PREDATION OF *SPISSISTILUS FESTINUS* (HOMOPTERA:MEMBRACIDAE) NYMPHS BY HEMIPTERAN PREDATORS IN THE PRESENCE OF ALTERNATIVE PREY

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ABSTRACT

The feeding preferences of *Geocoris punctipes* (Say) and *Nabis roseipennis* Reuter were studied in the laboratory. Female adult predators were exposed for 24h to three *Spissistilus festinus* (Say) nymphal densities and two *Pseudoplusia includens* (Walker) larval densities. Feeding responses of the predators when exposed to second and third *S. festinus* nymphal stages and second instar *P. includens* and/or *Helicoverpa zea* (Boddie) as a food choice also were studied. Predation of *S. festinus* nymphs by *G. punctipes* and *N. roseipennis* did not differ significantly in the presence of *P. includens* and/or *H. zea* larvae as alternative prey. *Geocoris punctipes* and *N. roseipennis* caused mortality of *S. festinus* nymphs of 33 to 83% and 33 to 100%, respectively, even in the presence of the lepidopterous larvae.

Key Words: Three-cornered alfalfa hopper, *Geocoris punctipes, Nabis roseipennis*, biological control

RESUMEN

Las preferencias alimentarias de *Geocoris punctipes* (Say) y *Nabis roseipennis* Reuter fueron estudiadas en el laboratorio. Las hembras predatoras adultas fueron expuestas durante 24 horas a tres densidades ninfales de *Spissistilus festinus* y a dos densidades larvales de *Pseudoplusia includens* (Walker). También fueron estudiadas las respuestas alimentarias de los predatores cuando se expusieron a el segundo y tercero estadios ninfales, y a *P. includens* y/o *Helicoverpa zea*, en el segundo estadio larval. La predación de ninfas de *S. festinus* por *G. punctipes* y *N. roseipennis* no mostró diferencias significativas cuando estaban presentes larvas de *P. includens* y/o *H. zea* como presas alternativas. *Geocoris punctipes* y *N. roseipennis* causaron mortalidades de ninfas de *S. festinus* del 33 al 83%, y del 33 al 100%, respectivamente, aun cuando tenían como alternativa alimentarse de las larvas lepidopteras.

Geocoris punctipes (Say) (Heteroptera: Lygaeidae) and *Nabis roseipennis* Reuter (Heteroptera: Nabidae) are polyphagous predators commonly found in soybean, *Glycine max* (L.), fields (Turnipseed 1974, Irwin and Shepard 1980). They feed on a diversity of arthropod pests (Elvin et al. 1983, Crocker and Whitcomb 1980) including nymphs of the three-cornered alfalfa hopper, *Spissistilus festinus* (Say) (Heteroptera: Membracidae) (Spurgeon 1992). The rate of predation on a given prey may be influenced by the presence of alternative prey (Ridgway and Jones 1968, Murdoch 1969, Ables et al. 1978). Although generalist predators such as *Geocoris spp*. and *Nabis spp*. attack a variety of prey, they may exhibit a preference for specific prey size or a prey with limited or no defense. Crocker and Whitcomb (1980) found that the largest percentage (79%) of target prey captured by *Geocoris spp*. were those that remained pas-

sive during physical contact with the predator. *Geocoris spp*. hunting behavior on soybean plants includes both searching actively on all plant parts and remaining motionless waiting for prey (Crocker and Whitcomb 1980). *Geocoris spp*. attack by walking fast or running toward their prey with the beak extended straight forward and quickly inserting the stylet to subdue the prey. This predator has been observed sometimes to lift the prey in the air with its beak while feeding.

Nabis roseipennis is larger and more aggressive than *G. punctipes*. Its hunting strategy also involves active random movements searching for prey in the soybean canopy and remaining motionless or 'waiting' for relatively long periods of time. This predator has been observed using its legs to grasp prey.

Previous laboratory and field studies indicate that *G. punctipes* and *N. roseipennis* feed on *S. festinus* nymphal stages (Medal et al. 1995). *Geocorispunctipes* has a preference for early (1st, 2nd) and intermediate (3rd) nymphal developmental stages, while *N. roseipennis* feeds equally well on all *S. festinus* nymphal stages.

Laboratory studies were designed to determine the feeding response or change in number of prey attacked by *G. punctipes* and *N. roseipennis* female adults as the *S. festinus* nymph density increased, and how the presence of *Pseudoplusia includens* (Walker) (Lepidoptera: Noctuidae) and *Helicoverpa zea* (Boddie) (Lepidoptera: Noctuidae) larvae as alternate prey affected predation on *S. festinus*.

Materials and Methods

Feeding Responses at Different Prey Densities

Geocoris punctipes used in these studies were obtained from a laboratory colony established from adults collected in southwestern Arkansas soybean, and alfalfa, *Medicago sativa* L. fields during the spring and summer of 1992-3. *Nabis roseipennis* were collected as immatures and reared in the laboratory to the adult stage on *H. zea* eggs and green bean, *Phaseolus vulgaris* L. pods. The 1-3 week old female adult predators were held with only bean pods for 24h before the experiment. Second and third *S. festinus* instars and second *P. includens* instars were obtained from a laboratory colony. *Spissistilus festinus* were maintained on *P. vulgaris* pods and *P. includens* on artificial diet (Burton 1969) at 26°±1 C, 70 to 80% RH, and a photoperiod of 14:10 (L:D)h. The studies were conducted in a growth chamber under similar environmental conditions.

Predator and prey were caged on individual potted soybean plants (CV: Bragg) in growth stages V2-3. The cages were 2-liter clear plastic soda bottles with the tops and bottoms removed. The top was covered with fine cloth to allow air movement. The base of the cage in contact with the soil was sealed by placing tape around the bottom of the cage and the upper rim of the pot.

Treatments were a predator species (single *G. punctipes* or *N. roseipennis* adult female), three *S. festinus* nymphal densities (3, 6, 9), and three *P. includens* larval densities (0, 2, 4) which were arranged in a 3×3 factorial in a completely randomized design with four replications for each predator. The two predator species with their respective prey combinations were run as two separate experiments. Prey mortality was recorded after 24h. Percent prey mortality data for each predator species were transformed using $\arcsin\sqrt{y}$ and analyzed separately by an analysis of variance (SAS Institute 1988). Means were separated using a LSD procedure when appropriate.

Feeding Responses with *P. includens* and *H. zea* as Alternative Prey

One early or intermediate *S. festinus* nymphal stage was provided along with second instar (1-week old) *H. zea* and/or *P. includens* larvae as alternative prey choices.

Source of predators and *S. festinus* was as previously described. These alternative prey were chosen because these lepidopteran larvae are commonly found on soybean plants when *S. festinus* nymphs are present.

The study was conducted in an environmental chamber under conditions previously described. *Geocoris punctipes* was exposed to second *S. festinus* nymphal stage, and *N. roseipennis* was exposed to third nymphal stage. Treatments included one starved, 1-3 week old female *G. punctipes* or *N. roseipennis* adult exposed for 24h to each of the following four prey combinations: 1) one *S. festinus* second or third instar, 2) one each *S. festinus* (N2 or N3) + *P. includens,* 3) one each *S. festinus* (N2 or N3) + *H. zea*, and 4) one each *S. festinus* (N2 or N3) + *P. includens* + *H. zea*. Prey (all combinations) with no predator were included as controls. All treatments were arranged in a completely randomized design with six replications. The two predator species with their respective prey combinations were conducted as two separate experiments. Prey mortality was recorded after 24h. Percent mortality data were analyzed by a 2-sample binomial test for equal proportions (Ott 1984).

Results and Discussion

Feeding Responses at Different Prey Densities

Spissistilus festinus nymphal density (P = 0.09), *P. includens* larval density (P = 0.72), and their interaction (P = 0.48) did not significantly affect the percent *S. festinus* nymphal mortality due to *G. punctipes*. The data indicate that a near constant percent prey mortality occurred regardless of the prey density (Table 1). Nonsignificance may be due to the relatively large variability in feeding among the individual predators.

Spissistilus festinus nymphal density and *P. includens* larval density interaction had a significant effect (P = 0.02) on percent *S. festinus* mortality when *N. roseipennis* was the predator (Table 2). Analysis of percent *P. includens* mortality due to *N. roseipennis* also indicated a significant interaction (P = 0.04). The percent *S. festinus*

Table 1. Mean percent mortality* of *Spissistilus festinus* nymphs and *Pseudoplusia includens* (P.I.) larvae when exposed simultaneously to adult female *Geocoris punctipes* for 24h.

Prey	P.I. Density	*S. festinus* Density 3	6	9	**Mean**
*S. festinus***	0	50.0	50.0	50.0	50.0
	2	75.0	29.2	33.3	45.8
	4	58.3	33.3	25.0	38.9
	Mean	61.1	37.5	36.1	44.9
*P. includens***	2	0.0	12.5	12.5	8.3
	4	25.0	12.5	6.6	14.6
	Mean	12.5	12.5	9.4	11.5

*Average of four replications. Analysis of variance was made using arcsin√y transformed data.

***Spissistilus festinus* density, *P. includens* density, and their interaction were not significant (P = 0.05, F-test).

mortality due to *N. roseipennis*, when the predator did not have *P. includens* as an alternative prey, did not differ significantly at the various *S. festinus* density levels (Table 2).

Percent mortality of *S. festinus* nymphs due to *N. roseipennis* was not significantly increased in the presence of *P. includens* larvae, but the percent *S. festinus* mortality was significantly decreased with this predator only at the six *S. festinus* and four *P. includens* density combinations (Table 2). The number of *P. includens* larvae killed due to *N. roseipennis* at the various *S. festinus* and *P. includens* density combinations ranged from 1.5 to 3.0. These values are higher than those obtained with *G. punctipes* which ranged from 0-1.

Nabis roseipennis and *G. punctipes* did not exhibit a preference for *P. includens* or *S. festinus*. *Nabis roseipennis* fed on approximately the same number of total prey when they consisted of both *S. festinus* nymphs and *P. includens* larvae. Murdoch (1969), and Murdoch and Marks (1973) indicated that generalist predators tend to concentrate their attack on the most abundant prey species, if it is an acceptable prey. Increased feeding by either predator on either prey species was not exhibited at the high prey densities although more frequent encounters between predators and prey would be expected at high prey densities. This suggests that *N. roseipennis* and *G. punctipes* do not have a strong preference for either of these prey and that they can feed on both prey when they are present simultaneously.

These results obtained indicate that *S. festinus* is a potential prey of adult *G. punctipes* and *N. roseipennis,* and that predator feeding responses were not generally affected by the presence of one-week old *P. includens* larvae at the prey density levels evaluated.

Feeding Responses with *P. includens* and *H. zea* as Alternative Prey

Mortality in control treatments (prey without predators) was extremely low (< 5%), so that correction was not necessary. The percent mortality of *S. festinus* nymphs due to adult *G. punctipes* did not differ significantly (P = 0.05, binomial test) in the

TABLE 2. MEAN PERCENT MORTALITY OF *SPISSISTILUS FESTINUS* NYMPHS AND *PSEUDOPLUSIA INCLUDENS* (P.I.) LARVAE WHEN EXPOSED SIMULTANEOUSLY TO ADULT FEMALE *NABIS ROSEIPENNIS* FOR 24H.

Prey	P.I. Density	*S. festinus* Density 3	6	9	**Mean**
*S. festinus***	0	33.3 abc	41.7 ab	47.2 ab	40.7
	2	16.7 bc	45.8 ab	25.0 abc	29.2
	4	58.3 a	8.3 c	22.2 abc	29.6
	Mean	36.1	31.9	31.5	33.2
*P. includens***	2	75.0 ab	75.0 ab	100.0 a	83.8
	4	75.0 ab	62.5 bc	37.5 c	58.3
	Mean	75.0	68.7	68.7	70.8

*Average of four replications. Analysis of variance was made using arcsin√y transformed data.

**Values within prey species followed by the same letter do not differ at the 0.05 probability level using LSD test.

TABLE 3. MEAN PERCENT MORTALITY* OF *SPISSISTILUS FESTINUS* (S.F.), *PSEUDOPLUSIA INCLUDENS* (P.I.), AND *HELICOVERPA ZEA* (H.Z.) EXPOSED TO *GEOCORIS PUNCTIPES* FOR 24H.

		Treatment						
		S.F. + P.I.		S.F. + H.Z.		S.F. + P.I. + H.Z.		
Prey	S.F.	S.F.	P.I.	S.F.	H.Z.	S.F.	P.I.	H.Z.
S. festinus	67a**	33a		67a		83a		
P. includens			67a				50a	
H. zea					0b			0b

*Average of six replications.
**Values followed by the same letter do not differ at the 0.05 probability level using 2-sample binomial test for equal proportions.

presence of *P. includens* and/or *H. zea* larvae as alternative prey (Table 3). *Spissistilus festinus* mortality ranged from 33 to 83%.

Comparison of the percent mortality of the two alternative prey species shows that the *P. includens* mortality was significantly higher (P = 0.05, binomial test) than that of *H. zea* (Table 3). *Geocoris punctipes* did not feed on *H. zea* larvae. A possible explanation for this lack of feeding may be related to the defense of *H. zea* larvae when attacked. When disturbed by a predator, *H. zea* swung its anterior or posterior end or made quick lateral body movements to repel the predator. Observations made by Crocker and Whitcomb (1980) on hunting behavior of *Geocoris spp.* under natural conditions indicated that when prey are abundant, this predator tends to abandon prey that resist capture.

Spissistilus festinus nymphal mortality by *N. roseipennis* was not significantly affected (P = 0.05, binomial test) by the presence of *P. includens* and/or *H. zea* larvae (Table 4). *Nabis roseipennis* showed a more generalist feeding response than *G. punctipes*, consuming individuals of all three kinds of prey available. *Nabis roseipennis*

TABLE 4. MEAN PERCENT MORTALITY* OF *SPISSISTILUS FESTINUS* (S.F.), *PSEUDOPLUSIA INCLUDENS* (P.I.), AND *HELICOVERPA ZEA* (H.Z.) EXPOSED TO *NABIS ROSEIPENNIS* FOR 24H.

		Treatment						
		S.F. + P.I.		S.F. + H.Z.		S.F. + P.I. + H.Z.		
Prey	S.F.	S.F.	P.I.	S.F.	H.Z.	S.F.	P.I.	H.Z.
S. festinus	67ab**	50b		100a		33b		
P. includens			100a				33b	
H. zea					67ab			83ab

*Average of six replications.
**Values followed by the same letter do not differ at the 0.05 probability level using a 2-sample binomial test for equal proportions.

was able to overcome (9 out of 12 events) the *H. zea* defensive responses probably because of its larger size and its aggressive use of the front legs to grasp prey.

Geocoris punctipes and *N. roseipennis* caused mortality of *S. festinus* nymphs of 33 to 83%, and 33 to 100%, respectively, even in the presence of the caterpillars as a food choice (Tables 3-4). Results indicate that predators such as *G. punctipes* and *N. roseipennis* contribute to the reduction of *S. festinus* even in the presence of lepidopterous larvae. Further biological studies on predator-prey interactions under field conditions will provide basic information to develop predictive models on population dynamics of crop pests and their natural enemies that can be used in pest management programs.

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