Flight Patterns of Phloem- and Wood-Boring Coleoptera (Scolytidae, Platypodidae, Curculionidae, Buprestidae, Cerambycidae) in a North Florida Slash Pine Plantation

THOMAS H. ATKINSON, JOHN L. FOLTZ, AND MICHAEL D. CONNOR[1]

Department of Entomology and Nematology, University of Florida, Gainesville, Florida 32611

Environ. Entomol. 17(2): 259-265 (1988)

ABSTRACT Sticky traps adjacent to severed and tipped slash pines and window traps with ethanol as attractant and collecting fluid (randomly located in the stand) were used to monitor flight patterns of Scolytidae, Platypodidae, Curculionidae, Buprestidae, and Cerambycidae in a slash pine plantation in North Florida. Forty-nine species were trapped, of which 35 breed in pines and 14 in hosts in the understory and nearby cypress domes. Sticky and window traps differed greatly with respect to species trapped, relative abundance of species, and seasonal trends in numbers of species, specimens, and diversity. Sticky traps caught a greater proportion of the pine-breeding species in the area. Window trap catches were dominated by ambrosia beetles, apparently attracted to ethanol, and included most of the species associated with the understory and cypress domes. Scolytidae and Platypodidae, present throughout the year, may breed continuously under local conditions. Larger species of Curculionidae, Buprestidae, and Cerambycidae showed distinct peaks and were absent during much of the year. Most pine-breeding scolytids showed peaks in the fall, spring, or both, with lows during the hottest and coldest months. There was a general correlation between breeding habits and height of window traps in which insects were captured.

KEY WORDS Insecta, Coleoptera, flight patterns, slash pine

WINDOW TRAPS have been used in different forest types in Alaska (Beckwith 1972), Maine (Hosking & Knight 1975), Missouri (Roling & Kearby 1975), and Georgia (Turnbow & Franklin 1980) to monitor seasonal patterns and other aspects of flight of Scolytidae. Although the purpose of all of these studies was to obtain seasonal data on as large a number of species as possible, the methods used have varied considerably, particularly with respect to the use of attractants. Attractants used include ethanol (Roling & Kearby 1975, Turnbow & Franklin 1980), host material (Beckwith 1972), or no attractant at all (Hosking & Knight 1975).

During the course of a study on the reproductive biology of *Pissodes nemorensis* Germar (Curculionidae) (Atkinson 1979), we used two different types of traps to follow its seasonal and vertical flight behavior—window traps with ethanol as a collecting fluid, and sticky traps adjacent to weakened slash pines (*Pinus elliottii* Engelm. var. *elliottii*). All species of phloem- and wood-boring Coleoptera (Scolytidae, Platypodidae, Curculionidae, Cerambycidae, Buprestidae) which invade trees during the initial stages of the degradation process were also counted. These data allow us to interpret seasonal flight patterns of several species of beetles in a slash pine plantation and compare the two types of traps for monitoring beetle activity.

Materials and Methods

Traps were placed in a 16-yr-old commercial slash pine plantation in southern Flagler County, Fla. (T14S, R30E, section 4). The plantation had a stocking of 923 trees/ha; average height and diameter at breast height of trees were 9.8 m and 12.8 cm, respectively (measurements taken in winter of 1978–79). The canopy was relatively open, and there was a dense shrubby understory of saw palmetto (*Serenoa repens* Bartr.), gallberry (*Ilex glabra* (L.) Gray), and wax myrtle (*Myrica cerifera* L.). Small cypress domes, lower-lying areas dominated by baldcypress (*Taxodium distichum* (L.) L. Rich.) and mixed hardwoods, were scattered in the stand; two domes were within 50 m of several of the traps.

Weekly temperature extremes were recorded with a maximum–minimum thermometer hung on the north side of a tree trunk at a height of 1.5 m from 2 November 1977 through 22 November 1978.

Four slash pines were partially severed at a height of 1 m and tipped over each month from June 1977 until June 1978 as part of a study of breeding biology of *Pissodes nemorensis* Germar (Atkinson 1979). Four-vaned hardware cloth sticky traps were placed next to each tree (Fig. 1A). Traps consisted

[1] Current address: USDA, Forest Service, Cooperative Forestry, Forest Pest Management, 2500 Shreveport Hwy., Pineville, La. 71360.

0046-225x/88/0259-0265$02.00/0

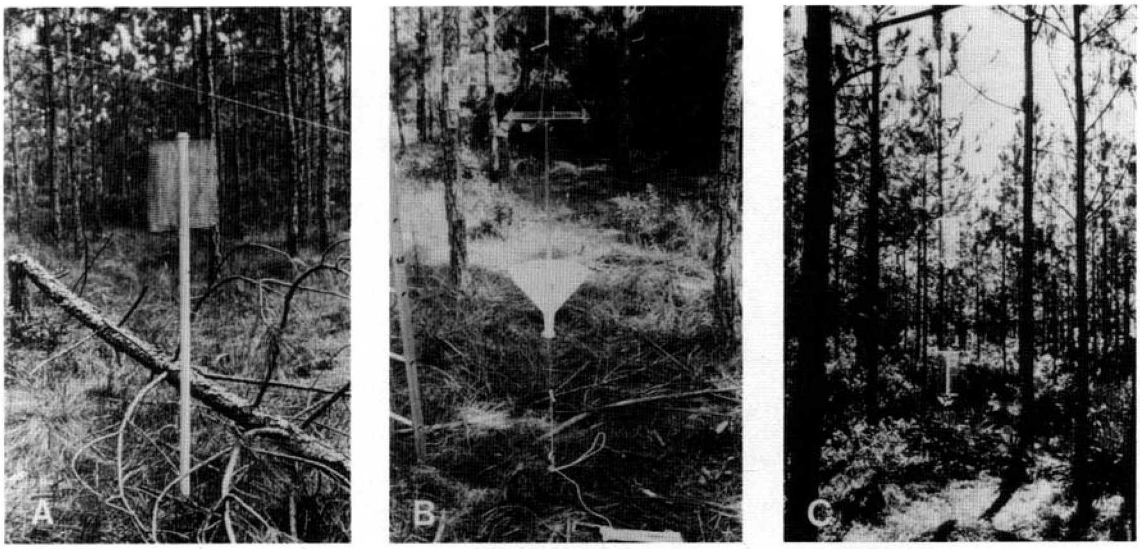

Fig. 1. Traps used to monitor seasonal flight patterns of phloem- and wood-boring insects. (A) Sticky trap next to partially severed and tipped slash pine trap-tree. (B) Closeup of Plexiglas window trap (collecting jar not shown). (C) Array of three window traps.

of two 30-cm squares cut halfway through the center and joined along the cuts. PVC pipes, with the ends cut to receive the screens, supported traps at a height of 1 m. Screens were sprayed with aerosol Tanglefoot, a nondrying, sticky compound.

Sticky traps were checked weekly until most of the phloem in the adjacent trees had been consumed. In most months trees in all stages of attack by phloem- and wood-boring insects were present. The number of traps in place ranged from 4 to 17. Most beetles, however, were associated with trees from the two most recent cuttings (about 3 to 8 wk after cutting). Only data from the period of August 1977 until August 1978 are presented here because of the relatively small numbers of traps in the field at the beginning and end of the trapping period. Monthly totals of beetles caught were standardized to compensate for variable numbers of traps and weekly observation periods.

Omnidirectional Plexiglas window traps were built, using a design similar to that described by Wilkening et al. (1981) but without the upper collecting chamber. Each trap consisted of four perpendicular vanes (15 by 60 cm) covered by a 30-cm-square lid and over a 30-cm-diameter plastic funnel (Fig. 1B). Traps were hung midway between two trees so that their centers were 1, 3, and 5 m above the ground (ground level, clear bole, and lower crown levels, respectively, Fig. 1C). Ethanol (70%) was used as the collecting fluid. Four arrays of three traps each were placed in the same stand as the trap trees and sticky traps and checked weekly from September 1977 until November 1978. These arrays remained in the same positions throughout the study and were not directly associated with cut trees. Traps were cleaned as necessary to remove accumulated dust and water spots. Monthly totals were adjusted in a manner similar to those for sticky traps.

Scolytidae, Platypodidae, and Curculionidae were identified by Atkinson. Buprestidae and Cerambycidae were identified by R. E. Woodruff, Division of Plant Industry, Florida Department of Agriculture and Consumer Services, Gainesville, Fla.

Results and Discussion

Species Trapped. A total of 49 species of phloem- and wood-boring beetles was collected (Table 1). Of these, 35 are known to breed in pines. The other 14 are known from hosts found in the understory and in nearby cypress domes. Six species of ambrosia beetles—*Ambrosiodmus devexulus* (Wood), *A. lecontei* Hopk., *Xyleborinus saxeseni* (Ratz.), *Xyleborus affinis* (Eichh.) and *X. ferrugineus* (F.)—breed in pines as well as hardwoods locally (Wood 1982; Atkinson, unpublished data). A total of 2,642 specimens of 34 species was caught in the sticky traps and 12,227 of 41 species in the window traps. Most specimens trapped were Scolytidae (87 and 98.4% of all specimens captured on sticky and window traps, respectively). Within each family there was a rough inverse correlation between size of insect and number trapped.

Although both trap types were operated in the same area, there were considerable differences in the species and quantities of insects captured by each. In general, sticky traps were more efficient in trapping the fauna associated with slash pines, and window traps did better on the fauna of cypress domes and the pine understory. The most abundant species in sticky traps were pine bark beetles (65% of all specimens, especially *Hylastes tenuis* Eichh.,

Table 1. Species of phloem- and wood-boring Coleoptera caught in sticky and window traps in a slash pine plantation in north Florida[a]

Family and species	Sticky		Window		Habits[b]
	N	%	*N*	%	
Scolytidae					
Carphoborus bifurcus Eichh.	3	0.1	—	—	Pine bark beetle
Crypturgus alutaceus Schwarz	13	0.5	1	*	Pine bark beetle
Dendroctonus terebrans (Oliv.)	—	—	3	*	Pine bark beetle
Hylastes salebrosus (Eichh.)	2	0.1	—	—	Pine bark beetle
H. tenuis Eichh.	510	19.3	10	0.1	Pine bark beetle
Ips avulsus (Eichh.)	227	8.6	—	—	Pine bark beetle
I. calligraphus (Germar)	78	3.0	13	0.1	Pine bark beetle
I. grandicollis (Eichh.)	345	13.1	21	0.2	Pine bark beetle
Orthotomicus caelatus Eichh.	4	0.2	—	—	Pine bark beetle
Pityoborus comatus (Zimm.)	2	0.1	10	0.1	Pine bark beetle
Pityophthorus spp.	527	20.0	11	0.1	Pine bark beetle
Ambrosiodmus lecontei Hopk.	3	0.1	34	0.3	Polyphagous ambrosia beetle
A. devexulus (Wood)	3	0.1	13	0.1	Polyphagous ambrosia beetle
A. tachygraphus (Zimm.)	—	—	1	*	Polyphagous ambrosia beetle
Corthylus spinifer Schwarz	—	—	26	0.2	Ambrosia beetle of hardwoods
C. punctatissimus (Zimm.)	—	—	3	*	Ambrosia beetle of hardwoods
Gnathotrichus materiarius (Fitch)	4	0.2	—	—	Ambrosia beetle of pines
Monarthrum fasciatum (Say)	—	—	1	*	Ambrosia beetle of hardwoods
M. mali (Fitch)	—	—	25	0.2	Ambrosia beetle of hardwoods
Xyleborinus saxeseni (Ratz.)	46	1.7	10,883	89.0	Polyphagous ambrosia beetle
Xyleborus affinis (Eichh.)	70	2.7	716	5.9	Polyphagous ambrosia beetle
X. ferrugineus (F.)	182	6.9	10	0.1	Polyphagous ambrosia beetle
X. pubescens Zimm.	142	5.4	1	*	Ambrosia beetle of pines
Xylosandrus compactus (Eichh.)	3	0.1	10	0.1	Ambrosia beetle of twigs of hardwoods
Cnesinus strigicollis LeC.	—	—	3	*	Pith borer of hardwoods
Cryptocarenus seriatus Eggers	—	—	31	0.3	Pith borer of hardwoods
Hypothenemus sp.	128	4.8	184	1.5	Polyphagous bark beetles and twig borers of hardwoods
Micracisella nanula (LeC.)	—	—	7	0.1	Pith borer of hardwoods
Pseudopityophthorus asperulus (LeC.)	2	0.1	1	*	Oak bark beetle
Platypodidae					
Platypus compositus Say	1	*	28	0.2	Ambrosia beetle, mostly hardwoods
P. flavicornis (F.)	196	7.4	1	*	Ambrosia beetle of pines
Curculionidae					
Hylobius pales (Herbst.)	4	0.2	7	0.1	Pine bark weevil
Pachylobius picivorus (Germar)	—	—	2	*	Pine bark weevil
Pissodes nemorensis Germar	14	0.5	12	0.1	Pine bark weevil
Buprestidae					
Acmaeodera pulchella (Herbst.)	5	0.2	—	—	Borer of *Taxodium distichum*
Buprestis maculipennis Gory	1	*	1	*	Pine bark and wood borer
B. lineata (F.)	1	*	—	—	Pine bark and wood borer
Chalcophora spp.	—	—	7	0.1	Pine wood borers
Chrysobothris spp.	54	2.0	3	*	Mostly pine bark and wood borers
Cerambycidae					
Amniscus arcuatus (LeC.)	21	0.8	110	0.9	Pine bark borer
Arhopalus nubilus (LeC.)	—	—	4	*	Pine wood borer, mostly old wood
Elaphidion mucronatum (Say)	—	—	3	*	Twigs of hardwoods
Eupogonius tomentosus (Hald.)	25	0.9	2	*	Pine bark borer
Monochamus spp.	—	—	6	*	Pine bark and wood borers
Neacanthocinus obsoletus (Oliv.)	4	0.2	1	*	Pine bark borer
Plectomerus dentipes (Oliv.)	—	—	4	*	Branches of hardwood
Rhagium inquisitor (L.)	1	*	—	—	Pine bark borer
Sternidius sp.	7	0.3	7	0.1	Pine bark borer
Xylotrechus sagittatus (Germar)	14	0.5	1	*	Pine wood borer
Totals	2,642		12,227		

[a] *N*, total number of individuals; %, percentage of total specimens trapped; *, <0.1%.
[b] Habits taken from Baker (1972), Wood (1982), and personal observations (T. H. Atkinson).

Ips spp., and *Pityophthorus* spp.) and pine ambrosia beetles (24.3%, especially *Platypus flavicornis* (F.), *Xyleborus pubescens* Zimm., and *X. ferrugineus*). In window traps, *Xyleborinus saxeseni* and *Xyleborus affinis* accounted for 94.9% of all specimens captured. Only 26 species, 23 of which breed in pines, were found in both types of trap. Seven pine-breeding species were found only in sticky traps; five only in window traps. These latter species included the relatively large insects *Mono-*

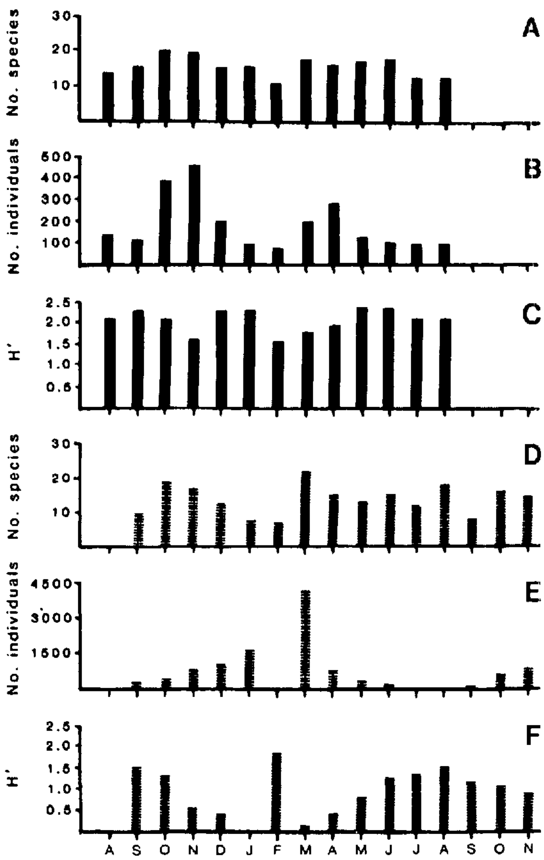

Fig. 2. Overall trends in trap catches. (A) Number of species in sticky traps. (B) Number of individuals in sticky traps. (C) Shannon-Weaver diversity index of sticky traps. (D) Number of species in window traps. (E) Number of individuals in window traps. (F) Shannon-Weaver diversity index from window traps.

chamus spp., *Chalcophora* spp., *Pachylobius picivorus* (Germar), and *Dendroctonus terebrans* (Oliv.), which may have been able to escape from sticky traps. On one occasion an individual of *Monochamus* was observed with adhesive on its elytra near a trap tree. Dixon & Payne (1979) also found that some larger insects were able to escape from similar traps.

Thirteen of 14 species associated with hosts other than pines were caught in the window traps, while only five of these were found in sticky traps. The dominance of ambrosia beetles was particularly noteworthy. Four species—*Platypus compositus* Say, *Monarthrum mali* (Fitch), *M. fasciatum* (Say), *Corthylus spinifer* Schwarz—were not breeding in the immediate vicinity of the traps and apparently were attracted to the area by ethanol, a known attractant for many species of ambrosia beetles (Moeck 1970, 1971, Roling & Kearby 1975, Turnbow & Franklin 1980, Bustamante & Atkinson 1984). The basis of this attraction is assumed to be the association of ethanol and suitable breeding material in the field; i.e., fermentation in dying or dead wood. The assumption is supported by observations that most corthyline ambrosia beetles (*Corthylus, Monarthrum, Corthylocurus, Glochinocerus*) captured in this type of trap are males (Roling & Kearby 1975, Bustamante & Atkinson 1984), the sex which initiates host attacks in this tribe (Wood 1982). The attractiveness of ethanol varies among species. The extremely high numbers of *Xyleborinus saxeseni* in window traps probably reflects its strong response to ethanol rather than its relative abundance. Although this species breeds locally in slash pine, it was relatively uncommon compared with other species. *Xyleborus ferrugineus, X. pubescens,* and *Platypus flavicornis* were uncommon in window traps yet were the most common ambrosia beetles in sticky traps. *Platypus flavicornis* was frequently observed breeding in stumps in the study area, and *X. ferrugineus* and *X. pubescens* were the ambrosia beetles most frequently reared from pine taken from the study area (Atkinson, unpublished data).

Seasonal Fluctuations and Species Diversity. Numbers of species and individuals in sticky traps were highest in October–November and April, and lowest in January–February and June–August (Fig. 2). Diversity was relatively constant throughout the trapping period with lows in November and February. The drop in diversity in November 1977 probably reflects the very large number of *Hylastes tenuis* caught during that month (Fig. 3), and the low diversity in February reflects the low numbers of species and individuals caught during the coldest month of the study (Fig. 2).

Trends in the window traps were very different from the sticky-trap trends. Numbers of species, individuals, and diversity varied widely during the study. This reflects the preponderance of *Xyleborinus saxeseni* in the traps (89% of all specimens). The plot of total number of specimens (Fig. 2) is virtually identical to that for *X. saxeseni* (Fig. 3), while that of diversity is almost the reciprocal of *X. saxeseni* abundance. Most other species were infrequently caught in window traps.

Species diversity indices consider both the species richness (number of species) and their proportional representations within a sample (Pielou 1969). Indices rise with increased richness or greater "balance" of component species, or both, and drop with decreased richness or increased preponderance of one or more species (i.e., decreased balance), or both. The relative constancy of the diversity index (H') for the sticky traps agrees with our subjective observations that a diverse beetle fauna was present in the area at all times. The wide variability of the index for the window traps reflects the behavior of one or two species with respect to the traps, not any real changes in the diversity of the fauna during the study period.

Monthly totals of the 24 most commonly trapped species are shown in Fig. 3. In most cases, trends were apparent only in the data of one type of trap, or were not discernible due to low catches of many

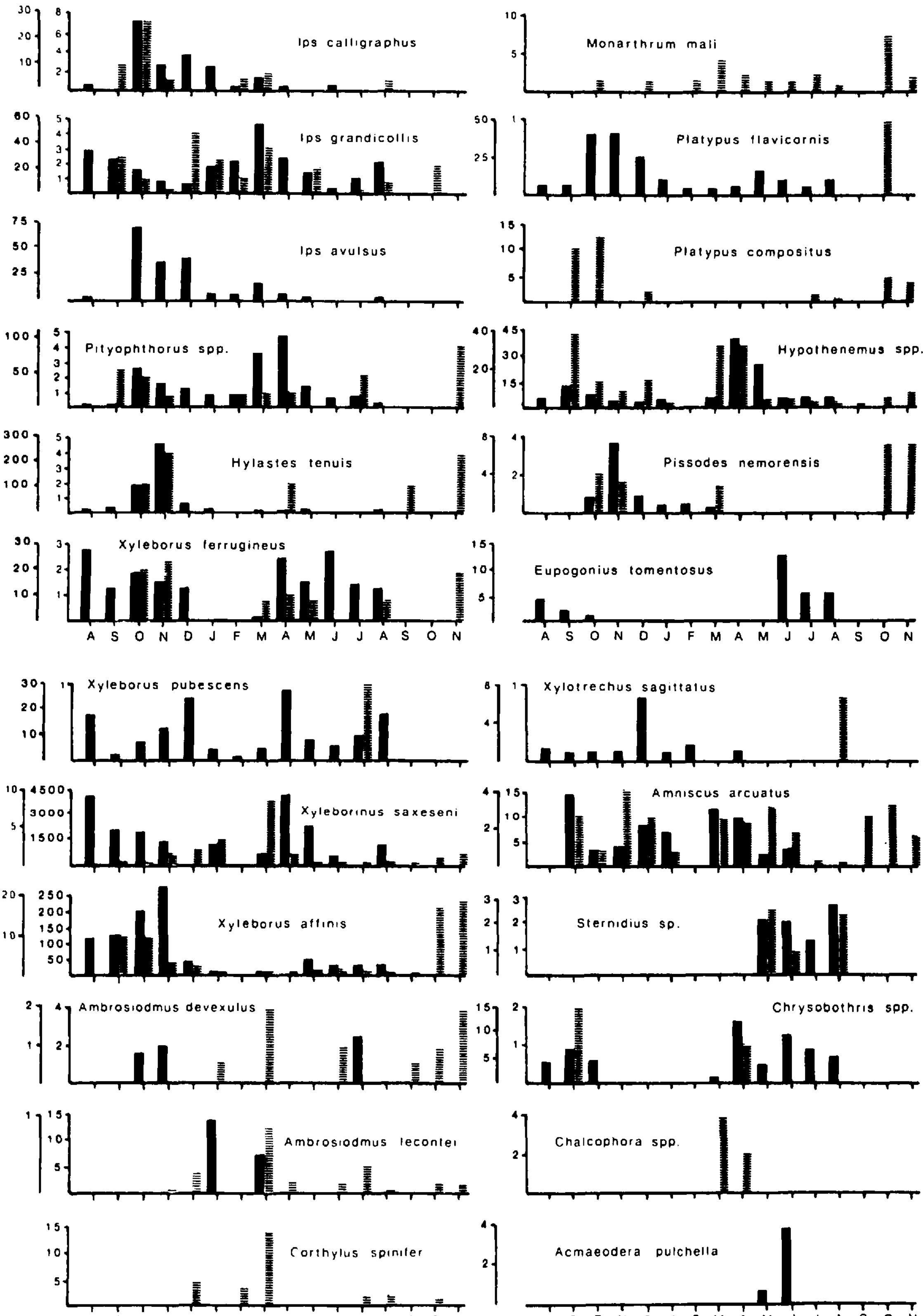

Fig. 3. Monthly totals of most abundant species caught in traps. Sticky traps (left axis, solid bars) run from August 1977 to August 1978. Window traps (right axis, striped bars) run from September 1977 to November 1978.

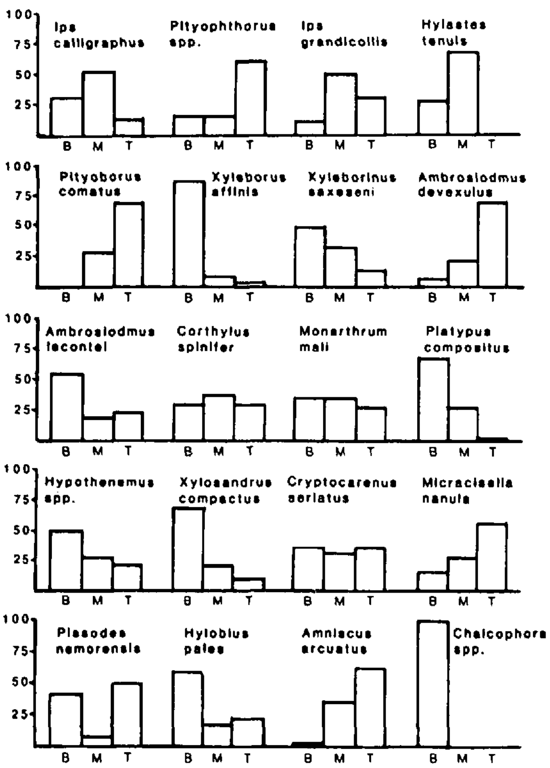

Fig. 4. Vertical distributions of commonly trapped species in window traps. Centers of traps at 1 (B), 3 (M), and 5 m (T) above ground.

species. Unlike other similar studies of seasonal activity (Beckwith 1972, Roling & Kearby 1975, Turnbow & Franklin 1980), most species of Scolytidae and Platypodidae were present throughout the year. It seems likely that the observed fluctuations do not reflect discrete generations, but rather periods of greater activity or higher populations. Under local conditions, most of the species in these two families probably breed continuously (Atkinson 1979, personal observation). Common patterns were peaks in the fall months of *I. calligraphus* (Germar), *I. avulsus* (Eichh.), *H. tenuis*, *P. flavicornis*, and *P. compositus*; in spring months of *I. grandicollis* (Eichh.), or in both periods of *Pityophthorus* spp., *X. ferrugineus*, *X. pubescens*, *Hypothenemus* spp. The low catches in January and February probably are due to the low flight activity by most species. Low catches in the hot summer months may reflect lower activity or lower survival rates. *Xyleborinus saxeseni* was most abundant during the colder months of the year (as indicated in window trap data).

Although fewer specimens of the larger species of Curculionidae, Buprestidae, and Cerambycidae were captured, most of them were encountered during relatively discrete periods and were absent during the rest of the year. These species may have discrete generations or very restricted periods of flight activity. *Pissodes nemorensis* Germar was active in the fall and winter, while *Chalcophora* spp. and *Acmaeodera pulchella* (Herbst.) were trapped in the spring months. *Eupogonius tomentosus* (Hald.), *Chrysobothris* spp., and *Sternidius* sp. were most frequently captured during the summer months. On the other hand, *Xylotrechus sagittatus* (Germar) and *Amniscus arcuatus* (LeC.) were captured throughout the year.

Vertical Distributions. Most species were not caught in window traps in large enough numbers to permit conclusions about their vertical flight patterns. However, among the more frequently encountered species, there was a rough correlation between breeding habits and height at which they were trapped (Fig. 4). *Pityoborus comatus* (Zimm.), *Pityophthorus* spp., and *Amniscus arcuatus* breed mostly in pine branches and were most frequently trapped in the upper levels. *Micracisella nanula* (LeC.), also more frequently captured in the upper levels, breeds in twigs of hardwoods. Larger pine bark beetles, such as *Ips calligraphus*, *I. grandicollis*, and *Hylastes tenuis*, breed in roots and trunks and were more abundant in the lower and middle levels. Captures of *Hylobius pales*, a root- and stump-breeding weevil of pines, and *Chalcophora* spp., trunk borers of pines, were also strongly skewed towards lower levels. The ambrosia beetles *Xyleborus affinis*, *Xyleborinus saxeseni*, *Ambrosiodmus lecontei*, and *Platypus compositus* were more abundant at lower trap levels; these species breed in the lower boles of standing or downed trees. *Ambrosiodmus dexevulus*, *Corthylus spinifer*, and *Monarthrum mali*, ambrosia beetles known to breed in branches as well as trunks, were trapped in similar numbers at all levels or predominantly at higher levels. *Hypothenemus* spp. and *Xylosandrus compactus* were most frequently captured at the lower trap levels and probably breed almost exclusively in twigs of the shrubby understory plants.

General trapping methods are frequently used in ecological studies to obtain data on population fluctuations or relative abundances of several to many species, or both. Interpreting results, often difficult for a single species, is even more difficult for multiple species. In practice, one cannot use the best trapping methods for each species of interest. We have shown here that two types of traps commonly used for forest Coleoptera present very different "pictures" of the fauna of wood- and phloem-boring beetles in a slash pine plantation in North Florida. Trap data are most useful when something is already known about the biology of the species caught. Familiarity with the area, general observations, other concurrent studies, and information available from the literature, are needed for critical interpretation of results.

Acknowledgment

We thank Mark Deyrup, Wayne Dixon, and Robert Turnbow for their reviews of early manuscripts. This study was supported by a grant from the Coastal Plains

Commission. Florida Agricultural Experiment Station Journal Series No. 7909.

References Cited

Atkinson, T. H. 1979. Bionomics of *Pissodes nemorensis* (Coleoptera: Curculionidae) in North Florida. Ph.D dissertation, University of Florida, Gainesville.

Baker, W. L. 1972. Eastern forest insects. U.S. Dep. Agric. For. Serv. Misc. Publ. 1175.

Beckwith, R. C. 1972. Scolytid flight in white spruce stands in Alaska. Can. Entomol. 104: 1977–1983.

Bustamante O., F. & T. H. Atkinson. 1984. Biologia del barrenador de las ramas del peral *Corthylus fuscus* Blandford (Coleoptera: Scolytidae) en el norte del estado de Morelos. Fol. Entomol. Mex. 60: 83–101.

Dixon, W. N. & T. L. Payne. 1979. Sequence of arrival and spatial distribution of entomophagous and associate insects on southern pine beetle-infested trees. Tex. Agric. Exp. Sta. Misc. Publ. 1432.

Hosking, G. P. & F. B. Knight. 1975. Flight habits of some Scolytidae in the spruce-fir type of northern Maine. Ann. Entomol. Soc. Am. 68: 917–921.

Moeck, H. A. 1970. Ethanol as the primary attractant for the ambrosia beetle *Trypodendron lineatum* (Coleoptera: Scolytidae). Can. Entomol. 102: 985–995.

1971. Field test of ethanol as a scolytid attractant. Can. Dep. Fish. For. Bi-Mon. Res. Notes 27: 11–12.

Pielou, E. C. 1969. An introduction to mathematical ecology. Wiley, New York.

Roling, M. P. & W. H. Kearby. 1975. Seasonal flight and vertical distribution of Scolytidae attracted to ethanol in an oak-hickory forest in Missouri. Can. Entomol. 107: 1315–1320.

Turnbow, R. H., Jr., & R. T. Franklin. 1980. Flight activity by Scolytidae in the northeast Georgia Piedmont (Coleoptera). J. Ga. Entomol. Soc. 15: 26–37.

Wilkening, A. J., J. L. Foltz, T. H. Atkinson & M. D. Connor. 1981. An omnidirectional flight trap for ascending and descending insects. Can. Entomol. 113: 453–455.

Wood, S. L. 1982. The bark and ambrosia beetles of North and Central America (Coleoptera: Scolytidae), a taxonomic monograph. Great Basin Natur. Mem. 6: 1–1359.

Received for publication 28 January 1987; accepted 28 October 1987.