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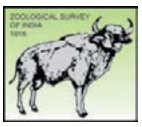

Spiders (Arachnida: Araneae) of the Shendurney Wildlife Sanctuary, Kerala, India

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Abstract

The spider fauna of the Shendurney Wildlife Sanctuary of Kerala is documented based on the present collections and published records. A total of 79 species of spiders belonging to 53 genera and 16 families are recognized from the sanctuary. Among these spiders, 24 species are endemic to India, and two species, *Clubiona melanosticta* Thorell, 1890, and *Oxyopes mirabilis* Zhang, Yang & Zhu, 2005, are new records to India and South Asia as well. Most of the species of spiders (63%) belong to the families Araneidae and Salticidae. Analysis of guild structure recognized six feeding guilds, with orb-weavers being the most common, followed by stalkers and ambushers.

Keywords: Araneae, checklist, new records, guilds, endemic, Western Ghats, protected area

Introduction

Spiders are among the most successful groups of animals on earth, and they inhabit almost all terrestrial ecosystems and are especially diverse in the tropical and subtropical regions of the world (Foelix, 2011). They play important roles in several ecosystems as primary predators and prey for a diverse range of organisms (Nyffeler, 1999). They are also valuable in evaluating the total species richness and health of terrestrial ecosystems (Norris, 1999), and they respond differently to natural conditions and human disturbances (Pearce and Venier, 2006). Several of these qualities make spiders an interesting group for studying biodiversity and assessing natural ecosystems.

Spiders are important members of the forest community, which play a vital role in the forest food chain and contribute significantly to the biodiversity. Their abundance and diversity in forest ecosystems are important factors for future conservation and management efforts. The present study is carried out in the Shendurney Wildlife Sanctuary, a protected area of Kerala in the Western Ghats. It is one of the richest areas of biodiversity in the Western Ghats, bestowed with rare and endangered species of both flora and fauna. The diversity and distribution of spiders in this area are poorly known as compared to the other protected areas of the Western Ghats. Asima *et al.* (2021, 2022), Sen & Sureshan (2022), and Sudhin *et al.* (2022) described some new species of spiders from this region. Asima and Prasad (2022), recently reported 38 araneid spiders from the sanctuary. No other work on spiders have been carried out in this sanctuary till date. Therefore, extensive surveys and studies are required to find out the true diversity of spiders occurring in the Shendurney Wildlife Sanctuary. In the present study, an updated checklist of the spiders of the Shendurney Wildlife Sanctuary is provided based on the present collections and published records.

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Material and methods

Study area: The Shendurney Wildlife Sanctuary, situated in the Kollam district of Kerala, falls within the Agasthyamalai Biosphere Reserve of the Western Ghats. The sanctuary (8°44' to 9°14' N N latitude and 76°59' to 77°16' E longitude) covers an area of 171 km^2 (Aditya *et al.* 2018; Bilyaminu *et al.* 2021). The sanctuary has substantial natural vegetation, ranging from the southern secondary moist mixed deciduous forest to the southern subtropical hill forest (Narayanankutty *et al.* 2014). The elevation in the sanctuary varies from 800 to 1920 m above MSL, with a general slope towards the west (Aditya *et al.* 2018).

Methods: Collection of spiders was carried out in the different locations of the sanctuary from April 2019 to March 2022. Spiders were collected using standard sampling techniques such as vegetation beating, ground hand collection, aerial hand collection, and sweep netting (Sebastian and Peter, 2009). Collected specimens were preserved in 70% alcohol. Specimens were later examined in detail using a Leica M205A stereomicroscope. Images were acquired by using a Leica DFC4500 digital camera attached to the Leica M205A stereomicroscope equipped with Leica Application Suite (LAS), version 4.1.2. Identification was made with the help of relevant literature available in the World Spider Catalog (2023). Description of the length of leg segments is as follows: total length [femur, patella, tibia, metatarsus (except palp) and tarsus]. The studied spiders were deposited in the National Zoological Collections of the Zoological Survey of India (NZC-ZSI), Kolkata, West Bengal, and the Western Ghat Regional Centre (ZSI/WGRC), Kozhikode, Kerala.

Abbreviations used in the text and figures: ALE = anterior lateral eye, AME = anterior median eye, PLE = posterior lateral eye, PME = posterior median eye.

Figure 1. Map of the Shendurney Wildlife Sanctuary, Kerala.

Results

The study resulted in the recognition of 79 species of spiders belonging to 53 genera and 16 families (Tables 1 & 2). Among the collected spiders, 24 species are endemic to India (Table 2). Araneidae was the most diverse family (35 species, 44.3%) of the sanctuary followed by Salticidae (15 species,19%) and Oxyopidae (5 species, 6.3%) (Table 1). The remaining spider families contributed less than five species (Table 1). The families with the highest number of genera were the Araneidae (17 genera) and Salticidae (14 genera), and the rest of the families represent less than four genera (Table 1).

Spiders from the sanctuary were classified into the following guilds based on their foraging mode (Uetz *et al.* 1999): (1) Orb web weavers; (2) Stalkers; (3) Ambushers; (4) Foliage hunters; (5) Sheet web builders; and (6) Scattered line weavers (Table 1). Among the spiders, 41 species (52%) belong to the guild of orb web weavers, followed by the stalkers (24 species, 30.4%), ambushers (5 species), foliage hunters (4 species), scattered line weavers (3 species), and sheet web builders (2 species) (Figure 2).

The current study also reports two new records for India: *Clubiona melanosticta* Thorell, 1890, and *Oxyopes mirabilis* Zhang, Yang & Zhu, 2005. The systematics of these two new records is given below.

Family Clubionidae Wagner, 1887

***Clubiona melanosticta* Thorell, 1890**

(Figures 3a–d)

Clubiona melanosticta Thorell, 1890: 374.

Clubiona melanothele Thorell, 1895: 42.

Clubiona melanosticta — Thorell, 1895: 42. — Deeleman-Reinhold, 2001: 123, figs 51–52. — Dankittipakul and Singtripop, 2008: 42, figs 8–10, 52–54. — Zhang, Yu & Li, 2021: 49, figs 44A–E, 45A–H, 59A, 69A, 78F, 86F, 94F.

Material examined. 1♀ (NZC-ZSI-8215/18), INDIA: Kerala, Kollam district, Shendurney Wildlife Sanctuary, 9°17'33.0"N, 77°03'33.9"E, h= 792 m a.s.l., 09.xii.2021, collected by P. Girish Kumar.

Diagnosis. The male of *C. melanosticta* Thorell, 1890 can be distinguished from other *Clubiona* species by the shape of the conductor, which is elongate, transverse, flat, aligned along the distal edge of tegulum, retrolaterally ending in a short beak (see Deeleman-Reinhold, 2001: figs 51-52; Zhang *et al.*, 2021: figs 59A, 69A). The female distinguished by the epigyne with anterior U-shaped window lined with conspicuous black rim, and copulatory openings representing two black spots (Figure 3c).

Description: Female (Figs 3a–d): Measurements: Body length 5.13. Carapace length 2.31, width 1.58. Abdomen Length 2.64, width 1.64. Eye diameters: AME 0.11; ALE 0.12; PME 0.13; PLE 0.12. Eye inter distances: AME-AME 0.11; AME-ALE 0.08; ALE-ALE 0.47; PME-PME 0.26; PLE-PLE 0.86; PME-PLE 0.18; ALE-PME 0.12; ALE-PLE 0.07; AME-PME 0.12; AME-PLE 0.28. Clypeus height 0.05. Length of chelicera 0.87. leg I 4.31 [1.27, 0.61, 1.06, 0.75, 0.62], II 4.54 [1.33, 0.61, 1.19, 0.79, 0.62], III 3.88 [1.11, 0.52, 0.81, 1.02, 0.42], IV 5.63 [1.39, 0.70, 1.37, 1.55, 0.62]. Leg formula: 4213. Carapace pale yellow, slightly darker on ocular region. Chelicerae light yellowish-brown, promargin with 1 and retromargin with 2 teeth. Endites light yellow, outer margin with dark brown lines. Labium light yellow. Sternum pale yellow. Abdomen whitish-yellow, mottled with dark brown spots; venter whitish-yellow, without any markings. Spinnerets light brown. Epigyne as shown in Figs 3c–d. Epigyne with anterior U-shaped window lined with conspicuous black rim; copulatory openings representing 2 black spots; copulatory ducts wide and elbow shaped (Figs 3c–d; see Zhang *et al.*, 2021: fig 45A–D).

Distribution. India (new record), China, Myanmar, Thailand, Laos, Indonesia, and Papua New Guinea (present study; World Spider Catalog, 2023).

Family Oxyopidae Thorell, 1869

***Oxyopes mirabilis* Zhang, Yang & Zhu, 2005**

(Figures 3e–h)

Oxyopes mirabilis Zhang, Yang & Zhu, 2005: 76, figs 2A–C.

Oxyopes mirabilis — Tang & Li, 2012: 32, figs 29A–D, 30A–D.

Material examined. 1♂ (NZC-ZSI-8214/18), INDIA: Kerala, Kollam district, Shendurney Wildlife Sanctuary, 852′20″°N, 77°11′36″E, h= 899 m a.s.l., 20.i.2019, collected by P.M. Sureshan.

Diagnosis. *O. mirabilis* is most similar to *O. gaofengensis* Zhang, Zhang & Kim, 2005, from which it can be distinguished by the male palp with triangular cymbial apophysis, L-shaped palpal tegular apophysis, and female epigynum with three times twisted copulatory ducts (cf. Figs 6g–h, and figs 29A–B, D in Tang & Li [2012] with figs 3–5 in Zhang, Zhang & Kim [2005]).

Description: Male (Figs 3e–h): Measurements: Body length 6.07. Carapace length 2.85, width 2.34. Abdomen length 3.12, width 1.56. Eye diameters: AME 0.11; ALE 0.24; PME 0.23; PLE 0.25. Eye inter distances: AME-AME 0.15; AME-ALE 0.08; ALE-ALE 0.25; PME-PME 0.23; PLE-PLE 1.06; PME-PLE 0.32; ALE-PME 0.45; ALE-PLE 0.23; AME-PME 0.76; AME-PLE 0.52. Clypeus height 0.47. Length of chelicera 0.81. leg I 11.56 [2.94, 0.79, 3.15, 3.22, 1.46], II 9.96 [2.59, 0.64, 2.53, 2.81, 1.39], III 8.29 [2.05, 0.94, 1.77, 2.47, 1.06], IV 10.04 [2.62, 0.94, 2.46, 2.94, 1.08]. Leg formula: 1423. Carapace yellow. Ocular area grayish brown. Clypeus yellow, with inconspicuous stripes extending from anterior median eyes to the distal tip of chelicerae. Chelicerae yellow, pro-and retromargins with single tooth. Labium pale yellow. Endites light yellowish to light brown. Sternum pale yellow. Abdomen grayish-white, dorsally with few grayish-black spots and laterally with several grayish-black markings. Venter grayish-white, medially with a broad light brown longitudinal stripe. Palp as in Figs 3g–h: Patella and tibia with long black spines; cymbium with few spines and several bristles; Ventral tibial apophysis leaf-shaped in retrolateral view; tegular apophysis large and "L"-shaped; embolus slender (figs 3g–h).

Distribution. India (new record) and China (present study; World Spider Catalog, 2023).

Table 1. Number of genera and species, and feeding guilds of spider families reported from the Shendurney Wildlife Sanctuary.

Sl. No.	Families	Genera	Species	Guilds
1	Araneidae	17	35	Orb-web weavers
2	Tetragnathidae	2	4	
3	Uloboridae	2	2	
4	Ctenidae	2	4	Stalkers
5	Oxyopidae	3	5	
6	Salticidae	14	15	
7	Thomisidae	3	3	Ambushers
8	Philodromidae	1	1	
9	Pisauridae	1	1	
10	Cheiracanthiidae	1	2	Foliage hunters
11	Clubionidae	1	1	
12	Sparassidae	1	1	
13	Theridiidae	2	2	Scattered line weavers
14	Pholcidae	1	1	
15	Eresidae	1	1	Sheet web builders
16	Theraphosidae	1	1	
Total		**53**	**79**	

Table 2. Checklist of spiders recorded from the Shendurney Wildlife Sanctuary, with registration numbers for the present collection.

Sl. No.	Species	Registration Numbers	Remarks
	Family: Araneidae Clerck, 1757 (Orb web spiders)		
1	*Acusilas coccineus* Simon, 1895	-	*
2	*Anepsion maritatum* (O. Pickard-Cambridge, 1877)	-	*
3	*Arachnura angura* Tikader,1970	-	*$
4	*Araneus viridisomus* Gravely, 1921	-	***$**
5	*Argiope aemula* (Walckenaer, 1841)	-	*
6	*Argiope anasuja* Thorell, 1887	ZSI/WGRC/I.R-INV 16747-16748	+
7	*Argiope catenulata* (Doleschall, 1859)	-	*
8	*Argiope pulchella* Thorell, 1881	NZC-ZSI-7701/18; ZSI/WGRC/I.R-INV 16749-16755	+
9	*Bijoaraneus mitificus* (Simon, 1886)	-	*
10	*Cyclosa bifida* (Doleschall, 1859)	--	*
11	*Cyclosa confraga* (Thorell, 1892)	-	*
12	*Cyclosa gossypiata* Keswani, 2013	-	***$**
13	*Cyclosa hexatuberculata* Tikader, 1982	-	*
14	*Cyclosa insulana* (Costa, 1834)	-	*
15	*Cyclosa moonduensis* Tikader, 1963	-	***$**
16	*Cyclosa neilensis* Tikader, 1977	-	***$**
17	*Cyclosa purani* Keswani, 2013	-	***$**
18	*Cyclosa simoni* Tikader, 1982	--	***$**
19	*Cyclosa spirifera* Simon, 1889	-	*
20	*Cyrtarachne raniceps* Pocock, 1900	ZSI/WGRC/I.R-INV 16136	+
21	*Cyrtophora unicolor* (Doleschall, 1857)	-	*
22	*Eriovixia excelsa* (Simon, 1889)	-	*
23	*Eriovixia lagleizei* (Simon, 1877)	-	*
24	*Eriovixia sakiedaorum* Tanikawa, 1999	-	*
25	*Gasteracantha dalyi* Pocock, 1900	NZC-ZSI-7699/18; 7703/18.	+
26	*Gasteracantha geminata* (Fabricius, 1798)	ZSI/WGRC/I.R-INV 16744-16746	+
27	*Gea subarmata* Thorell, 1890	-	*
28	*Herennia multipuncta* (Doleschall, 1859)	-	*

Sl. No.	Species	Registration Numbers	Remarks
29	*Neoscona bengalensis* Tikader & Bal, 1981	-	*
30	*Neoscona mukerjei* Tikader, 1980	-	*
31	*Neoscona nautica* (L. Koch, 1875)	-	*
32	*Neoscona yptinika* Barrion & Litsinger, 1995	-	*
33	*Nephila pilipes* (Fabricius, 1793)	NZC-ZSI-7698/18; 7700/18; 7705/18	+
34	*Nephilengys malabarensis* (Walckenaer, 1841)	-	*
35	*Parawixia dehaani* (Doleschall, 1859)	ZSI/WGRC/I.R-INV 16756-16757	+
Family: Cheiracanthiidae Wagner, 1887 (Yellow sac spiders)			
36	*Cheiracanthium melanostomum* (Thorell, 1895)	ZSI/WGRC/I.R-INV 16758-16760	+
37	*Cheiracanthium murinum* (Thorell, 1895)	ZSI/WGRC/I.R-INV 16761	+
Family: Clubionidae Wagner, 1887 (Sac spiders)			
38	*Clubiona melanosticta* Thorell, 1890	NZC-ZSI-8215/18	# +
Family: Ctenidae Keyserling, 1877 (Wandering spiders)			
39	*Africactenus unumus* Sankaran & Sebastian, 2018	ZSI/WGRC/I.R-INV 16062	$ +
40	*Bowie cochinensis* (Gravely, 1931)	ZSI/WGRC/I.R-INV 16066-069	$ +
41	*Bowie indicus* (Gravely, 1931)	ZSI/WGRC/I.R-INV 16063	$ +
42	*Bowie sikkimensis* (Gravely, 1931)	ZSI/WGRC/I.R-INV 16064-065	$ +
Family: Eresidae C. L. Koch, 1845 (Social spiders)			
43	*Stegodyphus sarasinorum* Karsch, 1892	ZSI/WGRC/I.R-INV 16070-107	+
Family: Oxyopidae Thorell, 1869 (Lynx spiders)			
44	*Hamataliwa indica* Sen & Sureshan, 2022	-	$ +
45	*Oxyopes hindostanicus* Pocock, 1901	NZC-ZSI-8144/18	+
46	*Oxyopes javanus* Thorell, 1887	ZSI/WGRC/I.R-INV 16762-16784	+
47	*Oxyopes mirabilis* Zhang, Yang & Zhu, 2005	NZC-ZSI-8214/18	# +
48	*Peucetia viridana* (Stoliczka, 1869)	NZC-ZSI-8147/18	+
Family: Philodromidae Thorell,1869 (Elongated crab spiders)			
49	*Psellonus planus* Simon, 1897	NZC-ZSI-8146/18	$ +
Family: Pholcidae C. L. Koch, 1850 (Cellar spiders)			
50	*Artema atlanta* Walckenaer, 1837	ZSI/WGRC/I.R-INV 16785-16789	+
Family: Pisauridae Simon, 1890 (Nursery web spiders)			

Sl. No.	Species	Registration Numbers	Remarks
51	*Nilus albocinctus* (Doleschall, 1859)	ZSI/WGRC/I.R-INV 16108-114	+
Family: Salticidae Blackwall, 1841 (Jumping spiders)			
52	*Cocalus shendurneyensis* Sudhin, Sen, Caleb & Hegde, 2022	-	*$
53	*Habrocestum shendurneyense* Asima, Caleb, Babu & Prasad, 2022	-	*$
54	*Carrhotus viduus* (C. L. Koch, 1846)	NZC-ZSI-8148/18	+
55	*Indopadilla insularis* (Malamel, Sankaran & Sebastian, 2015)	ZSI/WGRC/I.R-INV 16127-134; NZC-ZSI-7745/18	+$
56	*Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)	NZC-ZSI-7748/18	+
57	*Orientattus aurantius* (Kanesharatnam & Benjamin, 2018)	NZC-ZSI-7714/18	+
58	*Phintella vittata* (C. L. Koch, 1846)	ZSI/WGRC/I.R-INV 16793-16799	+
59	*Plexippus petersi* (Karsch, 1878)	NZC-ZSI-8150/18	+
60	*Rhene flavicomans* Simon, 1902	NZC-ZSI-8149/18	+
61	*Stenaelurillus albus* Sebastian, Sankaran, Malamel & Joseph, 2015	NZC-ZSI-7762/18	$ +
62	*Stenaelurillus lesserti* Reimoser, 1934	ZSI/WGRC/I.R-INV 17228-17240	+
63	*Tamigalesus munnaricus Żabka*, 1988	NZC-ZSI-7742/18	+
64	*Telamonia dimidiata* (Simon, 1899)	NZC-ZSI-7735/18; 7746/18	+
65	*Thiania bhamoensis* Thorell, 1887	NZC-ZSI-8153/18	+
66	*Siler semiglaucus* (Simon, 1901)	NZC-ZSI-8151/18	+
Family: Sparassidae Bertkau, 1887 (Giant crab spiders)			
67	*Olios lamarcki* (Latreille, 1806)	ZSI/WGRC/I.R-INV 16800	+
Family: Tetragnathidae Menge, 1866 (Long-jawed spiders)			
68	*Leucauge fastigata* (Simon, 1877)	NZC-ZSI-8152/18	+
69	*Leucauge tessellata* (Thorell, 1887)	NZC-ZSI-7697/18; 7704/18	+
70	*Tylorida flava* Sankaran, Malamel, Joseph & Sebastian, 2017	NZC-ZSI-7743/18	$ +
71	*Tylorida ventralis* (Thorell, 1877)	NZC-ZSI-8145/18	+
Family: Theraphosidae Thorell, 1869 (Tarantulas)			
72	*Poecilotheria striata* Pocock, 1895	-	$ + *β*
Family: Theridiidae Sundevall, 1833 (Comb-footed spiders)			
73	*Argyrodes flavescens* O. P. Cambridge, 1880	ZSI/WGRC/I.R-INV 16116-126	+
74	*Chrysso angula* (Tikader, 1970)	NZC-ZSI-7702/18	$ +

Sl. No.	Species	Registration Numbers	Remarks
Family: Thomisidae Sundevall, 1833 (Crab spiders)			
75	*Camaricus formosus* Thorell, 1887	NZC-ZSI-7734/18	+
76	*Strigoplus netravati* Tikader, 1963	ZSI/WGRC/I.R-INV 16801-16808	$ +
77	*Thomisus projectus* Tikader, 1960	ZSI/WGRC/I.R-INV 16137	$ +
Family: Uloboridae Thorell,1869 (Hackled web spiders)			
78	*Miagrammopes poonaensis* Tikader, 1971	ZSI/WGRC/ I.R - INV 16135; ZSI/ WGRC/I.R-INV 16137	$ +
79	*Uloborus shendurneyensis* Asima, Sudhikumar & Prasad, 2021	-	*$

Abbreviations used: + =Present study, ***β***=observed during the survey, # =First report from India, $ =Endemic to India, * =Reported from literature.

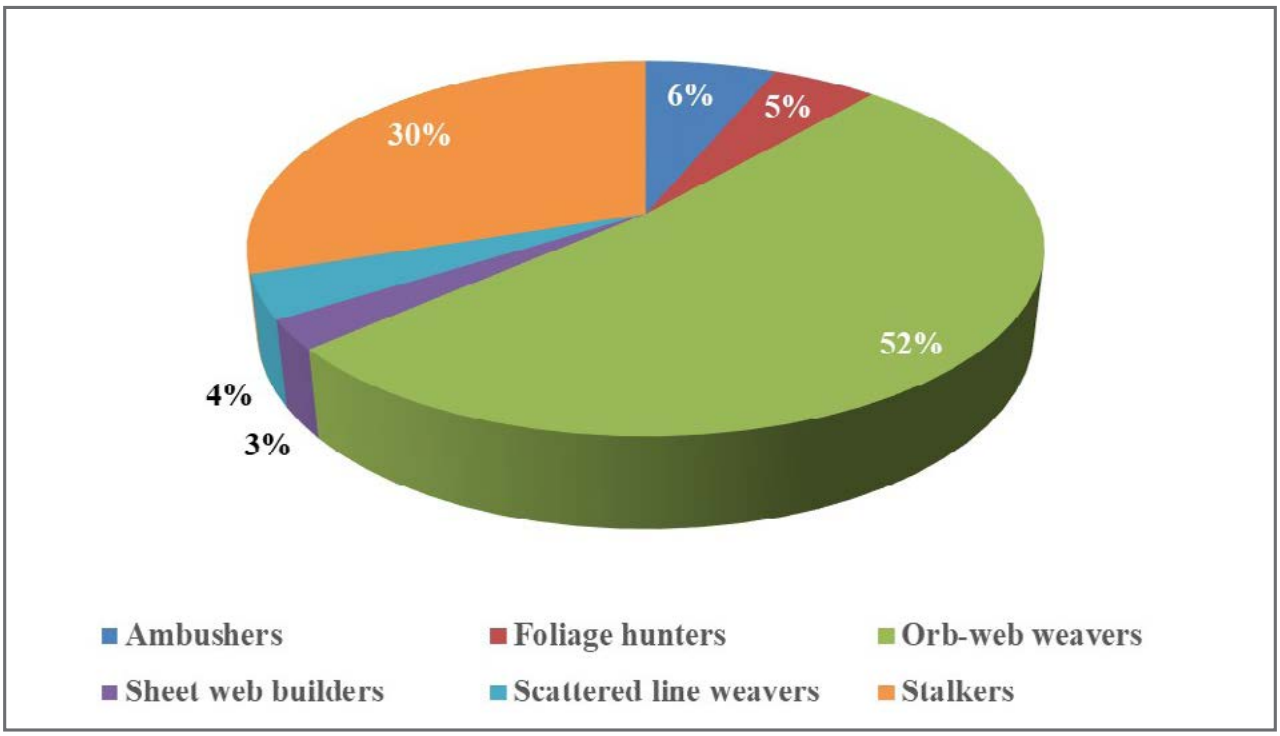

Figure 2. Guild structure analysis based on species richness of spiders reported from the Shendurney Wildlife Sanctuary.

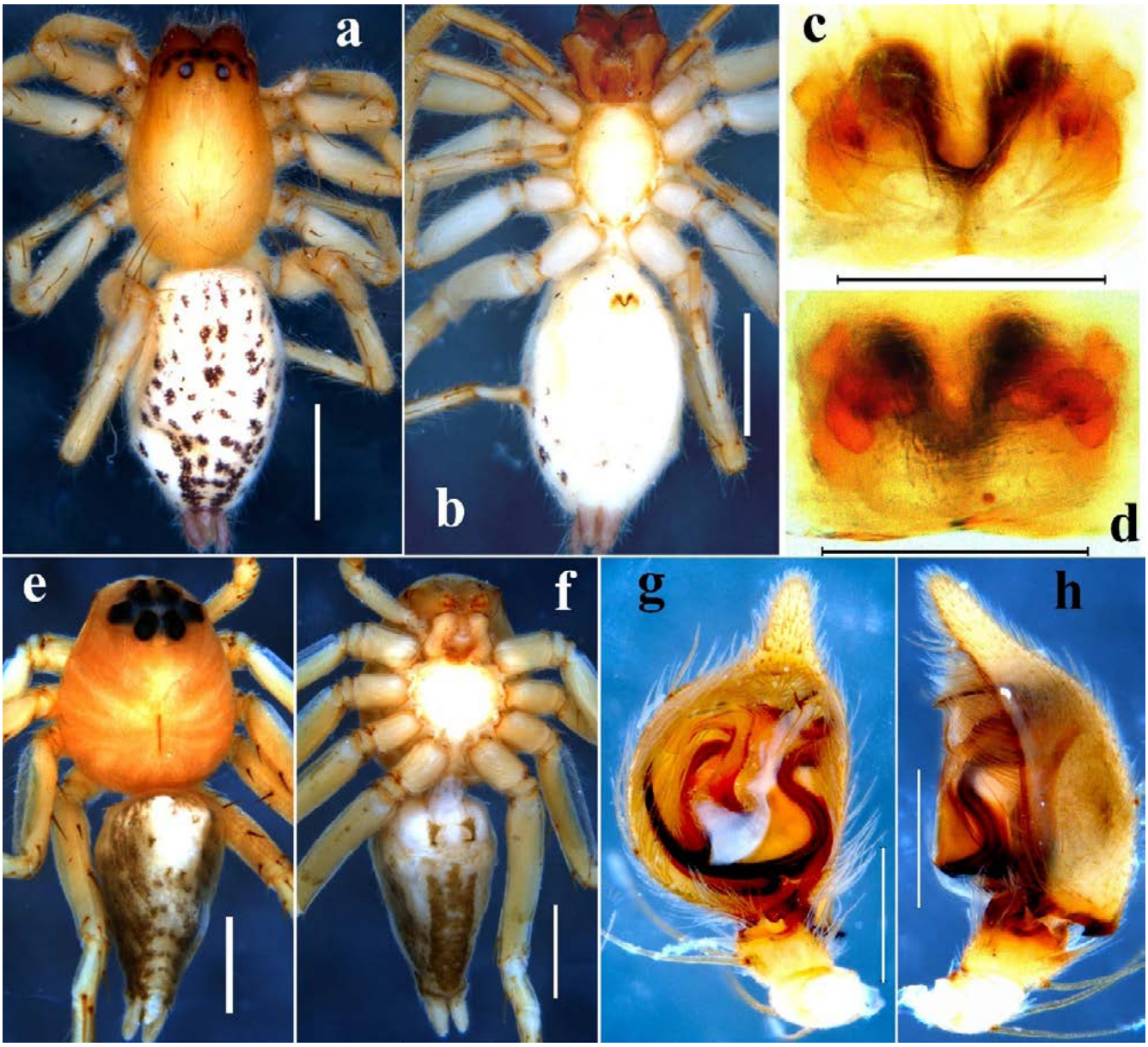

Figure 3. *Clubiona melanosticta*, ♀ (NZC-ZSI-8215/18) (a–d). *Oxyopes mirabilis* ♂ (NZC-ZSI-8214/18) (e–h). a, e –habitus dorsal view; b, f – habitus ventral view; c – epigyne ventral view; d – epigyne dorsal view; g – left male palp ventral view; h – left male palp retrolateral view. Scale bars: a, b, e, f = 1 mm; c, d = 0.2 mm; g, h = 0.5 mm.

Discussion

The present study was carried out with an aim to know the diversity of the spiders of the Shendurney Wildlife Sanctuary and to provide an updated checklist of spiders from the sanctuary. The spider fauna of the Shendurney Wildlife Sanctuary accounts for 4.1% of total species diversity, 9% of generic diversity, and 26.2% of family diversity recorded from India (Caleb and Sankaran, 2023). The most interesting finding of the current study is the first records of two species from India. The sac spider, *C. melanosticta*, is distributed mostly in Southeast Asia; while the lynx spider, *O. mirabilis*, is known only from China (World Spider Catalog, 2023). Both these species, therefore, constitute new records to South Asia as well.

The study shows that the overall diversity of spiders in the Shendurney Wildlife Sanctuary is higher, with Araneidae and Salticidae being the most dominant spider families. The result of this study consistent with earlier works, which confirm that the natural forest ecosystems support many species of Araneidae and Salticidae (Ganesan and Shunmugavelu, 2012; Solanki *et al.*, 2020; Sen *et al.*, 2022). Araneidae and Salticidae are the most species rich families found in India and are distributed across the country (Caleb and Sankaran, 2023). The dominance of these families in the study area is mainly due to the area's vegetation structure, which supports a variety of microhabitats in which araneids and salticids can live. The categorization of spider guilds also denotes the effect of habitat type on the spider composition (Freitas *et al.*, 2013). Orb web weavers and stalkers are the most common guilds observed in the study area. The sanctuary contains mostly bushes, shrubs, and understory plants, providing a convenient environment for spiders to build their webs, hunt for food and construct retreats (Uetz, 1991).

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