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LISTS OF SPECIES

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First data on spiders (Arachnida: Araneae) from dry dipterocarp forests of Thailand

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Abstract: Faunistic records of spiders in dry dipterocarp forests of Thailand are presented. Spiders were surveyed from November 2008 to December 2012. A total of 1,926 spider individuals were collected from 16 locations by visually searching, sweeping grasses and herb vegetation, beating shrubs and trees, and shifting leaf litters. Spiders were identified to 106 species in 86 genera of 29 families. The families Araneidae, Salticidae, Thomisidae, Tetragnathidae, and Theridiidae exhibited higher species richness. Several families that are rare and poorly known in Thailand were recorded, such as Stenochilidae, Eresidae, Idiopidae, Theraphosidae, and Nemesiidae. A faunistic overview of the spiders found in dry dipterocarp forest is presented. In general, the diverse composition of spiders and their guilds and the occurrence of rare and poorly known species in the Thai region confirm the high biotic value of dry dipterocarp forests. Continuing to maintain dry dipterocarp forest functions should be considered in future studies.

Key words: tropical forest; faunistics; biodiversity; Southeast Asia

INTRODUCTION

Dry dipterocarp forests occur naturally only in dry sites on the mainland of Southeast Asia: Vietnam, Laos, Cambodia, Thailand, Burma, and a small area of northeastern India (Murphy and Lugo 1986; Sist et al. 2003). This type of forest is identified by four characteristic Dipterocarpaceae tree species: *Shorea obtusa* Wall, *S. siamensis* Miq., *Dipterocarpus obtusifolius* Teysm., and *D. tuberculatus* Roxb. Dry dipterocarp forests are found where there is a monsoon climate with a 5 to 6 month marked dry period and where the total amount of rainfall ranges from 1,000 mm to 1,500 mm per year (Ashton 1983). In Thailand, dry dipterocarp forest is the most extensive forest type. It covers about 45% of the country's total forested area. This forest type occupies dry sites in northern, northeastern, eastern, and western parts of the country where the elevation ranges from 150 m to 1,300 m above sea level, but the Dipterocarpaceae are generally more common at elevations below 1,000 m (Bunyavejchewin 1983; Murphy and Lugo 1986). Although variations in this habitat type in Thailand in terms of both conditions and elevation may provide a potential high diversity of spiders, little information about the spider fauna in the dry dipterocarp forests of Thailand has in fact been reported (Deeleman-Reinhold 2001; Murphy and Murphy 2000). Although the araneofauna of the Indochina region is beginning to be better explored—mainly in evergreen forests, agricultural fields, and mountain forests (e.g., Jäger 2007; Jäger and Praxaysombath 2009, Jäger and Dankittipakul 2010; Jäger and Praxaysombath 2011)—arachnologists have rather neglected spiders in the dry dipterocarp forests of Thailand (Deeleman-Reinhold 2001).

This study aims to make a preliminary investigation of the diversity of spiders in Thailand's dry dipterocarp forests. Until now, only 480 species of spiders have been found from areas of Thailand during arachnological surveys in recent decades (World Spider Catalog 2016). Therefore, we anticipate that the recorded faunistic findings will significantly extend the knowledge of forest araneofauna in Thailand.

MATERIALS AND METHODS

Study sites

The study was carried out across Thailand mainland area. Study sites were spread across 16 locations within dry dipterocarp forests in Thailand (Figure 1; Table 1). We gathered spider data, once for each study site, from November 2008 to December 2012 (particular sampling dates for every location are showed in Table 1). A handheld Global Positioning System receiver (Garmin Oregon 450) was used to determine the precise geographical

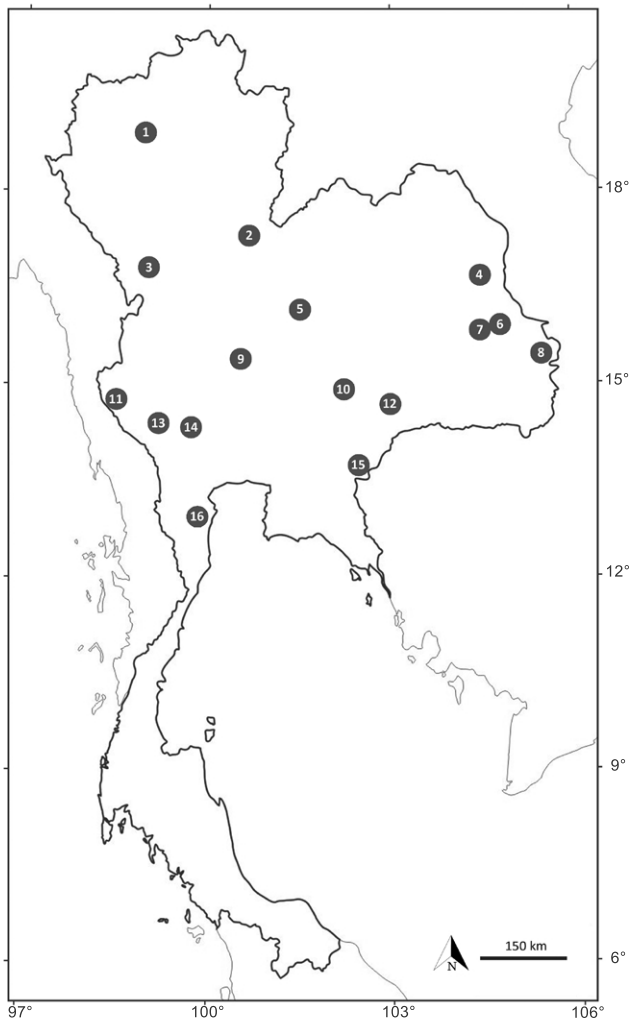

Figure 1. Map of sampling sites situated across 16 dipterocarp forest locations in Thailand (see Table 1 for locality identification and coordinates according to numbering).

location and the altitude of each study location (Table 1). Examples of some study habitats of dry diptercarp forests are shown in Figure 2.

Data collection

Four different sampling techniques, visual-searching, sweeping-net, litter sampling, and beating of shrubs and branches of trees, were used at each site to access different microhabitats, whether on plants, on the ground, or in leaf litter, as well as those spiders hiding within the specific area at each location within the transect 4 m wide and 50 m long. The sampled transects were located roughly in the centers of the forest stands. All studied forest stand of dry dipterocarp forests were not affected by tree logging and has stable semi-natural conditions without any artificial disturbances. The visual-searching method for collecting of spiders is synonymous with the "looking up" and "looking down" methods of Coddington et al. (1991) and it was used at night during 19:00–21:00 and in daylight during 06:00–09:00. The sweeping-net and beating methods were adopted from Toti et al. (2000) and Cardoso et al. (2009). The sweep-net had a diameter of 40 cm and was fitted with a heavy cloth suitable for sampling spiders in vegetation. We conducted 100 sweeps along the sampling transect in every study locations. The litter sampling method was carried out in randomly selected five patches along the sampling transect using a sieve with openings 1 cm in diameter. All collected specimens were stored in 70% ethyl alcohol in labeled glass vials.

Species identification

All adult spider specimens were identified to family and species using existing identification keys wherever possible (Tikader 1980, 1982; Barrion and Litsinger 1995; Daxiang et al. 1999; Murphy and Murphy 2000; Deeleman-Reinhold 2001; Jocqué and Dippenaar-Schoeman 2006; Jäger and Praxaysombath 2011). We used the hunting strategies proposed by Cardoso et al. (2011) to show guild structure of spiders in dry dipterocarp forests. The hunting strategies are sensing-web

Table 1. List of selected study locations with coordinates, altitude and sampling dates.

No.	Location	Province	Latitude	Longitude	Altitude	Sampling date
1	Mae Rim	Chiang Mai	18°53′16.05″ N	098°51′49.15″ E	858	3 Nov. 2008
2	Chattrakarn	Phitsanulok	17°17′09.88″ N	100°31′53.00″ E	243	20 May 2010
3	Muang Tak	Tak	16°51′27.46″ N	099°03′12.99″ E	169	5 Dec. 2010
4	Phu Pha Zan	Mukdahan	16°38′51.42″ N	104°22′19.80″ E	502	31 Mar. 2011
5	Phu Peng	Chaiyaphum	16°09′40.12″ N	101°29′27.89″ E	482	21 Aug. 2011
6	Sangthonoi	Amnat Charoen	15°39′31.78″ N	104°28′12.31″ E	150	12 Aug. 2011
7	Koh Wang	Yasothon	15°22′23.96″ N	104°20′13.60″ E	130	12 Aug. 2011
8	Vern Buk	Ubon Ratchathani	15°18′17.81″ N	105°30′02.99″ E	132	6 Dec. 2012
9	Takli	Nakhon Sawan	15°17′07.49″ N	100°25′43.44″ E	305	23 Oct. 2010
10	Sakaerat	Nakhon Ratchasima	14°40′08.29″ N	101°56′43.88″ E	328	13 Sep. 2012
11	Huay Khayeng	Kanchanaburi	14°30′34.94″ N	098°31′12.24″ E	356	1 Jan. 2009
12	Pakum	Burirum	14°29′13.85″ N	102°44′11.79″ E	220	8 Aug. 2011
13	Sai Yok	Kanchanaburi	14°06′50.44″ N	099°07′12.11″ E	125	20 Apr. 2011
14	Phra Tan Dongrang	Kanchanaburi	14°01′47.82″ N	099°47′02.57″ E	26	25 Apr. 2011
15	Wattana Nakhon	Sa Kaeo	13°53′16.19″ N	102°28′50.88″ E	114	8 Aug. 2011
16	Huay Sai	Phetchaburi	12°42′57.62″ N	099°53′40.21″ E	139	6 Dec. 2011

Figure 2. Examples of selected locations: interiors of dry diptercarp forests. **A**. Forest stand in location Phu Pha Zan during rainy season (31 March 2011). **B**. Forest stand in location Sakaerat during dry season (9 November 2013). **C.** Forest stand in location Sangthonoi during spider survey of 12 August 2011 (wet season). Photos: P. Wongprom (A, C); O. Košulič (B).

weavers, sheet-web weavers, space-web weavers, orb-web weavers, ambush hunters, other hunters, ground hunters, and specialists (Cardoso et al. 2011)

Due to a lack of available identification keys for many families and the time required for conventional taxonomic work, a morphospecies approach was used to classify hardly identifiable species of spiders. Moreover, because of the difficulty involved in identifying juveniles, juvenile specimens were excluded from the determination and faunistical evaluation. Nomenclature and arrangement of families, genera, and species follow the most recent version of the World Spider Catalog (2016).

Voucher specimens (including identified adults and morphospecies unidentified to the species level) are deposited for further examination in the public collection of the Thailand Natural History Museum (Prathum Thani, Thailand). Samples are available on request at curator of Thailand Natural History Museum (Dr. Weeyawat Jaitrong) and at first author of this study (Prasit Wongprom).

RESULTS

From November 2008 to December 2012, 1,926 individuals belonging to 106 species, 86 genera, and 29 families were collected and determined across the 16 studied dipterocarp forest localities (Tables 2 and 3). Araneidae was the most species-rich family in this study with 28 species (26%) in 16 genera. Salticidae was the next most species-rich family with 22 species (21%) in 18 genera. Thomisidae (9 species; 8%) Tetragnathidae (6 species; 6%), and Theridiidae (5 species; 5%) were the next three major families in this ecosystem. Several families that are rare and poorly known in Thailand were recorded, such as the Stenochilidae (*Colopea* sp.), Eresidae (*Stegodyphus tibialis* [O. P.-Cambridge, 1869]), Idiopidae (*Prothemenops* sp.), Theraphosidae (*Cyriopagopus minax* [Thorell, 1897]), and Nemesiidae (*Damarchus* sp.).

A higher number of species in some genera found across different collecting locations were expected, especially in the wide geographical range of our study, but the identity of some species could not be defined, as some genera are taxonomically poorly known. These include specimens from the families Linyphiidae (*Atypena* spp.), Lycosidae (*Hippasa* spp.), Oonopidae (*Ischnothyreus* spp.), Theridiidae (*Dipoena* spp.), Zodariidae (*Mallinella* spp.), and Ochyroceratidae (genus undetermined). All voucher specimens are fully accessible at the deposition in museum for further studies.

Table 2. Summary of families with guild characteristic in dry dipterocarp forests of Thailand.

Family	No. of genera	No. of species	No. of individuals	Guild
Araneidae	16	28	540	Orb web
Clubionidae	1	1	5	Other hunters
Corinnidae	1	1	15	Ground hunters
Eresidae	1	1	4	Sheet web
Eutichuridae	1	1	7	Other hunters
Gnaphosidae	1	1	6	Ground hunter
Hersiliidae	1	1	8	Sensing web
Idiopidae	1	1	2	Sensing web
Linyphiidae	2	2	26	Sheet web
Lycosidae	1	1	27	Ground hunters
Nemesiidae	1	1	3	Sensing web
Nephilidae	3	4	112	Orb web
Ochyroceratidae	1	1	12	Sheet web
Oonopidae	1	1	17	Ground hunters
Oxyopidae	2	3	70	Other hunters
Pholcidae	1	1	21	Space web
Pisauridae	1	1	24	Sheet web
Psechridae	2	2	40	Sheet web
Salticidae	18	22	388	Other hunters
Scytodidae	1	1	9	Other hunters
Selenopidae	1	1	6	Ambush hunters
Sparassidae	2	2	88	Other hunters
Stenochilidae	1	1	5	Ground hunters
Tetragnathidae	4	6	159	Orb web
Theraphosidae	1	1	3	Sensing web
Theridiidae	5	5	106	Space web
Thomisidae	8	9	136	Ambush hunters
Uloboridae	3	3	37	Orb web
Zodariidae	3	3	50	Specialist

Table 3. Checklist of spider species and their abundances recorded in study location of dry dipterocarp forests. Families are sorted in alphabetic order.

Taxon	Mae Rim	Muang Tak	Koh Wang	Dong Yai	Vern Buk	Phu Pha Zan	Phu Peng	Huay Khayeng	Sai Yok	Huay Sai	Wattana Nakhon	Sakaerat	Pakum	Phra Tan Donrang	Takli	Chattrakarn	Total abundance
Araneidae																	
Acusilas coccineus Simon, 1895	2		3	5	2	2	2	4	1			3	2	2	2	3	33
Acusilas malaccensis Murphy & Murphy, 1983								3	2								5
Anepsion japonicum (Bösenberg & Strand, 1906)	1			1	1	1		2	3	2		2			2	2	17
Arachnura sp.	1							2							3		6
Araneus mitificus (Simon, 1886)	4	2	1	4	2	1	1	3	2	2	1	2		1	2	2	30
Argiope aemula (Walckenaer, 1841)										1		3		1	1	1	7
Argiope catenulata (Doleschall, 1859)				2	1	1		7	1	1	1	2		1	3	1	21
Argiope dang Jäger & Praxaysombath, 2009	3	1		2	1		1	2				1	1			1	13
Argiope pulchella Thorell, 1881												2					2
Caerostris sumatrana Strand, 1915								2	2	1		1			1	1	8
Cyclosa bifida (Doleschall 1859)	6	5	2	2	3	7	2	2	4	2	2	5	2	1	3	3	51
Cyclosa insulana (Costa, 1834)	4	2	2	2	2	2	3	4	2	1	1	1	3	2	4	2	37
Cyclosa mulmeinensis Thorell, 1887		2	2						1		1	1		1	1		9
Cyrtophora beccarii (Thorell, 1878)		1			1		1		1	1					1	2	8
Cyrtophora cicatrosa (Stoliczka, 1869)	2	1	1	1				4	2	3		2			1	1	18
Cyrtophora citricola (Forsskål,1775)		1		1			2	2	1	1		1			1	2	12
Cyrtophora moluccensis (Doleschall, 1857)		1		1	1	3	2	4	2	1						1	16
Cyrtophora unicolor (Doleschall, 1857)	2	1	1	1	2	1	2	2	2	2	2	2	1	2	1	3	27
Eriovixia laglaizei (Simon, 1877)	1		2	4	1	1	1	2	3	2	1	2	2	2	1		25
Gasteracantha diadesmia Thorell, 1887	5	2		1	2	1		4	4	2	2	4		1		2	30
Gasteracantha hasselti C. L. Koch, 1837	2	2	1	4	3	3	2	5	2	2	2	4	2	2	3	1	40
Gasteracantha kuhli C. L. Koch, 1837	3	4	1	3	2	2	3	3	3	3	1	2	2	2	1	3	38
Gea spinipes C. L. Koch, 1843	1	2	1	2	1		1	2	2	1	1	5	1	2	2	1	25
Larinia phthisica (Koch, 1871)	1		1	3	1		1	3	1	1	1	3	1	1	1	1	20
Neoscona vigilans (Blackwall, 1865)	1	1					1		3		1	2		1	2		12
Poltys columnaris Thorell, 1890		1			1			1	1			1		1	1		7
Thelacantha brevispina (Doleschall, 1857)	2							2	1				1				6
Clubionidae																	
Clubiona sp.		1					1		1			1			1		5
Corinnidae																	
Castianeira sp.				1		1	2	1	2	2	1	1		1	2	1	15
Eresidae																	
Stegodyphus tibialis (O. P.-Cambridge, 1869)										1		3					4
Eutichuridae																	
Cheiracanthium sp.	1					1		2	1	1		1					7

Continued

Table 3. *Continued.*

Taxon	Mae Rim	Muang Tak	Koh Wang	Dong Yai	Vern Buk	Phu Pha Zan	Phu Peng	Huay Khayeng	Sai Yok	Huay Sai	Wattana Nakhon	Sakaerat	Pakum	Phra Tan Donrang	Takli	Chattrakarn	Total abundance
Gnaphosidae																	
Hitobia sp.								1	1	1		1			1	1	6
Hersiliidae																	
Hersilia asiatica Song & Zheng, 1982	1		1	1				1				3		1			8
Idiopidae																	
Prothemenops sp.												2					2
Linyphiidae																	
Atypena spp.				4				2			1	2			1	1	11
Neriene macella (Thorell,1898)	1	2		2	1	1	1	1	2		1	1		1	1		15
Lycosidae																	
Hippasa spp.			1	2	2	2	2	3	1	2	2	2	2	2	2	2	27
Nemesiidae																	
Damarchus sp.								1				1		1			3
Nephilidae																	
Herennia multipuncta (Doleschall, 1859)	2	2		2	2	1	1	2	2	1		1	1		2	1	20
Nephila antipodiana (Walckenaer, 1841)				1		1		2	2			4			1		11
Nephila pilipes (Fabricius, 1793)	3	2	3	5	3	2	3	4	3	2	1	11	2	2	1	3	50
Nephilengys malabarensis (Walckenaer, 1842)	1	1	2	6	3	2	2	5	3	1		3	2	2	2	1	36
Ochyroceratidae																	
Unidentified sp.	1							3	1			2		1	2	2	12
Oonopidae																	
Ischnothyreus spp.	2	1				1	2	1			2	4	1	1	1	1	17
Oxyopidae																	
Oxyopes javanus Thorell, 1887	1	1	3	1	1	1	3	9	3	4	2	4	3	3	4	5	48
Oxyopes lineatipes (C. L. Koch, 1847)		1	1		1	2	1	2	1	2		3		1		1	16
Peucetia viridana (Stoliczka, 1869)			1	2		1		1		1		2	1		1	1	11
Pholcidae																	
Leptopholcus borneensis Deeleman-Reinhold, 1986	3	2	1	1	1	2		2	1			4	2		1	1	21
Pisauridae																	
Perenethis venusta L. Koch, 1878	1	1	3	1	1	2	1	2	1	3	1	1	1	1	3	1	24
Psechridae																	
Psechrus sp.	1				1			3	2	1		1			1		10
Fecenia sp.	2	1	2	2	1	1	2	2	1	2	2	4	1	2	3	2	30
Salticidae																	
Bavia sexpunctata (Doleschall, 1859)		1	1	1			1	1		2				2	1	2	12
Burmattus pococki (Thorell, 1895)	1	1	1	2			1	1		1		2		2		1	13
Cosmophasis thalassina (C.L.Koch, 1846)	1	1		2					1	3	2	1				1	12
Epeus flavobilineatus (Doleschall, 1859)	1	1							1	2		1		2	2	1	11
Evarcha flavocincta (C. L. Koch, 1846)	1			1	2		2		3	1	1		1	1	1		14
Harmochirus cf. *brachiatus* (Thorell, 1877)		1		1				1	1	2	1		1		3		11
Hasarius adansoni (Audouin, 1826)	1	1	1		4			1		1	1	1	2				13
Hyllus diardi (Walckenaer, 1837)		1	1	1		1		1		2		2			2		11
Menemerus bivittatus (Dufour, 1831)	1	1	2	1	5		2	3	2	3	1	2		2	1	1	27
Myrmarachne maxillosa (C. L. Koch, 1846)	2			1			1	1	1			1	1			2	10
Myrmarachne plataleoides (O. P.-Cambridge, 1869)	2		1	2		2	1	1	1	1		1	1	1	1		15
Pancorius magnus Zabka, 1985	1	1						1	2	2				2	2		11
Phaeacius malayensis Wanless, 1981		1		1	1		1	2	1	1	1	1		2		1	13
Phintella versicolor (C. L. Koch, 1846)	1	1	1	1	3	1	2	3	4	2	3	5	1	1	1	1	31
Phintella vittata (C. L. Koch, 1846)	1	1	2	1	10	1	3	5	2	3	2	4	2	1	3	2	43
Plexippus paykulli (Audouin, 1826)	1	2	2	3	2	1	1	1	4	2	1	3	1	2	2	1	29
Plexippus petersi (Karsch, 1878)	3	1	4	5	2	2	4	2	2	1	2	6	2	1	1	2	40
Portia labiata (Thorell, 1887)	1	1	1	1		3	1	3	1		1	2		2	3	2	22
Rhene flavigera (C.L. Koch, 1848)			1			1		2	1	1		1	1	1	2	1	12
Siler semiglaucus (Simon, 1901)	2			1	1			2	1	1		1	1	1	1	2	14
Telamonia dimidiata (Simon, 1899)	1		1	1	1			1	1	1		2	1	1	1	1	13
Thiania bhamoensis Thorell, 1887	2			2	1		1	1		1	1	2	2		3		16

Continued

Table 3. *Continued.*

Taxon	Mae Rim	Muang Tak	Koh Wang	Dong Yai	Vern Buk	Phu Pha Zan	Phu Peng	Huay Khayeng	Sai Yok	Huay Sai	Wattana Nakhon	Sakaerat	Pakum	Phra Tan Donrang	Takli	Chattrakarn	Total abundance
Scytodidae																	
Scytodes lugubris (Thorell, 1887)	1			2				2				3			1		9
Selenopidae																	
Siamspinops sp.				1	1	1	1					1				1	6
Sparassidae																	
Olios sp.	1	1	3	2	1	2	2	3	1		3	2	1	2	2	2	28
Heteropoda venatoria (Linnaeus, 1767)	3	4	5	6	2	3	1	4	10	2	4	6	3	2	5	5	65
Stenochilidae																	
Colopea sp.												2			3		5
Tetragnathidae																	
Leucauge decorata (Blackwall, 1864)	4	2		4	2		4	3	3	2	2	2	3	4	3	1	39
Leucauge tessellata (Thorell, 1887)	2	1	1	1	2	1	2	5	1	1		3		2	2	2	26
Opadometa fastigata (Simon, 1877)	2	3	1	2	1	1	2	6	2	3		4		1	1	2	31
Tetragnatha hasselti Thorell, 1890	2	1	1	3	2	1	1	3		1	2	2	1	1	3		24
Tetragnatha maxillosa Thorell, 1895		2	1	2	1	1	2	3	1		1	3	1	2	1	1	22
Tylorida striata (Thorell, 1877)		1		4			4	9	1	1			1	1	1	1	24
Theraphosidae																	
Haplopelma albostriatum (Simon, 1886)					1	1								1			3
Theridiidae																	
Achaearanea sp.	1	1	1	4			2	1		1	2	1	1		1	1	17
Argyrodes flavescens Pickard-Cambridge,1880	2		1	2			1	3	3	3		3		1		2	21
Chrysso sp.		1		3	1		2	1	1	1	2	2			1	1	16
Dipoena spp.	2		1	6	2			3	2	1		5			1	2	25
Episinus sp.	3	1	2	4	1			2			2	6	1	1	2	2	27
Thomisidae																	
Amyciaea forticeps (O. P.-Cambridge, 1873)	1	2	2	2		1		2	2	1	1	2		1	1	2	20
Angaeus rhombifer Thorell, 1890	1	1		1			2	1		3	1	1		1	1	1	14
Camaricus formosus Thorell, 1887	2	1		2		1	2	2	1	1	2	3		2	2	1	22
Misumenops sp.		1		1			1	1		2	1	1	1	1	1	1	12
Oxytate sp.		1	1	1			1	1	2	1		1	1	1	3	2	16
Runcinia acuminata (Thorell, 1881)	1		2	1	1	1	3	1		1	2	1	1	2	1		18
Runcinia albostriata Bösenberg & Strand, 1906	1	1	1	2	1	1	2	2		1	2		2	1	2	1	20
Thomisus stoliczkai (Thorell, 1887)				1				2	1		1	3					8
Tmarus sp.	1		1	1	1			1	1			1					7
Uloboridae																	
Miagrammopes sp.	1	1	1	1	1	1	3	2				2		1			14
Philoponella raffrayi (Simon, 1891)	1	1	1	1	2	2	1				1	2		1			13
Uloborus sp.								1	1		2	3		1	1	1	10
Zodariidae																	
Asceua sp.	1			1			1	1	1	2		2			2	1	12
Mallinella spp.	1	1	1		1			1	1	1	1	2		1	3	1	15
Storenomorpha sp.			3	2			2	2	2			5			5	2	23
Total abundance	**118**	**88**	**85**	**161**	**100**	**76**	**109**	**216**	**140**	**115**	**79**	**225**	**68**	**97**	**146**	**114**	**1926**

The recorded spiders can be divided into eight functional groups based on their foraging behavior in the field (Cardoso et al. 2011). The most species-rich guild of dry dipterocarp forest spiders was that of orb-web weavers (Table 2; Figure 3), comprising 41 species in four families (Araneidae, Tetragnathidae, Nephilidae, and Uloboridae). Other hunters comprised the next most species-rich guild of spiders in this ecosystem, including 30 species in six families (Salticidae, Oxyopidae, Sparassidae, Scytodidae, Miturgidae, and Clubionidae).

Ambushers (10 species), sheet web weavers (7 species), space web weavers (6 species), and ground hunters (5 species) are the other common functional groups. Orb web builders dominated the material, represented (in descending order of abundance) by *Cyclosa bifida* (Doleschall 1859) (Figure 4A) (Araneidae), *Nephila pilipes* (Fabricius, 1793) (Figure 4B) (Nephilidae), *Gasteracantha hasselti* C. L. Koch, 1837 (Araneidae), and *Leucauge decorata* (Blackwall, 1864) (Tetragnathidae). All these species were found in high abundances within every studied dipterocarp forest.

The Salticidae, the most abundant of the other hunt-

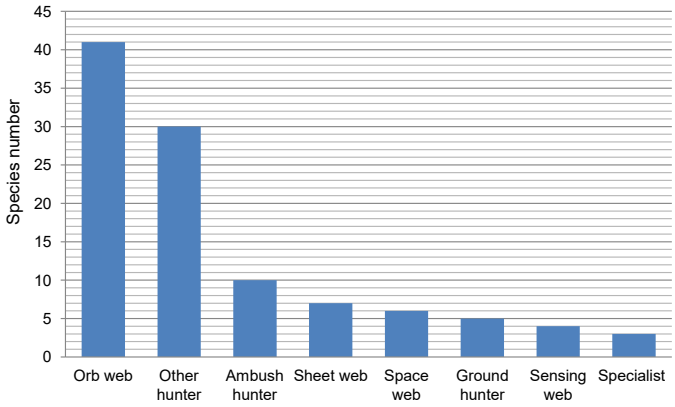

Figure 3. Guild composition of spiders in dry dipterocarp forests of Thailand.

ers, were composed with the greatest number of genera (18 genera) in our collection. Among four common species of salticids (Table 3), *Plexippus petersi* (Karsch, 1878) (Figure 4C) represented the most abundant species from this family. *Heteropoda venatoria* (Linnaeus, 1767) (Figure 4D), from the family Sparassidae, was the second most abundant hunter. This species was recorded at every study location. It is usually found on bark of different tree species including dipterocarps from lowland to higland regions. It also commonly lives in houses and other synanthropic structures.

Most ambush hunters belonged to the Thomisidae, represented by the commonly found *Amyciaea forticeps*

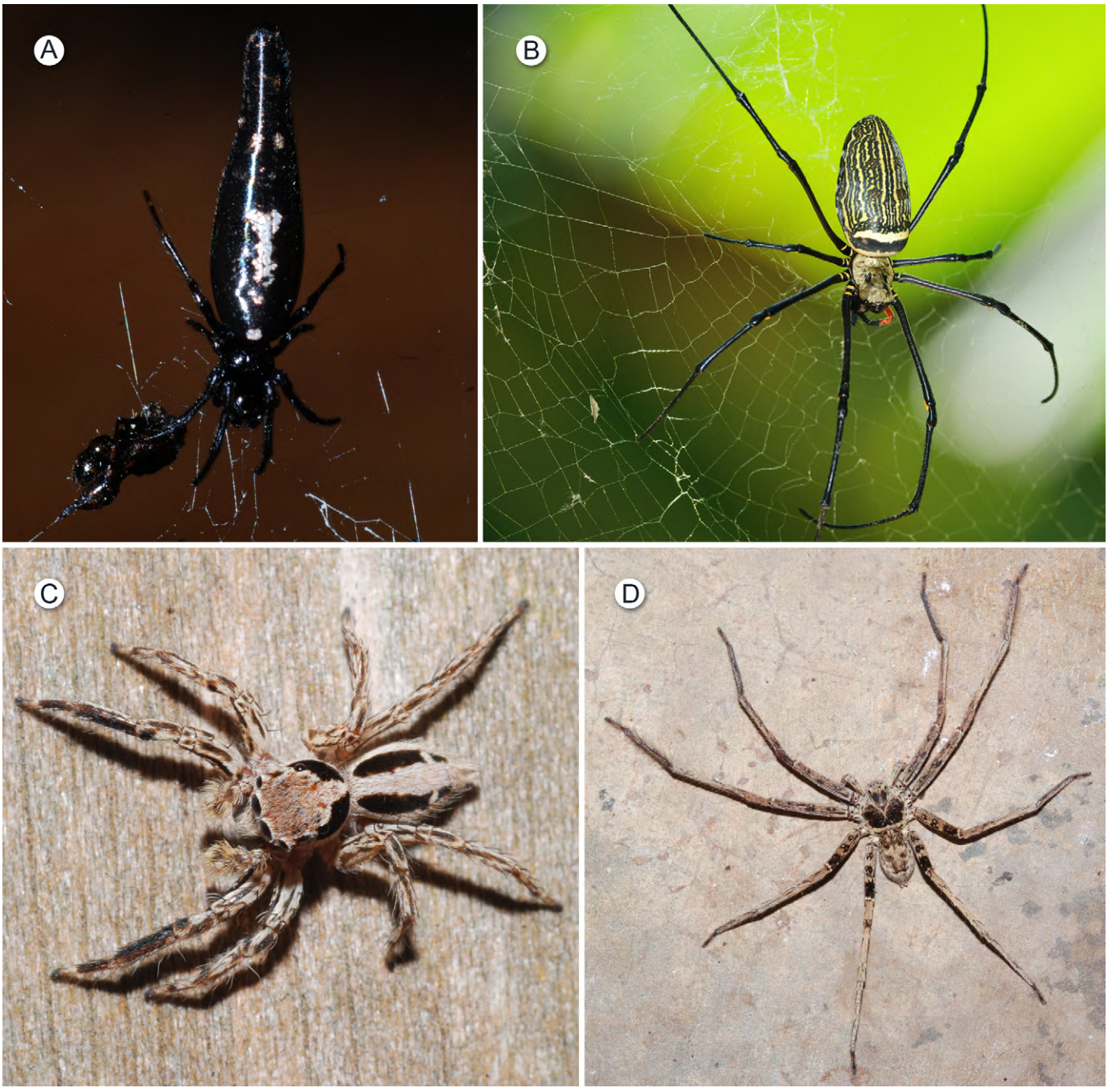

Figure 4. Some representatives of the most abundant and common species of spiders recorded during survey of dry dipterocarp forests. **A**. *Cyclosa bifida* (Doleschall 1859). **B.** *Nephila pilipes* (Fabricius, 1793). **C.** *Plexippus petersi* (Karsch, 1878). **D**. *Heteropoda venatoria* (Linnaeus, 1767). Photos: P. Wongprom.

Figure 5. Some rare and poorly known species of spiders recorded during survey of dry dipterocarp forests. **A.** *Stegodyphus tibialis* (O. P.-Cambridge, 1869), male. **B**. *Stegodyphus tibialis* (O. P.-Cambridge, 1869), female. **C**. *Argiope dang* Jäger & Praxaysombath, 2009. **D.** *Colopea* sp. **E.** *Damarchus* sp. **F.** *Siamspinops* sp. Photos: P. Wongprom (A, B, C, D); Ondřej Košulič (E); Nicky Bay (F).

(O. P.-Cambridge, 1873), *Camaricus* sp. and *Oxytate* sp., while another family of ambush hunters (Selenopidae) was very rare. Among spider species in these common functional groups, a few species, such as *Argiope pulchella* Thorell, 1881 and *Acusilas malaccensis* Murphy & Murphy, 1983, were rare and found only in one or two sampling sites of dry dipterocarp forest stands (Table 3).

The least common functional group that contained most of the rare species was sensing web builders. One genera of those rare specimens, (*Prothemenops* sp.), was found only in Sakaerat. In this location, we also found four other rare species (five or less individuals found) and the highest spider species richness and abundance specimens which were recorded during our arachnological research of dry dipterocarp forests (Table 3).

DISCUSSION

This faunistical study provides the first comprehensive compilation on spiders from dry dipterocarp forests in Thailand. The total of 29 spider families in Thailand's dry dipterocarp forests recorded from this study represented 25% of those families reported from around the world (World Spider Catalog 2016). The species richness in the study locations is rather high with structured guild composition, representing approximately 22% of the araneofauna in region of Thailand (Murphy and Murphy 2000; World Spider Catalog 2016).

Sakaerat was the site containing the highest species richness and spider abundance. This site was part of the Sakaerat Environmental Research Station (SERS) which have been recognized as one of five biosphere reserve in Thailand (UNESCO 2007). The forest area had been reported as improving in reduction of habitat degradation and higher forest restoration of dipterocarp forests (Trisurat 2010). Several not common and rare spider species with low distribution range found in this area had proved the importance of activities that help maintaining biotic value of forest stands in this biosphere reserve.

Among studied araneocenosis, we made several significant discoveries of poorly known and rare species of spiders. In the dipterocarp forests in the southern part of central Thailand (Huay Sai-Phetchaburi province) and northeastern part of Thailand (Sakaerat-Nakhon Ratchasima province), several specimens of *Stegodyphus tibialis* (Figure 5A and B) were found. This species was known to be distributed in India and Myanmar (Kraus and Kraus 1988), but there had been only one reported finding from Tak province, northwestern Thailand (Ono 1995). Therefore, the locations of the present records in Huay Sai and the Sakaerat indicate the southernmost and easternmost distribution range of this genus (Miller et al. 2012). Although the genus is known for its social manner of living (Johannesen et al. 2007), the present specimens were collected solitarily in typical nests found in grass undergrowth and their social behavior was not observed.

Other significant discoveries include the rare and poorly known species *Argiope dang* Jäger & Praxaysombath, 2009 (Figure 5C), which was found in the Sakaerat Biosphere Reserve in the northeastern part of Thailand. This species had been known only from Laos, where males and females had been found at several locations by Jäger and Praxaysombath (2009). Later, several specimens were collected in two locations in the central part of Thailand (Chotwong and Tanikawa 2013), so our finding is the second recording of this species within Thailand. Including our results, this species is now known from three locations in different habitats of Thailand (an agriculture field, an artificial garden, and a dipterocarp forest). Thus, we presume this species occurs more abundantly and in a variety of places and ecosystems within Thailand and more findings would be expected. Other significant discoveries include several specimens of the rare Selenopidae genus *Siamspinops* (Figure 5F) which were found in low abundances (n = 6) in six different locations. Representatives of the family Selenopidae are rather infrequently collected and especially poorly studied, mainly because they are confined to a specific microhabitat, i.e., the surface of large rocks and trunk of fallen trees (Deeleman-Reinhold 2000). Until now, only three species of genus *Siamspinops* are represented in Thailand (Dankittipakul and Corronca 2009). We provided only morphospecies as we have found only subadult females during our survey.

We also found several representatives of poorly known and uncommon spider families, namely Nemesiidae and Stenochilidae (Deeleman-Reinhold 2001; Murphy and Murphy 2000). These findings include species from the genera *Damarchus* (Figure 5E) and *Colopea* (Figure 5D). These representatives were found in low abundaces and at a few locations, mainly in the dipterocarp forest of Sakaerat and Takli. In general, specimens of *Damarchus* are not found commonly due to their natural history (trapdoor burrows) (Norma-Rashid and Li 2009). Stenochilids occur mainly in natural and seminatural conditions of undisturbed forest ecosystems (Murphy and Murphy 2000); however, there are also findings from disturbed agroecosystems such as physic nut plantations in rural human altered landscape (Košulič and Vichitbandha 2015).

In general, the rich composition of the spider fauna and the occurrence of some rare and uncommon species for the Thailand region confirm the biotic value of dipterocarp forest habitats and altogether significantly enhance knowledge of spiders in Thailand. However, future studies need to clarify how the diversity of spiders is structured along different gradients (e.g., disturbance, elevation, latitude, and seasonality) and what are the exact mechanisms affecting occurrence and function of spiders occurring in dipterocarp forests of Thailand (Michalko et al. in prep).

To conclude, we assume that these first results can

help to establish and promote dry dipterocarp forest as an important habitat and refuge for a variety of spider species, and for its overall biodiversity in the sensitive and endangered nature of the tropical region (Murphy and Lugo 1986; Sist et al. 2003; Navjot et al. 2004). This is very important for future studies involving nature protection and habitat management of lowland forest ecosystems in Thailand and other countries in southeastern Asia.

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APPENDIX

Table A1. Voucher museum numbers of collected material which is deposited in public collection of Thailand Natural History Museum in Prathum Thani, Thailand.

Taxon	Male specimens	Female specimens
Araneidae		
Acusilas coccineus Simon, 1895	THNHM-AR-00052	THNHM-AR-00035; THNHM-AR-00044; THNHM-AR-00047; THNHM-AR-00053
Acusilas malaccensis Murphy & Murphy, 1983	THNHM-AR-000154	THNHM-AR-00155
Anepsion japonicum (Bösenberg & Strand, 1906)	THNHM-AR-00189	THNHM-AR-00190; THNHM-AR-00191
Arachnura sp.		THNHM-AR-00126; THNHM-AR-00128
Araneus mitificus (Simon, 1886)	THNHM-AR-00188	THNHM-AR-00187; THNHM-AR-00194; THNHM-AR-00199
Argiope aemula (Walckenaer, 1841)		THNHM-AR-00060; THNHM-AR-00074
Argiope catenulata (Doleschall, 1859)	THNHM-AR-00091	THNHM-AR-00089; THNHM-AR-00090; THNHM-AR-00092
Argiope dang Jäger & Praxaysombath, 2009	THNHM-AR-00102	THNHM-AR-00099; THNHM-AR-00101
Argiope pulchella Thorell, 1881	THNHM-AR-000138	THNHM-AR-00136; THNHM-AR-000137
Caerostris sumatrana Strand, 1915		THNHM-AR-00168; THNHM-AR-00169
Cyclosa bifida (Doleschall 1859)	THNHM-AR-00223; THNHM-AR-00225	THNHM-AR-00224; THNHM-AR-00226; THNHM-AR-00227
Cyclosa insulana (Costa, 1834)	THNHM-AR-00248	THNHM-AR-00249; THNHM-AR-00250
Cyclosa mulmeinensis Thorell, 1887		THNHM-AR-00205; THNHM-AR-00206
Cyrtophora beccarii (Thorell, 1878)	THNHM-AR-00110	THNHM-AR-00111; THNHM-AR-00112
Cyrtophora cicatrosa (Stoliczka, 1869)		THNHM-AR-00149; THNHM-AR-00150
Cyrtophora citricola (Forsskål,1775)		THNHM-AR-00156; THNHM-AR-00157; THNHM-AR-00158
Cyrtophora moluccensis (Doleschall, 1857)		THNHM-AR-00159; THNHM-AR-00161
Cyrtophora unicolor (Doleschall, 1857)		THNHM-AR-00162; THNHM-AR-00171; THNHM-AR-00172
Eriovixia laglaizei (Simon, 1877)	THNHM-AR-00173; THNHM-AR-00176	THNHM-AR-00174; THNHM-AR-00175
Gasteracantha diadesmia Thorell, 1887		THNHM-AR-00177; THNHM-AR-00201; THNHM-AR-00202
Gasteracantha hasselti C. L. Koch, 1837	THNHM-AR-00204; THNHM-AR-00208	THNHM-AR-00207; THNHM-AR-00209
Gasteracantha kuhli C. L. Koch, 1837		THNHM-AR-00210; THNHM-AR-00211; THNHM-AR-00212
Gea spinipes C. L. Koch, 1843	THNHM-AR-00213	THNHM-AR-00214; THNHM-AR-00215
Larinia sp.		THNHM-AR-00216; THNHM-AR-00217
Neoscona sp.		THNHM-AR-00218; THNHM-AR-00219
Parawixia dehaani Doleschall, 1859		THNHM-AR-00243; THNHM-AR-00244; THNHM-AR-001245
Poltys sp.		THNHM-AR-00246; THNHM-AR-00247
Thelacantha brevispina (Doleschall, 1857)		THNHM-AR-00220; THNHM-AR-00221; THNHM-AR-00222
Clubionidae		
Clubiona sp.		THNHM-AR-00272
Corinnidae		
Castianeira sp.		THNHM-AR-00273; THNHM-AR-00274
Eresidae		
Stegodyphus tibialis (O. P.-Cambridge, 1869)	THNHM-AR-00228	THNHM-AR-00229; THNHM-AR-00230
Eutichuridae		
Cheiracanthium sp.		THNHM-AR-00252; THNHM-AR-00253
Gnaphosidae		
Drassodes sp.		THNHM-AR-00282; THNHM-AR-00283
Hersiliidae		
Hersilia asiatica Song & Zheng, 1982	THNHM-AR-00057	THNHM-AR-00058
Idiopidae		
Prothemenops sp.		THNHM-AR-00038

Continued

Table A1. *Continued.*

Taxon	Male specimens	Female specimens
Linyphiidae		
Atypena spp.		THNHM-AR-00004; THNHM-AR-00086; THNHM-AR-00097
Neriene macella (Thorell,1898)	THNHM-AR-00002	THNHM-AR-00033; THNHM-AR-00034
Lycosidae		
Hippasa spp.	THNHM-AR-00133	THNHM-AR-00113; THNHM-AR-00134
Nemesiidae		
Damarchus sp.		THNHM-AR-00014
Nephilidae		
Nephila antipodiana (Walckenaer, 1841)	THNHM-AR-00080	THNHM-AR-00071; THNHM-AR-00072
Nephila pilipes (Fabricius, 1793)	THNHM-AR-00068	THNHM-AR-00069; THNHM-AR-00070; THNHM-AR-00081
Herennia multipuncta (Doleschall, 1859)	THNHM-AR-00039	THNHM-AR-00031; THNHM-AR-00032; THNHM-AR-00040
Nephilengys malabarensis (Walckenaer, 1842)	THNHM-AR-00041; THNHM-AR-00042; THNHM-AR-00049	THNHM-AR-00050(m)
Ochyroceratidae		
Unidentified sp.	THNHM-AR-00087	THNHM-AR-00037
Oonopidae		
Ischnothyreus spp.	THNHM-AR-00009	THNHM-AR-00015; THNHM-AR-00020
Oxyopidae		
Oxyopes javanus Thorell, 1887	THNHM-AR-00231	THNHM-AR-00232; THNHM-AR-00233
Oxyopes lineatipes (C. L. Koch, 1847)	THNHM-AR-00234	THNHM-AR-00235; THNHM-AR-00236
Peucetia viridana (Stoliczka, 1869)		THNHM-AR-00125; THNHM-AR-00135
Pholcidae		
Leptopholcus borneensis	THNHM-AR-00066	THNHM-AR-00063
Pisauridae		
Perenethis venusta L. Koch, 1878	THNHM-AR-00148	THNHM-AR-00141; THNHM-AR-00144
Psechridae		
Psechrus sp.		THNHM-AR-00240; THNHM-AR-00241
Fecenia sp.		THNHM-AR-00242; THNHM-AR-00251
Salticidae		
Bavia sp.		THNHM-AR-00139; THNHM-AR-00140
Burmattus pococki (Thorell, 1895)	THNHM-AR-00167	THNHM-AR-00166
Cosmophasis umbratica Simon, 1903	THNHM-AR-00143	THNHM-AR-00142
Epeus flavobilineatus (Doleschall, 1859)	THNHM-AR-00114	THNHM-AR-00115; THNHM-AR-00116
Evarcha flavocincta (C. L. Koch, 1846)	THNHM-AR-00198	THNHM-AR-00195; THNHM-AR-00196; THNHM-AR-00197
Harmochirus brachiatus (Thorell, 1877)	THNHM-AR-00145; THNHM-AR-00147	THNHM-AR-00146
Hasarius adansoni (Audouin, 1826)	THNHM-AR-00151	THNHM-AR-00152
Hyllus diardi (Walckenaer, 1837)	THNHM-AR-00153	THNHM-AR-00193
Menemerus bivittatus (Dufour, 1831)	THNHM-AR-00192	THNHM-AR-00200
Myrmarachne maxillosa (C. L. Koch, 1846)	THNHM-AR-00103	THNHM-AR-00160
Myrmarachne plataleoides (O. P.-Cambridge, 1869)	THNHM-AR-00121	THNHM-AR-00122; THNHM-AR-00123
Pancorius magnus Zabka, 1985	THNHM-AR-00127	THNHM-AR-00129
Phaeacius malayensis Wanless, 1981	THNHM-AR-00130	THNHM-AR-00131; THNHM-AR-00132
Phintella versicolor (C. L. Koch, 1846)	THNHM-AR-00117; THNHM-AR-00120	THNHM-AR-00118; THNHM-AR-00119
Phintella vittata (C. L. Koch, 1846)		THNHM-AR-00180; THNHM-AR-00181; THNHM-AR-00182
Plexippus paykulli (Audouin, 1826)	THNHM-AR-00106; THNHM-AR-00108	THNHM-AR-00107
Plexippus petersi (Karsch, 1878)	THNHM-AR-00163; THNHM-AR-00164; THNHM-AR-00186	THNHM-AR-00165
Portia labiata (Thorell, 1887)	THNHM-AR-00178; THNHM-AR-00179	
Rhene flavigera (C.L. Koch, 1848)	THNHM-AR-00124	
Siler semiglaucus (Simon, 1901)	THNHM-AR-00109	
Telamonia dimidiata (Simon, 1899)	THNHM-AR-00170	
Thiania subopressa Strand, 1907	THNHM-AR-00183	THNHM-AR-00184; THNHM-AR-00185
Scytodidae		
Stedocys sp.	THNHM-AR-00012	THNHM-AR-00051; THNHM-AR-00029; THNHM-AR-00073
Selenopidae		
Siamspinops sp.		THNHM-AR-00059; THNHM-AR-00075

Continued

Table A1. *Continued.*

Taxon	Male specimens	Female specimens
Sparassidae		
Olios sp.		THNHM-AR-00284; THNHM-AR-00285
Heteropoda venatoria (Linnaeus, 1767)	THNHM-AR-00286; THNHM-AR-00287	THNHM-AR-00288; THNHM-AR-00289
Stenochilidae		
Colopea sp.		THNHM-AR-00104; THNHM-AR-00105
Tetragnathidae		
Leucauge decorata (Blackwall, 1864)	THNHM-AR-00008	THNHM-AR-00010; THNHM-AR-00013; THNHM-AR-00006
Leucauge tessellata (Thorell, 1887)	THNHM-AR-00011	THNHM-AR-00019; THNHM-AR-00023
Opadometa fastigata (Simon, 1877)	THNHM-AR-00026	THNHM-AR-00021; THNHM-AR-00022; THNHM-AR-00028
Tetragnatha hasselti Thorell, 1890	THNHM-AR-00078	THNHM-AR-00055; THNHM-AR-00062; THNHM-AR-00084
Tetragnatha maxillosa Thorell, 1895	THNHM-AR-00016	THNHM-AR-00017; THNHM-AR-00018
Tylorida striata (Thorell, 1877)	THNHM-AR-00027	THNHM-AR-00024; THNHM-AR-00030
Theraphosidae		
Haplopelma minax (Thorell, 1897)		THNHM-AR-00001;THNHM-AR-00025
Theridiidae		
Achaearanea sp.		THNHM-AR-00082; THNHM-AR-00083; THNHM-AR-00096
Argyrodes flavescens Pickard-Cambridge,1880	THNHM-AR-00046	THNHM-AR-00056; THNHM-AR-00077
Chrysso sp.	THNHM-AR-00065	THNHM-AR-00045; THNHM-AR-00064; THNHM-AR-00085
Dipoena sp.	THNHM-AR-00048; THNHM-AR-00061	THNHM-AR-00007; THNHM-AR-00095
Episinus sp.	THNHM-AR-00079	THNHM-AR-00076; THNHM-AR-00093; THNHM-AR-00094
Thomisidae		
Amyciaea forticeps (O. P.-Cambridge, 1873)	THNHM-AR-00254	THNHM-AR-00255; THNHM-AR-00256
Angaeus rhombifer Thorell, 1890	THNHM-AR-00258	THNHM-AR-00257; THNHM-AR-00259
Camaricus sp.		THNHM-AR-00263; THNHM-AR-00264
Misumenops sp.		THNHM-AR-00265; THNHM-AR-00266
Oxytate sp.		THNHM-AR-00267; THNHM-AR-00268
Runcinia albostriata Bösenberg & Strand, 1906	THNHM-AR-00271	THNHM-AR-00269; THNHM-AR-00270
Runcinia acuminata (Thorell, 1881)	THNHM-AR-00261	THNHM-AR-00260; THNHM-AR-00262
Thomisus sp.		THNHM-AR-00239
Tmarus sp.		THNHM-AR-00237; THNHM-AR-00238
Uloboridae		
Miagrammopes sp.	THNHM-AR-00036	THNHM-AR-00005;THNHM-AR-00043; THNHM-AR-00098
Philoponella raffrayi (Simon,1891)	THNHM-AR-00088	THNHM-AR-00003; THNHM-AR-00100
Uloborus sp.	THNHM-AR-00067	THNHM-AR-00054
Zodariidae		
Asceua sp.	THNHM-AR-00276	THNHM-AR-00275
Mallinella spp.	THNHM-AR-00277	THNHM-AR-00278
Storenomorpha sp.	THNHM-AR-00279	THNHM-AR-00280; THNHM-AR-00281