



Diversity and Abundance of Spiders (*Araneae*) in Different Habitats in Mt. Lantoy, Cebu, Philippines

John Gabriel A. Fortuna^{1*}, Rosalyn P. Alburo^{1,2}, Tylo Junior L. van Steenhuyse¹, Roselle C. Olmilla², John Paul L. Alvarez², and Hemres M. Alburo^{1,2}

¹ Biodiversity, Environment and Natural Resources Research Center, Cebu Technological University – Argao Campus, Philippines

² College of Forestry, Agriculture, & Environment, Cebu Technological University – Argao Campus, Philippines

* Correspondence: benrc.argao@ctu.edu.ph

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Abstract: Spiders are essential Ecological regulators that help maintain ecosystem stability through their roles as both predators and prey in food webs. Despite their importance, information on their diversity and distribution is still scarce, especially in regions that remain poorly explored. This study aims to assess the abundance and diversity of spiders across different habitats at Mt. Lantoy: Forest, Riparian, Plantation, and Grassland. A combination of search-and-capture techniques and beat-sheet methods was employed during a 160-man-hour sampling period. The study documented 276 individuals across 101 species in 20 families. Among the families, Araneidae exhibited the highest species richness with 35 species, while *Tetragnatha cf. ceylonica* was the most abundant species, with 16 individuals. Nine recorded species are Philippine endemics (*Acusilas dahoneus*, *Gasteracantha parangdiadesmia*, *Chrysso tiboli*, *Neoscona facundoi*, *Neoscona aldinei*, *Nusatidia luzonica*, *Phlogiellus baeri*, *Phintella piatensis*, and *Lepidemathis sericea*) and eight species are classified as threatened under DENR Administrative Order 2019-09 (*Cyrtophora exanthematica*, *Eriovixia laglaizei*, *Neoscona punctigera*, *Neoscona aldinei*, *Neoscona vigilans*, *Parawixia dehaani*, *Poltys illepidus*, and *Phlogiellus baeri*); two species — *Neoscona aldinei* and *Phlogiellus baeri* — carry both endemic and threatened status, yielding 15 unique conservation-priority species in total. Forest and riparian had significantly higher plot-level abundance and species richness than plantation and grassland; forest and riparian were not significantly different from each other. These findings highlight Mt. Lantoy as a key habitat for spider populations, underscoring its value for future conservation initiatives and biodiversity management.

Keywords: Guilds; habitats, Mt. Lantoy; spiders

1. Introduction

Spiders (*Araneae*) are among the most diverse and ecologically significant groups of arthropods, playing crucial roles in maintaining ecosystem balance as both predators and prey [1, 2]. They contribute to natural pest control, energy flow, and trophic interactions across various ecosystems [2, 3]. The diversity, distribution, and guild composition of spiders are strongly influenced by habitat structure, vegetation complexity, and environmental conditions [4, 5]. Habitats with greater structural heterogeneity, such as forests and riparian zones, tend to support higher spider diversity and abundance than simpler or disturbed habitats, such as plantations and grasslands [2, 6, 7]. Despite their ecological importance, studies on spider diversity and community structure in

the Philippines remain limited, especially in understudied areas such as Mt. Lantoy in Cebu. Mt. Lantoy is home to various habitat types, including forest, riparian, plantation, and grassland ecosystems that differ in vegetation structure, microclimate, and levels of human disturbance. Understanding how spider communities vary across these habitats can provide insights into their ecological preferences, functional roles, and the effects of habitat modification on biodiversity.

This study aims to assess the diversity, abundance, and guild structure of spiders in different habitats within Mt. Lantoy, Cebu. Specifically, it seeks to determine the species richness, abundance, and diversity indices of spiders across habitats, compare guild composition, and identify habitat characteristics that influence spider assemblages. The findings will contribute to local biodiversity documentation and inform conservation strategies for the area.

2. Materials and Methods

2.1 Study area

Mt. Lantoy is located in the barangays (villages) of Argao, and the study was established in the barangays of Conalum, Usmad, Catang, and Tabayag in Argao, Cebu. It is known for its rich biodiversity and serves as a critical habitat for many endemic and native species of flora and fauna. The Mt. Lantoy Key Biodiversity Area (KBA) spans approximately 3,000 hectares and provides a refuge for several endemic and native species [8]. It is one of the 117 terrestrial KBAs in the Philippines, identified based on the criteria of vulnerability and irreplaceability. It has also been recognized as part of a new KBA site [9]. Mt. Lantoy forms part of the Argao-Dalaguete Watershed Forest Reserve, a protected landscape declared under Presidential Proclamation No. 414 on June 29, 1994. Primarily a limestone area, Mount Lantoy has been a site for various biodiversity studies, including research on native plant species, and the abundance and distribution of land snail species [9, 10]. It remains a priority site for future conservation and sustainable development programs.

2.2 Sampling Sites

Four habitat types were identified in Mt. Lantoy for recording spider abundance and species richness: forest, riparian, plantation, and grassland. Five plots were randomly established in each habitat with at least 50 m between plots. The size of each plot (10 m long × 2 m wide × 2.5 m high) was based on the study of Pinkus-Rendón [11]. Ground coordinates were recorded for each sampling plot.

2.3 Collection and processing of samples

Sampling was conducted on November 8-13, 2022, December 6-11, 2023, July 25-30, 2024, and September 19-21, 2024, totaling 160 person-hours across all habitats with 40 man-hours per habitat and 8 man-hours per plot. A Wildlife Gratuitous Permit and Local Transport Permit were secured from the Department of Environment and Natural Resources before specimen collection. Because spiders are active during both daylight and nighttime, sampling was conducted for 4 man-hours during the day and 4 man-hours during the night in each plot. Sampling was conducted from 6:00 AM to 9:00 AM and again from 7:00 PM to 10:00 PM to capture both diurnal and nocturnal species [12]. Individuals were collected through active search and capture, using a combination of beat-sheet methods. A flashlight was used during the search. For targeted capture of individuals dislodged by beating or spotted in the vegetation, a handmade hand net was used, consisting of a circular tie-wire hoop frame approximately 15 cm ($\approx$ 6 in) in diameter fitted with a fine white cloth bag. This implement is a hand net for directed capture of located specimens rather than a sweep net for vegetation sweeping; standard sweep nets (30–38 cm) were not used because the primary collection methods were visual active search and beat-sheet sampling, for which a smaller, more maneuverable hoop is better suited to extracting individual spiders from foliage and beat-sheet drops without damaging soft-bodied specimens. The hoop diameter accommodated the full range of spider body sizes encountered in this study (approximately 2–25 mm body length). All encountered individuals were counted to record abundance, while up to two individuals per species were collected as voucher specimens. Each plot was surveyed by six collectors for a total of four collector-hours per plot, with careful examination of spiders present in available microhabitats. The distribution of sampling effort across periods was based on the Philippine Atmospheric, Geophysical and

Astronomical Services Administration [13], and no sampling was conducted on rainy days. The sampling habitats are summarized in Table 1.

Table 1. Sampling periods, plots sampled per habitat, and person-hours per period

Sampling period	Season	Forest (plots/hrs)	Riparian (plots/hrs)	Plantation (plots/hrs)	Grassland (plots/hrs)	Total man-hours
November 8–13, 2022	Wet	0 / 0	2 / 16	1 / 8	3 / 24	48
December 6–11, 2023	Dry (cool)	2 / 16	0 / 0	2 / 16	2 / 16	48
July 25–30, 2024	Wet	3 / 24	0 / 0	2 / 16	0 / 0	40
September 19–21, 2024	Wet	0 / 0	3 / 24	0 / 0	0 / 0	24
Total	—	5 / 40	5 / 40	5 / 40	5 / 40	160

2.4 Identification of Spiders

Spiders were identified based on external morphological characters, including eye arrangement, web architecture, leg morphology, body form, coloration, and overall size. Preliminary field identification was done whenever possible at the family level using available spider field guides [14]. Specimens were subsequently examined in the laboratory for more detailed confirmation. Additional verification of selected specimens was undertaken at the Museum of Natural History, University of the Philippines, Los Baños. Taxonomic validation was also aided by online reference resources, including the World Spider Catalog [15], the Global Biodiversity Information Facility (GBIF) [16], and the Jumping Spiders of the World database [17].

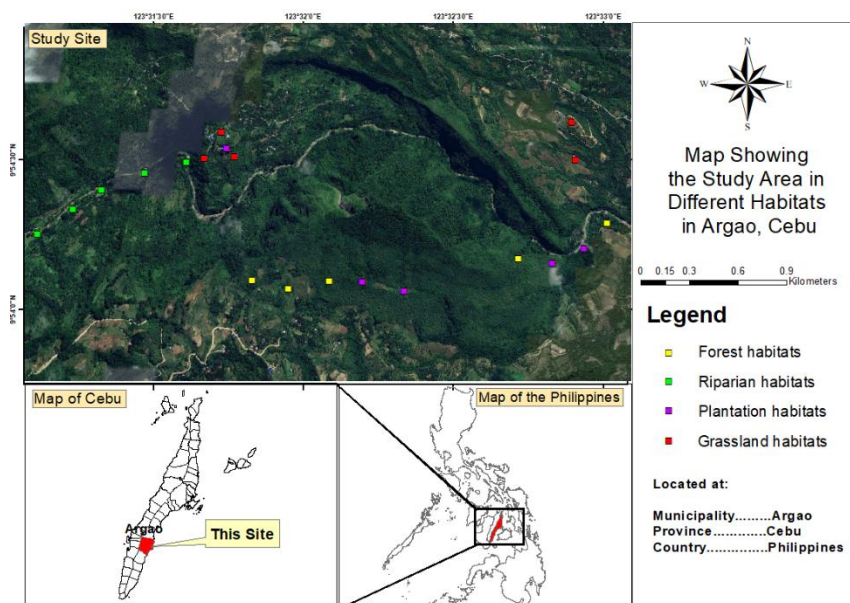


Figure 1. Map of the study area showing the location of the selected habitats in Mt. Lantoy, Argao, Cebu, Philippines.

2.5 Preservation of collected spider specimens

Collected specimens were preserved individually in glass vials containing 90% ethanol, with the preservative volume maintained at more than twice the volume of the specimen. Dry preservation was avoided because spiders' soft bodies can easily shrink and become brittle under such conditions [18]. Each vial was labeled with scientific names, collection locality, and date of collection. To maintain specimen quality, the ethanol was replaced after 48-72 hours to remove discoloration and cloudy residue.

2.6 Statistical analysis

Statistical analyses were conducted in R version 4.5.3 [19]. Species abundance was summarized as the total number of individuals recorded, while species richness was calculated as the number of unique species. Relative abundance was computed as the total number of individuals of each species divided by the total number of individuals recorded, multiplied by 100. Shannon-Wiener diversity index was calculated as $H' = -\sum p_i \ln(p_i)$, where p_i is the proportional abundance of each species, and Pielou's evenness was calculated as $J' = H'/\ln(S)$, where S is species richness. Simpson diversity was also computed to support the interpretation of habitat-level diversity. Diversity indices and species richness were calculated using the vegan package in R [20]. Sampling effort per habitat consisted of 5 plots $\times$ 8 man-hours, with 4 man-hours during the day and 4 man-hours during the night, totaling 40 man-hours per habitat and 160 man-hours across all habitats, as reported in Table 1. Sampling spanned four periods across both wet and dry seasons over two years (November 2022, December 2023, July 2024, and September 2024); Because habitat coverage was not fully balanced across seasons, season was treated as a potential limitation rather than as a formal factor in the inferential analysis, although not all habitats were sampled in every sampling period because riparian plots were sampled only during wet-season periods. Therefore, habitat comparisons were interpreted as standardized-effort inventory comparisons at the habitat level rather than as fully season-controlled experimental comparisons, with each habitat receiving a total of 40 man-hours of sampling effort. For habitat-level comparisons, a plot was used as the unit of replication. Species observations were aggregated to calculate total abundance and species richness for each plot. Normality of ANOVA residuals was assessed using the Shapiro-Wilk test, and homogeneity of variance among habitats was assessed using Levene's test through the car package [21]. When both assumptions were acceptable at $\alpha = 0.05$, one-way analysis of variance (ANOVA) was used to test for differences in abundance and species richness among habitats, followed by Tukey's Honestly Significant Difference (HSD) test for pairwise comparisons. If either assumption had been violated, the Kruskal-Wallis test followed by Dunn's post-hoc test with Bonferroni correction was considered as the non-parametric alternative. Day and night sampling were compared using paired plot-level data because the same plots were sampled during both periods. For each plot, daytime and nighttime abundance and species richness were paired and compared using a paired t-test. The test direction was set to evaluate whether nighttime values were greater than daytime values, based on the expectation that many spiders are more active or more detectable at night. Results were considered significant at $\alpha = 0.05$. Because the total number of individuals differed among habitats, individual-based rarefaction and extrapolation curves were generated using the iNEXT package in R to compare species richness at standardized sample sizes [22,23]. The rarefaction analysis used 95% confidence intervals and Hill number $q = 0$, corresponding to species richness. Rarefied richness estimates were compared at a common sample size equal to the smallest habitat sample, which was 18 individuals in the plantation habitat. Guild composition was summarized by habitat using the guild assigned to each recorded species. Guild assignments followed the spider guild framework of Cardoso et al. [24], supported by field observations of web architecture or hunting mode where available. Guild abundance was calculated as the number and percentage of individuals belonging to each guild within each habitat. Figures were generated using ggplot2 [25].

3. Results and Discussion

3.1 Species composition and relative abundance

A total of 276 individuals across 101 species representing 20 families of spiders were recorded in Mt. Lantoy in four habitats during day and night collections. During daytime sampling, 87 individuals from 38 species were recorded, while during nighttime sampling, 189 individuals from 82 species were recorded. Sixty-four species were recorded exclusively during the night, twenty species were only recorded during the day sampling, and eighteen species were recorded during both day and night sampling. As illustrated in Table 1, the three most abundant families were Araneidae, with 101 individuals representing 36.59% RA of the total recorded individuals, followed by Salticidae with 50 individuals (18.12% RA) and Tetragnathidae with 35 individuals (12.68% RA). Moreover, the forest habitat had the highest abundance, with 114 individuals across

78 species from 15 families, followed by riparian with 98 individuals across 52 species from 13 families, grassland with 46 individuals across 24 species from 8 families, and plantation habitat with 18 individuals across 16 species from 7 families. Among the 101 recorded species, (*Tetragnatha cf. ceylonica*) was found to be the most abundant species, with 16 individuals, followed by *Chrysso sp.* with 14 individuals and *Neoscona melomensis* with 13 individuals. Based on the World Spider Catalog version 27 of the Natural History Museum Bern, there were a total of nine species of spiders that are endemic in the Philippines, namely: *Acusilas dahoneus*, *Gasteracantha parangdiadesmia*, *Chrysso tiboli*, *Neoscona facundoi*, *Neoscona aldinei*, *Nusatidia luzonica*, *Phlogiellus baeri*, *Phintella piatensis*, and *Lepidemathis sericea*. Endemic spiders are often habitat specialists with narrow ecological niches, making them highly susceptible to habitat loss and fragmentation [26]. Eight species are classified as threatened under the Department of Environmental and Natural Resources Administrative Order 2019-09: *Cytophora exanthematica*, *Eriovixia laglaizei*, *Neoscona punctigera*, *Neoscona aldinei*, *Neoscona vigilans*, *Paravixia dehaani*, *Poltys illepidus*, and *Phlogiellus baeri*. Two species — *Neoscona aldinei* and *Phlogiellus baeri* carry both endemic (*) and threatened (^) status in Table 1, indicating they are Philippine endemics that are simultaneously listed under DENR AO 2019-09; the 9 endemic and 8 threatened species therefore comprise 15 unique conservation-priority species. The endemic and threatened classifications were verified against the World Spider Catalog version 27 (2026) and DENR Administrative Order 2019-09.

Table 2. Species diversity and abundance of spiders on different habitats in Mt. Lantoy, Argao, Cebu, Philippines. Species with * Philippine endemic, ^ Threatened species.

Family	Scientific name	Forest	Riparian	Plantation	Grassland	TOTAL	RA (%)
Araneidae	<i>Acusilas dahoneus</i> (Barrion & Litsinger, 1995)*	2	1	0	0	3	1.09
	<i>Arachnura melanura</i> (Simon, 1867)	3	1	1	0	5	1.81
	<i>Araneus</i> sp.	2	0	0	0	2	0.72
	<i>Argiope aemula</i> (Walckenaer, 1841)	1	1	0	0	2	0.72
	<i>Argiope appensa</i> (Walckenaer, 1841)	1	1	0	0	2	0.72
	<i>Argiope</i> sp.	0	1	0	0	1	0.36
	<i>Cyclosa insulana</i> (Costa, 1834)	4	3	2	1	10	3.62
	<i>Cyclosa bifida</i> (Dolschall, 1859)	2	1	0	0	3	1.09
	<i>Cyclosa confragra</i> (Thorell, 1892)	2	1	1	1	5	1.81
	<i>Cyrtophora cicutrosa</i> (Stoliczka, 1869)	1	0	1	0	2	0.72
	<i>Cyrtophora cylindroides</i> (Walckenaer, 1841)	1	0	0	0	1	0.36
	<i>Cyrtophora exanthematica</i> (Dolschall, 1859)^	1	0	0	0	1	0.36
	<i>Cyrtarachne</i> sp.	1	0	0	0	1	0.36
	<i>Eriovixia laglaizei</i> (Simon, 1877)^	3	1	0	0	4	1.45
	<i>Eriovixia sakiedaorum</i> (Tanikawa, 1999)	1	0	0	1	2	0.72
	<i>Gasteracantha janopol</i> (Barrion & Litsinger, 1995)	0	2	0	0	2	0.72
	<i>Gea spinipes</i> (C. L. Koch, 1843)	1	1	0	1	3	1.09
	<i>Gasteracantha kuhli</i> (C.L. Koch, 1837)	3	1	1	0	5	1.81
	<i>Gasteracantha parangdiadesmia</i> (Barrion & Litsinger, 1995)*	1	0	0	1	2	0.72
	<i>Herennia multipuncta</i> (Dolschall, 1859)	1	0	0	0	1	0.36
	<i>Neoscona facundoi</i> (Barrion-Dupo, 2008)*	1	1	0	0	2	0.72
	<i>Neoscona melomensis</i> (Tikader & Bal, 1981)	0	7	1	5	13	4.71
	<i>Neoscona</i> sp.	0	1	0	1	2	0.72

Table 2. Species diversity and abundance of spiders on different habitats in Mt. Lantoy, Argao, Cebu, Philippines. Species with * Philippine endemic, ^ Threatened species. (continue)

Family	Scientific name	Forest	Riparian	Plantation	Grassland	TOTAL	RA (%)
Araneidae	<i>Neoscona punctigera</i> (Doleschall, 1857)^	1	2	1	2	6	2.17
	<i>Neoscona aldinei</i> (Barrion-Dupo, 2008)*^	1	0	0	0	1	0.36
	<i>Neoscona vigilans</i> (Blackwall, 1865)^	2	1	0	0	3	1.09
	<i>Nephila pilipes</i> (Fabricius, 1793)	3	0	0	0	3	1.09
	<i>Paravixia dehaani</i> (Doleschall, 1859)^	1	0	0	0	1	0.36
	<i>Paravixia</i> sp.	2	0	1	1	4	1.45
	<i>Poltys illepidus</i> (C. L. koch, 1843)^	0	2	1	0	3	1.09
	<i>Poltys elevatus</i> (Thorell, 1890)	1	0	0	0	1	0.36
	<i>Singa nitidula</i> (C. L. koch, 1844)	1	0	0	0	1	0.36
	<i>Singa perpolita</i> (Thorell, 1892)	0	1	0	0	1	0.36
	<i>Talithybia depressa</i> (Thorell, 1898)	1	0	0	0	1	0.36
	<i>Thelacantha brevispina</i> (Doleschall, 1857)	1	1	0	0	2	0.72
	<i>Neoscona punctigera</i> (Doleschall, 1857)^	1	2	1	2	6	2.17
	<i>Neoscona aldinei</i> (Barrion-Dupo, 2008)*^	1	0	0	0	1	0.36
	<i>Neoscona vigilans</i> (Blackwall, 1865)^	2	1	0	0	3	1.09
	<i>Nephila pilipes</i> (Fabricius, 1793)	3	0	0	0	3	1.09
	<i>Paravixia dehaani</i> (Doleschall, 1859)^	1	0	0	0	1	0.36
	<i>Paravixia</i> sp.	2	0	1	1	4	1.45
	<i>Poltys illepidus</i> (C. L. koch, 1843)^	0	2	1	0	3	1.09
	<i>Poltys elevatus</i> (Thorell, 1890)	1	0	0	0	1	0.36
	<i>Singa nitidula</i> (C. L. koch, 1844)	1	0	0	0	1	0.36
	<i>Singa perpolita</i> (Thorell, 1892)	0	1	0	0	1	0.36
	<i>Talithybia depressa</i> (Thorell, 1898)	1	0	0	0	1	0.36
	<i>Thelacantha brevispina</i> (Doleschall, 1857)	1	1	0	0	2	0.72

Table 2. Species diversity and abundance of spiders on different habitats in Mt. Lantoy, Argao, Cebu, Philippines. Species with * Philippine endemic, ^ Threatened species. (continue)

Family	Scientific name	Forest	Riparian	Plantation	Grassland	TOTAL	RA (%)
Cheiracanthidae	<i>Cheiracanthium approximatum</i> (O. Pickard-Cambridge, 1885)	0	2	0	0	2	0.72
Clubionidae	<i>Nusatidia luzonica</i> (Simon, 1897)*	1	0	0	0	1	0.36
	<i>Clubiona</i> sp.	0	1	0	0	1	0.36
Corinnidae	<i>Corinnomma severum</i> (Thorell, 1877)	0	1	0	1	2	0.72
Hersiliidae	<i>Hersilia</i> sp.	1	0	0	0	1	0.36
Deinopidae	<i>Asianopis</i> sp.	1	0	0	0	1	0.36
Liocranidae	<i>Oedignatha scrobiculata</i> (Thorell, 1881)	0	0	1	1	2	0.72
Lycosidae	<i>Hippasa holmerae</i> (Thorell, 1895)	0	0	0	5	5	1.81
	<i>Pardosa</i> sp.	0	0	1	1	2	0.72
Oxyopidae	<i>Oxyopes javanus</i> (Thorell, 1887)	1	1	0	0	2	0.72
	<i>Oxyopes macilentus</i> (L.Koch, 1878)	2	1	0	0	3	1.09
Pisauridae	<i>Pisaurina</i> sp.	0	2	0	0	2	0.72
Psecruidae	<i>Psecrurus</i> sp.	1	0	0	0	1	0.36
Salticidae	<i>Carrhotus</i> sp.	0	2	0	0	2	0.72
	<i>Cosmophasis</i> sp.	1	0	0	0	1	0.36
	<i>Cytaea</i> sp.	1	2	1	1	5	1.81
	<i>Epeus</i> sp.	0	1	0	0	1	0.36
	<i>Hamatilaeva</i> sp.	0	1	0	1	2	0.72
	<i>Lepidemathis sericea</i> (Simon 1899)*	3	1	0	1	5	1.81
	<i>Myrmarachne assimilis</i> (Banks 1930)	1	0	0	0	1	0.36
	<i>Myrmarachne cf. markaha</i> (Barrion & Litsinger 1995)	2	0	0	0	2	0.72
	<i>Myrmarachne cf. biseratensis</i> (Badcock, 1918)	1	0	0	0	1	0.36
	<i>Nannenus</i> sp.	3	3	0	1	7	2.54

Table 2. Species diversity and abundance of spiders on different habitats in Mt. Lantoy, Argao, Cebu, Philippines. Species with * Philippine endemic, ^ Threatened species. (continue)

Family	Scientific name	Forest	Riparian	Plantation	Grassland	TOTAL	RA (%)
Salticidae	<i>Parabathippus shelfordi</i> (G. W. Peckham & E. G. Peckham, 1907)	1	0	0	0	1	0.36
	<i>Phintella piatensis</i> (Barrion & Litsinger, 1995)*	2	4	1	2	9	3.26
	<i>Phyrnerachne</i> sp.	1	0	0	0	1	0.36
	<i>Portia labiata</i> (Thorell, 1887)	3	2	0	2	7	2.54
	<i>Pystira</i> sp.	1	0	0	0	1	0.36
	<i>Rhene flavigera</i> (C.L. Koch, 1846)	1	0	0	0	1	0.36
	<i>Telamonia festiva</i> Thorell, 1887	1	0	0	0	1	0.36
	<i>Thiana bhamoensis</i> (Thorell, 1887)	0	1	0	0	1	0.36
	<i>Siler semiglaucus</i> (Simon, 1901)	0	1	0	0	1	0.36
Scytodidae	<i>Scytodes</i> sp.	1	0	0	0	1	0.36
	<i>Scytodes pallida</i> (Dolleschall, 1859)	4	2	0	0	6	2.17
Sparacidae	<i>Heteropoda cf. venatoria</i> (Linnaeus, 1767)	2	4	1	2	9	3.26
	<i>Heteropoda</i> sp.1	2	1	0	0	3	1.09
	<i>Heteropoda</i> sp.2	1	1	0	0	2	0.72
	<i>Olios</i> sp.	1	0	0	0	1	0.36
Tetragnathidae	<i>Leucage fastiga</i> (Simon, 1905)	2	2	0	1	5	1.81
	<i>Leucauge argentina</i> (Hasselt, 1882)	2	0	0	0	2	0.72
	<i>Leucauge decorata</i> (White, 1841)	1	1	0	0	2	0.72
	<i>Tetragnatha cf. ceylonica</i> (O.P.-Cambridge 1869)	0	9	0	7	16	5.80
	<i>Tetragnatha</i> sp.	0	1	0	1	2	0.72
	<i>Tylorida striata</i> (Thorell, 1877)	2	5	1	0	8	2.90
Theraphosidae	<i>Orphnaeus</i> sp.	1	0	0	0	1	0.36
	<i>Phlogiellus baeri</i> (Simon, 1877)**^	1	0	0	0	1	0.36

Table 2. Species diversity and abundance of spiders on different habitats in Mt. Lantoy, Argao, Cebu, Philippines. Species with * Philippine endemic, ^ Threatened species. (continue)

Family	Scientific name	Forest	Riparian	Plantation	Grassland	TOTAL	RA (%)
Theridiidae	<i>Parasteatoda</i> sp.1	0	1	0	2	3	1.09
	<i>Parasteatoda mundula</i> (L. Koch, 1872)	2	1	0	0	3	1.09
	<i>Argyrodes antipodianus</i> (O. Pickard-Cambridge, 1880)	1	0	0	0	1	0.36
	<i>Chrysso</i> sp.	1	8	2	3	14	5.07
	<i>Chrysso tiboli</i> (Barrión & Litsinger, 1995)*	1	0	0	0	1	0.36
	<i>Chrysso trimaculata</i> (Zhu, Zhang & Xu, 1991)	1	0	0	0	1	0.36
	<i>Janula triangularis</i> (Yoshida & Koh, 2011)	3	0	0	0	3	1.09
	<i>Meotipa</i> sp.	1	0	0	0	1	0.36
	<i>Phycosoma</i> sp.	1	0	0	0	1	0.36
	<i>Rhomphaea</i> sp.	1	0	0	0	1	0.36
Thomisidae	<i>Camaricus formosus</i> (Thorell, 1887)	0	1	0	0	1	0.36
	<i>Phrynarachne</i> cf. <i>rugosa</i> (Lareille, 1804)	1	0	0	0	1	0.36
	<i>Strigoplus</i> sp.	1	0	0	0	1	0.36
	<i>Thomisus</i> sp.1	1	0	0	0	1	0.36
	<i>Thomisus</i> sp.2	0	2	0	0	2	0.72
	<i>Tmarus</i> sp.	0	1	0	0	1	0.36
	<i>Xysticus</i> cf. <i>cristatus</i> (Clerck, 1757)	1	0	0	0	1	0.36
	<i>Uloborus</i> sp.	1	1	0	0	2	0.72
	<i>Zosis geniculata</i> (Oliver, 1789)	1	0	0	0	1	0.36
	<i>Mallinella</i> sp.	1	0	0	0	1	0.36
Total no. of Individuals		114	98	18	46	276	
Total no. of Species		77	52	16	25		
Total no. of Families		15	13	7	8		

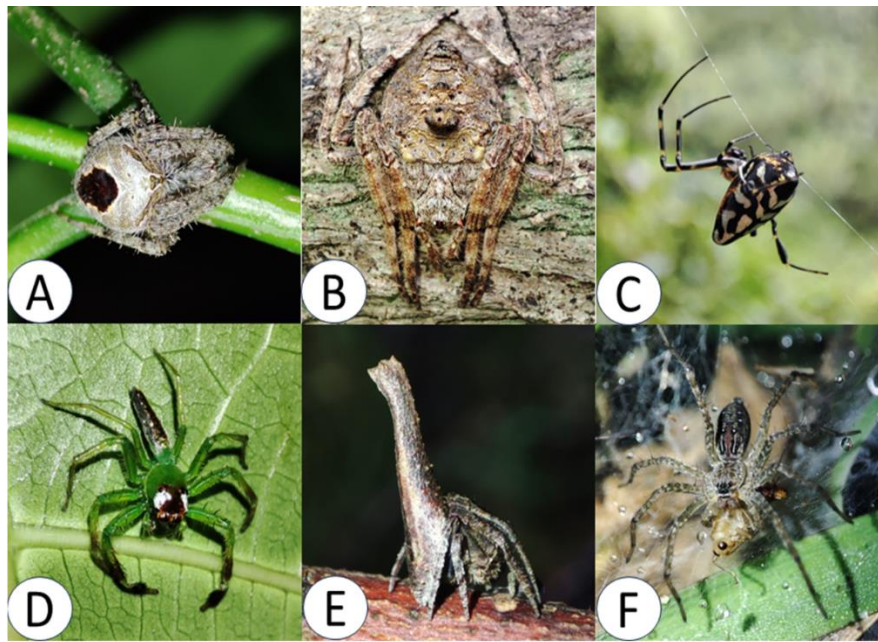


Figure 2. Some of the spider recorded (A) *Neoscona* sp., (B) *Talithybia depressa*. (C) *Leucage fastiga*, (D) *Epeuss p.*, (E) *Poltys elevates*, (F) *Hippasa holmera*.

3.2 Biodiversity indices and rarefaction analysis

Table 3 shows clear differences in spider diversity among habitats in Mt. Lantoy. Forest habitat had the highest number of individuals (114) and species (77), and the highest Shannon diversity value ($H' = 4.23$). Riparian habitat ranked second (98 individuals, 52 species; $H' = 3.67$), while grassland (46 individuals, 25 species; $H' = 2.96$) and plantation (18 individuals, 16 species; $H' = 2.74$) supported comparatively poorer assemblages. Evenness values were consistently high (0.92–0.97), indicating a relatively uniform distribution of individuals among species. The plantation habitats showed the most even distribution of species richness to abundance, but had the lowest values of richness and abundance, suggesting that no species dominated these areas, while the grassland and riparian habitats showed slightly lower evenness. Shannon-Wiener (H') and Pielou's evenness (J') were computed using the natural-logarithm formulation $H' = -\sum(p_i \ln p_i)$ and $J' = H' / \ln(S)$ values were independently re-checked against the raw counts in Table 1 to confirm accuracy. The findings in the biodiversity indices suggest that habitat complexity is a major driver of spider community structure in Mt. Lantoy. Forest habitat provides multilayered vegetation, shaded microclimates, and a wider range of attachment sites for web construction, retreats, and hunting substrates, all of which can support more species and greater abundance. The riparian habitat also maintained relatively high diversity, likely because moisture, edge vegetation, and insect activity near water create favorable foraging conditions for spiders. In contrast, the structurally simplified plantation and grassland habitats appear to offer fewer niches and less stable microhabitats, which likely limited both species richness and total abundance.

Table 3. Biodiversity indices of spider assemblages by habitat

Habitat	Individuals	Species richness	Family richness	Shannon index (H')	Simpson index	Pielou's evenness (J')
Forest	114	77	15	4.23	0.98	0.97
Riparian	98	52	13	3.67	0.97	0.93
Plantation	18	16	7	2.74	0.93	0.99
Grassland	46	25	8	2.96	0.93	0.92

The unusually high evenness in the Forest habitat ($J' = 0.97$ with $S = 77$ species) warrants cautious interpretation (Table 3). Such near-maximal evenness is uncommon in tropical arthropod assemblages, where rank-abundance distributions are typically log-normal or log-series with several dominant species. Evenness values in Table 3 were unusually high across habitats. A large proportion of the recorded species were represented by only one or two individuals (Table 4). In the forest, 67 of 77 species (87.01%) were singletons or doubletons. Riparian showed a similar pattern, with 44 of 52 species (84.62%) represented by only one or two individuals. Grassland also had a high rarity proportion, with 21 of 25 species (84.00%) recorded as singletons or doubletons. Plantation showed the strongest pattern: all 16 recorded species (100%) were represented by only one or two individuals each. In this dataset, evenness was high not necessarily because the communities were ecologically balanced, but because many species were recorded at very low abundance. Plantation had the highest evenness value because only 1 or 2 individuals represented each plantation species. Thus, the high evenness in the plantation reflects sparse detection rather than strong community stability or high habitat quality. In all habitats, at least 84% of species were represented by only one or two individuals, and in the plantation, all recorded species were singletons or doubletons. This indicates that the assemblage contained many rare records and that sampling likely captured only part of the local spider community. The high proportion of rare species suggests that additional sampling may reveal more individuals of currently rare taxa and could change estimates of dominance and evenness. Therefore, the diversity results should be interpreted as a standardized inventory across surveyed plots rather than as a complete estimate of Mt. Lantoy's spider fauna.

Table 4. Singleton and doubleton summary by habitat

Habitat	Singletons	Doubletons	Singleton + doubleton species	Total species	Singleton + doubleton (%)
Forest	52	15	67	77	87.01
Riparian	32	12	44	52	84.62
Plantation	14	2	16	16	100
Grassland	16	5	21	25	84

Note: Across habitats, 84.0–100.0% of species were represented by only one or two individuals, explaining why evenness values were high despite low abundance in some habitats.

Table 5 and Figure 3 provide a standardized comparison of species richness across habitats, accounting for differences in the number of individuals recorded. This is necessary because raw species richness is strongly influenced by sample size and total abundance. In the observed data, the forest had 114 individuals and 77 species, while the plantation had only 18 individuals and 16 species. Directly comparing raw richness alone would therefore favor habitats where more individuals were recorded. Rarefaction addresses this problem by comparing habitats at a common sample size. Rarefied richness was compared at 18 individuals, which corresponds to the smallest habitat sample size recorded in the plantation. At this standardized sample size, forest still had the highest estimated richness ($qD = 16.84$; 95% CI = 16.37–17.31), followed by plantation ($qD = 16.00$; 95% CI = 12.89–19.11), riparian ($qD = 14.99$; 95% CI = 13.93–16.05), and grassland ($qD = 13.05$; 95% CI = 11.21–14.90). These estimates show that forests retained high spider richness even after standardization, supporting their importance as diverse spider habitats. However, the rarefaction results also show why caution is warranted in the interpretation. Plantation had a high rarefied richness estimate of 18 individuals, but also the widest confidence interval. This wide interval reflects uncertainty caused by its small sample size. Because the plantation itself had only 18 individuals, the estimate is based on very limited information and should not be interpreted as evidence that the plantation is as diverse as the forest. Instead, it means that the few individuals collected from plantations were spread across many species, consistent with the high evenness and 100% singleton/doubleton pattern shown in Tables 3 and 4. The rarefaction and extrapolation curves show that observed richness differences among habitats become smaller after standardization, and some confidence intervals overlap. This indicates that part of the observed richness

difference was influenced by unequal numbers of individuals recorded per habitat. Therefore, the safest interpretation is that forest and riparian habitats supported the greatest total abundance and observed richness, while rarefaction shows that standardized richness comparisons are more conservative and should not be overclaimed.

Table 5. Individual-based rarefaction estimates at standardized sample size

Habitat	Observed individuals	Observed species richness	Standardized sample size (m)	Estimated richness qD	95% LCL	95% UCL
Forest	114	77	18	16.84	16.37	17.31
Riparian	98	52	18	14.99	13.93	16.05
Plantation	18	16	18	16	12.89	19.11
Grassland	46	25	18	13.05	11.21	14.9

Note: Individual-based rarefaction was conducted at $m = 18$ individuals, corresponding to the smallest habitat sample size. qD represents Hill number diversity at $q = 0$, equivalent to species richness. LCL and UCL denote the lower and upper 95% confidence limits, respectively.

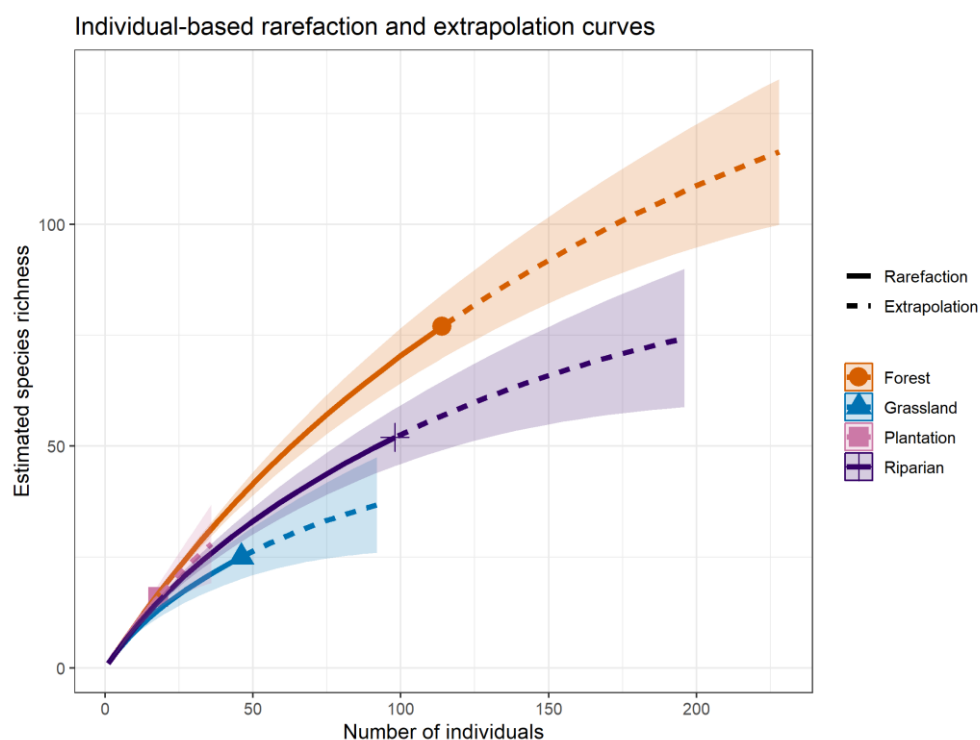


Figure 3. Individual-based rarefaction and extrapolation curves for spider species richness across forest, riparian, plantation, and grassland habitats in Mt. Lantoy. Curves were generated using Hill number $q = 0$, corresponding to species richness; shaded bands represent 95% confidence intervals.

3.3 Habitat-level comparison of abundance and species richness

Table 6 shows the assumption tests used to determine whether one-way ANOVA was appropriate for comparing spider abundance and species richness among habitats. This table is important because count-based ecological data can sometimes violate ANOVA assumptions, particularly those of normality and homogeneity of variance. Therefore, assumption testing was necessary before retaining the ANOVA and Tukey HSD framework. For abundance, the Shapiro-Wilk test for normality of residuals produced $W = 0.959$ and $p = 0.527$. Since the p -value was greater than 0.05, there was no significant evidence that the residuals departed from normality. Levene's test for homogeneity of variance produced a statistic of 1.402 and $p = 0.279$, also greater than 0.05. This indicates that the abundance data did not show significant heterogeneity of

variance among habitats. For species richness, the Shapiro-Wilk test likewise indicated acceptable residual normality, with $W = 0.971$ and $p = 0.774$. Levene's test also supported homogeneity of variance, with a statistic of 1.300 and a p -value of 0.309. Since both abundance and species richness passed the normality and variance tests at $\alpha = 0.05$, one-way ANOVA was retained for the habitat-level comparison, followed by Tukey's HSD for pairwise comparisons.

Table 6. Assumption tests for habitat-level comparisons

Response variable	Assumption tested	Test	Statistic	p-value	Decision
Abundance	Normality of residuals	Shapiro-Wilk	0.959	0.527	Acceptable
	Homogeneity of variance	Levene's test	1.402	0.279	Acceptable
Species richness	Normality of residuals	Shapiro-Wilk	0.971	0.774	Acceptable
	Homogeneity of variance	Levene's test	1.3	0.309	Acceptable

Note: Assumptions were considered acceptable at $\alpha = 0.05$. Therefore, one-way ANOVA followed by Tukey's HSD was used for habitat-level comparisons.

Table 7 shows that habitat type significantly affected both spider abundance and species richness. This indicates that the four habitat types differed in their ability to support spider assemblages. Because the plot was used as the unit of replication, the analysis reflects variation among plots within habitats rather than a simple comparison of habitat totals. For spider abundance, the ANOVA was significant, $F(3, 16) = 16.57$, $p < 0.001$. This indicates that plot-level spider abundance differed significantly among the four habitat types. For species richness, the ANOVA result was also significant, $F(3, 16) = 20.47$, $p < 0.001$, indicating that plot-level richness varied significantly among habitats. Because the plot was used as the unit of replication, these results reflect variation among the five plots per habitat rather than simple comparisons of total habitat counts. The one-way ANOVA followed by Tukey's HSD mean comparison further demonstrates that habitat type strongly influenced spider abundance and species richness in Mt. Lantoy. Forest recorded the highest mean abundance (22.80) and mean species richness (21.20), indicating it is the most favorable habitat for spiders. Riparian habitat showed intermediate values of mean abundance (19.60) and mean species richness (16.40) and remained relatively close to the forest in terms of spider abundance, whereas plantation and grassland generally supported lower means. Post-hoc analysis using Tukey's HSD test for abundance and species richness showed that forest and riparian differed significantly from plantation and grassland. Overall, the analysis supports the interpretation that habitats with greater structural heterogeneity support richer, more abundant spider assemblages than those with reduced vegetation complexity.

Table 7. One-way ANOVA summary for spider abundance and species richness among habitats

Response variable	Source	df	SS	MS	F	p-value
Abundance	Habitat	3	1199.2	399.73	16.57	<0.001
	Residual	16	386	24.13	—	—
Species richness	Habitat	3	968.8	322.93	20.47	<0.001
	Residual	16	252.4	15.78	—	—

Note: df = degrees of freedom; SS = sum of squares; MS = mean square. Plot was used as the unit of replication ($n = 5$ plots per habitat).

Table 8. Habitat-level abundance and species richness with Tukey HSD groupings

Response variable	Habitat	n plots	Mean $\pm$ SE	Tukey group
Abundance	Forest	5	22.80 $\pm$ 2.40	a
	Riparian	5	19.60 $\pm$ 3.14	a
	Grassland	5	9.20 $\pm$ 1.77	b
	Plantation	5	3.60 $\pm$ 0.75	b
Species richness	Forest	5	21.20 $\pm$ 2.40	a
	Riparian	5	16.40 $\pm$ 2.20	a
	Grassland	5	7.60 $\pm$ 1.21	b
	Plantation	5	3.60 $\pm$ 0.75	b

Note: Means followed by the same letter are not significantly different at $p \leq 0.05$ based on Tukey's HSD test.

3.4 Day and night differences in spider abundance and richness

The paired t-test indicates that both spider abundance and species richness were significantly higher during night sampling than during daytime sampling (Table 9). Mean abundance declined from 9.5 at night to 4.3 during the day, while mean species richness decreased from 8.85 to 4. In both comparisons, the p-values were below 0.05, confirming that the differences were statistically significant. This result is ecologically meaningful because many spiders are nocturnally active predators; cooler temperatures, higher humidity, and reduced disturbance at night may increase foraging activity and make more individuals detectable during sampling. This supports the importance of paired day-night sampling in spider biodiversity surveys because diurnal-only sampling would have underestimated both abundance and richness.

Table 9. Day and night comparison of spider abundance and species richness

Response variable	Time period	n plot-time units	Total	Mean $\pm$ SE	Test	Statistic	p-value
Abundance	Day	20	86	4.30 $\pm$ 0.77	Paired t-test	—	—
	Night	20	190	9.50 $\pm$ 1.39	Paired t-test	t = 5.656	<0.001
Species richness	Day	20	80	4.00 $\pm$ 0.68	Paired t-test	—	—
	Night	20	177	8.85 $\pm$ 1.28	Paired t-test	t = 5.685	<0.001

Note: Paired comparisons were performed between day and night observations from the same plots. The test direction was night > Day.

3.5 Habitats

Four habitat types were identified in the study area, namely: forest, riparian, grassland, and plantation. Among these, the forest habitat had the highest spider abundance, followed by the riparian, plantation, and grassland habitats. The number of individuals recorded in the forest accounted for 41.3% of the total 276 individuals, nearly half of all individuals recorded across the four habitats, compared to riparian (35.51%), plantation (6.52%), and grassland (16.67%). The recorded spiders in the forest habitat are 114 individuals from 77 species under 15 families. Of the 101 spider species from 20 families recorded in Mt. Lantoy, 78 species from 15 families are present in the forest area. Araneidae is the most abundant family in the forest, with 29 species, and Cyclosa insulana and Scytodes pallida are the most abundant species in the area, with 4 individuals each recorded. The forest area has dense vegetation, including native species such as *Leea philippinensis*, *Cratoxylum sumatranum*, and *Erythrina variegata*. The structure of the forest habitat, with its diverse tree species, likely influenced spider abundance in the area. Spiders benefit from tree-species diversity because it promotes the development of leaf-litter layers, which in turn support a higher diversity of prey [27]. The rich plant diversity in the area contributes to the abundance of observed spider species. Web-building spiders, in particular, are closely tied to vegetation structure, as the parameters required to construct webs depend on the habitat's physical characteristics [28]. The dense forest canopy influences the types of spiders that thrive there. Similarly, the study by Deeleman-Reinhold [29] on Southeast Asian forest spiders supports the observation that mountainous areas exhibit greater spider species richness compared to lowland areas.

Riparian habitat ranked second in both abundance and species richness, with 98 individuals under 52 species representing 13 families. The five plots were established near the river, and some were also adjacent to cultivated areas, creating a transitional habitat influenced by both natural and managed vegetation. This setting may help explain the relatively high spider abundance. Riparian environments commonly support dense insect populations because water, moisture, and riparian vegetation favor many aquatic-emergent and terrestrial prey taxa. As predominantly insectivorous predators, spiders are expected to respond positively to this prey base. At the same time, the proximity of some plots to agricultural areas may have contributed to a mixed assemblage by combining semi-natural habitat features with open foraging spaces. This agrees with the view that riparian habitat supports intermediate levels of spider abundance, likely due to the high availability of aquatic-derived prey, as emerging aquatic insects serve as a vital energy subsidy for riparian predators [30,31]. Grassland and plantation habitats supported comparatively poorer spider communities than forest and riparian sites. The grassland contained 46 individuals from 25 species across eight families, with Araneidae again being the most represented family and (*Tetragnatha cf. ceylonica*) the most abundant species. Although grasses and shrubs such as *Chromolaena odorata* and *Imperata cylindrica* provide some support for web-building spiders, this habitat remains more exposed and structurally less diverse than the forest. The plantation had the lowest overall values, with only 18 individuals representing 16 species across 7 families. This reduced diversity is likely related to the dominance of mahogany stands, which create a more uniform habitat structure, as well as to the absence of saplings and seedlings of other native plants in the understory and the lack of insects that serve as food for spiders. Monoculture and low plant heterogeneity generally reduce the variety of microhabitats, prey niches, and web-attachment sites available to spiders. The marked decline in spider diversity observed in the plantation is therefore consistent with broader evidence that converting natural vegetation to simplified monoculture systems tends to reduce arthropod richness and biomass [2, 7].

3.6 Guild Structure

Table 10. Guild structure of spider family.

Guild	Family
Ambushers	Deinopidae
	Hersiliidae
	Pisauridae
	Thomisidae
Foliage runners	Cheiracanthiidae
	Clubionidae
Ground hunters	Lycosidae
	Corinnidae
	Liocranidae
	Scytodidae
	Sparacidae
	Theraposidae
	Zodariidae
Orb weavers	Araneidae
	Tetragnathidae
	Uloboridae
Stalkers	Oxyopidae
	Salticidae
	Psechridae
Sheet web weavers	Theridiidae
Space-web weavers	

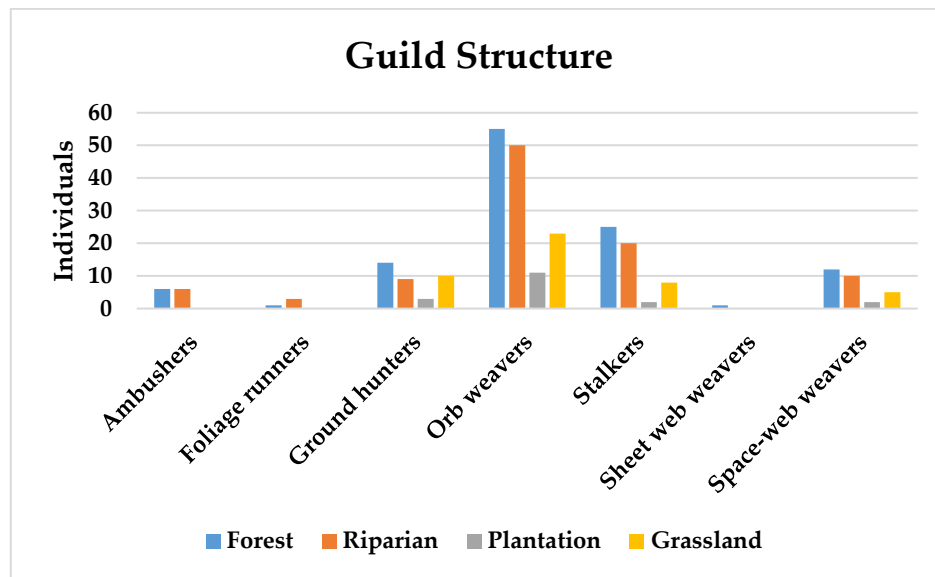


Figure 4. Guild structure of spider assemblages across the four habitats (Forest, Riparian, Plantation, Grassland) in Mt. Lantoy, Cebu, Philippines.

The guild structure analysis revealed distinct patterns in spider functional groups across the different habitats of Mt. Lantoy. The composition of spider guilds reflects the influence of habitat structure and vegetation complexity on community organization. Spiders were assigned to functional guilds following the classification system of Cardoso et al. [24] and Uetz et al. [32], which groups species by foraging strategy and prey-capture behavior rather than taxonomy. Family- and genus-level assignments followed the World Spider Catalog and primary literature on Philippine and Southeast Asian araneofauna; in the few cases where a genus included species spanning more than one guild, assignment was made at the species level based on documented web architecture or hunting mode. In this study, seven functional guilds were identified: Ambushers (Deinopidae, Hersilidae, Pisauridae, Thomisidae), Foliage runners (Cheiracanthidae, Clubionidae), Ground hunters (Lycosidae, Corinnidae, Liocranidae, Scytodidae, Sparacidae, Theraposidae, Zodariidae), Orb weavers (Araneidae, Tetragnathidae, Uloboridae), Orb wavers (Araneidae, Tetragnathidae, Uloboridae), Stalkers (Oxyopidae, Salticidae), Sheet web weavers (Psechridae), and Space-web weavers (Theridiidae). The most dominant guild was the Orb Weavers (50.36%), comprising members of the families Araneidae, Uloboridae, and Tetragnathidae. These spiders construct circular webs and are typically found in habitats with abundant vertical structures, such as forested areas. The high proportion of orb weavers suggests that structurally complex habitats, such as forests and riparian zones, provide optimal conditions for web construction and prey capture. The second most abundant guild was the Stalkers (19.93%), represented by families such as Oxyopidae and Salticidae. Other guilds, including Ambushers, Foliage runners, and Sheet web weavers, cannot be found in the plantation and grassland habitats. The similarity in guild composition across habitats highlights the role of vegetation layout in shaping spider communities [32]. Structurally complex habitats provide diverse web-building opportunities and foraging grounds, promoting functional diversity and ecosystem stability.

3.7 Discussion

Spider assemblages in Mt. Lantoy showed clear habitat-related differences in abundance, richness, and functional composition. Forest and riparian habitats supported the highest observed abundance and species richness, while plantation and grassland habitats supported poorer assemblages. This pattern suggests that structurally complex habitats provide more favorable conditions for spiders. Forest had the highest observed richness and diversity, reflecting the importance of multilayered vegetation and microhabitat heterogeneity. Riparian habitat also supported high abundance and richness, likely because moisture, riparian vegetation, and aquatic-emergent insects can increase prey availability for arthropod predators [2, 4, 7, 30, 31].

In contrast, plantation and grassland habitats were structurally simpler, which may have reduced the availability of web-building sites, litter-layer refuges, and prey diversity. Forest recorded the highest Shannon and Simpson diversity values, while the plantation had the highest Pielou's evenness despite having the lowest abundance and richness. The high proportion of rare species also suggests that additional sampling may reveal more individuals of currently rare taxa and may change estimates of dominance and evenness. Rarefaction analysis further showed that raw species richness should not be interpreted alone. At the standardized sample size of 18 individuals, forest retained the highest rarefied richness estimate, but differences among habitats became smaller, and some confidence intervals overlapped, especially for the plantation. This indicates that observed richness patterns were partly influenced by unequal numbers of individuals recorded among habitats. Therefore, the strongest interpretation is that forest and riparian habitats supported the greatest observed abundance and richness, while rarefaction provides a more conservative comparison of richness after accounting for sample-size differences [22, 23]. The inferential tests confirmed that habitat type significantly affected both plot-level abundance and species richness. Assumption tests supported the use of one-way ANOVA, and Tukey's HSD showed that forest and riparian formed the higher group, while plantation and grassland formed the lower group. Importantly, forests and riparian areas did not differ significantly. Day-and-night sampling also revealed a strong detection pattern. Night sampling recorded substantially higher abundance and richness than daytime sampling, indicating that daytime-only surveys would underestimate the local spider assemblage. This is likely because many spiders are more active or more visible at night while foraging, occupying webs, or moving through vegetation. Guild composition was dominated by orb weavers, emphasizing the role of vegetation structure in supporting web-building spiders [24, 32]. Overall, the results highlight the conservation value of structurally complex forest and riparian habitats and support the use of paired day-night sampling in future spider biodiversity assessments.

4. Conclusions

This study revealed that spider diversity, abundance, and guild composition in Mt. Lantoy are strongly influenced by habitat type. Among the four habitats surveyed, the forest exhibited the highest species richness, abundance, and Shannon diversity index, followed by the riparian zone, grassland, and plantation. High evenness values across all habitats indicate a relatively balanced distribution of individuals among species. Guild analysis showed that orb weavers dominated the spider community, reflecting the importance of vertical structure for web-building species. The one-way ANOVA revealed significant differences in spider abundance and species richness among habitats. The forest habitat recorded the highest mean abundance and species richness, both significantly higher than those in the plantation and grassland habitats. This indicates that forest conditions characterized by structural complexity and diverse microhabitats are more favorable for spider communities, whereas simplified habitats, such as plantations, support fewer species. Results from the paired t-test showed that spider abundance and species richness were significantly higher during night sampling compared to day sampling. The findings emphasize the ecological value of forested habitats in maintaining high spider diversity and functional richness. In contrast, simplified habitats such as plantations and grasslands support fewer species and guilds, likely due to limited structural complexity. These results highlight the need to prioritize the conservation of forest and riparian ecosystems in Mt. Lantoy to sustain ecological balance and biodiversity.

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