The Great Lakes Entomologist

Volume 23
Number 2 - Summer 1990 *Number 2 - Summer 1990*

Article 6

June 1990

Seasonal Flight Patterns of Hemiptera (Excluding Miridae) in a Southern Illinois Black Walnut Plantation

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SEASONAL FLIGHT PATTERNS OF HEMIPTERA (EXCLUDING MIRIDAE) IN A SOUTHERN ILLINOIS BLACK WALNUT PLANTATION

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ABSTRACT

The seasonal flight patterns of 99 species and subspecies of Hemiptera collected in window traps in a southern Illinois black walnut plantation are compared with similar data from a North Carolina black walnut plantation. Flying height distributions and seasonal flight activities of *Corythucha juglandis, Orius insidiosus, Piesma cinerea, Acanthocephala terminalis, Alydus eurinus, Sehirus cinctus cinctus, Acrosternum hilare, Brochymena quadripustulata, Euschistus servus,* and *Euschistus variolarius* are considered in detail.

Previously, we presented information on seasonal flight patterns of Hemiptera in a black walnut (*Juglans nigra*) plantation near Asheville, North Carolina (NC) (McPherson and Weber 1980; 1981a, b, c, d, e; McPherson et al. 1983); these papers were based on weekly collections of specimens from window flight traps during 1977 and 1978. Similar data were collected during 1979 and 1980 in a black walnut plantation in southern Illinois (SI). We present here the SI data and compare them, where possible, with results from the NC plantation. We deal with all families collected except the Miridae, which we will consider in a second paper.

MATERIALS AND METHODS

The black walnut plantation, commonly known as the Pleasant Valley Plantation, is located in Alexander County, IL, 37°17′30″N and 89°20′30″W, ca. 153 m elevation on clay loam soil in the Shawnee National Forest. It is a 2.8 ha plot established by the U. S. Forest Service to test growth differences among walnut seedlings collected from various seed sources and to use later as a seed production orchard. Within this plantation are 2,700 trees planted at a 1.83 x 3.66 m spacing. Further information about these trees can be obtained from the U. S. Forest Service, North Central Forest Experiment Station, Forestry Sciences Laboratory, Carbondale, IL.

The window flight traps were described in detail by McPherson and Weber (1980). The main differences between the SI and NC studies were in number of traps used (16 in SI, 28 in NC) and their height above the ground (SI, set at 1 m intervals 1 to 4 m above the ground; NC, 1 to 7 m above the ground). Also, the average height and

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diameter of trees at breast height were 2.1 m and 1.9 cm, respectively, during the last year (1980) of the SI study; they were 2.84 m and 3.12 cm during the last year (1978) of the NC study. In the SI study, flying height and seasonal distributions were determined in 1979; only seasonal distribution was determined in 1980. Insects were removed weekly from 30 March to 13 October in 1979, and from 28 March to 10 October in 1980.

The difference in height of traps betwen the SI and NC plantations resulted from the primary emphasis of this study, which was to determine the flying height and seasonal distribution of the ambrosia beetle *Xylosandrus germanus* (Blandford). The SI traps were set at a maximum of 4 m because we found that most flight activity of this beetle in the NC plantation was at 1 m (Weber and McPherson 1983). Unfortunately, this makes comparison of flight activity of the Hemiptera between the two plantations more difficult.

All specimens collected during this study are deposited in the Southern Illinois University Entomology Collection (SIUEC).

RESULTS AND DISCUSSION

Species diversity was lower in SI than in NC and, with few exceptions, was evident at the family level. Ninety-nine species and subspecies, excluding Miridae, were collected during the two years of the SI study, compared to 126 for NC. These included (NC numbers in parentheses): Tingidae, 5 (11); Nabidae, 2 (6); Anthocoridae, 5 (6); Reduviidae, 12 (15); Phymatidae, 1 (3); Aradidae, 5 (6); Piesmatidae, 1 (1); Berytidae 2 (3); Lygaeidae, 21 (27); Largidae, 1 (0); Coreidae, 6 (8); Alydidae 3 (2); Rhopalidae, 4 (6); Cydnidae, 6 (6); Thyreocoridae, 5 (4); and Pentatomidae, 20 (22). Although scutellerids and acanthosomatids were collected in NC, none was collected in SI.

Several SI taxa were collected at all four heights; numbers of specimens ranged from 1 to 6,167. Flying heights for most taxa averaged lower in the SI than in the NC plantation; this undoubtedly resulted, at least in part, from the lack of traps at 5 to 7 m in the SI plantation but may also have been influenced by the shorter trees there.

CIMICOMORPHA
TINGIDAE

Only three species were collected in both the SI (Table 1) and NC (McPherson and Weber 1981e) plantations, i.e., *Corythucha ciliata* (Say), *C. juglandis* (Fitch), and *Melanorhopala infuscata* Parshley.

Corythucha ciliata feeds primarily on sycamore, *Platanus occidentalis* (Drake and Ruhoff 1965). It was rarer in SI (N = 13) than in NC (N = 70). In NC, it overwintered as adults and was apparently bivoltine (McPherson and Weber 1981e). Adults began to emerge from overwintering sites in early April and were present to mid-May. Their adult offspring (summer generation) occurred from late June to late July or early August. Adults of the second (overwintering) generation were present in September.

In SI, adults were first collected in early July, which roughly corresponds to the appearance of the summer generation in NC. The most plausible explanation for this difference, in our opinion, is that the overwintering adults simply were not collected in the traps.

Corythucha ciliata flew at an average height of 3.40 m (N = 10) in SI, and at an average height of 4.27 m in NC.

Corythucha juglandis feeds on several plants, including black walnut (Drake and Ruhoff 1965). It was more common in SI (N = 159) than in NC (N = 26), but the period of flight activity was similar (SI, 9 May-28 September, Table 1; NC, 1 April-

13 October, McPherson and Weber 1981e). It flew at an average height of 3.33 m (N = 60) in SI, and at an average height of 4.62 m in NC.

This species overwinters as adults and is apparently bivoltine in southern Illinois (Vogt and McPherson 1986). Adults generally emerge from overwintering sites in early May. Their adult offspring (summer generation) appear in late June. Adults of the second (overwintering) generation appear in early August and began to enter overwintering sites in September.

In the SI study, the May peak (Fig. 1) undoubtedly corresponded to the emergence of overwintered adults noted by Vogt and McPherson (1986). However, there were no distinct peaks later in the season although reduced flight activity was evident.

Melanorhopala infuscata was rare in both collections (one specimen). Its food plants include *Ceanothus* spp. and *Liriodendron* sp. (Drake and Ruhoff 1965), indicating that its collection in the two plantations was a chance occurrence.

The most striking difference in the tingid fauna between SI and NC involved *Gargaphia solani* Heidemann, which was the most common species collected in NC (N = 91) (McPherson and Weber 1981e) but was completely absent in SI. This tingid is primarily southern and southwestern in distribution (Bailey 1951). It occurs mainly on eggplant (e.g, Bailey 1951, Horn et al. 1979) but also on horse-nettle (Blatchley 1926), white horse-nettle (Froeschner 1944), and sunflower (Horn et al. 1979). Because it has been collected elsewhere in SI (based on specimens housed in the SIUEC), its absence from the SI window traps may simply reflect the lack of suitable host plants near the plantation.

NABIDAE

Two species were collected in both the SI (Table 1) and NC (McPherson and Weber 1981c) plantations, i.e., *Nabis americoferus* Carayon and *Nabis roseipennis* Reuter. *N. americoferus* feeds on aphids, leafhoppers, and caterpillars (Harris 1928); and N. *roseipennis* feeds on insects inhabiting grassy and herbaceous vegetation (Blatchley 1926). Although both species were more common in NC than in SI, the seasonal flight patterns were similar between the two plantations. *N. americoferus* was collected from 6 April to 3 October (N = 26) and flew at an average height of 2.75 m (N = 8) in SI, and from 31 March to 13 October at an average height of 2.48 m (N = 58) in NC. *N. roseipennis* was collected from 11 April to 12 October (N = 73) and flew at an average height of 2.58 m (N = 31) in SI, and from 1 April to 6 October at an average height of 3.07 m (N = 123) in NC.

In NC, both species apparently overwintered as adults and were bivoltine (McPherson and Weber 1981c). Overwintered adults began to emerge during late March and early April. Their adult offspring (summer generation) occurred from about June through August. Adults of the second (overwintering) generation were present during September and October.

In SI, flight activity for both species peaked in April–May and June. These corresponded to the emergence of overwintered adults and adults of the first (summer) generation, respectively. The third peak of activity noted in NC (i.e., the second or overwintering generation) was not evident in SI. For *N. americoferus* (N = 26), the numbers for the two peaks were 5 (19.2%) and 15 (57.7%), respectively; and for *N. roseipennis* (N = 73), the numbers were 13 (17.8%) and 43 (58.9%), respectively.

ANTHOCORIDAE

Three species were collected in both the SI (Table 1) and NC (McPherson and Weber 1981c) plantations, i.e., *Calliodis temnostethoides* (Reuter), *Lyctocoris stalii* (Reuter), and *Orius insidiosus* (Say). *O. insidiosus* was the most abundant of all

Table 1. Seasonal flight activity of Hemiptera (excluding Miridae) during 1979–80 in a southern Illinois black walnut plantation.

Taxon	No. Collected[a]	Collection Height (M)[b] $\bar{X} \pm$ SE	Range	Range of Collection Dates
CIMICOMORPHA				
TINGIDAE				
Corythucha aesculi Osborn & Drake	1 (0, 1)	---	---	19 May
Corythucha ciliata (Say)	13 (10, 3)	3.40 ± 0.27	2–4	6 July–12 Oct.
Corythucha juglandis (Fitch)	159 (60, 99)	3.33 ± 0.11	2–4	9 May–28 Sept.
Leptodictya plana Heidemann	1 (1, 0)	1.00	---	28 Sept.
Melanorhopala infuscata Parshley	1 (1, 0)	1.00	---	13 July
NABIDAE				
Nabis americoferus Carayon	26 (8, 18)	2.75 ± 0.45	1–4	6 April–3 Oct.
Nabis roseipennis Reuter	73 (31, 42)	2.58 ± 0.22	1–4	11 April–12 Oct.
ANTHOCORIDAE				
Calliodis temnostethoides (Reuter)	14 (12, 2)	3.08 ± 0.26	2–4	20 June–28 Sept.
Lyctocoris stalii (Reuter)	5 (2, 3)	1.58 ± 0.50	1–2	25 April–29 Aug.
Orius insidiosus (Say)	6,167 (4,815; 1,352)	2.71 ± 0.02	1–4	11 April–12 Oct.
Xylocoris cursitans (Fallen)	2 (2, 0)	1.50 ± 0.50	1–2	22–29 June
Xylocoris galactinus (Fieber)	5 (4, 1)	2.50 ± 0.50	2–4	1 Aug.–12 Oct.
REDUVIIDAE				
Acholla multispinosa (De Geer)	1 (0, 1)	4.00	---	7 Sept.
Apiomerus crassipes (Fabricius)	35 (20, 15)	2.15 ± 0.23	1–4	6 June–3 Aug.
Arilus cristatus (L.)	1 (0, 1)	---	---	12 Sept.
Melanolestes abdominalis (Herrich-Schaeffer)	3 (1, 2)	1.00	---	25–27 April
Melanolestes picipes (Herrich-Schaeffer)	10 (5, 5)	1.00 ± 0.00	---	25 April–20 June
Narvesus carolinensis Stål	6 (4, 2)	2.25 ± 0.63	1–4	22 June–20 July
Oncerotrachelus acuminatus (Say)	38 (4, 34)	1.00 ± 0.00	---	16 May–29 Aug.
Pnirontis modesta Banks	7 (1, 6)	1.00	---	11 May–11 July
Rhiginia cruciata (Say)	3 (1, 2)	1.00	---	23 May–6 July
Sinea diadema (Fabricius)	1 (0, 1)	---	---	27 June
Stenopoda spinulosa Giacchi	10 (1, 9)	2.00	---	6 June–5 Sept.
Zelus luridus Stål	1 (0, 1)	---	---	27 June
PHYMATIDAE				
Phymata pennsylvanica Handlirsch	2 (2, 0)	2.00 ± 0.00	---	27 June
PENTATOMOMORPHA				
ARADIDAE				
Aradus kormilevi Heiss	1 (1, 0)	1.00	---	28 Sept.
Aradus ornatus Say	1 (1, 0)	1.00	---	20 April
Aradus robustus Uhler	2 (1, 1)	2.00	---	20–25 April
Aradus similis Say	1 (0, 1)	---	---	9 May
Mezira sayi Kormilev	6 (4, 2)	3.00 ± 0.71	1–4	11 May–29 June

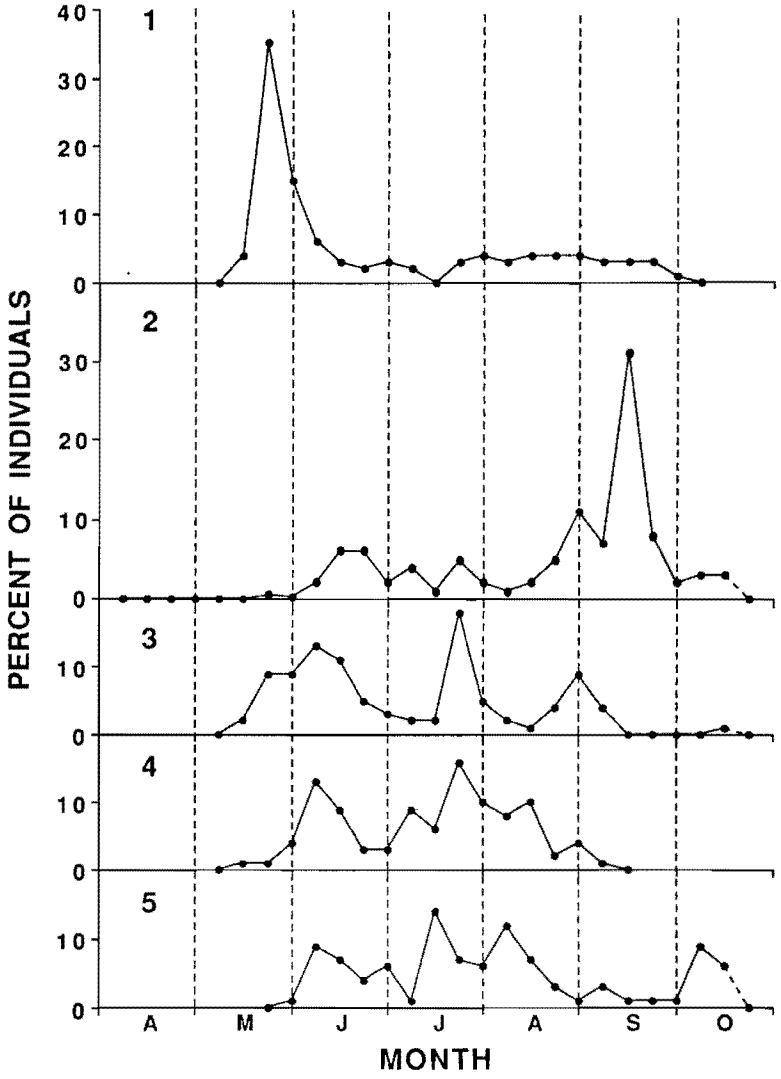
(continued)

PIESMATIDAE				
Piesma cinerea (Say)	125 (87, 38)	2.84 ± 0.11	1–4	9 May–12 Oct.
BERYTIDAE				
Jalysus spinosus (Say)	2 (2, 0)	2.00 ± 1.00	1–3	20 April–5 Oct.
Jalysus wickami Van Duzee	11 (2, 9)	2.50 ± 0.50	2–3	11 April–10 Oct.
LYGAEIDAE				
Antillocoris pilosulus (Stål)	28 (8, 20)	2.13 ± 0.35	1–4	25 April–10 Oct.
Atrazonotus umbrosus (Distant)	1 (1, 0)	4.00	---	13 July
Belanochilus numenius (Say)	5 (2, 3)	4.00 ± 0.00	---	11 May–3 Oct.
Blissus leucopterus (Say)	2 (0, 2)	---	---	18 Aug.–10 Oct.
Cryphula trimaculata (Distant)	1 (0, 1)	---	---	22 Aug.
Cymus angustatus Stål	64 (28, 36)	2.54 ± 0.19	1–4	11 April–29 Aug.
Geocoris punctipes (Say)	4 (0, 4)	---	---	15 Aug.–10 Oct.
Geocoris uliginosus (Say)	16 (6, 10)	1.67 ± 0.33	1–3	8 June–3 Oct.
Kleidocerys resedae (Panzer)	1 (1, 0)	3.00	---	6 April
Lygaeus kalmii angustomarginatus Parshley	8 (3, 5)	3.33 ± 0.67	2–4	4 May–3 Oct.
Malezonotus sodalicius (Uhler)	13 (11, 12)	2.00 ± 0.43	1–4	20 April–15 Aug.
Myodocha serripes Olivier	4 (2, 2)	4.00 ± 0.00	---	9 May–22 June
Nysius niger Baker	3 (1, 2)	4.00	---	8 June–10 Oct.
Nysius raphanus Howard	47 (24, 23)	2.33 ± 0.23	1–4	25 April–12 Oct.
Nysius scutellatus Dallas	1 (1, 0)	1.00	---	12 Oct.
Oedancala dorsalis (Say)	37 (22, 15)	1.59 ± 0.20	1–4	11 May–27 July
Ortholomus scolopax (Say)	1 (0, 1)	---	---	20 June
Pachybrachius basalis (Dallas)	31 (11, 20)	1.36 ± 0.28	1–4	11 April–25 July
Perigenes constrictus (Say)	1 (0, 1)	---	---	6 June
Phlegyas abbreviatus (Uhler)	1 (1, 0)	3.00	---	20 April
Ptochiomera nodosa Say	14 (3, 11)	1.67 ± 0.67	1–3	20 June–12 Oct.
LARGIDAE				
Largus succinctus (L.)	1 (0, 1)	---	---	6 June
COREIDAE				
Acanthocephala terminalis (Dallas)	117 (47, 70)	3.00 ± 0.12	1–4	9 May–7 Sept.
Anasa tristis (De Geer)	1 (1, 0)	1.00	---	15 June
Archimerus alternatus (Say)	1 (0, 1)	---	---	18 July
Euthochtha galeator (Fabricius)	52 (30, 22)	1.60 ± 0.16	1–4	25 April–12 Oct.
Leptoglossus fulvicornis (Westwood)	2 (0, 2)	---	---	25 July–8 Aug.
Leptoglossus oppositus (Say)	23 (19, 4)	3.68 ± 0.15	2–4	18 May–12 Sept.
ALYDIDAE				
Alydus eurinus (Say)	81 (12, 69)	1.25 ± 0.18	1–3	30 May–12 Oct.
Alydus pilosulus Herrich-Schaeffer	8 (3, 5)	2.33 ± 0.33	2–3	3 July–12 Oct.
Megalotomus quinquespinosus (Say)	1 (0, 1)	---	---	18 July
RHOPALIDAE				
Arhyssus lateralis (Say)	23 (18, 5)	2.00 ± 0.21	1–4	9 May–28 Sept.
Harmostes fraterculus (Say)	7 (3, 4)	2.33 ± 0.67	1–3	20 April–19 Sept.
Harmostes reflexulus (Say)	9 (7, 2)	2.14 ± 0.40	1–4	25 April–19 Sept.

(continued)

Liorhyssus hyalinus (Fabricius)	3 (0, 3)	---	---	26 Sept.-10 Oct.
CYDNIDAE				
Cydinnae				
Melanaethus pensylvanicus (Signoret)	1 (1, 0)	2.00	---	22 June
Melanaethus robustus Uhler	5 (5, 0)	3.00 ± 0.55	1–4	15 June
Amnestinae				
Amnestus pallidus Zimmer	21 (12, 9)	2.08 ± 0.29	1–4	11 April–22 June
Amnestus pusillus Uhler	9 (8, 1)	3.38 ± 0.26	2–4	20 April–14 Sept.
Amnestus spinifrons (Say)	93 (73, 20)	2.18 ± 0.13	1–4	11 April–23 May
Sehirinae				
Sehirus c. cinctus (Palisot de Beauvois)	43 (16, 27)	1.94 ± 0.27	1–4	11 April–10 Aug.
THYREOCORIDAE				
Corimelaena pulicaria (Germar)	9 (8, 1)	1.63 ± 0.42	1–4	20 April–15 June
Galgupha aterrima Malloch	1 (1, 0)	4.00	---	25 May
Galgupha carinata McAtee & Malloch	1 (0, 1)	---	---	25 May
Galgupha loboprostethia Sailer	1 (1, 0)	3.00	---	22 June
Galgupha ovalis Hussey	3 (3, 0)	3.33 ± 0.33	3–4	11 May–1 June
PENTATOMIDAE				
Pentatominae				
Acrosternun hilare (Say)	153 (112, 41)	3.29 ± 0.07	1–4	27 April–3 Oct.
Brochymena arborea (Say)	7 (5, 2)	3.40 ± 0.40	1–4	9 May–5 Oct.
Brochymena p. punctata Van Duzee	3 (2, 1)	3.50 ± 0.50	3–4	11 May–6 June
Brochymena quadripustulata (Fabricius)	269 (169, 100)	2.98 ± 0.06	1–4	25 April–12 Oct.
Coenus delius (Say)	1 (0, 1)	---	---	25 July
Cosmopepla bimaculata (Thomas)	1 (1, 0)	3.00	---	27 July
Dendrocoris humeralis (Uhler)	11 (5, 6)	3.80 ± 0.20	3–4	25 April–20 July
Euschistus servus (Say)	158 (59, 99)	1.78 ± 0.13	1–4	11 April–10 Oct.
Euschistus t. tristigmus (Say)	43 (10, 33)	2.60 ± 0.31	1–4	11 April–10 Oct.
Euschistus variolarius (Palisot de Beauvois)	58 (9, 49)	2.33 ± 0.44	1–4	11 April–12 Oct.
Holcostethus limbolarius (Stål)	8 (4, 4)	2.00 ± 0.71	1–4	13 April–10 Oct.
Hymenarcys aequalis (Say)	2 (1, 1)	1.00 ± 0.00	---	13 April–5 Oct.
Hymenarcys nervosa (Say)	7 (3, 4)	1.33 ± 0.33	1–2	20 April–10 Aug.
Mormidae lugens (Fabricius)	15 (4, 11)	2.50 ± 0.65	1–4	18 May–20 July
Oebalus p. pugnax (Fabricius)	13 (2, 11)	2.50 ± 1.50	1–4	1 June–3 Oct.
Thyanta accerra McAtee	6 (4, 2)	1.00 ± 0.00	---	11 April–6 July
Thyanta calceata (Say)	1 (0, 1)	---	---	19 May
Trichopepla semivittata (Say)	1 (0, 1)	---	---	25 April
Asopinae				
Apateticus cynicus (Say)	6 (2, 4)	3.50 ± 0.50	3–4	13 June–8 Aug.
Podisus maculiventris (Say)	19 (10, 9)	2.60 ± 0.27	1–4	20 April–25 July

[a]Total number of specimens for 1979–80, 1979, and 1980, respectively.
[b]Based only 1979 specimens.



Figures 1–5. Seasonal flight activities of six hemipteran species during 1979–80 in a southern Illinois black walnut plantation. 1, *Corythucha juglandis* (N = 159); 2, *Orius insidiosus* (N = 6,167); 3, *Piesma cinerea* (N = 125); 4, *Acanthocephala terminalis* (N = 117); 5, *Alydus eurinus* (N = 81).

hemipterans collected in both plantations (SI, N = 6,167; NC, N = 5,187). It feeds on both insects and plants (e.g., Barber 1936, Dicke and Jarvis 1962, Marshall 1930).

The seasonal flight activity of *O. insidiosus* was similar in both plantations; this species was collected from 11 April to 12 October in SI and from 31 March to 13 October in NC. However, average flying heights averaged 2.71 m (N = 4,815) in SI and 3.45 m in NC.

As noted in NC, this species was apparently bivoltine, although the data were not clear-cut. In SI, the data were much clearer (Fig. 2). Overwintering adults emerged in early April and gave rise to a summer generation whose adults were present during most of June and July. These adults gave rise to the second (overwintering) generation whose adults began to dramatically decrease in number during late September.

REDUVIIDAE

This predaceous family was well-represented in both the SI (Table 1) and NC (McPherson and Weber 1981b) plantations with 12 and 15 species, respectively; most SI species were represented by 10 or fewer specimens. Eight of the 12 SI species were also collected in NC. The exceptions were *Oncerotrachelus acuminatus* (Say), *Rhiginia cruciata* (Say), *Stenopoda spinulosa* Giacchi, and *Zelus luridus* Stål (Table 1). The latter three were represented in the SI plantation by 10 or fewer specimens. *O. acuminatus* was the most common SI species (N = 38), but almost all specimens were collected in 1980 (N = 34). Thus, we have no solid information on its flying height distribution. Nor can we explain why no specimens were captured in the NC plantation because the species is known to occur in that state (Blatchley 1926).

Oncerotrachelus acuminatus was collected from 16 May to 29 August. Almost 87% (N = 33) of the specimens were collected from mid-May to early June. No specimens were collected in July and only two adults were collected in August. These data suggest this species is univoltine.

Only one specimen of *S. diadema* was collected in SI although it was the most common reduviid collected in NC (N = 45). We cannot explain this dramatic difference.

Apiomerus crassipes (Fabricius) was the second most common SI species (N = 35) and third most common NC species (N = 19). It was collected from 6 June to 3 August and flew at an average height of 2.15 m (N = 20) in SI, and from 2 June to 18 August at an average height of 2.26 m in NC. Eighty percent of all SI specimens (N = 28) were collected in June, suggesting this species is univoltine.

PHYMATIDAE

This family was uncommon in both the SI (Table 1) and NC (McPherson and Weber 1981b) plantations with only one and three species, respectively, all represented by seven or fewer specimens. Only *Phymata pennsylvanica* Handlirsch was collected in both plantations, with only two specimens in each.

PENTATOMOMORPHA
ARADIDAE

This family was represented by five species in the SI plantation (Table 1) and six in the NC (McPherson and Weber 1981e) plantation. However, no species was collected in both plantations. All SI species were uncommon.

PIESMATIDAE

Piesma cinerea (Say), the only representative of this family collected, was found in both the SI (Table 1) and NC (McPherson and Weber 1981d) plantations. It has been collected from several host plants, including species of *Amaranthus* (Drake and Davis 1958). As it has not been reported, to our knowledge, from black walnut, it was probably moving through the plantation and not feeding on this tree. It was more common in SI (N = 125) than in NC (N = 32), but the period of flight activity was similar (SI, 9 May–12 October, Table 1; NC, 14 April–13 October). It flew at an average height of 2.84 m (N = 87) in SI, and at an average height of 3.72 m in NC.

This species apparently overwintered as adults in SI and was apparently bivoltine (Fig. 3). Adults began to emerge from overwintering sites in early May and peaked in abundance from mid-May to mid-June. Their adult offspring (summer generation) peaked in late July. Adults of the second (overwintering) generation occurred from late August to the end of the season.

BERYTIDAE

Jalysus spinosus (Say) and *Jalysus wickhami* Van Duzee were collected in both the SI (Table 1) and NC (McPherson and Weber 1981d) plantations. *J. spinosus* was rare in both plantations (SI, N = 2; NC, N = 1). *J. wickhami* was relatively more abundant in both plantations (SI, N = 11; NC, N = 30) but not enough for us to make any definite conclusions about seasonal flight patterns of this primarily phytophagous species. It was collected from 11 April to 10 October and flew at an average height of 2.50 m (N = 2) in SI, and from 3 June to 8 September at an average height of 3.40 m in NC.

LYGAEIDAE

This family was the most common (excluding the Miridae) in the SI (Table 1) and NC (McPherson and Weber 1981d) plantations with 21 and 27 species collected, respectively. Fifteen of the 21 SI species were also collected in NC. Of the remaining six, *Atrazonotus umbrosa* (Distant), *Nysius scutellatus* Dallas, and *Perigenes constrictus* (Say) were each represented by a single specimen; and *Malezonotus sodalicius* (Uhler), *Nysius raphanus* Howard, and *Oedancala dorsalis* (Say) by 13, 47, and 37 specimens, respectively.

Malezonotus sodalicius was collected from 20 April to 15 August and flew at an average height of 2.00 m (N = 11), *N. rhaphanus* from 25 April to 12 October at an average height of 2.33 m (N = 24), and *O. dorsalis* from 11 May to 27 July at an average height of 1.59 m (N = 22).

Nysius raphanus has been reported attacking vegetables including lettuce, cabbage, turnips, and mustard greens (Wene 1958). We found no substantial information in the literature on its life cycle.

The number of generations in the SI study was not evident from the seasonal flight activity. Adults were evenly distributed during the season (i.e., no definite peaks of flight activity) until the second week of October when there was a dramatic increase in activity in both years. Of all individuals collected during the two years, ca. 43% (N = 20) were collected during that time.

Oedancala dorsalis feeds on seeds of *Scirpus* spp. and *Carex* spp. in damp places (Slater and Baranowski 1978). It overwinters as adults (Slater 1951). In the SI study, ca. 92% (N = 34) of the specimens were collected between the second week of May and the third week of June, suggesting these were the overwintering adults and that the species is univoltine.

The most common SI lygaeid was *Cymus angustatus* Stål (N = 64), which was uncommon in NC (N = 4); we have no explanation for this difference. It feeds on *Scirpus atrovirens* and probably other species of *Scirpus* and *Carex*; it probably overwinters as adults (Slater 1952). Adults were collected from 11 April to 29 August and flew at an average height of 2.54 m (N = 28) in SI, and from 31 March to 25 August at an average height of 3.00 m in NC.

Cymus angustatus was apparently univoltine. Of the 64 specimens collected, 48 (75%) were captured between the second week of April and early June.

Antillocoris pilosulus (Stål), the most common species in NC (N = 311), was also common in SI relative to most of the other species (N = 28). It apparently is a seed-feeder because it readily feeds on sunflower seeds in the laboratory (Sweet 1964). It overwinters as adults and is univoltine (Sweet 1963). Adults were collected from 25 April to 10 October and flew at an average height of 2.13 m (N = 8) in SI, and from 31 March to 13 October at an average height of 4.26 m in NC.

As noted in our NC study, this species overwintered as adults but the number of generations was unclear from the data available. In SI, the data were even more limited but do support Sweet's 1963 conclusion that adults overwinter. Of the 28 specimens collected, ca. 46% (N = 13) were collected between early September and the end of the season.

Crophius disconotus (Say) was the second most common species collected in NC, but no specimens were collected in SI. It has not been reported from Indiana (Blatchley 1926; Slater 1964). And although Blatchley (1926) included Missouri in its range, Froeschner (1944) did not report it from that state; thus, it would seem to be, at most, uncommon in Missouri.

LARGIDAE

This family was represented in SI by only a single specimen of *Largus succinctus* (L.) and was not collected in NC.

COREIDAE

Five of the six SI species (Table 1) were also collected in NC (McPherson and Weber 1981a). Of these, the most striking differences were in the relatively high SI numbers of *Acanthocephala terminalis* (Dallas) (117) and *Euthochtha galeator* (Fabricius) (52) compared to NC (9 and 19, respectively).

Acanthocephala terminalis feeds on several plants including species of *Rhus, Vitis, Physocarpus,* and *Celtis* (Schaefer and Mitchell 1983). It life cycle has been investigated in southern Wisconsin by Yonke and Medler (1969). They reported on the seasonal occurrence of each of the developmental stages and stated the species was univoltine; adults were collected from 13 June to 24 September and were the overwintering stage.

In SI, adults were collected from 9 May to 7 September, probably because the SI site was south of the Wisconsin site. However, it also appears this species may be bivoltine, although the data are not conclusive (Fig. 4). If bivoltine, then adults emerged from overwintering sites in early May; they were most actively flying in early to mid-June, and their offspring most actively flying during July and August. Certainly, there would have been adequate time for the summer adults to reproduce and their offspring (overwintering generation) to reach adulthood during September and October. Average flying height was 3.00 m (N = 47) in SI and 3.67 m in NC.

*Euthochtha galeato*r feeds on several plants including species of *Agrimonia, Achillea, Aster, Monarda, Desmodium, Quercus* (Yonke and Medler 1969), *Prunus, Gaura, Ambrosia, Cirsium,* and *Heterotheca* (Schaefer and Mitchell 1983). Its life cycle has been investigated in Wisconsin by Yonke and Medler (1969). They reported

on the seasonal occurrence of each of the developmental stages and stated the species was univoltine; adults were collected from 25 May to 8 October and were the overwintering stage.

The SI study also found this species to be univoltine. Adults were collected between 25 April and 12 October. Of the 52 adults collected, 43 (82.7%) were taken by the third week of June. These probably were the overwintered adults from the previous year. Average flying height was 1.60 m (N = 30) in SI, close to the 1.05 m in NC.

ALYDIDAE

Alydus eurinus (Say) and *Alydus pilosulus* Herrich-Schaeffer were collected in both the SI (Table 1) and NC (McPherson and Weber 1981a) plantations. *A. eurinus* was, by far, the most common alydid in both plantations.

Alydus eurinus feeds on several plants including species of *Baptisia, Lespedeza, Ceanothus, Amorphus, Trifolium,* and *Vigna* (Schaefer 1980). It was collected from 30 May to 12 October (N = 81) and flew at an average height of 1.25 m (N = 12) in SI, and from 27 May to 13 October at an average height of 1.30 m (N = 145) in NC.

Yonke and Medler (1968) found *A. eurinus* to be bivoltine and to overwinter as eggs in southern Wisconsin. Adults were found from 29 June to 19 October.

In SI, as in NC, the results agree with those of Yonke and Medler (1968). Assuming the eggs overwintered, then they hatched in spring and the resulting adults were found from about late May to late June and their adult offspring from mid-July to late August (Fig. 5). The peak in October probably represented the end of the second generation, which would have had sufficient time to lay overwintering eggs.

RHOPALIDAE

All four SI rhopalid species (Table 1) were also collected in NC (McPherson and Weber 1981a). *Arhyssus lateralis* (Say) was the most common in SI (N = 23) and also common in NC (N = 32). It feeds on species of *Polygonum* (Paskewitz and McPherson 1983, Schaefer and Chopra 1982) and *Rumex* (Paskewitz and McPherson 1983). It was collected from 9 May to 28 September and flew at an average height of 2.00 m (N = 18) in SI, and from 28 April to 7 October at an average height of 1.50 m in NC. In SI, 82.6% (N = 19) of the specimens were collected between early May and mid-June. Because this species overwinters as adults and is bivoltine (Paskewitz and McPherson 1983), the early peak of flight activity undoubtedly represents overwintered adults.

SCUTELLERIDAE

No specimens were collected in SI, and only seven (two species) were collected in NC (McPherson and Weber 1980).

CYDNIDAE

Of the six species collected (Table 1), five were also found in NC (McPherson and Weber 1980). *Amnestus spinifrons* (Say) was common in both the SI (N = 93) and NC (N = 78) plantations. Little is known about its biology, including host plants. It

flew from 11 April to 23 May at an average height of 2.18 m (N = 73) in SI (Table 1) and from 31 March to 26 May at an average height of 3.33 m in NC. This short early flight period probably represents the emergence of overwintered adults and suggests this species is univoltine.

Amnestus basidentatus Froeschner was, by far, the most common cydnid in NC with 609 specimens collected. It has never been reported from Illinois (McPherson 1982) and, so, its absence from the SI traps was not surprising.

Sehirus cinctus cinctus (Palisot de Beauvois) was more common in SI (N = 43) (Table 1) than in NC (N = 6) (McPherson and Weber 1980). It feeds on *Lamium* sp. in SI (Sites and McPherson 1982). It flew from 11 April to 10 August at an average height of 1.94 m (N = 16) in SI, and from 1 April to 21 July at an average height of 2.50 m in NC.

This subspecies is apparently univoltine in SI, with adults collected between early April and early September (Sites and McPherson 1982). Thus, the flight period in the SI study apparently included overwintered adults and their offspring (Fig. 6). This assumption is further supported by the early flight peak in late April, which would represent the overwintered adults, and the second peak in late June, which would represent their adult offspring.

THYREOCORIDAE

Few specimens of this family were collected in either the SI (Table 1) or NC (McPherson and Weber 1980) plantation, and most species were represented by only a single specimen. *Corimelaena pulicaria* (Germar) was the most common species in both the SI (N = 9) and NC (N = 16) plantations. It was collected from 20 April to 15 June and flew at an average height of 1.63 m (N = 8) in SI, and from 31 March to 24 June at an average height of 2.94 m in NC.

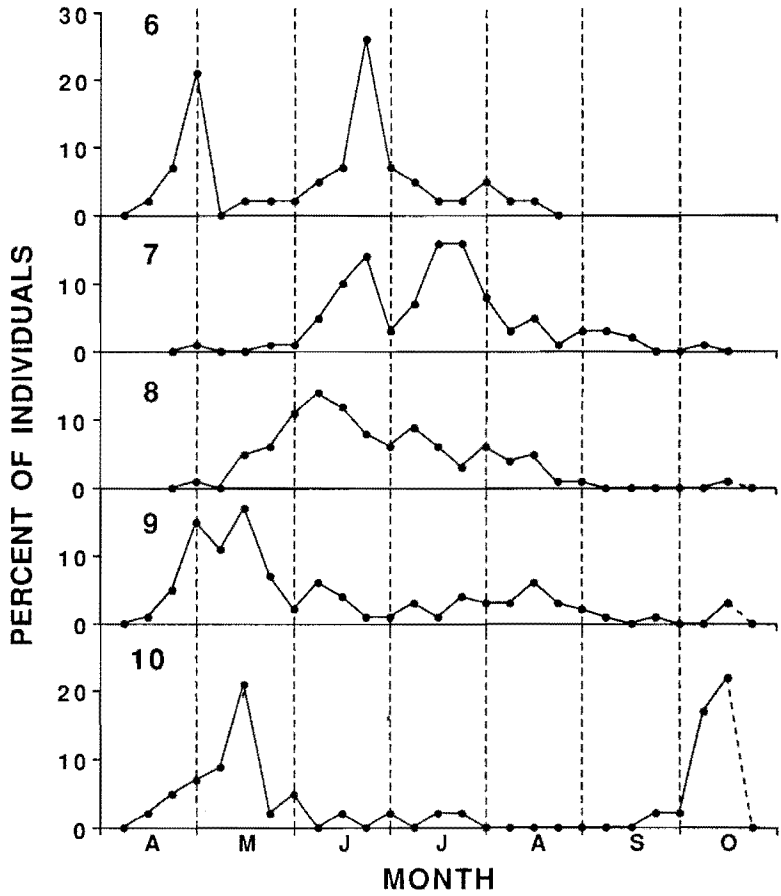
PENTATOMIDAE

This was one of the more common families collected in the SI (Table 1) and NC (McPherson and Weber 1980) plantations, both in numbers of species and individuals. The three most common SI species, *Acrosternum hilare* (Say), *Brochymena quadripustulata* (Fabricius), and *Euschistus servus* (Say), were among the four most common NC species. *Euschistus variolarius* (Palisot de Beauvois) was noticeably more common in SI (N = 58) than in NC (N = 25). Conversely, *Podisus maculiventris* (Say) was noticeably more common in NC (N = 49) than in SI (N = 19).

Acrosternum hilare has been reported from numerous plants (McPherson 1982) and, undoubtedly, many of these are host plants. It has been collected from black walnut but has never been observed feeding (Nixon and McPherson 1977, Nixon et al. 1975). It was collected from 27 April to 3 October (N = 153) and flew at an average height of 3.29 m (N = 112) in SI (Table 1), and from 20 May to 6 October and flew at an average height of 4.50 m (N = 48) in NC (McPherson and Weber 1980).

This species overwinters as adults and becomes active in mid-April in SI (McPherson and Mohlenbrock 1976); most authors have considered it univoltine (McPherson 1982). However, McPherson and Mohlenbrock (1976) stated it was apparently bivoltine in SI. They reported that the fourth and fifth instars were common in late July and early October, suggesting bivoltism; adults were found as late as the end of October.

If *A. hilare* is bivoltine, then the seasonal flight pattern during this study suggests that the overwintered adults reproduced during the spring, their adult offspring (summer generation) were collected in June and July, and the second (overwintering) generation adults were collected in September and October (Fig. 7). However, it also



Figures 6–10. Seasonal flight activities of four hemipteran species and subspecies during 1979–80 in a southern Illinois black walnut plantation. 6, *Sehirus cinctus cinctus* (N = 43); 7, *Acrosternum hilare* (N = 153); 8, *Brochymena quadripustulata* (N = 269); 9, *Euschistus servus* (N = 158); 10, *Euschistus variolarius* (N = 58).

is possible that the peaks during June and July represent the overwintered adults. More study of this species' life cycle is needed.

Brochymena quadripustulata is an arboreal species, which has been reported from numerous host plants (McPherson 1982). It is known to feed and reproduce on black walnut (Cuda and McPherson 1976, Nixon and McPherson 1977). It was collected from 25 April to 12 October (N = 269) and flew at an average height of 2.98 m (N = 169) in SI (Table 1), and from 14 April to 7 October at an average height of 3.02 m (N = 513) in NC (McPherson and Weber 1980).

This species overwinters as adults and is univoltine (Cuda and McPherson 1976). Although the early peak flight period was more than one month earlier in NC (McPherson and Weber 1980) than in SI (Fig. 8), the overall flight pattern was

somewhat similar. The first peak in both plantations in relation to the general life history (Cuda and McPherson 1976) shows that this peak undoubtedly represents the flight activity of overwintered adults, and the small early October peak represents their adult offspring.

Euschistus servus is a general feeder and has been reported from numerous host plants (McPherson 1982). It is known to feed and reproduce on black walnut (Nixon and McPherson 1977, Nixon et al. 1975). It was collected from 11 April to 10 October (N = 158) and flew at an average height of 1.78 m (N = 59) in SI (Table 1), and from 1 April to 13 October at an average height of 2.10 m (N = 143) in NC (McPherson and Weber 1980).

This species overwinters as adults and is bivoltine (McPherson 1982). This is supported by both the SI (Fig. 9) and NC (McPherson and Weber 1980) flight patterns, which show three peaks. The early peak (April–May) probably corresponds to the emergence of overwintered adults; and the second (late July–August) and third (October) peaks correspond to adults of the first (summer) and second (overwintering) generations, respectively.

Euschistus variolarius has been reported from numerous host plants (McPherson 1982) but not from black walnut (Nixon and McPherson 1977, Nixon et al. 1975). It was collected from 11 April to 12 October (N = 58) and flew at an average height of 2.33 m (N = 9) in SI (Table 1), and from 7 April to 15 September at an average height of 1.96 m (N = 25) in NC (McPherson and Weber 1980). It overwinters as adults and has been listed as being both uni-and bivoltine (McPherson 1982). Adults have been collected from 23 March to 3 November in SI (McPherson and Mohlenbrock 1976). Its flight pattern during this study suggests that it is bivoltine.

Flight activity of *E. variolarius* during this study peaked during May, June–July (very small), and October (Fig. 10). The first peak (May) undoubtedly represents the overwintered adults. Nymphs (2nd–5th instars) have been collected from late May to early July in SI (McPherson and Mohlenbrock 1976) and probably represent the offspring of overwintered adults. If so, they are probably represented as adults by the small June–July peak and their offspring (overwintering adults) are represented by the October peak. If not, then the late peak in October represents the adult offspring of the overwintered adults from the previous year. More study of the life history of this species is needed.

ACKNOWLEDGMENTS

We thank D. M. Baines, D. E. Alley, and F. D. McBride, North Central Forest Experiment Station, Forestry Sciences Laboratory, Carbondale, IL (FSL-C), for their help in maintaining the traps. We appreciate the cooperation and assistance of Shawnee National Forest personnel in providing access to the Pleasant Valley Plantation. We are grateful to M. E. Dix, Rocky Mountain Forest and Range Experiment Station, Lincoln, NE; and to J. W. Van Sambeek (FSL-C), for their review comments of an earlier draft of the manuscript. We are also grateful to C. Clabough, Scientific Photography and Illustration Facility, Southern Illinois University, Carbondale (SIU-C), for preparing the final illustrations and photographs of the figures; and to Dr. J. A. Slater, University of Connecticut, Storrs, and Dr. Merrill H. Sweet, Texas A&M University, College Station, for identifying some of the lygaeid species. Cost of the illustrations was met by the SIU-C Office of Research Development and Admininstration and by the Department of Zoology.

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