**Bulletin of Environment, Pharmacology and Life Sciences**
Bull. Env. Pharmacol. Life Sci., Vol 9[4] March 2020 : 19-30

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.876
Universal Impact Factor 0.9804
NAAS Rating 4.95
**ORIGINAL ARTICLE** **OPEN ACCESS**

# Species Diversity and microhabitats of spiders in riparian areas of Kanapulan falls, Naawan, Misamis Oriental, Philippines

**Jhanna Dawn Apal [1], Olga M. Nuñeza[1]**
[1]- Department of Biological Sciences, College of Science and Mathematics, MSU- Iligan Institute of Technology , A. Bonifacio Ave., Tibanga, Iligan City, Philippines
*Corresponding author's email: jhannadawn.apal@g.msuiit.edu.ph

**ABSTRACT**
*Spiders are highly sensitive to different changes in the environment which make them excellent bioindicators of environmental health. This study aimed to determine the diversity and microhabitats of spiders in the riparian areas of Kanapulan falls, Naawan, Misamis Oriental. Three sampling sites were established. Sampling was done for 12 days. Opportunistic sampling was used employing a combination of vial tapping and beat netting methods. Sixty four species of spiders belonging to 14 families were recorded. Highest species richness and abundance were observed in the downstream riparian area (Site 2) and lowest in the upstream area (Site 3). Araneidae is the spider family with the highest species richness and abundance. Genus Neoscona of family Araneidae had the most abundant species. Even distribution was recorded in the whole study area. Leaf surfaces, branches, and stem of plants were the most common microhabitats of spiders. Five guilds were recorded with the orb weavers as the most dominant guild (38%). Highest diversity was recorded in midstream riparian area (H'=3.405). Although high species spider diversity (H'=3.825) was recorded in Kanapulan falls, potential threats were observed which indicate a threatened ecosystem that needs conservation action.*
***Keywords:*** *Araneidae, bioindicator, conservation, orb-weavers, vial tapping.*

Received 19.01.2020 Revised 16.02.2020 Accepted 21.03.2020

## INTRODUCTION

Spiders which belong to order Araneae have vital functions in the ecosystem [1]. They have adapted to a variety of niches and exhibit various survival techniques [2]. They could be seen in a variety of sizes, shapes, different eye patterns, and colors [3]. They may be found at different locations such as bark, dried leaves, on the forest floor, on trees, on the ground, underground territories, under stones, and near water [4].

Spiders are carnivorous and are useful predators feeding on insects and small arachnids and hence play a critical role in ecosystems [1]. They play a potential role in regulating insect pests in agriculture ecosystems and terrestrial habitats [5, 6]. Spiders have well-defined habitat preferences. They are mostly found everywhere making them one of the most diverse groups in the world [7].They are good bioindicators as they are chemically sensitive to natural and anthropogenic disturbances and are diversified and abundant [8]. A small change in their habitat structure including vegetation complexity, litter depth, and microclimate characteristics can affect and change their diversity and abundance [9].

In Flanders, Belgium, spiders are used as bio-indicators of anthropogenic stress and are assessed for nature conservation and management in natural and semi-natural habitats [10]. Spider webs found in polluted areas could absorb air contaminants and can serve as an effective tool to indicate presence of pollutants [11].

Spider assemblages are closely associated with the characteristics of the plant community where they live [12] and often depend on habitat quality with regard to species-specific ecological demands [9]. Disturbance increases the number of niches of species providing new opportunities for spiders. The structure and composition of the landscape, vegetation, habitat type, and period of plant growth play a role in the diversity of the spider species [13].

Spiders comprise more than 48,165 species of over 117 families distributed worldwide [14]. They can be found in all continents except Antarctica [15] and are the second most diverse order after the mites [16]. Distribution and diversity of spiders are influenced by habitat structure and vegetation parameters, complexity of the structure of the plant and their environmental conditions [17, 6], alteration of the habitat [18], and environmental parameters [9, 19].

Agriculture can alter and destroy the natural habitats of spiders [20] yet, numerous spider species have been successful in occupying different agro-ecosystems to a large extent [21]. Chen and Tso [22] reported that tropical regions including the Philippines receive only fewer data and investigation on spiders compared to temperate regions. Studies on spiders in the country are limited only to agricultural areas particularly rice fields but Barrion [23] reported that it has the highest record in all of Asia's tropical rice fields. In the Philippines, 517 species of spiders are recorded [23]. Data on spiders in the Philippines particularly Mindanao include the species richness of spiders in Mt. Matutum [24], rapid assessment of spider fauna in Pulacan falls, Zamboanga Del Sur [25], cave spiders in Mindanao [26], spider diversity in Mt. Pinukis, Zamboanga del Sur [3], spider diversity in Marilog District, Davao City [27], Mt. Malindang Range Natural Park [28], and in Impasug-Ong Protected Area, Bukidnon [29]. However, no data on spiders have been reported in Kanapulan falls, Naawan, Misamis Oriental. This study determined the species diversity and identified the microhabitats of spiders in the riparian areas of Kanapulan falls in Naawan, Misamis Oriental, Philippines.

## MATERIAL AND METHODS

### Study Area

Kanapulan falls is located in Barangay Tagbalogo, Naawan, Misamis Oriental (Fig. 1). The municipality constitutes 2.83% of Misamis Oriental's total area. Kanapulan falls is located at approximately 8° 24' North, 124° 20' East, on the island of Mindanao. Elevation at these coordinates is estimated at 8.2 meters above sea level (masl). Kanapulan falls is a 20-feet high waterfall that has three separate and distinct waterfalls. Three sampling sites were established in the riparian areas of Kanapulan falls, Naawan, Misamis Oriental. The first waterfall was designated as sampling site 1, the second as sampling site 2, and the third waterfall as sampling site 3.

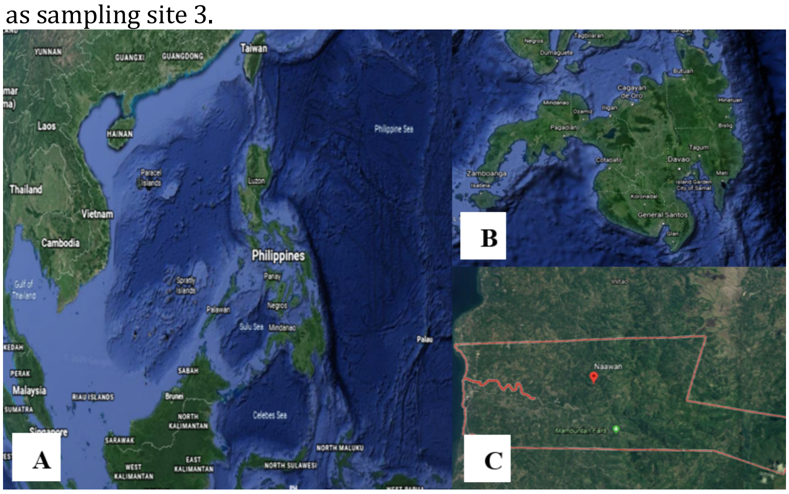


**Figure 1. A.** Map of the Philippines [57]. **B.** Map of Mindanao [57]. **C.** Map of Naawan, Misamis Oriental [57].

### Sampling sites

Sampling site 1 is located in the downstream riparian area of Kanapulan falls. The site has an agricultural type of vegetation at an elevation of 30 masl. The area was predominantly planted with corn (*Zea mays)*, *Musa* sp., coconut (*Cocus nucifera*), guava (*Psidium guajava*), mango (*Mangifera indica*), and cacao (*Theobroma cacao*). Trees like "togas" (*Vitex parviflora*), mahogany *(Swietenia mahogany),* and "narra" (*Pterocarpus indicus*) were present. Ferns and shrubs like "San Francisco" (*Codiaeum variegatum*) were found in moderate abundance. Underground plants were few including yam (*Dioscorea alata*) and taro (*Colocasia sp.*). Depth of leaf litter is about 0.1-2 cm. The site is characterized by exposed rocks in the stream. The estimated distance to anthropogenic disturbance was about 10 meters from the stream. High disturbance was observed as indicated by the presence of plastics and garbage, natural tree fall, and modification of the landscape. Sampling site 2 is located in the midstream riparian area of Kanapulan falls. The site has an agricultural type of vegetation at an elevation of 50 masl. Midstream riparian area was dominated by "gemelina" (*Gmelina arborea*), fig trees (*Ficus carica*), coconut (*Cocos nucifera*), rattan (*Calamus deerrhatus*), carabao grasses *(Bouteloua dactyloides*), yam (*Dioscorea alata*), and moderately abundant taro (*Colocasia sp*.). Ferns and shrubs like "San Francisco" (*Codiaeum variegatum*) and flowering plants and weeds like "hagunoy" (*Chromolaena odorata*) and "kantutay" (*Lantana camara*) were found in moderate abundance. The estimated distance to anthropogenic disturbance was about 200 meters from the stream. The site is characterized by exposed rocks in the stream. Leaf litter was about 0.1-2cm. Sampling site 3 is located in the upstream riparian area of Kanapulan falls. The site has an agricultural type of vegetation at an elevation of 100 masl. Plants commonly found were rattan (*Calamus deerrhatus*), ferns, flowering plants, vines, grasses, and trees. The estimated distance to anthropogenic disturbance was about 800 meters from the stream. This site is characterized by exposed rocks in the stream. Leaf litter is about 0.1-1cm.

**Collection of Samples**

Gratuitous permit (GP) was obtained first from the Department of Environment and Natural Resources-Northern Mindanao region before the collection of samples. Field sampling was conducted for 12 sampling days from 700 hours up to 1200 hours and 1900 to 2200 hours for a total of 96 person-hours. A one-kilometer transect line extending 10 meters on each side heading perpendicular from the transect line was established at each sampling site. Ground, rocks, forest floor, fallen logs, and crevices were explored for ground-dwelling spiders while foliage, bushes, tree trunks, ferns, and visible webs for arboreal spiders were checked using a combination of beat netting and vial tapping methods [25]. Samples, when captured, were placed in cups with cover and temporarily transferred to zip lock plastic bags. Two-three voucher specimens were preserved in glass vials with 90% ethyl alcohol labeled with place and date of collection [3] while other samples were released back to their habitats after identification. Vegetation structure was also documented and described at each sampling site using habitat description form. The geographical position and altitude were taken using the Global Positioning System (GPS).

**Processing and Identification of Samples**

Collected specimens were transported to the Wildlife Laboratory of MSU-Iligan Institute of Technology (MSU-IIT) in Iligan City, Philippines. Spiders were initially identified using Riceland Spiders of South and Southeast Asia by Barrion and Litsinger [30], the website insectoid.info, and some published papers and verified by arachnid experts.

**Statistical Analysis**

Biodiversity indices were obtained using Paleontological Statistics Software Package (PAST) version 3.16 [31]. Values of Shannon-Weiner diversity index generally ranged from 1 to 3 which means that the diversity is moderate, low diversity if the index value is below 1, and high diversity if the index value is greater than 3 [55].

## RESULTS AND DISCUSSION

**Species composition and Abundance**

A total of 156 individuals belonging to 64 species under 38 genera and 14 families were collected (Table 1). This number is higher compared to other areas in Mindanao such as spiders recorded in Mt. Matutum, South Cotabato [24] with 23 species under 19 genera and nine families, Sacred Mountain in Marawi City [32] with 43 species belonging to 11 families under 31 genera, and cave spiders in Mindanao with 18 species under 12 families and 12 genera [26]. However, this result is relatively lower compared to the spider fauna in Marilog District, Davao City [27] which consists of 171 species under 25 families and in Mt. Pinukis Zamboanga del Sur [3] with 99 species, 16 families, and 64 genera.

Memah et al. [6] reported that habitat complexity and environmental conditions affect the distribution and species richness of spiders. Site 2 (midstream riparian area) had the most abundance (59 individuals) and highest species richness while upstream riparian area (site 3) had the least abundance and species richness. Both downstream and midstream riparian areas are agricultural sites but downstream is more exposed to anthropogenic disturbance like cutting of trees, stream utilized for washing clothes, and is near human settlements. Human disturbance has an impact on spider communities and greatly lower the species richness in the disturbed site [33]. Spiders relocate webs in response to web destruction and rebuild them in sites where enough stable structure is provided [34] and thus, it may explain why the midstream riparian area is more diverse even if vegetation type is almost the same with other sites.

Araneidae is the most abundant and had highest species richness in midstream riparian area with 12 species and 21 individuals since the area is composed of trees, bushes, shrubs, and fallen branches which is suitable for building webs for arboreal spiders such as orb weavers. Barrion *et al*. [35] reported that Araneidae prefers constructing webs on the canopy structure of complex plants with relatively open branches or twigs which serve as anchors to stabilize their webs. Spiders under the Genus *Neoscona* with eight species and 34 individuals were the most species-rich and abundant in all sites. The species

*Neoscona molemeinsis* was the most dominant with 12 individuals throughout the sites. Barrion *et al*. [35] reported that *Neoscona* sp. is common throughout the world. One individual of *Damon* sp. under order Amblypygi, family Phrynichidae was found in the upstream riparian area. Differences in crop structure, size, and the number of leaves, twigs, branches, spaces in between branches, twigs, and leaves, and depth of leaf litter and canopy shape affect the adaptability and availability of species of other families [6].

Figure 2 shows that family Araneidae ranked first in terms of species richness (16 species) while Salticidae (11 species) ranked second and Sparassidae (10 species) ranked third. Araneidae dominates both downstream (9 species) and midstream riparian areas (12 species). Salticidae was distributed evenly in all sites. Sparassidae dominated the upstream riparian area (9 species). Spider families with low species richness are Eutichuridae (1 species), Nephilidae (1 species), Pholcidae (1 species), Phrynichidae (1 species), Theridiidae (1 species), Thomisidae (2 species), Clubionidae (3 species), and Tetragnathidae (3 species). Low species richness may be due to spider assemblages that are highly influenced by variations and modifications in plant community structure, ecosystem dynamics such as disturbance, and abiotic factors such as soil texture, environmental humidity, and temperature [36]. Some specific plants are also associated with distinct spider fauna and thus affecting species richness and spider assemblages [37].

Eight families, namely: Araneidae, Lycosidae, Nephilidae, Oxyopidae, Pisauridae, Salticidae, Sparassidae, and Tetragnathidae were found to be present in all three sites indicating that they are well adapted to these areas. Saini *et al*. [38] reported that spiders occupy virtually every habitat with a wide range of morphological adaptations, lifestyles, and behavior.

Table 2 shows the relative abundance of the major families: Araneidae (27.57%), Sparassidae (19.23%), and Salticidae (14.75 %). Araneidae with 16 species is evenly distributed in the downstream and midstream riparian areas. Family Araneidae is common throughout different regions of the world [25]. It was easily seen on low-lying shrubs and tree branches. Foliage or canopy of the plant vegetation serves as anchors to stabilize the webs. The same information was obtained by Garciano *et al*. [24] in Mt.Matutum, South Cotabato, Philippines. In the present study, Araneidae was commonly found between midstream and the downstream riparian areas where agroecosystem is near. Spiders are likely found in agroecosystem due to the abundance of prey [23] that may be the reason for the abundance in the midstream and downstream riparian areas.

Proximity to water and shaded vegetation may also affect the abundance of Family Araneidae. Ward [39] reported that this family prefers locations near water, shaded vegetations or logs and trunks of trees. Also, stagnant water because of the slow-moving stream provides opportunities for mosquitoes. According to Rain *et al*. [40], mosquito prefers stagnant water that will result in more food source for the spiders since mosquitoes are the primary food source of Araneidae and jumping spiders.

Salticidae was evenly distributed in all the sites. Salticidae is the second most diverse taxon in order Araneae [41]. Most of the spiders under this family were widely distributed in the downstream riparian area with agro-ecosystem and thus providing a range of microhabitats. Richman *et al*. [42] reported that they occur in many microhabitats from under or below leaf litter up into the canopy. Mosquitoes from stagnant water also provide food sources for Salticidae [40]. However, Sparassidae (10.9%) was found to be most abundant in the upstream riparian area compared to Araneidae (9.62%) and Salticidae (3.84%). This family is important in tropical countries as it preys on cockroaches that is why spiders of this family are commonly seen at night [43]. Genus *Heterapoda* under Sparassidae was found mostly in the upstream riparian area. Bowden and Buddle [44] reported that local change in climate and vegetation as a result of increasing elevation can affect species diversity of spiders and can only tolerate limited spiders. Since there is little competition, this is why spiders are more abundant in an environment that is convenient for the individual to reproduce and survive [45]. In this case, elevation does not affect Sparassidae particularly *Heterapoda* sp. The same information was obtained by Garciano *et al*. [24] that *Heterapoda* could be found in different elevations.

## Guild structure

Guild structure is important in describing diversity in communities [46] and useful if spiders respond in roughly the same way to similar changes in the environment, independently of the specific taxonomic composition [47]. Guild type is based on family level that reflects their foraging manner, web type, microhabitat, and activity patterns [58]. Figure 3 shows that the most dominant guild is orb weavers comprising 38% of the distribution in the sampling area. The guild is composed of Araneidae, Tetragnathidae, and Nephilidae.

Orb weavers were found in secondary vegetation, near cultivated areas, shrubs, and bushes near the stream which provide wider opportunity for web building and anchoring webs between branches or stem. The same observation was obtained by Lalisan *et al.* [3], Juario *et al*. [32], Patiño *et al*. [27], and

Garciano *et al*. [24]. Ward [39] reported that Araneidae, Nephilidae, and Tetragnathidae favor habitats near water, shaded vegetation or buttresses or trunks of trees or logs. The abundance of orb-weavers is influenced by the physical structure of the vegetation and the availability of web sites [48]. Ground runners (Sparassidae and Lycosidae) that were collected on fallen logs, leaf litter, and forest floor formed the next dominant guild (28%). Forest areas cover about 0.1-2 cm of leaf litter and provide an opportunity for the ground runners. Foliage runners (Salticidae, Clubionidae, Oxyopidae, and Eutichuridae) had 24% relative abundance, mostly found on the surfaces of leaves. This guild is dependent on vegetation for food and for constructing retreats or the building of webs [49, 3]. Kanapulan falls had vegetation with wide leaves which provide more opportunity for the foliage runners. Furthermore, ground and foliage runners favor dry climate and exposure to sunlight [46] and thus contributing to the abundance of both guilds. Ambushers (Thomisidae, Pisauridae) had 9% relative abundance. Forest floor consisted of humus, cover plants, and rocks providing habitats for ambushers. Lastly, space builders (Theridiidae and Pholcidae) had a relative abundance of only 1%. Rocks and branches/stem of plants provide space builders anchor in their webs. Araneidae was more abundant in branches/stem of plants which provides competition for space builders. The different guilds and different web support structures brought about by the differences in microhabitat affect spider diversity [50].

**Microhabitats**

Spiders in the riparian area of Kanapulan falls had a wide variety of microhabitats. Figure 4 shows the different microhabitats which are the following: rocks, forest floor, near or on the surface of a slow-moving stream, leaf surfaces/foliage, *Musa* sp., fallen branches, stem, and logs, leaf litter, branches/stem of plants, and corn farm (*Zea mays)*. Rocks serve as microhabitat for ground-dwelling spiders like Sparassidae, Lycosidae, and some orb weavers. Leaf litter and forest floor provide an opportunity for ground-dwelling and burrowing spiders. Stream bank or the surface of the slow current-stream provides microhabitat for *Hygropoda* sp. and other spiders that prey on mosquitoes. The many leaf surfaces in the sampling area serve as microhabitats for foliage runners and leaf-dwelling spiders. *Musa* sp. and *Zea mays* which are rich in insect pests and prey for spiders provide general microhabitats for ground, leaf dwelling spiders, and orb weavers. Fallen logs and branches were the microhabitats of some spiders such as the burrowing spiders. Lastly, branches/stem of plants were the most common microhabitats used by spiders to anchor their webs. Araneidae is among those which anchor its web on the branches of plants in an open area as a strategy to catch prey and to provide stable habitat.

Table 3 shows the different species of spiders with their respective microhabitats. Studies of relationships between spiders and the structure of habitats have shown that spiders use structures in their environment as cues to habitat quality, architectural foundations for prey-catching webs, and as vibration-conducting and monitoring surfaces in communication and prey capture [51]. Mondejar & Nuneza [52] reported that the selection of microhabitat by spider communities is influenced by various environmental factors as well as by plant structure. Most of the microhabitats used by spiders are between branches/stem of plants, ground/forest floor, and leaf surfaces/foliage. This explains why the orb-weavers, ground runners, and foliage runners were the most abundant guilds in the area to which the families Araneidae, Sparassidae, and Salticidae, the most abundant families with high species richness belong, respectively. Stanska *et al*. [53] reported that possible factors that affect microhabitat selection include prey availability, the structure of vegetation which provides sufficient humidity and shelter for spiders, and suitability of leaf structure for web attachment.

**Biodiversity indices**

Table 4 shows high diversity and even distribution of species in Kanapulan falls, Naawan. Since spiders are important as bioindicators and in controlling several insect pests, serious efforts are required to understand their diversity [54]. The high diversity and even species distribution observed in all sites were observed to be due to the fact that all sites are agricultural. Greater variety of habitat types normally increases diversity, physical structure, and species composition of vegetation that define the diversity of species and abundance through habitat availability [3]. This indicates that the type of vegetation in the midstream area is favorable to spiders. Downstream riparian area (H'=3.244) with the highly disturbed vegetation had lower species diversity compared to midstream area because of easy access resulting in human disturbance and serves as the main port of entry into the stream. Although considered an agricultural vegetation which provides prey availability, changes done by human intervention to vegetation structure had an effect on spider community by means of a reduction in the number of supports for webs (branches and aerial litter) and by altering the microclimatic conditions through a higher direct exposure to the sun, wind, and rain [33]. These changes could result in more unstable and less equitable spider community with reduced species richness. Upstream riparian area (H'=3.203) with

100 masl has the lowest diversity. Despite the high diversity in the sampling sites, potential threats were observed in the area.

Uetz [56] reported that changes in ecological gradients due to human activities influence spider distribution and alter the community's composition. Existing threats were observed in different sites. Site 1 (downstream riparian area) as being near to human settlements had the highest disturbance observed indicated by the presence of plastics and garbage, modification of landscape, and grazing.

**Table 1.** Species richness and relative abundance of spiders in the three sampling sites.

| Species Name | Site 3 (Down-Stream riparian area) | Site 2 (Midstream riparian area) | Site 1 (Upstream riparian area) | Total | RA |
|---|---|---|---|---|---|
| **Family Araneidae** | | | | | |
| *Argiope anasuja* (Thorell, 1887) | 1 | 1 | 0 | 2 | 1.28 |
| *Cyclosa insulana* (Costa, 1834) | 1 | 0 | 0 | 1 | 0.641 |
| *Cyclosa* sp. | 0 | 1 | 0 | 1 | 0.641 |
| *Cyrtophora cylindroides* (Walck, 1841) | 1 | 0 | 0 | 1 | 0.641 |
| *Eriovixia* sp. | 0 | 1 | 0 | 1 | 0.641 |
| *Gasteracantha cancriformis* (Linnaeus, 1758) | 0 | 1 | 0 | 1 | 0.641 |
| *Neoscona facundoi* (Barrion-Dupo, 2008) | 0 | 1 | 1 | 2 | 1.28 |
| *Neoscona molemeinsis* (Tikader and Bal, 1982) | 5 | 5 | 2 | 12 | 7.7 |
| *Neoscona punctigera* (Doleschall, 1857) | 1 | 2 | 3 | 6 | 3.84 |
| *Neoscona rufofemorata* (Simon, 1884) | 0 | 1 | 1 | 2 | 1.28 |
| *Neoscona rumpfi* Thorell,1878 | 0 | 1 | 0 | 1 | 0.641 |
| *Neoscona vigilans* (Blackwall,1865) | 1 | 2 | 0 | 3 | 1.92 |
| *Neoscona* sp. 1 | 1 | 0 | 0 | 1 | 0.641 |
| *Neoscona* sp. 2 | 3 | 4 | 0 | 7 | 4.49 |
| *Poltys* sp. | 1 | 0 | 0 | 1 | 0.641 |
| *Singa perpolita* (Thorell, 1892) | 0 | 1 | 0 | 1 | 0.641 |
| **Clubionidae** | | | | | |
| *Clubiona biembolata* (Deeleman-Reinhold, 2001) | 0 | 0 | 1 | 1 | 0.641 |
| *Clubiona* sp.1 | 1 | 0 | 0 | 1 | 0.641 |
| *Clubiona* sp.2 | 1 | 0 | 1 | 2 | 1.28 |
| **Eutichuridae** | | | | | |
| *Cheiracanthium* sp. | 1 | 1 | 0 | 2 | 1.28 |
| **Lycosidae** | | | | | |
| *Hippasa* sp. | 2 | 0 | 0 | 2 | 1.28 |
| *Pardosa* sp.1 | 3 | 2 | 2 | 7 | 4.49 |
| *Pardosa* sp.2 | 4 | 0 | 0 | 4 | 2.56 |
| *Trochosa* sp. | 1 | 0 | 0 | 1 | 0.641 |
| **Nephilidae** | | | | | |
| *Nephila pilipes* (Fabricius, 1793) | 1 | 5 | 2 | 8 | 5.13 |
| **Oxyopidae** | | | | | |
| *Oxyopes javanus* (Thorell, 1887) | 0 | 2 | 0 | 2 | 1.28 |
| *Oxyopes lineatipes* (C. L. Koch, 1848) | 0 | 1 | 1 | 2 | 1.28 |
| *Oxyopes macilentus* (L.Koch, 1878) | 0 | 0 | 1 | 1 | 0.641 |
| *Oxyopes* sp.1 | 0 | 2 | 0 | 2 | 1.28 |

| | | | | | |
|---|---|---|---|---|---|
| *Oxyopes* sp.2 | 1 | 0 | 0 | 1 | 0.641 |
| *Oxyopes* sp.3 | 0 | 1 | 0 | 1 | 0.641 |
| **Pholcidae** | | | | | |
| *Pholcus* sp. | 0 | 1 | 0 | 1 | 0.641 |
| **Pisauridae** | | | | | |
| *Hygropoda* sp.1 | 0 | 2 | 0 | 2 | 1.28 |
| *Hygropoda* sp.2 | 3 | 1 | 4 | 8 | 5.13 |
| *Hygropoda* sp.3 | 0 | 1 | 0 | 1 | 0.641 |
| *Hygropoda* sp.4 | 0 | 0 | 1 | 1 | 0.641 |
| **Salticidae** | | | | | |
| *Emathis* sp. | 1 | 2 | 1 | 4 | 2.56 |
| *Bavia cf. Sexpunctata* (Doleschall, 1859) | 1 | 0 | 0 | 1 | 0.641 |
| *Burmattus* sp. | 1 | 1 | 2 | 4 | 2.56 |
| *Cosmophasis miracoides (*L.Koch, 1880) | 1 | 0 | 0 | 1 | 0.641 |
| *Epeus* sp. | 0 | 1 | 0 | 1 | 0.641 |
| *Heliophanus* sp. | 1 | 0 | 0 | 1 | 0.641 |
| *Paraphiddipus* sp. | 0 | 0 | 1 | 1 | 0.641 |
| *Phintella* sp. | 4 | 1 | 0 | 5 | 3.21 |
| *Omodeus* sp. | 3 | 0 | 0 | 3 | 1.92 |
| *Telamonia* sp. | 0 | 0 | 1 | 1 | 0.641 |
| *Thiania bhamoensis* (Thorell, 1877) | 0 | 0 | 1 | 1 | 0.641 |
| **Sparassidae** | | | | | |
| *Heteropoda davidbowie* (Jager, 2008) | 0 | 0 | 1 | 1 | 0.641 |
| *Heterapoda tetrica* (Thorell, 1897) | 0 | 4 | 4 | 8 | 5.13 |
| *Heterapoda cf. venatoria* | 1 | 1 | 0 | 2 | 1.28 |
| *Heterapoda* sp.1 | 0 | 2 | 1 | 3 | 1.92 |
| **Sparassidae** | | | | | |
| *Heterapoda* sp.2 | 0 | 0 | 1 | 1 | 0.641 |
| *Heterapoda* sp.3 | 0 | 0 | 4 | 4 | 2.56 |
| *Bergara* sp. | 0 | 1 | 1 | 2 | 1.28 |
| *Olios* sp.1 | 0 | 1 | 3 | 4 | 2.56 |
| *Olios* sp.2 | 2 | 1 | 1 | 4 | 2.56 |
| *Olios* sp.3 | 0 | 0 | 1 | 1 | 0.641 |
| **Tetragnathidae** | | | | | |
| *Opadometa fastigata* (Simon, 1877) | 0 | 1 | 0 | 1 | 0.641 |
| *Leucauge cf. granulata* (Walckenaer, 1841) | 1 | 2 | 1 | 4 | 2.56 |
| *Tetragnatha cf. extensa* | 1 | 0 | 0 | 1 | 0.641 |
| **Theriididae** | | | | | |
| *Arachaeranea sp.* | 1 | 0 | 0 | 1 | 0.641 |
| **Thomisidae** | | | | | |
| *Misumena vatia* ( Clerck, 1757) | 0 | 1 | 0 | 1 | 0.641 |
| *Thomisus callidus* (Thorell, 1890) | 0 | 0 | 1 | 1 | 0.641 |
| **Order Amblypygi** | | | | | |
| **Phrynichidae** | | | | | |
| Damon sp. | 0 | 0 | 1 | 1 | 0.641 |
| Total no. of Individuals | **51** | **59** | **46** | **156** | |
| Total no. of Species | **31** | **36** | **29** | **64** | |
| Total no. of Families | **11** | **11** | **12** | **14** | |

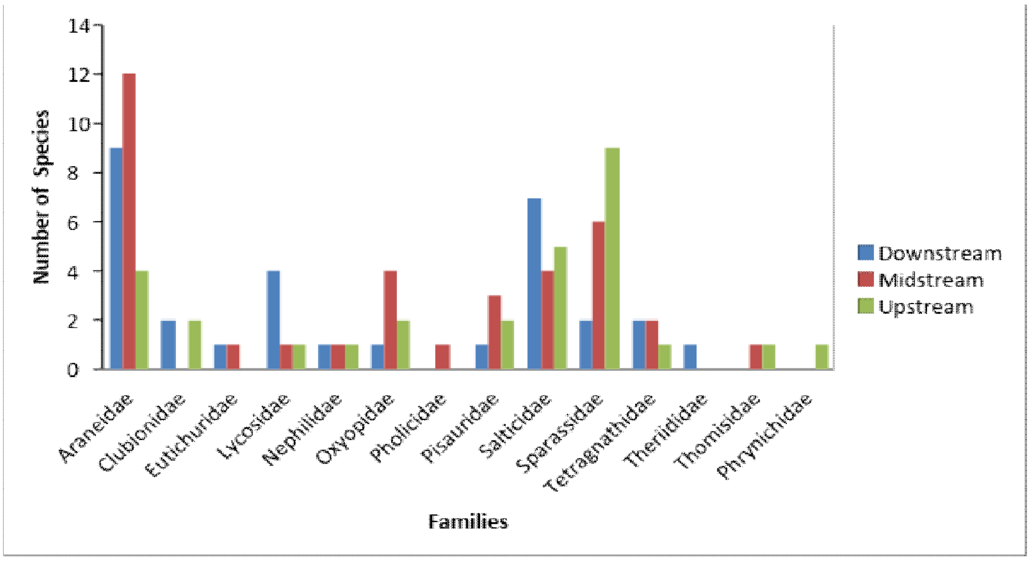


**Figure 2.** Number of species and family composition in each sampling site of Kanapulan falls, Naawan, Misamis Oriental.

**Table 2.** Abundance of spider families in Kanapulan Falls, Naawan, Misamis Oriental.

| Relative Abundance (%) | | | | |
|---|---|---|---|---|
| Family | Downstream Riparian area | Midstream Riparian area | Upstream Riparian area | Total |
| Araneidae | 15 (9.62) | 21 (13.46) | 7 (4.49) | 43 (27.57) |
| Clubionidae | 2 (1.28) | 0 (0) | 2 (1.28) | 4 (2.56) |
| Eutichuridae | 1 (0.641) | 1 (0.641) | 0 (0) | 2 (1.282) |
| Lycosidae | 10 (6.41) | 2 (1.28) | 2 (1.28) | 14 (8.97) |
| Nephilidae | 1 (0.641) | 5 (3.21) | 2 (1.28) | 8 (5.131) |
| Oxyopidae | 1 (0.641) | 6 (3.84) | 2 (1.28) | 9 (5.761) |
| Pholicidae | 0 (0) | 1 (0.641) | 0 (0) | 1 (0.641) |
| Pisauridae | 3 (1.92) | 4 (2.56) | 5 (3.21) | 11 (7.69) |
| Salticidae | 12 (7.7) | 5 (3.21) | 6 (3.84) | 23 (14.75) |
| Sparassidae | 3 (1.92) | 10 (6.41) | 17 (10.9) | 30 (19.23) |
| Tetragnathidae | 2 (1.28) | 3 (1.92) | 1 (0.641) | 6 (3.841) |
| Theriididae | 1 (0.641) | 0 (0) | 0 (0) | 1 (0.641) |
| Thomisidae | 0 (0) | 1 (0.641) | 1 (0.641) | 2 (1.282) |
| Phrynichidae | 0 (0) | 0 (0) | 1 (0.641) | 1 (0.641) |

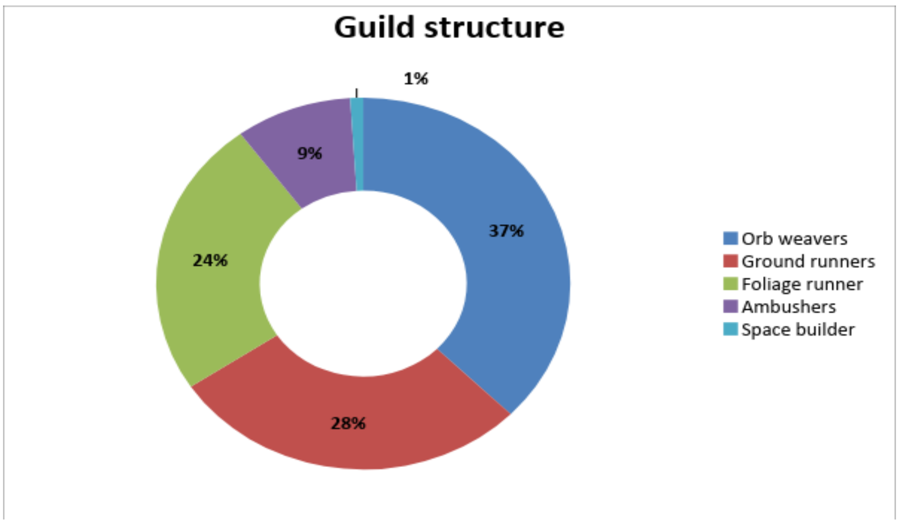


**Figure 3.** Percentage distribution of the different spider guilds at Kanapulan falls, Naawan, Misamis Oriental.

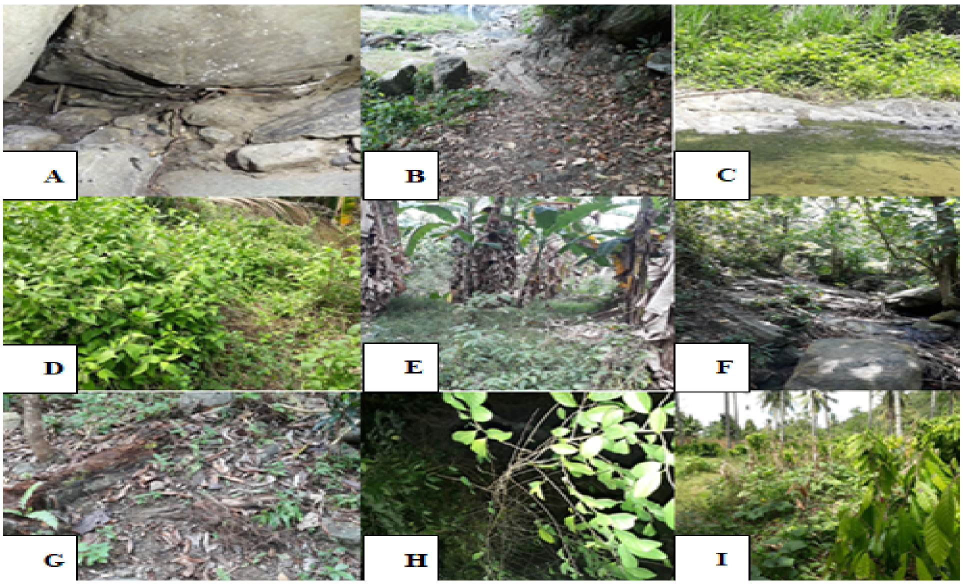


**Figure 4.** Different Microhabitats of Spiders in Kanapulan Falls. A. Rocks; B. Forest floor; C. Near or on surface of slow-moving stream; D. Leaf surfaces/foliage; E. *Musa* sp.; F. Fallen branches, stem and logs; G. Leaf litter; H. Branches/Stem of plants; I. Corn (*Zea mays)* farm.

**Table 3**. Distribution of Spiders in Different Microhabitats

| Species | On the web between branches/stem | Leaf surfaces | Flower surfaces | On ground/forest floor | under bark or in caves or hollow trees |
|---|---|---|---|---|---|
| **Araneidae** | | | | | |
| *Argiope anasuja* | ■ | | | | |
| *Cyclosa insulana* | ■ | | | | |
| *Cyclosa* sp. | ■ | | | | |
| *Cyrtophora cylindroides* | ■ | | | | |
| *Eriovixia* sp. | | ■ | | | |
| *Gasteracantha cancriformis* | ■ | | | | |
| *Neoscona facundoi* | ■ | | | | |
| *Neoscona molemeinsis* | ■ | ■ | | | |
| *Neoscona punctigera* | ■ | | | | |
| *Neoscona rufofemorata* | ■ | | | | |
| *Neoscona rumpfi* | ■ | | | | |
| *Neoscona vigilans* | ■ | | | | |
| *Neoscona* sp. 1 | ■ | | | | |
| *Neoscona* sp. 2 | ■ | | | | |
| *Poltys* sp. | ■ | | | | |
| *Singa perpolita* | | ■ | | | |
| **Clubionidae** | | | | | |
| *Clubiona biembolata* | ■ | | | | |
| *Clubiona* sp.1 | | ■ | | | |
| *Clubiona* sp.2 | | ■ | | | |
| **Eutichuridae** | | | | | |
| *Cheiracanthium* sp. | ■ | | | | |
| **Lycosidae** | | | | | |
| *Hippasa* sp. | | ■ | | ■ | |
| *Pardosa* sp.1 | | | | ■ | |
| *Pardosa* sp.2 | | ■ | | ■ | |
| *Trochosa* sp. | | | | ■ | |
| **Nephilidae** | | | | | |
| *Nephila pilipes* | ■ | | | | |
| **Oxyopidae** | | | | | |
| *Oxyopes javanus* | | ■ | | | |
| *Oxyopes lineatipes* | | ■ | | | |
| *Oxyopes macilentus* | | ■ | | | |
| *Oxyopes* sp.1 | | ■ | | | |

| | | | | | |
|---|---|---|---|---|---|
| *Oxyopes* sp.2 | | [redacted] | | | |
| *Oxyopes* sp.3 | | [redacted] | | | |
| **Pholcidae** | | | | | |
| *Pholcus* sp. | | [redacted] | | | |
| **Pisauridae** | | | | | |
| *Hygropoda* sp.1 | | [redacted] | | | |
| *Hygropoda* sp.2 | [redacted] | | | | |
| *Hygropoda sp.4* | | | | [redacted] | |
| **Salticidae** | | | | | |
| *Emathis sp.* | | [redacted] | | | |
| *Bavia cf. Sexpunctata* | | [redacted] | | | |
| *Burmattus sp.* | | [redacted] | | | |
| *Cosmophasis miracoides* | | [redacted] | | | |
| *Epeus sp.* | | [redacted] | | | |
| *Heliophanus sp.* | | | | [redacted] | |
| *Paraphiddipus sp.* | | | [redacted] | | |
| *Phintella sp.* | | [redacted] | | | |
| *Omodeus sp.* | | | | [redacted] | |
| *Telamonia sp.* | | [redacted] | | | |
| *Thiania bhamoensis* | | [redacted] | | | |
| ***Sparassidae*** | | | | | |
| *Heteropoda davidbowie* | [redacted] | | | [redacted] | |
| *Heterapoda tetrica* | [redacted] | | | [redacted] | |
| *Heterapoda cf. venatoria* | [redacted] | | | [redacted] | |
| *Heterapoda sp.1* | [redacted] | | | [redacted] | |
| *Heterapoda sp.2* | | [redacted] | | | |
| *Heterapoda sp.3* | | [redacted] | | [redacted] | |
| *Bergara sp.* | | | | [redacted] | |
| *Olios* sp.1 | | | | [redacted] | |
| *Olios* sp.2 | | [redacted] | | | |
| *Olios* sp.3 | | [redacted] | | | |
| **Tetragnathidae** | | | | | |
| *Opadometa fastigata* | | [redacted] | | | |
| *Leucauge cf. granulata* | [redacted] | [redacted] | | | |
| *Tetragnatha cf. extensa* | | [redacted] | | | |
| **Theriididae** | | | | | |
| *Arachaeranea* sp. | | [redacted] | | | |
| **Thomisidae** | | | | | |
| *Misumena vatia* | | [redacted] | | | |
| *Thomisus callidus* | | [redacted] | | | |
| **Phrynichidae** | | | | | |
| *Damon* sp. | | | | | [redacted] |

**Table 4.** Biodiversity indices of the three sampling sites in Kanapulan Falls,Naawan,Misamis Oriental.

| Indices | Downstream | Midstream | Upstream | Total |
|---|---|---|---|---|
| Species | 31 | 36 | 29 | 64 |
| Individuals | 51 | 59 | 46 | 156 |
| Shannon | 3.244 | 3.405 | 3.203 | 3.825 |
| Evenness | 0.8267 | 0.8368 | 0.8486 | 0.716 |

## CONCLUSION

Kanapulan Falls in Barangay Tagbalogo, Naawan, Misamis Oriental, Philippines has high species diversity (H'=3.825) with even distribution (E=0.716) of spiders. Sixty-four species of spiders were documented. Family Araneidae was the most abundant and species-rich family. Of the five guilds recorded, orb weavers (38%) were the most distributed, being found in all sites. *Neoscona* sp. (21.79%) was the most abundant species in the study area. The most common microhabitat types of spiders were leaf surfaces and branches or stem of plants. Threats to spider habitats such as garbage and modification of the landscape were noted.

## ACKNOWLEDGEMENTS

We acknowledge the following arachnid experts for their great help in the identification and verification of the id of spiders: Robert Whyte, Dr. Akio Tanikawa, Dr. Łukasz Trębicki, Dr. Sunil Jose, Dr. Francesco

Ballarin, Bastian Drolshagen, Geonyzl Alviola, and Dr. Booppa Petcharad. We also acknowledge the Department of Environment and Natural Resources (DENR) Region X for the gratuitous permit.

## REFERENCES


1. Sharma, S., Vyas, A., & Sharma, R. (2010). Diversity and Abundance of Spider Fauna of Narmada River at Rajghat (Barwani) (Madhya Pradesh) India. India. Researcher, 2(12):113-117. p. 1-263
2. Warui, C.M. (2004). Impacts of Wildlife and Cattle Grazing On Spider (Araneae) Biodiversity in a Highland Savanna Ecosystem, in Laikipia, Central Kenya. PhD Thesis. Rhodes University, South Africa
3. Lalisan, J.A., Dupo, A.L.B., & Nuneza, O.M. (2015). Diversity of spiders along an elevational gradient in Mt.Pinukis, Zamboanga del Sur, Philippines. Journal of Biodiversity and Environmental Sciences, 7(5):190-201.
4. Perveen, F., Jamal, A., Yasmin, S., & Khatak, K.U. (2012). Biodiversity of spiders' fauna in the Frontier Region, Peshawar, Pakistan. Journal of Entomology and Nematology, 4(3): 22-33.
5. Mathew, M.J., Sudhikumar, A.V., & Joseph, J. (2009). Natural history and bioecology. In: Sebastian PA, Peter KV, eds. Spiders of India. Universities Press (India) Private Limited Hyderabad India, p. 40-63
6. Memah, V.V., Tulung, M., Warouw, J., & Maramis, R.T.D. (2014). Diversity of Spider Species in Some Agricultural Crops in North Sulawesi, Indonesia. International Journal of Scientific & Engineering Research 5(1). ISSN 2229-5518
7. Cunha, J.A.S., Andrade, E.B., Silva, P.R.R., & Barros, R.F.M. (2015). Araneofauna (Arachnida, Araneae) in conventional and organic crops of watermelon (Citrullus lanatus) in northeastern Brazil. Revista Colombiana de Entomología, 41(1): 68-75
8. Buchholz, S. (2010). Ground-spider assemblages as indicators for habitat structure in inland sand ecosystems. Biodiversity conservation, 19: 2565-2595.
9. Ossamy, S., Elbanna, S.M., Orabi, G.M., & Semida, F.M. (2016). Assessing the potential role of spiders as bioindicators in Ashtoum El Gamil Natural Protected area, Port Said, Egypt. Indian Journal of Arachnology, 5(1-2): 100-112.
10. Maelfait, J.P., & Hendrickx, F. (1998). Spiders as bio-indicators of anthropogenic stress in natural and semi-natural habitats in Fladers (Belgium): some recent developments. Proceedings of the 17th European Colloquium of Arachnology, Edinburgh 1997.
11. Rybak, J. (2014). Possible use of spider webs for the indication of organic pollutants. Journal of Ecological Engineering, 15(3): 39-45.
12. Foelix, R. (2011). Biology of Spiders. Oxford University Press, New York.
13. Suana, I.W., Solihin, D.D., Buchori, D., Manuwoto, S., & Triwododo, H. (2004). Komunitas laba-laba pada lansekap persawahan di Cianjur.*Hayat*, 11:145-152.
14. World Spider Catalog. (2019). World Spider Catalog. Natural History Museum Bern, online at http://wsc.nmbe.ch, version 20.0, accessed on {04/30/2019}. doi: 10.24436/2.
15. Sharma, S. (2014). A study on Spiders as predators in the Agro-ecosystem. Mun.Ent.Zoology, 9(1): 80-83.
16. Francke, O. F. (2014). Biodiversidad de Arthropoda (Chelicerata: Arachnida exacari) en México. Revista Mexicana de Biodiversidad, 85: 408–418.
17. Rinaldi, I.M.P., Mendes, B.P., & Cady, A.B. (2002).Distribution and importance of spiders inhabiting a Brazilian sugar cane plantation. Revta bras. Zool., 19 (1): 271 – 279.
18. Malumbres-Olarte, J., Vink, C.J., Ross, J.G., Cruickshank, R.H., & Paterson, A.M. (2013) The role of habitat complexity on spider communities in native alpine grasslands of New Zealand. Insect Conservation and Diversity, 6(2): 124-134.
19. Halarnkar, M.M., & Pai, I. (2018). Distribution, Diversity and Ecology of Spider Species At Two Different Habitats. Int J Environ Sci Nat Res., 8(5): IJESNR.MS.ID.555747.
20. Bhuvad, N.V., Patil, V.K., Bhave, S.G., Narkhede, S.S., Jalgaonkar, V.N., & Mhaiske, V.M. (2011). Spider diversity attributes in a cultural landscape dominated by field crops and fruit orchards in the Konkan Region of Maharashtara, 14(1): 21-38.
21. Young, O.P., & Edwards, G.B. (1990). Spiders in United States field crops and their potential effect on crop pests. J. Arachnology, 18:1-27.
22. Chen, K., & Tso, I. (2004). Spider Diversity on Orchid Island, Taiwan: A Comparison between Habitats Receiving Different Degrees of Human Disturbance. Zoological Studies, 43(3), 598-611.
23. Barrion, A.T. (2001). Spiders: natural biological control agents against insect pests in Philippine rice fields. Transactions of the National Academy of Science and Technology 23, 121-130.
24. Garciano, D.N., Nuñeza, O.M., & Barrion-Dupo, A.L. (2014). Species richness of spiders in Mt. Matutum, South Cotabato, Philippines. Journal of Biodiversity and Environmental Sciences, 4(6): 214-224.
25. Dacanay, C.C., Barrion-Dupo, A.L., & Nuñeza, O.M. (2014). Rapid assessment of spider fauna of Pulacan falls, Zamboanga Del Sur, Philippines. Journal of Biodiversity and Environmental Sciences, 5(1): 455- 464.
26. Enriquez, C.M.D., & Nuñeza, O.M. (2014). Cave spiders in Mindanao, Philippines. ELBA Bioflux, 6(1): 46-55.
27. Patiño, S.C., Barrion-Dupo, A.L., & Nuñeza, O. (2016). Rapid assessment of spider fauna in Marilog District, Davao City, Philippines. Journal of Biodiversity and Environmental Sciences, 8(1) p. 95-109
28. Ballentes, M.G., Mohagan, A.B., Gapud, V.P., Espallardo, M.C.P., & Zarcilla, M.O. (2006). Arthropod Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang, Misamis Occidental. Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA), p. 1-166


 

29. Alviola, G.L., & Disomimba, A.M.A. (2017). Diversity of Spiders in Three Habitat Types in Impasug-Ong Protected Area, Bukidnon, Philippines. Ecology and Evolutionary Biology 2017, 2(6): 101-109.
30. Barrion, A., & Litsinger, J. (1995). Riceland Spiders of South and Southeast Asia, 1-701
31. Hammer, O., Harper, D.A.T., & Ryan, P.D. (2001). Paleontological Statistics Software Package for Education and Data analysis. Retrieved from https://palaeo electronica.org/2001_1/past/issue1_01.htm.
32. Juario, J., Nuñeza, O.M., & Dupo, A.L. (2016). Species richness of spiders in Sacred Mountain, Marawi City, Philippines. Journal of Biodiversity and Environmental Sciences, 8,(1) p. 86-94
33. Maya-Morales, J., Ibarra- Nuñez, G., Leon- Cortes, J.L., & Infante, F. (2012). Understory spider diversity in two remnants of Tropical Montane Cloud Forest in Chiapas, Mexico. Journal of Insect Conservation, 16(1):25-38.
34. Hodge, M. (1988). Factors influencing web site residence time of the orb weaving spider, Micrathena gracilis. Psyche, 94, 363-71. Texas A&M University, 1-86.
35. Barrion, A.T., Villareal, S.S., Catindig, J., Cai, D., Yuan, Q.H., & Heong, K.L. (2012).The spider fauna in the rice agricultural landscape of Hainan Island, China: Composition, abundance and feeding structure. Asia Life Sciences, 21(2): 625-651.
36. Bonte, D., Leon, B., & Maelfait, J.P. (2002). Spider assemblage structure and stability in a heterogeneous coastal dune system. J Arachn., 30, 331-343.
37. Larrivee, M., & Buddle, CM. (2009). Diversity of canopy and understory spiders in north temperate hardwood forests. Agricultural and Forest Entomology, 11:225- 237.
38. Saini, K. C., Chauhan, R., & Singh, N. P. (2013). Collection and rearing practices with spiders and their maintenance in laboratory conditions. International Journal of Advanced
39. Ward, L. (2007). Habitat Specificity of Selected Spiders of Dominica. Texas A&M University, Study Abroad Dominica Program, p.1-16
40. Rain, F.F., Howlader, A.J., & Bashar, K. (2016). Diversity and abundance of spider fauna at different habitats of Jahangirnagar University Campus, Bangladesh. Journal of Entomology and Zoology studies, 4(5):87-93.
41. Peng, X., Tso, I., & Li, S. (2001). Five New and Four Newly Recorded Species of Jumping Spiders from Taiwan (Araneae: Salticidae). Zoological Studies, 41(1):1-12.
42. Richman, D.B., Edwards, G.B., & Cutler, B. (2005). "Salticidae". Spiders of North America: an identification manual. ( D. Ubick, P. Paquin, P.E. Cushing & V. Roth, eds.) American Arachnological Society, 205-216.
43. Edwards, G.B. Jr. (2009). Huntsman Spider, *Heteropoda venatoria* (Linnaeus) (Arachnida: Araneae: Sparassidae). EENY-160. Retrieved from: http://entomology.ifas.ufl.edu/creatures
44. Bowden, J.J., & Buddle, C.M. (2010). Spider Assemblages across Elevational and Latitudinal Gradients in the Yukon Territory, Canada. Arctic, 63(3): 261 – 272
45. Tsai, Z.I., Huang, P.S., & Tso, I.M. (2006). Habitat Management by Aboriginals Promotes High Spider Diversity on an Asian Tropical Island. Ecography, 29: 84-94.
46. Freitas, G.C.C., Brescovit, A.D., & Vasconcelos, S.D. (2013). Spider diversity on the oceanic island of Fernando de Noronha, Brazil, and implications for species conservation. Journal of Insect Science, 13(148): 1-16.
47. Cardoso, P. (2011). Diversity and Community assembly patterns of epigean vs. troglobiont spiders in the Iberian Peninsula. International Journal of Speleology, 4(1): 83-94.
48. Wise, D.H. (1993). Spiders in Ecological Webs. Cambridge University Press. Cambridge, 328.
49. Sudhikumar, A.V., Mathew, M.J., Sunish, E., Murugesan, S., & Sebastian, P.A. (2005a). Preliminary studies on the spider fauna in Mannavan shola forest, Kerala, India (Araneae). Acta zoologica bulgarica, Suppl., 1: 319-327.
50. Balfour, R.A., & Lypstra, A.L. (1998). The influence of habitat structure on spider density in a no-till soybean agroecosystem. The Journal of Arachnology, 26, 221-226.
51. Uetz, G.W. (1991). Habitat structure and spider foraging. In: Bell SS, McCoy ED, Mushinsky HR, Editors. Habitat structure: The Physical arrangement of objects in space, p. 325–348
52. Mondejar, E., & Nuneza, O.M. (2015). Microhabitats of pholcid spiders (Araneae:Pholcidae) in the vicinity of Katibawasan falls, Mambajao, Camiguin, Philippines. Journal of Biodiversity and Environmental Sciences. 7(6): 2222-3045
53. Stanska, M., Stanski, T., Wielgosz, E., & Hajdamowicz. (2018). Impact of Habitat complexity on Body size of two spiders species, *Alopecosa cuneata* and *A.pulverulenta* (Araneae, Lycosidae), in River valley Grasslands. Pol. J. Environ. Stud., 27(2): 853-859.
54. Umarani, S., & Umamaheswari, S. (2013). Diversity of spider fauna at different sites in Palani Hills Dindigul District, Tamil, Nadu, South India. International Journal of Advance Biological Research, 3(4): 535-539.
55. Richardson, J.L. (1977). Dimensions of Ecology. Williams and Wilkins Co. Baltimore USA, 412p.
56. Uetz, G.W. (1976). Gradient analysis of spider communities in a streamside forest. Oecologia, 22(4): 373–385.
57. Google Earth. (2018). Retrieved from http://www.earth.google.com
58. Uets, G.W., Halaji, J., & Cady, A.B. (1999). Guild structure of spiders in major crops. Journal Arachnology, 27: 270-280.

## CITATION OF THIS ARTICLE

Apal J D B, Nuñeza O M. Species Diversity and microhabitats of spiders in Kanapulan falls, Naawan, Misamis Oriental, Philippines . Bull. Env. Pharmacol. Life Sci., Vol 9[4] March 2020 : 19-30