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Microhabitats of leaf-dwelling pholcid spiders (Araneae: Pholcidae) in Mount Mupo, Marawi City, Philippines

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Abstract

Microhabitat utilization is an important factor for species diversification. This study examined the microhabitat utilization of leaf-dwelling pholcids. The occurrence of 241 collected samples showed different degrees of plant occupancy as evaluated by Bodenheimer Constancy: *Schismatoglottis sp.* (constant; 51.25%), *Homalomena philippinensis* (accessory; 25%), *Curculigo latifolia* (rare; 11.86%), *Aglaonema sp***.** (rare; 11.25%) and dicot seedling, *Dillenia megalantha* (rare; 0.63%). Concentration of Relative Dominance (CRD) of leaf-dwelling pholcids per plant species showed that *Schismatoglottis sp.* had the highest percentage (48.96%). Analysis of foliar parametersindicated certain level of association with the occurrence of leaf-dwelling pholcids. Chi-square test showed that there is a significant association between *Schistomaglottis sp.* and dicot seedling, *Dillenia megalantha.*

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Introduction

Leaf-dwelling pholcid spiders are sensitive to environmental conditions and can be used as indicator of good habitat quality. In general, pholcids are one of the most species-rich spider families having 79 genera and 1455 species (World Spider Catalog, 2015). Among them, leaf-dwellers are more diverse in tropical region. In Southeast Asia, pholcid genera that are classified as leaf-dwellers are *Belisana*, *Calapnita, Leptopholcus*, *Panjange*, and *Pholcus* (Deeleman-Reinhold and Deeleman, 1983). However they are poorly studied in the Philippines and very limited data are available about their biology which limits our understanding of their microhabitats. Microhabitat choice is a crucial factor for reproductive success, survival rate, and diversification of species (Pianka, 2000).

Leaves provide important microhabitat for a wide range of organisms. Specific relationship between the host plant leaf and spiders has been studied (Young and Lockley, 1989; Romero and Vasconcellos-Neto, 2004; Dias and Brescovit, 2004; Romero, 2006) but very little is known about microhabitats of leaf-dwelling pholcids.

The microhabitat choice of leaf-dwelling pholcids is evident in their morphology and behavior. Leaf-dwelling pholcids are usually pale green, have delicate bodies, and thin long legs. Behaviorally, they spend the day tightly pressed on the underside of the leaves to make them invisible to predators (Deeleman-Reinhold, 1986). In addition, egg sacs are often elongated probably to enhance the similarity to a leaf vein (Murphy and Murphy, 2000). This is more remarkable in *Calapnita* with all eggs aligned in a single row carried on the chericerae of the female.

At present, most studies on pholcids were concentrated on taxonomic issues (Huber, 2011; Yao and Li, 2013; Yao *et al.*, 2015). Studies on microhabitats of leaf-dwelling pholcids have been very poorly considered and received very little attention. The only exemption was the study of Huber and Schutte (2009) on the leaf preferences of two species of leaf-dwelling *Metagonia* pholcid spiders of Costa Rica. More specifically, there are no existing studies on microhabitats of leaf-dwelling pholcids in the Philippines.

This study was conducted to determine the microhabitat of leaf-dwelling pholcids in Mt.Mupo, Marawi City, Philippines. Association between leaf-dwelling pholcids and foliar parameters such as number of leaves, leaf size, and height above the ground were considered in this study.

Materials and methods

Study Area

Field study was conducted in a secondary forest of Mt. Mupo (also known as Sacred Mountain) located at barangay Guimba and Papandayan, Marawi City, Philippines (801’20”N 124017’51”E) (Fig. 1). It is a protected area designated as National Park on August 5, 1965 by virtue of Republic Act no.4190.

Despite this, deforestation and agricultural activities were observed in the area. A 1km transect line was established in three different elevations (1000, 900, 800 meters above sea level). Every transect line was divided into two sites: the first 500m of the 1km transect line being the first site and the succeeding 500m being the second site, a total of six sites. Moreover, 10m perpendicular to the transect line was added as part of the sampling site in order to maximize the sampling area.

Sampling Methods

Collection of samples was conducted for six days from Nov.16-17 and Nov.19-22, 2014 for a total of 24- man hours.

Visual searching (Chetia and Kalita, 2012) or cryptic searching (Sorensen *et al.*, 2002) and manual technique were employed for the collection of samples (Huber, 2009) by turning the leaves upside down. Manual technique is in effective sampling technique for leaf-dwelling pholcids that are wellcamouflaged and spend their resting time with their body firmly pressed against the underside of the leaf (Deeleman-Reinhold and Deeleman, 1983). The spider was collected by sliding up a small disposable sauce cup underneath the spider then the cup was covered. Each specimen was contained in a single disposable sauce cup and was transferred to a 10ml glass vial fixed in 70% ethanol (Fourie *et al.*,2013).

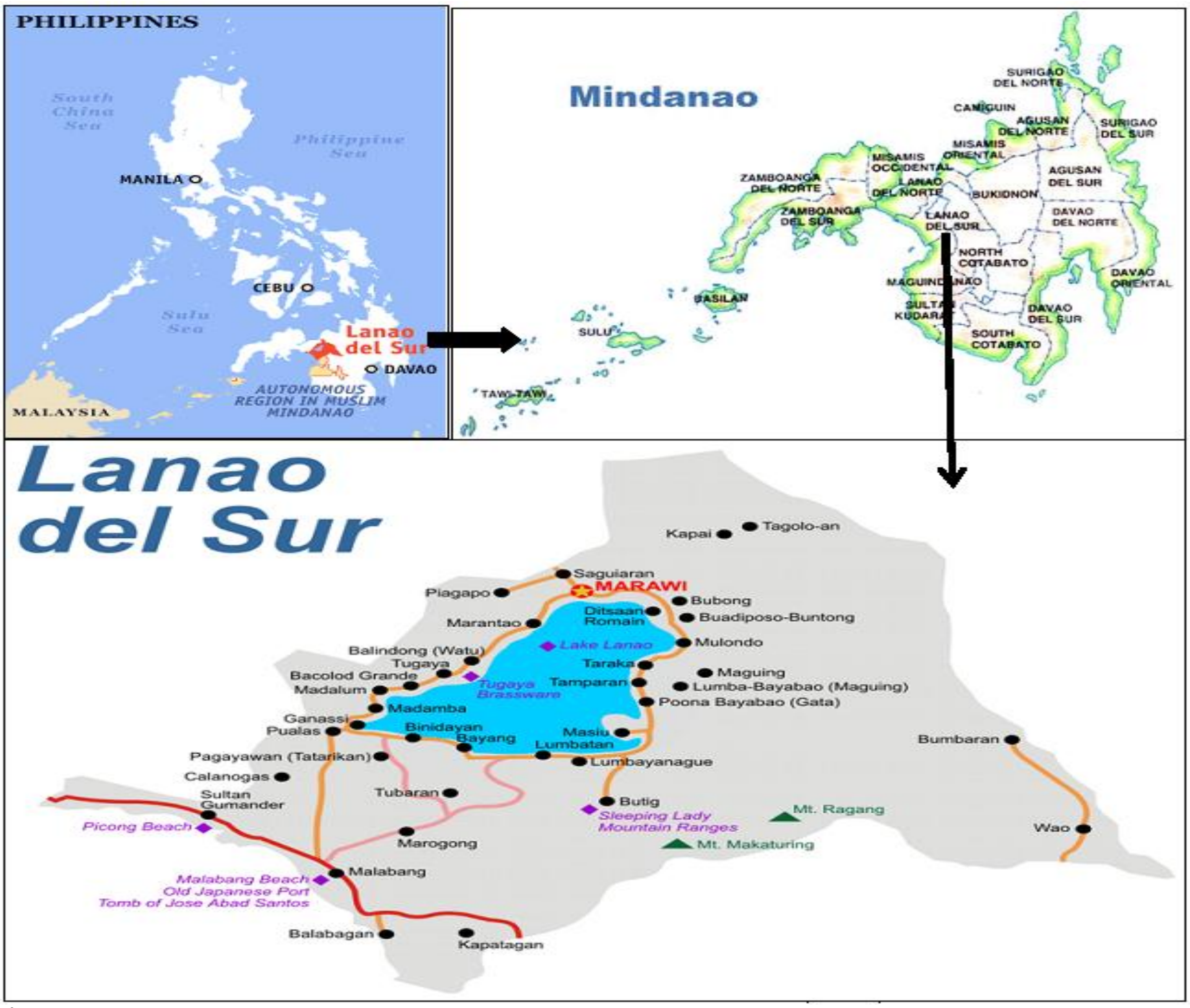

Fig. 1. Geographical location of the study in red mark (www.google.com.ph/maps/; www.mcministries1.tripod.com; www.letters2mindanao.wordpress.com).

For foliar parameters, the number of leaves per plant was recorded. Table 1 shows the total number of leaves of plants occupied by leaf-dwelling pholcids and the percentage of leaves with pholcids. Measurements (cm) of the length and width of plant leaf with pholcids and the height above the ground were also noted.

Identification of samples was done by Bernhard A. Huber. Voucher specimens will be deposited at Alexander Koenig Zoological Research Museum, Bonn, Germany and Mindanao State University-Iligan Institute of Technology College of Science and Mathematics Natural Science Museum, Iligan City, Philippines.

Sampling Sites

Sites 1 and 2 were at 1000 masl elevation. They are the least disturbed sites among the six sites. Ferns comprised most of the canopy epiphytes whereas rattan (*Calamus sp.)* is present as understory vine. Araceae, ground ferns were found at about 40% abundance. Ficus density was rare (approximately 20%). Leaf litter cover was about 40% and humus cover was about 5 cm. in depth. The soil was very moist. Fallen logs due to weather disturbances were very rare.

Sites 3 and 4 were at an elevation of 900masl. Canopy epiphytes and understory vines were similar to sites 1 and 2. Ground seedlings and *Curculigo latifolia* were present (20%) in addition to species of Araceae and ground ferns. Fallen logs were present in higher amount compared to sites 1 and 2. Bamboo clumps were also present.

Sites 5 and 6 were located at the lowest elevation of 800masl. Ground flora includes dicot seedlings, Araceae, *C. latifolia*, *Wedelia biflora* and shrubs. Fruit trees such as *Mangifera indica,* and *Artocarpus odoratissimus* were present. Musa density was rare. Human trail in the area was seen as an on-site disturbance. About 20-25 meters away from the site was a clearing used for agricultural farming.

Ecological and Statistical Analysis

The data on microhabitat and leaf preference of leaf-dwelling pholcids were based on the number of specimens collected in 160 plants (*Schismatoglottis sp.* 82; *Aglaonema sp.* 18, *H.philippinensis* 40, *C. latifolia* 19, and dicot seedling*, Dillenia megalantha* 1).

To evaluate the concentration of leaf-dwelling pholcids per plant species, the Concentration of Relative Dominance (CRD) (Silveira Neto *et al.,* 1976) was calculated based on the formula: CRD=(i/t) x 100 where: i is the number of pholcids found in a specific plant species, and t is the total number of sampled pholcids all plants.

Bodenheimer's Constancy (1955) apud (Silveira Neto *et al.,* 1976) was used to analyze the occupation choice of leaf-dwelling pholcids.

The following formula was used: C= (px100)/N where: p is the number of specific plant species occupied by leaf-dwelling pholcids and N is the total number of plants with pholcids. The occurrence of leaf-dwelling pholcids per occupied plant species was considered: Constant > 50%; Accessory=25-50% and Accidental < 25%.

The degree of association of the occurrence of leaf-dwelling pholcids with the foliar parameters was assessed through box plot analysis of univariate data. Chi-square test was used to verify if there was a significant association between a specific plant species and the occurrence of leaf-dwelling pholcids. Analyses were done using PAleontological STatistics (PAST) version 2.17.

Results and discussion

There are five species of plants recorded in this study which are used by leaf-dwelling pholcids as microhabitat: *Schismatoglottis sp.* (Araceae)*, Aglaonema sp.* (Araceae)*, H. philippinensis* (Araceae)*, C. latifolia* (Hypoxidaceae)and a dicot seedling, *Dillenia megalantha*.

Table 1. Quantitative data of the number of leaves per plant occupied by leaf-dwelling pholcids.

Plant Taxon	N leaves	N of leaves with Pholcids	%
Schismatoglottis sp.	505	110	21.78
Aglaonema sp.	187	24	12.83
H. philippinensis	243	107	44.03
Curculigo latifolia	153	106	69.28
Dicot seedling (*Dillenia megalantha)*	8	5	62.5

The first four plants are all monocots. They have broad leaves with an exception of *C. latifolia* which has longer length and narrower width. The occurrence of 241 leaf-dwelling pholcid individuals was recorded on 82 *Schismatoglottis sp.,* 18 *Aglaonema sp.,* 40 *H. philippinensis,* 19 *C. latifolia* and one dicot seedling, *Dillenia megalantha.* The percentage of leaves occupied by leaf-dwelling pholcids (Table 1) showed that *C. latifolia* (69.28%) and dicot (62.5%) seedling, *Dillenia megalantha* have high percentage of leaves occupied. On the contrary, *Schismatoglottis sp.*had the highest constancy (C=51.25%), followed by *H. philippinensis* (C=25%), *C. latifolia* (C=11.86%), *Aglaonema sp.* (C=11.25%), and dicot seedling, *Dillenia megalantha* (C=0.63%). According to Bodenheimer's Constancy, this result means that leaf-dwelling pholcids are constantly using *Schismatoglottis sp.* as a microhabitat whereas *H. philippinensis* is used in an accessory form and *C. latifolia,Aglaonema sp.* and the dicot seedling, *Dillenia megalantha* are used as an accidental form.

Table 2. Concentration of Relative Dominance (CRD) of leaf-dwelling pholcids per plant species.

Schismatoglottis sp.	*Aglaonema sp.*	*H. philippinensis*	*C. latifolia*	Dicot
48.96%	10.79%	25.31%	12.86%	2.07%

Table 3. Microhabitat preference of leaf-dwelling pholcids (O) Observed numbers of leaf-dwelling pholcids per plant species, (E) Expected value.

Plant Taxon	O	E	X^2	P value
Aglaonema sp.	26	48.2	10.22	>0.01
Schismatoglottis sp.	118	48.2	101.08	<0.01
H.philippinensis	61	48.2	3.4	>0.01
C. latifolia	31	48.2	6.14	>0.01
Dicot seedling (*Dillenia megalantha)*	5	48.2	38.72	<0.01

This is further supported by the result of the Concentration of Relative Dominance (CRD) of leaf-dwelling pholcids per plant species as shown in Table 2. Foliar parameters such as number of leaves per plants, leaf size (length and width), and height above the ground were examined as possible factors that could influence the pholcid's choice of microhabitat. Among the five plants *Aglaonema sp.* has the highest average number of leaves per plant (10.39) followed by *C. latifolia* (8.05), then the dicot seedling, *Dillenia megalantha* (8), *Schistomaglottis sp.* (6.16) and *H. philippinensis* (6.06). There is no significant relation with the relative dominance of leaf-dwelling pholcids with the number of leaves.

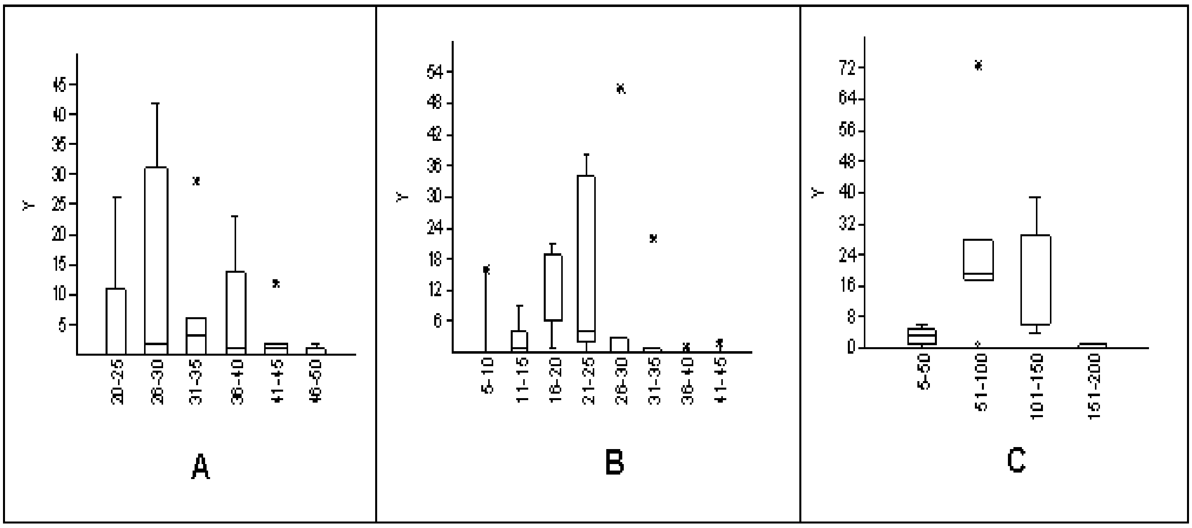

Fig. 2. Association of Leaf-dwelling Pholcid with (A) leaf size (length); (B) leaf size (width); (C) height above the ground.

Leaf-dwelling pholcid occurrence increases with an increase in leaf length, leaf width, and height above the ground but decreases when it reaches a certain maximum level. Fig. 2(A) shows the box plot analysis of leaf-dwelling pholcids occurrence against leaf length which tends to increase with increasing leaf length but decreases when it reaches 30cm. Fig. 2(B) shows that leaf-dwelling pholcids increase at a maximum leaf width of 25cm and decrease abruptly after thereof.

The same trend is shown in Fig. 2(C) where maximum increase is at 150cm. Huber and Schutte (2009) also found no evidence between leaf size and leaf preference of leaf-dwelling *Metagonia* pholcid spiders of Costa Rica.

Chi-square test showed that there is a significant correlation between leaf-dwelling pholcids and *Schistomaglottis sp.* and dicot seedling (*Dillenia megalantha*) shown in Table 3.

Parallel to the study of Huber and Schutte (2009) this study shows that leaf-dwelling pholcids are mostly found on monocots but they could also inhabit dicots. Indicative of their cryptic adaptation, their microhabitat choice could be largely attributed to predator avoidance. In general, spiders are prey for higher trophic levels which explains the need for cryptic adaptation (Foelix, 1996). Other possible factors that affect microhabitat selection include prey availability, leaf toxicity, and suitability of leaf structure for web attachment.

Conclusion

Leaf-dwelling pholcids were mostly found on large-leaved monocots typically under Araceae family. *Schismatoglottis sp.* was highly utilized by leaf-dwelling pholcids as microhabitats in Mt. Mupo, Marawi City, Philippines. The occurrence of leaf-dwelling pholcids is associated with leaf size and height above the ground.

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