EFFECT OF *VAIRIMORPHA* SP.[1] ON SURVIVAL OF *GEOCORIS PUNCTIPES*[2] IN THE LABORATORY

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ABSTRACT

Survival of *Geocoris punctipes* (Say) (Hemiptera: Lygaeidae) after ingestion of fall armyworm, *Spodoptera frugiperda* (J. E. Smith), tissues infected with *Vairimorpha* sp. (Microspora: Microsporida) was studied in the laboratory. In six tests involving 532 adult *G. punctipes,* survival averaged 38.1 days when infected larvae were consumed and 42.9 days when healthy larvae were eaten. These means were significantly different ($P < 0.05$). There was no germination of *Vairimorpha* spores or development of the pathogen in *G. punctipes.* Differences in survival between treated and control groups were attributed to ingestion of a non-nutritive meal equivalent to a brief period of starvation. The insect should be able to compensate in its natural habitat by seeking other prey. We believe the potential of this insect as a vector in spore dispersal outweighs the relatively minor effects of spore ingestion observed in the laboratory.

Key Words: *Geocoris punctipes, Vairimorpha* sp., biocontrol, non-target organism, microsporidia.

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INTRODUCTION

The adverse effects of pesticides on beneficial insects (Newsom 1967; Shepard et al. 1977), including *Geocoris punctipes* (Say), have produced increased interest in the use of biocontrol measures against crop pests. While much of this interest has centered on the use of bacteria and viruses and on parasitic and predaceous arthropods, the use of microsporidia as biocontrol agents has also received attention. Maddox et al. (1981) reviewed the potential of the microsporidium *Vairimorpha necatrix* (Kramer) for control of agricultural pests.

An undescribed species of *Vairimorpha,* originally found in Bolivia in *Alabama argillacea* (Hübner), the cotton leafworm, and maintained in this laboratory since 1978, has also shown promise in the control of several noctuids, including *Heliothis zea* (Boddie), the corn earworm, *Spodoptera frugiperda* (J. E. Smith), the fall armyworm, and *Feltia subterranea* (F.), the granulate cutworm (Hamm and Lynch 1982; Hamm and Hare 1982). However, little is known about the effects of this microsporidium on *G. punctipes* and other predators of target insects.

Geocoris punctipes, the big-eyed bug, is a small, predatory hemipteran common in cultivated crops, particularly soybean (Buschman et al. 1984; Waddill and Shepard 1974) and cotton (Ridgway et al. 1967), where it consumes eggs and early instars of noctuids and other pests. The purpose of this report is to describe the

[1] MICROSPORA: Microsporida
[2] HEMIPTERA: Lygaeidae

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effects of *Vairimorpha* sp. on the survival of *G. punctipes* after feeding on infected prey in the laboratory.

MATERIALS AND METHODS

Adults and late instar nymphs of *G. punctipes* were obtained from Fito Technica Floridana, Inc., Gainesville, Florida, between March and June, 1984. The insects were maintained at room temperature (25 - 27°C) in the laboratory in petri dishes (10 × 1.5 cm) containing a split 2-cm portion of green bean pod *(Phaseolus* sp.). Insects were held at least one week in the laboratory before use and observed for disease or mortality.

Individual insects were assigned to petri dishes in a completely randomized design, after which the dishes were randomly assigned to treatments, either treated or control. All insects used in a test were from the same shipment received from the supplier. Each dish contained three adult *G. punctipes* and a split 2-cm section of bean pod for moisture. Six tests, with 23 to 62 insects per treatement per test, were conducted. Overall, 532 *G. punctipes* were evaluated. Bean sections were replaced twice weekly and all dishes were maintained in the laboratory at ambient temperature (25 - 27°C), 50 to 70% RH, and a natural photoperiod.

Vairimorpha was maintained in a laboratory colony of the fall armyworm (FAW). Heavily infected larvae selected for feeding to *G. punctipes* were cut into equal portions of about 0.02 g each. One portion of an infected FAW larva was placed in each of the petri dishes containing *G. punctipes* assigned to a treated group. The treated insects were fed new portions of infected FAW larvae on each of three consecutive days, whereas controls were simultaneously offered equal portions of uninfected FAW larvae. After three feedings, all *G. punctipes* were subsequently maintained on beans only. All dishes were examined daily for dead insects, which were removed and examined by phase contrast microscopy for developmental stages amd spores of *Vairimorpha* sp. Where appropriate, Geimsa-stained smears were prepared to determine the presence or absence of developmental stages.

Data were analyzed using the GLM and FREQ procedures of SAS (1982). Mean (± SE) survival of treated and control insects in each test as well as overall means were compared. Chi-square analysis was conducted to compare cumulative mortality of insects in each treatment at selected post-infection intervals.

RESULTS

In five of the six tests, 220 *G. punctipes* which fed on *Vairimorpha*-infected FAW survived a mean of 41.6 ± 3.42 days and 219 *G. punctipes* which fed on healthy FAW survived a mean of 45.1 ± 3.35 days. These means were not significantly ($P > 0.05$) different. Only in test 6 was there a significant ($P < 0.01$) within-test difference in survival between treatments. In test 6, 45 *G. punctipes* which fed on *Vairimorpha*-infected FAW lived a mean of 20.6 ± 2.11 days and 48 *G. punctipes* which fed on healthy FAW lived a mean of 32.9 ± 1.80 days. Overall, 265 treated and 267 control *G. punctipes* lived a mean of 38.1 ± 1.53 and 42.9 ± 1.41 days, respectively. The overall means were significantly different ($P < 0.05$).

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Cumulative mortality of *G. punctipes* between days 3 and 63 after feeding on infected or healthy FAW larvae was examined by Chi-square analysis. Differences between treatments were obvious within a few days (Table 1), with the greatest significant cumulative mortality difference of the two groups occurring on day 15. For each day, from 3 to 28, inclusive, with the exception of days 6 through 10, when there was no significant difference between treatments ($P > 0.05$), the cumulative percent mortality of the treated group was greater ($P < 0.05$) than that of the controls. Rate of mortality in the treated group decreased after day 45. By day 63, there was no discernible difference in cumulative mortality of *G. punctipes* that were fed infected or healthy FAW larvae.

Table 1. Cumulative mortality of *Geocoris punctipes* from 3 to 63 days after feeding on *Vairimorpha*-infected or non-infected fall armyworm (FAW) larvae.

Days after infection	Cumulative mortality of *G. punctipes* feeding on Infected FAW N	Infected FAW Percent	Non-infected FAW N	Non-infected FAW Percent	X^2
3	26	9.8	10	3.7	7.111*
5	32	12.1	15	5.6	6.149*
6	33	12.5	21	7.9	2.667
7	36	13.6	23	8.6	2.864
8	39	14.7	24	9.0	3.571
10	44	16.6	25	9.4	3.232
15	61	23.0	33	12.4	8.340*
20	77	29.1	46	17.2	7.813*
25	93	35.1	65	24.3	4.962†
28	103	38.9	75	28.1	4.404†
30	110	41.5	87	32.6	2.685
32	122	46.0	99	37.1	2.394
35	130	49.1	112	41.9	1.339
40	149	56.2	129	48.3	1.439
50	184	69.4	170	63.7	0.554
63	208	78.5	206	77.2	0.010

* Cumulative percentages are significantly different ($P < 0.01$), X^2 test.
† Cumulative percentages are significantly different ($P < 0.05$), X^2 test.

No evidence of infections by *Vairimorpha* or other pathogens was found in *G. punctipes* in either stained smears or in fresh preparations examined by phase contrast microscopy. In several individuals, intact spores could be found 24 to 30 days after feeding, although most insects were negative within 7 days after the last feeding of infected FAW. Exposure of neonatal FAW to *Vairimorpha* spores collected from *G. punctipes* droppings produced infections in all larvae, indicating that spores remained viable after passage through the gut of *G. punctipes*.

DISCUSSION

The apparent lack of spore germination and absence of developmental stages of *Vairimorpha* in treated *G. punctipes* indicated that the pathogen did not develop

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in this insect. Among the microsporida, only the genera *Nosema* and *Octosporea* have been reported to occur in both Hemiptera and Lepidoptera, whereas *Vairimorpha* is known only from Lepidoptera (Hazard et al. 1981), although a recent report by Bykova and Issi (1984) indicated that *Vairimorpha* may also occur in Diptera.

Our results showed that 3 consecutive days of feeding, followed by maintenance on beans, produced sufficient stress to reduce overall survival of treated *G. punctipes* compared to untreated controls. *Geocoris punctipes* and other predators feeding on *Vairimorpha*-infected larvae in natural habitats consume spores, developing stages of the pathogen, metabolic products, as well as host tissues and ingesta. Microsporidian developmental stages have not been reported to be infective to predators after ingestion. A brief period of starvation produced by feeding large numbers of indigestible spores appears to best account for the effects we have observed.

In a related study, Marti and Hamm (1985) reported that this species of *Vairimorpha* failed to develop in larvae of *Calleida decora* (F.) (Coleoptera: Carabidae), yet produced deleterious effects including higher mortality of female larvae than male larvae and a longer developmental period in treated larvae than in untreated larvae. These effects in *C. decora* were attributed to a starvation period of several days' duration. Hamm et al. (1983) reported that *Vairimorpha* sp. also lengthened the development time of two hymenopteran parasitoids, *Microplitis croceipes* (Cresson) and *Cotesia marginiventris* (Cresson), yet did not reduce their survival. They concluded that *Vairimorpha* sp. did not reduce the effectiveness of these parasitoids.

Geocoris punctipes normally feeds on aphids and eggs or early instars of moth larvae (Whitcomb and Bell 1964). Its feeding behavior in the presence of dead or moribund larger prey in nature is not known, but it presumably feeds on these only if other food sources are not available. Ordinarily, FAWs and other noctuid larvae acquire microsporidian infections while very small. In light to moderate infections, these larvae grow to a size not suitable for small predators such as *G. punctipes*. Small FAW larvae which acquire a heavy, acute infection of microsporidia usually die early from septicemia (Fuxa 1981). Thus, opportunities for *G. punctipes*, in their natural habitat, to ingest the number or concentration of spores that they received in these tests are probably infrequent. Since the microorganism does not develop in this predator, *G. punctipes* should be able to compensate for the effects of non-nutritive meals by seeking other prey. Therefore, *Vairimorpha* sp. should not be a significant threat to *G. punctipes* in the field. Our findings of intact, viable spores in the gut of this predator for extended periods after feeding indicates that *G. punctipes* is a potential vector of microsporidian pathogens of injurious insect pests and may augment the effects of pathogens applied to crops by aiding in their dispersal. As a vector, the value of *G. punctipes* in the dissemination of *Vairimorpha* sp. is of potentially greater importance than the relatively minor and temporary effects from ingestion of spores under laboratory conditions.

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