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ORIGINAL ARTICLE **OPEN ACCESS**

Microhabitats of Pholcid Spiders (Araneae: Pholcidae) at the Center for Ecological Development and Recreation, Impasug-ong, Bukidnon, Philippines

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ABSTRACT
Microhabitats are key determinants of species distribution, abundance, and species diversity. This study was conducted to determine the microhabitats of pholcid spiders at the Center for Ecological Development and Recreation, Impasug-ong, Bukidnon. Sampling was conducted using the cruising method.All possible microhabitats of pholcids were searched particularly broad-leaf plants, buttresses, rock crevices, and forest floor litter. Twelve microhabitats were identified.Species richness was high on bamboo sheath, understory plant, leaf litter, and the aroid plant Schismatoglottis sp.The degree of complementarity (C) or distinctness between microhabitats of pholcid spiders was high, with C=100%. This accounts for 51% distinctness of the total number of paired microhabitats. This indicates that microhabitats of pholcid spiders may be species-specific.
Keywords: *Complementarity,Cruising method, Determinants, Distinctness, species diversity.*

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INTRODUCTION

Microhabitats influence the organism in various ways including the physiology, distribution, and diversity of different groups of spiders. Most spiders choose their preferred microhabitats according to vegetation cover so as to resist desiccation, avoid thermal stress, get access to food, enhance ability to construct web, and camouflage against predator [1, 2, 3, 4, 5].

The family Pholcidae is one of the most diverse groups of spider families [6]. Pholcids occupy different microhabitats like leaf litter, underside of live leaves, rocks, rock crevice, between buttresses, and even tree holes. Their microhabitats reflect the body shape and coloration. For instance, litter and ground-dwelling pholcids are small, have short-legs, and with dark coloration [7]. In contrast, leaf dwellers have long and slender bodies and legs and pale greenish in color [8, 9].

In the Philippines, very few pholcid spiders have been described [10]. Ecological data like microhabitats of Philippine pholcids are entirely unknown but these data are necessary in our understanding of species diversification. Hence, the study was conducted to determine microhabitats of pholcid spiders at the Center for Ecological Development and Recreation (CEDAR), Impasug-ong, Bukidnon, Philippines.

MATERIALS AND METHODS

The sampling sites were chosen according to the observed vegetation type and distance to bodies of water. Descriptions of habitats were based on the Habitat Description Form [11] and Chart for estimation of foliage cover [12]. Sample collections were done at the Center for Ecological Development and Recreation (CEDAR), located at 8°15'3.6"N latitude and 125°02'2.4"E longitude in Brgy. Impalutao, Impasug-ong, Bukidnon (Figure 1). Five sampling sites were established. The first site was near the stream (~ 2meters away) where a mixed vegetation of Poaceae and Araceae family are abundant. The second site was along the river near the Gantungan falls where rock boulders dominate the area. The third site was within the mixed dipterocarp forest, about seven meters away from a water source. The fourth site was near the Natigbasan Falls where some species of Poaceae, Araceae, Arecaceae, and Cyperaceaeare dominant near the Natigbasan stream. The 5th site was near the Dila falls which is characterized by rock boulders, grasses and sedges, and within the dipterocarp forest.

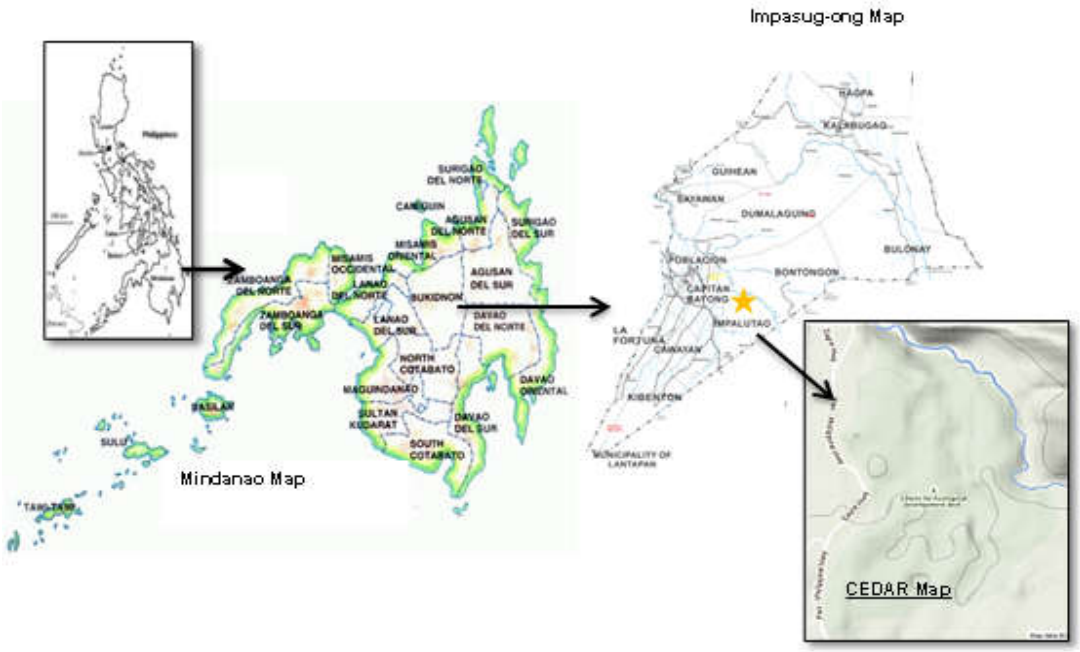

Figure 1. Map showing the location of the sampling sites at the Center for Ecological Development and Recreation in Impalutao, Impasug-ong, Bukidnon [13, 14, 15, & 16].

Collection, Processing, and Identification of specimens

The collection of pholcid spiders was done on November 15-16, 2014 and February 7, 2015 for a total of 36man-hours. Sampling was done in the morning between 700hrs to 1100 hrs and in the afternoon from 1500 hrs to 1900 hrs. Sampling was carried out after the collection permit was issued by the Department of Environment and Natural Resources (DENR). Using a combination of cruising and visual search methods, pholcid spiders were collected by actively searching under leaf litter, turning live leaves, checking between tree buttresses and other microhabitats with a maximum time limit of two hours in each site. Pholcid spiders were collected by hand and according to the microhabitat and the defense strategy of the particular species. Prior putting into the collecting jar, the sample was photographed to capture details like coloration and microhabitat. The spiders were then placed in Eppendorf tubes with 95% ethyl alcohol. Voucher specimens were identifiedby Dr. B.A. Huber and deposited at the Alexander Koenig Zoological Research Museum, Germany and at the Natural Science Museum of MSU-Iligan Institute of Technology. Each specimen that is probable new species was assigned a specific code in order to facilitate future record tracking.

Statistical Data Analyses

Data analyses were performed using Paleontological Statistics software (PAST) package version 2.17c [17] to calculate biodiversity indices of microhabitats; Statistical Process Control software (SPC) for excel to calculate ANOVA for testing means between microhabitats; and Microsoft excel 2010 software to calculate the degree of complementarity or distinctness between microhabitats, given the formula $C_{jk} = U_{jk}/S_{jk}$, where U_{jk} is the number of species unique to either site, and S_{jk} is the species richness for both sites combined; $U_{jk} = S_j + S_k - 2V_{jk}$, and $S_{jk} = S_j + S_k - V_{jk}$; S = the number of species in sites j and k, and Vjk = the number of species shared by sites j and k [18].

RESULTS AND DISCUSSION

Twelve microhabitats were identified (Table 1). The most utilized microhabitats of pholcid spiders based on the observed number of species were bamboo sheath, understory plant, leaf litter, and the aroid plant, *Schismatoglottis sp.* with three species of pholcids each. The diversity of pholcid species in each microhabitat was found low in all identified microhabitats. The abundance and species richness of pholcid spiders varied in different microhabitats. More than half of the total number of individual pholcids in CEDAR were recorded in the aroid plant, *Schismatoglottis sp.* (52%), followed by leaf litter (15%), and bamboo sheath (9%). This indicates that vegetation in the area has possibly influenced the observed abundance of pholcid spiders. A complex vegetation structure has been shown to affect the

abundance and diversity of species inhabiting foliage and even ground dwelling spiders [19, 20, 21, 22, 23, 24, 25, & 26].

Table 1. Microhabitats of assemblages of Pholcid spiders in CEDAR, Impasug-ong, Bukidnon.

Microhabitats	No. of individuals	Species Richness, S_{obs}	Shannon, H'	Evenness, E
Bamboo hole	1	1	0	1
Rock crevice	5	1	0	1
Bamboo sheath	11	3	0.7595	0.7124
Schismatoglottis sp.	63	3	0.2218	0.4161
Understory Plant	7	3	0.9557	0.8668
Leaf litter	18	3	0.7778	0.7256
Ground fern	1	1	0	1
Curculigo sp.	4	1	0	1
Artocarpus sp.	5	1	0	1
Ground/Soil	3	2	0.6365	0.9449
Sago Petiole	2	1	0	1
Decaying *Calamus*	2	1	0	1

The observed species richness between paired microhabitats was compared with the number of shared species between pairs of microhabitats (Table 2). The degree of complementarity or distinctness of species between microhabitats was significantly high, with complementarity (C) value of 100%. These high values accounted for 51% of the total number of paired microhabitats and indicate that these paired microhabitats exhibit a high level of complementarity or distinctness. This suggests that selection of microhabitat among pholcid spiders was influenced by vegetation type and microclimate [27, 28, 29, 30, 31, 32, & 33].

Table 2. Degree of Complementarity or distinctness (C) between microhabitats of Pholcid spiders. S_{jk} = combined species richness; V_{jk} = number of species shared between two microhabitats.

Microhabitats	Observed Species Richness S_j		S_k	V_{jk}	S_{jk}	Distinctness (%)
Bamboo hole - *Schismatoglottis sp.*	1	vs	3	0	4	100
Bamboo hole - Understory Plant	1	vs	3	0	4	100
Bamboo hole - Leaf litter	1	vs	3	0	4	100
Bamboo hole - Ground fern	1	vs	1	0	2	100
Bamboo hole - *Curculigo sp.*	1	vs	1	0	2	100
Bamboo hole - Alive *Artocarpus sp.*	1	vs	1	0	2	100
Bamboo hole - Ground/Soil	1	vs	2	0	3	100
Bamboo hole - Sago Petiole	1	vs	1	0	2	100
Bamboo hole - Decaying *Calamus*	1	vs	1	0	2	100
Rock crevice - *Schismatoglottis sp.*	1	vs	3	0	4	100
Rock crevice - Understory Plant	1	vs	3	0	4	100

Table 2 continued…

Rock crevice - Leaf litter	1	vs	3	0	4	100
Rock crevice - Ground fern	1	vs	1	0	2	100
Rock crevice - *Curculigo sp.*	1	vs	1	0	2	100
Rock crevice - Alive *Artocarpus sp.*	1	vs	1	0	2	100
Rock crevice - Ground/Soil	1	vs	2	0	3	100
Rock crevice - Sago Petiole	1	vs	1	0	2	100

Rock crevice	-	Decaying *Calamus*	1	vs	1	0	2	100
Bamboo sheath	-	*Schismatoglottis sp.*	3	vs	3	1	5	80
Bamboo sheath	-	Understory Plant	3	vs	3	1	5	80
Bamboo sheath	-	Ground fern	3	vs	1	0	4	100
Bamboo sheath	-	*Curculigo sp.*	3	vs	1	0	4	100
Bamboo sheath	-	Alive *Artocarpus sp.*	3	vs	1	0	4	100
Schismatoglottis sp.	-	Sago Petiole	3	vs	1	0	4	100
Schismatoglottis sp.	-	Decaying *Calamus*	3	vs	1	0	4	100
Understory Plant	-	Sago Petiole	3	vs	1	0	4	100
Understory Plant	-	Decaying *Calamus*	3	vs	1	0	4	100
Ground fern	-	Ground/Soil	1	vs	2	0	3	100
Ground fern	-	Sago Petiole	1	vs	1	0	2	100
Ground fern	-	Decaying *Calamus*	1	vs	1	0	2	100
Curculigo sp.	-	Ground/Soil	1	vs	2	0	3	100
Curculigo sp.	-	Sago Petiole	1	vs	1	0	2	100
Curculigo sp.	-	Decaying *Calamus*	1	vs	1	0	2	100
Alive *Artocarpus sp.*	-	Ground/Soil	1	vs	2	0	3	100
Alive *Artocarpus sp.*	-	Sago Petiole	1	vs	1	0	2	100
Alive *Artocarpus sp.*	-	Decaying *Calamus*	1	vs	1	0	2	100

The distribution of pholcid species in the microhabitats was also examined by looking at the proportion of the total number of species per microhabitat and the total number of microhabitats inhabited by pholcid spiders. Figure 2 showed that most pholcid species were distributed among the four microhabitats with about 14.28% of the pholcids in bamboo sheath, understory plant, leaf litter, and on the plant, *Schismatoglottis* species. Most spiders were distributed according to food availability, less potential predator, and microclimate that influence the physiological capacities of the spiders [34, 35].

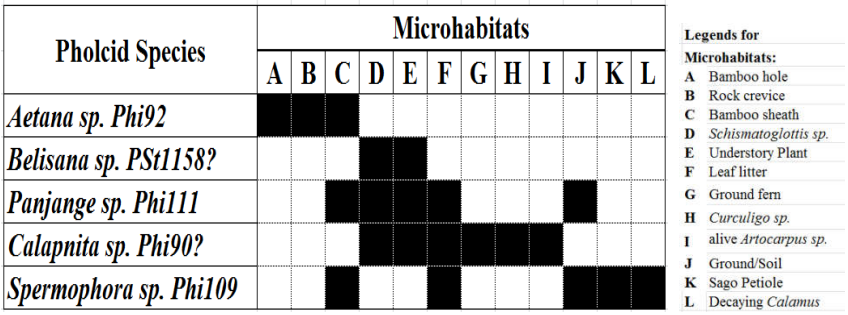

Figure 2. Seriation analysis of microhabitats.

The microhabitat preferences of pholcid spiders were also examined using the Analysis of Variance (Table 3). The result showed a significant difference in the observed number of individuals of pholcid spiders between microhabitats (p=0.0175).

Table 3. Analysis of Variance between microhabitats of Pholcid spiders in CEDAR, Bukidnon.

Source	Sum of Squares	Degrees of Freedom	Mean Square	*F*	*p* Value
Treatments	5905.019	11	536.82	2.53	0.0175
Error	7625.148	36	211.8097		

**significant*

Microhabitat preferences of spiders have been associated with the plant architecture, such as the branch orientation, the height from the ground, and the hunting strategy of the species [36].

CONCLUSION

Twelve microhabitats of pholcid spiders were identified at the Center for Ecological Development and Recreation (CEDAR), Impasug-ong, Bukidnon. The most utilized microhabitats were bamboo sheath, understory plant, leaf litter, and the aroid plant (*Schismatoglottis sp.*). Some of the identified microhabitats were shown to influence the observed species richness of pholcid spiders and differ significantly in the degree of complementarity or distinctness of pholcid spider assemblages.

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