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Rapid assessment of spider fauna of Pulacan falls, Zamboanga Del Sur, Philippines

Charmaine C. Dacanay[1], Aimee Lynn A.Barrion-Dupo[2], Olga M. Nuñeza[1*]

[1]*Department of Biological Sciences, College of Science and Mathematics, MSU-Iligan Institute of Technology, Andres Bonifacio Avenue, Tibanga, 9200 Iligan City, Philippines*

[2]*Institute of Biological Sciences, Environmental Biology Division and Museum of Natural History, College, University of the Philippines Los Baños, Laguna, Philippines*

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Abstract

The spider as a group is one of the most abundant predatory groups in terrestrial ecosystems with more than 40,000 described species. In the Philippines, 517 species of spiders are recorded. This study was conducted to determine the species richness and abundance of spiders in Pulacan Falls, Zamboanga del Sur, Philippines. Spiders were collected using beat-netting, sweep-netting and vial-tapping methods. Thirty-seven species of spiders belonging to 22 genera and 10 families were recorded. Four are possibly new species. Two species are new record in Mindanao. Family Araneidae had the highest species richness and abundance. Species diversity was low in the disturbed sampling site. The new record for Mindanao and possibly new species of spiders found in the study indicates that Pulacan falls is a species- rich area.

***Corresponding Author:** Olga M. Nuñeza ✉ olgamnuneza@yahoo.com

Introduction

Spiders are predators in the terrestrial ecosystems with more than 3694 genera and 40462 species (Sharma, 2014). They occur in all continents except Antarctica (Sewlal and Cutler, 2003). They are hunters of insects and other small invertebrates (Sharma *et al.,* 2010), thus they are useful components in regulating insect population in many terrestrial habitats (Mathew *et al.,* 2009). They serve as buffers that limit the exponential growth of pest populations in various ecosystems by virtue of their predatory potency (Sharma, 2014).

Spiders also serve as good biological indicators for evaluating the impact of anthropogenic disturbance on natural ecosystems (Maelfait and Hendrickx, 1998). Their webs are useful indicators of environmental chemistry (Hose *et al.,* 2002) and their growth has been used as an indicator of habitat quality (Vollrath, 1988). Although their life cycles occur similar over time scales to the disturbance needed to be monitored, they do not track seasonal changes but do respond to sustained grazing pressure (Warui, 2004).

Spiders are widespread and abundant group in nature (Wilder, 2011), and found on many types of habitats (Warui, 2004). Although spiders occur in the most barren landscapes, botanically complex regions sustain high spider diversity and abundance (Foelix, 1996) with presence of many endemics, at both the genus and species levels (Deltshev, 2008) which are widely distributed from the islands to the highlands of varying altitudes (Foelix, 1996). Spider assemblages are highly influenced by variations in plant community structure, ecosystem dynamics such as disturbance, and abiotic factors such as soil and ambient humidity and temperature (Bonte *et al.,* 2000). Spiders can also be classified into guilds based on family-level determination, which reflect their foraging manner, web type, microhabitat use, and activity patterns (Uetz *et al.,* 1999). Guild classification of spiders is a useful tool in ecological studies that seek to describe diversity in communities and functional relationships (Freitas *et al.,* 2013).

Worldwide, there are many studies conducted about spiders, particularly in temperate regions, and relatively less investigation in tropical areas (Chen and Tso, 2004). However, spider fauna is still incompletely known, and with cursory survey a new species could actually be found (Sewlal and Cutler, 2003). A study of Armendano and Gonzalez (2011) showed the association of spider fauna with wheat crops and adjacent habitat in Buenos Aires, Argentina. A study of Horvath *et al.*, (2009) showed that spiders are not less diverse in small and isolated grasslands, but less diverse in overgrazed grasslands in East Hungary. In China, Barrion *et al.,* (2012) discovered 21 new spider species. In the Philippines, about 517 spider species are recorded (Barrion, 2001) which is the highest record of spider species in the entire tropical rice agro-ecosystems in Asia (Barrion, 1999a; Barrion, 1999b). However, the current knowledge on the systematics of Philippine spiders is very bleak and limited only to the fauna of rice fields and areas adjacent environs, and the current record based on the available specimens at hand or those kept in museums abroad is unrealistic considering the many islands in the Philippines (Barrion, 2001). A recent study on the spiders in Mindanao, the second largest island in the Philippines, is in Mt. Matutum (Garciano *et al.,* 2014) and the caves of Mindanao (Cabili and Nuñeza, 2014) and Siargao Island (Enriquez and Nuñeza, 2014). Considering the lack of data on spiders in Mindanao particularly in Zamboanga del Sur, this study assessed the spider fauna of Pulacan Falls, Zamboanga del Sur through species richness and relative abundance.

Materials and methods

The study area was in Pulacan Falls (Fig.1), 12 km from Pagadian City. Five sampling sites were established (Table 1).

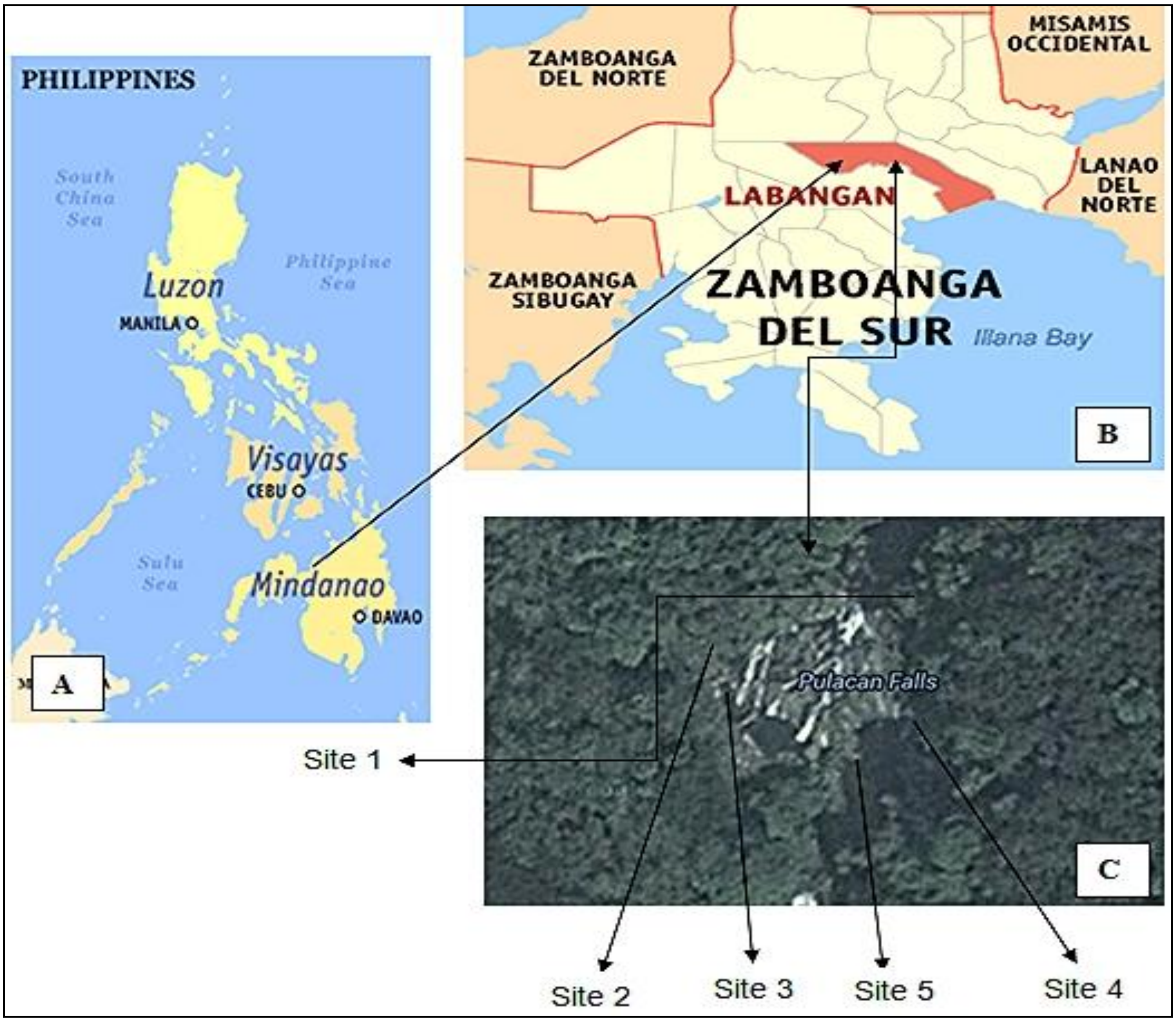

Fig. 1. Map of the Philippines (A) (Factgrabber.com, 2014), Labangan Zamboanga del Sur (B) (Wikipedia.org, 2005) and Pulacan falls (C) (Googlemaps.com, 2014) showing the five sampling sites.

Table 1. Graphical location and habitat description of the five sampling sites.

Site	Geographical Location (GPS)	Habitat Description
1	7° 54' 55.8885"N 123° 29' 23.4981"E 120.396masl	Mountainous slope with secondary vegetation type. Dominated by mahogany (*Swietenia mahogani*) as emergent tree.
2	7° 54' 56.0415"N 123° 29' 22.2236"E 114.91masl	Undulating slope with secondary vegetation type. Presence of ferns on trees as epiphytes.
3	7° 54' 54.9703"N 123° 29' 21.8759"E 113.386masl	Flat slope with disturbed vegetation. Surrounded with mahogany and *gmelina trees.*
4	7° 54' 55.0086"N 123° 29' 23.614"E 108.814masl	Mountainous slope with secondary vegetation type. The site is dominated by a slow pacing current. Leaf litters were abundant, decomposing naturally.
5	7° 54' 54.4348"N 123° 29' 22.8995"E 106.07masl	Undulating slope with secondary vegetation type. Near the rocky cliff. Surrounded by ferns, bushy grasses and leaf litters.

Sampling was conducted for seven field days from December 25- 31, 2013 for a total of 40 man-hours. A 200 m transect was used to set up the five different sites. Spider microhabitats like under leaf litter and fallen or dry wood were checked for ground- dwelling spiders. Herbs and shrubs were checked and leaves of trees and visible webs were searched for arboreal spiders. Beat-netting, sweep-netting, and vial-tapping methods were used. Samples were placed in vials with 70% ethyl alcohol. The date of collection, site and habitat were written on the label. Identification of collected specimens was done at the Institute of Biological Sciences, UP Los Banos, College, Laguna. Biodiversity indices were calculated using Microsoft Excel 2010. Detrended Correspondence Analysis was calculated using the PAST 3 application.

Results and discussion

Thirty-seven species were recorded belonging to 10 families (Table 2). This is relatively high compared to the spider fauna in Mt. Matutum (Garciano *et al.,* 2014) and in the caves of Mindanao (Cabili and Nuñeza, 2014) and Siargao Island (Enriquez and Nuñeza, 2014). However this result is relatively low compared to the spider fauna in Philippine rice fields consisting of 337 species under 28 families (Barrion, 2001). The peaks of abundance of spiders in non-rice habitats are in August, September and December (Barrion, 1999a; Barrion, 1999b) which coincides with the month of sampling in this study. Both *Neoscona bengalensis* which was found in site 3 and *Tetragnatha chauliodus* which was found in site 5 are new records in Mindanao. *Neoscona bengalensis* is typically nocturnal species and is endemic in India (Sebastian, 2009). This species was recorded from Kaghaan and Northern areas (Razzaq, 2002), from different localities in Punjab (Mukhtar, 2012) and from five districts of Punjab (Parveen, 2003). *Tetragnatha chauliodus* is distributed in Singapore, Malaysia, and Myanmar (Thorell, 1980). This species was also reported by Barrion *et al.,* (2011) in Hainan Island, China. Four species which are possibly new, namely, *Eriovixia* sp., *Neoscona* sp., *Telamonia* sp. and *Diaea* sp. were recorded in this study. *Eriovixia* sp., a small tropical genus of araneid spiders and *Neoscona* sp., also of Family Araneidae are common throughout the different regions of the world. Another possibly new species, *Telamonia* sp. belonging to family Salticidae, is Oriental in its distribution. *Diaea* sp. of family Thomisidae is a possibly new species, the genus of which is mostly from Australia and the Pacific Islands (Barrion, 2001). Site 4 had the most abundant spiders with 46 individuals and the most diverse with 22 species belonging to seven families. It is well known that spiders respond to the complexity and diversity of vegetation (Seyfulina, 2005). Malumbres-Olarte *et al.,* (2013) reported that physical structure and species composition of vegetation determine species diversity and abundance through habitat availability. This indicates that the vegetation type in Site 4 is conducive to spiders.

Table 2. Species richness and abundance of spiders in five sampling sites of Pulacan Falls, Zamboanga del Sur.

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Total	RA (%)
Family Araneidae							
Argiope aemula _ (Walckenaer, 1842)	2 (5.71)	1 (3.85)	0	0	0	3	2
Argiope cf. catenulate	0	1 (3.85)	0	0	0	1	0.68
Argiope cf. pulchella	1(2.86)	0	0	0	0	1	0.68
Argiope pulchella Thorell, 1881	4(11.43)	1(3.85)	0	0	0	5	3.4
Argiope versicolor (Doleschall, 1859)	1 (2.86)	2 (7.69)	0	1(2.17)	0	4	2.72
Cyrtophora cf. cylindroides	0	1(3.85)	0	0	0	1	0.68
Eriovixia cf. excels	0	1(3.85)	0	0	0	1	0.68
Eriovixia excelsa (Simon, 1889)	0	1(3.85)	0	2(4.35)	1 (5.26)	4	2.72

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Total	RA (%)
Eriovixia laglaisei (Simon, 1877)	0	1(3.85)	0	3(6.52)	2 (10.53)	6	4.08
Eriovixia sp.*	0	0	0	1(2.17)	0	1	0.68
Gasteracantha kuhli C. L. Koch, 1837	0	0	0	1(2.17)	1(5.26)	2	1.36
Neoscona bengalensis Tikader and Bal, 1981**	0	0	1 (4.76)	0	0	1	0.68
Neoscona facundoi Barrion-Dupo, 2008	0	0	0	1(2.17)	1(5.26)	2	1.36
Neoscona molemensis Tikader & Bal, 1981	0	0	0	1(2.17)	5 (26.31)	6	4.08
Neoscona punctigera Doleschall, 1857	0	8 (30.77)	8	7 (15.21)	0	23	15.65
Neoscona sp.*	0	0	0	1(2.17)	0	1	0.68
Neoscona theisi _ (Walckenaer, 1841)	0	1(3.85)	1(4.76)	1(2.17)	0	3	2
Neoscona vigilans _ (Blackwall, 1865)	0	2(7.69)	4 (19.05)	1(2.17)	0	7	4.76
Poltys illepidus C. L. Koch, 1843	11 (31.43)	2 (7.69)	6 (28.57)	3 (6.52)	1 (5.26)	23	15.65
Family Clubionidae							
Cheiracanthium insulanum (Thorell, 1878)	0	0	0	1(2.17)	0	1	0.68
Cheiracanthium sp.1	0	0	0	0	1(5.26)	1	0.68
Cheiracanthium sp. 2	0	0	0	0	1(5.26)	1	0.68
Family Deinopidae							
Deinopis sp.	5 (14.29)	0	0	0	0	5	3.4
Family Nephilidae							
Nephila pilipes fenestra	11 (31.43)	0	0	0	0	11	7.48
Family Oxyopidae							
Oxyopes javanus Thorell, 1887	0	0	1(4.76)	0	0	1	0.68
Oxyopes macilentus L. Koch, 1878	0	0	0	1(2.17)	0	1	0.68
Oxyopes matiensis Barrion & Litsinger, 1995	0	0	0	1(2.17)	0	1	0.68
Family Pisauridae							
Pisauridae sp.	0	0	0	1(2.17)	0	1	0.68
Family Salticidae							
Chalcotropis sp.n	0	0	0	0	2 (10..53)	2	1.36
Telamonia sp.*	0	0	0	1(2.17)	0	1	0.68
Family Sparassidae							
Heteropoda sp.	0	0	0	1(2.17)	0	1	0.68
Heteropoda sp.	0	0	0	0	1 (5.26)	1	0.68
Micrommata sp.	0	0	0	0	1 (5.26)	1	0.68
Olios sp.	0	1(3.85)	0	0	0	1	0.68
Pseudopoda sp.	0	1(3.85)	0	0	0	1	0.68
Yellow *Pseudopoda*	0	1(3.85)	0	0	0	1	0.68
Family Tetragnathidae							
Leucauge tessellate (Thorell, 1887)	0	0	0	1(2.17)	0	1	0.68
Opadometa fastigiata Simon 1877	0	0	0	13 (28.26)	0	13	8.84
Tylorida striata (Thorell, 1877)	0	0	0	1(2.17)	0	1	0.68
Tetragnatha cf. ceylonica	0	0	0	2 (4.35)	0	2	1.36

Species	Site 1	Site 2	Site 3	Site 4	Site 5	Total	RA (%)
Tetragnatha chauliodus Thorell, 1890 **	0	0	0	0	2 (10.53)	2	1.36
Family Thomisidae							
Diaea sp.*	0	1	0	0	0	1	0.68
Total number of individuals	35	26	21	46	19	147	
Total number of species (Species Richness)	7	15	6	22	11	37	
Total number of families	3	2	2	7	5	10	

*Possibly New species;**New Record

Fig. 2 shows 10 families of spiders documented in the study. Family Araneidae was the most abundant (98 individuals) followed by Tetragnathidae (19 individuals). Occurrence of high number of Araneidae and Tetragnathidae (orb-web spiders) could be due to mixed vegetation of the forest, which provides enough space to build webs of different sizes and protection from predators. Both families can be seen in secondary type vegetation. Rodrigues *et al.,* (2014) reported that vegetation structure has been hypothesized to affect spiders, but this impact might be best seen in specific subgroups or guilds within spiders. Araneidae and Tetragnathidae prefer locations either near water, in shaded vegetation, or logs, trunks, or buttresses of trees (Ward, 2007). Richardson and Hanks (2009) reported that the species diversity of orb-weaving spiders seems to be strongly influenced by species composition of the plant community.

Site 3 with disturbed vegetation type had the lowest species diversity compared to other sites (Table 3). The same observation was obtained by Topping and Love (1997) that low spider density and species richness are shown in highly disturbed areas. Henderson (2007) stated that spider community is affected by disturbance and vegetation structure and as the area is subjected to high levels of disturbance it is characterized by lower spider abundance and species diversity. Human disturbance has an influence on spider communities which could significantly lower the species richness in the disturbed site (Maya-Morales *et al.,* 2012). Uneven distribution was observed in sites 1 and 3 due to dominance of *Nephila pilipes fenestra* in site 1 and *Poltys illepidus* in site 3. A more or less even distribution was observed in the other sites. Species diversity increases as individuals become more evenly distributed (Price, 1975).

Table 3. Species Diversity and Evenness of Spiders in Pulacan Falls, Zamboanga del Sur.

	Site 1 120.396 masl	Site 2 114.91 masl	Site 3 113.386 masl	Site 4 108.814 masl	Site 5 106.07 masl
Vegetation type	Secondary vegetation	Secondary vegetation	Disturbed vegetation	Secondary vegetation	Secondary vegetation
Abundance	35	26	21	46	19
Shannon	1.6201	2.4583	1.1087	2.6041	2.3020
Evenness	0.4557	0.7545	0.3642	0.6802	0.7818

In order to isolate any significant difference between the sites, Detrended Correspondence Analysis (DCA) was used. Fig. 3 shows that Site 3 is the only sampling site that is isolated from the remaining four sampling sites. It is also the sampling site with disturbed vegetation. Spiders with the same tree preference most likely stay in the same site, since stands of vegetation refer to a community of tress uniform in species. Specific preference of many spiders to different levels of vegetation is shown in similar stands of vegetation (Robinson, 1981). It is therefore no surprise that separation should occur in areas of differing plant composition and architecture and hence the formation of individual spider guilds.

Spiders occupy virtually every habitat with a wide range of morphological adaptation, life styles, and behaviors (Saini *et al.,* 2013) and their abundance in any particular habitat is influenced by both abiotic (e.g. light levels, temperature, humidity) and biotic factors (e.g. prey availability) (Voss *et al.,* 2007).

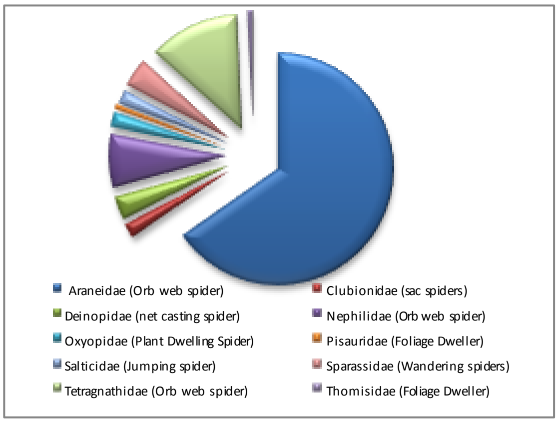

Fig. 2. Three-dimensional pie chart of spider population according to family.

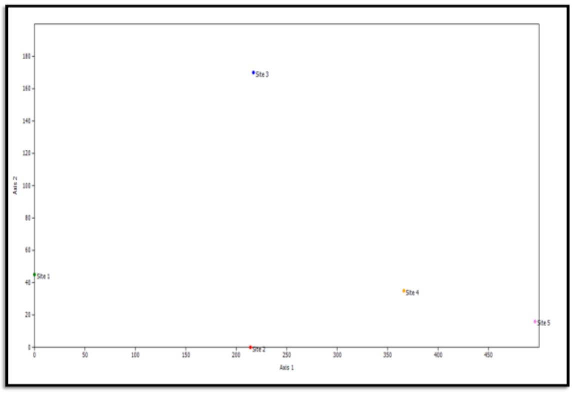

Fig. 3. The Detrended Correspondence Analysis (DCA) Plot of the sampling site per elevation.

Four spider species, namely: *Neoscona bengalensis, Neoscona vigilans, Poltys illepidus* and *Oxyopes javanus* were located in the disturbed site (site 3). The first three species are of the orb-web guild occupying the same habitat indicating that they can survive and are able to thrive in a disturbed area. Holt *et al.,* (1994) stated that species occupying the same habitat intensively compete with each other. *Oxyopes javanus* is a species of lynx spiders that build no webs and live within the rice canopy. They prefer drier habitats, and colonize rice fields after canopy development (Shepard *et al.,* 1987). *Poltys illepidus* and *Nephila pilipes fenestrata* were common in site 1; both are orb-web spiders. *Neoscona punctigera* dominated site 2 while family Tetragnathidae was only seen in site 4.

Conclusion

Pulacan Falls is a species-rich area with four possibly new species and two which are new record in Mindanao. Most of the spider species recorded belongs to the large group of web builders (Araneidae). Species richness and diversity were lowest in the disturbed site.

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