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Microhabitats of Leaf-Dwelling Pholcid Spiders (Araneae: Pholcidae) in Selected Streams of Zamboanga del Sur, Philippines

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Abstract

Studies on the microhabitat preferences of leaf-dwelling pholcids are yet to be generated in the Philippines. In this study, the microhabitat preferences of the 150 specimens of three leaf-dwelling pholcid genera and their association to certain microhabitats at Aurora and Ramon Magsaysay, Zamboanga del Sur were examined. The plant, *Schistomatoglottis* sp., through Bodenheimer's Constancy, exhibited the highest constancy value at C= 83.62% (Constant) while*Caryota* sp. showed the lowest (C = 20%).Seriation analysissuggests that the leaf-dwelling pholcids are all found in monocot plants and not microhabitat-specific. However, results from the bar diagram and Canonical Correspondence Analysis (CCA) suggest that the genus *Calapnita* showed a higher degree of preference to *Schistomatoglottis*sp., while*Belisana*sp. showed high preference for *Homalomenaphilippinensis. Panjange* sp.has high preference for *Aglaonema* sp.

Key words : *Belisana,* Bodenheimer's Constancy, *Calapnita, Schistomatoglottis*

INTRODUCTION

Studying the microhabitats of leaf-dwelling spiders can yield substantial information about their biodiversity. Most spider species use plants as sites for reproduction [1-4], for foraging [4], or even as a shelter against desiccation [1]. The spider family Pholcidae (cellar spiders, daddy longlegs) which includes a total of 90 genera and 1416 described species prefers mainly dark spaces, underground objects, leaf and plant detritus, soil openings or rock crevices and caves [5-7]. However, pholcid spiders can also be found on the underside of large leaves in forested regions (Huber 2005b). Microhabitats of pholcid spiders are reflected in their body shape and coloration [7]. Pholcid species adapted to life on the underside of living leaves tend to have long and slender bodies and legs and appear to be pale greenish [9,10]. The coloration allows this leaf-dwelling pholcidsto camouflage with their microhabitat [11]. Some leaf-dwelling pholcids can be probably considered as potential bio indicators since certain species respond differently to environmental conditions such as microhabitat availability [12]. A considerable amount of endemism was also observed in this spider group and it is feared that a number of species will be pushed towards extinction by the rapid destruction of Asian rainforests even before their discovery [13].Zamboanga del Sur in Mindanao, Philippines is one of the places that is currently under significant human pressures such as mining activity, timber extraction, and other forms of landscape modifications[14]. As pointed out by Deeleman-Reinhold &Deeleman (1983), these pressures contribute to the loss of leaf-dwelling pholcid microhabitats in the province.The microhabitat preferences of leaf-dwelling pholcids are still understudied particularly the leaf preferences of leaf-dwelling pholcids in tropical regions. Although a study about the microhabitat preferences of the genus *Metagonia* was already conducted by Huber and Schutte (2009) in Costa Rica, majority are still understudied particularly in Southeast Asia. In the Philippines, pholcids that are classified as leaf-dwellers are *Calapnita*[15], *Uthina*[15], *Panjange*[10,13], and *Belisana*[16], all of which are yet to be fully scrutinized in terms of their microhabitats. The main objectives of the study are to determine the microhabitats of leaf-dwelling pholcid genera from two selected streams in Aurora and Ramon Magsaysay, Zamboanga del Sur and to determine whether these microhabitats are associated with the abundance of the leaf-dwelling pholcid genera.

MATERIALS AND METHODS

Study Area

Two municipalities, namely, Aurora and Ramon Magsaysay in Zamboanga del Sur (Figure 1) were selected as study areas. Six samplings sites (Table 1) were established where three sampling sites were established in each area.

Cabilinan Stream at, Aurora is a permanent water system which originates from the two Barangays in Aurora: Cabilinan and Bag-Ong Maslog. The location is characterized by undulating steep slope [14]. Sampling Sites 1 to 3 are all from Cabilinan Stream.Bobongan-Wakat Streamat, Ramon Magsaysay is also a permanent water system originating from Barangay Bobongan and traversing some parts of Barangay Wakat. Like Cabilinan Stream, it is also generally characterized as having an undulating steep slope. Sampling Sites 4 to 6 are from this area.

Sampling Methods

Field sampling was conducted for a total of 24 man-hours on July 28-30, 2015 for Cabilinan Stream, Aurora and September 5-7, 2015 for Bobongan-Wakat Stream, Ramon Magsaysay. Random sampling method was used with some modifications from Coddington et al. (1991) and Sorensen et al. (2002) particularly in the collection part. Two hours were allocated for each sampling point excluding interruptions (e.g. time, travelling to a different sampling point, personal tasks). Aerial hand collection was done from knee level to as high as one can reach [18]. During aerial hand collection, pholcids found in foliage or shrubs were searched by gently turning the leaves and collecting the pholcids found on the underside [17, 18]. Transparent glass vials containing pure ethanol (>96%) were utilized to collect samples and were labeled with microhabitat, coordinates/locality, date and

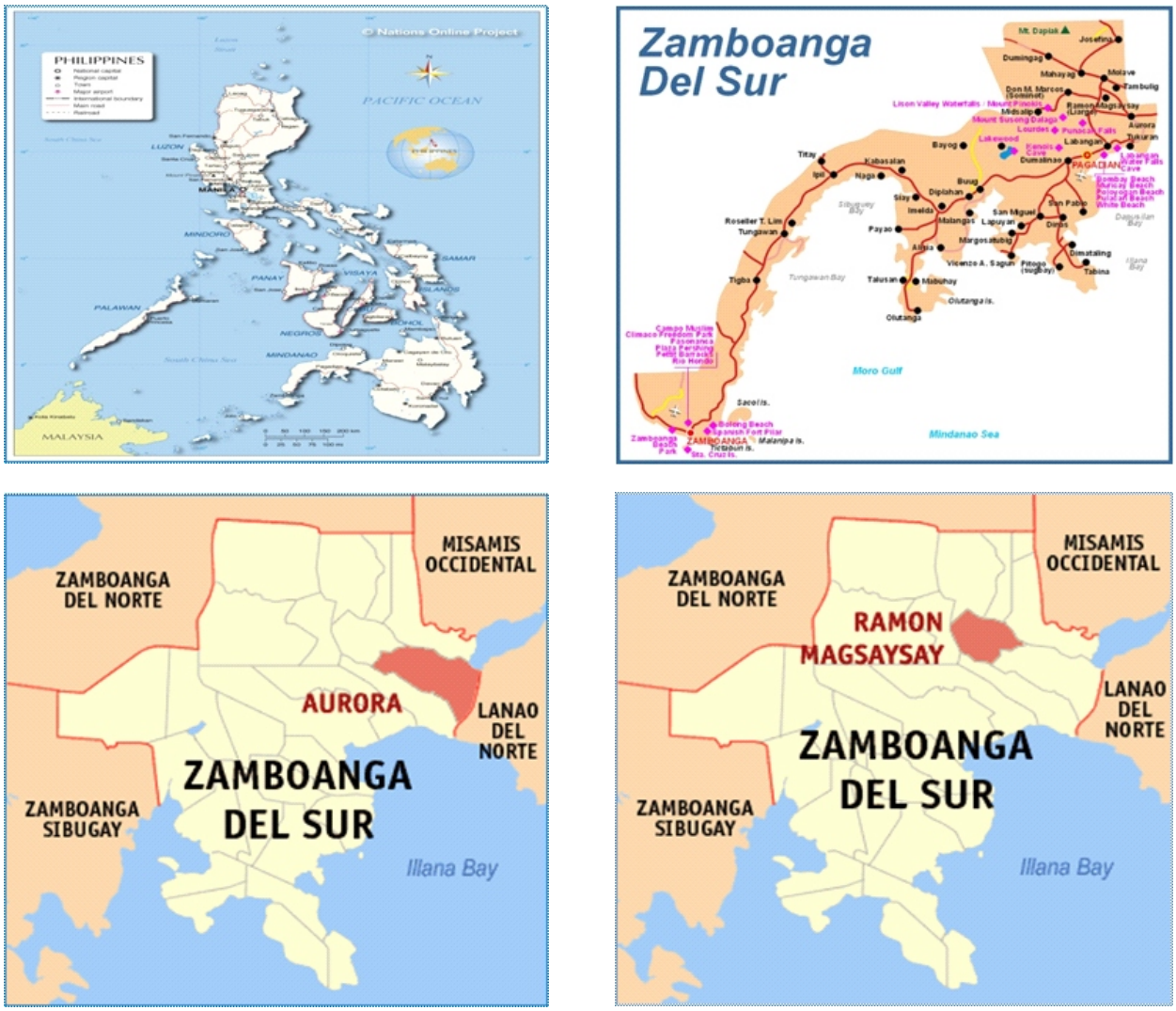

Fig. 2: A) Map of the Philippines B) Map of Zamboanga del Sur C) Map of Zamboanga del Sur with the municipality of Aurora highlighted D) Map of Zamboanga del Sur showing the municipality of Ramon Magsaysay (highlighted). Source: wikipedia.org/wiki/Zamboanga del Sur.

time of collection. For transport, samples were transferred to eppendorf tubes containing pure ethanol (>96%) and were each labeled with a code that corresponds to a temporary identification table. Specimens were then sent to Dr. B.A. Huber of the Alexander Koenig Zoological Research Museum, Bonn Germany for identification. Voucher specimens are deposited at MSU Iligan Institute of Technology Natural Science Museum and at Alexander Koenig Zoological Research Museum.

Microhabitat Identification

Identifying microhabitat preferences includes taking note of the leaf preferences of pholcids particularly during aerial hand collection. Photographs of the plants or leaves were taken for identification by an expert.

Statistical Analysis

Analysis was performed using XLSTAT 2015 and Paleontological Statistics Software Package for Education and Data Analysis (PAST) version 2.17c. Seriation was used to determine if the leaf-dwelling pholcid genera from the two sampling areas are restricted to a microhabitat or microhabitat-specific. To determine the concentration of the leaf-dwelling pholcid genera per microhabitat, Concentration of Relative dominance[19] was used. CRD is defined as,

$$CRD = (i / t) \times 100,$$

where *i* is the total of individuals of one species per microhabitat, and *t* is the total of all sampled individuals.

Bodenheimer's constancy (1955) was used to quantify and analyze the selection [20] of all sampled leaf-dwelling pholcid genera to a given plant leaf/microhabitat. Constancy was represented by the following equation,

$$C = (p \times 100)/N,$$

where p is the number of leaves of a certain plant including the identified pholcid genus and N is the total number of recorded leaves. Results from constancy were interpreted as: Constant > 50%; Accessory 25 or 50% and Accidental < 25%.

A bar diagram using abundance data was created to determine if each pholcid genus exhibits preference to certain microhabitats. Canonical Correspondence Analysis (CCA) was used to test the association of the abundance of both the pholcid genera and the microhabitats with the six sampling sites. CCA is mostly focused

Table 1 : Coordinates of the Sampling Sites in the two municipalities.

Site Number	Site Name	Coordinates	
1	Cabilinan Stream	7°55' 13.40" N	123° 35' 52.67" E
2	Cabilinan Stream	7°55' 07.16" N	123° 35' 55.56" E
3	Cabilinan Stream	7°55' 40.73" N	123° 35' 19.93" E
4	Bobongan-Wakat Stream	7°59' 50.14" N	123° 27' 11.89" E
5	Bobongan-Wakat Stream	8°00' 03.42" N	123° 27' 17.37" E
6	Bobongan-Wakat Stream	8°00' 14.95" N	123° 27' 18.19" E

on species abundance (individual counts) and data from microhabitats [21, 22].

RESULTS

Three leaf-dwelling pholcid genera namely *Calapnita* sp., *Belisana*sp., and *Panjange sp.* (Figure 2) were identified and selected for this study. One hundred and fifty specimens

Six specific microhabitats of the leaf-dwelling pholcids were also identified namely *Schistomatoglottis*sp. (Araceae), *Homalomenaphilippinensis*(Araceae), A*glaonema* sp. (Araceae), *Heliconia* sp. (Heliconiaceae), *Caryota* sp. (Arecaceae), and *Musadomestica*(Musaceae). All identified microhabitats are monocots and microhabitat specificity was then determined using Seriation (Table 2).

The genus *Calapnita* was observed and collected in all six microhabitats while *Belisana* was collected in all four microhabitats but absent in *Heliconia* sp. and *Caryota* sp. The genus *Panjange* was only collected in three microhabitats namely, *Schistomatoglottis* sp., *Aglaonema* sp., and *Caryota* sp. Seriation results suggest that the leaf-dwelling pholcid genera from Cabilinan Stream and Bobongan-Wakat Stream are not microhabitat-specific. However, CRD (Table 3) together with constancy values (Table 4) and the bar diagram in Figure 3 suggest that the sampled leaf- dwelling pholcid genera from the two streams exhibit preferences to certain microhabitats.

CRD was calculated to determine the concentration of the leaf-dwelling pholcid genera on each microhabitat from the six sampling sites. The microhabitat with the highest concentration of pholcids is *Schismatoglottis* sp. (CRD = 64.67%) and then followed by *Aglaonema* sp. (CRD=16.67%). The lowest concentration of pholcidswas observed in *Caryota* sp. and *Musa domestica* in which only a handful of pholcids were collected as also shown in the bar diagram. Both yielded a CRD value of just 3.33%. Together with the constancy values, this results suggest that the leaf-dwelling pholcid genera from the six sampling sites showed preferences to certain microhabitats.

It appears that the leaf-dwelling pholcids from the two streams constantly utilizes*Schistomatoglottis*sp, at C = 83.62% (>50%). This is also similar to what was shown in the bar diagram in which the bulk of the sampled pholcid population congregated on *Schismatoglottis*sp. Microhabitats that were used by the pholcids in an accessory way (25% or 50%) include *Aglaonema* sp. (C=43.10%), *Homalomenaphilippinensis* (32.43%), *Heliconia* sp. (30%), and *Musa domestica* (29.41%). The microhabitat *Caryota* sp. (C=20%)was used by the pholcids in an accidental form. Accidental means that *Caryota* sp. was just rarely used by the sampled leaf-dwelling pholcids when compared to the other microhabitats that were sampled from all six sampling sites.As mentioned above, all the sampled pholcid genera congregated on *Schismatoglottis* sp. in the bar diagram. The highest number in terms of absolute value for *Calapnita*, *Belisana*, and *Panjange*were all attributed to *Schistomatoglotti*s sp. in which the genus *Calapnita* is the highest followed by *Belisana* and then

Fig. 2: GLeaf-dwelling pholcid genera from Cabilinan Stream and Bobongan-Wakat Stream.
(A) *Calapnita* (B) *Belisana* (C) *Panjange.*

Table 2 : Seriation results to determine the microhabitat specificity of *Calapnita, Belisana,* and *Panjange.* (A) *Schismatoglottissp.* (B) *Homalomenaphilippinensis* (C) *Aglaonema sp.* (D) *Heliconiasp.* (E) *Caryota sp.* (F) *Musadomestica.* Dark cells indicate presence of pholcids.

	Cal	Bel	Panj
A			
B			
C			
D			
E			
F			

Table 3 : Concentration of Relative Dominance (CRD) of the leaf-dwelling pholcid genera per microhabitat.

MICROHABITAT	CRD
***Schistomatoglottis* sp.**	64.67%
H.*philipinensis*	8%
***Aglaonema* sp.**	16.67%
***Heliconia* sp.**	4%
***Caryota* sp.**	3.33%
Musa domestica	3.33%
Total	100

Table 4 : Constancy values of the different microhabitats occupied by the leaf-dwelling pholcids and theirinterpretations.

MICROHABITAT	*C=(px100)/N*	Interpretation
Schismatoglottis sp.	83.62%	Constant
Homalomenaphilippinensis	32.43%	Accessory
Aglaonema sp.	43.10%	Accessory
Heliconia sp.	30%	Accessory
Caryota sp.	20%	Accidental
Musa domestica	29.41%	Accessory

Panjange. This suggests that all of the sampled pholcid genera prefer *Schismatoglotti*ssp, as a microhabitat more than others. To test if the preference to *Schistomatoglottis* sp. refers to all pholcids collected or if the preference was only associated to specific genus, Canonical Correspondence Analysis (CCA) was used. To visually represent the association between the abundance of the leaf microhabitats with the abundance of leaf-dwelling pholcids and to associate the abundance of both the pholcid genera and the microhabitats with the six sampling sites, a Canonical Correspondence Analysis map (Figure 4) was generated.

In CCA, microhabitats and pholcids that are more associated to each other are closer or in the same ordination axis. *Homalomena philippinensis* and *Belisana* are closer to each other along with Sampling Site 3 in which *Homalomena philippinensis* is dominant. This seems to suggest that the genus *Belisana* preferred the microhabitat *Homalomena philippinensis* over

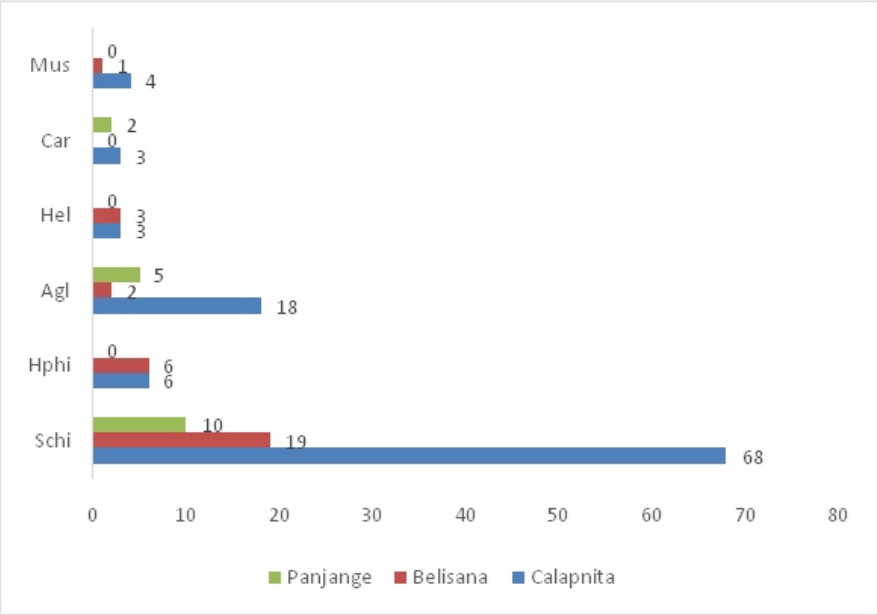

Fig. 3: Bar diagram showing the absolute numbers of Calapnita, Belisana, and Panjange found on each of the six plant microhabitats.

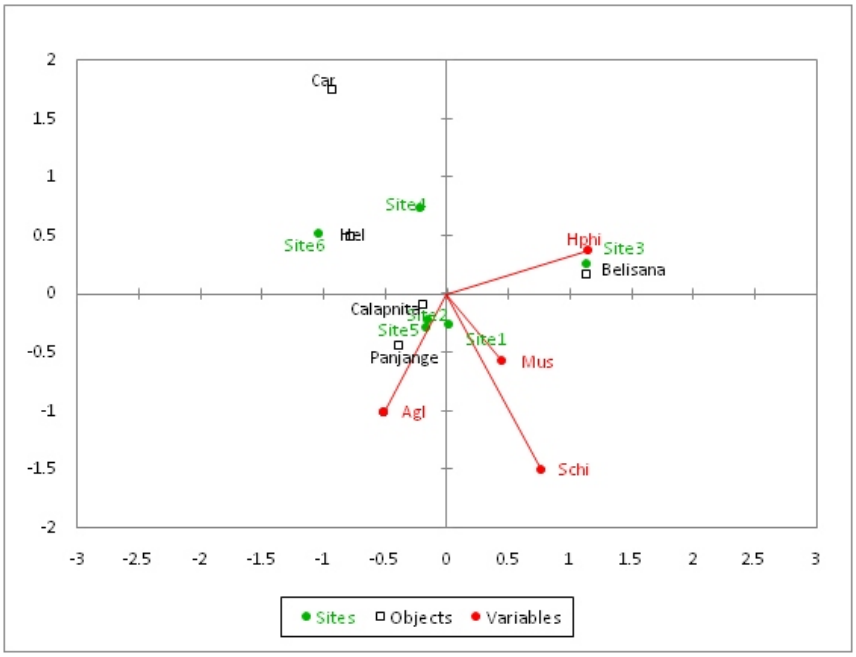

Fig. 4: CCA results. Association of microhabitat abundance and leaf-dwelling pholcidae genera at Cabilinan Stream and Bobongan-Wakat Stream. Schi=*Schistomatoglottissp,* Hphi= *H.pilippinensis* , Agl = *Aglaonema sp.,* Hel = *Heliconia sp.,* Car = *Caryota sp.,* and Mus = *Musa domestica.*

others.*Calapnita* and *Panjange* are closer to *Aglaonema* sp., and *Schistomatoglottis* sp. along with Sampling Sites 1, 2, and 5. The microhabitats *Schistomatoglottis*sp, and *Aglaonema* sp. are one of the dominant understory plants for Sampling Sites1, 2 and 5 thus explaining their close proximity to each other in the CCA map. A higher degree of preference to the microhabitat *Schistomatoglottis* sp. was exhibited by the genus *Calapnita*since it is much closer to the said plant. This seems contrary to the results from the bar diagram in which all the sampled leaf-dwelling genera preferred *Schistomatoglottis* sp. The genus *Panjange* is also closer to *Aglaonema* sp. hence, the preference of *Panjange* sp. to the said plant is higher compared to the other plants. The leaf-dwelling pholcid generaappears to have poor associations with *Heliconia* sp., *Caryota* sp., and *Musa domestica* as also shown in the bar diagram, CRD values, and Constancy. This may be due to the low number of samples collected in these microhabitats particularly in *Caryota* sp.

DISCUSSION

Similar studies onpholcid microhabitat preferences like the leaf preferences of *Metagonia* by Huber and Schütte[11]also showed that pholcids have a degree of preference to certain plants

but not microhabitat-specific. However, test for association was not used in the said study so there is no indication if the relationships between the leaves and *Metagonia* were significant. Another similarity between Huber and Schütte[11]and this study is that the leaf-dwelling pholcids were commonly observed and collected in monocot plant leaves like *Heliconia* sp. which was also listed as a microhabitat. However, the results of their studyalso showed that a handful of *Metagonia* were found in eudicots but despite this, the preference of the pholcids to monocot leaves is still prevalent. Another study by Huber[23]considered *Musa domestica* as the preferred microhabitat of the leaf-dwelling *Metagoniamariguitarensis* in Northern Venezuela. This was confirmed by Romero [24]by stating that majority of the reports concerning the restricted associations of spiders and specific plant groups, the plants are monocots. The reasons for the selection or preference of leaf-dwelling pholcids to monocot leaves are yet to be properly established. Several factors were considered by Huber and Schütte[11] and this were prey availability, thermal conditions that may vary among plant species, leaf surface ultrastructure, and leaf size. However, no significant differences were found among the mentioned factors.

The preference of the genus *Belisana* to *Homalomena philippinensis* and Site 3 (which is located at the vicinity of a coconut and corn farm) as shown in CCA seems to be contrary to the fact that it is usually collected in primary forests and rarely in secondary forests/forest edges[9], but Deeleman-Reinhold [10]pointed out that it can also be found in fruit plantations or disturbed areas. As stated above, leaf-dwelling pholcids from Cabilinan Stream and Bobongan-Wakat Stream are not entirely restricted to a specific species or genus of plants as shown in seriation analysis much like the results from Huber and Schütte[11]on the genus *Metagonia*. However results from Constancy and CCA suggest that the leaf-dwelling pholcids exhibit preferences to certain plants. It was implied by Deeleman-Reinhold [10]and Huber and Schütte[11]that leaf-dwelling pholcids are usually collected on monocots like Liliaceae and Araceae, but they are still considered as vague assumptions since data are still inconclusive particularly on association data. In this study, the preference of the genus *Calapnita*, genus *Belisana*, and genus *Panjange* to Araceae monocots like *Schismatoglottis* sp., *Homalomena philippinensis*, and *Aglaonema* sp. as shown through CCA seems to provide the necessary association data to at least confirm some of the microhabitat preferences of leaf-dwelling pholcids. However, it was stated by Romero &Vasconcellos-Neto[25]that in general, spiders do not always have a strong association with the plants on which they occur .This means that more studies with regards to the microhabitat preferences of leaf-dwelling pholcidsneed to be conducted until the exact parameters are narrowed down.

CONCLUSION

The leaf-dwelling pholcids of this study did not exhibit microhabitat specificity as shown in seriation results. However it is probable that certain pholcid species are strongly associated to distinct microhabitats like the preference of all the sampled leaf-dwelling pholcid genera to *Schistomatoglottis*sp. and the higher degree of preference of the genus*Calapnita* to the monocot *Schismatoglottis* sp., *Belisana* to *Homalomena philippinensis* and *Panjange* to *Aglaonema* sp. All the sampled leaf-dwelling pholcid genera were found and collected only on monocot plant leaves particularly from the family Araceae.

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