

THE OBSERVED SEX RATIO OF *PEDIOBIUS FOVEOLATUS*
 [HYM.: EULOPHIDAE] IN FIELD POPULATIONS OF
EPILACHNA VARIVESTIS
 [COL.: COCCINELLIDAE] (1)

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Larvae of *Epilachna varivestis* MULSANT, parasitized by *Pediobius foveolatus* (CRAWFORD), were collected in soybean fields in Maryland during 1975. Adult *P. foveolatus* emerging from the larvae were sexed and counted. The ratio of males to females increased as the availability of food within the host decreased. This information is useful in development of exponential models predicting host-parasite interactions.

Pediobius foveolatus (CRAWFORD), a parasite of epilachnine larvae from India (ANGALET *et al.*, 1968), is presently used in the state of Maryland, U.S.A., as a biological control for suppressing *Epilachna varivestis* MULSANT populations on soybeans (STEVENS *et al.*, 1975a). Because the parasite does not overwinter, it must be released annually. To predict expected increase in the parasite population with exponential models, a reliable estimate of the sex ratio is required (MCGUIRE, unpublished manuscript). The sex ratio of a sample of field collected *P. foveolatus* was 1 ♂:1.33 ♀, but laboratory-reared parasites had a sex ratio of 1 ♂:6.75 ♀ (STEVENS *et al.*, 1975b). These widely divergent ratios indicated that a dynamic situation existed. The following study was initiated to clarify the seasonal changes in sex ratio under conditions in Maryland.

MATERIALS AND METHODS

P. foveolatus adults were released throughout the Maryland soybean growing area from mid-June to mid-July, 1975. The parasite population increased and dispersed so that by September, parasitized larvae of *E. varivestis* were present in almost all soybean fields infested by the beetle. From September 5 through October 4, 922 parasitized larvae were collected at random from various fields. These larvae were held individually until the adult parasites emerged. Numbers emerging from each parasitized larva were recorded and the individual parasite adults were sexed, based on presence or absence of the ovipositor. Sex ratios were calculated for each collection date. Sex ratios were also calculated for adult parasites based on the numbers emerging

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from each parasitized larva. For ease in analysis, the results were grouped in increments of 5 (i.e. 1 to 5, 6 to 10, 11 to 15, etc. adult *P. foveolatus* emerging per parasitized larva).

RESULTS AND DISCUSSION

There was no apparent relationship between sex ratios of parasite adults and collection date. However, when the data were grouped on the basis of numbers of adults emerging per parasitized larva, the sex ratio decreased as the number of adults emerging per parasitized larva increased (table 1). The average sex ratio of 1 to 20 adults that emerge per larva is 1 ♂:3.29 ♀. If more than 20 adults per larva emerge, the sex ratio is almost halved immediately and continues to decline as numbers increase. In prior laboratory studies (STEVENS *et al.*, 1975b) the average number of parasite adults emerging from a larva parasitized by a single oviposition was 11.1 and ca. 95% of the time the range involved was 1 to 21 parasites. On this basis one might state that the parasitized larvae in the 1st 4 groups in table 1 (with 1 to 20 parasites emerging) represent those that received a single oviposition. Those with more than 20 emerging adult parasites probably reflect multiple (2 or more) ovipositions, a situation that occurs as a result of host scarcity in relation to ovipositing females. This state is achieved in the field as host larvae decline in numbers or abundance of *P. foveolatus* increases.

TABLE 1

The sex ratio of Pedicobius foveolatus dependent on number of parasites per mummy collected in Maryland soybean fields during the period of September 5 to October 4, 1975

Range category of the number of parasites emerging per mummy	Number of mummies contributing parasites to sex ratio	Sex ratio ♂/♀
1-5	107	1 : 3.23
6-10	232	1 : 3.59
11-15	120	1 : 2.85
16-20	111	1 : 3.18
21-25	96	1 : 1.78
26-30	76	1 : 1.28
31-35	68	1 : 0.91
36-40	41	1 : 0.71
41-100	71	1 : 0.48

That the sex ratio of ♂ : ♀ declines as the number of parasites developing within the host larva increases is evident. The reason for this association is less apparent. *P. foveolatus* is an arrhenotokous species (STEVENS *et al.*, 1975b). Sex of developing individuals is determined prior to egg hatch within the host larva. Therefore it would appear likely that environmental factors within the host larva could impose a differential determination and/or survival between the sexes (KERR, 1962). The obvious factor is the reduced availability of food as numbers of developing parasites increase within each host larva. Another possible factor is that ovipositing female parasites

are able to control fertilization of eggs as they are laid in response to an external stimulus, such as the presence on the host of a marking pheromone left during prior ovipositions. Regardless of the mechanism, it appears that the sex ratio declines markedly as host availability declines. Evolution of this mechanism would be advantageous to the parasite species in terms of constraining the number of ovipositing females during host scarcity.

Various factors affect the population dynamics of *E. varivestis*. One factor is the changing sex ratio of the parasite, *P. foveolatus*, under different environmental conditions. Sex ratio information is indispensable to development of exponential models to follow the probable population interactions between host and parasite. We conclude that the sex ratio of *P. foveolatus* changes during the season according to the ratio of the parasite to its host. At a low ratio of parasite to host, the sex ratio favors females, but at a high ratio of parasite to host, the sex ratio favors males. Any realistic model of *E. varivestis* and *P. foveolatus* interaction must account for this observed changing sex ratio.

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RÉSUMÉ

Rapport des sexes de *Pediobius foveolatus* [Hym. : Eulophidae] dans les populations naturelles de *Epilachna varivestis* [Col. : Coccinellidae]

Des larves de *Epilachna varivestis* MULSANT, parasitées par *Pediobius foveolatus* (CRAWFORD) ont été récoltées en 1975 dans des champs de soja du Maryland. Les adultes de *P. foveolatus* issus de ces larves ont été dénombrés et les sexes reconnus. Le nombre de mâles par rapport aux femelles augmente lorsque la disponibilité de la nourriture offerte par l'hôte diminue. Ces renseignements sont utiles pour l'établissement de modèles exponentiels destinés à prévoir les interactions hôtes/parasites.

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