Asian Journal of Biological and Life Sciences | Original Research

Microhabitat utilization of leaf-dwelling pholcids (Araneae: Pholcidae) in Mount Baya, Camp Abubacar, and Dimapatoy Watershed in Mindanao, Philippines

Noraya U. Elias[1,2], Olga M. Nuñeza[1]*

1 Department of Biological Sciences, College of Science and Mathematics,
Mindanao State University-Iligan Institute of Technology, Iligan City, Philippines.
2 Mindanao State University-Malabang Community High School, Malabang, Lanao del Sur, Philippines.

E-mail : nurrowling@gmail.com Contact No. : +2348063786386

Submitted : 05.09.2015 Accepted : 12.11.2015 Published : 31.12.2015

Abstract

Leaf-dwelling pholcidspiders do not eat plants but leaves serve as microhabitat necessary for their survival, proliferation, and diversification. This paper dealt with microhabitat utilization of leaf-dwelling pholcids in three selected areas of mainland Mindanao part of Autonomous Region in Muslim Mindanao.Manual technique by means of turning the leaves upside down was adopted to collect samples. Eighty-five leaf dwelling pholcids under the genera *Belisana* Thorell, 1898, *Calapnita* Simon, 1892, and *Pholcus* Walckenaer, 1805 were found to utilize four monocots *Schismatoglottissp.* (Araceae), *Aglaonema sp.* (Araceae), *Homalomenaphilippinensis* (Araceae), *Alpinia sp.* (Zingiberaceae), and palm seedling (Arecaceae) as microhabitats. Quantitative analysis showed no significant association between these plants and leaf-dwelling pholcids, however,Bodenheimer Constancy and Concentration of Relative Dominance (CRD) pointed to *H. philippinensis* as highly utilized by leaf-dwelling pholcids as microhabitat compared to the other plants. Furthermore, box plot analysis showed association between leaf size, leaf width, and height above the ground with the presence of leaf-dwelling pholcids. This paper provides additional data on the very limited resources on the microhabitats of pholcidae.

Key words : Araceae, *Belisana,* Monocots, Spider

INTRODUCTION

Five genera of the Southeast Asian long-legged pholcidsare leaf-dwellers. These genera include *Belisana*Thorell, 1898, *Calapnita* Simon, 1892,*Leptopholcus* Simon, 1893,*Panjange* Deeleman-Reinhold & Deeleman, 1983, and *Pholcus* Walckenaer, 1805[1].Species of these genera are cryptic to make them safe from predators [1]and make collection of samples tough as well [2]. They spend the day tightly pressed on the underside of the leaves. Species of genus *Belisana* however are very small that pressing their bodies against the leaf may not be important to keep them hidden [3].

Leaves serve as microhabitat for many organisms. Many arachnid species utilize the leaves either for shelter against predators and desiccation, foraging, reproduction site or nursery for spiderlings[4]. Some groups even spend their entire life cycle on specific plant leaves. *Psecaschapoda*for example spend its entire life span exclusively on *Bromeliabalansae* utilizing it for shelter, feeding, breeding, and nursing spiderlings[5].Strong association of some spider species such as salticid with *bromeliaceae* had been extensively investigated [6-9].

In contrast to the well-studied salticid-bromeliad system, basic understanding of the microhabitat of leaf-dwelling pholcids is mostly based on crude observations. Studies on the mechanism of leaf preferences and microhabitat choice are extremely limited because taxonomic studies of the group have earned more attention [10-15]. The study of Huber and Schuette[16]pioneered on exploring the leaf preferences of Costa Rican leaf-dwelling pholcids*Metagoniaosa* and *Metagoniauvita.* These leaf-dwelling pholcids were found to utilize a variety of monocot leaves.

This paper aims to provide baseline data on microhabitat and leaf-utilization of leaf-dwelling pholcids in three selected areas of Autonomous Region in Muslim Mindanao, Philippines. Relationship between microhabitat choice of leaf-dwelling pholcids and foliar parameters such as number of leaves, leaf size, and height above the ground were examined in this study.

MATERIALS AND METHODS

Study Area

The study sites were selected since they are the few remaining forested areas in the mainland Mindanao part of Autonomous Region in Muslim Mindanao, Philippines.The study area (Figure 1) was divided into three: Mt.Baya, Pualas, Lanaodel Sur (7.7829^{0}N, 124.0847^{0}E), Camp Abubacar, Barira, Maguindanao (7.5698^{0}N, 124.3198^{0}E), and Dimapatoy Watershed, Datu Odin Sinsuat, Maguindanao (7.1407^{0}N, 124.2018^{0}E). Mt. Baya is a dormant volcano with secondary forest situated at Pualas and Ganassi, Lanaodel Sur at an elevation of 1484 meters above sea level (masl). Camp Abubacar, Barira, Maguindanao is a former stronghold of Moro Islamic Liberation Front (MILF) with a relatively small secondary forest at an elevation of 747masl. Dimapatoy Watershed, Datu Odin Sinsuat, Maguindanao is a reforested area of 37.65km^2 at an elevation of 157 masl. In each sampling locality one km transect line was made and was extended to 10m at both sides in order to maximize the sampling area.

Collection of samples

Collection of leaf-dwelling pholcids was done at 800 to 1600 hourson Dec.1-2, 2014 in Mt.Baya; Dec.14-15, 2014 in Camp

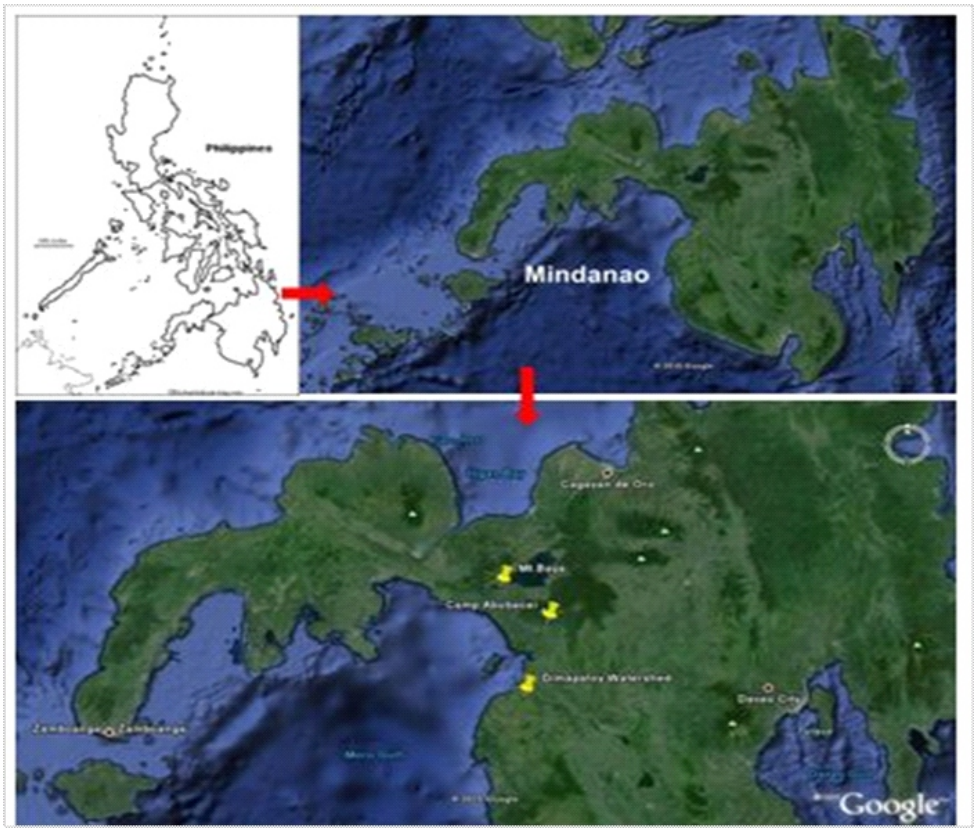

Fig 1: Geographical location of the study area[17, 18]

Abubacar; and Dec. 12 and 17, 2014 in Dimapatoy Watershed. Twenty-four man- hours were spent for the entire duration of the sampling period spending eight man-hours hours for each sampling site. Manual technique using visual searching or cryptic searching [3, 19, 20,]was adopted to collect samples. Leaf-dwelling pholcids were morphologically and behaviourally cryptic. They spend the day well-hidden on the underside of green leaves. These characteristics made collection of samples quite laborious which requires scrutinizing countless of leaves one by one. Thus manual technique was an appropriate sampling method[3].Leaf-dwelling pholcids were collected by sliding up a small disposable sauce cup underneath the pholcid then the cup was covered. Collected specimens were fixed in 70-75% ethanol individually in a 10ml glass vial[21]. Identification of samples was done by Bernhard A. Huber. Voucher specimens will be deposited at Alexander Koenig Zoological Research Museum, Bonn, Germanyand MSU-IIT CSM Natural Science Museum, Iligan City, Philippines.

Ecological and Statistical Analysis

Concentration of Relative Dominance (CRD)[22] was used to assess the concentration of leaf-dwelling pholcids per plant taxon. This was computed according to 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 in all plants.

Occupation choice of leaf-dwelling pholcids was analyzed using Bodenheimer's Constancy (1955) apud[22] with the formula 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%.

Chi-square test was used to verify if there was a preference towards a specific plant species as a microhabitat.Box plot analysis of univariate data was used to determine the level of association of leaf-dwelling pholcids with the foliar parameters. Analysis was done using Paleontological Statistics (PAST) version 2.17.Nonparametric estimators were used to know the predicted species richness. This is necessary to reduce under sampling bias. Chao's estimated coefficient of variation for incidence distribution is 1.333 which is >0.5, therefore, estimators were recomputed using the classic option instead of the bias-corrected option. Four common species richness estimatorsChao1, Chao2, Abundance-based Coverage Estimator (ACE)andIncidence-based Coverage Estimator (ICE) were used. Chao1 and ACE were abundance-based whereas Chao2 and ICE were both incidence-based richness estimators. Estimates were computed using EstimateS version 9 [23]

RESULTS

The occurrence of 85 leaf-dwelling pholcids was recorded on 25 *H. philippinensis,* 13*Aglaonema sp.,*12 Palm seedlings (Arecaceae), 12*Schismatoglottissp.,* and6 *Alpinia sp.* (Zingiberaceae). The percentage of leaves occupied by leaf-dwelling pholcids (Table1) showed that *Schismatoglottissp.* (18.97%) had the highest percentage of leaves inhabited by leaf-dwelling pholcids and palm seedlings (6.78%) has the lowest percentage. However, Table 2 shows that *H. philippinensis* (36.76%) had the highest Bodenheimer's Constancy value.Concentration of Relative Dominance (CRD) also showed that*H. philippinensis* (36.47%)and *Alpinia sp.* (9.41%) had the highest andlowest values respectively. Chi-square test (Table 3) shows no significant association between leaf-dwelling pholcids

Table 1: Comparison of fluid intake ALT, AST, creatinine and urea levels in rats

Plant Taxon	Number of leaves	Number of Occupied Leaves	%
Schismatoglottissp.	58	11	18.97
Aglaonema sp.	142	12	8.45
H. philippinensis	139	22	15.83
Alpinia sp. (Zingiberaceae)	19	3	15.79
Palm(ArecaceaeSeedling)	59	4	6.78

and the different plant taxon.

Foliar parameters such as number of leaves per plant, 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.* had the highest average number of leaves per plant (10.92) and *Alpinia sp.* (3.17) had the lowest. There is no significant relationship with the relative dominance of leaf-dwelling pholcids with the number of leaves.

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. Figure 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. Figure 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 Figure 2(C) where maximum increase is at 100cm.

DISCUSSION

Leaf-dwelling pholcids under the genera*Belisana, Calapnita*, and *Pholcus* were recorded inhabiting the underside of the leaves of five plant species. These plant species were *Schismatoglottissp.* (Araceae), *Aglaonema sp.* (Araceae), *Homalomenaphilippinensis* (Araceae), *Alpinia sp.*

Table 2: Concentration of Relative Dominance (CRD) of leaf-dwelling pholcids per plant species and Bodenheimer's Constancy (C).

Plant Taxon	CRD (%)	C (%)	Occupation Choice	Average Number of Leaves
Schismatoglottissp.	16.47	17.65	Accidental	4.83
Aglaonemasp.	23.53	19.12	Accidental	10.92
H. philippinensis	36.47	36.76	Accessory	5.56
Alpinia sp. (Zingiberaceae)	9.41	8.82	Accidental	3.17
Palm (ArecaceaeSeedling)	14.12	17.65	Accidental	4.92

Table 1: Chi-square test for independence between microhabitat and leaf-dwelling pholcids. (O) Observed numbers of leaf-dwelling pholcids per plant species, (E) Expected value.

Plant Taxon	O	E	X^2	P value
Schismatoglottissp.	14	17	0.53	>0.01
Aglaonema sp.	20	17	0.53	>0.01
H. philippinensis	31	17	11.53	>0.01
Alpinia sp. (Zingiberaceae)	8	17	4.76	>0.01
Palm (Arecaceae Seedling)	12	17	1.47	>0.01

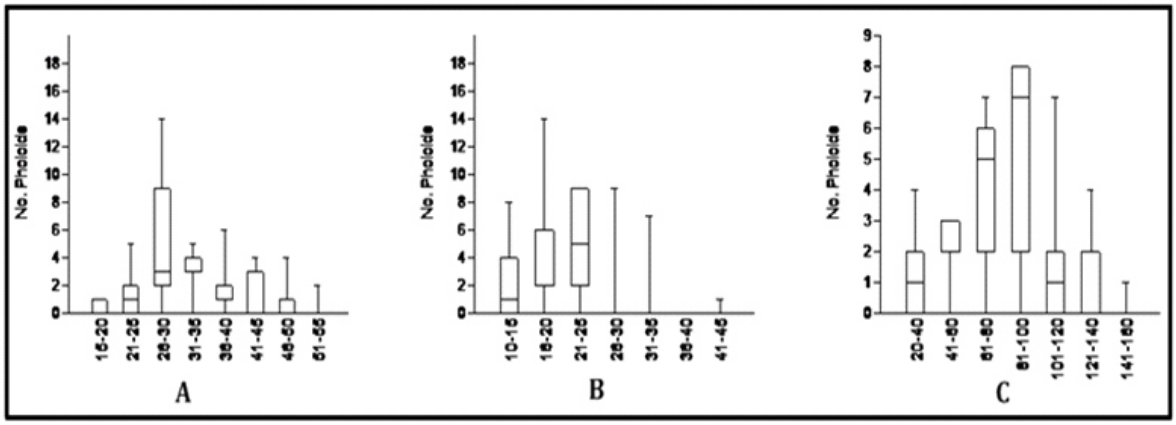

Fig 2: Association of Leaf-dwelling Pholcid with (A) leaf size (length); (B) leaf size (width); (C) height above the ground.

(Zingiberaceae), and Palm seedling (Arecaceae). These plants are all monocots with broad leaves except palm seedling which has longer length and narrower width. *H. philippinensis* was utilized by leaf-dwelling pholcids in an accessory form. *Aglaonema sp.,* palm seedlings, *Schismatoglottissp.,* and*Alpinia sp.* accounted for <25% of Bodenheimer'svalue, therefore, these plants were used by leaf-dwelling pholcidsrarelyor in an accidental form. This is supported by the result of Concentration of Relative Dominance (CRD) where the highest number of leaf-dwelling pholcids was found to be concentrated on *H. philippinensis.* However, the result of Chi-square test did not show asignificant association between leaf-dwelling pholcids and the different plant taxon. This leads to the fact that leaf-dwelling pholcids can inhabit a variety of leaves although certain plants might be more preferred than the other [16]. The reason for utilization and preference towards some plants might be attributed to predator avoidance as evident with the cryptic adaptation of leaf-dwelling pholcids. Many other factors as well play a significant role in the microhabitat choice such as prey availability, leaf toxicity and suitability of leaf structure for web attachment.

Plants under Liliaceae, Araceae, Arecaceae, Cyclanthaceae, Marantaceae, Heliconiaceae, other similar monocots, and some dicots were reported as utilized by leaf-dwelling pholcids as microhabitats [16, 24]. Zingiberaceaeis, therefore, an addition to the list of microhabitats of leaf-dwelling pholcids.

Regarding the leaf size (length and width) and height above the ground,certain trend was observed but the data is inadequate to show preference towards a certain leaf size because only the leaves with pholcids were measured. The study of Huber and Schutte[16] showed no significant relationship between leaf size and leaf preferences of the leaf-dwelling *Metagonia*pholcid spiders of Costa Rica. On the other hand Romero et al.[7] found that two Salticid species *Coryphasiamonteverde*and*Coryphasia Cardoso* prefer bromeliads with larger leaf size. A better assessment, however, could be better understood with experimental studies under controlled conditions.

Further research with longer sampling time should be conducted as suggested by the result of estimators. Nonparametric estimators of total species richness based on incidence-abundance matrices showed that species richness was between 7 (Chao1) to 45 (ICE) for an observed richness of 7. Inventory completeness (observed richness/Chao 1 estimate) [25] was 42.86% and sampling intensity (no. individual/no. spp) was 12.14. Inventory completeness is <50% therefore it is expected that there are still more species to be found at the end of the sampling period.

CONCLUSION

This study added Zingiberaceae to the list of microhabitats of leaf-dwelling pholcids. Plants utilized by leaf-dwelling pholcids are all monocots mostly with big leaves. There was no significant relationship between specific plant taxon with microhabitat choice however*H. philippinensis was highly utilized by leaf-dwelling pholcids compared to other plants.*The present study provides a dataset necessary for understanding the microhabitat of leaf-dwelling pholcids in Autonomous Region in Muslim Mindanao.

ACKNOWLEDGEMENT

The authors acknowledge the Department of Science and Technology Accelerated Science and Technology Human Resource Development Program (DOST-ASTHRDP), Philippines for the research funds and the DENR-ARMM for the gratuitous permit. The authors are also grateful to Dr. Bernhard A. Huber and Prof. Edgardo C. Aranico for the identification of pholcid samples and plants, respectively and to Dr. Mark Anthony J. Torres for some recommendations on statistical analysis.

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