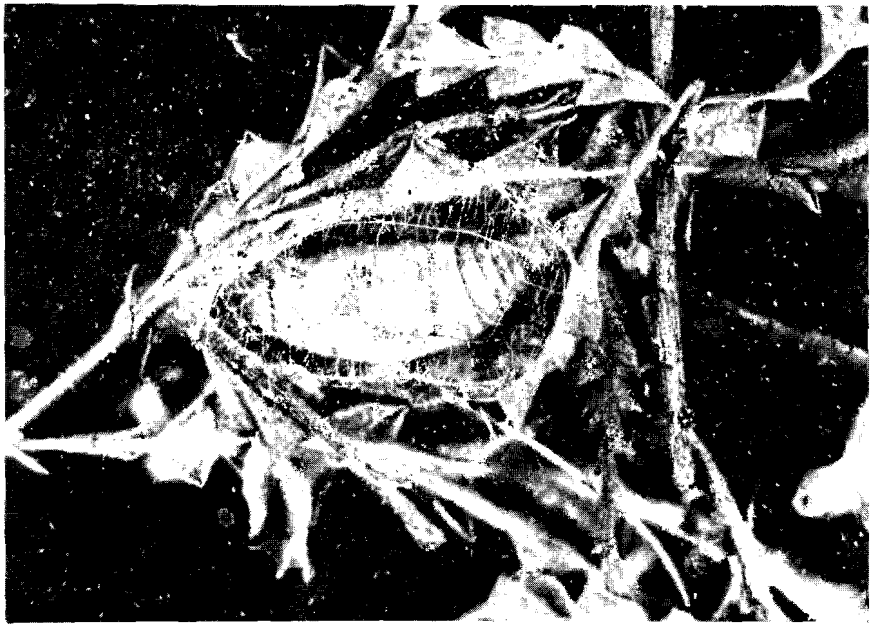

Fig. 3. Pupa of sweet fern underwing in cocoon in leaf litter.

Fig. 4. Adult of sweet fern underwing.

genus *Microplitis* were at first thought to be three distinct species from their kinds of cocoons. They were, however, identified as two species, *M. bradleyi* Muesebeck and *Microplitis* n.sp.–the latter having sexually dimorphic cocoons. Easily separable, the cocoon of the male of the latter is elongated, somewhat irregular in contour, and tan with the black band around the middle; that of the female is more smoothly contoured with a faint, almost imperceptible band. The cocoon of *M. bradleyi*, in contrast, is strongly prolate and dark brown with raised gray ridges.

Schaffner and Griswold (1934) also reared *Hyposoter annulipes*, a new species of *Microplitis*, and two dipterans, *Chaetophlepis* sp. and *Winthemia* sp., from *C. antinympha* larvae from the New England States.

PARASITISM AND HEAD CAPSULE SIZE.–Each kind of parasitoid emerged as fully developed larvae from two different instars of the underwing. *M. bradleyi* and *Microplitis* n.sp. female emerged from 4th and 5th instars, and *Microplitis* n.sp. male emerged from 5th and 6th instars.

All *microplitis* parasitoids reduced the head capsule size of the host in the instar of emergence (Table 1), not in any of the instars prior to the one in which the parasitoid emerged. For example, head capsules for normal and parasitized larvae averaged 1.24 and 1.25 mm, respectively, for 4th instars, and 1.75 and 1.77 mm, respectively, for 5th instars–the measurements for the parasitized ones being in the instar prior to parasitoid emergence.

The reason that *Microplitis* spp. emerge in more than one instar is not fully clear, but it probably has to do with the instar in which the host is parasitized. Several of the parasitized larvae that were reared in the laboratory passed through two "normal looking" instars prior to the instar with the reduced head capsule (*i.e.*, instars II and III, and III and IV for those parasitoids emerging in instars IV and V respectively), so the larvae must have been parasitized in the 1st and 2nd instar before they were collected. Older larvae collected later in the season, however, may have been parasitized in the 3rd and 4th instars and thus the parasitoid emerged in the last instar.

Head capsule reduction was greatest when the parasitoid emerged from a later instar (Fig. 5). For example, *M. bradleyi* emerging from the 4th instar *Catocala* larva reduced the 4th instar head capsule an average of 35%, whereas when emerging from the 5th instar, it reduced that head capsule an average of 88%. This reduction can be readily seen by comparing growth ratios or "progression factors"–the ratios of mean head capsule widths between two successive instars. Growth ratios for normal larvae for the last three instars were 1.44, 1.42, and 1.42, indicating a nearly constant progression of development. Head capsules of parasitized larvae, however, showed a declining progression of

Table 1. Head capsule widths and growth ratios of normal and parasitized larvae of *Catocala antinympha*. Parasitoids emerged from stage indicated.

Larval instar of *Catocala*	Normal larvae	Larvae parasitized by *Microplitis*		
		bradleyi	n.sp. ♀	n.sp. ♂
		Head capsule widths (mm)		
IV	1.25 ± 0.02[a]	1.10 ± 0.01	1.17 ± 0.02	–
V	1.77 ± 0.01	1.31 ± 0.04	1.56 ± 0.01	1.65 ± 0.02
VI	2.53 ± 0.03	–	–	2.09 ± 0.05
		Growth ratios[b]		
IV	1.44	1.36	1.34	–
V	1.42	1.05	1.25	1.33
VI	1.42	–	–	1.18

[a]Standard error. Means calculated from 3 to 36 measurements.
[b]Ratios of mean widths between IV/III, V/IV, VI/V instars.

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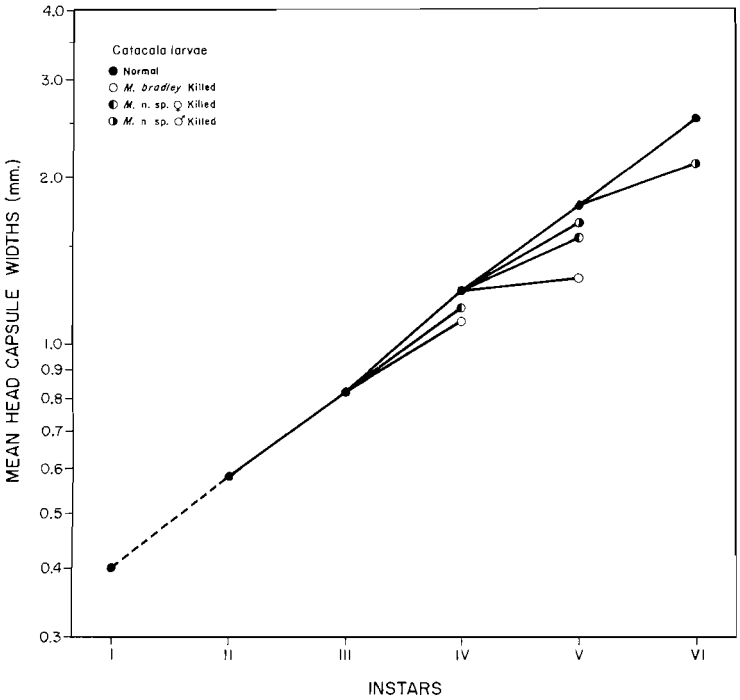

Fig. 5. Head capsule width development for normal sweet fern underwing larvae and for *Microplitis* spp. parasitized larvae. (Dashed line indicates estimate of first instar larval size.)

development, especially if the parasitoid emerged in a later instar. For example, *M. bradleyi* reduced the growth ratio from 1.44 to 1.36 when emerging from the 4th instar *Catocala* and from 1.42 to 1.05 when emerging from the 5th instar (Table 1).

COMMENT ON HOW PARASITISM CAN INTERFERE WITH DETERMINATION OF INSTARS HEAD CAPSULE SIZE.–Insect development and the number of instars are determined for many insects by either rearing immatures through all their instars and counting moults, or by collecting many immatures throughout the developmental period and plotting their head capsule measurements as a frequency histogram. The latter method also provides reliable estimates of means and standard errors if sufficient measurements are used and if there is a gap between measurements of adjacent size classes.

When parasitism affects head capsule size, errors will be introduced in these measurements as in the following example. Larval head capsule measurements of *antinympha,* when plotted as a frequency histogram, showed distinct size classes that normally should provide reliable means and standard errors. However, head capsules from larvae parasitized by *Microplitis,* when plotted with normal ones, causes some classes to become shifted to the left (Fig. 6) so that there was an underestimate of these class means. Also, highly reduced head capsules either produced false classes in between the true classes, or they were among those of the prior instar class (Fig. 6). Such errors were greatest for *C. antinympha* larvae parasitized by *M. bradleyi,* which reduced head capsule size in the 5th instar. Head capsules were reduced sufficiently to cause an underestimate of the class means of the last three instars, and, of course, the more larvae parasitized, the greater will be the expected underestimate.

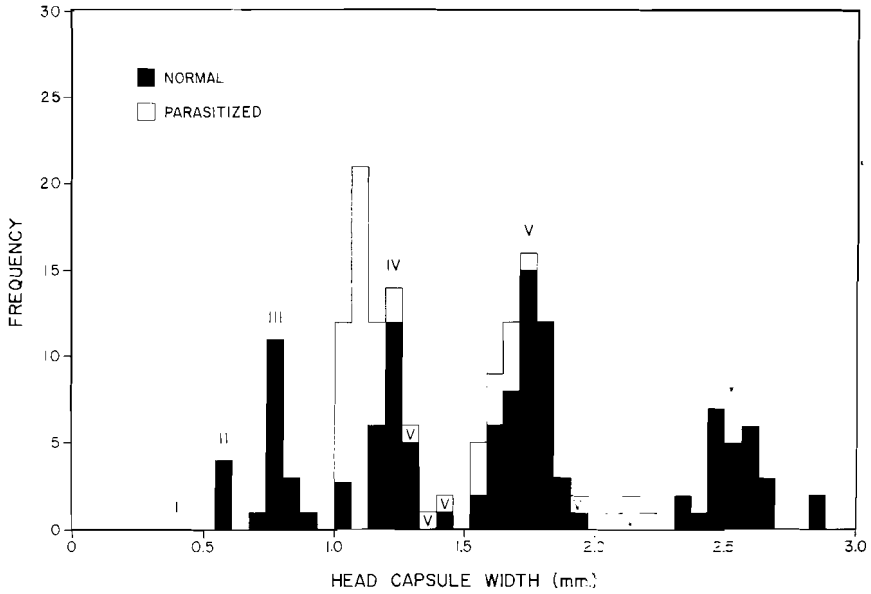

Fig. 6. Frequency histogram of head capsule width measurements of normal and *Microplitis* spp. parasitized larvae of the sweet fern underwing.

Different kinds of parasitoids can affect the head capsules of their hosts in several ways. First, the parasitoid may affect the head capsule only during the instar in which it emerges, as occurs with *antinympha* parasitized by *Microplitis* spp. In this case, one cannot determine by head capsule width which larva is parasitized until the instar in which the parasitoid emerges. Conversely, one can recognize a parasitized larva and tell at what instar the parasitoid will emerge by the less-than-normal head capsule size.

Second, the parasitoid can affect head capsule size in several instars and then emerge either in a late larval or the pupal stage, as occurs with the larch sawfly, *Pristophora erichsonii* Hartig, when parasitized by *Olesicampe benefactor* Hinz (Muldrew, 1967). In this particular case, the head capsule size of the sawfly progressively decreases through the last four instars of larval development. Thus, this type of parasitism strongly affects means and histograms of head capsule data, but easily permits one to identify parasitized larvae during several instars before parasitoid emergence.

Third, there may be no appreciable size reduction in any instar, as for example, when the yellow-headed spruce sawfly, *Pikonema alaskensis* (Rohwer), is parasitized (Van Derwerker and Kulman, 1974). This type of parasitism, of course, does not affect frequency histograms or means of head capsule measurements, but does prevent one from identifying parasitized larvae by head capsule size alone, if that is desirable.

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