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Species Diversity of Salticid Spiders (Araneae: Salticidae) according to Elevation and Vegetation Type in Western Mindanao State University – Experimental Forest Area, Upper La Paz, Zamboanga City, Philippines

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ABSTRACT
Salticidae is the largest and one of the most diverse spider families. Considering how species diversity patterns vary across spatial gradients, this study aimed to determine the species diversity of salticids along an elevation gradient in WMSU-EFA, La Paz, Zamboanga City. Collection methods were beat netting and vial tapping. Forty-four species under 26 genera were documented. Phintella piatensis was the most abundant species. Leaf litter and leaf surfaces/foliages were the most preferred microhabitats. Data analysis using PAST 3.0 showed highest species diversity at mid-elevation (H'=3.39), high diversity at high elevation (H'=3.02), and the lowest diversity at low elevation (H'=2.57), thus showing a hump-shaped pattern. An even distribution was recorded. However, factors such as vegetation structure and habitat complexity appear to influence species diversity aside from elevation itself.
***Keywords**: Diversity pattern, elevation, microhabitat, spatial, vial tapping*

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INTRODUCTION

Spiders which comprise the order Araneae are among the most diverse groups on earth [1] consisting of 47,582 species under 117 families and 4091 genera [2]. Salticidae includes 5678 known species under 636 genera [2] and is thus, the largest family of spiders [3]. Salticids or jumping spiders can be abundantly found in all non-polar terrestrial ecosystems with a broad range of microhabitats from beneath leaf litter to the forest canopy [4]. Diverse as they are, studies, however, on spider diversity in tropical areas such as the Philippines are lacking in comparison to those in temperate regions [5].

In Zamboanga City, Philippines, the total forest cover is 29,377 hectares with an open forest of 9,107 ha, closed forest of 15,294 ha, and mangrove forest of 4,976 ha [6]. Located at Upper La Paz, Zamboanga City, the Western Mindanao State University – Experimental Forest Area is a marginal second growth forest with few patches of old growth forest stand [7] with an area of more or less 1,227 hectares as stated in Proclamation No. 407, s. 1994. However, it is already a logged-over area with extensive and unsustainable upland farming practices thus causing the denudation of the area. In fact, only 16.2% of the total area are covered by forest tree species [8]. According to a study by Ghione et al. [9], predators such as spiders are particularly vulnerable to habitat fragmentation and are considered to be good bio-indicators of habitat degradation or nature conservation.

Along the northern borders, tall mountains line the city ranging from moderately steep to very steep slopes [10]. In La Paz, the lowest elevation in the southern portion is about 600 meters above sea level (masl) while in the northern part, elevation ranges from 1,000-1,500 masl with some areas almost vertically aligned [11].

With salticids being known as the most diverse of all spiders [12], new genus and species continue to be discovered. This includes new records such as genus *Bavirectagen* with three new species in Sri Lanka

[13], five new species of genus *Phintella* in China [14], the first record of the female *Idastandria orientalis* from Singapore [15], and more.

Several studies on salticid species diversity in the Philippines showed that Family Salticidae is the most widespread in Basilan and also the second most prevalent family in Tawi-tawi. In addition, Family Salticidae has the highest species richness in Sacred Mountain, Marawi City [16] and also showed high species diversity and greater evenness of the salticids in Rajah Sikatuna Protected Landscape, Bohol [17]. Meanwhile, studies on composition of ecological communities contribute important insights on species diversity [18]. In a study by Argañaraz et al. [19] in the Argentinian Atlantic forest, a strong association has been observed between Salticidae spiders and microhabitat type and differences in species composition were detected between habitats. Moreover, elevation gradient studies on several taxa imply that there is a large variation in diversity patterns [20] which includes a monotonic decline, mid elevation peak, and a linear increase in species richness with elevation [21]. Indeed, in a study by Lalisan et al. [22] in Mt. Pinukis, Zamboanga del Sur, spider diversity along an elevational gradient was highest in mid-elevation.

Understanding elevational diversity patterns has strong conservation implications [23]. This study was conducted at Western Mindanao State University – Experimental Forest Area in Upper La Paz, Zamboanga City to determine diversity pattern of salticid spiders along an elevational gradient. This can be of benefit in the formulation of conservation program in the face of recent global phenomenon [24] and the assessment of the area's current ecological health status.

MATERIAL AND METHODS

Sampling Area

Sampling was conducted in Western Mindanao State University - Experimental Forest Area, Upper La Paz located 26 km west coast from the city proper of Zamboanga City(Fig.1). It has an area of more or less 1,227 hectares and lies between 7° 01' and 7° 06' latitude; and 121° 58' 30" to 122° 02' 30" longitude. It is bounded on the west to north by Zamboanga Special Economic Zone and Freeport Authority otherwise known as Zamboanga ECOZONE. To the southeast is a cancelled mining area previously operated by Zambales Base Metals, Inc. now known as Ayala Watershed. On the east, is the Pasonanca Natural Park.

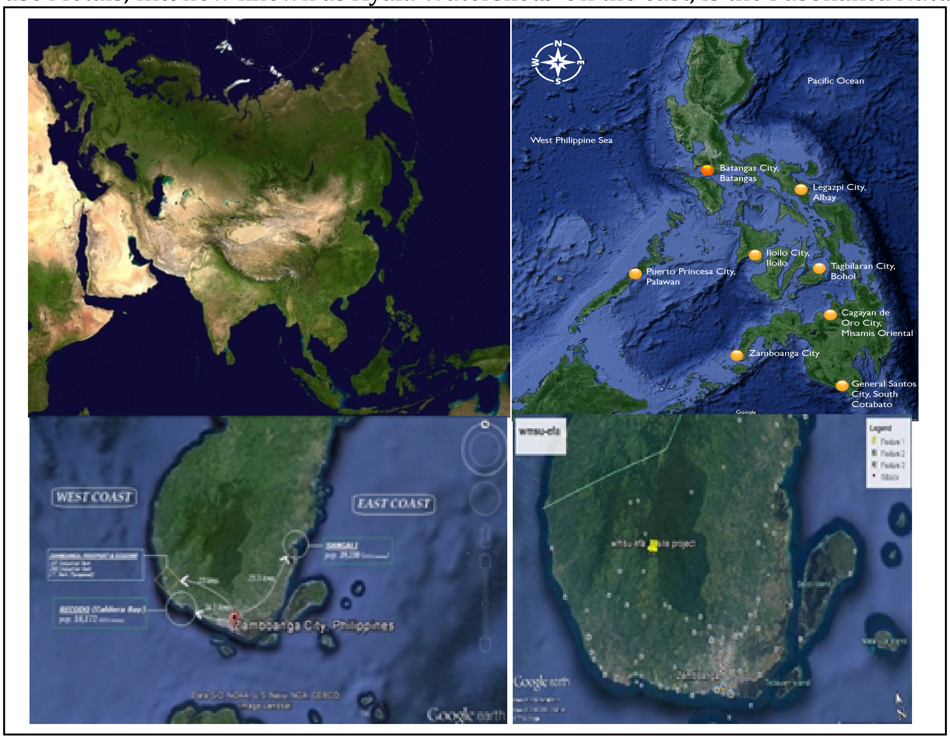

Figure 1. Map of Asia [25], Philippines, Zamboanga City and study area [26].

Description of Sampling Sites

The Experimental Forest Area has a relatively soft rolling to rugged terrain with moderate to very steep slopes. Due to high elevation gradients ranging from 600-1,200 meters above sea level (masl), cool climate is maintained throughout the year. In the months of December to February, recorded temperature could be as low as 16°C to 18°C with presence of thick fog. The soil is predominantly loam type with a color of reddish-brown to dark brown. Vegetables and forest trees are well adapted, indicating a nutrientrich soil due to high organic matter and potassium content [11]. However, slight to moderate soil erosion can be observed during rainy season due to patches of open and cultivated hillside areas in addition to slash-and-burn farming system. The primary sources of water are Limon, Mais, Fortunato, and Ayala Rivers.

In a wildlife inventory conducted by DENR, WMSU, and KFI on September 2004, avian species are predominant. Despite the area being subjected to logging, patches of dipterocarp species exist mainly dominated by "lauan" tree species. Such trees are considered mother trees used as source of seeds for the propagation of dipterocarp seedlings. The area occupied by forest trees is only 16.2% or a total of 128.12 ha while 7.82% or 97.23 ha are occupied by non-timber plant species such as rattan and palms [27].

The tree DBH which refers to the tree diameter at 4.5 feet above ground was measured using a calibrated diameter tape. It was calculated by converting the circumference measurement to diameter by dividing the circumference by pi (3.14).

Sampling site 1 of Area 1 is an open-area grassland with coordinates of 7°01'47.3"North and 122°00'19.4"East. It has an elevation of 645 masl with a rolling undulating slope facing east. Both the emergent and canopy trees were *Cocos nucifera* with a height of 12 m and DBH of 30 cm. Canopy epiphytes and vines were absent. Plants include *Parkinsonia aculeata*, *Colocasia esculenta, Gliricidia sepium*, *Pseudelephantopus spicatus*, *Ludwigia adscendens, Mimosa pudica*, *Chromolaena odorata*, *Angiopterise vecta*, *Allium sativum*, *Bouteloua dactyloides,* as well as various ferns from subivision Tracheopyta. Fruit density was moderate which comprised*Carica papaya*, *Artocarpus heterophyllus*, and *Musa sp.* aside from coconuts. Soil type is clay loam. Moss, leaf litter, humus, and fallen logs or exposed rockswere absent. Since it is a cultivated area, site disturbance was evident. Water supply comes from an intermittent stream 100m away.

Sampling site 2 of Area 1 is an open area grassland with coordinates of 7°02’46.0’’North and 122°01’05.1’’East. It has an elevation of 875 masl and a moderate-rugged slope. The emergent tree was *Shorea contorta* (white lauan) with a height of 25 m and DBH of 40 cm. Canopy trees which are also *Shorea contorta* (White "lauan") had a 5m height and 5 cm DBH. Alongside the sandy stream were epiphytes such as *Schizostachyum diffusum* and *Lygodium circinnatum* together with mosses and canopy vines like *Parkinsonia aculeate* and rattan vines of family Rhamnaceae. The high density of grasses or sedges includes *Bouteloua dactyloides*, *Hypoxis hemerocallidea*, *Thysanolaena latifolia*, *Megathyrsus maximus*, and ferns from subdivision Tracheophyta. Meanwhile, grasses along the stream include *Angiopterisevecta*, *Typhonium trilobatum*, *Jussiaea inclinata*, and *Pseudelephantopus spicatus*. Leaf litter cover has a depth of approximately 10 cm while humus cover was 5 cm deep with a porous upper portion. The soil was a very fine clay type which indicates soil erosion. Fallen logs and branches were present, as well as sedimentary and metamorphic exposed rocks. Anthropogenic disturbance was evident due to cultivation of fruits such as *Ananas comosus*, *Durio sp.*, *Musa* sp., and *Citrofortunella microcarpa.*

Sampling site 3 of Area 2 is a secondary forest with coordinates of 7°01'47.3" North, 122°00'19.4" East and an elevation of 750 masl. The site had a rugged slope with a flowing intermittent stream. The emergent tree was *Conocarpus lancifolius* with a height(H) of 18 m and a DBH of 40 cm. The canopy trees were *Oncosperma tigillarium* and *Caryota sabolifer*, with a height and DBH of 8 m and 30 cm, respectively. Orchids and canopy vines which include *Scutellaria baicalensis* and *Lygodiumcircinnatum* were also observed on the trunks of the canopy trees. Plants include ferns, *Alocasia sp., Pseudel ephantopus spicatus*, *Donax canniformis, Drynaria quercifolia,* rattan vines of family Rhamnaceae, ferns of order Cyatheales, *Schizostachyum diffusum*, "hagithit", and "anibong" (palmay).Moderate density of *Musa sp.* was observed while *Pandanus sp.*, *Ficus sp.,* pitcher plants, and fruit treeswere absent. Grasses and sedges were also absent while mosses were rare but present on the ground along with exposed sedimentary rocks and fallen branches. The site had a porous loamy soil with thick humus and leaf litter cover of 10 cm. The site was vulnerable to disturbances as tree nursery was located inside the forest and anthropogenic clearing was only 25 m away.

Sampling site 4 of Area 2 is a secondary forest with coordinates of 7°02'46.0" North, 122°01'05.1" East at an elevation of 990 masl. The site had a rugged terrain slope with a stream. The emergent and canopy tree was *Averrhoa bilimbi* with H=20m, DBH=20m of the emergent tree and H= 15 m and DBH= 40cm of the canopy tree. Lichens and canopy vines of *Cassytha filiformis* were observed on the trunks of the canopy trees. Other plants include *Pityrogramma calomelanos*, *Pseudelephantopus spicatus*, *Ludwigia adscendens*, and *Caryota mitis*. *Pandanus sp.* was common while *Musa sp.* was rare, however, pitcher plants and *Ficus sp.* were not observed. Carabao grasses and mosses were present on the ground along with exposed sedimentary rocks. The site had a porous, loamy moist soil with a humus cover of 10 cm and leaf litter cover of 20 cm. No anthropogenic clearing was observed at the site.

Sampling site 5 of Area 3 is a dipterocarp closed canopy forest with coordinates of 7° 01' 52.5" North and 122° 00' 04.0" East at an elevation of 860 msl. It is a primary forest that has a rugged terrain. Emergent tree was *Casuarina equisetifolia* with a height of 15 m and a DBH of 15 cm. Canopy tree was *Shorea squamata* with a height of 10 m and a DBH of 10 cm. Understory plants jnclude*Cyatheaceae, Colocasia esculenta, Urtica dioica, Musa acuminata, Blechnum orientale, Pityrogramma calomelanos, Etlingera elatior, and Caryota sabolifer.* Mosses were present and leaf litter depth measured about 15 cm. Grasses, sedges,*Ficus sp.*, and *Musa sp.Pandan sp.* and and pitcher plants were absent. The site has a sandy loam type of soil with thick humus that measured about 10 cm. Exposed igneous rocks, fallen logs, dead branches, and fallen timber were present. Water type was an intermittent tributary. The distance to its anthropogenic clearing was 10 m.

Sampling site 6 of area 3 is a dipterocarp closed canopy forest with coordinates of 7° 02' 50.2" North and 122° 00' .54.3" East and elevation of 1080 masl. The site has a steep slope on the western side and a primary vegetation type. Sunlight cannot easily penetrate through the ground due to the high density of emergent and canopy trees. Emergent tree was *Shorea sp.* with a height of 35 m and a DBH of 70 cm. Canopy tree was *Vitex parviflora* with a height of 15 m and a DBH of 40 cm whichwas covered with epiphytes and vines coiling on its trunk. Understory plants like *Cyatheaceae* and *Calamus deerratus* were present. Thick forest litter was present and moss depth measured about 10 cm. Grasses, sedges, and pitcher plants were rare.*Pandan sp.* and other fruits were absent. *Ficus sp.* and *Musa spw*ere moderate. The site has a sandy loam soil and porous with thick humus because of the presence of organic matter such as decayed plant and animal matter. Freshwater stream was located 50 m away. The distance to its anthropogenic clearing was 50 m and the distance to its site disturbance which was previously a slash-and-burn area was 20 m North.

Collection, Processing, and Identification of Samples

The sampling was done for seven days (July 22-28, 2018) with one day attributed to reconnaissance. It was done throughout the day starting early in the morning until late evening, totaling to approximately 180 person-hours. In each elevation, a one km transect line was established. As spiders are diverse in their ways of life, a combination of methods like beat netting and vial tapping was used to collect representatives from all habitats. One to three voucher specimens were temporarily stored in either salad cups or eppendorf tubes. The voucher specimens were then transferred to glass vials labeled with date and location of collection after preservation. Microhabitats and any field observations were noted.

For preservation, 95% ethanol was utilized to soak samples for later processing. A stereo microscope was used to view the characteristics necessary for initial identification. Diagnostic features include a well-defined ocular quadrangle or ocular trapezium on the cephalothorax delimited by eight eyes arranged in three or four rows. The anterior row is formed of four eyes among which the two centrally placed anterior median eyes are very prominent. Situated on either side, the anterior lateral eyes are also prominent but generally only half the size of the former. Moreover, the legs are two-clawed with claw tufts and among the four pairs of legs, the first pair is generally more prominent and stouter than others [28]. Photodocumentation was done. All samples were identified through the use of taxonomic keys by Barrion & Litsinger [29]. Mr. Aloke Sahu of the Philippine Arachnophiles – Philippine Spiders and Allied Groupshelped in the identification.

In the identification of sex, males can easily be differentiated due to their enlarged pair of rounded pedipalps used to transfer sperm to the female genitalia during mating. Males also tend to be more colorful and have longer legs than females although they are generally smaller in size, sometimes only half the size of the female. Meanwhile, juvenile male and female spiders were identified by their undeveloped pedipalps and epigynum, respectively.

Statistical Analysis

Statistical analysis was done using Paleontological Statistics Software Package (PAST) version 3.0.

RESULTS AND DISCUSSION

Species Composition and Abundance according to vegetation

A total of 259 individuals representing 44 species under 26 genera were collected during the sampling period (Table 1). Site 4 of Area 2 (990 masl) which is a secondary forest recorded the highest number of individuals at 72, as well as the highest number of species at 26, which is 59% of the total number of species. This was followed by Site 3 of Area 2 (750 masl) at 55 individuals and 22 species recorded. In general, it was in Area 2 where we documented not only the highest number of individuals but also the highest species richness at 37 species. This can be attributed to the secondary forest vegetation structure in Area 2 that supports various spider microhabitats by which salticids can dwell in. Habitat structure influences spider diversity and richness, wherein complex habitats can be expected to be more diverse

[30,31,32]. As the vegetation matures, becoming denser and more stratified, more spider species become available [33], thus further supporting the hypothesis that structural complexity of plants influences spider species richness [34].

On the other hand, area 3 (sites 5 and 6) of elevations 860 and 1080 masl, respectively, are dipterocarp closed canopy forests where the second highest species richness at 24 species was recorded. This was due to vast bushes, shrubs, and understory plants which provide a preferable environment for food hunting, nesting, and retreat construction [35] for the jumping spiders to thrive in. Sites 5 and 6 of Area 3 had 35 and 48 individuals, respectively. This is lesser in comparison to Area 2 due to anthropogenic clearings approximately 10-20 m away. This stresses the impact of habitat fragmentation on species richness and endemism maintenance [36].

Meanwhile, Sites 1 and 2 of Area 1 (645 and 875 masl), had the lowest species richness at 9 and 11 species, respectively. The area only had 17 species recorded since it is an open-area agroecosystem with evident anthropogenic or site disturbance due to cultivation of fruits and vegetables. Truly, the role of disturbance in shaping biodiversity is widely recognized wherein it negatively affects species diversity and abundance [37], especially since spiders in general are very sensitive to even the slightest change in microenvironments.

Phintella piatensis was the most abundant species comprising 10.81% of the total number of individuals. *Pristobaeus jocosus* ranked second at 8.88%, then *Plexippus paykulli* at 7.34%. Salticids from genus *Phintella* thrive in abundance which was 20.46% of all individuals consisting of five different species despite the numerical dominance of ants (spider predators) in the arthropod community of tropical forest canopies [38,39]. This is because they are ant-associates, which are species that neither mimic nor eat ants (Nelson et al., 2004). The most abundant species, *Phintella piatensis* in particular, gains protection from predatory spitting spider (*Scytodes sp.)* by living with territorial weaver ants (*Oecophylla smaragdina)* [40]. These salticids build their nesting sites based on active living ants nearby since the spitting spiders are repelled by the specific airborne olfactory compounds that these ants release. Moreover, they build ant-proof nests of an unusually tough and dense weave of silk[41]. With this, *Phintella* salticids, together with genus *Myrmarachne* which are myrmecomorphic or ant mimics, have a relatively higher survival rate due to their survival tactics that permit close proximity to ants [42] and their ability to mimic the ants' chemical scent (chemical mimicry) in comparison to other genera which only depend on their defensive behavior [43].

Physical structure and species composition according to vegetation determine spider diversity through habitat availability [44]. Indeed, there is a variation in species diversity in accordance to their habitat preferences. Open-area agroecosystem recorded the least number of species attributed to agricultural activities, anthropogenic disturbances, and clearings. Secondary forests on the other hand, support the highest species richness due to high plant species richness and vegetation height which depict a major influence on spider assemblages thus, offering diverse habitat structure and potential sites for nesting [45]. The thick leaf litter in secondary forests supports a wide array of species thus, positively correlating to high species richness as well [46]. Meanwhile, the closed canopy forests also had high diversity but lower than the secondary forest due to the presence of nearby site disturbances and anthropogenic clearing such as the road.

However, aside from the vegetation composition in the sampling area, the sampling season is to be noted as well since spider species have their period of abundance in relation to different seasons [47], in which Salticidae is most dominant during the summer season [48]. Taking this into consideration, this explains why there were only 44 species collected since the sampling period was in July, which is a rainy season in the Philippines.

As observed, the three areas yielded different number of species, with area 2, secondary forest being the highest, followed by areas 3 and 1. However, there were also species such as the *Phintella piatensis* and *Pristobaeus jocosus* that were found in all areas, further giving emphasis on the abundance of these two species. This similarity may be attributed to differences in climatic and habitat conditions along the modest elevation range which is too small to result in significant differences in the number of salticid species collected with the applied sampling protocol [49]. Moreover, Area 1 showed an overlap of only three species (*P. piatensis, P. jocosus, Brancus sp.)* which were also found in other sites except A3S6. Furthermore, Area 2 had a six species overlap and Area 3 with five species. This low overlap of spider fauna at adjacent sites may suggest that the spider fauna in WMSU-EFA, Zamboanga City is considerably richer than estimated which is also the case in a spider fauna study by Sorensen [32] in the canopy of a montane forest in Tanzania. In addition, there were also species that were found in one site only. These include *Thiania bhamoensis* and *Thiania sp.* exclusive in A2S3; *Cosmophasis sp., Myrmarachne sp. 4, Opisthoncus sp.,* and *Thorelliola sp.* in A2S4; *Habronattus decorus* and *Phintella debilis* in A3S5; and *Rene* *sp. and Thiania subopressa.* in A3S6. This distinctive salticid species composition in each site may be a result of the differences related to habitat heterogeneity [50]. The vegetation structure specifically the tree species [33], presence of epiphytes [31], and age of vegetation [51,33] explains some of the variation in spider communities.

Rearranging the data according to elevation, Table 2 shows that among the six sampling sites, A1S1 recorded the lowest number of species (9) at 645 masl. Species richness then increased to 22 at 750 masl, after which continued to decrease to 17 and 11 species per site at 860 and 875 masl, respectively. This decreasing pattern is in accordance to a study by Rahbek [52] where a decrease in diversity is correlated with increasing elevation. Meanwhile, species richness peaked at 990 masl, increasing from 11 to 26 species, which then decreased yet again to 16 species at 1080 masl. This hump-shaped pattern was a similar to the result ofChatzaki et al. [53] in Crete, Greece where ground-dwelling spiders showed a hump-shaped response to increasing elevation. This conveys how elevation has a measurable effect on species richness [54]. As altitudinal gradients are usually characterized by rapid changes in the environment over short distances, they are considered to be ideal for investigating diversity patterns [55]. Moreover, looking at the abundance of the six sampling sites, there seems to be no evident pattern. This can be attributed to terrestrial arthropod communities showing either a decrease or no effect at all with increasing elevation or latitude [56].

Age and Sex Structure

Female salticids were dominant comprising 51.4% (133) of the 259 collected individuals in the study area while 29.3% (76) were males and 19.3% (50) were juvenile salticids. The high abundance of females coincides with a study in Mpumalanga Lowveld of South Africa where female salticids exceed males [57]. At the beginning of the rainy season which is the month of July whensampling was done in this study, most salticids have a peak reproduction according to a study by Crane [58] in Venezuela [59]. This explains the high number of females attributed to sexual cannibalism, a common sexual conflict where females kill or consume potential or actual mates [60]. This highlights the importance of courtship in sexual selection, specific recognition, female mating stimulation, and cannibalism reduction [61]. Aside from this, males risk fatal predator encounters and intense competition among males for mate access [62]. Female longevity in comparison to males is also an important factor [17].

Biodiversity Indices

The typical values of Shannon diversity index generally range from 1 to 3 thus showing moderate species diversity with which values below 1 indicates low diversity and values more than 3 indicates high diversity [63]. Table 3 shows that site 4 of Area 2 (990 masl) has the highest diversity among all sites (H'=3.163) followed by site 3 of Area 2 (750 masl) at H'=2.771, both of which are at secondary forest vegetation. Meanwhile, sites 1 and 2 of area 1 which are open agroecosystem areas had diversity values of H'=2.194 and H'=2.087 respectively, indicating moderate diversity. However, in comparison to the other study areas, it is area 1 that had the least diversity.

For species evenness, a value closer to one means that abundance of the compared species is generally of the same number, while a value closer to zero signifies a dominating species in an area [64,17]. Since results showed values close to one, this indicates an even distribution of salticids in the area. It is worth noting though, that it is yet again site 4 of area 2 that had the highest value of 0.9096 due to the complex vegetation structure in the secondary forest, which in turn, contributes to its diversity and evenness. It may also be attributed to its elevation wherein spiders flourish best at this altitude. In fact, in a study by Bowden & Buddle in 2009 [56], changes along spatial gradients associated with changes in habitat can have significant effects on the structure of spider assemblages.

A number of diversity models have been made with regard to species richness along elevational gradients. Models predicting a monotonic decrease in the number of species with altitude and a hump-shaped pattern with a peak in the middle of the gradient are the most commonly referred to [65]. A mid-domain effect best explains a hump-shaped species richness distribution on the gradient [66]. This was the case in this study, wherein mid-elevation (990 masl) recorded the highest species richness, abundance, and diversity based on the analysis of the biodiversity indices. This coincides with the findings of the study on spider diversity along an elevational gradient in Mt. Pinukis, Zamboanga del Sur [22].

With species richness and abundance peaking at 990 masl, elevation may not be the only reason. It could also be a result of higher speciation rate in a more heterogeneous landscape [67]. It is caused by the dependence of spiders on the vegetation of their habitat due to a way of life and foraging, which plays a significant role in shaping these communities [20]. In fact, in a study by Jimenez-Valverde and Lobo [68], results showed a strong correlation between spider species richness and habitat complexity than with elevation at a regional scale of sampling.

Microhabitats

Figure 2 shows four types of microhabitats, namely: leaf litter, understory plant leaf surfaces or foliages, forest floor, and tree trunk. Table 2 shows that the first two mentioned were the most utilized microhabitats of the jumping spiders. In terms of microhabitat preference, spiders generally do not have a strong association with the plants on which they live [69]. However, spiders are known to be selective of their microhabitats and foraging sites, increasing their survivorship and reproductive success [70]. Leaf litter is where decomposition and nutrient recycling occurs, wherein bacteria, fungi, and various insects live [71]. This makes it an ideal place for spiders to live and hunt, highlighting the importance of microhabitats as a supportive realm for the survival of these diverse and sensitive salticid spiders [72].

Table 1. Species Composition and Abundance of salticids collected from the six sampling sites.

Species	Area 1 Agroecosystem		Area 2 Secondary forest		Area 3 Closed canopy forest		Total	RA (%)
	Site 1 645 masl	Site 2 875 masl	Site 3 750 masl	Site 4 990 masl	Site 5 860 masl	Site 6 1080 masl		
Bavia aericeps		3♀	2 (1♀,1♂)	2♀	3 (2♀, 1♂)	4 (2♀2♂)	14	5.41
Bathippus sp. 1		2♀	1♂				3	1.16
Bathippus sp. 2			1♀	3 (1♀,2j)		2♀	6	2.32
Brancus sp.	2♀	2 (1♀,1♂)	1♀	3 (2♂, 1j)	1♀		9	3.47
Breda sp. 1	1♂					1♀	2	0.77
Burmattus sp.			3 (2♀, 1♂)		2♀		5	1.93
Chalcoscirtus infimus	1♀			2♂	1♂	2♀	6	1.93
Chalcotropis cf. caerulus			3♂	3♀			6	2.70
Cosmophasis sp.				2♀			2	0.77
Euryattus sp.			1♂			3 (2♀, 1♂)	4	1.93
Evarcha bulbosa			2♀		3(2♂,1j)		5	1.93
Habronattus decorus					1♂		1	0.39
Harmochirus brachiatus				2♀	2(1♀,1♂)		4	1.54
Harmochirus sp. 1			1♀	3(2♀,1♂)	2♀		6	2.32
Harmochirus sp. 2		1♀	1♂				2	0.77
Heliophanus sp.				5(2♀,1♂,2j)			5	1.93
Heliophanus melinus				2(1♀,1♂)		6(2♂,4j)	8	3.08
Leikung sp.					2(1♀,1♂)	3♂	5	1.93
Malloneta guineensis	1♂			2♀			3	1.16
Table 1. Continuation. Species Composition and Abundance of salticids collected from the six sampling sites.								
Myrmarachne sp.		2♀	2(1♀,1♂)				4	1.54
Myrmarachne sp. 2		3(2♀,1♂)		4(3♀,1♂)			7	2.70
Myrmarachne sp. 3		1♀	2(1♀,1♂)				3	1.16
Myrmarachne sp. 4				3(1♀,2♂)			3	1.16
Opisthoncus parcedentatus				4(3♀,1♂)		4(1♀,3j)	8	3.09
Opisthoncus sp. 1				2♂			2	0.77
Opisthoncus sp. 2				2♀	1♂		3	1.16
Parabathippus sp.	2♀		2♀	2♂		3(2♀,1j)	9	3.86
Portia sp. 1		1♂	2(1♀,1♂)		2♀		5	1.93
Portia sp. 2			1♀	1♂			2	0.77
Phintella piatensis	3♀	3♀	7(3♀,1♂,3j)	6(2♂,4j)	5(2♀,3j)	4(2♂,2♀)	28	10.81
Phintella versicolor	3♂			4 (2♂,2 j)	2♂	3♀	12	4.63
Phintella debilis					1♂		1	0.39
Phintella sp. 1					3♀	6(3♀,3j)	9	3.47
Phintella sp. 2			1♀	2(1♀,1♂)			3	1.16
Plexippus paykulli		8(3♀,5j)	11(5♀,2♂, 4j)				19	7.34
Pristobaeus jocosus	4(2♀,2 j)	4(2♂,2 j)	5(2♀,3j)	4(3♀,1♂)	3♀	3♂	23	8.88
Rene sp.						1♂	1	0.39
Simaetha sp. 1			1♂	2♀			3	1.16
Simaetha sp. 2	2♀			1♂			3	1.16

Table 1. Continuation. Species Composition and Abundance of salticids collected from the six sampling sites.

Species	Area 1 Agroecosystem		Area 2 Secondary forest		Area 3 Closed canopy forest		Total	RA (%)
	Site 1 645 masl	Site 2 875 masl	Site 3 750 masl	Site 4 990 masl	Site 5 860 masl	Site 6 1080 masl		
Simaetha thoracica				4(2♀,2♂)	1♀	2♀	7	2.32
Thiania bhamoensis			2♂				2	0.08
Thiania subopressa						1♂	1	0.39
Thiania sp.			3(1♀,2♂)				3	0.77
Thorelliola sp.				2♀			2	0.77
Total number of individuals	19	30	55	72	35	48	259	
Total number of species per site	9	11	22	26	17	16	Total of **44 species**	
Total number of species per area	17 species		37 species		24 species			
Total number of adults and juveniles	12♀,5♂, 2j	18♀,5♂, 7j	26♀,19♂, 10j	36♀. 25♂, 11j	20♀,9♂, 6j	21♀,13♂, 14j	**133♀,76♂, 50j**	

Legend: ♀ - Female, ♂ - Male, j – juvenile

Table 2. Species richness and abundance of the six sites arranged according to elevation.

	645 masl A1S1	750 masl A2S3	860 masl A3S5	875 masl A1S2	990 masl A2S4	1080 masl A3S6
Total number of species per site	9	22	17	11	26	16
Total number of individuals	19	55	35	30	72	48

Legend: A1S1 – Agroecosystem Site 1; A2S3 – Secondary forest Site 3; A3S5 – Closedcanopy forest Site 5; A1S2 – Agroecosystem Site 2; A2S4 – Secondary forest Site 4; A3S6 – Closed canopy forest Site 6

Table 3. Biodiversity indices of the six sampling sites.

Biodiversity Indices	Area 1 Agroecosystem		Area 2 Secondary forest		Area 3 Closed canopy	
	Site 1 645 masl	Site 2 875 masl	Site 3 750 masl	Site 4 990 masl	Site 5 860 masl	Site 6 1080 masl
Taxa_S	9	11	22	26	17	16
Individuals	19	30	55	72	35	48
Dominance_D	0.1357	0.1356	0.08628	0.04591	0.07429	0.07812
Simpson_1-D	0.8643	0.8644	0.9137	0.9541	0.9257	0.9219
Shannon_H	2.087	2.194	2.771	3.163	2.711	2.647
Evenness_e^H/S	0.8954	0.8152	0.7264	0.9096	0.8851	0.8817

Table 4. Presence or absence of saliticid spiders in the identified microhabitats in WMSU-EFA.

Species Name	Microhabitats			
	Leaf surfaces or foliages	Leaf litter	Forest floor	Tree trunk
Bavia aericeps		■		
Bathippus sp. 1	■			
Bathippus sp. 2	■			
Brancus sp.	■			
Breda sp. 1		■		
Burmattus sp.		■		
Chalcoscirtus infimus		■		
Chalcotropis cf. caeruleus			■	
Cosmophasis sp.	■			
Euryattus sp.	■			
Evarcha bulbosa		■		
Habronattus decorus	■			
Harmochirus brachiatus			■	
Harmochirus sp. 1			■	
Harmochirus sp. 2	■		■	
Heliophanus sp.				
Heliophanus melinus	■			

Leikung sp.		■		
Malloneta guineensis	■			
Myrmarachne sp.	■		■	
Myrmarachne sp. 2	■		■	
Myrmarachne sp. 3	■		■	
Myrmarachne sp. 4	■		■	

Table 4. Continuation. Presence or absence of saliticid spiders in the identified microhabitats in WMSU-EFA.

Species Name	**Microhabitats**			
	Leaf surfaces or foliages	**Leaf litter**	**Forest floor**	**Tree trunk**
Opisthoncus parcedentatus	■			
Opisthoncus sp. 1		■		
Opisthoncus sp. 2		■		
Parabathippus sp.	■			
Portia sp. 1	■			■
Portia sp. 2	■			■
Phintella piatensis	■			■
Phintella versicolor	■			■
Phintella debilis	■			
Phintella sp. 1	■			
Phintella sp. 2	■			
Plexippus paykulli		■		
Pristobaeus jocosus	■			■
Rene sp.		■		
Simaetha sp. 1	■	■		
Simaetha sp. 2	■	■		
Simaetha thoracica	■			■
Thiania bhamoensis	■	■		
Thiania subopressa		■		
Thiania sp.		■		
Thorelliola sp.	■	■		

Legend: - Presence; ■ - Absence □

CONCLUSION

A total of 259 individuals comprising 44 species under 26 genera were documented in this study. Salticids from genus *Phintella* had the highest relative abundance, specifically the *P. piatensis* (10.81%)and *P. versicolor* (8.88%). Female salticids were numerically dominant comprising 51.4% of the total individuals. Diversity varied along different elevations, having different and unique species compositions. Area 2 (750 and 990 masl) which is a secondary forest recorded the highest species richness and abundance. Analysis of the diversity patterns revealed a monotonic decrease in species richness at elevations 750, 860, and 875 masl, which then peaked at mid elevation (990 masl), having the highest species richness, abundance, and diversity after which declined at 1080 masl thus depicting a hump-shaped pattern. Areas 2 and 3 recorded high species diversity while Area 1 had moderate diversity. High species richness and even distribution were recorded in all sites. Leaf litter and leaf surfaces/foliages were the most preferred microhabitats. However, aside from elevation, factors such as vegetation structure and habitat complexity contributed to the mid-peak elevational gradient in species richness and abundance. Biotic factors such as food availability and processes, together with humidity and temperature may have contributed influence as well.

As the salticid spider fauna of the Philippines remains poorly known despite the archipelago's vast biogeographical landscape, this study serves as baseline data for jumping spider species diversity especially in WMSU-EFA, Zamboanga City. The lack of taxonomic knowledge on Salticidae in the Philippines stresses the importance of future studies in this field.

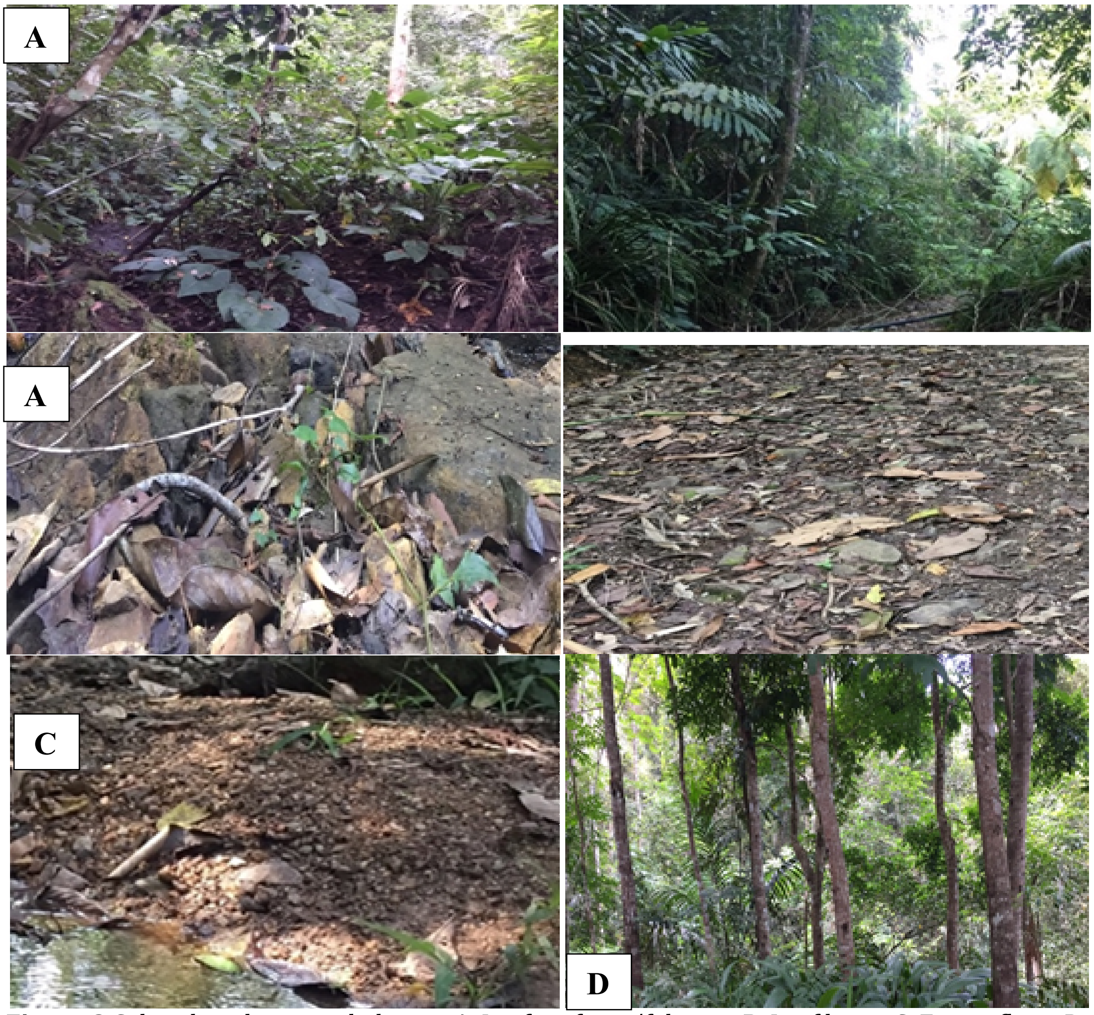

Figure 2. Salticid spider microhabitats; A. Leaf surfaces/foliages, B. Leaf litter, C. Forest floor, D. Tree trunk.

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