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## **A COMPARISON OF THE SPIDERS OF THREE CONIFEROUS TREE SPECIES**

**Gail E. Stratton and George W. Uetz**

Department of Biological Sciences  
University of Cincinnati  
Cincinnati, Ohio 45221

and

**Dean G. Dillery**

Department of Biology  
Albion College  
Albion, Michigan 49224

### **ABSTRACT**

Composition of the arboreal spider community of three coniferous tree species (red pine, white spruce, and white cedar) was studied in northern Minnesota. The number of species of spiders found on each tree species was similar (22-25 spp.), although there was low similarity of species composition between trees. Numbers of adult individuals varied greatly between trees.

Each tree species contained approximately the same proportions of web building and hunting spiders, indicating some basic resource similarity of the trees. Significant differences in composition of hunting spiders and web-building spiders at the family level were found. The importance of vegetative structure in determining the composition of each group is discussed relative to structural differences of the trees and aspects of the natural history of the spiders.

### **INTRODUCTION**

There are suggestions in the literature that the structure and composition of a spider community depends less on the herbivore population on which it preys than it does on the physical form of the vegetation (physiognomy). Luczak (1963) compared eight stands of pines which differed in age, density and presence of other plants. The stands were found to constitute three phytosociological habitats, yet the same assemblage of orb weavers was found on all eight stands. Barnes and Barnes (1955) found that spider communities in widely separated stands of broomsedge exhibit a high degree of constancy

in structure and composition. The Barnes' and Luczak both suggest that there is a relationship between the structure of plant communities and the communities of spiders that inhabit them. Riechert and Reeder (1970) observed associations between spiders and certain plant species, in a study on the effect of prairie fires on spider distribution. They attributed these associations to structural characteristics of the plants. Duffey (1966, 1970) has shown that habitat structure plays an important role in limiting the distribution of some spider species, both by providing sites of particular architecture or by influencing micro-climate. Likewise, Cherrett (1964) noted that small variations in physical factors within a habitat are associated with significant changes in the spider species present and their density.

A component community (Root 1973) is an assemblage of species associated with a particular resource and is thus a well integrated, coevolved system. Component communities may be associated with plant taxa, e.g., a tree species, or with a microhabitat, e.g., leaf litter or tree holes. Spiders are known to play an important role in a variety of component communities as predatory arthropods. For this reason studies of the spider fauna of various economically important tree species have been made (Allen et. al. 1970, Bosworth et. al. 1971, Chant 1956, Coppel et. al. 1963, Dondale 1956, 1958, 1961, Fichter 1939, Hukusima 1961, Jennings 1976, Legner and Oatman 1964, Loughton et. al. 1963, Luczak 1963, Peck et. al. 1971, Putman 1967, Renault and Miller 1972, Specht and Dondale 1960, Turnbull 1956, 1960, Uetz and Dillery 1969, Warren et. al. 1967).

We pursued the question of the effect of vegetation structure on communities of spiders by comparing the spider fauna on three species of coniferous trees common in Northern Minnesota. The tree species were red pine (*Pinus resinosa* Ait.), white spruce (*Picea glauca* (Moench)), and white cedar (*Thuja occidentalis* L.), and were chosen for the study because they differ in physical structure.

## METHODS

The study was completed at the Field Biology Station of the Associated Colleges of the Midwest between July and August, 1975. The station was located on Basswood Lake in the Boundary Waters Canoe Area (BWCA) in northeastern Minnesota. The forest in this area is predominantly coniferous. The three species of trees were all common in the immediate area of the field station, but they differed in exact location as well as in age and size representation. The white cedar was most common on the islands in Basswood Lake, and was represented primarily by mature trees. White spruce was common inland in large stands. Red pine was also common inland. Data were collected from immature trees located in small planted stands near the station.

Collections were made with a sweep net, and were made only from branches within reach of the ground (max. 1.5 m). The branches were placed within the sweep net and shaken vigorously. The net was then emptied onto a small ground cloth and the spiders were caught and placed in vials of 75% ethanol. A total of 30 minutes collecting with the sweep net was spent on each tree species. No spiders were collected from the trunk region. There was no attempt to test the adequacy of this sample size. There was also no attempt to determine site variance, seasonal variance, or variance between trees of the same species. Future research should account for these variables.

The spiders were separated to adults and immatures and identified to family and where possible, identified to genus and species. Spiders that could not be identified to

species were separated and counted as morpho-species. The criterion for morpho-species was general appearance (not genitalia). Adult spiders were the basic working unit of all the comparisons made in the study.

Sorensen's Similarity Quotient (QS) (Sorensen 1948) was used to determine the degree of similarity of spider faunas collected from the trees:  $QS=2C/(A+B)$ , where A and B are numbers of species from each sample, and C is the number of species held in common. If QS is less than 50%, the two samples being compared are considered dissimilar (Price 1975).

A second test of similarity, percentage similarity (PS) (Czekanowski 1909, Curtis 1959) was calculated to determine the percentage of spider species held in common between the tree species. The formula is:  $PS=2w/(a+b)$ , where  $w$ =minimum sum of individuals of species held in common between the samples being compared;  $a$  and  $b$  = the totals of individuals found on the cedar, spruce or pine. No unidentified spider was counted in either the total or the sum of spiders held in common.

## RESULTS

A total of 577 adults were collected, representing 9 families, 36 genera and at least 38 species. A species list is given in Appendix 1. The number of species of spiders found on each tree species was fairly constant, while the number of adult individuals varied greatly between tree species. The spruce had both the highest number of species and the highest number of individuals.

Spider composition was compared according to method of prey capture, with hunting spiders comprising one group and web building spiders comprising a second (Figure 1). The same relative composition of each group was found on each of the tree species. The

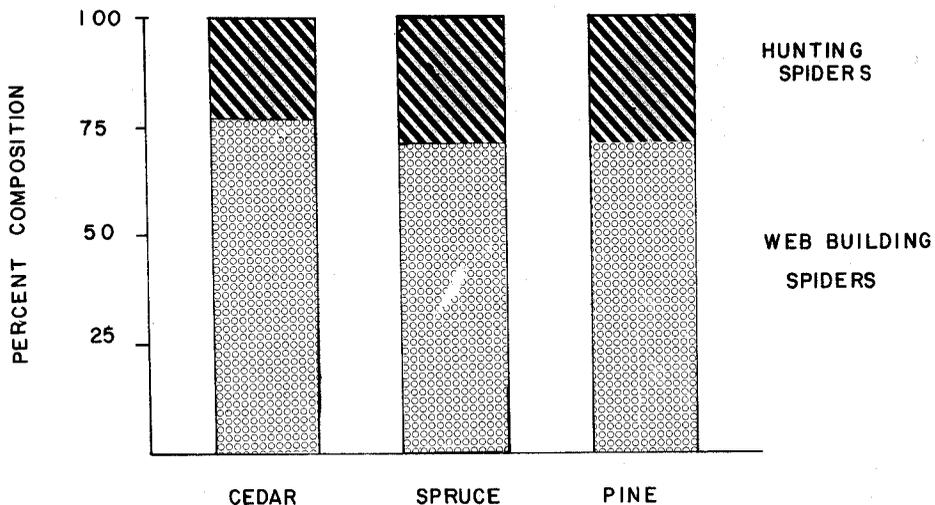


Fig. 1.—Composition of spiders by foraging strategy on three tree species in the BWCA, Minn. The two groups, web building spiders and hunting spiders, represent the major foraging strategies of spiders.

Table 1.—Number of adult spiders and number of spider species collected from three tree species found in the BWCA, Minn.

	TREE SPECIES			Total
	Cedar	Spruce	Pine	
Total Number of Individuals (Adults)	133	267	177	578
Number of species	22	25	24	41

web building group made up 74.6%, 74.3% and 79.7% for pine, spruce, and cedar, respectively. To test significance of differences in relative composition between tree species, a test of independence for R X C contingency tables was used (G-test; Sokal and Rohlf 1969).

Relative composition of the groups representing the two major spider foraging strategies (web building and hunting spiders) is not significantly different between tree species (Figure 1) ( $G=1.622; 0.1 < p < 0.5$ ). Although the proportions of the groups are constant for all the trees examined, there are marked differences in the families comprising the groups on each of the tree species. In the web building group, the orb weavers, Araneidae and Tetragnathidae are more numerous on cedar than on spruce (Figure 2). In the pine and spruce, the space web builders are more prominent than the orb weavers. The theridiids, dictynids and linyphiids are termed space web builders, because their webs are three dimensional and fill spaces between structures like needles or branches. Theridiidae (scattered line weavers) and Dictynidae (hackled band weavers) are the predominant space web builders on cedar. The Linyphiidae (sheet line weavers) make up the largest proportion of space webs in the spruce. Tree species has a significant influence on the relative composition of spiders ( $G=85.623; p < 0.01$ ) of the web-building group.

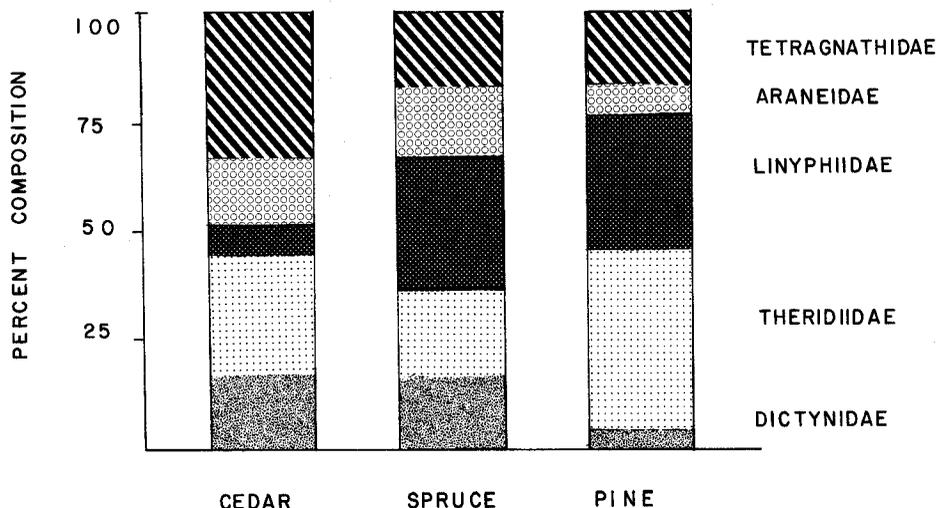


Fig. 2.—Composition of web building spiders by family on each of the three tree species.

Table 2.—Two indices of similarity: 1) Similarity quotient (QS), species similarity based on presence or absence of species (Sorensen 1948) and 2) Percentage Similarity (PS), based on relative abundance of species held in common (Curtis 1959), calculated for spider faunas on the three tree species.

	Pine and Spruce		Pine and Cedar		Spruce and Cedar	
	QS	PS	QS	PS	QS	PS
Hunting Spiders	0.66	0.51	0.54	0.39	0.41	0.32
Web Building Spiders	0.63	0.48	0.31	0.45	0.42	0.49
All Spiders	0.65	0.48	0.43	0.44	0.41	0.55

The hunting spider group (Figure 3) contains the families Salticidae (jumping spiders) and Thomisidae (crab spiders). Hunting spider composition of the cedar and spruce were similar; though Salticidae were less well represented on red pine. These differences were of marginal significance ( $G=8.843; 0.1 > p > 0.05$ ).

There is a higher similarity quotient (QS) for all three groupings of spiders found on pine and spruce than on pine and cedar or on spruce and cedar (Table 2). The lowest similarity quotient was found comparing the web building spiders on pine and cedar. The percentage similarity (PS) showed the same trend (higher similarity on pine and spruce) for the hunting spiders only. Interestingly, while the web building spiders showed variable similarity quotients (0.31 to 0.63), the percentage similarity was fairly constant (0.45 to 0.48).

DISCUSSION

Although the community of spiders of each tree is different, the relative composition of groups of spiders (defined by their method of prey capture) appears to be similar from

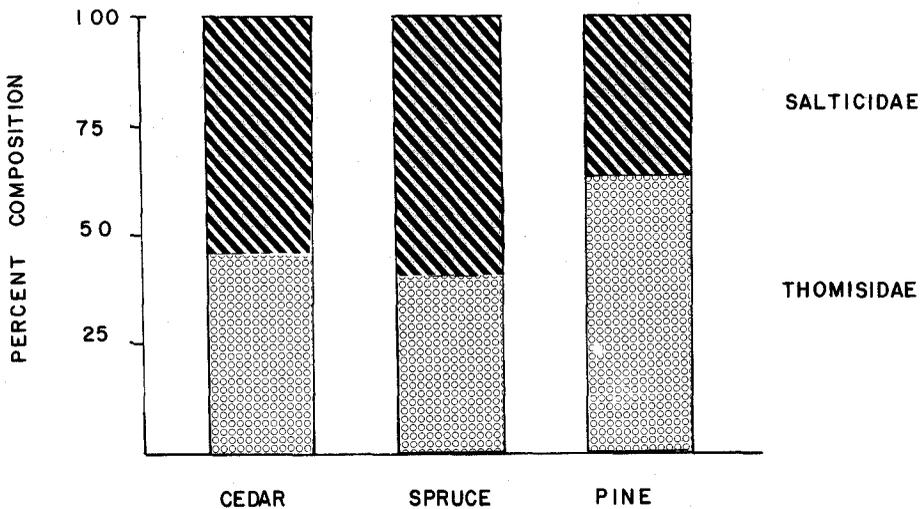


Fig. 3.—Composition of hunting spiders by family on each of the three tree species.

one tree type to the next. Similar ecological roles—predation by active hunting or predation by construction of webs—may be taken by different families on different trees. The similarity in proportions of wandering spiders and web building spiders may imply some basic resource similarity of the trees. However, the differences in the relative composition of families implies that there may be subtle differences in the trees which influence spiders at the family level. Web building spider families differ in web type, while hunting spiders may differ in foraging behavior. Many of the differences seen in the composition of spiders on the three conifers might then be explained by structural differences of the trees and aspects of the natural history of each group.

The dominance of the space web group (Linyphiidae and Theridiidae) on the pine and spruce could be explained by the structure of needles and branches. There are numerous spaces in the spruce that such webs could fill. The Dictynidae are small space web builders and were relatively more abundant on both the cedar and spruce. Their webs fill the spaces between the needles of the spruce and between the ends of the overlapping needles of the cedar branches. Red pine does not provide a suitable structure for their webs as the needles are divergent and very flexible.

The orb weavers, a large portion of which are tetragnathids, are predominant on white cedar. Tetragnathid webs tend to be oriented at an angle or nearly horizontal and are commonly found near water (Kaston 1972). These two characteristics might affect the web building site preference of these spiders. Branches of cedars tend to hang down or droop, leaving large areas beneath the branches for horizontal webs. The cedar trees were most common on the smaller islands and were close to the waters edge. The higher humidity of these sites might favor tetragnathids, as suggested by Cherrett (1964).

Hunting spiders are not as likely to be dependent on tree structure, as they do not build webs. However, differences in the hunting spider fauna on different trees do exist (Figure 3) and the structure of the tree may be important. The greater relative abundance of thomisids on the red pine might be explained by the structural characteristics of the needles. The red pine needles are flexible and are in clusters of two. They might not provide sufficient support for the larger salticid spiders who need a solid platform from which to jump. Also, the clustering of the needles could provide a suitable hiding place for the thomisids, who tend to "sit and wait" for their prey.

Lower similarity index values indicate that the spider fauna of cedar is the most unique of the three trees examined. The cedar has the most distinctive needle structure of the three tree species. It also differs the most in location from the other trees, which in turn could affect many important variables: microclimate, rates of immigration and emigration and mortality.

The differences between patterns shown by the two similarity indices reflect differences in the indices themselves. The presence or absence of species is included in calculation of QS, while relative abundance of species is included in the PS index. It is unclear why there should be a different pattern for web building spiders in the PS index and not hunting spiders.

These examples fit the categories that Turnbull (1973) suggested as how the structure of vegetation could influence the spider fauna: (1) the architectural characteristics of some plants could suit the behavioral patterns of some spiders, (2) the plant formation could provide favorable or unfavorable microclimatic factors. This study exemplifies the first category suggested by Turnbull; data are not available to test the second. There are likely to be several important microclimatic variables that might be influenced by tree structure. For example, wind speed, air temperature, and humidity could all potentially

affect spider species composition. Despite a lack of microclimate data, we believe that our data strongly suggest that vegetative structure is important in determining the composition of the arboreal spider community.

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## APPENDIX I

## List of Genera and Species and Numbers of Adults.

	Hunting Spiders				Web-Building Spiders		
	Pine	Spruce	Cedar		Pine	Spruce	Cedar
Family Salticidae	16	37	14	Family Tetragnathidae	20	32	40
<i>Zygoballus</i> sp.	1			<i>Teragnatha</i> sp.	20	32	40
<i>Eris</i> sp.	1	7	3	Family Araneidae	9	32	15
<i>Sassacus</i> sp.		1		<i>Mangora</i> sp.			1
<i>Agassa</i> sp.		2		<i>Araniella displicata</i> Hentz		1	
<i>Thiodina</i> sp.		2	4	<i>Zygiella</i> sp.		2	12
<i>Phidippus</i> sp.	4	3		<i>Metepeira</i> sp.			2
<i>Metacryba</i> sp.	3	1		Unidentified	9	29	
<i>Sarinda</i> sp.			2	Family Linyphiidae	42	60	7
<i>Metaphidippus</i> sp.			2	<i>Frontinella</i> sp.	6	11	
<i>Ballus youngii</i> Peckham			2	<i>F. pyramitela</i> (Walckenaer)	3	20	
<i>Icius</i> sp.			1	<i>Pityohyphantes</i> sp.		1	
<i>Phlegra</i> sp.		6		<i>P. costatus</i> (Hentz)	2		
Unidentified	7	15		<i>Bathyphantes</i> sp.	5		
Family Thomisidae	27	26	12	<i>Drapetisca</i> sp.	26		3
<i>Tmarus</i> sp.	2	3		Unidentified		28	4
<i>Coriarachne</i> sp.	5	1	2	Family Theridiidae	59	41	29
<i>Misumenoides</i> sp.	8	12	7	<i>Achaeearanea</i> sp.			1
<i>Ozyptila</i> sp.	2	5		<i>Ctenium</i> sp.	7		2
<i>Xysticus</i> sp.		1		<i>Theridion</i> sp.	45	25	26
<i>Thanatus</i> sp.			2	<i>Anelosimus</i> sp.	7	16	
Unidentified	10	4	1	Family Dictynidae	2	34	15
Family Gnaphosidae	1			<i>Dictyna</i> sp.	2	34	15
<i>Drassyllus</i> sp.	1						
Family Clubionidae	1	5	1				
Unknown	1	5	1				