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Microhabitats of pholcid spiders (araneae: pholcidae) in Mt. Kitanglad Agri-Ecological and Techno-Demo Center, Imbayao, Bukidnon, Philippines

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Key words: Broad-leaf, Leaf-litter, Rock crevice, *Spathiphyllum sp.,* Species-specific.

Abstract

This study was conducted in Mt. Kitanglad Agri-Ecological and Techno-Demo Center, Brgy. Imbayao, Malaybalay, Bukidnon. The study aims to determine the microhabitats of pholcid spiders. Using Cruising method combined with visual search, pholcid spiders were searched on the underside of broad-leaf plants, buttresses, between rock and rock crevices, fallen logs, forest floor litter, and other possible microhabitats. Fourteen microhabitats were identified. Leaf litter and understory plant were the most species-rich with moderate diversity of pholcid spiders. High species richness of pholcid species was found between the paired microhabitats of bamboo sheath and understory plant, with degree of complementarity or distinctness value of 100%. This indicates that pholcid spiders tend to be more species-specific in the selection of microhabitats.

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Introduction

Pholcidae is well adapted to various microhabitats such as under objects, dead leaves, rocks, logs on the ground, between buttresses, in little holes or caves, or on the underside of live leaves. The different species exhibit cryptic coloration that indicates avoidance with visually hunting predators, but desiccation resistance and wetness may be also involved. Most if not all pholcids are sedentary predators and exhibit nocturnality (Deeleman-Reinhold, 1986; Huber, 2009; Lapinski and Tschapka, 2014; Huber, 2014).

Microhabitat preferences are assumed to be adaptive in higher forms of organisms, and microhabitat-associated microclimate differs among species, thus, some species partition either microhabitat or microclimate within each guild in order to maintain the physiological equilibrium (Martin, 1998). However, it seems this is also true with some invertebrates like spiders. Litter-dwelling spiders for instance tend to aggregate in groups and use large, complex tree buttresses with more leaf litter than sparse litter that depends on the available herbaceous vegetation and variable microclimates (Cady, 1984; Chapin, 2014). In addition, some spiders show seasonal variability in a certain microhabitat that indicates the low rates of emergence of their prey (Yuen and Dudgeon, 2015).

Our current knowledge on other families of spiders may be of help in understanding the microhabitat preference of pholcid spiders. Many studies associate selection of microhabitat based on physical structure of host plants such as the leaf architecture that provides shelter, forage, and reproductive sites (Figueira and Vasconcellos-Neto, 1993; Harwood *et al.,* 2003; Harwood and Obrycki, 2005; de Omena and Romero, 2008; de Omena and Romero, 2010; Carvalho *et al.,* 2012).

However, only few studies on pholcid microhabitats were conducted. Huber and Schütte (2009) conducted a pioneering work in the study of microhabitat of two leaf dwelling pholcid spiders, *Metagonia uvita* and *M. osa*. The result showed that the two pholcid species prefer certain microhabitat and tend to be species-specific. Hence, this study was conducted to determine the microhabitats of pholcid spiders found in Imbayao, Malaybalay, Bukidnon.

Materials and methods

The Mt. Kitanglad Agri-Ecological Techno-Demo Center (MKAETDC) is located in Brgy. Imbayao, Malaybalay City, Bukidnon at 8°2’12”N latitude and 125°02’03”E longitude (Fig. 1).

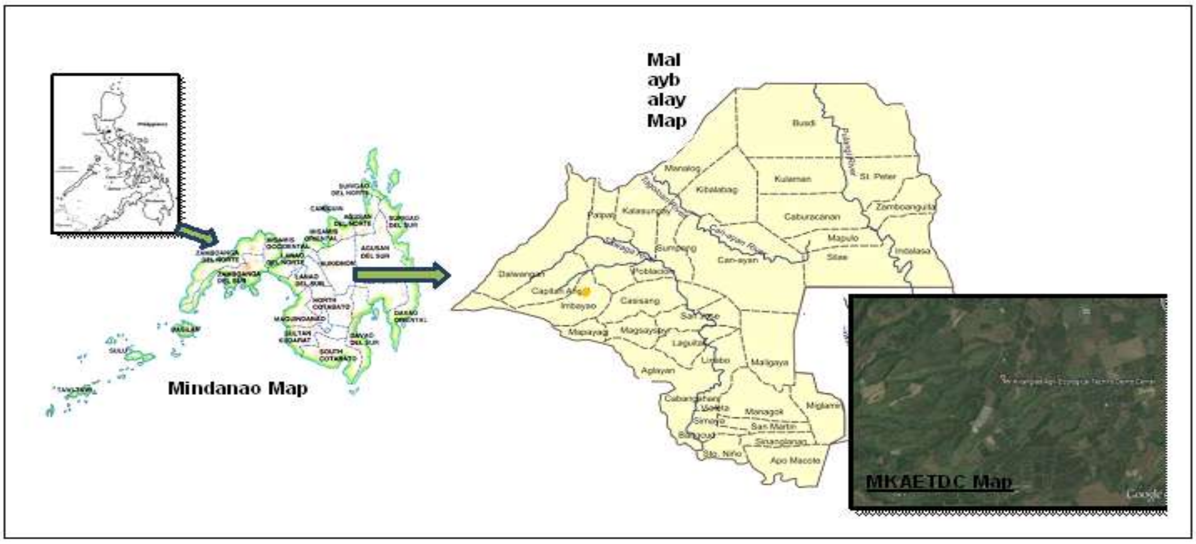


Fig. 1. Map showing the location of the sampling sites in Mt. Kitanglad Agri-Ecological and Techno-Demo Center, Imbayao, Malaybalay, Bukidnon (www.ivoteph.com, 2013; www.googleearth.com, 2015).

Sampling site was selected according to the vegetation and distance to water source. Habitat was described using the Habitat Description Form (Heaney, 2001) and vegetation cover was estimated using chart for estimation of foliage cover (Luttmerding *et al.*, 1990). Four sampling sites were established. The first site was within the natural forest and ecological walk area. The second site was within the abaca experimental site and the Natural forest. The third site was within the rain forestation area while the fourth site was between the Ceremonial ground area and the buffer zone of Mt. Kitanglad Range Natural Park, Bukidnon.

Collection, processing, and identification of samples

The collection of pholcid spiders was done on February 9-10, 2015 for a total of 24 man-hours. The specimens were collected using the cruising method combined with visual search of possible microhabitats such as under fallen and decaying logs, leaf litter, on the underside of live leaves, tree buttresses, rock surface and crevice, and other microhabitats where pholcid spiders are usually found, with a maximum time limit of two hours in each site. Hand collecting was used to capture the pholcid spiders according to microhabitat. The specimens were photographed in their microhabitat before putting them into the collecting jar. Specimens were then placed in Eppendorf tubes containing 95% ethanol. All collected unidentified specimens in the field were taken as voucher specimens for identification. Surveys were conducted in the morning between 700 hrs to 1100 hrs and in the afternoon and evening from 1500 hrs to 1900 hrs. Collection of samples was carried out as soon as all the necessary local and DENR permits were available. Specimens were identified by Dr. Bernhard Huber of the Alexander Koenig Zoological Research Museum, Germany. Each specimen that is probable new species was assigned a specific code in order to facilitate future record tracking.

Statistical analysis

Data analyses were performed using Paleontological Statistics software (PAST) package version 2.17c (Hammer *et al.,* 2001) for Multivariate analysis - Seriation; Statistical Process Control software (SPC) for excel to calculate ANOVA; and Microsoft excel 2010 software to determine 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 (Colwell and Coddington, 1994).

Results and discussion

Fourteen plant microhabitats were identified for the pholcid spiders in Imbayao, Malaybalay, Bukidnon (Table 1).

Table 1. Microhabitats of Pholcid spiders in Imbayao, Bukidnon.

Microhabitats	No. of individuals	Species Richness, S_{obs}	Shannon, H'	Evenness, E
Bamboo sheath	5	3	1.055	0.9572
Schismatoglottis sp.	3	1	0	1
Understory plant	11	4	1.295	0.9123
Leaf litter	10	4	1.168	0.8041
Ground fern	4	1	0	1
Ground/Soil	1	1	0	1
Decaying *Calamus*	1	1	0	1
Dracaena sp.	33	2	0.2286	0.6284
Spathiphyllum sp.	9	2	0.5297	0.8492
Molineria sp.	2	2	0.6931	1
Cordyline sp.	3	1	0	1
Calamus sp.	1	1	0	1
Livistona sp.	1	1	0	1
Medinilla sp.	1	1	0	1

The most utilized microhabitats of pholcid spider species were leaf litter and understory plant, with four species each. In leaf litter, *Belisana sp.PSt365, Belisana sp.Phi129?, Holocneminus sp.PSt1291, and Spermophora sp.Phi109 were found.* In understory plants, *Belisana sp.PSt365, Belisana sp.Phi129?, Calapnita sp.Phi90?, and Panjange sp.Phi125?* were documented.

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

Microhabitats			Observed			V_{jk}	S_{jk}	Distinctness
			Species Richness					(%)
			S_j		S_k			
Bamboo sheath	-	*Schismatoglottis sp.*	3	vs	1	0	4	100
Bamboo sheath	-	Understory plant	3	vs	4	0	7	100
Bamboo sheath	-	Leaf litter	3	vs	4	1	6	83
Bamboo sheath	-	Ground fern	3	vs	1	0	4	100
Bamboo sheath	-	*Dracaena sp.*	3	vs	2	0	5	100
Bamboo sheath	-	*Spathiphyllum sp.*	3	vs	2	0	5	100
Bamboo sheath	-	*Molineria sp.*	3	vs	2	0	5	100
Bamboo sheath	-	*Cordyline sp.*	3	vs	1	0	4	100
Bamboo sheath	-	*Calamus sp.*	3	vs	1	0	4	100
Bamboo sheath	-	*Livistona sp.*	3	vs	1	0	4	100
Bamboo sheath	-	*Medinilla sp.*	3	vs	1	0	4	100
Schismatoglottis sp.	-	Leaf litter	1	vs	4	0	5	100
Schismatoglottis sp.	-	Ground/Soil	1	vs	1	0	2	100
Schismatoglottis sp.	-	Decaying *Calamus*	1	vs	1	0	2	100
Schismatoglottis sp.	-	*Dracaena sp.*	1	vs	2	0	3	100
Schismatoglottis sp.	-	*Molineria sp.*	1	vs	2	0	3	100
Schismatoglottis sp.	-	*Cordyline sp.*	1	vs	1	0	2	100
Schismatoglottis sp.	-	*Calamus sp.*	1	vs	1	0	2	100
Understory plant	-	Ground/Soil	4	vs	1	0	5	100
Understory plant	-	Decaying *Calamus*	4	vs	1	0	5	100
Leaf litter	-	Ground fern	4	vs	1	0	5	100
Leaf litter	-	*Dracaena sp.*	4	vs	2	1	5	80
Leaf litter	-	*Spathiphyllum sp.*	4	vs	2	1	5	80
Leaf litter	-	*Molineria sp.*	4	vs	2	1	5	80
Leaf litter	-	*Calamus sp.*	4	vs	1	0	5	100
Leaf litter	-	*Livistona sp.*	4	vs	1	0	5	100
Leaf litter	-	*Medinilla sp.*	4	vs	1	0	5	100
Ground fern	-	Ground/Soil	1	vs	1	0	2	100
Ground fern	-	Decaying *Calamus*	1	vs	1	0	2	100
Ground fern	-	*Dracaena sp.*	1	vs	2	0	3	100
Ground fern	-	*Molineria sp.*	1	vs	2	0	3	100
Ground fern	-	*Cordyline sp.*	1	vs	1	0	2	100
Ground fern	-	*Calamus sp.*	1	vs	1	0	2	100
Ground/Soil	-	Decaying *Calamus*	1	vs	1	0	2	100

Ground/Soil	-	*Dracaena sp.*	1	vs	2	0	3	100
Ground/Soil	-	*Spathiphyllum sp.*	1	vs	2	0	3	100
Ground/Soil	-	*Molineria sp.*	1	vs	2	0	3	100
Ground/Soil	-	*Cordyline sp.*	1	vs	1	0	2	100
Ground/Soil	-	*Calamus sp.*	1	vs	1	0	2	100
Ground/Soil	-	*Livistona sp.*	1	vs	1	0	2	100
Ground/Soil	-	*Medinilla sp.*	1	vs	1	0	2	100
Decaying *Calamus*	-	*Dracaena sp.*	1	vs	2	0	3	100
Decaying *Calamus*	-	*Spathiphyllum sp.*	1	vs	2	0	3	100
Decaying *Calamus*	-	*Molineria sp.*	1	vs	2	0	3	100
Table 2 continued…								
Decaying *Calamus*	-	*Cordyline sp.*	1	vs	1	0	2	100
Decaying *Calamus*	-	*Calamus sp.*	1	vs	1	0	2	100
Decaying *Calamus*	-	*Livistona sp.*	1	vs	1	0	2	100
Decaying *Calamus*	-	*Medinilla sp.*	1	vs	1	0	2	100
Dracaena sp.	-	*Livistona sp.*	2	vs	1	0	3	100
Dracaena sp.	-	*Medinilla sp.*	2	vs	1	0	3	100
Spathiphyllum sp.	-	*Calamus sp.*	2	vs	1	0	3	100
Molineria sp.	-	*Livistona sp.*	2	vs	1	0	3	100
Molineria sp.	-	*Medinilla sp.*	2	vs	1	0	3	100
Cordyline sp.	-	*Calamus sp.*	1	vs	1	0	2	100
Cordyline sp.	-	*Livistona sp.*	1	vs	1	0	2	100
Cordyline sp.	-	*Medinilla sp.*	1	vs	1	0	2	100
Calamus sp.	-	*Livistona sp.*	1	vs	1	0	2	100
Calamus sp.	-	*Medinilla sp.*	1	vs	1	0	2	100

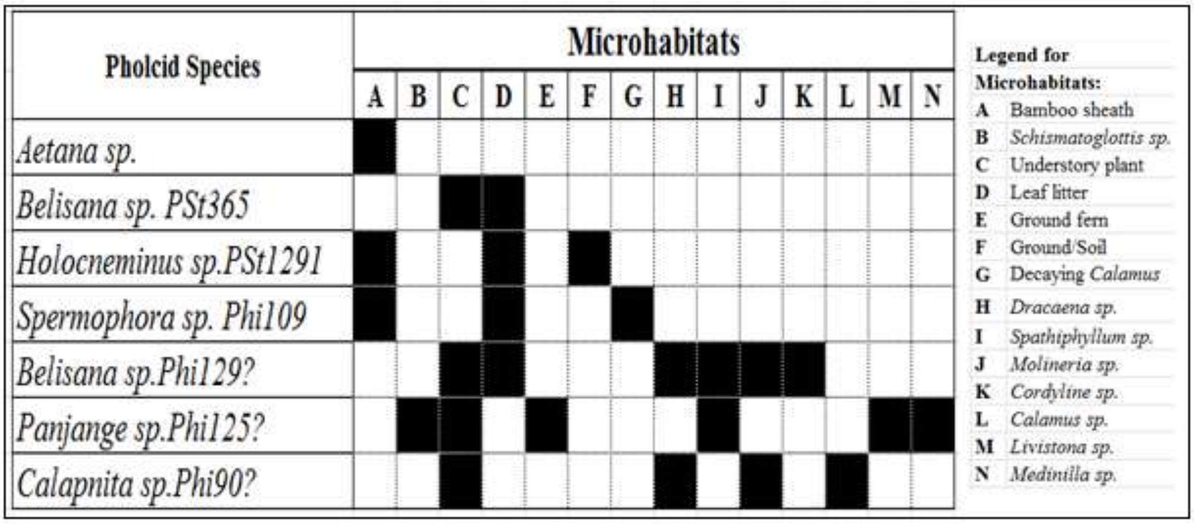
Field observation showed that some of the species of *Belisana* were found in leaf litter, but this could possibly be an accidental encounter during field sampling because this genus is known to inhabit in live leaves and also reported to occur in caves (Huber, 2005; Tong and Li, 2009).

The diversity of pholcid species was moderate in understory plants (H'=1.295), leaf litter (H'=1.168), and in *bamboo sheath* (H'=1.055). The abundance of pholcid spiders varies with different microhabitats. *Belisana sp.Phi129?* showed dominance value of 36% in *Dracaena sp.* and lowest in understory plant and in the plant, *Molineria sp.* (1.18%). The observed dominance of one pholcid species might be due to the available resources that favor its specific resource requirements (Redborg and Redborg, 2000; Mallis and Hurd, 2005; Butt and Tahir, 2010).

Table 2 shows paired microhabitats which exhibit a high level of complementarity value (C=100%), accounted for 59% of the total number of paired microhabitats.

This result demonstrates resource partitioning among species of pholcid spiders which may be in response to interspecific competition, differences in microclimate, behavior, and ecological niche (Schoener, 1974; Hanski and Koskela, 1979; Morrison and With, 1987; Walter, 1991; Amezaga and Rodriguez, 1998; Redborg and Redborg, 2000; Albrecht and Gotelli, 2001; Blackledge *et al.,* 2003; Sushma and Singh, 2006; Butt and Tahir, 2010).

Eight percent of other paired microhabitats exhibited sharing of the observed pholcid spiders, with complementarity value of 0%.



Pholcid Species	Microhabitats													
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Aetana sp.	■													
Belisana sp. PSt365			■	■										
Holocneminus sp.PSt1291	■			■		■								
Spermophora sp. Phil09	■			■			■							
Belisana sp.Phil29?			■	■				■	■	■	■			
Panjange sp.Phil25?		■	■		■				■				■	■
Calapnita sp.Phi90?			■					■		■		■		

Legend for Microhabitats:

A	Bamboo sheath
B	*Schismatoglottis sp.*
C	Understory plant
D	Leaf litter
E	Ground fern
F	Ground/Soil
G	Decaying *Calamus*
H	*Dracaena sp.*
I	*Spathiphyllum sp.*
J	*Molineria sp.*
K	*Cordyline sp.*
L	*Calamus sp.*
M	*Livistona sp.*
N	*Medinilla sp.*

Fig. 2. Seriation Analysis of Microhabitats of Pholcid spiders.

This implies strong overlap in both food and habitat utilization, not because of insufficient food but rather due to the abundance of food, vegetation cover, and relative species abundance (Bengtson, 1984; Kozlowski *et al.,* 2008).

Fig. 2 shows that 16% of the collected pholcid species in Mt. Kitanglad Agri-Ecological and Techno-Demo Center (MKAETDC), Imbayao, Bukidnon were mostly found in leaf litter and in understory plant.

The distribution of litter-dwelling pholcid spiders may be relevant to the foraging mode of prey-predator interactions in leaf litter and reproduction (Casas *et al.*, 2008; Hebets *et al., 2008*). In addition, a study has also demonstrated that different microhabitat structures (e.g. inflorescence) influence the distribution of spiders (de Souza and Modena, 2004; Rocha-Filho and Rinaldi, 2011).

Conclusion

Among the 14 identified microhabitats, leaf litter and understory plant were found to be the most utilized microhabitats of the pholcid spiders. The degree of complementarity between microhabitats of pholcid spiders was highly significant among paired microhabitats in Mt. Kitanglad Agri-Ecological and Techno-Demo Center, Brgy. Imbayao, Malaybalay, Bukidnon. Species diversity was moderate which indicates that microhabitats may play a role in species composition of pholcid spiders.

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