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Inventory of Spider (Arachnida: Araneae) Diversity in CALSANAG Watershed Forest Reserve in Romblon, Philippines

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Abstract - A rapid biodiversity assessment of spiders was conducted in the CALSANAG Watershed Forest Reserve (WFR), Romblon from 22nd October to 26th November 2016. Specimens were collected from forest, shrublands, grassland, and riverbank area. A total of 597 individuals were collected representing 24 species from 14 genera under the families of Araneidae, Clubionidae, Oxyopidae, Linyphiidae, Thomisidae, Nephilidae, Pisauridae, Sparassidae, Tetragnathidae, Theridiidae, and Theraphosidae. Two are possibly new species and two are new records species for the Philippines. Grassland area shows highest species richness and diversity among the sampling sites. Family Araneidae had the highest species richness and abundance. Results indicate that habitat and vegetation type affect the species richness and abundance of spiders.

Keywords - Araneae, CALSANAG, spider diversity inventory, taxonomy, watershed

INTRODUCTION

The Calatrava-San Andres-San Agustin, or commonly referred to as CALSANAG Watershed Forest Reserve is one of the 240 protected areas in the Philippines overseen by the Department of Environment and Natural Resources Biodiversity Management Bureau under the National Integrated Protected Areas System (NIPAS) Act of 1992. It is located in the municipalities of Calatrava, San Andres and San Agustin in the island of Tablas in Romblon. The land area covered by the reserve per municipality is approximately 1,137 ha in San Andres, 913 ha in Calatrava, and 620 ha in San Agustin or a total land area of 2,670 hectares (PENRO-DENR, 1997; 2001). The watershed area is dominated by forest, grassland, open land, cocoland, brushlands, pastures and cultivated land. Based on the report (PENRO-DENR, 2001), approximately, 36% (967.89 ha) of the total land area of the CALSANAG WFR is forest, while 28% (755 ha) and 25% (680.36 ha) is grassland and coconut land, respectively, while the rest of the area which constitutes 11% is covered with shrubs, pasture land, and cultivated land. In year 1982 it was proclaimed as conservation priority area and watershed forest reserve (Presidential Proclamation No. 2186), which is now identified as the priority area for conservation and research for arthropods, classified extremely high for amphibians and reptiles, extremely high for marine, very high for birds and very high biological level of importance for terrestrial and inland water areas (Ong, Afuong & Rosell-Ambal, 2002).

This area is interesting with its fauna and flora with an elevation ranging from 100-600 masl which starts from the lowest level and gradually rising to the highest peak, (Initial Protected Area Plan, 2016). The forest reserve is more of a dipterocarp type of forest such as “lauan”, “tanguile”, “apitong”, “bagtikan”, “yakal”, and “manggachapui”, comprised of old growth and second growth forests (PENRO-DENR, 1997). A total of 84 plant species have been reported in the reserve area. Rare and endangered wildlife species which include wild pig, fruit bats, Philippine monkey, Philippine hanging parakeet, parrots, Rufous Hornbill, and monitor lizard have been found in the reserve area. Monkeys were reported to be the most dominant wildlife species in the reserve. Avifauna, such as wood duck, pink belle imperial pigeon, oriental hobby, crested lizard hawk, stork billed kingfisher, white collared kingfisher, twisted billed hornbill, serpent eagle, Philippine koel, and barrel scoop owl, was also sighted (PENRO-DENR, 2001).

Aside from these faunas, many other species are yet to be discovered and identified. Spiders, like every other form of species, play an important role as ecological indicators. They are terrestrial arthropods

that have long been monitored for early warning signs of environmental degradation (Kremen et al., 1993). Since no inventory of spiders in CALSANAG WFR was done to contribute to the checklist of biodiversity of this highland, a biodiversity assessment on spider species diversity was conducted to assess the presence of spider species in CALSANAG WFR in Tablas, Romblon.

MATERIALS AND METHODS

Study Site and Study Design

The study was conducted in CALSANAG Watershed Forest Reserve, Barangay Balogo in the Municipality of San Andres, Romblon. The CALSANAG WFR is situated at the northern portion of Tablas Island, approximately between 12° 35' N and 122° 04' E. It covers a total area of 2,670 hectares in which general topography of the area is rolling, moderately steep to very steep (PENRO-DENR, 1997) (Figure 1).

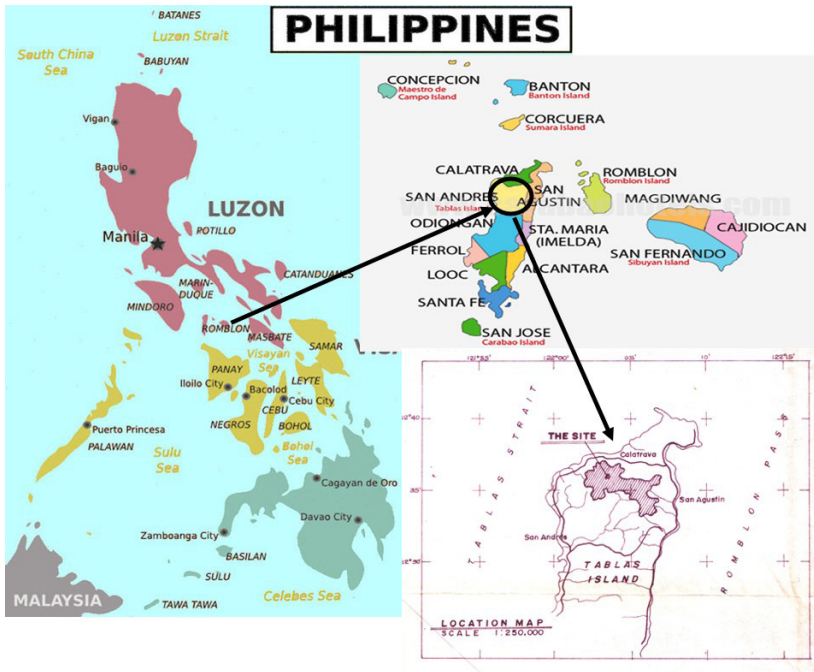

Figure 1. Map of the Philippines (Googlemaps.com, 2016) and the location map of CALSANAG WFR and municipal boundaries *(Source: CENRO-DENR Odiongan, Romblon).*

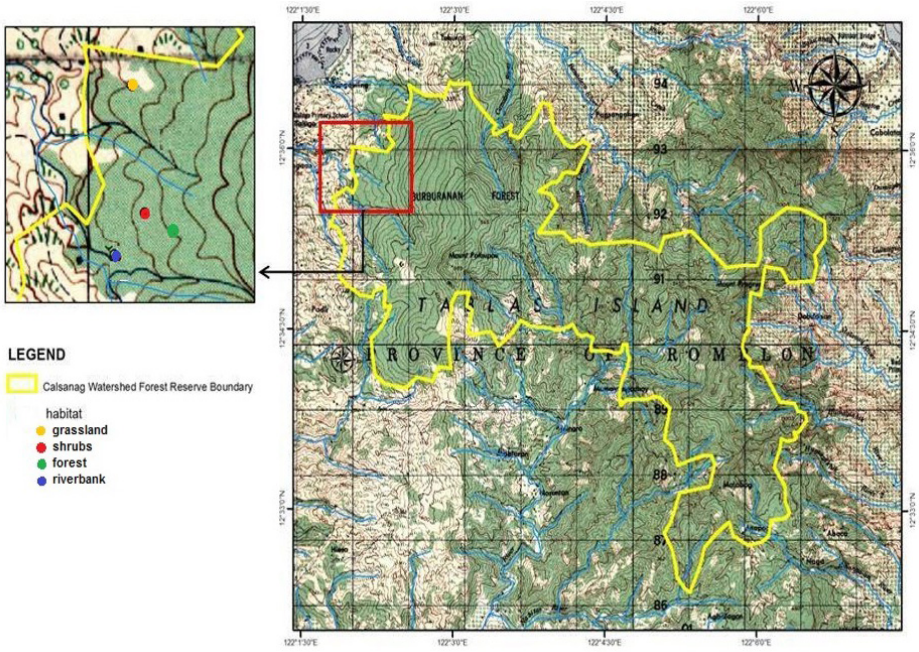

Figure 2. The CALSANAG Watershed Forest Reserve
(Source: CENRO-DENR Odiongan, Romblon) showing the collection sites (Googlemaps.com, 2016).

Collection of Specimens

Specimens (live spiders) were collected from different habitats in the watershed area, forest (122˚ 02.101' E 145m masl), shrubs (122° 02.149' E 104 masl), grassland (122° 02.149' E 104 masl), and riverbank (122° 02.75' E 95 masl) every morning (7:00am to 11:00am) for five (5) weeks from October 22 to November 26, 2016 using opportunistic sampling method. To collect the specimens, visual and hand collections were done by searching beneath the barks of dead trees, breaking open old logs and dead free-standing trees, and even over-turning logs and stones. Other methods included sweep net to collect spiders on the top of tall trees and other vegetation, and beating for sturdier vegetation. Beating methods for sturdier vegetation, like trees and shrubs were used by tapping the plant with a stick to catch whatever fell off in an upturned light colored umbrella. Moreover, pitfall traps containing 20 ml water, 3 tbsp salt and a few drops of liquid detergent soap in a 250 ml volume and 7.5 cm diameter container were also used for catching ground-living spiders. Twenty (20) pitfall traps were then placed in each habitat with

10m distance from each other. Containers were checked every three days and specimens were collected from the traps.

Preservation of Specimens

All spiders collected were photographed and preserved in 70% ethyl alcohol. These were brought to the Biology laboratory department in Romblon State University, Odiongan, Romblon for sorting and identification. Long-term preservation process followed (Barrion & Litsinger, 1995). Specimens were preserved in a glass jar with 70% ethyl alcohol, and each jar was labelled properly. Collection date, compartment name, and habitat were recorded on each vial.

Identification of Spiders

Collected spiders were identified up to species level, if possible using available keys, figures and descriptions from Barrion and Litsinger (1995). Characteristics useful for identification were examined in detail, namely: body shape, eye pattern, eye arrangement, chelicerae, shape of the sternum, maxillae, and legs. In order to facilitate observation of these characteristics, the spiders were mounted in a petri dish containing 70% ethyl alcohol to prevent the specimen from drying. A dissecting microscope was used to view the details of some features which are invisible to the naked eye. For verification and final identification, the assistance of an expert was solicited, and specimens were brought to the Biological Research Unit (BCRU), Science and Technology Center, De La Salle University, Biñan City, Laguna. All specimens were verified and identified by Dr. Alberto T. Barrion.

Data Analysis

Biodiversity indices which include species richness, relative abundance, Shannon-Weiner Diversity Index, and Pielou's evenness were calculated using BioDiversity Professional statistics analysis software (McAleece, Gage, Lambshead, & Paterson, 1997). The same program was used for a dendrogram based on Bray-Curtis distances for clustering to determine the similarity among study sites.

RESULTS AND DISCUSSION

Throughout the study period, specimens of spiders were obtained from four habitats (grassland, forest, riverbanks, and shrubs) in CALSANAG Watershed Forest Reserve in Tablas, Romblon.

A total of 597 individual spiders were collected from the watershed with 24 species belonging to 11 families, namely: Araneidae (10 spp), Cubionidae (3 spp.), Tetragnathidae (2spp.), Thomisidae (2 spp.), and one each in Sparassidae, Theridiidae, Pisauridae, Oxyopidae, Linyphiidae, Nephilidae and Theraphosidae (Table 1).

Table 1. Species richness and abundance of spiders in the four sampling sites of CALSANAG Watershed Forest Reserve in Tablas, Romblon on October 22 to November 26, 2016.

Taxa	Habitat				Total	RA%
	Grassland	Forest	Riverbank	Shrubs		
Phylum Arthropoda						
Class Arachnida						
Order Araneae						
Family **Ranidae** (Dahl, 1912)						
Argiopecatenulata (Doleschall, 1859)	13	0	9	2	24	0.402
Argiopeluzona (Walckenaer, 1841)	15	0	0	0	15	0.251
Argiopeaemula (Walckenaer, 1841)	41	27	0	0	68	1.139
Neosconatheisi (Walckenaer, 1841)	5	5	7	16	33	0.553
Neosconamolemensis (Tikader&Bal, 1981)	3	30	8	0	41	0.687
Neosconapunctigera (Doleschall, 1857)	0	5	0	0	5	0.084
Gasteracanthadiasdemia (Thorell, 1887)	3	17	10	5	35	0.586
Poltysillepidus (C. L. Koch, 1843)	11	38	0	37	86	1.441
*Poltys*n. sp.	0	0	0	1	1	0.017

Taxa	Habitat				Total	RA%
	Grass-land	For-est	River-bank	Shrubs		
Poltyselevatus (Thorell, 1890)	0	0	0	2	2	0.034
Family **Sparassidae** (Simon, 1874)						
Heteropodavenatoria (Linnaeus, 1767)	2	11	5	35	53	0.888
Family **Clubionidae** (Wagner, 1887)						
Clubionadrassodes (O. P.-Cambridge, 1874)	5	0	0	0	5	0.084
Clubionajaponicola (L. Koch, 1878)	46	0	0	0	46	0.771
*Clubiona*sp. 1	0	0	0	6	6	0.101
Family **Theridiidae** (Sundevall, 1833)			0		0	
Coleosomablandum (O. P.-Cambridge, 1882)	10	0	0	0	10	0.168
Family **Pisauridae** (Simon, 1890)						
Perenethisunifasciata (Thorell, 1891)	0	6	12	0	18	0.302
Family **Oxyopidae** (Thorell, 1870)						
Oxyopesjavanus (Thorell, 1887)	0	10	13	0	23	0.385
Family **Linyphiidae** (Blackwall, 1859)						
Erigonebifurca (Locket, 1982)	0	0	13	0	13	0.218
Family **Tetragnathidae** (Menge, 1866)						
Tetragnathaiwahigensis (Barrion & Litsinger, 1995)	10	0	0	0	10	0.168
Tetragnathanitens (Audouin, 1826)	0	0	0	6	6	0.101
Family **Thomisidae** (Sundevall, 1833)						
*Thomisus*sp. 1	1	0	0	0	1	0.017
Thomisusguangxicus (Song & Zhu, 1995)	3	0	0	0	3	0.050
Family **Nephilidae** (Simon, 1894)						
Nephilapilipes (Fabricius, 1793)	19	0	9	11	39	0.653

Taxa	Habitat				Total	RA%
	Grass-land	For-est	River-bank	Shrubs		
Family **Theraphosidae** (Thorell, 1870)						
*Orphnaecus*n. sp.	30	0		2	32	0.536
Total number of individuals	**217**	**149**	**108**	**123**	**597**	
Total number of species	**16**	**9**	**10**	**11**		

Spider abundance between families

Based on the number of individuals in a family Araneidae is the most abundant with 310 individuals (percent abundance of 52%) with ten species, namely: *Argiopecatenulata, Argiopeluzona, Argiopeaemula, Neosconatheisi, Neosconamolemensis, Neosconapunctigera, Gasteracanthadiasdemia, Poltysillepidus, Poltys*n. sp*, Poltyselevatus* belonging to 4 genera (Argiope, Neoscona, Gasteracantha, and Poltys) (Fig. 3). Family Clubionidae or sac spiders is the second most abundant with 57 individuals (9% abundance) with three identified species (*Clubionadrassodes, Clubionajaponicola, Clubiona*sp. 1). Moreover, Family Sparassidae and Theraphosidae, with 53 and 54 collected spiders (both with 9% abundance) with only one species (*Heteropodavenatoria* and *Orphnaecus*n.sp), respectively. Family Nephilidae has 6% abundance or with 39 individuals of *Nephilapilipes*. All the other families contributed not more than 4% to the overall abundance.

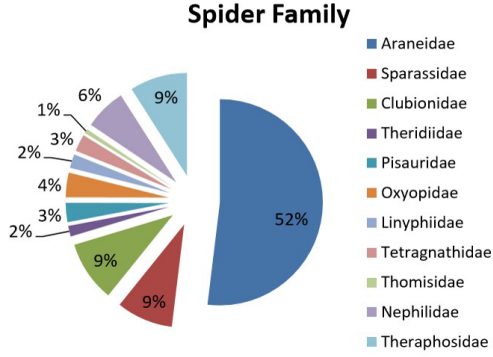

Figure 3. Percentage of specimens collected for each spider family in CALSANAG Watershed Forest Reserve in Tablas, Romblon on October 22 to November 26, 2016.

Family Araneidae was found to be the most abundant spider family in all four sites which was dominated by the species *Poltysillepidus* with 86 or 24% number of individuals (Table 1). It is one of the most successful spider families with approximately 2600 species according to Foelix, (1996), and is relatively easy to detect because of their size, colouration, and orb webs. Araneidae are the typical orb-weaver spiders, whose web consists of concentric rings and a series of radii that hang down from the center of the web (Barrion & Litsinger, 1995). The presence of such web would make it more visible during collection; hence, a large number of species were identified in the area. Orb-weavers are also very good predators as they bite and eat the insects which stick to the web. Thus, their dominance may reflect more affinity towards the availability of prey.

Majority of Araneidae species were collected in forest area (Table 1) during rainy days (October to November) and with high humidity. It is assumed that they are the most abundant in all areas since orb weavers are common in humid habitats than in dry ones (Hammond, n.d.). Amongst the spider families, Araneidae also has a high number of collected individual species in grassland and shrubs. According to Barrion et al. (2012), orb-weavers are frequently encountered at the shrubs and grassy areas. Furthermore, these species are also abundant in the riverbank area, since Ward (2007) reported that Araneidae also prefer locations, such as: near water, inshaded vegetation, logs, trunks or buttresses of trees.

Spider abundance between sampling sites

With 217 or 36% individual spiders (Fig. 4), grassland area was recorded with the most abundant number of spiders. Grassland has less slope area amongst others thus spotting spiders is made easier.

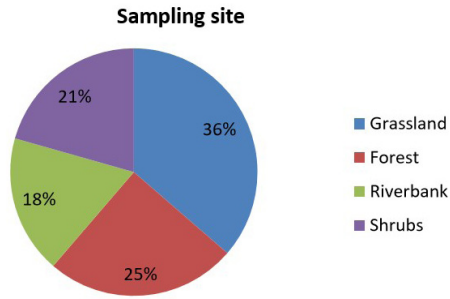

Figure 4. Percentage of spiders found in each habitat at CALSANAG Watershed Forest Reserve, in Tablas, Romblon on October 22 to November 26, 2016.

Unlike grassland, forest area was more difficult to explore in collecting specimens because of the dense vegetation and hilly road. A total of 149 or 25% of individual spiders were recorded in this area, but according to Döbe, Denno, and Coddington (1990) and Gunnarsson (1990), spider abundance is also directly related to habitat complexity and vegetation since many spiders live directly in specific environments related to the kind of vegetation present (Foelix, 1982; Malumbres-Olarte, Vink, Ross, Cruickshank, & Paterson, 2013).

It is believed that the presence of these spiders is due to high plant diversity and vegetation around the site which is also associated with a rich abundance of insects (Morse 1993; Henschel & Lubin, 1997) since prey availability is an important factor governing the distribution of spider species. Spiders are found in all terrestrial and freshwater ecosystems. It is also considered the most important biomes and ecosystems for the spiders since a relatively moist area provides suitable habitat for spiders. However, because of the rainy weather conditions during the collection, the riverbank had the fewest collected spiders with 108 or 18% only of spider individuals. The slippery path going to the riverbank area limited the number of collected specimen. However, since shrubs are ideal habitats for spiders, a good yield of specimens with 123 or 21% of individual species were found in this site. The site had thicker leaf litter depth in which the presence of some species may be facilitated by leaf litter size that increases the essential surface area for some foraging species (Uetz, 1991). Also, manipulations of shrub and tree structure were found to influence spider species diversity and abundance (Hatley & MacMahon, 1980). Therefore, habitat structure is an important aspect of spider assemblage structure (Gibson, Hambler, & Brown, 1992).

Diversity indices and spider abundance across ecosystems

Table 2 shows the biodiversity indices of the four sampling sites. Diversity is high in the grassland area near reformed habitats brought about by agricultural activities. All four sampling sites were found to be more or less evenly distributed though shrub areas had the lowest value compared with the three sites. In this case, it means that the area was dominated by *Poltysillepidus* and *Heteropodavenatoria* species belonging to Araneidae and Sparassidae families, respectively. The orb web building spiders (*P. illepidus*) are mostly found in forest and shrub areas with bush cultivated crops. It is believed that abundance of orb-weavers is influenced by the physical structure of the vegetation and the availability of the web sites (Wise, 1993). *H. venatoria*, a hunting spider was present in the same habitat. The thin ground-layer vegetation that is required for

web construction in shrub area in the watershed might have supported a large population of such spider species thus explaining their dominance. Areas consisting of a high diversity of grassland and shrubs that create greater habitat complexity, means that there are many niches in which spiders may live (Haddad, 2005); and/ or it can also indicate that different elevations in the lowland area can provide favorable environment for various spider species. The pattern of species diversity can considerably be affected by the vegetation structure, landscape, and environmental conditions which may result in the absence of some less tolerant or fragile species (Uniyal, Sivakumar, & Quasin, 2011).

Furthermore, while the grassland area has the highest species richness and more diverse species, the riverbank area has the highest value of evenness. This is because individuals in the community are distributed more equitably among these species. Species diversity increases as individuals become more evenly distributed (Price, 1975).

Table 2. Biodiversity indices of the four sampling sites at CALSANAG Watershed Forest Reserve, in Tablas, Romblon on October 22 to November 26, 2016.

Indices	Grassland	Forest	Riverbank	Shrubs
Species Richness	16	9	10	11
Shannon H'	2.338	1.959	2.225	1.865
Evenness	0.843	0.892	0.966	0.778

Agricultural activities are done regularly as it is the means of livelihood for the local people on the site. Spiders are ubiquitous in terrestrial ecosystems and they have a substantial presence in the agricultural landscape (Turnbull, 1973). Several studies have suggested that spider dispersal and re-colonization of fields are significant aspects of spider population dynamics in agro-ecosystems (Bishop & Riechert, 1990). Similarly, spiders are sensitive to disturbances brought about by agricultural activities. The disturbance has an influence on spider communities which could significantly lower the species richness in the disturbed site (Maya-Morales, Ibarra-Nuñez, Leon-Cortes, & Infante, 2012). However in this study, spider species diversity and abundance is presumed to be resistant to these disturbances, and thus play an important role in regulating insect pests in agriculture ecosystems. They feed on insects and other arthropods, which can also play a role in pest control on the site. This only means that spider abundance and diversity truly depends on the availability of habitats which is important for spider colonization and establishment (Jögar, Metspalu, & Hiiesaar, 2004). This may be correlated with the specific vegetation characteristics of the site.

Moreover, the presence of singleton species may possibly reflect specific habitat preferences.

Table 3. Bray-Curtis species analysis showing species percent similarity between the different collection sites.

Collection Sites	Similarity Matrix			
	Grassland	**Forest**	**Riverbank**	**Shrubs**
Grassland	*	27.8689	32.6154	21.1765
Forest	*	*	34.2412	42.6471
Riverbank	*	*	*	25.974
Shrubs	*	*	*	*

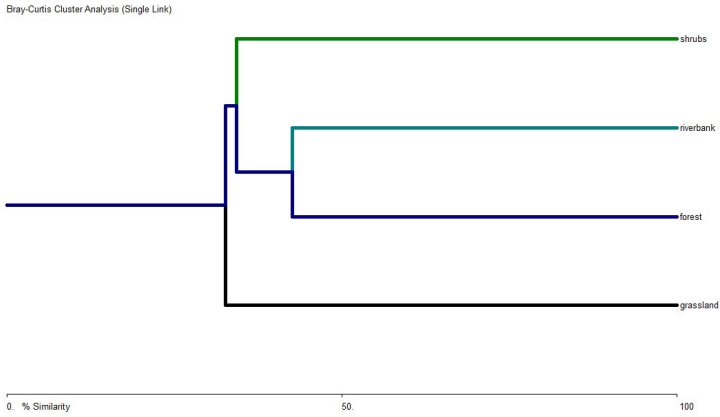

Figure 5. Bray- Curtis species analysis showing percent similarity between the different collection sites at CALSANAG Watershed Forest Reserve, in Tablas, Romblon on October 22 to November 26, 2016.

The dendrogram shows that there is 43.6 % similarity in species composition between shrubs and forest belonging to family Araneidae (orb weavers), while grassland and shrubs show least similarity (21.2%). This could be due to the variable habitat type (Table 4, Figure 5).

CONCLUSIONS AND RECOMMENDATION

Spiders are the largest assemblage of animals with jointed legs and exoskeleton with only two body regions – a cephalothorax and abdomen. They are eight-legged and have no compound eyes and wings. They are the largest order of arachnids and rank seventh in total species diversity among all other groups of organisms. However, multiple factors have threatened and reduced the numbers of spiders and reduced its diversity.

Based on this inventory study of spiders in CALSANAG WFR, the number of spiders collected were 597 individuals belonging to eleven (11) families with 24 species of spiders. Of this 24 species recorded, two are possibly new species and two are new records for the Philippines. Most of the spider species recorded belong to the large group of web builders (Araneidae) which makes the most distributed species, being found in all sites. The watershed has high species diversity index with more or less even distribution. Species richness and diversity were highest in the area with a high diversity of grassland near agricultural sites. Apparently, most spider species are well adapted to a specific habitat. In addition, this study showed that an important determinant of spider species richness and diversity in the watershed was habitat diversity. The result also indicated that structurally more diverse vegetation supports a higher number of spider species which could be explained by a greater variety of available niches both for spiders and its prey.

The study shows that CALSANAG Watershed Forest Reserve must be preserved being the last remaining intact forest in Tablas Island. Since this is the first study on spider diversity that was carried out in the Province of Romblon particularly in CALSANAG WFR, the presence of such number of organisms including the discovery of possibly two new species and two new records for the Philippines is a significant contribution to the biodiversity studies in the watershed leading to the protection and conservation of both flora and fauna in this area. Moreover, this possibly new species and new recorded spider species in the Philippines should be further described for documentation purposes and for further studies as part of the biodiversity study in the watershed.

The collection of specimens was carried out between months of October and November when the rainy season is at the onset with a steep and slippery road. Thus, the less maximum number of spider individual species was found in the rest of the habitats. This only means that a future study must be done during summer and/ or dry season.

Furthermore, the abundance of spider species in CALSANAG WFR in Romblon only implies that there is still a lot of places and organisms which are actually less explored especially in a rich and diverse country like the Philippines. These also include local studies on spiders which are relatively low because of less support from taxonomists.

However, this is not a final conclusion regarding species richness and diversity of spiders in CALSANAG Watershed Forest Reserve in Romblon as the number of areas and habitats in the entire site is still to be explored. A follow-up study that will cover a larger study site is also suggested to further identify spider species richness and even species diversity especially in a protected area in CALSANAG Watershed Forest Reserve in Romblon.

ETHICAL CONSIDERATIONS

This study was made possible through MODECERA Research Program, the researcher being a Student Research Fellow. The study follows the ethical guidelines proposed for the MODECERA Research Program approved by the DENR.

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