AN INVESTIGATION OF DIVERSITY AND BIOECOLOGY OF ARANEFAUNA OF PATHIRAMANAL ISLAND IN VEMBANAD LAKE, A RAMSAR SITE, KERALA, INDIA

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Abstract. A preliminary checklist of araneofauna of Pathiramanal Island is provided. A total of 147 species belonging to 26 families under 92 genera are documented. Tylorida ventralis (Thorell 1877) is considered to be the dominant species, and orb weavers are seen as the dominant guild. Araneidae, Salticidae, Theridiidae, Tetragnathidae and Thomisidae are five dominant families. The Shannon diversity, Simpson’s (1-D) diversity, evenness and Chao1 indices have been calculated. Seven species new to science such as Indopadilla insularis, Epeus triangulopalpis, Marengo sachintendulkar, Indomarengo chavarapater, Icius vikrambatrai, Piranthus planolancis (Salticidae) and Wolongia papafrancisi (Tetragnathidae) are documented as well as three genera and four species are added to the Indian spider taxonomy. The males of Meotipa picturara, Curubis tetrica and Pscellonus planus are described for the first time. Eight species are synonymized and redescribed. Mating plug formation in Argyrodes flavescens is reported for the first time. It is noted that spider species from Pathiramanl Island bear affinities with Oriental and Palearctic regions.

INTRODUCTION

A healthy ecosystem and its smooth functioning is an indicator of the potentiality of the biodiversity of that particular ecosystem (Pettersson 1996). Pathiramanal Island seems to be a healthy ecosystem with a tower of biodiversity of both plants and animals. As far as a local legend goes, Pathiramanal Island originated as a result of divine intervention. A young Brahmin (a person belonging to the Hindu higher caste worthy of priesthood) dived into Vembanad Lake to perform his evening prayers, and the water made way for land to rise from below, thus forming the enchanting Island of Pathiramanal which means ‘sands of midnight’. A great charming look, wide waterfront, flourishing coconut palms, floating weeds and hyacinths, tiny birds building nests on weeds, and varieties of rare fauna and flora among the dense foliage of this tiny Island make it really a biodiversity hotspot. But, regrettably, no previous biodiversity studies have been done in Pathiramanal Island. An informal report indicates that the Island possesses some sort of fauna like odonates, birds, mammals, reptiles and arthropods (not a precise data). Arthropod diversity in this area remains undocumented, and a pilot study disclosed that it is a refuge for a rich volume of arachnids, to which spiders make a great contribution. But no organized work has been carried out to date on the taxonomy and diversity of spiders of this biologically unique ecosystem. 23 species of spiders have been named unofficially from this ecological zone. However, it is sure that a number of spiders have yet to be explored in this ecosystem, which prompts the need for an inventory of the spider fauna of this unique environmental sector. As spiders free us from most of insect pests like a key component to balancing the ecosystem both as prey and predator, they are very important animal taxa for humans (Benitez and Méndez 2011). In order to understand the potentiality of the Island and to conserve the spider species there, it is essential to explore the Island comprehensively. Therefore, this study is an attempt to throw light on the diversity, richness, abundance and dominance of spiders in Pathiramanal Island.

MATERIALS AND METHODS

Study Area
Pathiramanal Island (hereinafter, Island) is a small tropical island with an area of approximately 1 km². It lies between the latitudes 9°37'07.11'' N and longitudes 76°23'04.95'' E (Figure 1). Though small in size, Pathiramanal Island is blessed with rich flora and fauna owing to the presence of a wide forest cover and thick vegetation (Figure 2). With respect to its geographical, climatic and ecological features, the Island harbours a rich amount of arachnids, of which spiders have a huge share. The temperature ranges from 28.6° C to 33.5° C, with an annual mean of 31.0° C and plentiful rainfall in June–July (annual rainfall > 250 mm). The dense vegeta-
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The diversity, richness and spatial distribution of spider species were investigated from October 2014 to September 2016. In the present study, four hours of sampling involved active searching for spiders, employing a combination of five collection methods such as aerial hand collection, ground hand collection, litter sampling, sweep netting and vegetation beating. All the specimens collected during the survey were transferred to a fixative (70% alcohol) for preservation. The sex and developmental stage of all trapped individuals were determined in the laboratory. Species-level identification was mainly made by looking at the genital features of the spiders. The palp and epigyne were dissected, and the epigyne was cleared in 10% KOH for identifying the species. A detailed taxonomic study was carried out using the data provided by the World Spider Catalog (2020).

Data analysis

Statistical relevance of collected data was supported by calculating the following diversity indices:

Shannon-Weiner diversity index ($H'$) was calculated using the formula:

$$H' = -\sum (p_i \times \ln(p_i)),$$

where $\sum$ = summation, $p_i$ = proportion of total sample represented by species $i$.

Simpson’s diversity index ($D' = 1 - D$) was calculated using the formula:

$$D' = 1 - \frac{\sum n(n - 1)}{N(N - 1)}$$

$$N(N - 1),$$

where $D$ = Simpson’s index, $n$ = total number of organisms of a particular species, $N$ = total number of organisms of all species.

Evenness in species distribution was calculated using Simpson’s formula:

$$E = D/D_{\text{max}},$$

where $D = 1/\sum P$, 2.

Chao1, an estimate of total species richness, was calculated using the formula:

$$\text{Chao1} = S + F1(1 - F1) / (2 (F2 + 1),$$

where $F1$ = the number of singleton species, $F2$ = the number of doubleton species.

RESULTS

A total of 147 species of spiders belonging to 92 genera and 26 families were collected during the entire sampling period (Table 1). The Shannon diversity, Simpson’s (1–D) diversity, evenness, and Chao1 indices were calculated to be 4.05, 0.970, 0.394, and 149.3, respectively. The most dominant five families reported were Araneidae (22%, 33 species), followed by Salticidae (21.5%, 32 species), Theridiidae (11%, 16 species), Tetragnathidae (9.5%, 14 species) and Thomisidae (5.5%, 8 species), while families such as Cheiracanthiidae, Gnaphosidae, Hersiliidae, Linyphiidae, Oonopidae, Philodromidae, Pholcidae, Pisauridae, Psechridae, Scytodidae, Sicariidae and Zodariidae were represented by only one species each. *Tylorida ventralis* was an abundant species throughout the study period. Out of 26 families, 23 are classified as entelegyne spiders and three (Oonopidae, Scytodidae, Sicariidae) are haplogyne spiders. Some families were more widely.
distributed throughout Pathiramanal Island, while others were restricted to one or a few habitat types. Two families were found in almost all sites: jumping spiders (Salticidae) and orb-web spiders (Araneidae). Two families were found in 75% of the sites: comb-footed spiders (Theridiidae) and long-jawed spiders (Tetragnathidae). Some other families found in more than 30% of all sites included wolf spiders (Lycosidae), crab spiders...
## Table 1. Checklist of spiders of Pathiramanal island.

| Sl. No. | Family/Species | Remarks |
|---------|----------------|---------|
| 1       | *Anapsion maritatum* (O. Pickard-Cambridge, 1877) | New synonymy |
| 2       | *Araneus diadematus* Clerck, 1757 | |
| 3       | *Araneus ellipticus* (Tikader & Bal, 1981) | |
| 4       | *Araneus* sp.3 | |
| 5       | *Araneus* sp.4 | |
| 6       | *Argiope aemula* (Walckenaer, 1841) | |
| 7       | *Argiope anasuja* Thorell, 1887 | |
| 8       | *Argiope pulchella* Thorell, 1881 | |
| 9       | *Chorizopes anjanes* Tikader, 1965 | |
| 10      | *Chorizopes* sp.2 | |
| 11      | *Cyclosa bifida* (Doleschall, 1859) | |
| 12      | *Cyclosa confraga* (Thorell, 1892) | |
| 13      | *Cyclosa mulmeinensis* (Thorell, 1887) | |
| 14      | *Cyclosa* sp.4 | |
| 15      | *Cyrtophora cicatrosa* (Stoliczka, 1869) | |
| 16      | *Cyrtophora citricola* (Forsskal, 1775) | |
| 17      | *Cyrtophora moluccensis* (Doleschall, 1857) | |
| 18      | *Cyrtophora unicolor* (Doleschall, 1857) | |
| 19      | *Érioxyxia excelsa* (Simon, 1889) | |
| 20      | *Érioxyxia laglaizei* (Simon, 1877) | |
| 21      | *Érioxyxia* sp.3 | |
| 22      | *Gasteracantha geminata* (Fabricius, 1798) | Redescription |
| 23      | *Guzzygiella nadleri* (Heimer, 1984) | |
| 24      | *Herennia multipuncta* (Doleschall, 1859) | |
| 25      | *Neoscona bengalensis* (Tikader & Bal, 1981) | |
| 26      | *Neoscona molemensis* Tikader & Bal, 1981 | |
| 27      | *Neoscona mukerjei* Tikader, 1980 | |
| 28      | *Neoscona nautica* (Koch, 1875) | |
| 29      | *Neoscona theisi* (Walckenaer, 1841) | |
| 30      | *Neoscona vigilans* (Blackwall, 1865) | |
| 31      | *Neoscona* sp.7 | |
| 32      | *Parawixia dehaami* (Doleschall, 1859) | First record |
| 33      | *Porcataraneus bengalensis* (Tikader, 1975) | |
| 34      | *Clubiona drassodes* O. Pickard-Cambridge, 1874 | |
| 35      | *Clubiona* sp.2 | |
| 36      | *Castianeira zetes* Simon, 1897 | |
| 37      | *Corinnoma severum* (Thorell, 1877) | |
| 38      | *Dictyna* sp. | |
| 39      | *Nigma* sp. | |
| 40      | *Cheiracanthium danieli* Tikader, 1975 | |
| 41      | *Cheiracanthium melanostomum* (Thorell, 1895) | |
| 42      | *Cheiracanthium* sp.3 | |
| 43      | *Urozelotus* sp. | |
| 44      | *Hersilia savignyi* Lucas, 1836 | |
| 45      | *Nasoonna crucifera* (Thorell, 1895) | First record |
| 46      | *Oedignatha binoyii* Reddy & Patel, 1993 | |
| 47      | *Oedignatha scrobiculata* Thorell, 1881 | |
| 48      | *X. FAMILY LYCOSIDAE* Sundevall, 1833 | |
| Sl. No. | Family/Species | Remarks |
|---------|----------------|---------|
| 48      | Hippasa greenalliae (Blackwall, 1867) |         |
| 49      | Lycosa sp.   |         |
| 50      | Pardosa pseudoannulata (Bösenberg & Strand, 1906) |         |
| 51      | Pardosa sumatrana (Thorell, 1890) |         |
| 52      | Pardosa sp.3 |         |
| 53      | Zoica puellula (Simon, 1898) |         |
| 54      | Orchestina sp. |         |
| 55      | Hamataliwa sp. 1 |         |
| 56      | Hamataliwa sp. 2 |         |
| 57      | Oxyopes birmanicus Thorell, 1887 |         |
| 58      | Oxyopes javanus Thorell, 1887 |         |
| 59      | Oxyopes shweta Tikader, 1970 |         |
| 60      | Oxyopes sunandae Tikader, 1970 |         |
| 61      | Oxyopes sp.5 |         |
| 62      | Psellonus planus Simon, 1897 | Redescription |
| 63      | Crossopriza lyoni (Blackwall, 1867) |         |
| 64      | Pholcus sp.  |         |
| 65      | Dendrolycosa gitae Tikader, 1970 |         |
| 66      | Fecenia protensa Thorell, 1891 | New Synonymy |
| 67      | Brettus cingulatus Thorell, 1895 |         |
| 68      | Carrhotus samio (Thorell, 1877) |         |
| 69      | Carrhotus vihius (C. L. Koch, 1846) |         |
| 70      | Chalcotropis pennaia Simon, 1902 |         |
| 71      | Cosmophasis sp. |         |
| 72      | Curubis tetrica Simon, 1902 | Redescription |
| 73      | Epeus tener (Simon, 1877) |         |
| 74      | Epeus triangulopalpis Malamel et al. 2018 | New species |
| 75      | Epeus sp.3 |         |
| 76      | Epocilla aurantiaca (Simon, 1885) |         |
| 77      | Evarcha pococki Zabka, 1985 | First record |
| 78      | Hyllus semicupreus (Simon, 1885) |         |
| 79      | Icicus vikrambhatl Malamel et al 2018 | New species |
| 80      | Indomarengo chavarapater Malamel et al 2018 | New species |
| 81      | Indopadilla ularlis Malamel et al. 2015 | New species |
| 82      | Marengo sachintendulkar Malamel et al 2018 | New species |
| 83      | Myrmaplata platiaeoides (O. Pickard-Cambridge, 1869) |         |
| 84      | Myrmarchne melanocephala MacLeay, 1839 |         |
| 85      | Myrmarchne robusta (Peckham & Peckham, 1892) |         |
| 86      | Myrmarchne prava Tikader, 1973 |         |
| 87      | Phaeaeus lancearius (Thorell, 1895) |         |
| 88      | Phintella vittata (C. L. Koch, 1846) |         |
| 89      | Piranthus planolancis Malamel et al. 2018 | New species |
| 90      | Plexippus paykulli (Audouin, 1826) |         |
| 91      | Portia fimbrigata (Doleschall, 1859) |         |
| 92      | Rheni danieli Tikader, 1973 |         |
| 93      | Rheni flavicosans Simon, 1902 |         |
| 94      | Rheni flavigera (Koch, 1846) |         |
| 95      | Siler semiglaucus Simon, 1961 |         |
| 96      | Telamonia dimidiata (Simon, 1899) |         |
| 97      | Thiana bhanoensis Thorell, 1887 |         |
| 98      | Uroballus sp. |         |
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| Sl. No. | Family/Species | Remarks |
|---------|----------------|---------|
| 99      | **Scytodes thoracica** (Latreille, 1802) |         |
| 100     | **Loxosceles rufescens** (Dufour, 1820) |         |
| 101     | **Heteropoda venatoria** (Linnaeus, 1767) |         |
| 102     | **Olios** sp.1 |         |
| 103     | **Olios** sp.2 |         |
| 104     | **Theleticopis virescens** Pocock, 1901 |         |
| 105     | **Dolichognatha** sp. |         |
| 106     | **Leucauge decorata** (Blackwall, 1864) |         |
| 107     | **Leucauge granulata** (Walckenaer, 1841) | New synonym |
| 108     | **Tetragnatha cochinensis** Gravely, 1921 |         |
| 109     | **Tetragnatha javana** (Thorell, 1890) |         |
| 110     | **Tetragnatha mandibulata** Walckenaer, 1841 |         |
| 111     | **Tetragnatha versicolor** Walckenaer, 1841 |         |
| 112     | **Tetragnatha viridiorufa** Gravely, 1921 |         |
| 113     | **Tetragnatha** sp.6 |         |
| 114     | **Tetragnatha** sp.7 |         |
| 115     | **Tetragnatha** sp.8 |         |
| 116     | **Tylorida striata** (Thorell, 1877) |         |
| 117     | **Tylorida ventralis** (Thorell, 1877) |         |
| 118     | **Wolongia papafrancisi** Malamel et al. 2018 | New species |
| 119     | **Achaearanea** sp. |         |
| 120     | **Argyrodes argentatus** O. Pickard-Cambridge, 1880 |         |
| 121     | **Argyrodes bonadea** (Karsch, 1881) |         |
| 122     | **Argyrodes flavescens** O. Pickard-Cambridge, 1880 |         |
| 123     | **Argyrodes gazedes** Tikader, 1970 |         |
| 124     | **Ariannes flagellum** (Doleshall, 1857) |         |
| 125     | **Chryso** sp. |         |
| 126     | **Colesosoma blandum** O. Pickard-Cambridge, 1882 |         |
| 127     | **Euryopis** sp. |         |
| 128     | **Meotipa picturata** Simon, 1895 | Redescription |
| 129     | **Nihonhimea mundula** (L. Koch, 1872) |         |
| 130     | **Parasteatoda tepidariorum** (C.L Koch, 1872) |         |
| 131     | **Parasteatoda** sp.2 |         |
| 132     | **Steatoda** sp. |         |
| 133     | **Rhomphaea** sp. |         |
| 134     | **Theridion manjithar** Tikader, 1970 |         |
| 135     | **Amyciaea fortecpsi** (Cambridge, 1873) |         |
| 136     | **Epidius parvati** Benjamin, 2000 | First record |
| 137     | **Epidius** sp.2 |         |
| 138     | **Indoxycticus minutus** (Tikader, 1960) |         |
| 139     | **Misumenops** sp. |         |
| 140     | **Thomisus lobosus** Tikader, 1965 |         |
| 141     | **Thomisus projectus** Tikader, 1960 |         |
| 142     | **Thomisus** sp.3 |         |
| 143     | **Trachelas** sp. |         |
| 144     | **Utivarachna** sp. |         |
| 145     | **Uloborus krishnae** Tikader, 1970 |         |
| 146     | **Zosis geniculata** (Olivier, 1789) |         |
| 147     | **Tropizodium virudorbium** Prajapati et al. 2016 |         |
(Thomisidae), huntsman spiders (Sparassidae), and families that were only found in a single site included flat-bellied ground spiders (Gnaphosidae), running crab spiders (Philodromidae), violin spiders (Sicariidae) and mesh-web spiders (Dictynidae).

The spiders of Pathiramanal Island can be divided into seven feeding guilds based on the foraging behaviour. They are ambushers, foliage runners, ground runners, orb weavers, sheet web builders, space web builders and stalkers. The dominant guild was of orb weavers (33%), followed by stalkers (27%), space web builders (13%), ambushers (11%), ground runners (9%), foliage runners (6%) and sheet web builders (1%) (Table 2, Figure 3).

One of the most notable achievements of the study is the discovery and documentation of seven species new to science, such as *Indopadilla insularis*, *Epeus triangulopalpis*, *Marengo sachindulkar*, *Indomarengo chavarapater*, *Piranthus planolancis* (Salticidae) and *Wolongia papafrancisi* (Tetragnathidae) (Figure 4, Table 3). Three genera and four species are documented as new records from Indian region (Figure 5) and 124 species are newly recorded from Pathiramanal Island. It was surprising to note the presence of the poisonous spider *Loxosceles rufescens* coming under the family Sicariidae.

Mating plug formation is often common in the genus *Argyrodes* since these spiders are found both sexes together and live as kleptoparasites in the webs of large orb-weaving spiders (Koh and Li 2002). Although a number of reports on mating plug formation in this genus had been done before, mating plug formation in the sixth species of *Argyrodes* (*A. flavescens*) was observed for the first time during this study based on the specimens collected from Pathiramanal Island (Figure 6).

### Table 2: Total number of families, genera, species and functional guilds of spiders in Pathiramanal island.

| Sl. No. | Family | No. of genera | No. of species | Guild |
|--------|--------|---------------|----------------|-------|
| 1      | FAMILY ARANAEIDAE Menge, 1890 | 13 | 33 | Orb weavers |
| 2      | FAMILY CLUBIONIDAE Wagner, 1887 | 1 | 2 | Foliage runners |
| 3      | FAMILY CORINNIDAE Karsch, 1880 | 2 | 2 | Ground runners |
| 4      | FAMILY DICTYNIDAE Karsch, 1880 | 2 | 2 | Foliage runners |
| 5      | FAMILY CHEIRACANTHIIDAE Wagner, 1887 | 1 | 3 | Foliage runners |
| 6      | FAMILY GNAPHOSIDAE Thorell, 1870 | 1 | 1 | Ground runners |
| 7      | FAMILY HERSILIIDAE Thorell, 1870 | 1 | 1 | Ambushers |
| 8      | FAMILY LINYPHIDAE Blackwall, 1859 | 1 | 1 | Space web builders |
| 9      | FAMILY LIOCRANIDAE Simon, 1897 | 1 | 2 | Ground runners |
| 10     | FAMILY LYCOSIDAE Sundevall, 1833 | 4 | 6 | Ground runners |
| 11     | FAMILY OONOPIDAE Simon, 1890 | 1 | 1 | Ground runners |
| 12     | FAMILY OXYOPIDAE Thorell, 1870 | 2 | 7 | Stalkers |
| 13     | FAMILY PHILODROMIDAE Thorell, 1870 | 1 | 1 | Ambushers |
| 14     | FAMILY PHOLCIDAEC. L. Koch, 1850 | 2 | 2 | Space web builders |
| 15     | FAMILY PISAURIDAE, Simon, 1890 | 1 | 1 | Ambushers |
| 16     | FAMILY PSECHRIDAE, Simon, 1890 | 1 | 1 | Sheet web builders |
| 17     | FAMILY SALTICIDAE, Blackwall, 1841 | 25 | 32 | Stalkers |
| 18     | FAMILY SCYTODIDAE Blackwall, 1864 | 1 | 1 | Ground runners |
| 19     | FAMILY SICARIIDAE Keyserling, 1880 | 1 | 1 | Ambushers |
| 20     | FAMILY SPARASSIDAE Berkuti, 1891 | 3 | 4 | Ambushers |
| 21     | FAMILY TETRAGNATHIDAE Menge, 1866 | 5 | 14 | Orb weavers |
| 22     | FAMILY THERIDIIDAE Sundevall, 1833 | 12 | 16 | Space web builders |
| 23     | FAMILY THOMISIDAE Sundevall, 1833 | 5 | 8 | Ambushers |
| 24     | FAMILY TRACHELIDAE Simon, 1897 | 2 | 2 | Foliage runners |
| 25     | FAMILY ULOBORIDAE, Thorell, 1869 | 2 | 2 | Orb weavers |
| 26     | FAMILY ZODARIIDAE Thorell, 1881 | 1 | 1 | Ground runners |
| Total  |        | 92 | 147 |       |
Figure 4. New species described (field photos): A, B, male and female of *Epeus triangulopalpis*; C, D, male and female of *Indopadilla insularis*; E, female of *Piranthus planolancis*; F, female of *Marengo sachintendulkar*; G, male and female of *Indomarengo chavarapater*, H, I, male and female of *Wolongia papafrancisi*; J, K, male and female of *Icius vikrambatrai*.

**DISCUSSION**

The present study is the first comprehensive documentation of the spider fauna in Pathiramanal Island. The present study revealed that the total spider diversity of Pathiramanal Island represents 10% of total species, 22% of total genus and 43% of total family diversity reported from India (Sebastian and Peter 2009) and accounts for 35% of total species, 40% of total genus and 60.5% of total family diversity from Kerala (Jobi and Sebastian, in preparation). However, it seems that a good number of species remains that probably are new species but cannot be described due to lack of proper literature on these taxa. A high number of species recorded indicates a rich spider diversity of this region which was also indicated by Shannon diversity.
Figure 5. New records from India: A, B, female of Cytrophora unicolor; C, D, male and female of Nasoona crucifera; E, F, male of Phaeacius lancearius; G, H, female of Epidius parvati.
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index (H = 4.05) and Simpson’s diversity index (1-D = 0.970). Even though the observed species richness was 147, the estimated species richness (Chao1) was found to be 149.3, which designates that a number of species could be collected from a thorough sampling of a long period. The existence of spiders is mainly dependent on the habitat they live in and select based on the physiological factors of the habitat, availability of prey and the apt site for web building.

The guild study was done to form the basis of community organization of spiders in Pathiramanal Island, and the study yielded seven ecological guilds based

| No | Family   | Genus   | Species            | Status   |
|----|----------|---------|--------------------|----------|
| 1  | Salticidae | Epeus   | triangulopalpis   | New species |
| 2  | ,,        | Icius   | vikrambatrai       | ,,       |
| 3  | ,,        | Indomarengo | chavarapater  | ,,       |
| 4  | ,,        | Indopadilla | insularis       | ,,       |
| 5  | ,,        | Marengo | sanchintendukar    | ,,       |
| 6  | ,,        | Piranthus | planolancis     | ,,       |
| 7  | Tetragnathidae | Wolongia | papafrancisi   | ,,       |

Figure 6. A–D, mating plug formation in *Argyrodes flavescens*; E, epigyne with mating plug (dorsal view); F, epigyne without mating plug.

Table 3. New species described.
on their foraging mode (Figure 3). Orb weavers were the dominant guild (33%) including the families such as Araneidae, Tetragnathidae and Uloboridae, and this might be due to the collecting localities of Pathiramanal Island that take care of shelter, reproductive behaviour and foraging of these orb webs. The sheet web builders were the lowest guild type (1%) with the family Psechridae. The presence of the poisonous spider *Loxosceles rufescens* in the Island reminds that tourists should be aware of these spiders because of their ability to cause skin necrosis or loxoscelism with their necrotizing venom.

As *Argyrodex flavescens* is a social spider and often seen with both sexes together, it is easier for male spiders to make plugs in female openings. This observation suggests that their nature of living is critical in plug formation. The reason behind mating plug formation being common in this species could be its kleptoparasitic nature in the webs of host species and the usual presence of males.

According to Holloway (1974), Indian fauna formed as a result of displacement by invaders from other regions of the Oriental region after its separation from Gondwanaland and merger with Asia. So spider species from Pahiramanal Island also bear affinities with Oriental and Palearctic regions since it is a part of Vembanad Lake, a Ramsar site in India. Some species of the genera *Argiope*, *Cyclosa*, *Eriovixia*, *Gasteracantha* (family Araneidae); *Tylorida*, *Tetragnatha* (family Tetragnathidae) exhibit Sri Lankan affinities. Some species of genera *Argiope*, *Cyclosa*, *Eriovixia*, *Gasteracantha* (family Araneidae); *Tylorida*, *Tetragnatha* (family Tetragnathidae) had affinities with Oriental and Palearctic regions. A araneid species *Eriovixia laglaizei* shows Palearctic affinities.

Spiders can easily colonize any habitat, especially the isolated lands like Pathiramanal Island, as they are able to disperse over long distances using wind currents (‘ballooning’) in general. The difficulty in spider biodiversity assessment in Pathiramanal Island seems to be related to the lack of historical expeditions focusing on this group of arthropods. High richness and variability as well as the rate of new species records and new species descriptions indicate a satisfactory picture of spider diversity in Pathiramanal Island.

Pathiramanal Island is a land of a dense forest cover and thick vegetation. This investigation showed that an important determinant of spider species richness and diversity in the Island is habitat diversity. The data revealed that structurally vegetation which is more diverse supports a higher number of spider species, which could be explained by a greater variety of available niches within more complex vegetation. Overall, the results showed that vegetation differed from one Island spot to another, and spider composition was also highly dissimilar in different plots of the Island. This study report emphasizes the importance of maintaining a mosaic-like pattern in the habitat, because different vegetation patches (e.g. thick/thin vegetation, tall/short vegetation) can provide habitats for very different spider assemblages and thus enhance the overall spider diversity.

**Faunal affinities of spiders collected from Pathiramanal Island**

The araneofauna of Pathiramanal Island bears affinities with Oriental and Palearctic regions and with the fauna of Sri Lanka. It is hypothesized that Indian biota is the result of displacement by invaders from other regions of the Oriental region after its separation from Gondwanaland and merger with Asia (Holloway 1974). Species such as *Araneus ellipticus*, *Argiope aemula*, *A. anasuja*, *A. pulchella*, *Cyclosa bifida*, *C. confraga*, *C. atriceps*, *C. moluccensis*, *Eriovixia laglaizei*, *Gasteracantha geminata*, *Herennia multipuncta*, *Neoscona molemensis*, *N. vigilans*, *N. nautica*, *Parawixia dehanii* (family Araneidae); *Clubiona drossodes* (family Clubionidae); *Castianeira seta* (family Corinnidae); *Stegodyphus sarasinorum* (family Eresidae); *Hipposa greenalliae*, *Pardosa pseudoanamulta*, *P. sumatrana* (family Lycosidae); *Cheiracanthium melanostomum* (family Cheiracanthiidae); *Oxyopes birmanicus*, *O. javanus* (family Oxyopidae); *Fecenia protensa* (family Psechridae); *Carrhotus vittatus*, *Menemerus bivittatus*, *Myrmarachne melanocephala*, *Phintella vittata*, *Plexippus paykulli*, *Portia fimбриata*, *Rhene flavigera*, *Siler semiglaucus*, *Telamonia dimidiata*, *Thiania bhamaensis* (family Salticidae); *Heteropoda venatoria* (family Sparassidae); *Argyrodex flavescens*, *Araniem flagellum*, *Nihonhimea mundula* (family Theridiidae) and *Zosi geniculata* (family Uloboridae) bear Oriental affinities.

Palaeartic affinities are shown by species like *Eriovixia laglaizei*, *Porcaratanus bengalensis* (family Araneidae); *Clubiona drossodes* (family Clubionidae); *Hipposa greenalliae* (family Lycosidae); *Oxyopes birmanicus*, *O. Shweta* (family Oxyopidae); *Myrmaplata plateloides* (family Salticidae); *Leucauge decorata*, *Tetragnatha javana* (family Tetragnathidae) and *Argyrodes flavescens* (family Theridiidae).

It was studied by Bossuyt et al. (2004) analyzing the links between the Western Ghats (southern India) and Sri Lanka, using multiple vertebrate and invertebrate groups, that Sri Lankan fauna derived from mainland India. The current study partially approves this hypothesis from the remarkable similarities exhibited between the spider fauna of Pathiramanal and Sri Lanka. Species such as *Argiope aemula*, *A. anasuja*, *A. pulchella*, *Cyclosa confraga*, *C. atriceps*, *C. moluccensis*, *Eriovixia laglaizei*, *Gasteracantha geminata*, *Herennia multipuncta*, *Parawixia dehanii* (family Araneidae);
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Stegodyphus sarasinorum (family Eresidae); Hersilia savigyni (family Hersiliidae); Hippasa greenalliae (family Lycosidae); Hylus semicupreus, Myrmaplata plataleoides (family Salticidae); Heteropoda venatoria (family Sparassidae); Argyrodes flavescens, Ariamnes flagellum, Nihonhimea mundula (family Theridiidae) bear affinities to the Island fauna of Sri Lanka.

CONCLUSION

Until now, Pathiramanal Island was considered to be home to only 23 spider species due to the lack of studies in this region. However, the current survey of the araneofauna in this remote Island has challenged this view. A high species diversity of spiders in Pathiramanal Island can be attributed to a high floral diversity of the Island, which sustains high faunal diversity by providing diverse microhabitat, especially for invertebrates. Contrasting to other ecologically important zones, there is no previous work to compare the spider diversity. This indicates the need for a further systematic sampling in this area. The presence of diverse habitats like big trees, bushes and grasslands in this ecosystem is a revelation to show Pathiramanal Island harbours many smaller but diverse environmental niches, which makes the Island an important centre of speciation in the Vembanad, a Ramsar site. Since Pathiramanal Island shows a surprisingly diverse spider community, further research should be encouraged in this biome to maintain and manage this high diversity, and the factors other than habitat type, which are important in influencing diversity, need to be investigated.

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