EVIDENCE FOR DIEL ACTIVITY OF *OPHION FLAVIDUS* BRULLE (HYMENOPTERA: ICHNEUMONIDAE), A PARASITOID OF THE FALL ARMYWORM[1]

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ABSTRACT

The diel activity of *Ophion flavidus* Brulle (Hymenoptera: Ichneumonidae) was determined by observing the movement of two-day-old mated female parasitoids confined with 4th-instar larvae of *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) on R4-R5-stage peanut plants. Observations were made for 1-h periods at 0600, 1200, 1830, and 2400 h CST. Fourteen *O. flavidus* adult females were used in the study. Movement of *O. flavidus* was greater ($P = 0.05$) at 0600 and 2400 h than at 1200 or 1830 h. Attacking and/or ovipositing occurred more frequently ($P = 0.05$) at 0600 and 2400 h than at 1200 or 1830 h.

Key Words: Diel activity, Circadian rhythms, Hymenoptera, Ichneumonidae, *Ophion flavidus, Spodoptera frugiperda.*

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INTRODUCTION

Ophion flavidus Brulle is the most common larval parasitoid of the fall armyworm, *Spodoptera frugiperda* (J. E. Smith) (Lepidoptera: Noctuidae) in Alabama (Reed 1980). A computerized literature search indicated that there were no published studies on the biology and behavior of *O. flavidus.* Consequently, research was initiated to evaluate the potential of *O. flavidus* use in an insect pest management program by providing basic information on its life history and by examining its host-parasitoid behavioral interactions. These studies included the determination of the length of the *O. flavidus* life cycle at a constant temperature, its adult sex ratio, and synchrony of its life with that of its host (Rohlfs and Mack 1984b); the effects of parasitization by *O. flavidus* on the consumption and utilization of a pinto bean diet by fall armyworm larvae (Rohlfs and Mack 1983); and the functional response of *O. flavidus* to various densities of fall armyworm larvae (Rohlfs and Mack 1984a).

Hooker (1912) and Townes (1971) reported that most species in the genus *Ophion* appeared to be crepuscular or nocturnal in habit. However, Lewis and Taylor (1965) reported in a diurnal flight periodicity study of 400 taxa that most Ichneumonidae were active at ca. 1200 - 1800 h, and that only small numbers of *Ophion* spp. were caught at night. The purpose of this study was to obtain additional information on the biology of *O. flavidus* by examining its diel activity pattern.

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MATERIALS AND METHODS

The study was conducted at Auburn University on fair weather days during July and August of 1983. All *O. flavidus* females utilized in this experiment were obtained from a laboratory colony reared by a method described by Rohlfs and Mack (1983). In the greenhouse, *O. flavidus* females were individually placed in 3.8-liter jars with a small container filled with 10% honey water for ca. 48 h prior to the experiment to acclimate the parasitoids to natural lighting conditions. The treatments employed in the study corresponded to times of day (0600, 1200, 1830, and 2400 h CST). Fourteen replicates (parasitiods) were used in the experiment, with 1 replicate per day. Each female parasitoid used in the study was placed individually in an outdoor screen cage 30 cm tall, 14 cm wide at the bottom and 18 cm wide at the top. The initial observation period for each wasp was randomly selected from the 4 treatments so that the time of day each female was first exposed to was randomly assigned. Five 4th-instar fall armyworm larvae from a laboratory culture were randomly placed on the top of mature leaflets on a peanut plant (var "Florunner") at the R4-R5 plant growth stage (Boote 1982) in the cage. One two-day-old mated female *O. flavidus* was then released into the cage at the randomly selected initial observation period. Two-day-old adult *O. flavidus* were used because laboratory reared adults of this age will sting and oviposit in fall armyworm larvae, and because we wanted to keep parasitoid age constant so that it would not be confounded with the treatment effects. A 25-watt red light bulb was suspended over the cage during the entire experiment to facilitate observations in reduced light conditions. Stopwatches were used during each of the four 1-h observation periods to time total parasitoid movement (walking or flying) and time spent on the plant. Records were maintained on the number of larvae attacked by each wasp for each 24-h period. After each 1-h observation period, fall armyworm larvae were removed from the plant and placed in 29.6-ml plastic cups containing pinto bean diet until parasitoid emergence or until pupation of unparasitized larvae. Also, the parasitoid was removed from the cage at this time and returned to its jar until the next observation hour.

Due to unequal variances among treatments, a Friedman's nonparametric test was used to rank the means for total movement time, total time on the plant, and number of larvae parasitized during each time period. A Duncan's multiple range test ($P = 0.05$) was then used on the rankings (Friedman 1937) to determine if there were diel effects among the means for each variable.

RESULTS AND DISCUSSION

Movement of *O. flavidus* females was significantly ($P = 0.05$) greater at 0600 and 2400 h than at 1200 or 1830 h (Table 1). During the 1200 and 1830 h observation periods, the wasps were often motionless for 30 or more consecutive minutes, and usually rested on the top or sides of the cage. At 0600 and 2400 h, *O. flavidus* females were often very active (i.e. flying about the cage and walking on cage walls, soil surface, and all plant surfaces). *Ophion flavidus* females spent more time on the plant at 0600 h and 2400 h than at 1200 h or 1830 h (Table 1). Thus, *O. flavidus* diel activity appears to be nocturnal and crepuscular, which concurs with Hooker (1912). Nocturnal activity peaks have also been noted for the encyrtid *Ooencyrtus kuvanai* (Howard) (Weseloh 1976) and for the braconid

Dendrosoter sulcatus Meus., (Dix and Franklin 1983). Crepuscular activity peaks have been noted for other ichneumonids (Juillet 1960).

Table 1. Movement time, time spent on the plant, and number of fall armyworm larvae attacked by 14 *O. flavidus* females during four 1-h observation periods.*

Observation period beginning	Mean ± SE time (min.)		Mean ± SE no. hosts attacked
	In movement	On plant	
0600 h	26.41 ± 3.79 a	4.01 ± 1.19 a	1.93 ± 0.49 a
1200 h	3.92 ± 1.38 b	0.56 ± 0.32 bc	0.50 ± 0.25 b
1830 h	0.75 ± 0.25 b	0.09 ± 0.05 c	0.29 ± 0.22 b
2400 h	22.30 ± 4.05 a	2.47 ± 0.74 ab	2.07 ± 0.56 a

* Means in each column followed by the same letter are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Adult *O. flavidus* females were observed attacking 67 larvae during this study and larvae were attacked during all time periods (Table 1). Attacks, however, were more numerous ($P = 0.05$) at 0600 and 2400 h than at 1200 or 1830 h. *Ophion flavidus* adults emerged from 53 of the 67 larvae attacked. The wasps appeared to locate hosts by both sight and chemotaxis, the latter being evidenced by female *O. flavidus* tapping their antennae on the soil or leaf surface prior to locating a host in that vicinity. Chemical factors have been shown to play an important role in the host finding activity of many ichneumonid parasitoids (Madden 1968; Spradbery 1970).

In two instances, female wasps stung the same larva more than once. In both of those cases, no parasitoid developed in that host and the host survived to adulthood. On numerous occasions a wasp was observed tapping her antennae on the dorsum of a previously stung larva and then leaving it without further attempts to sting.

In summary, these data provide evidence for a diel change in *O. flavidus* activity, and indicate that *O. flavidus* is a nocturnal and crepuscular parasitoid of the fall armyworm.

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