Phenology and Abundance of *Nabis americoferus*, *N. roseipennis*, and *N. rufusculus* (Hemiptera: Nabidae) and Their Parasitoids in Alfalfa and Soybean

S. K. BRAMAN[1] AND K. V. YEARGAN

Department of Entomology, University of Kentucky, Lexington, Kentucky 40546

J. Econ. Entomol. 83(3): 823–830 (1990)

ABSTRACT The seasonal abundance and phenology of three *Nabis* species and their parasitoids were studied in alfalfa (*Medicago sativa* L.) and soybean (*Glycine max* (L.) Merrill). Although all three species were present in both crops, differences were noted in composition of the *Nabis* complex between the two systems. *Nabis americoferus* (Carayon) was numerically dominant in alfalfa, a crop in which this species produced three generations per year in central Kentucky. In soybean, where one generation is produced, *N. roseipennis* Reuter rather than *N. americoferus* or *N. rufusculus* Reuter produced the greatest number of nymphs for the three consecutive years of study. Sweep sampling recovered fewer nymphal nabids in comparison with suction or shake sampling and, thus, was less satisfactory in assessing population trends. Parasitoids reared from nabids that had been collected as adults or nymphs in alfalfa or soybean included the tachinid *Leucostoma simplex* (Fallén) and the braconid *Wesmaelia pendula* Foerster. Parasitism by the mymarid egg parasitoid *Polynema boreum* Girault was much higher in alfalfa than in soybean (50% versus 5%).

KEY WORDS Insecta, *Nabis* spp., predators, seasonal occurrence

PREDACEOUS HEMIPTERANS, including the damsel bugs (Nabidae), generally constitute the majority of insect predators in soybean fields (Irwin & Shepard [1980] and the references therein). Several nabid species are commonly encountered in field crops throughout North America. *Nabis americoferus* (Carayon) is reported to be prevalent throughout southern Canada and the northern half of the United States from coast to coast (Harris 1928). *Nabis alternatus* Parshley, however, is distributed primarily over the western United States, east to the Mississippi River. *Nabis roseipennis* Reuter occurs "everywhere east of the Mississippi River and in the Northwest to British Columbia, Alberta, and Colorado" (Slater & Baranowski 1978). Harris (1928) reported that *Nabis kalmii* Reuter was more southern in distribution than *Nabis rufusculus* Reuter, yet differed only very slightly from *N. rufusculus* in external morphological characters. Mitri (1960) found the structure of the female genitalia of these two species to be extremely similar and supported the suggestion of Harris (1928) that the two species were synonymous. *Nabis capsiformis* (Germar) has a southerly distribution extending westward to Texas and southward into South America (Harris 1928). Two species which are also commonly recorded from the southern states are *Hoplistoscelis deceptivus* (Harris) and *Hoplistoscelis sordidus* (Reuter) (Hormchan et al. 1976, Elvin & Sloderbeck 1984).

Because determination of nabid species is somewhat difficult, estimates of seasonal population trends often have been reported at the generic level. Reports regarding the number of generations per year for particular *Nabis* species are scarce, and most of them are based on studies in perennial plant ecosystems (e.g., Stoner et al. 1975, Wheeler 1977, Guppy 1986). Studies of predator abundance in annual crops necessarily concentrate on population events that occur within the growing season for that crop. To gain a clear understanding of predator phenology for incorporation into pest management strategies, it is useful to examine seasonal occurrence not only in the crop of interest but also in adjacent or surrounding vegetation. We report here the seasonal abundance and phenology for *N. americoferus*, *N. roseipennis*, and *N. rufusculus*, the three most numerous *Nabis* species in soybean (*Glycine max* (L.) Merrill) in central Kentucky. To elucidate events occurring outside the annual soybean growing season, we also sampled alfalfa (*Medicago sativa* L.), a perennial crop. In addition, we compared sweep sampling for nabids to suction sampling in alfalfa, and shake sampling in soybean. Occurrence of parasitoids of the various stages of different *Nabis* species also was examined.

Materials and Methods

Sampling for *Nabis* Species in Alfalfa. *Nabis* populations in an established stand of alfalfa (cv. Buffalo) were sampled on a weekly basis using a

[1] Current address: University of Georgia, Georgia Station, Griffin, Ga. 30223-1797.

0022-0493/90/0823–0830$02.00/0

suction sampler (D-vac Company, Ventura, Calif.) for 3 yr. A collecting head (0.09 m^2, 34.3 cm diameter) modified with an encircling flange was used to prevent the arthropods from escaping (Yeargan & Cothran 1972). After the first 2 yr of study, the original sampling site was plowed and reseeded. Therefore, the sample area was moved approximately 100 m to another site within the same 3-ha alfalfa field; that part of the field had been reseeded 2 yr previously. No insecticides were applied during the study. Plots were located in Fayette County, Ky.

During 1983 and 1984 each sample consisted of 20 suctions (0.09 m^2) of 10 s duration each. Samples were collected along two parallel transects in each of four blocks (15.2 by 15.2 m) resulting in eight samples for each sampling date. Sampling was similar in 1985, except that each sample was increased to 40 suctions (0.09 m^2). The sampling device consisted of a cone (34.3 cm [13.5 in] diameter) designed to collect 0.09 m^2 (1 ft^2) plant samples on the ground surface. Individual suctions may in fact overestimate populations on a per area basis by sucking in insects from surrounding areas while the collecting head is being lowered (Pruess et al. 1977). Time required to place the head in position is fairly constant, and an effective radius of the D-vac collecting head may be calculated if desired (Pruess et al. 1977). Here we use the conventional designation and describe sample unit size based on the size of the collecting cone opening. Additionally, during all 3 yr, 25 sweeps, using a 15-cm-diameter sweep net, were collected on each sampling date along the diagonal in each of the same four blocks used for suction sampling. During 1983, insects collected in D-vac samples were processed in Berlese funnels for 48 h, and the specimens were stored in 70% ethanol. Nabids sorted from sweep and D-vac samples were then identified in the laboratory. D-vac samples taken during 1984 and 1985, however, were hand sorted, and the nabids were identified.

Sampling for *Nabis* Species in Soybean. Sampling was conducted in a 1-ha field (cv. Williams in 1983 and cv. Williams 82 in 1984 and 1985). During 1983 and 1984, the soybean sampling site was adjacent to the alfalfa field being sampled. In 1985, the soybean sampling site was separated from the alfalfa sampling site by another 3.2-ha alfalfa field. A herbicidal mixture of alachlor–linuron was applied at planting according to label directions, but no insecticides were applied.

Four blocks, each 15.2 by 15.2 m, were sampled once per week by means of a shakecloth (two 2-row-meter shake samples per block) and a standard beating net (25 sweeps per block). Shake samples were taken by carefully placing the plastic cloth (1 m long) on the ground between two rows and vigorously shaking the foliage of those two rows over the cloth. The cloth was then lifted and rolled, and the contents were transferred to plastic bags and returned to the laboratory. One row in each block was swept with 25 passes of a 15-cm-diameter standard beating net, and the contents of the net were returned to the laboratory.

To determine whether nabids collected in research plots near Lexington (central Kentucky, Fayette County) were representative of the nabid fauna in other soybean-growing regions in Kentucky, a brief survey of the nabid fauna in soybean was conducted in other parts of Kentucky during the first 2 wk of August 1986. Thirty 2-row-meter shake samples were collected in each of three fields per county in each of three counties (western and southwestern Kentucky, Meade, Caldwell, and Todd Counties).

Sampling for Parasitoids of *Nabis* Species in Alfalfa. Nabids from D-vac samples taken during 1984 and 1985 were kept alive in the laboratory individually to await parasitoid emergence.

Activity of egg parasitoids was monitored during the 1985 growing season. Parasitism of eggs was not sampled directly because the volume of plant material necessary to obtain sufficient sample sizes (of eggs) proved to be prohibitive. Instead, females of each nabid species were collected in the field at intervals corresponding to peak occurrence of the adult stage. These nabids were then caged by species on alfalfa in the field in ventilated, cast acrylic cylinders 61 cm tall by 15.2 cm diameter as described by Simmons et al. (1984) to provide eggs at known locations. Twenty-four cages spaced approximately 4.5 m apart were used for each trial.

Caged nabids were allowed to oviposit in alfalfa stems for 24 h, cages were then removed, and eggs within plant material were left exposed in the field until thermal unit accumulations predicted nymphal emergence should have occurred (Braman et al. 1984, Braman & Yeargan 1988). Stems then were harvested and returned to the laboratory. Parasitoid development within the host egg is extended compared with the development of the nabid egg itself (Hendrick & Stern 1970). Leaving stems in the field until eggs had hatched maximized length of time that eggs were exposed to parasitoids. Stems were examined under the microscope, and those stems containing eggs were washed with 5% hypochlorite solution to prevent fungal growth. Stems were then inserted into vials of water to prevent desiccation and enclosed in 0.95-liter cardboard cartons held at room temperature to await parasitoid emergence. Following parasitoid emergence, eggs from which nothing had emerged were dissected to determine their contents.

Parasitism of the egg stage of *N. americoferus* was monitored three times during the 1985 season. Periods of exposure of eggs in the field were 29 April–15 May, 17–24 June, and 5–12 August. Female nabids were collected and caged at intervals corresponding to times when adult nabids from the overwintering generation and the subsequent two generations were abundant in the field. *N. americoferus* also was caged during the period 18–25 September but failed to oviposit, probably because

adult females at that time had entered a reproductive diapause. *N. roseipennis* produced eggs in the field during 29 April–15 May and 9–16 July but failed to lay eggs in the field during 18–25 September. *Nabis rufusculus* laid eggs on 29 April–15 May, but females of this species caged 12–19 July produced only three eggs, one of which was subsequently parasitized. Weather conditions during this period were normal and so cannot account for the failure of the nabids to oviposit. This species also failed to lay eggs in the field during the September exposure period.

Sampling for Parasitoids of *Nabis* Species in Soybean. Nabid nymphs and adults collected in shake samples during 1984 and 1985 were kept alive and held individually as previously described for parasitoid emergence. To monitor egg parasitism, females of all three nabid species were caged in soybean in cast acrylic cylinders as previously described and were allowed to oviposit for 24 h. Cages were then removed and plants were marked. When degree-day accumulations indicated that nymphs were likely to have emerged (5–12 August 1985), plants were taken to the laboratory and examined for eggs. Parasitoids were reared by the same methods used for the alfalfa samples. Voucher specimens of nabids and their parasitoids have been placed in the museum in the Entomology Department of the University of Kentucky, Lexington.

Results and Discussion

Sampling for *Nabis* Species in Alfalfa. The three *Nabis* species most commonly collected were *N. americoferus*, *N. roseipennis*, and *N. rufusculus*. During all three years of sampling, *N. americoferus* was the most abundant nabid in the perennial alfalfa habitat (Fig. 1). Studies of developmental and reproductive biologies of the three *Nabis* species indicated that *N. americoferus*, with its more rapid developmental rate and high daily oviposition rate, should have the greatest potential for population increase (Braman & Yeargan 1988). In alfalfa in central Kentucky, that potential is apparently realized. *N. roseipennis* and *N. rufusculus* were present in alfalfa all 3 yr but never in numbers equaling those of *N. americoferus*.

Adult *N. roseipennis* and *N. rufusculus* and nymphs of all species were poorly represented in sweep samples, whereas sweep collection of adult *N. americoferus* more closely followed trends revealed by suction samples (Fig. 1). Regression analysis to determine degree of fidelity of sweep samples to suction samples indicated that values obtained by the sweep sampling method were good predictors of values obtained by suction sampling only for *N. americoferus* and *N. roseipennis* adults (significant regression $P < 0.05$, adjusted $R^2 \geq 0.49$ for 2 of 3 yr of the study). Sweep samples of nymphal nabids accurately reflected trends revealed in suction samples in only one case (*N. roseipennis*, 1984, $P < 0.05$, adjusted $R^2 = 0.64$). The better representation of *N. americoferus* adults in sweep samples may in part be caused by their greater numbers but also may indicate their tendency to occur higher on the plant than the other two species (and thus be more easily captured by the net). Harris (1928) described *N. americoferus*, a pale cream–gray-colored nabid, as a "sun loving" meadow species, whereas the darker, brown *N. roseipennis* and *N. rufusculus* were described as preferring marshy or more humid habitats. These preferences or requirements may influence their intraplant distribution in alfalfa. In separate studies, Braman & Yeargan (1989) found that nabid species distribute themselves differently within the soybean habitat and that *N. americoferus* adults are higher in the plant canopy than adults of the other two species.

Nabids that were collected from the field during the first week in March and then immediately caged in alfalfa in the field oviposited within a week (K.V.Y., unpublished data). This fact suggests that overwintering nabids have completed their postdiapause development and are producing their first generation as early as the first of March in central Kentucky. Development of the final generation of all three species usually is completed in September and always by early October.

Our data suggest that *N. americoferus* produced three generations in alfalfa (Fig. 1). Age structure of nymphs collected during sampling supported this conclusion. For example, although nymphs collected on 20 June 1985 were primarily first instars, those collected during July of that year were progressively older instars. In this way, the maturation of each generation was observed. Number of generations per year and relative abundances are likely to vary for a given multivoltine species depending upon geographic location. Thus, although *N. americoferus* develops through five generations in Arizona (Stoner et al. 1975) and two generations in eastern Ontario (Guppy 1986), three generations are produced in Kentucky. The number of generations produced in alfalfa by the other two nabid species is less clear from field samples because fewer individuals were collected.

The observation that three generations are produced by *N. americoferus* is in agreement with predictions based on developmental data (Braman et al. 1984). Using weather data collected from the research area, we examined degree-day accumulations for 1983, 1984, and 1985 above the calculated threshold for total development for *N. americoferus* (Braman et al. 1984), the best-represented nabid in suction samples. Despite the limitations of the use of developmental rate data to predict phenology, occurrence of *N. americoferus* in the field was, nonetheless, closely predicted. For example, during 1984, peak occurrence of the adult stage of *N. americoferus* was observed on 20 June, 1 August, and 12 September (Fig. 1). Using the calculated thermal unit requirements for this

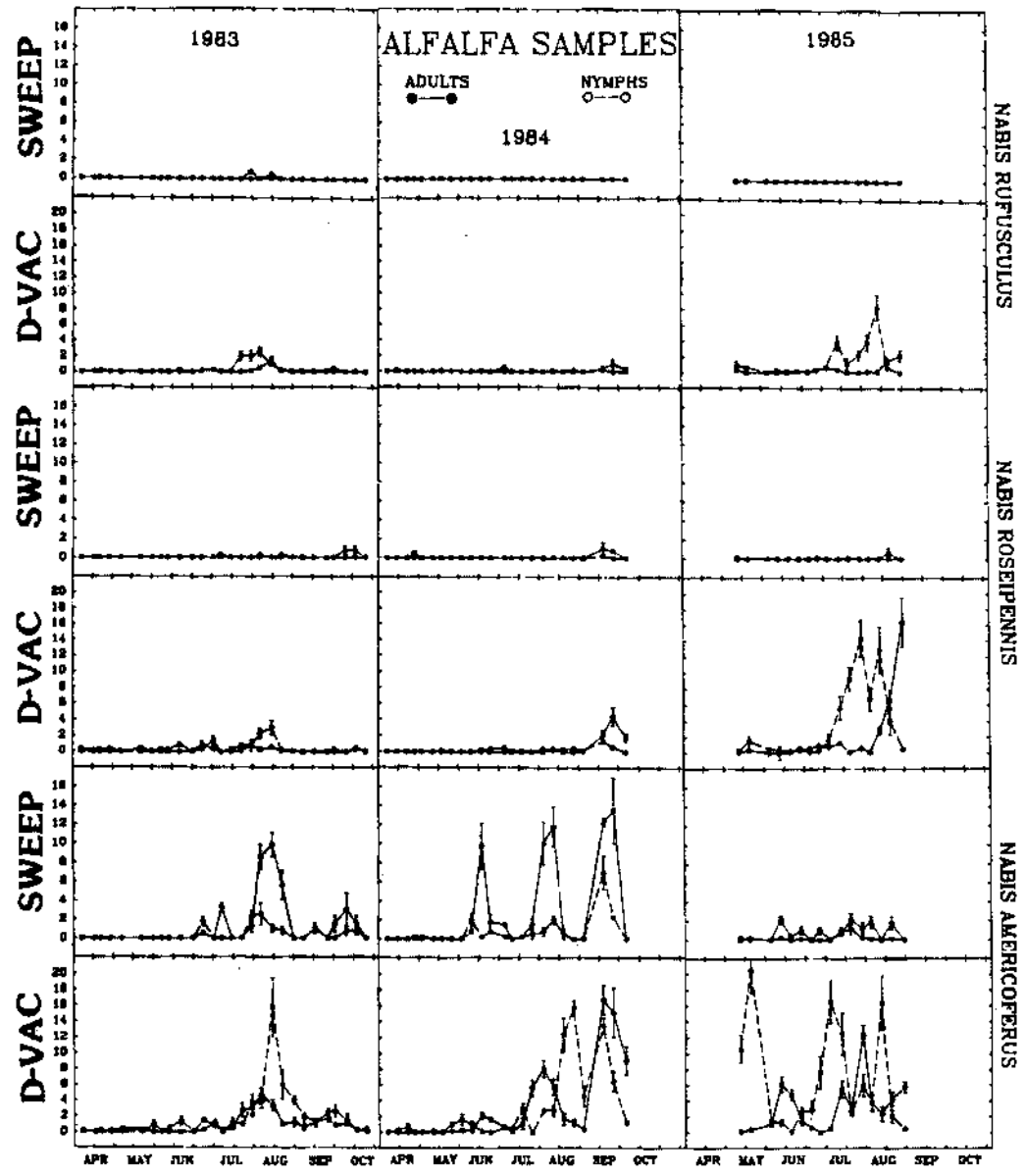

Fig. 1. Number of *Nabis* spp. adults and nymphs ($\bar{x} \pm$ SE) sampled in alfalfa. Sample size during 1983 and 1984 consisted of mean number per 20, 0.09-m² suctions or 25 sweeps; during 1985, sample size increased to mean number per 40, 0.09-m² suctions.

species, including a preovipositional period, and calculated degree-day accumulations, we compared predicted peak occurrence to observed peak occurrence. When the first peak (20 June) served as a starting point, thermal unit requirements predicted subsequent peaks on 2 August and 13 September. These represent 1-d departures from observed peak occurrence.

Sampling for *Nabis* Species in Soybean. In soybean as indicated by shake samples, *N. roseipennis* consistently produced the greatest number of nymphs during all 3 yr of study (Fig. 2). Thus, in central Kentucky, soybean *N. roseipennis* appears to have greater reproductive success than *N. americoferus*, the most abundant species in alfalfa. Adult *N. americoferus* were consistently observed and collected in soybean, yet nymphal populations of that species failed to reach the correspondingly high numbers that would be expected, based on our observations in alfalfa. Isenhour & Yeargan (1982) found that eggs of *N. americoferus* were relatively rare in soybean throughout the season

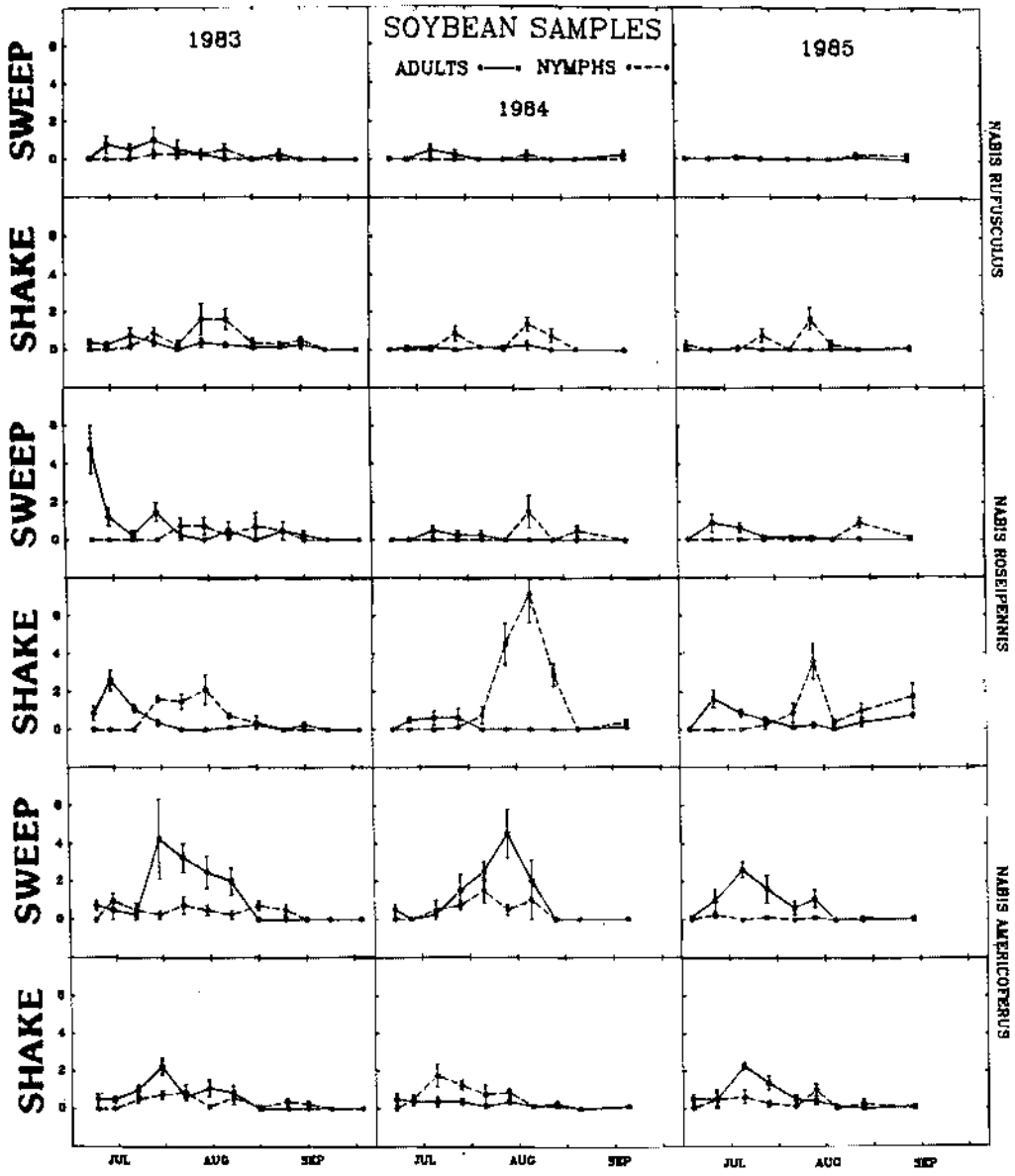

Fig. 2. Number of *Nabis* spp. adults and nymphs ($\bar{x} \pm$ SE) sampled in soybean. Sample size consisted of mean number per 2-row-meter shakes or 25 sweeps.

compared with those of *N. roseipennis*, indicating that *N. americoferus* rarely oviposited in soybean, even though the adults often are present in large numbers.

Nabis roseipennis and *N. rufusculus* each produced one generation per year in soybean. Adults colonized soybean during July, and nymphs matured by late August or early September. Colonizers likely were second-generation adults that immigrated from surrounding perennial habitats. Adults that matured later in soybean dispersed into surrounding overwintering habitats when soybeans senesced in the fall.

Sweep sampling recorded occurrence of adult nabids in soybean but recovered fewer nymphs compared with shake samples (Fig. 2). Comparison (regression analysis) of values obtained by the two sampling methods revealed high fidelity between sweeps and shakes for *N. americoferus* and *N. rosetpennis* adults ($P < 0.05$, adjusted $R^2 \geq 0.49$ for 2 of 3 yr of study). Sweep samples were good predictors of shake sample catches of nymphs in two cases (*N. roseipennis* and *N. rufusculus;* 1984, $P < 0.05$ adjusted $R^2 \geq 0.46$). Seasonal trends for *N. americoferus* adults as reflected in sweep samples, however, were similar to trends revealed in shake

samples. This probably reflects their location higher on the plant (Braman & Yeargan 1989), which makes adults of this species susceptible to capture by the sweep net. Nymphs of all three species, especially early instars, were uncommon in sweep samples. This was apparently because of their location further down on the plant (Braman & Yeargan 1989). Funderburk & Mack (1989) reported that adult and nymphal patterns differ in soybean also in relation to degree of aggregation; nymphs of *Nabis* spp. were aggregated in nearly all situations, whereas adult distribution was only slightly aggregated or random.

Species composition, expressed below as a percentage of the total mean capture averaged over three fields sampled per county in Meade, Caldwell, and Todd Counties, was similar to that in Fayette County. *N. roseipennis* was more abundant than *N. rufusculus* or *N. americoferus*. In addition, a few *N. capsiformis* (11 total individuals) were collected in Todd and Caldwell Counties, which are in southwestern Kentucky. Because *N. capsiformis* has a southerly distribution in the United States, it was not surprising to collect this species in those counties. We have occasionally collected *N. capsiformis* in alfalfa in Fayette County, but it is rare there. Mean total number of nabids collected per 30, 2-row-meter shake samples in Meade, Caldwell, and Todd Counties were, respectively, 66.2, 31.1, and 25.8. Species composition in Meade, Caldwell, and Todd Counties was, respectively, 29.6, 9.7, and 10.5% *N. americoferus;* 44.3, 50.2, and 69.0% *N. roseipennis;* 26.2, 30.6, and 18.3% *N. rufusculus;* and 0, 9.6, and 0.6% *N. capsiformis*.

As mentioned previously, reports of number of generations or seasonal abundance of particular nabid species are scarce. Nabids as a group peaked in abundance in mid-July in soybean in the Mississippi Delta area (Pitre et al. 1978). Early-season populations consisted primarily of *N. roseipennis*, although there was a large increase in numbers of *N. capsiformis* in that area later in the season (Hormchan et al. 1976, Pitre et al. 1978). Shepard et al. (1974) reported two peaks in abundance of nymphal populations of *Nabis* species in soybean and suggested that this indicated two generations per season in that crop in South Carolina. Bechinski & Pedigo (1981) did not consider reference to number of generations in soybean to be meaningful because the multispecies *Nabis* complex had not been separated by species in their study. They did report, however, that *Nabis* species populations increased through soybean flower bloom and pod development, with populations being particularly abundant during pod fill, as was the case in the present study.

Parasitoids of *Nabis* Species in Alfalfa and Soybean. Parasitoids recovered from *N. americoferus* collected as nymphs or adults in alfalfa D-vac samples during 1984 were *Leucostoma simplex* (Fallén) (Diptera: Tachinidae) and *Wesmaelia pendula* Foerster (Hymenoptera: Braconidae). These parasitoids attack late-instar nymphs and adults, with *W. pendula* emerging primarily from males and *L. simplex* attacking either sex (Hendrick & Stern 1970). *L. simplex* was by far the more abundant of these two parasitoids (51 *L. simplex* versus only one *W. pendula* reared during 1984). Nevertheless, *L. simplex* rarely was responsible for a high percentage mortality on any sampling date during the season. *L. simplex* was reared from nabids collected on 10 of 20 total dates during 1984. However, when a mean of at least 2 nabids/20-ft² area were collected, parasitism by *L. simplex* never exceeded 13%. The majority of *L. simplex* emerged from nabids that had been collected as adults (41 of 51). Because *L. simplex,* which emerges from the adult nabid, usually attacks fourth and fifth instar and adult nabids in the field (Hendrick & Stern 1970), adults having had the longer exposure period should be more heavily parasitized than nymphs. Far fewer parasitoids were recovered from *N. americoferus* collected during 1985 (four *L. simplex* and seven *W. pendula*). Two of the *W. pendula* emerged from female *N. americoferus*, although this parasitoid has been reported to attack primarily male nabids (Stoner 1973, Stoner et al. 1975).

Benedict & Cothran (1978) recorded *L. simplex* as attacking a maximum of 12% of *N. americoferus* adults collected during the season in alfalfa in California, but they did not recover *W. pendula* in any samples. In Arizona, two tachinid parasitoids, *L. simplex* and *Hyalomya aldrichii* Townsend, conferred a combined mortality ranging from 0 to 48%. *Wesmaelia pendula* was at least as common as the dipteran parasitoids near Tucson but was not encountered at all in the Mesa area, perhaps because of differences in altitude or climate (Stoner 1973).

No *N. rufusculus* were parasitized in alfalfa during 1984. Two *W. pendula* emerged, one each from a male and female nabid of that species collected in alfalfa the following year. Seven and four *L. simplex* were reared from *N. roseipennis* in 1984 and 1985, respectively.

Fewer nymphal and adult nabids were parasitized in soybean than in alfalfa. The few parasitoids that emerged from nabids collected in soybean were as follows: in 1984, one *L. simplex* and one *W. pendula* from *N. americoferus* males, and one *L. simplex* from *N. rufusculus;* in 1985, four *W. pendula* (from males) and three *L. simplex* from female *N. americoferus,* and one *W. pendula* from a male *N. roseipennis*. No parasitoids were collected from *N. roseipennis* in 1984 or from *N. rufusculus* in 1985.

Eggs of all three species of nabid were parasitized by the mymarid *Polynema boreum* Girault in alfalfa. During the first exposure period (29 April to 15 May) when all three species had oviposited in the field at the same time, percentage parasitism was roughly equal (approximately 50%) for all three

Table 1. Location of *Nabis* species eggs and parasitism by *P. boreum* in alfalfa

Species	No. eggs	$\bar{x}$ No. eggs/ cluster	Location of eggs[a]			% Parasitism
			Main stem	Lateral stem	Leaflet	
N. americoferus	109	2.9	96%	4%	0	48.6
N. roseipennis	158	3.4	97%	3%	0	53.8
N. rufusculus	39	1.9	46%	10%	44%	49.4

[a] χ^2 114.4, df 4, $P < 0.001$, location of eggs among species.

species (Table 1) despite species differences (χ^2 114.4, df = 4, $P < 0.001$) in egg location. *N. americoferus* and *N. roseipennis* deposited the majority of their eggs in the main stem, whereas *N. rufusculus* placed approximately equal numbers in the main stem and leaflet petiolules. Parasitism levels of the second and third generation of *N. americoferus* eggs were 35.6% (n = 191 eggs) and 32.1% (n = 109 eggs), respectively. Percentage parasitism of the *N. roseipennis* eggs exposed during 9–16 July (n = 186 eggs) was 57.5%.

On the basis of data reported, here it appears that *P. boreum* may have a significant effect on populations of all three *Nabis* species by parasitizing their eggs. Benedict & Cothran (1978) reported an increase in percentage parasitism by this species as the season progressed, peaking at 70% in late September in California alfalfa. Graham & Jackson (1982) reported 35% parasitism of *Nabis* species eggs by *P. boreum* in Arizona. Lakin et al. (1984) determined that field parasitism of *N. alternatus* and *N. americoferus* eggs by *P. boreum* in lucerne tended to follow host population fluctuation. Peak parasitism in alfalfa grown for seed exceeded that in alfalfa grown for hay. Percentage parasitism in our study remained fairly constant throughout the season.

Parasitism by *P. boreum* in soybean was much lower than that recorded in alfalfa (Table 2). Soybean is an annual habitat supporting not more than one generation of each of the three *Nabis* species. The opportunity for populations of *P. boreum* to become established in soybean is perhaps not as great in this annual crop as it is in the perennial habitat, which supports several generations of all three nabid species. Greater parasitism in alfalfa also may be related to the structure of the alfalfa plant or ground cover that favors the parasitoid.

Nabis americoferus, when caged on soybean plants in the field, oviposited in fairly high numbers (149 total eggs on 24 plants) which may have been atypical behavior based on a previous report by Isenhour & Yeargan (1982). Their season-long study, which dealt with the number and location of naturally oviposited nabid eggs in soybean, revealed that very few *N. americoferus* eggs were present (42 versus 257 *N. roseipennis* eggs in approximately 180 randomly selected plants). Caging nabids on soybean may therefore have resulted in greater numbers of eggs being laid than would ordinarily occur under more natural conditions and may have resulted in an increased clumping in the egg distribution. However, 24 cages were used, and number of eggs per cage was usually fairly low. For example, in soybean, *N. americoferus* deposited 44 egg clusters which averaged 3.4 ± 0.7 eggs per cluster. Parasitism of nabids in alfalfa may influence the number of nabids dispersing to surrounding habitats. Once nabids colonize soybean, however, parasitism appears to be negligible and should not constitute a major mortality factor for nabids in that crop.

In summary, *N. americoferus* was the numerical dominant among three *Nabis* species in alfalfa and produced three generations per year in that perennial habitat. *N. roseipennis*, however, was the dominant species in soybean. Dispersing adults of the three species appear to enter soybean fields in similar numbers, although this may be affected by such factors as planting date of soybean fields in relation to nabid phenology in surrounding habitats and management practices (e.g., mowing) in those habitats. For unknown reasons, however, *N. roseipennis* and *N. rufusculus* reproduce more successfully than does *N. americoferus* in the soybean habitat.

Knowledge of nabid phenology, combined with refined quantitative estimates of predator effect on pest species, will allow greater flexibility in pest management decision making. To achieve this goal,

Table 2. Location of *Nabis* species eggs and parasitism by *P. boreum* in soybean

Species	No. eggs	$\bar{x}$ No. eggs/ cluster	Location of eggs[a]						% Parasitism
			Petiole	Median petiolule	Lateral petiolule	Stem	Leaf	Leaf vein	
N. americoferus	149	3.7	55%	29%	0.6%	2.7%	7.4%	4.7%	1.3
N. roseipennis	173	2.3	42%	53%	3%	2%	0	0	5.8
N. rufusculus	34	1.9	71%	15%	3%	0	0	11%	0

[a] χ^2 61.5, df 10, $P < 0.001$, location of eggs among species.

further research on the quantification of predator impact on pest populations is necessary (Braman & Yeargan 1989).

Acknowledgment

We gratefully acknowledge determinations of *Nabis* species made by T. J. Henry. Specimens of *L. simplex*, *W. pendula*, and *P. boreum* were identified by N. E. Woodley, P. M. Marsh, and M. E. Schauff, respectively. L. Blanton provided valuable technical assistance. K. F. Haynes, D. A. Potter, and two anonymous reviewers provided helpful comments on an earlier version of this manuscript. The investigation reported in this paper (No. 88-7-16) is in connection with a project of the Kentucky Agricultural Experiment Station and is published with the approval of the director.

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Received for publication 21 November 1988; accepted 18 August 1989.