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CONTINUITY STUDY OF SPIDER DIVERSITY IN UNIVERSITI TEKNOLOGI MARA (UiTM) NEGERI SEMBILAN BRANCH, KUALA PILAH CAMPUS, NEGERI SEMBILAN, MALAYSIA

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Abstract

The data of the arachnids especially spider species in Malaysia are lacking due to the threats of the rainforest which is known to be the habitats of the species. Ninety-nine samples of spiders have been identified and documented in this study conducted in Universiti Teknologi MARA (UiTM) Negeri Sembilan Branch, Kuala Pilah Campus area with 11 families that consist of Araneidae, Corinnidae, Deinoppidae, Linyphiidae, Lycosidae, Oxyopidae, Pholcidae, Pisauridae, Salticidae, Sparassidae and Trachelidae. Sample collections were conducted at three different sites inside the campus using two different sampling techniques (active and passive). The highest abundance of spiders was in Site A (44%) but Lycosidae revealed to be the most abundant between the spider families. Site C had the uttermost diversity indices where Shannon-Wiener index, H' = 1.55, evenness index, E = 0.71 and richness index, RI = 8.70 due to 13 spider species spotted in the site. This study is in continuity with preliminary surveys done at Forest Reserve in UiTM Negeri Sembilan Branch, Kuala Pilah Campus with much longer sampling time period and it revealed that diversity increased to 23 genera collected from the whole campus area in present study as compared to 13 genera from previous study. The continuation of arachnid study is beneficial to the ecosystem to conserve the spider's species and habitats.

Keywords: Diversity, Abundance, Lycosidae, Spider, Arachnids

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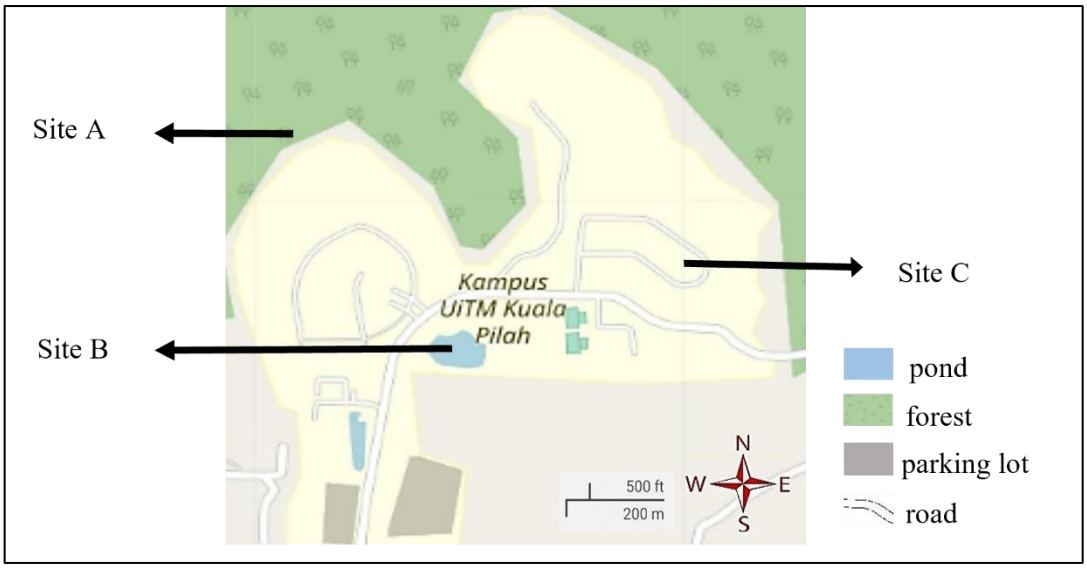
Introduction

Arachnids are publicly recognised as spiders although there are different species classified under the same class known as Arachnida. Myers (2020) stated that there are over 60,000 described species of arachnids in this large class Arachnida all over the world where the majority of the species reported is from the largest order of class Araneae. Order Araneae is generally acknowledged as spiders include 48,000 described species. According to Castanheira et al. (2016), spiders have variable lifestyles for the species to survive and adapt to the terrestrial environments as well as aquatic habitats to feast on prey as predators. So far, researchers have identified and recorded 49,583 spider species from 129 families over the years (World Spider Catalog, 2021). Lacked amounts of spider species in Malaysia was a concern because there were limited numbers of spider documented especially in Peninsular Malaysia as stated from the previous report of Dzulhelmi and Nasir (2016). In addition, the preliminary study at UiTM Negeri Sembilan Branch, Kuala Pilah Campus was only conducted in the forest but the diversity of the spiders was not discussed. This study

was the continuation of previous study at the campus in a much longer period to discover a greater number of arachnids based on the diversity indices and the abundance. Moreover, there were major threats towards the rainforests in Malaysia such as deforestation that resulted the habitat destruction of spider species in the ecosystem (Mokthsim, 2018; Potapov et al., 2019). Dzulhelmi and Nasir (2016) also stated that spider was least known in Malaysia because the study regarding to arachnids was neglected. Because of the concerning limited amounts of data recorded, this study of spider diversity was carried out at the campus due to the location that was situated near Hutan Pelangai Forest Reserve. The findings of the study could be beneficial for the future researchers and conservationist to acknowledge the status of the spider species in Malaysia.

Methods Study Area

The location of the study sites was in UiTM Negeri Sembilan Branch, Kuala Pilah Campus where three different sites involved for collection of spider samples (Figure 1). Site A (2°47′42″ N, 102°13′03″ E) was in the forest where a larger number of tall trees and denser canopy were found, site B (2°47′34″ N, 102°13′09″ E) surrounded with less number of trees and bushes and data collection was done near the pond and site C (2°47′38″ N, 102°13′20″ E) was situated in the building area with larger number of bushes, a moderate number of small trees in the surroundings and it was closely located to Hutan Pelangai Forest Reserve. Figure 1 was retrieved from Leaflet version 1.7.1 (2020), an open-source JavaScript library for the interactive maps. The spider samples collection was conducted during the day from 0800 h to 1200 h and during the evening from 1600 h to 1800 h. The duration of the study was carried on for six weeks from late March 2021 to early May 2021. The sample collection was repeated four times at each site respectively.



Source: Leaflet, (2020)

Figure 1. Map of UiTM Negeri Sembilan. Kuala Pilah Campus, Negeri Sembilan

Collection and identification of sample

Three methods were applied to capture the spider species as sample collection and to obtain the desired data with the intention of achieving the objectives of the study. These three methods were classified into two types of technique: active technique and passive technique. Net sweeping and direct hand picking were active techniques whereas pitfall trap was passive technique. Each study site had similar catch effort except pitfall trap which was only done in site A. For the first method, net sweeping. Net was used to sweep and capture the spiders. According to Gibb and Oseto (2006), the net rapidly swept through the vegetation to capture the specimen, followed by forcing the specimen into the net. The net was twisted to entrap the

specimen. The collected samples were then placed inside the plastic bottles and closed containers. Second method was direct hand picking. This method was the easiest because it did not require special equipment and it took a less time to collect the sample species with the help of bottles or small closed containers. Moreover, it was called active technique because the collection of the spider species not only took place in a location site but various location such as on the tree barks, on the bushes, on dead leaves of the floor, on the tree branches or even on the rocks. Last method used to carry out the study was pitfall trap. The trap buried in the ground with the opening of the trap as the same level of ground's surface covered with the dried leaves and other animals from entering the trap. The trap was filled with 70% concentration of ethanol. Spider species that wandered or moved on the ground fall into the trap and unable to get out of the trap.

In terms of identification of spider species, the spiders were distinguished from different sites by recognizing the morphology and characteristics differences between the spiders on the specific week and place respectively. The samples were submerged with 70% concentration of ethanol for preservation. The samples were then observed under a Olympus SZ51 stereo microscope and differentiated by recognizing the morphology and characteristics differences between the spiders under magnification with the range of 0.8x to 40x. The families of sample species were determined by observing the morphologies of spiders under the microscope. A book called "Common Malaysian Spider" written by Nasir and Su (2015) and a website with the title of "Spiders of Borneo, Spiders of Sabah, Malaysia" by Wong (2019) were mostly referred to identify spider species.

Result and Discussion

Evenness, Richness and Abundance of Arachnids (Order: Araneae) in UiTM, Negeri Sembilan Branch, Kuala Pilah Campus

Ninety-one samples of spiders collected from three main different sites in UiTM, Negeri Sembilan Branch, Kuala Pilah Campus. The spiders of 11 families which consists of Araneidae, Corinnidae, Deinoppidae, Linyphiidae, Lycosidae, Oxyopidae, Pholcidae, Pisauridae, Salticidae, Sparassidae and Trachelidae along with 23 genera were observed and recorded as referred to both Table 1.

As previously stated, this spider study was in the continuity with the preliminary study at UiTM Negeri Sembilan Branch, Kuala Pilah Campus based on the previous report of Dasran and Rahim (2021). The findings in the report were only discussed about the composition of spider based on the abundance of recorded spider species in the campus. The findings of the preliminary study revealed that there were 13 genera listed where Salticidae (53 total individuals) was the highest in numbers compared to other spider families such as Sparrasidae, Araneidae, Ctenidae, Eutichuridae, Oxyopidae and Pholcidae.

The spider family was found in both sites which the first site was the building area with moderate amounts of shrubs and the second site was the forest margin. The abundance of spider was also recorded that spiders found in the forest margin was more abundant compared to the building area. However, the recent findings were recorded and analysed with much longer sampling time which increased to 23 genera as the samples were collected from three different sites (Site A, Site B and Site C). In the contrast to the previous findings, Lycosidae was the largest spider family found based on Table 1 in the campus because the spiders were collected in the forest, near the pond and at the building area.

Shannon-Wiener Diversity Index, Evenness Index and Richness Index were applied to analyze the diversity of the spiders in campus from the different sites. Result shown in Table 1 that spider species influenced the diversity index. The highest Shannon-Wiener Diversity Index value was found at Site C (H'=1.55) compared to the index values at Site B (H'=0.58) which was the lowest Shannon-Wiener Index and Site A

(H'=1.36). The result seemed impossible because Site C was building area where only few spider species found in the building such as *Heteropoda* sp. from Family Sparassidae live in synanthropic habitats which closely together with humans in buildings compared to Site A was the forest with high abundance of higher trees and more denser canopy considered that various spider species could be discovered more. However, the building area of UiTM Negeri Sembilan Branch, Kuala Pilah Campus was positioned close to Hutan Pelangai Forest Reserve where a larger number of bushes and moderately small trees found were almost closely covered the surroundings where Site C was reasonable enough to be suitable habitat due to the number of vegetations and shrubs found in the building area as confirmed based on the report by Vasconcellos-Neto et al. (2017) and its easy access to detect and collect spider sample around the bushes and small trees instead of trees in a denser canopy. This result showed that number of individuals with less species led to slighter diversity of the arachnids because species of spiders influenced diversity index as total individuals recorded in Site A with 40 in total was higher compared to Site C with 29 total individuals collected but Site A had the lowest Shannon-Wiener Index (H'=1.36) due to 10 spider genera detected whereas the highest Shannon-Wiener Index was Site A (H'=1.55) with 13 genera of spiders were recorded in the site.

The contrast of the spider diversity in each site was indeed noted as the Evenness Index was calculated where Site C (E=0.71) dominated the index compared to Site A (E=0.70) and Site B (E=0.52). According to Ifo et al. (2016), various species consists of the same abundance will be resulted to equal 1 and the nearest to 0 is when the arachnids is concentrated to only one species. Site A and Site C almost had similar Evenness Index in the consequences of abundance of species reported in Table 1 where both respective sites were almost the same total of genera which Site A was 10 out of 23 genera recorded and Site C was collected for 13 out of 23 genera compared to Site B; four out of 23 genera only were reported. Thus, greater the abundance of species in an ecosystem led to a higher evenness of the species. Based on Table 1, Site B (E=0.52) was the most stunted because the evenness value was close 0 compared the other sites where *Pardosa* sp. (Family Lycosidae), *Oxyope*s sp. (Family Oxyopidae), and *Epeus* sp. and *Phlegra* sp. (Family Salticidae) were the only spider species found at the site.

As expected, the highest richness index value was R=8.70 from Site C whereas both of richness index values in Site A (R=6.73) and Site B (R=2.68) were least dominated in based on both Table 1. As it has been pointed out, the richness of spider species in the ecosystem influenced by the habitat and the sustainability for the arachnids to obtain their own needs to survive based on a report by Štokmane and Spungis (2016). The indices of diversity allowed to achieve the purpose of the study which is to determine the abundance, species richness and evenness of spider diversity in UiTM Negeri Sembilan Branch, Kuala Pilah Campus.

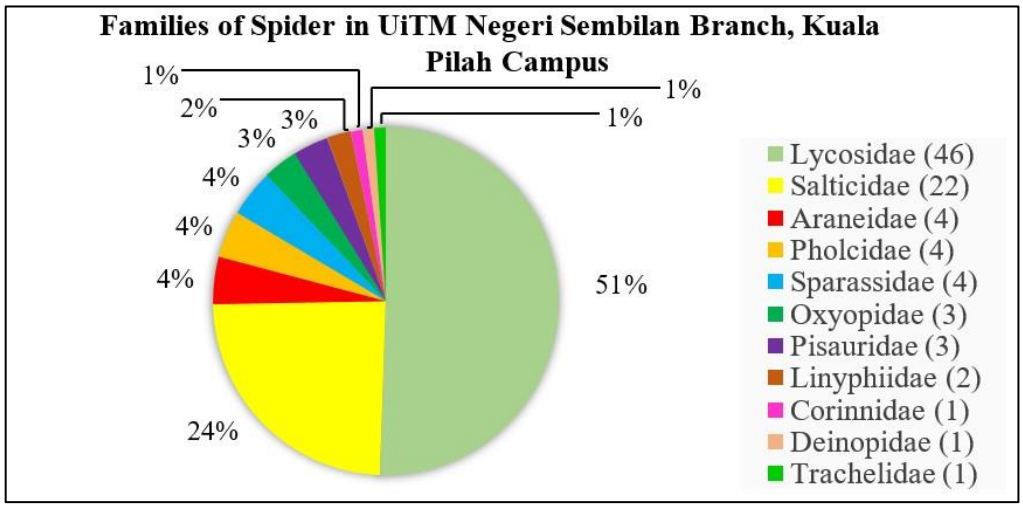


Figure 2. Recorded spider families in UiTM Negeri Sembilan Branch, Kuala Pilah Campus.

Table 1. Total Amount of Spider Families, Genera, Species, Individuals sampled and Diversity Index of Arachnids in UiTM Negeri Sembilan Branch, Kuala Pilah Campus

Families	Genera	Total Species	Site A	Site B	Site C
Araneidae	*Gasteracantha*	2	2	0	0
	Macracantha	1	1	0	0
	Neoscona	1	1	0	0
Corinnidae	*Castaponera*	1	0	0	1
Deinopidae	*Deinopis*	1	0	0	1
Linyphiidae	*Angulipgantes*	2	1	0	1
Lycosidae	*Pardosa*	46	24	18	4
Oxyopidae	*Oxyopes*	3	0	1	2
Pholcidae	*Crossopriza*	3	3	0	0
	Physocyclus	1	0	0	1
Pisauridae	*Hygropoda*	3	3	0	0
Salticidae	*Cosmophasis*	1	0	0	1
	Epeus	2	1	1	0
	Hasarius	8	0	0	8
	Myrmarachne	1	1	0	0

	Parabathippus	1	1	0	0
	Phlegra	2	0	2	0
	Portia	1	0	0	1
	Plexippus	4	0	0	4
Sparassidae	*Heteropoda*	2	0	0	2
	Sinopoda	2	2	0	0
Trachelidae	*Cetonana*	1	0	0	1
Total		91	40	22	29
Number of Genus			10	4	13
Shannon-Wiener Diversity Index			1.36	0.58	1.55
Evenness Index			0.70	0.52	0.71

Furthermore, the most fitting habitat of arachnids was determined from the number of spider species recorded in each site. Consistent with the habitat fitting, the data recorded led to identify the abundance of arachnids from Site A, Site B and Site C. Based on Figure 3, Site A in UiTM Negeri Sembilan Branch, Kuala Pilah Campus had the greatest percentage of abundance of spider (44%) compared to the percentages in Site B (24%) and Site C (32%) as a result of total individuals recorded. Although every species was obligated to inhabit in a respective ecosystem, it was undeniable that the forest was the most suitable habitat for the spiders because of diverse flora and fauna found were beneficial for the spiders to hunt prey or even to mate for the fitness. Based on Figure 3, the habitat of spider samples in Site A had the richest diversity of flora and fauna which led to different species of spiders to be found at the site consists of seven families and 11 genera whereas Site B had the lowest percentage of spider sample recorded (three families and four genera) due to the lack flora and fauna diversity.

This was because different variation of flora such as higher trees to smaller trees in size and abundant of bushes occupied in the forest canopy and a variety of fauna such as small vertebrates such as birds and mammals and invertebrates such as insects were included for spider to feast on present in Site A which resulted in the highest percentage of abundance of spider compared to Site B where lack of bushes and small trees were nearby the pond and a few amphibians such as frogs were seen to inhabit in that particular location. Most of the spiders were dependent to flora which acted as the shelter or even a hiding spot from the prey, the lack of food availability in the habitats caused the spiders to move to another area that had sufficient of prey to be consumed (Vasconcellos-Neto et al., 2017). Nevertheless, spiders in Site C (nine families and 13 genera) was the most diverse based on diversity index due to the location of the site in urbanized area that close to Hutan Pelangai Forest Reserve. Even though the abundance of spider recorded (32%) was higher in percentage compared to Site B but was lower in percentage compared to Site A because less total individual of spiders collected as shown in Table 1 as most of each species obtained was one individual.

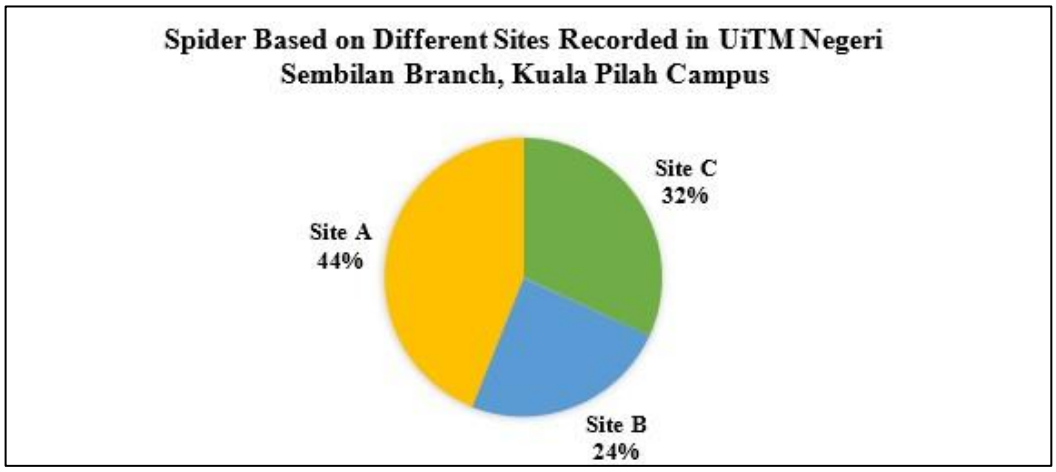
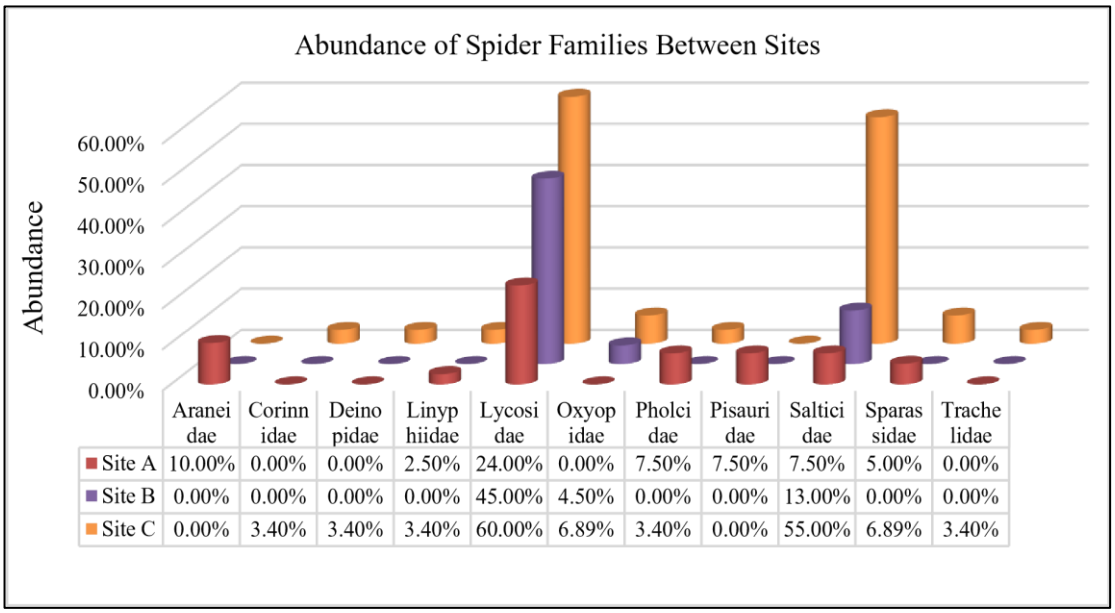


Figure 3. Abundance of Spider Based on Different Sites

Based on Figure.2, family Lycosidae had the highest number of spiders to be found in UiTM Negeri Sembilan Branch, Kuala Pilah Campus compared to the other spider families. 51% spiders from family Lycosidae itself among order Araneae had been identified. The abundance of spider of family Lycosidae occurred in both Site A (24%) and Site B (45%) as shown in Figure 4. Site A was located at the humid and dry forest and Site B was located near the pond. Both sites were favour by Lycosidae spiders due to their preference to hunt the prey in the wetlands area which was confirmed by Tietjen et al. (2017). There was also the occurrence of Lycosidae spiders in Site C (60%) as shown in Figure 4 but a few in amounts due to the unfavourable area where the urban ecosystem lack of wetland areas. In addition, family Salticidae contributed to the most various spider species found in the campus which nine out of 23 genera (*Cosmophasis, Epeus, Hasarius, Hyllus, Mymarachne, Parabathippus, Phlegra, Portia* and *Plexippus*) had the largest number of spider species based on Figure 4 where the abundance of Salticidae spiders in Site A recorded 7.50% of spiders, Site B for 13% and Site C was reported the highest percentage of Salticidae which was 55%. Genus *Hasarius* and genus *Plexippus* were the most genera identified among the other genera in family Salticidae as shown in Table 1 due to the behaviour of spiders to jump quickly to escape themselves from the predators and the distinctive morphological patterns of genera as shown in Figure 5. According to the previous study of Dasran and Rahim (2021), Salticidae spider also was the largest spider family recorded in UiTM Negeri Sembilan Branch, Kuala Pilah Campus. The reason family Salticidae was detected the most from different species due to the adaptation and the survival rate of the spiders with various patterns and morphological structures of species to inhabit in the broad range of different ecosystem which was stated from the previous study of Labanon and Nuñeza (2020).



	Aranei dae	Corinn idae	Deino pidae	Linyp hiidae	Lycosi dae	Oxyop idae	Pholci dae	Pisauri dae	Saltici dae	Sparas sidae	Trache lidae
Site A	10.00%	0.00%	0.00%	2.50%	24.00%	0.00%	7.50%	7.50%	7.50%	5.00%	0.00%
Site B	0.00%	0.00%	0.00%	0.00%	45.00%	4.50%	0.00%	0.00%	13.00%	0.00%	0.00%
Site C	0.00%	3.40%	3.40%	3.40%	60.00%	6.89%	3.40%	0.00%	55.00%	6.89%	3.40%

Figure 4. Abundance of Spider Families Between Sites.

(a)

(b)

Figure 5. (a) Genus *Hasarius* under 3x magnification of microscope; (b) Genus *Plexippus* under 3x magnification of microscope.

Conclusion

In conclusion, the study of spider diversity at UiTM Negeri Sembilan Branch, Kuala Pilah Campus discovered that there was various distribution of spider species identified and recorded inhabit in every location of the campus. The diversity of the spiders detected during the sampling was affected by the crowdness of vegetation in each site where higher the amount of vegetation, the more diverse of the species in the habitat. Based on the results and discussion, the highest abundance of spiders was in Site A (44%) but family Lycosidae revealed to be the most abundant between the spider families with 24% in Site A, 45% in Site B and 60% in Site C compared to the previous findings at the campus. However, the diversity index calculated in the analysis stated that Site C had the uttermost indices where Shannon-Wiener Index, H' = 1.55, Evenness Index, E = 0.71 and Richness Index, R = 8.70 due to 13 spider genera spotted in the site. The data of diversity of spiders in UiTM Negeri Sembilan Branch, Kuala Pilah Campus was analysed

with much longer sampling period although the identification of the spiders was only referred to the morphologies and patterns under a stereo microscope. Thus, it is suggested for researchers to do more research on spider study in UiTM Negeri Sembilan Branch, Kuala Pilah Campus with more advanced technologies to identify and determine the spider species in the future. Furthermore, this spider study encourages researchers to have interest to do more research on spiders in future and the study is essential for conservationist to conserve and preserve spiders' habitats from being threatened which can lead to species endangered in the future if there is no awareness regarding to the importance of spider diversity.

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