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A SAMPLING OF FOREST-FLOOR SPIDERS (ARANEAE) BY EXPELLANT, MOOSEHORN NATIONAL WILDLIFE REFUGE, MAINE

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ABSTRACT

Spiders of 14 families, 34 genera, and at least 36 species were collected by formalin extraction from sub-litter habitats of the forest floor, Moosehorn National Wildlife Refuge, Washington County, Maine, in 1987. Species per family ranged from 1 to 7; the Erigonidae had the richest representation with 19.4% of all species. Most species (64.0%) were represented by sexually mature spiders; the ratio of female to male spiders was 3.2:1. Species of web-spinning spiders outnumbered species of hunting spiders 2 to 1. Numbers of spiders/0.25 m^2 circular plot ranged from 1 to 4; mean overall density of sub-litter spiders was 1.12 ± 0.17 SE, where N = 36 plots. Most (67.3%) of the spiders were associated with only one forest-stand type, possibly indicating species-habitat specificity.

INTRODUCTION

Spiders are increasingly recognized as important components of forest ecosystems (e.g., Moulder and Reichle 1972); however, relatively few studies have addressed the forest-floor araneofauna of particular forest-stand types. For northeastern forests of the United States and Canada, spruce-fir (*Picea-Abies*) stands have received the most attention (Freitag et al. 1969; Rudolf 1970; Carter and Brown 1973; Varty and Carter 1974; Jennings et al. 1988; Hilburn and Jennings 1988). Northern hardwood stands and mixed hardwood-softwood stands have received much less attention (Cutler et al. 1975), particularly those in Maine (Procter 1946). Most araneological studies of hardwood types concern forest-litter spiders of southern and midwestern deciduous forests (Bultman and Uetz 1984; Coyle 1981; Gasdorf and Goodnight 1963; Uetz 1979).

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As part of an investigation on the bioenergetics of the American woodcock, *Scolopax minor*, spiders were collected by a limited sampling technique from numerous forest-floor habitats of the Moosehorn National Wildlife Refuge in eastern Maine. Because detailed information was taken on tree-species composition and forest-stand type, these collections provide descriptive, habitat-associational information for the collected spider species.

METHODS

Spiders were collected from the soil surface following litter removal and formalin extraction on 36 circular 0.25-m^2 plots established temporarily at several locations on the Moosehorn National Wildlife Refuge, Calais and Baring Minor Civil Divisions, Washington County, Maine. The collections were made from 24 April to 16 June 1987, with plot-sampling dates distributed unevenly among months; April (N = 3 dates), May (N = 14), and June (N = 6). Plots were located at sites used by radio-marked woodcock and were sampled only once. Because of differential selection of forest stands by woodcock, the 36 sampling plots were distributed unevenly among forest-stand types, predominantly deciduous trees (N = 27 plots), coniferous trees (N = 8), and mixed coniferous-deciduous trees (N = 1). Forest-stand types were determined by a modified version (G. F. Sepik, Moosehorn NWR, unpubl.) of the Society of American Foresters (SAF) classification system (Eyre 1980). Each stand type was characterized by one or two predominant tree species. Deciduous tree species were: speckled alder, *Alnus rugosa*; bigtooth aspen, *Populus grandidentata*; quaking aspen, *P. tremuloides*; red maple, *Acer rubrum*; gray birch, *Betula populifolia*; and paper birch, *B. papyrifera*. Coniferous tree species were: balsam fir, *Abies balsamea*; spruces, *Picea* spp.; and eastern white pine, *Pinus strobus*. Common and species names of trees follow Little (1979).

At each site, a 0.25-m^2 ring (PVC pipe) was placed on the ground and all leaf litter removed down to the humus-mineral soil layer (Fig. 1). Spiders were not collected from the loose leaf litter; however, some litter-inhabiting species probably descended to the soil as the litter was removed. After litter removal, a 0.2% formalin solution was poured over the soil to extract spiders and earthworms (Reynolds et al. 1977). All spiders captured within 10 minutes following application of the expellant were placed in 75-80% ethanol.

For the most part, only sexually mature spiders were identified to species. Juvenile and penultimate stages were identified to family or generic level. Representative specimens of most spider species found will be deposited in the arachnid collections of the U.S. National Museum of Natural History, Washington, DC.

RESULTS

Spiders of 14 families, 34 genera, and at least 36 species were collected by formalin extraction from sub-litter habitats of the forest floor, Moosehorn National Wildlife Refuge, Maine, in 1987 (Table 1). Species per family ranged from 1 to 7. The Erigonidae had the richest representation with 19.4% of all species. Most (64.0%) of the species were represented by sexually mature spiders.

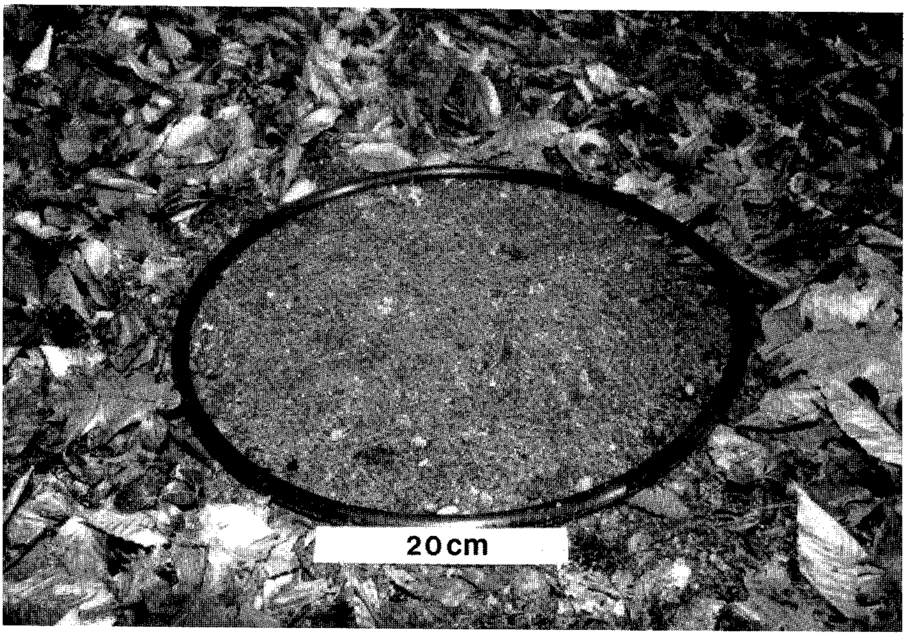

Figure 1.—Ring of PVC pipe used to delineate 0.25-m^2 plots. Spiders were collected from the sub-litter layer after removal of leaf-litter.

Species of web-spinning spiders (66.7%) outnumbered species of hunting spiders (33.3%) 2 to 1.

Eighty-one spiders were collected from the 36 circular 0.25-m^2 plots. Individuals were distributed unevenly among life stages; juveniles and penultimate stages comprised 58% of all specimens, while sexually mature males and females made up the remaining 42%. Overall, more females ($\Sigma = 26$) than males ($\Sigma = 8$) were collected.

Because of the limited sampling method used, the number of spiders per plot was very low, ranging from 1 to 4. The mean overall density of spiders collected from sub-litter habitats was 1.12 ± 0.17 SE, where $N = 36$ 0.25-m^2 circular plots.

The frequency distribution of forest-stand types among spider taxa ranged from 1 to 4 (Table 1). Most (67.3%) of the spiders were associated with only one forest-stand type; few (32.7%) were found in two or more stand types. As expected, spider species and individuals paralleled the apportionment of plots among forest-stand types (Table 2). Interestingly, nearly all (87.5%) of the hunting spiders were collected from stands with predominantly deciduous trees; few were collected from stands with coniferous trees.

DISCUSSION

Most of the species of spiders collected during this study are typical ground-inhabiting species often associated with forest leaf litter. Many have been taken by pitfall traps in spruce-fir forests of central and west-central Maine (Jennings et al. 1988; Hilburn and Jennings 1988); others have been collected from under stones and among dead leaves and by sifting spring-flood debris in Connecticut (Kaston 1981). The species we collected that appear unusual for forest-floor

Table 1.—Species and numbers of spiders collected from 36 circular 0.25-m^2 plots, sub-litter habitats of the forest floor, Moosehorn National Wildlife Refuge, Maine, 1987.

FAMILY Genus species	Number Males	 Females	 juv.	Forest-stand type
	WEB SPINNERS			
AGELENIDAE	(0)	(3)	(5)	
Agelenopsis sp.			1	Alder
Cicurina brevis (Emerton)		3		Aspen-Maple; W. Pine-Aspen; W. Pine
Cicurina sp.			3	Aspen; Maple-P. Birch; Maple-G. Birch
Wadotes sp.			1	Maple
HAHNIIDAE	(0)	(1)	(1)	
Antistea brunnea (Emerton)		1		Alder-Aspen
Undet. sp.			1	W. Pine
AMAUROBIIDAE	(1)	(4)	(4)	
Amaurobius borealis Emerton	1	3		Alder; Aspen; Maple
Amaurobius sp.			1	Alder
Callobius bennetti (Blackwall)		1		Aspen-Maple
Undet. sp.			3	Alder; Alder-Aspen
DICTYNIDAE	(0)	(1)	(1)	
Dictyna minuta Emerton		1		Alder
Dictyna sp.			1	Balsam fir
THERIDIIDAE	(1)	(4)	(6)	
Euryopis argentea Emerton	1			Spruce-Fir
Robertus riparius (Keyserling)		2		Alder; W. Pine
Theridion aurantium Emerton		1		Spruce-Fir
Theridion sexpunctatum Emerton		1		Balsam fir
Theridion sp.			3	Alder; Aspen
Undet. sp.			3	Alder; Maple; Balsam fir
LINYPHIIDAE	(0)	(2)	(2)	
Lepthyphantes zebra (Emerton)		2		Aspen; W. Pine-Aspen
Prolinyphia marginata (C. L. Koch)			1	Spruce-Fir
Undet. sp.			1	Aspen-Maple
ERIGONIDAE	(3)	(5)	(7)	
Ceraticelus fissiceps (O.P.-Cambridge)		1		Maple-G. Birch
Diplocephalus cuneatus Emerton		1		Aspen
Hypselistes florens (O.P.-Cambridge)	1			Aspen
Maso sundevallii (Westring)	1	1		Alder; Maple-G. Birch
Tunagyna debilis (Banks)		1		Aspen
Walckenaëria auranticeps (Emerton)	1			G. Birch
Walckenaëria directa (O.P.-Cambridge)	1			Maple-Aspen
Undet. sp.				Aspen; Maple-Aspen; W. Pine; Balsam fir
ARANEIDAE	(0)	(1)	(4)	
Araneus sp.			1	Spruce-Fir
Mangora placida (Hentz)		1		Balsam fir
Mangora sp.			1	Aspen
Neoscona sp.			2	Aspen; Maple-Aspen
TETRAGNATHIDAE	(0)	(0)	(1)	
Tetragnatha sp.			1	Aspen

	HUNTERS			
LYCOSIDAE	(0)	(0)	(6)	
Pardosa sp.			1	Aspen
Pirata sp.			3	Alder-Aspen; Maple-Aspen
Trochosa sp.			2	Aspen; W. Pine
GNAPHOSIDAE	(1)	(0)	(1)	
Callilepis sp.			1	Aspen-Maple
Zelotes fratris Chamberlin	1			Aspen-Maple
CLUBIONIDAE	(0)	(4)	(2)	
Agroeca ornata Banks		1		Aspen
Clubiona sp.			1	Aspen
Phrurotimpus alarius (Hentz)		3		Aspen; Aspen-Maple
Phrurotimpus sp.			1	Aspen
THOMISIDAE	(1)	(1)	(5)	
Ozyptila sp.			1	W. Pine
Xysticus elegans Keyserling	1	1		Aspen; Aspen-Maple
Xysticus sp.			4	Maple-Aspen; G. Birch; Maple-G. Birch; Balsam fir
SALTICIDAE	(1)	(0)	(2)	
Habrocestum sp.			1	Aspen
Metaphidippus flaviceps Kaston	1			Aspen
Metaphidippus sp.			1	Aspen

habitats include *Araneus* sp., *Mangora placida* (Hentz), *Neoscona* sp., *Hypselistes florens* (O.P.-Cambridge), *Prolinyphia marginata* (C. L. Koch), *Tetragnatha* sp., and *Metaphidippus flaviceps* Kaston. Because these species generally are associated with herb-shrub-tree strata, we suspect that individuals descended from upper levels to the forest floor.

Seven of the species of spiders collected by formalin extraction from forest-floor habitats of the Moosehorn National Wildlife Refuge have not been captured by extensive pitfall trapping in coniferous forests of Maine (Jennings et al. 1988; Hilburn and Jennings 1988). These include species represented by sexually mature spiders—*Dictyna minuta* Emerton, *Walckenaeria auranticeps* (Emerton), *Euryopis*

Table 2.—Distribution of forest-floor plots and collected spiders among three groups of forest-stand types, Moosehorn National Wildlife Refuge, 1987. *Groupings based on predominant trees; see text for tree species. †Mixed coniferous-deciduous trees. ††Conservative estimate; excludes undetermined species. Some species were found in more than one forest-stand type.

		Forest-stand type*					
		Deciduous		Coniferous		Mixed†	
Parameter	*N*	Σ	(%)	Σ	(%)	Σ	(%)
Plots	36	27	(75.0)	8	(22.2)	1	(2.8)
Species††							
web spinners	31	20	(64.5)	9	(29.0)	2	(6.4)
hunters	14	11	(78.6)	3	(21.4)	0	(0.0)
Individuals							
web spinners	57	40	(70.2)	15	(26.3)	2	(3.5)
hunters	24	21	(87.5)	3	(12.5)	0	(0.0)

argentea Emerton, and *Phrurotimpus alarius* (Hentz)—and species represented only by juveniles—*Callilepis* sp., *Habrocestum* sp., and *Ozyptila* sp. Little is known about their specific micro-habitat requirements; our data on forest-stand associations broaden the range of known habitats for these species.

No doubt, our sampling method (i.e., removal of litter without sorting for spiders) greatly contributed to the relatively low densities of spiders observed in sub-litter habitats of Maine. Hand sorting the litter, or extraction of leaf-litter spiders by Berlese or Tullgren funnel (Southwood 1978) should substantially add species and individuals to the list of spiders from forest-floor habitats.

Collection of spiders by expellant yielded a greater proportion (3.2:1) of females to males. Pitfall traps, on the other hand, are selectively biased toward capture of male spiders. Male spiders generally are more mobile and may move considerable distances in search of female spiders; hence, the sexes are seldom equally represented in pitfall-trap catches (Hallander 1967; Muma 1975).

Our study suggests that forest-floor spiders are not confined to the leaf-litter layer; we collected spiders from the sub-litter layer. After treatment with formalin, some spiders emerged from cracks and crevices in the soil. However, some of the spiders in our samples may have descended from upper layers, including leaf-litter and herb-shrub-tree strata.

Results of this study indicate that the araneofauna associated with forest-floor habitats of the Moosehorn National Wildlife Refuge is: (1) diverse, (2) composed of species and individuals that represent at least two spider-foraging strategies, and (3) possibly habitat specific, with few species shared in common among forest-stand types. Additional studies are needed to better define the araneofauna of any one forest-stand type. Studies also are needed to compare sampling methodologies (e.g., expellant vs pitfall-traps) at the same time, place, and stratum. On the basis of our study and previous studies (Bultman and Uetz 1984; Carter and Brown 1973; Uetz 1975, 1979), we predict that each forest-stand type will be composed of spider-species assemblages that are characteristic and descriptive for that type.

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