SCIENTIFIC NOTES

DEVELOPMENT OF *HELIOTHIS VIRESCENS* (LEPIDOPTERA: NOCTUIDAE) LARVAE AFTER PARASITIZATION BY *MICROPLITIS CROCEIPES* AND *MICROPLITIS DEMOLITOR* (HYMENOPTERA: BRACONIDAE)

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Microplitis croceipes (Cresson) is an important parasitoid of *Heliothis* spp. in the U.S.; *M. demolitor* Wilkinson was imported into the U.S. from Australia (Shepard et al. 1983). The following study was conducted primarily to determine how many times *Heliothis virescens* (F.) larvae molt after being parasitized by *Microplitis* spp.

Heliothis virescens larvae were reared in plastic cups (25-ml) on an artificial insect diet (King & Hartley, 1985). Adult parasitoids were held in wooden cages (0.14 cu m) with Plexiglas® tops and ventilated in the back with organdy fabric. Undiluted honey was streaked on the top of the cage as a food source, and a water source was provided by means of soaked cotton balls held in plastic cups (25-ml). Rearing methods for the parasitoid colony are detailed by Powell & Hartley (1987).

Host larvae were parasitized by exposing them singly on a small brush to several (15-20) female parasitoids (1-5 d-old) held in a plastic container (500-ml). Use of two to four such containers was rotated during manual exposure of hosts to wasps. This method improved the likelihood that each larva was parasitized because oviposition was observed. Multiple ovipositions in the same host were not allowed. Determining the occurrence of molting was facilitated by lightly powdering each host's entire cuticle with Day-glo® fluorescent pigment (DAY-GLO Color Corp., 4515 St. Clair Ave., Cleveland, OH 44103); when larvae molted, the dye was cast with the exuviae.

While in the first instar (ca. 24-h old), 36 host larvae were exposed for parasitization to *M. croceipes* and 36 were exposed to *M. demolitor*. The same number and procedure were used for three additional groups of larvae when they reached the early second, third, and fourth instars. In addition, 36 non-parasitized larvae for each instar group were held as controls and treated in the same manner as test larvae. Larvae were checked during morning hours to observe the occurrence of molting. When molting was observed, control and test larvae were re-powdered and developmental times (to the nearest day) between molts were recorded. Each larva was held individually in plastic cups containing diet (total of 36 control and 144 test larvae).

Studies were conducted at 26 ± 2°C, 60 ± 10% RH, and a photoperiod of 15L:9D. Data were analyzed using a least squares analysis of variance procedure with an *a priori* significance level (α) of 0.01.

The percentage of *H. virescens* larvae developing to different instars after parasitization by *M. croceipes* and *M. demolitor* is illustrated in Fig. 1. When host larvae were in later instars at the time of parasitization by either *Microplitis* spp., they molted fewer times than larvae parasitized as earlier instars. For example, 94% of the hosts exposed to *M. demolitor* in the second instar molted twice more to develop to the fourth instar, while 93% of those exposed in the fourth instar molted only once more. The

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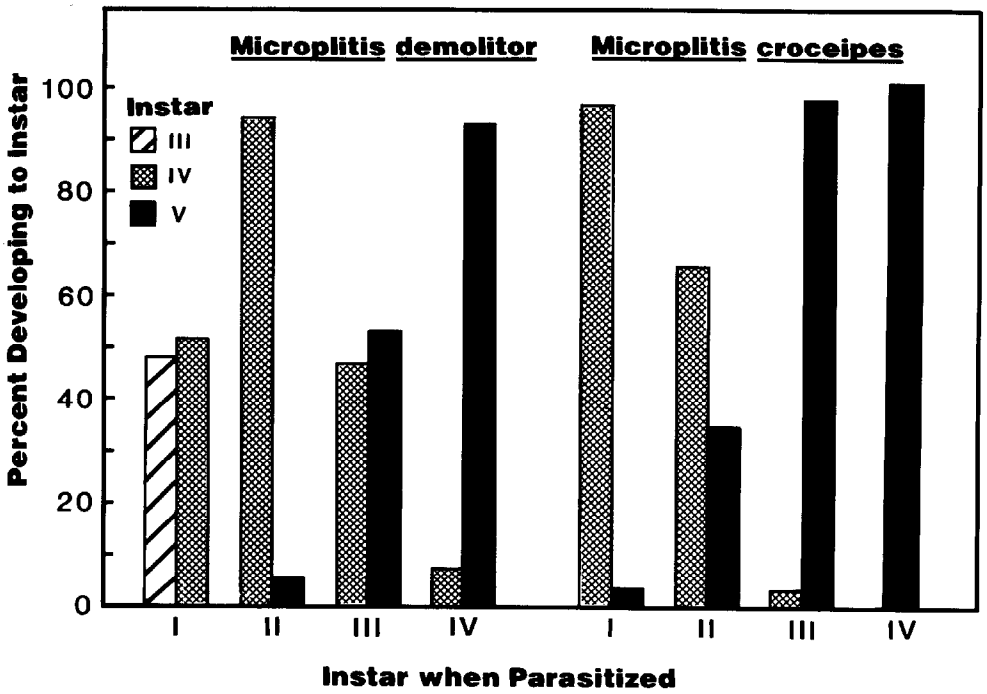

Fig 1. Percentage of *Heliothis virescens* (F.) larvae with final development to the third, fourth, or fifth instar after parasitization by *Microplitis demolitor* Wilkinson or *M. croceipes* (Cresson) while in the first, second, third, or fourth instar.

results reported here for *M. croceipes* generally agree with those of Lewis (1970). The host generally is known to have five instars, and parasitization did not result in a greater number of instars. Host larvae parasitized by *M. croceipes* showed a sharp decline in number of larvae developing only to the fourth instar, and an increase in number of those developing to the fifth instar. A greater percentage of larvae in first and second instars that were parasitized by *M. croceipes* reached the fifth instar than did first and second instars parasitized by *M. demolitor*. Thus, *M. demolitor* was more efficient than *M. croceipes* in preventing early instars from reaching late instars.

The feeding habits of late instars often are such that they escape the effects of insecticides and/or predators; therefore, preventing development to late instars would be a useful management tool. However, when larvae are parasitized, feeding rates usually are reduced greatly anyway, so the larva's presence in a crop does not necessarily indicate damage. Information on host instar at time of parasitoid pupation would be useful in ecological studies where predicting instar at time of parasitization is important.

Developmental times for *M. demolitor* were significantly faster ($P<0.01$) for *H. virescens* larvae parasitized in the first and second than third and fourth instars (Table 1). *Microplitis croceipes* tended to develop fastest in larvae parasitized in the third instar, agreeing with data of Hopper & King (1984). They found developmental time for *M. croceipes* to be fastest in the preferred third instar. For a thorough discussion of preference, acceptance, and fitness components of *M. croceipes* attacking *H. virescens*, see Hopper (1986). *Heliothis virescens* larvae held as unparasitized controls developed to pupae in ca. 13 d (Table 1). No differences were expected among the four groups of non-parasitized larvae; pooled data yields 13.1 ± 0.1 d (n = 120 larvae).

A closer look at developmental times when host larvae were exposed in different instars reveals that as the number of molts increases from one to two to three, the

TABLE 1. MEAN TOTAL DEVELOPMENTAL TIMES (D) OF *MICROPLITIS DEMOLITOR* AND *M. CROCEIPES* PARASITOIDS (N = NUMBER) FROM TIME OF EXPOSURE OF *HELIOTHIS VIRESCENS* HOSTS IN THE FIRST, SECOND, THIRD, OR FOURTH INSTAR TO PUPATION AND COCOON FORMATION, AND OF NON-PARASITIZED *H. VIRESCENS*.[a]

	Host instar when exposed to parasitoid							
	First		Second		Third		Fourth	
Treatment	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$	n	$\bar{x} \pm SE$
M. demolitor	33	7.4 + 0.1 a	35	7.2 + 0.1 a	34	7.9 + 0.1 b	27	8.6 + 0.1 c
M. croceipes	31	8.5 + 0.1 a	32	8.2 + 0.1 ab	33	8.0 + 0.1 b	33	8.3 + 0.1 ab
Non-parasitized[b]	32	13.2 + 0.1 a	26	12.9 + 0.1 a	32	13.1 + 0.1 a	30	13.1 + 0.1 a

[a]Means followed by the same letter within a row are not significantly different ($P<0.01$).
[b]Mean time for non-parasitized larvae with data pooled = 13.1 ± 0.1 d.

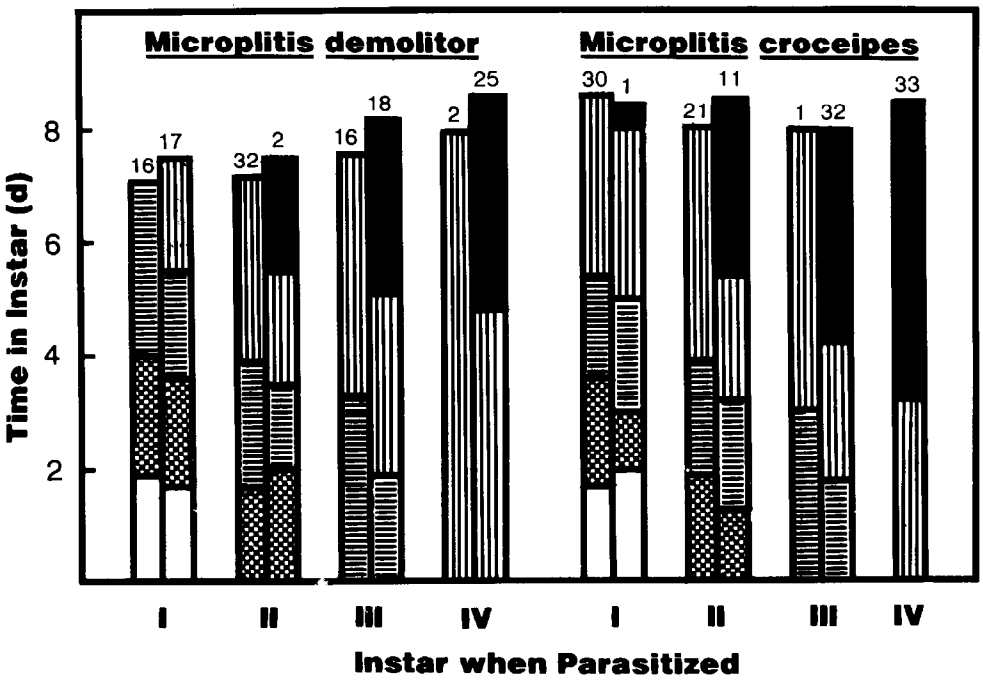

Fig. 2. Cumulative developmental times to pupation of *Microplitis demolitor* Wilkinson and *M. croceipes* (Cresson) when *Heliothis virescens* (F.) was parasitized in instars I through IV. Each bar is divided to show ca. times the host spent in different instars (I—no pattern, II—checkered, III/horizontal lines, IV—vertical lines, and V-solid). The number above each column indicates the number of observations.

average time spent per instar decreases respectively, from 4.1, to 2.5, to 1.9 d (n = 126 obs.) for *M. demolitor*, and from 4.1, to 2.7, to 2.1 d (n = 128 obs.) for *M. croceipes* (Fig. 2). In extreme cases, two fourth instar hosts exposed to *M. demolitor* produced parasitoid cocoons without molting; and one first instar exposed to *M. croceipes* molted four times, and produced a parasitoid pupa shortly after the last molt. I thank M. M. Ford and C. S. Jany for assisting with this study and Day-glo Color Corp. for providing the fluorescent pigment.

Endnotes

Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the U.S. Dept. of Agric. and does not imply its approval to the exclusion of other products that may also be suitable.

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GATHERING OF FUNGAL HONEYDEW BY *POLISTES* SPP. (HYMENOPTERA: VESPIDAE) AND POTENTIAL TRANSMISSION OF THE CAUSAL ERGOT FUNGUS

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Ergot honeydew is a sweet, viscous exudate found on flowering cereal heads infected by *Claviceps* spp. (Ascomycetes). The honeydew is a complex mixture of mono-, di- and oligosaccharides resulting from fungal conversion of host phloem constituents (Mower & Hancock 1975a,b). Infective fungal conidia are protected from desiccation by the exudate (Mower & Hancock 1975a), which also assists in dissemination of the fungus by attracting insects that feed on it (Langdon & Champ 1954, Moreno et al. 1971, Carter 1973).

Many insect species are known or suspected vectors of ergot conidia. Diptera and Coleoptera comprise the majority of insects on record (Atanasoff 1920), although other orders, including Hemiptera, Lepidoptera and Hymenoptera have been reported also (Atanasoff 1920, Langdon & Champ 1954, Parris & Moore 1961, Mongolkiti et al. 1969, Moreno et al. 1971, Sharma et al. 1983). The present report describes foraging behavior of several species of *Polistes*, confirms their exploitation of ergot honeydew as a nutritional resource and implicates these wasps as potential vectors of the fungus.

Observations were made from 14 July to 18 August 1987, in a five-ha field of mixed grasses in Baton Rouge, Louisiana, between 1600 and 2000 hours at temperatures of 27° to 32° C. Fifty individuals were observed. The majority were *Polistes fuscatus* (F.) and *Polistes metricus* Say (n = 40), but *Polistes dorsalis* (F.) (n = 10) also were recorded. Observation periods for individual wasps rarely exceded 10 min and were terminated by observer intervention or by flight of the wasp beyond following distance. Individuals of all three species were seen collecting droplets of honeydew on infected florets of dallis grass, *Paspalum dilatatum* Poir, which was abundant in the field and had a high incidence of infection by *Claviceps paspali* F. L. Stevens & J. G. Hall. Infection was determined by visual inspection of florets for the presence of honeydew droplets. Similar foraging activities on inflorescences of vasey grass, *Paspalum urvillei* Steud., and bahia grass, *Paspalum notatum* Flugge, led to observations of honeydew-producing fungal infections on these grasses as well. Individual wasps alternated freely between these grasses while collecting honeydew during a single observation period. All three grasses are reported hosts for *C. paspali* (USDA 1960).