

THE SPIDER FAUNA OF MALDIVE ISLANDS IN INDIAN OCEAN (ARANEAE)

Jose K. Sunil*

* Department of Zoology, Deva Matha College, Kuravilangad, Kerala, INDIA-686 633. E-mail: sunil32@gmail.com

[Sunil, J. K. 2012. The spider fauna of Maldives in Indian Ocean (Araneae). *Munis Entomology & Zoology*, 7 (1): 424-431]

ABSTRACT: The present study documents the diversity and characteristics of spider families occurring in the coral islands of Maldives in Indian Ocean. The faunistic survey yielded 57 species of spiders belonging to 35 genera and 17 families. Araneidae was the most dominant family recording 12 species belonging to 7 genera. On species level, *Tetragnatha mandibulata* Walckenaer, 1842 was the dominant species. Guild structure analysis revealed six feeding guilds, namely orb weavers, stalkers, ground hunters, foliage runners, scattered line weavers and ambushers. Orb weavers and stalkers were the dominant feeding guilds representing 35% and 22% respectively of the total collection. 12 genera namely *Artema*, *Crossopriza*, *Argyrodes*, *Latrodectus*, *Linyphia*, *Neoscona*, *Pardosa*, *Clubiona*, *Martensopoda*, *Thanatus*, *Bavia*, *Myrmarachne* are reported for the first time from Maldives.

KEY WORDS: Maldives, spiders, diversity, oceanic islands.

Maldives is a small island nation, but the tropical environment supports a rich biodiversity of invertebrates. Although many reports were made on the terrestrial and aquatic animals the spider fauna is totally neglected by the workers. Because of its proximity to several lands masses like India, Seychelles, Australia and Madagascar the fauna exhibit several unique features not seen in other parts of the world. In his pioneering work on spiders in Maldives, Pocock (1904) recorded 19 species from these islands. For more than century after that no work on spiders in Maldives has been conducted by anyone till now. The aim of the present paper is to provide a preliminary checklist about the spiders of these coral islands. Though the study of spiders from Maldives islands is still far from complete, the present study forms a basis for further investigations on this group.

MATERIALS AND METHODS

Checklist is based on an examination of specimens collected by the author while he was in Maldives, during the period from January 2007 to November 2008 and on reviews of published literature like Pocock, 1904 and Platnick, 2006. The checklist is presented in a taxonomic order: suborder, family, genus and species. The classification of araneae follows Platnick 2010. For each species presented in the checklist information is provided in the following sequence: name of the species, author, material examined guild structure, affinities and the distribution. specimens were placed directly into 75% alcohol for preservation. Global Positioning System hand unit (GPS) was used to determine the exact geographical locations. The identification of spiders was done following Pocock (1900, 1904), Tikader (1980, 1982), Koh (1989), Murphy & Murphy (2000) and Dippenaar (2002). The specimens used in the present study are deposited in the Arachnological Collections of Deva Matha College, Kuravilangad, Kerala.

Study area: The Maldives consists of a chain of coral atolls, 80-120km wide, stretching 860 kms from latitude 7°6'35"N to 0°42'24"S, and lying between longitude 72°33'19"E to 73°46'13"E. These coral atolls are located on the 1600 kms long Laccadives-Chagos submarine ridge extending into the central Indian Ocean from the south-west coast of the Indian sub-continent. It is believed that the Maldives was formed about 65-225 million years ago in the Mesozoic Era (Maniku, 1990). The 26 geographic atolls in the Maldives vary enormously in shape and size. A total of 1192 islands are found in the chain of 26 geographic atolls, and the islands differ depending on location, form and topography. The islands vary in size from 0.5 km² to around 5.0 km² and in shape from small sandbanks with sparse vegetation to elongated strip islands. The maximum height of land above mean sea level within the Maldives is around 3 meters and around 80% of the land area is less than 1 meter above mean high tide level (MHAHE, 1999). Out of the 1192 islands 199 are inhabited and 87 have been developed as tourist resorts. The largest island is Gan (1°55'N and 73°32'5"E) in Laamu Atoll with an area 5.16 km² and most of the present study was conducted in this island during the period January 2007-November 2008. The relative humidity ranges from 73% to 85%. Daily temperatures vary little throughout the year with a mean annual temperature of 28°C. Average annual rainfall varies from 1,407mm to 2,707mm between different atolls.

RESULTS

Family Diversity: 17 families are recorded from Maldives during the study (Table. I & VI). Families like Araneidae (12 species), Salticidae (10 species), Tetragnathidae (7 species) and Sparassidae (7 species) exhibit highest species diversity. Theridiidae (2 species), Pholcidae (2 species) are also widely present in the islands. Families like Barychelidae, Hersilidae, Desidae, Scytodidae, Thomisidae and Uloboridae are represented by one species only.

Generic Diversity: 35 genera are found in 17 families (Table II). Maximum generic diversity is found in families like Araneidae (7), Salticidae (5), Tetragnathidae (2), Pholcidae (2) and Sparassidae (2). Most genera discovered show affinities with oriental region and are widely present in the Indian mainland. Genera like *Cyclosa*, *Cyrtophora* (Fam: Araneidae), *Hersilia* (Fam: Hersilidae), *Pardosa* (Fam: Lycosidae), *Artema*, *Crossopriza* (Fam: Pholidae), *Bavia*, *Myrmarachne*, *Plexippus* (Fam: Salticidae), *Tylorida* (Fam: Tetragnathidae) and *Linyphia* (Fam: Linyphiidae) are first records from Maldives.

Species Diversity: 57 species are collected from Maldives during the study. Genera like *Neoscona* (6 species), *Tetragnatha* (5 species), *Oxyopes* (3 species), *Heteropoda* (3 species) and *Olios* (3 species) show highest diversity of species in the collection. The analysis of species data with reference to the area of the country (Table III) shows that the Maldives islands exhibit comparatively higher species and generic level diversity compared with other south Asian countries in the area.

New records: The most striking feature of the spider fauna of Maldives islands is the high number of new records. About 30 species recorded during the study are new records to Maldives. Araneidae and Salticidae exhibit highest number of new records. Similarly 12 genera namely *Artema*, *Crossopriza* (Fam. Pholcidae);

Argyrodes, *Latrodectus* (Fam. Theridiidae); (*Linyphia*) Fam. Linyphiidae; *Neoscona* (Fam. Araneidae); *Pardosa* (Fam. Lycosidae); *Clubiona* (Fam. Clubionidae); *Martensopoda* (Fam. Sparassidae); *Thanatus* (Fam. Philodromidae); *Bavia*, *Myrmarachne* (Fam. Salticidae) recorded during the study are also new to Maldives.

Dominant species: The dominant species in each vegetation zone are shown in Table IV. The dominant species is calculated by counting the species number of collected specimens. The three top scorer species in the locality are *Tetragnatha mandibulata* Walckenaer, 1842, *Argiope anasuja* Thorell, 1887 and *Pardosa* sp. 1. The total number of top scorers (Table IV) was 20, of which six were araneids, four were salticids and three were tetragnathids. A general trend was the dominance of lycosid species among ground dwelling species and araneid species in web building species.

Functional groups: The collected spiders can be divided into six functional groups (guilds) (Table V) based on their foraging behaviour in the field (Uetz et al. 1999). The dominant guild was of the orb web builders and it comprised of 20 species of spiders. Spiders of the families Araneidae, Tetragnathidae and Uloboridae fall under this category. Spiders of the category Stalkers formed the next dominant guild comprising of 13 species of spiders. Ground runners (10 species), scattered line weavers (4 species), ambushers (3 species) and Foliage runners (1 species) are the other functional groups.

Endemism: A total of 57 species are discovered from Maldives so far. Among the collection *Heteropoda atollicola* is endemic to Maldives. *Desis gardineri*, and *Tetragnatha foveata* are also restricted to Laccadive and Srilankan region.

Affinities: The present study conducted in Maldives revealed that the spider fauna of these islands bears affinities with Oriental (21 spp), Australian (3 spp.), Palearctic (4 spp.) and Nearctic (1 sp.) regions. High number of Indian species suggests the arrival of majority of spiders here from the neighbouring Indian mainland.

Zoogeographic Analysis: About 29 species recorded in Maldives are widely distributed in South Asia; a few of these are found only in the Indo-srilankan region. Most of the widely distributed species in south Asia belong to Araneidae (11 species) and Salticidae (6). Because of bright colouration and large orb webs, spiders of the above mentioned families were easily observed. Species like *Crossopriza lyoni* (Blackwall, 1867); *Plexippus paykulli* (Audouin, 1826) are cosmopolitan in distribution; whereas species like *Artema atlanta* Walckenaer, 1837; *Zosis geniculata* (Olivier, 1789); *Heteropoda venatoria* (Linnaeus, 1767) are pantropical in distribution.

DISCUSSION

The spider fauna of Maldives is not rich compared with many other tropical islands. Around 1447 species are reported from the neighbouring Indian mainland and around 354 species are reported from Srilanka (Siliwal, 2007). The lack of high species diversity can be attributed to the limited diversity of habitats in these coral islands. The limited floral diversity is also a contributing factor in reducing the number of invertebrates. A notable feature in the diversity of spiders

is the higher family and generic diversity. Except the common families like Araneidae and Salticidae most families are represented by a few species. Seven families are represented by only single species. Rare families like Desidae which are not found in neighbouring mainland are also recorded from these coral islands.

The spider fauna here is a chance assemblage of species arrived from neighboring lands. Most species found here are also found in Indian mainland and Srilanka, which shows the primary route of spider migration. The sub order Mygalomorphae is represented by only a Barychelid species, *Sason robustum*. The scarcity of mygalomorphs can be attributed to the vast separation of these coral islands from the neighbouring land. Legendre (1979) suggested that in the case of *Sason*, its arboreal nest allowed for its transport as flotsam in ocean currents.

Only a few endemic species are recorded from Maldives which reflects the limited local character of the fauna. Another notable feature in the spider fauna is the high number of Tetragnathid spiders of the genus *Tetragnatha* observed during the study. These are common in most areas; the frequent equatorial rain also favours the abundance of moisture loving genera.

There are many environmental factors that affect species diversity. However, when spiders were divided according to their functional group there was a significant effect of habitat on the diversity of these groups. The web building and foliage running spiders rely on vegetation for some part of their lives, either for finding food, building retreats or for web building. The structure of the vegetation is therefore expected to influence the diversity of spiders found in the habitat. Studies have demonstrated that a correlation exists between the structural complexity of habitats and species diversity (Hawksworth, Kalin-Arroyo 1995). Diversity generally increases when a greater variety of habitat types are present (Ried, Miller 1989). Uetz (1991) suggests that structurally more complex shrubs can support a more diverse spider community. The lack of high diversity of spiders in Maldives has to be viewed in this context.

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Table I. Species diversity in different families found in Maldives.

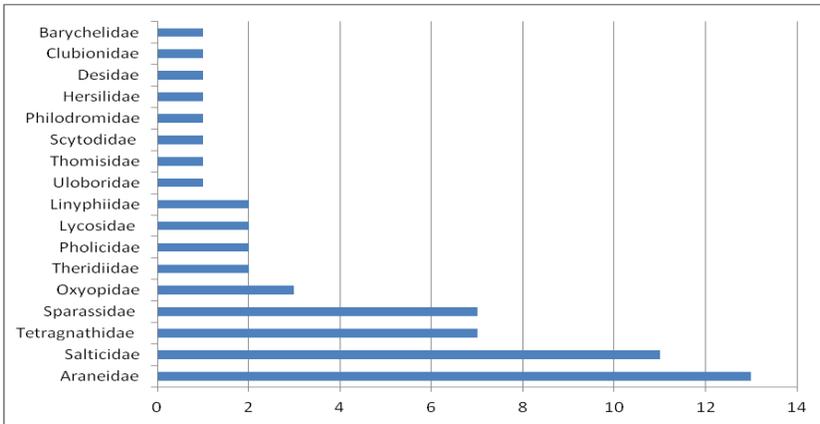


Table II. Diversity of genera found in different families.

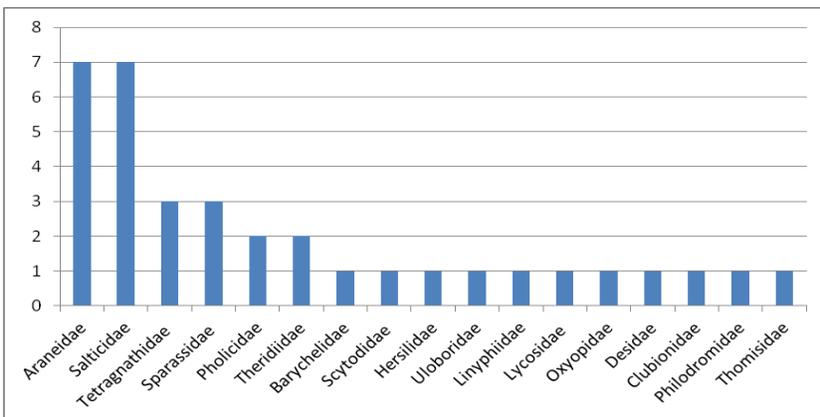


Table III. Comparison of area and spider species richness of some Asian countries.

Country	Area (km ²)	Genera	Spider species	Sources
Afghanistan	652,090	65	113	Siliwal (2006)
Bangladesh	143,998	24	50	Siliwal (2006)
Bhutan	38,394	51	105	Siliwal (2006)
India	3,201,446	365	1447	Siliwal (2006)
Malaysia	330,803	238	425	Rashid (2009)
Maldives	300	35	57	
Nepal	147,18179	221		Siliwal (2006)
Pakistan	796,095	79	138	Siliwal (2006)
Singapore	705	186	310	Song (2002)
Srilanka	65,610	213	354	Siliwal (2006)

Table IV. List of dominant species.

<p>FAM. PHOLCIDAE C. L. Koch, 1850 <i>Artema atlanta</i> Walckenaer, 1837 <i>Crossopriza lyoni</i> (Blackwall, 1867)</p> <p>FAM. HERSILIIDAE Thorell, 1870 <i>Hersilia savignyi</i> Lucas, 1836</p> <p>FAM. ULOBORIDAE Thorell, 1869 <i>Zosis geniculata</i> (Olivier, 1789)</p> <p>FAM. TETRAGNATHIDAE Menge, 1866 <i>Tetragnatha mandibulata</i> Walckenaer, 1842 <i>Tetragnatha viridorufa</i> Gravely, 1921 <i>Tylorida ventralis</i> (Thorell, 1877)</p>	<p>FAM. ARANEIDAE Clerck, 1757 <i>Argiope anasija</i> Thorell, 1887 <i>Cylosa insulana</i> (Costa, 1834 <i>Cyrtophora cicatrosa</i> (Stoliczka, 1869) <i>Neoscona mukerjei</i> Tikader, 1980 <i>Neoscona theisi</i> (Walckenaer, 1842) <i>Thelacantha brevispina</i> (Doleschall, 1857)</p> <p>FAM. LYCOSIDAE Sundevall, 1833 <i>Pardosa</i> sp. 1</p> <p>FAM. SPARASSIDAE Bertkau, 1872 <i>Heteropoda venatoria</i> (Linnaeus, 1767) <i>Olios</i> sp. 1</p> <p>FAM. SALTICIDAE Blackwall, 1841 <i>Carrhotus decorata</i> Tikader, 1974 <i>Hyllus semicupreus</i> (Simon, 1885) <i>Plexippus paykulli</i> (Audouin, 1826) <i>Plexippus petersi</i> (Karsch, 1878)</p>
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Table V. Composition of different functional groups.

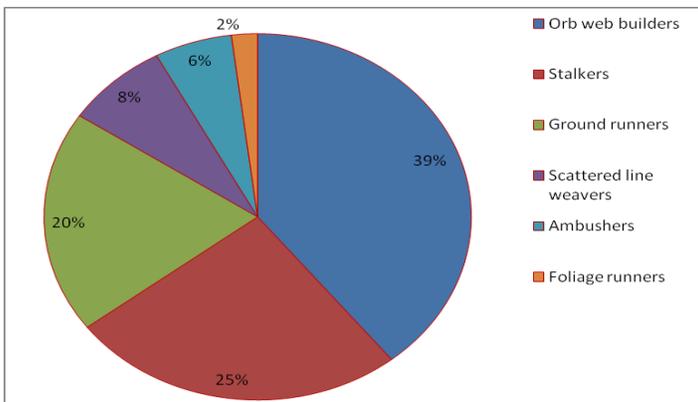


Table VI. Checklist of spiders in Maldive Islands.

Species	Material	Guild	Affinities	Distribution
FAM. BARYCHELIDAE Simon, 1889				
1. <i>Sason robustum</i> (O. P.-Cambridge, 1883)	--	Ambushers	Oriental	India, Sri Lanka, Seychelles
FAM. SCYTODIDAE Blackwall, 1864				
2. <i>Scytodes gilva</i> (Thorell, 1887)	--		Oriental	India, Myanmar
FAM. PHOLCIDAE C. L. Koch, 1850				
3. <i>Artema atlanta</i> Walckenaer, 1837	1 female	Scattered line weaver	Pantropical	Introduced in Belgium
4. <i>Crossopriza lyoni</i> (Blackwall, 1867)	2 females	Scattered line weaver	Cosmopolitan	
FAM. HERSILIIDAE Thorell, 1870				
5. <i>Hersilia savignyi</i> Lucas, 1836	2 females	Stalkers	Oriental	Sri Lanka, India to Philippines
FAM. ULOBORIDAE Thorell, 1869				
6. <i>Zosis geniculata</i> (Olivier, 1789)	2 females	Orb weavers	Oriental	Pantropical
FAM. THERIDIIDAE Sundevall, 1833				
7. <i>Argyrodes</i> sp. 1	1 male	Sheet web builders		
8. <i>Larrodectus hasselti</i> Thorell, 1870		Sheet web builders	Oriental	Southeast Asia to Australia
FAM. LINYPHIIDAE Blackwall, 1859				
9. <i>Linyphia</i> sp. 1	1 male	Sheet web builders		
10. <i>Linyphia</i> sp. 2	1 female	Sheet web builders		
FAM. TETRAGNATHIDAE Menge, 1866				
11. <i>Leucauge</i> sp. 1	1 female	Orb weavers		
12. <i>Tetragnatha foveata</i> Karsch, 1891	--	Orb weavers	Oriental	Sri Lanka, Lakswweep, Maldive Is.
13. <i>Tetragnatha mandibulata</i> Walck, 1842	2 females	Orb weaver	Oriental, Australian	West Africa, Australia, Bangladesh, Philippines,
14. <i>Tetragnatha vermiformis</i> Emerton, 1884	3 females	Orb weavers	Oriental, Palearctic	Canada to Panama, Japan, Philippines
15. <i>Tetragnatha viridorufa</i> Gravely, 1921	1 female	Orb weavers	Oriental	India
16. <i>Tetragnatha</i> sp. 1	2 females	Orb weavers		
17. <i>Tylorida ventralis</i> (Thorell, 1877)	3 females	Orb weavers	Oriental	India to Taiwan, Japan, New Guinea
FAM. ARANEIDAE Clerck, 1757				
18. <i>Araneus</i> sp. 1	2 females	Orb weaver		
19. <i>Argiope anasuja</i> Thorell, 1887	3 females	Orb weavers	Oriental	Pakistan to Maldives
20. <i>Cylosa insulana</i> (Costa, 1834)	2 females	Orb weavers	Palearctic, Oriental	Mediterranean to Philippines, Australia
21. <i>Cyrtophora cicatrosa</i> (Stoliczka, 1869)	3 females	Orb weavers	Oriental	Pakistan to Northern Territory
22. <i>Neoscona achine</i> (Simon, 1906)	4 females	Orb weavers	Oriental	India, China
23. <i>Neoscona mikerjeji</i> Tikader, 1980	2 females	Orb weavers	Oriental	India
24. <i>Neoscona punctigera</i> (Doleschall, 1857)	2 females	Orb weavers	Palearctic	Réunion to Japan
25. <i>Neoscona scylla</i> (Karsch, 1879)	2 females	Orb weavers	Palearctic	Russia to Korea,
26. <i>Neoscona theisi</i> (Walckenaer, 1842)	2 females	Orb weavers	Palearctic	China to Pacific Is.
27. <i>Neoscona</i> sp. 1	2 females	Orb weavers		
28. <i>Neoscona</i> sp.2	2 females	Orb weavers		
29. <i>Polys illepidus</i> C. L. Koch, 1843	2 females	Orb weavers	Oriental, Australian	Thailand to Australia,

30. <i>Thelacantha brevispina</i> (Doleschall 1857)	2 females	Orb weavers	Oriental, Australian	Madagascar, India to Philippines, Australia
FAM. LYCOSIDAE Sundevall, 1833				
31. <i>Pardosa</i> sp. 1	2 females	Ground runners		
32. <i>Pardosa</i> sp. 2	2 females	Ground runners		
FAM. OXYOPIDAE Thorell, 1870				
33. <i>Oxyopes hindostanicus</i> Pocock, 1901	2 females	Stalkers	Oriental	Pakistan to Sri Lanka
34. <i>Oxyopes</i> sp. 1	2 females	Stalkers		
35. <i>Oxyopes</i> sp. 2	2 females	Stalkers		
FAM. DESIDAE Pocock, 1895				
36. <i>Desis gardineri</i> Pocock, 1904	--		Oriental	Laccadive Is.
FAM. CLUBIONIDAE Wagner, 1887				
37. <i>Clubiona</i> sp. 1	1 females	Foliage runner		
FAM. SPARASSIDAE Bertkau, 1872				
38. <i>Heteropoda atollicola</i> Pocock, 1904	--	Foliage runner	Oriental	Maldive Is
39. <i>Heteropoda nilgirina</i> Pocock, 1901	2 females	Foliage runner	Oriental	India
40. <i>Heteropoda venatoria</i> (Linnaeus, 1767)	2 females	Foliage runner	Oriental	Pantropical
41. <i>Martensopoda minuscula</i> (Reimoser, 1934)	2 females	Foliage runner	Oriental	India
42. <i>Olios lamarcki</i> (Latreille, 1806)	--	Foliage runner	Oriental	Madagascar to India
43. <i>Olios</i> sp. 1	1 male	Foliage runner		
44. <i>Olios</i> sp. 2	1 female	Foliage runner		
FAM. PHILODROMIDAE Thorell, 1870				
45. <i>Thanatus</i> sp. 1	1 female	Ambushers		
FAM. THOMISIDAE Sundevall, 1833				
46. <i>Thomisus pugilis</i> Stoliczka, 1869	1 female	Ambushers	Oriental	India
FAM. SALTICIDAE Blackwall, 1841				
47. <i>Bavia</i> sp. 1	1 male	Stalkers		
48. <i>Carrhotus decorata</i> Tikader, 1974	1 female	Stalkers	Oriental	India
49. <i>Carrhotus viduus</i> (C. L. Koch, 1846)	1 female	Stalkers	Oriental, Palearctic	India to China, Java
50. <i>Hyllus pudicus</i> Thorell, 1895	2 females	Stalkers	Oriental	India, Myanmar
51. <i>Hyllus semicupreus</i> (Simon, 1885)	2 females	Stalkers	Oriental	India, Sri Lanka
52. <i>Myrmarachne</i> sp. 1	2 females	Stalkers		
53. <i>Myrmarachne</i> sp. 2	2 females	Stalkers		
54. <i>Plexippus paykulli</i> (Audouin, 1826)	2 females	Stalkers	Cosmopolitan	
55. <i>Plexippus peteri</i> (Karsch, 1878)	1 female, 1 male	Stalkers	Palearctic	Africa to Japan, Philippines, Hawaii
56. Genus 1, sp. 1	1 female	Stalkers		
57. Genus 2, sp. 2	1 female	Stalkers		