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Spider Assemblages in Rimba Ilmu Botanical Garden, Kuala Lumpur, Malaysia

(Himpunan Spesies Labah-labah di Taman Botani Rimba Ilmu, Kuala Lumpur, Malaysia)

M.N. DZULHELMI* & Y. NORMA-RASHID

ABSTRACT

The seasonal variation of spider assemblages in botanical garden was investigated. The spiders were manually collected by diurnal and nocturnal session between two seasons. A total of 19 families from 65 genera and 96 species were recorded. Richness-estimator indicates the inventory were 67% complete within the botanical garden. The capture rate for web-weavers were higher compared with non-web weavers. The comparison value showed the species composition and abundance were similar between seasons. Spider abundance was not affected between wet and dry season in tropical countries.

Keywords: Arachnida; botanical garden; diversity; Malaysia; spiders

ABSTRAK

Variasi kepelbagaian spesies labah-labah mengikut musim di taman botani telah dikaji. Labah-labah telah ditangkap pada waktu pagi dan malam dalam dua musim. Terdapat 19 famili daripada 65 genus dan 96 spesies telah direkodkan. Penganggar-Richness menunjukkan 67% telah pun selesai dikenal pasti di dalam taman botani ini. Penangkapan labah-labah yang membina jejaring adalah lebih tinggi jika dibandingkan dengan labah-labah yang tidak membina jejaring. Perbandingan jumlah komposisi dan limpahan adalah sama mengikut musim. Kelimpahan labah-labah tidak dipengaruhi oleh musim lembap dan musim kering di negara tropika.

Kata kunci: Arachnida; kepelbagaian; labah-labah; Malaysia; taman botani

INTRODUCTION

Spiders are among the most diverse and abundant invertebrate predators that inhabits the terrestrial ecosystem (Wise 1993). Their guild partitioning and composition are mostly responding to habitat structure and vegetation diversity (Hore & Uniyal 2008). Studies have shown that spider density and abundance have influence on pest populations (Rendon et al. 2006). Relatively, high abundance of spiders in an area for pest control is a requirement although the roles of different spider species are not well understood (Rendon et al. 2006). Rationally, an advantage of variation on spider species, size and prey capture strategies, spiders should be able to capture a wide range of pest that carry diseases and may be danger to human. It has been suggested for the use of spiders to suppress targets insect groups which can cause significant disease (i.e. *Aedes* mosquito) to avoid it from spreading (Maimusa et al. 2012). For example, web-weaves such as the genus *Cyclosa* and non-web weavers from the genus *Evarcha* and *Plexippus* (Maimusa et al. 2012) and ground hunters from the genus *Heteropoda* (Sulaiman et al. 1990) preys on *Aedes* mosquitoes as its preferred diets.

Meanwhile, spiders had also been a targeted group of predators that was suggested to be used as biological control agents to reduce crop damage and increase crop production in an agroecosystem (Greenstone & Sunderland 1999). The impact on agriculture would be more severe without the presence of such natural predators (Marc & Canard 1997). For example, web-weavers from the genus *Leucauge* and *Nephila* captured flying insects like Coleoptera (Noraina 1999) while non-web weavers from the genus *Passiena* hunt for caterpillars and plant hopper (Marc & Canard 1997) that are considered as pests. These information triggers the conscious on the importance of spider diversity and population close to human settlements which has added the bonus to reduce uncontrollable insects groups which had become a pest. Hence, preserving the spider diversity and population could limit the use of pesticides in botanical gardens. But, the lack of knowledge on spider diversity and abundance in botanical gardens hinder the potential use of spiders as potential biological control in areas with pest and disease problems. Therefore, there is an urgent need for baseline data on spiders in botanical garden in Malaysia. This study provides comprehensive quantitative information of spider diversity and abundance in Rimba Ilmu Botanical Gardens.

MATERIALS AND METHODS

STUDY AREA

The study area was mainly conducted at Rimba Ilmu Botanical Garden of University of Malaya (RIBGUM) with a 40-ha in size (Figure 1). This botanical garden is surrounded by a buffer zone within the university's campus and is the only systematically and scientifically organised botanic garden within the city of Kuala Lumpur (Wong & Mustapha 1997). More than a thousand species of plants classified to some 500 genera and over 160 families can be found at RIBGUM which is emerging as an important conservatory for indigenous plants (Wong & Mustapha 1997).

SAMPLING

The manual search method was conducted once a month by two collectors on wet season (Jan-Feb 2012) and dry season (Jun-Jul 2012) at the four RIBGUM sections - Bamburetum, Medicinal, Citrus and Citroid and Palmae. Spider collection was done during the day (1000-1200 h) and night time (2200-0000 h) to maximize the species richness. Since each section have different area size, the active manual sampling session were conducted for 2 h, respectively, for each session and was measured with a stopwatch (Hore & Uniyal 2008). The samples collected were identified using the morphospecies approach to the lowest taxa level wherever possible using the identification keys with the aid of illustrations notably by Dippenaar-Schoeman and Jocque (1997), Koh (1989), Murphy and Murphy (2000) and Ubick et al. (2011).

ANALYSES

Species-accumulation curve and estimation curves Chao 1 and Jacknife 2 were generated after 100 randomization of sample order using EstimateS 8.2 (Colwell 2009). Kruskal-Wallis test was performed to detect the significant differences of spiders captured between Rimba Ilmu sections. Mann-Whitney test was used to determine whether if there were any significant differences of total species collected between the four sections, spiders found between the day and night sampling and also between wet and dry season. The data were analyzed using the Minitab 16 software.

RESULTS

A total of 946 individuals represented 19 families, 65 genera and at least 96 species were caught at Rimba Ilmu (Figure 2). There were 16 families and 40 genera which are considered common (>0.5%) (Table 1). The spider diversity and abundance caught was not statistically significant between the Rimba Ilmu sections (Kruskal-Wallis test: H-value = 0.91, df = 3, p-value: 0.823 > 0.05). However, there are differences between the spider population occurring between the day and night time (Mann-Whitney test: p-value: 0.026 < 0.05). Although the capture rate for the web-weavers were much higher than the non-web-weavers for all sampling sessions, but the results does not show any significant differences in their abundance (Mann-Whitney test: p-value = 0.085 > 0.05) (Figure 4). The most dominant family for the web-builders is Araneidae (45.60%) which constitute nearly half of the communities. Meanwhile, the most abundance for the non-web builders is represented by the family Salticidae (19.18%), which make up one-fifth of the community while other families constitute less than 5% from totalled specimens (Figure 1). The pooled spider species-accumulation curve for Chao 1 and Jacknife 2 shows an ascending trend, indicating that more spider species are still yet to be discovered (Figure 3). From all the species collected, 32% are singletons and 10% are doubletons (Table 2). The ratio between observed and estimated species richness was 67%, suggesting one-third of species richness is still to be discover. In addition, spiders abundance were not affected between

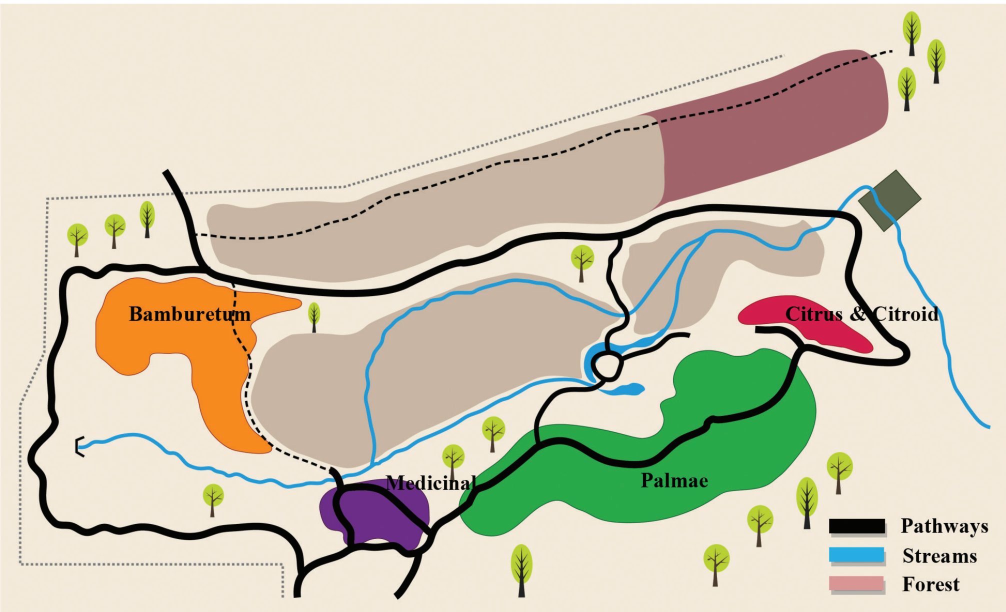

FIGURE 1. Map of Rimba Ilmu Botanical Garden (RIBGUM). The figure is not drawn to scale

TABLE 1. List of 16 families and 40 genera of spiders from RIBGUM. The list is restricted to genera which contributed >0.5% from total captured

Family	Genera	Bamburetum	Medicinal	Citrus	Palmae	% abundance
Araneidae	*Acusilas*	x	-	-	x	0.74
	Arachnura	x	x	x	x	2.54
	Araneus	x	x	x	x	6.24
	Argiope	x	x	x	x	4.12
	Cyclosa	x	x	x	x	9.94
	Cyrtarachne	-	x	-	x	2.01
	Eriovixia	x	x	x	x	6.77
	Heurodes	x	x	x	x	3.07
	Neoscona	x	x	x	x	1.16
	Poltys	x	-	x	-	0.64
	Pronous	-	x	x	x	0.85
	Zygiella	x	-	x	x	3.28
Clubionidae	*Clubiona*	x	x	-	x	0.85
Hersiliidae	*Hersilia*	x	x	-	-	0.63
Heteropodidae	*Heteropoda*	-	x	x	-	0.53
Miturgidae	*Cheiracanthium*	x	x	x	x	1.80
Oxyopidae	*Oxyopes*	x	x	x	-	0.95
Philodromidae	*Philodromus*	x	x	x	x	0.95
Pholcidae	*Smeringopus*	x	-	-	-	0.85
Psechridae	*Psechrus*	x	x	x	x	0.95
Salticidae	*Harmochirus*	x	x	x	-	0.63
	Myrmarachne	x	x	x		1.06
	Pancorius	x	x	x	x	1.59
	Phintella	x	x	-	x	1.27
	Plexippus	-	x	x	x	0.63
	Pystira	x	x	-	x	0.85
	Telamonia	x	x	x	x	4.97
	Viciria	-	-	x	-	0.53
Scytodidae	*Scytodes*	x	x	x	-	1.59
Tetragnathidae	*Leucauge*	x	-	x	x	1.69
	Tetragnatha	-	x	-	x	0.63
	Tylorida	x	x	x	-	1.90
Theridiidae	*Archaeranea*	x	x	x	x	5.29
	Argyrodes	x	x	x	-	2.43
	Chrysso	x	x	x	x	4.76
	Euryopsis	x	-	x	x	1.37
Thomisidae	*Amyciaea*	-	-	x	-	0.95
Uloboridae	*Miagrommopes*	x	-	x	x	1.59
Zodariidae	*Mallinella*	x	-	-	-	0.53
	Storena	x	-	x	x	0.95

the two seasons (Mann-Whitney test: p-value: $0.203 > 0.05$) (Figure 4).

DISCUSSION

The species richness of spider is relatively high for a 40-ha size area botanical garden. This was probably due to the diverse plant composition and vegetation stratification that provides heterogeneous microhabitat and niche for different spider species in Rimba Ilmu (Noraina 1999). Vegetation structure may influences spiders through a variety of biotic and abiotic factors i.e. structures for web building, level of shade covers, type of prey available, natural predators, intraguild predation, temperature and humidity (Wise 1993). The differences in vegetation structures at each section did not show much effect on spider abundance. However, the differences in spider diversity and abundance were merely influence between the day and night time for Rimba Ilmu. This was probably because different spider species are active and perform different hunting strategies at different time, which indicates that the food and space

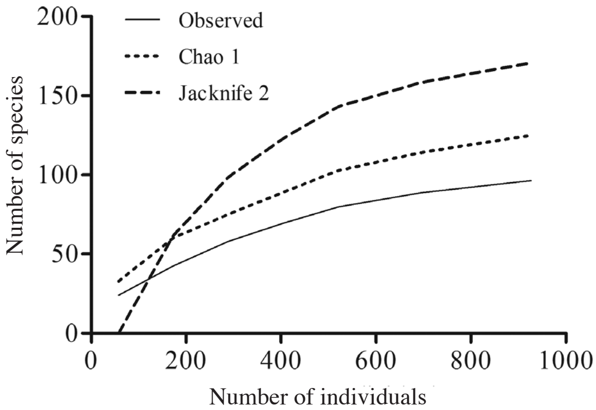

FIGURE 2. Species-accumulation curve and estimation curves Chao 1 and Jacknife 2 for pooled spiders species collected at RIBGUM

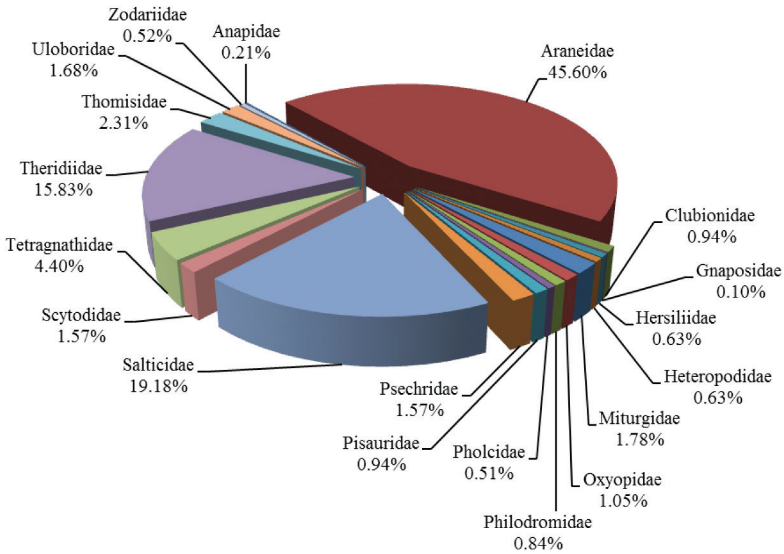

FIGURE 3. Relative abundance of different spider families collected at RIBGUM

TABLE 2. Spider diversity indices and inventory completeness for each RIBGUM sections. Richness-estimator values (Chao 1 and Jacknife 2) represents the mean for 100 randomization sample order. The completeness value (%) were the ratio from Chao 1 and observed richness

RIBGUM sections	Bamburetum	Medicinal	Citrus	Palmae	Total
No. of specimens	252	205	231	238	926
Observed richness	22	31	40	24	144
No. of singletons	9	9	21	16	46
No. of doubletons	4	12	7	3	15
Chao 1	32	34	72	67	215
Jacknife 2	38	59	75	45	243
Shannon index	2.91	3.26	3.27	2.86	4.41
Simpson index	21.68	30.16	21.89	16.89	62.61
Completeness (%)	69	91	56	36	67

resource partitioning may be achieved and competition avoided between different species (Marc & Canard 1997). Meanwhile, there were no differences in spider diversity and abundance between the dry and wet seasons. The constant in rainfall, temperature and humidity throughout the year offers consistent environment effect in tropical countries.

The Palmae section (36%) was far from species completeness because the Palmae section was the biggest in acre-size compared with others where some spider

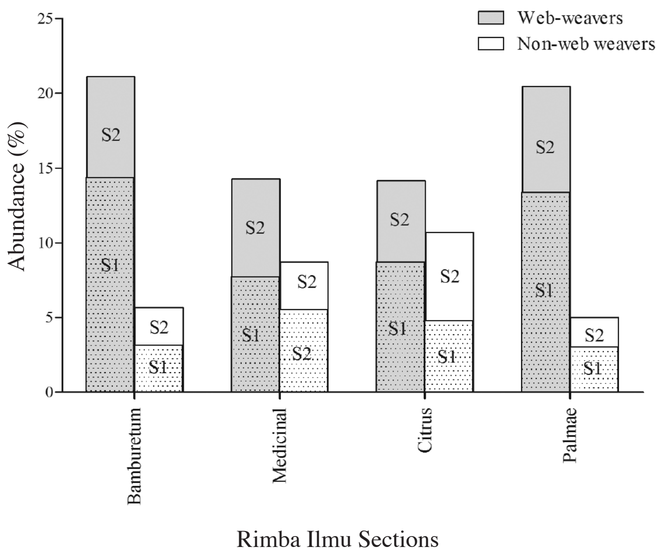

FIGURE 4. Abundance (%) of web-weavers and non-web weavers in RIBGUM. S1: sampling session 1; S2: sampling session 2

species might have occupied in-and-out from the sampling site making the overall species caught as a singleton or doubleton (Figure 4). Conversely, Medicinal section (91%) obtained the reach to completeness because the acre-size of the section is small and filled with undersized plants and are easier to access the whole section. Then again, Citrus and Citroid section (56%) was rather smaller than Bamburetum section (69%) in acre-size, but the tree were mostly covered with dense leaves. However, Bamburetum section mostly is occupied with long bamboo trees and less leaves where most spider species were found on the tree bark. Above all, the dominance of certain species were easily detected, while few cryptic species which tend to be more difficult to detect are less exposed to be encountered (Rendon et al. 2006).

Palmae and Bamburetum section have medium to higher trees but provide homogeneous niche for web-weavers to construct their web, though more space are available for non-web weavers at different stratification. This in turn results in high abundance for similar and dominant species because of the space availability but is lower in species richness. Meanwhile, Medicinal and Citrus and Citroid sections contain short to medium trees with dense leaves and provide heterogeneous niche for different spider species and thus provide higher species richness although it is lower in abundance. Wise (1993) stated that if one competitve dominant population increase, the less dominant population would decrease. Hence, this study could determine the type of structure of the spider community within a particular area even at small-scale level.

The high abundance for some dominant species was most probably related to their adaptation in favorable microclimate and adequate web support for these spiders (Rendon et al. 2006). This could be recognized for some spider species which occur in all sections namely Araneidae (*Cyclosa*, *Eriovixia*, *Araneus*, *Argiope*, *Zygiella* and *Heurodes*), Theridiidae (*Archaeranea* and *Chrysso*) and Salticidae (*Telamonia*) (Table 1). Web-weavers such as Araneidae, Tetragnathidae and Theridiidae construct their web with multiple attachment in-between leaves, branches and thorns on tree bark (i.e. *Onconsperma* spp.). Their presence were easier to detect by the mean of the web constructed which makes it rather visible because they do not move-about in-between leaves but rather stay on its web, although few web-weavers were found hanging on its silk without constructing any web structure.

Furthermore, web-weavers tend to construct web at niche which provide more leaves or thorn cover which would protect them from adverse weather effect, predators but at the same time provide them with adequate food sources (Noraina 1999). They construct webs and practice 'sit-and-wait' strategy to capture their prey and mostly aim for flying insect such as mosquito and flies which are highly abundant in the Rimba Ilmu (Noraina 1999). This is because the area have a stream providing a breeding site for these insects. Most web-weavers depend largely on few prey species group but are available in high numbers (Nyffeler 1999). Thus, it is common to find web-weavers such as Araneidae and Tetragnathidae at places with high abundant of mosquitoes and other flying insects as their most preferred food source (Noraina 1999).

On the contrary, the non-web weavers were difficult to detect due to their 'hunting' strategy, freely running in-between bark and leaves as a mean to capture their prey, indicating their capability and a better chance to find suitable food sources within extensive area (Nyffeler 1999). If detected, especially while using the flashlight during the night sampling, some of these non-web weavers tend to run into the available cavities which made it difficult to capture or to determine the species. Nonetheless, non-web weavers tend to be low in abundance in a particular area mainly due to their cannibalism habits (Nyffeler 1999). If the non-web weavers encounter other non-web weavers by chance, the larger and faster individual will overpower and eat the other individual opportunistic and not by target (Jackson 1992). Some non-web weavers were mainly captured while they were not alert especially while feeding on the insects. It could be concluded that if the number of dominant species were higher, then the number of rare species would be lower within the area.

Conclusion

This study provides a checklist of genus comprising 16 families and 40 genera that are considered common (>0.5%) in RIBGUM. The totaled estimated species richness suggested only 67% with 32% singletons and 10% doubletons from species completeness. It is important to document and maintain the spiders data and increase their efficiency to act as natural pest control along with the decrease of pesticide usage against a variety of pests, as they are more effective towards the development stage and life cycle of the pests. The authority should consider the role of spiders as a key to biological control in decreasing pests and maintain the botanical garden. Since the information on the spider species in Malaysia is still scarce, future studies on the ecological-guild and prey-specific should be conducted to comprehend the significant role of the spider fauna in botanical gardens.

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Institute of Biological Science
Faculty of Science, University of Malaya
50603 Kuala Lumpur
Malaysia

*Corresponding author; email: dzul_3my@yahoo.com

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