# SPIDER FAUNA IN THE FOREST AND AGRICULTURAL ECOSYSTEMS OF CENTRAL KERALA, INDIA

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## ABSTRACT

Investigations were carried out on the spider species compositions in the forests, as well as rice, vegetable (bitter gourd, snake gourd, ivy gourd, cowpea and cabbage) and coconut agroecosystems, in Ernakulam, Idukki, Trichur and Palghat districts of central Kerala, India. A total of 169 species of spiders belonging to 82 genera and 24 families were sampled from the various ecosystems in central Kerala during the study. A total of 35 species were unique to the forest ecosystem, whereas 49 species were unique to the agricultural ecosystems. Eighty-five species were shared by both the ecosystems. A total of five new species were discovered during this investigation. Further, at the generic level, four genera, and at the species level, six species have been reported for the first time from India. A total of five species recorded from the study area are endemic to Kerala and 27 species endemic to the Indo-Sri Lankan region. Biogeographical analysis revealed that the araneofauna of central Kerala bears affinities mainly to the Oriental and Palearctic regions, as well as to the fauna of Sri Lanka. Analysis of the faunal composition revealed that the family Araneidae was the taxonomically dominant family in the forest, rice and vegetable ecosystems, whereas in the coconut ecosystem, the family Salticidae (jumping spiders) was the dominant family in terms of species diversity.

## INTRODUCTION

Spiders (Arachnida: Araneae) are an integral part of biodiversity since they play many important roles in ecosystems as predators and sources of food for other creatures. They have clearly established themselves as model organisms in biochemical (silk proteins and venom), behavioural (sexual and web-building behaviours) and ecological (foraging, predator-prey systems and integrated pest management) research. Spiders are also utilized by ecologists in the form of conservation tools as ecological indicators of overall biodiversity in many terrestrial communities (Noss 1990). Spiders are extremely sensitive to small changes in habitat structure, including vegetation complexity, litter depth and microclimatic characteristics (Uetz 1991).

Currently 42,751 species of spider in 3859 genera and 110 families have been described validly (Platnick 2012). The estimated total number of spider species in the world can only be guessed at. Coddington and Levi (1991) commented that up to 170,000 species could exist. Platnick explains that if 170,000 species exist, 638 years will pass before the job is finished at the present rate of description.

Regardless of the fact that they form one of the most diverse groups of organisms, and that they have multifaceted ecological functions, spiders have largely been ignored by the conservation community and taxonomists alike because of the human tendency to favour some organisms over others of equal importance because they lack universal appeal (Humphries *et al*. 1995). Many people have a profound dislike for spiders and will not miss an occasion to kill them. This may be due to fear and a dislike of their appearance, behaviour and the venomous nature of a few species. Most likely it is due to a combination of these factors.

Hundreds of spider species are described every year, but the status taxonomic knowledge about spiders is far from adequate. No comprehensive key to modern world families exists, and only about 20% of the families have been revised using modern methods. The scenario is even more dismal in India, with only meagre baseline information existing on the taxonomy and

bioecology of spiders in this tropical country, which is considered as one of the 12 mega-biodiversity countries in the world, with about 125,000 described species of living organism and about 400,000 as yet undescribed species (Nagendra & Gadgil 1998). Kerala, one of the small states, lying in the southernmost part of India, is blessed with a rich flora and fauna owing to the presence of the Western Ghats, one of the biodiversity hotspots of the world, in the state. With respect to its geographical, climatic and ecological features, the central Kerala region harbours a rich variety of arachnids, of which spiders have a huge share. This area is also endowed with an extensive forest area and therefore possesses various assemblages of spiders. However, it is saddening to observe that no systematic work has been carried out till date on the systematics, diversity and bioecology of the spiders of this region.

Against this backdrop, a study was carried out with the prime objective of documenting and analysing the spider fauna in the central region of Kerala state, consisting of four districts*, viz,* Ernakulam, Idukki, Trichur and Palghat districts.

## MATERIALS AND METHODS

### STUDY AREA

The study area consisted of Ernakulam, Idukki, Trichur and Palghat districts in central Kerala, India. The altitude in these districts ranges from the seaboard to 2695 m above MSL. The forest ecosystems selected for the study were Periyar Tiger Reserve, Idukki Wildlife Sanctuary, Eravikulam National Park and Chinnar Wildlife Sanctuary. The agricultural ecosystems selected included rice (*Oryza sativa L.*), coconut (*Cocos nucifera* L.) and vegetables including bitter gourd (*Momordica charantia* L.), snake gourd (*Trichosanthes cucumerina* L.), ivy gourd (*Coccinia grandis* (L.) Voigt), cowpea (*Vigna unguiculata* L. Walp.) and cabbage (*Brassica oleracea* L. var. capitata).

## SAMPLING

In the rice and vegetable ecosystems, the study was conducted over a period of 3 years. In rice, sampling was done in the selected sites in six cropping seasons (two crops in a year), whereas in the vegetable crops, sampling was carried out in three cropping seasons (one crop per year). In the coconut and forest ecosystems, fortnightly sampling was conducted over a period of 2 years.

The Quadrat Method: In the rice and vegetable ecosystems, samplings were done fortnightly to study the species composition, diversity and abundance of the spider fauna. Spiders were collected from quadrats (1 m × 1 m). Four quadrats were placed at the four corners of a 10 m × 10 m area. A sufficient core area was left to avoid the edge effect. The hand-picking method was used to collect the spiders from the leaf blades, flowers and dry leaves and from the ground stratum. The area around each plant was searched for possible webs, and the plants were thoroughly examined from the bottom to the top for spiders and pests. Leaves and flowers were also examined. All four quadrats were searched for a total of 1 hour. Spiders were collected by being led into glass tubes (5.2 cm × 2 cm) from the ground stratum and from the tips of plants by beating them with a rod. The falling spiders were collected in glass tubes. Specimens collected were preserved in 70% ethyl alcohol with proper labelling of the locality, date and crop stage and other notes of importance.

The Transect Method: The random transect method using the technique adopted by Aiken and Coyle (2000) was used for spider sampling in forests and coconut plantations. This technique involved a combination of four collection methods to assess the diversity of the spider fauna, namely, ground hand collection, aerial hand collection, beating and sweeping. Time was used as a measure of the sampling effort to make the methods comparable. One sample unit equalled 1 hour of uninterrupted time, during which all spiders encountered were collected (Sebastian et al. 2005). Ground collection involved searching mostly on hands and knees, exploring the leaf litter, logs, rocks and plant surfaces below knee level. Aerial sampling involved searching leaves, branches, tree trunks and the spaces in between, from knee height up to the maximum overhead arm's reach. Beating consisted of striking the vegetation with a 1 m long stick or shaking the vegetation with the hands and catching the falling spiders on an inverted umbrella held below the vegetation. They were later transferred to a fixative. The sweeping method was mainly employed in grasslands. The collected specimens were preserved in 75% alcohol in separate (flat bottomed) tubes with labels containing information regarding the collection.

## IDENTIFICATION

The collected spiders were identified with the help of the literature (Tikader 1987; Barrion & Litsinger 1995; Dippenaar-Schoeman & Jocque 1997; Deeleman-Reinhold 2000) using stereoscopic microscopes (Leica MS5, Olympus SZ112). Adult males and females collected from the field were identified up to the species level, whereas immature spiders were identified up to the generic level.

## RESULTS

A total of 169 species of spiders belonging to 82 genera and 24 families were sampled from various ecosystems in central Kerala (Table 1). A checklist of the collected spiders is provided in Table 2. In the forest ecosystems, spiders belonging to 118 species, 68 genera and 23 families were sampled (Table 3). The taxonomically dominant family was the family Araneidae, with 27 species of 13 genera. The family Salticidae was represented by 16 species belonging to 13 genera.

In rice, sampling across six cropping seasons yielded individuals belonging to 117 species, 60 genera and 19 families (Table 4). At the generic level, the family Salticidae was the taxonomically dominant family, with a total of 15 genera and 20 species. However, at the species level, the family Araneidae was dominant, with 29 species belonging to 12 genera. Other taxonomically important families were the families Tetragnathidae (18 species belonging to 6 genera), Lycosidae (10 species belonging to 3 genera and Theridiidae (9 species of 7 genera).

In coconut, spiders belonging to 55 species, 38 genera and 14 families were sampled from the four study sites in Ernakulam district of central Kerala during the study (Table 5). The taxonomically dominant family was the family Salticidae, with a total of 17 species belonging to 13 genera recorded during the investigation. The families Araneidae and Lycosidae were represented by 8 species of 5 genera and 8 species of 3 genera, respectively. Monotypic families included the families Clubionidae, Corinnidae, Gnaphosidae, Hersilidae, Miturgidae and Pisauridae.

Individuals belonging to 66 species, 41 genera and 14 families were sampled from bitter gourd crop (Table 6). The family Araneidae was found to be taxonomically dominant, with 19 species of spider belonging to 10 genera. The family Salticidae was represented by 9 species belonging to 8 genera, the family Theridiidae by 8 species of 6 genera and the family Tetragnathidae by 8 species of 3 genera.

In snake gourd, sampling yielded spider species belonging to 41 species, 29 genera and 11 families (Table 7). The family Aranediae was the taxonomically dominant family, with 13 species of 8 genera. The family Salticidae was represented by 7 species of 7 genera. The other taxonomically important families were the families Lycosidae (6 species of 3 genera) and Tetragnathidae (4 species belonging to 2 genera).

In ivy gourd, spiders belonging to 33 species, 23 genera and 10 families were sampled (Table 8). The family Araneidae was the taxonomically dominant family, comprising 13 species of 8 genera. The family Salticidae was represented by 6 species belonging to 6 genera. In cowpea, sampling yielded individuals belonging to 33 species, 23 genera and 8 families (Table 9). Family-level analysis reveals that the family Aranediae was the taxonomically dominant family, with 13 species belonging to 8 genera recorded. The family Salticidae was represented by 5 species of 5 genera, whereas the family Lycosidae was also represented by 5 species of 3 genera. In cabbage, spiders belonging to 21 species, 15 genera and 6 families were sampled (Table 10). The family Araneidae was the taxonomically dominant family, with 8 species belonging to 6 genera. The family Salticidae was represented by 4 species belonging to 4 genera, and the family Tetragnathidae was represented by 4 species of 2 genera.

## DISCUSSION

Efforts at inventorying the araneofauna in the various ecosystems of central Kerala resulted in the documentation of 169 species of spider belonging to 82 genera and 24 families (Tables 1 & 2). This study, covering four districts in central Kerala, revealed that the spider fauna in the study area is very rich both qualitatively and quantitatively. The 24 spider families recorded from central Kerala represent 40% of the total number of families reported from the country (Platnick 2012). Thirty-five species were unique to the forest ecosystems, whereas 49 species were unique to the agricultural ecosystems. Eighty-five species were shared by both the ecosystems (Table 2). Among the spiders sampled, five species turned out to be newly discovered, viz. *Acusilas* sp. nov. (Araneidae), *Gea* sp. nov. (Araneidae), *Ctenus* sp. nov. (Ctenidae), *Linyphia* sp. nov. (Linyphiidae) and *Achaearanea* sp. nov. (Theridiidae).

The number of species reported from central Kerala is higher than the number recorded from many other regions surveyed in India. For instance, Sugumaran et al. (2005) studied the spider fauna in different forest ecosystems in the Western Ghats of Tamil Nadu and reported 56 species of spider belonging to 18 families. Sivaperuman and Rathore (2004) recorded 28 species of spider belonging to 13 families and 21 genera from Desert National Park in Rajasthan. The species richness is very high when compared with some other regions such as Sikkim (55 species (Tikader 1970)) and the Andaman and Nicobar Islands (65 species (Tikader 1977)). The present investigation is comparable with a study by Siliwal *et al.* (2003), who recorded 116 species belonging to 66 genera and 25 families from Purna Wildlife Sanctuary, Dangs, Gujarat. Hore and Uniyal (2008) studied the diversity and composition of spider assemblages in five vegetation types of the Terai Conservation Area between the Himalayan foothills and the Gangetic plains and sampled 3666 adult spiders representing 22 families, 60 genera, and 160 species. From these results, it can be summarized that the spider fauna of central Kerala is more rich and diverse compared

with any other region in India. Because of the complex interaction of various climatic factors such as the high rainfall and humidity with diverse topographical features, central Kerala possesses many smaller but diverse environmental niches that can support a diverse spider fauna.

The discovery of new species, as well as the sighting of a number of species and genera for the first time from India, indicates the biological wealth of this region and further points out the necessity for more detailed exploration in order to comprehensively understand the biodiversity of our country. The discovery of any new species is significant considering the fact that biodiversity is disappearing from our planet at an astonishing rate. Accurately naming new species and subspecies helps create a more meaningful map of biodiversity distribution. It is also a necessary prerequisite for achieving legal protection for threatened habitats such as the Western Ghats.

## ENDEMISM

A total of five species recorded from the study area are endemic to Kerala. These are *Gasteracantha geminata* (family Araneidae); *Ctenus indicus* (family Ctendiae); *Fecenia travancoria* and *Psechrus torvus* (family Psechridae); and *Tetragnatha cochinensis* (family Tetragnathidae). Further, 27 species reported from central Kerala are endemic to the Indo-Sri Lankan region. These are *Uloborus danolius, Uloborus krishnae* (family Uloboridae); *Achaearanea durgae, Argyrodes andamanensis, Argyrodes gazedes* and *Theridula angula* (family Theridiidae); *Linyphia urbasae* (family Lyniphiidae); *Leucauge dorsotuberculata, Leucauge pondae, Tetragnatha andamanensis, Tetragnatha cochinensis* and *Tetragnatha viridorufa* (family Tetragnathidae); *Arachnura angura, Cyclosa hexatuberculata, Neoscona bengalensis* and *Neoscona mukerjei* (family Araneidae); *Lycosa poonaensis* and *Lycosa tista* (family Lycosidae); *Pisaura gitae* (family Pisauridae); *Oxyopes ashae* and *Oxyopes rukminiae* (family Oxyopidae); *Ctenus cochinensis* and *Ctenus indicus* (family Ctenidae); *Heteropoda nilgirina* (family Sparassidae); and *Thomisus andamanensis, Thomisus lobosus* and *Thomisus projectus* (family Thomisidae).

It is apparent that many species found in central Kerala have not been reported from any other regions in India. This phenomenon can be explained by the relative isolation of the study area provided by the Western Ghats in the east and the Arabian Sea in the west (Nagendra & Gadgil 1998). Thus, the existing data suggest that central Kerala represents one of the main centres of speciation in Asia.

Endemism may arise by several mechanisms, but underlying them all is the principle of geographical isolation. Conserving biological wealth requires action in both areas rich in endemic species and areas of high biological diversity. The uniqueness of species compositions, as indicated by the levels of endemism and habitat specialization, is more important in establishing regional conservation priorities (Platnick 1991). Threatened centres of endemism are major biodiversity hotspots (Roberts et al. 2002), and conservation efforts targeted toward them could help avert the loss of biodiversity. The present investigation could serve as a baseline for future studies on the spiders of Kerala, especially the Western Ghats. These future investigations can be conducted as a continuation of the present investigation by utilizing additional collecting methods and/or sampling all available habitats, thereby inventorying poorly documented spider taxa and perhaps discovering new species along the way.

## AFFINITIES

The araneofauna of central Kerala displays affinities mainly to the Oriental and Palearctic regions, as well as to the fauna of Sri Lanka. Species such as *Stegodyphus sarasinorum* (family Eresidae); *Zosis geniculata* (family Uloboridae); *Achaearanea mundula, Argyrodes flavescens, Ariamnes flagellum, Chrysso argyrodiformis, Phycosoma martinae* (family Theridiidae); *Neriene sundaica* (family Linyphiidae); *Herennia multipuncta, Nephila kuhlii, Nephila pilipes* (family Nephilidae); *Dyschiriognatha dentata, Leucauge celebesiana, L. tessellata, Opadometa fastigatata, Tetragnatha ceylonica, Tetragnatha andamanensis* and *Tyloridae culta* (family Tetragnathidae); *Araneus ellipticus, Argiope aemula, Argiope. anasuja, Argiope catenulata, Argiope pulchella, Cyclosa bifida, Cyclosa confraga, Cyclosa insulana, Cyrtophora cicatrosa, Cyrtophora moluccensis, Eriovixia laglaizei, Gasteracantha geminata, Gasteracantha haselltii, Gasteracantha kuhli, Neoscona molemensis, Neoscona vigilans, Neoscona nautica* and *Parawixia dehaani* (family Araneidae); *Hippasa agelenoides, Hippasa greenalliae, Pardosa pseudoannulata, Pardosa sumatrana* (family Lycosidae); *Thalassius albocinctus* (family Pisauridae); *Oxyopes birmanicus, Oxyopes. javanus* and *Peucetia viridana* (family Oxyopidae); *Fecenia travancoria* and *Psechrus torvus* (family Psechridae); *Cheiracanthium melanostomum* (family Miturgidae); *Clubiona drassodes* (family Clubionidae); *Castianeira zetes* (family Corinnidae); *Heteropoda venatoria* (family Sparassidae); *Camaricus formosus* (family Thomisidae); *Carrhotus viduus, Menemerus bivittatus, Myrmarachne orientates, Phintella vittata, Plexippus paykulli, Plexippus petersi, Portia fimbriata, Rhene flavigera, Siler semiglaucus, Telamonia dimidiata* and *Thiania bhamoensis* (family Salticidae) have Oriental affinities.

The affinities shown by the araneofauna to the Oriental region are not surprising since the general hypothesis is that the Indian biota is formed as a 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 *Leucauge decorata, Leucauge subgemmea, Tetragnatha ceylonica* and *Tetragnatha javana* (family Tetragnathidae); *Nephila pilipes* (family Nephilidae); *Eriophora himalayaensis, Chorizopes bengalensis, Eriovixia laglaizei, Gasteracantha hasseltti* and *Gibbaranea bituberculata* (family Araneidae); *Argyrodes flavescens* (family Theridiidae); *Hippasa greenalliae* and *Hippasa lycosina* (family Lycosidae); *Oxyopes birmanicus* and *Oxyopes shweta* (family Oxyopidae); *Clubiona drassodes* (family Clubionidae); and *Myrmarachne plataleoides* (family Salticidae) have Paleartic affinities.

Species such as *Argiope anasuja, Argiope aemula, Argiope catenulata, Neoscona vigilans, Cyclosa confraga, Cyclosa insulana, Eriovixia laglaizei, Gasteracantha geminata, Gasteracantha remifera, Parawixia dehanii* and *Cyrtophora moluccensis* (family Araneidae); *Stegodyphyus sarasinorum* (family Eresidae); *Herennia multipuncta, Nephila pilipes* and *Nephilengys malabarensis* (family Nephilidae); *Tylorida culta, Opadometa fastigata* and T*etragnatha ceylonica,* (family Tetragnathidae); *Hersilia savigyni* (family Hersilidae); *Argyrodes flavescens* (family Theridiidae); *Heteropoda venetoria* and *Olios milleti* (family Sparassidae); *Oxyopes hindostanicus* and *Peucetia viridana* (Family Oxyopidae); *Artema Atlanta* (Family Pholcidae); *Hippasa greenalliae* (family Lycosidae);and *Hyllus semicupreus* and *Myrmarachne plataleoides* (family Salticidae) bear affinities to the island fauna of Sri Lanka.

Analysing the relationships between the Western Ghats (southern India) and Sri Lanka using multiple vertebrate and invertebrate groups, Bossuyt *et al.* (2004) inferred that the Sri Lankan fauna was derived from mainland India. The present investigation confirms this hypothesis, as evidenced by the remarkable similarities existing between the spider faunas of central Kerala (Western Ghats) and Sri Lanka.

## FAUNAL COMPOSITION

An analysis of the faunal composition of spiders in forest and agricultural ecosystems in central Kerala revealed that the family Araneidae was the taxonomically dominant family in forest, rice and vegetable ecosystems, whereas in coconut, the family Salticidae (jumping spiders) turned out to be the dominant family in terms of species diversity.

The family Araneidae is the largest family of spiders. Members of this family construct orb-webs (wheel-shaped two-dimensional webs) and are often found in gardens, fields and forests. The dominance of this family in the study area is a direct consequence of the vegetational architecture. The vegetational architecture plays a major role in the species composition found within a habitat (Scheidler 1990), and vegetation that is structurally more complex can sustain a higher abundance and diversity of spiders (Hatley & MacMahon 1980). It is apparent that tropical forests possess a congenial environment for the construction of orb webs. In a study conducted in Costa Rica, Greenstone (1984) found that vegetation structure but not prey availability significantly determined the diversity of web spiders. Since the abundance of orb-weavers is influenced by the physical structure of the vegetation and the availability of sites for webs (Greenstone 1984; Wise 1993), the undisturbed bushes and sparse ground-layer vegetation in primary forests might be able to support a larger population of orb-weaving spiders that require larger spaces for web construction. This also holds true for the various vegetable crops studied, which provide the necessary substrata at different vertical strata for the construction and anchoring of orb-webs and thereby favour the survival of araneids over members of other spider families.

Even though the availability of substrates for anchoring webs in rice fields is limited compared with other terrestrial habitats, araneids dominated the rice fields of central Kerala in terms of species diversity. This result is in conformity with the findings of Bambaradeniya and Edirisinghe (2001) in the rice fields of Sri Lanka. It can be inferred that even simple vegetational structures such as rice plants can provide ample opportunities for the construction and maintenance of webs at different strata for successful prey capture. Web-building species are stationary predators that wait for food to come to them. Most web weavers depend largely on relatively few prey groups that are available in high numbers in a particular environment. The rice agroecosystem provides a continuous supply of prey species, namely insects, in great numbers at all seasons of crop growth, and this explains the probable dominance of araneids, the most diverse web weavers among spiders, in this ecosystem.

The dominance of the family Salticidae in coconut is a consequence of the unique vegetational architecture of this crop. Due to the perennial nature of the crop, web-anchoring substrata are practically unavailable in coconut gardens. Routine weeding and other cultural practices further eliminate herbs and shrubs that provide ideal habitats for the survival of web weavers such as araneids and tetragnathids. This condition favours the survival of free living spiders such as salticids (jumping spiders), which do not construct webs for prey capture but rather use their eyesight and agility to hunt prey. Salticids can often be observed on the barks of coconut palms, actively moving in pursuit of the prey, whereas the leaf folds of the coconut palm provide perfect sites for construction of retreats where the females can protect their eggs, and these retreats also serve as shelters when the spiders are moulting.

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Table 1.

Total numbers of families, genera and species of spider recorded from forest and agricultural ecosystems (combined) in central Kerala, India

| Sl. No. | Family | Genera | Species |
|---|---|---|---|
| 1 | Araneidae | 15 | 42 |
| 2 | Clubionidae | 1 | 2 |
| 3 | Corinnidae | 1 | 1 |
| 4 | Ctenidae | 1 | 2 |
| 5 | Eresidae | 1 | 1 |
| 6 | Filistatidae | 1 | 1 |
| 7 | Gnaphosidae | 1 | 1 |
| 8 | Hersillidae | 1 | 1 |
| 9 | Lyniphidae | 2 | 4 |
| 10 | Lycosidae | 3 | 13 |
| 11 | Miturgidae | 1 | 1 |
| 12 | Nephilidae | 3 | 4 |
| 13 | Oxyopidae | 2 | 13 |
| 14 | Philodromidae | 2 | 2 |
| 15 | Pholcidae | 1 | 1 |
| 16 | Pisauridae | 2 | 3 |
| 17 | Psechridae | 2 | 2 |
| 18 | Salticidae | 18 | 25 |
| 19 | Scytodidae | 1 | 1 |
| 20 | Sparassidae | 2 | 3 |
| 21 | Tetragnathidae | 6 | 20 |
| 22 | Theridiidae | 8 | 14 |
| 23 | Thomisidae | 4 | 7 |
| 24 | Uloboridae | 3 | 5 |
| | Total | 82 | 169 |

Table 2. Checklist of spiders recorded from forest and agricultural ecosystems in central Kerala, India

| Sl. No. | Taxon | Distribution | | |
|---|---|---|---|---|
| | | Forest ecosystem | Agricultural ecosystems | Shared |
| | I. Family Araneidae Simon, 1895 | | | |
| 1 | *Acusilas* sp. nov.* | | | x |
| 2 | *Arachnura angura* Tikader, 1970 | x | | |
| 3 | *Araneus bilunifer* Pocock, 1900 | | | x |
| 4 | *A. ellipticus* (Tikader & Bal, 1981) | | | x |
| 5 | *Araneus* sp. | | | x |
| 6 | *Argiope aemula* (Walckenaer, 1842) | | | x |
| 7 | *A. anasuja* Thorell, 1887 | | | x |
| 8 | *A. catenulata* (Doleschall, 1859) | | x | |
| 9 | *A. pulchella* Thorell, 1881 | | | x |
| 10 | *Argiope* sp. | | | x |
| 11 | *Chorizopes bengalensis* Tikader, 1975 | | | x |
| 12 | *Cyclosa bifida* (Doleschall, 1859) | | | x |
| 13 | *C. confraga* (Thorell, 1892) | | | x |
| 14 | *C. hexatuberculata* Tikader, 1982 | x | | |
| 15 | *C. insulana* (Costa, 1834) | x | | |
| 16 | *C. mulmeinensis* (Thorell, 1887) | | x | |
| 17 | *Cyclosa* sp. | | | x |
| 18 | *Cyrtarachne* sp. | | | x |
| 19 | *Cyrtophora cicatrosa* (Stoliczka, 1869) | | | x |
| 20 | *C. citricola* (Forskål 1775) | | | x |
| 21 | *C. feai* (Thorell, 1887) | | x | |
| 22 | *C. moluccensis* (Doleschall, 1857) | x | | |
| 23 | *Cyrtophora* sp. | | x | |
| 24 | *Eriophora himalayaensis* Tikader, 1975 | x | | |
| 25 | *Eriovixia excelsa* (Simon, 1889) | | | x |
| 26 | *E. laglaizei* (Simon, 1877) | | | x |
| 27 | *E. poonaensis* (Tikader & Bal, 1981) | | | x |
| 28 | *Eriovixia* sp. | | x | |
| 29 | *Gasteracantha dalyi* Pocock, 1900 | x | | |
| 30 | *G. geminata* (Fabricius, 1798) | | | x |
| 31 | *G. kuhli* C.L. Koch, 1837 | x | | |
| 32 | *Gea* sp. nov. | | x | |
| 33 | *Gibbaranea bituberculata* (Walckenaer, 1802) | | x | |
| 34 | *Neoscona bengalensis* Tikader & Bal, 1981 | | | x |
| 35 | *N. molemensis* Tikader & Bal 1981 | | x | |
| 36 | *N. mukerjei* Tikader, 1980 | | | x |
| 37 | *N. nautica* (L. Koch, 1875) | | x | |
| 38 | *N. pavida* (Simon, 1906) | | x | |
| 39 | *N. theisi* (Walckenaer, 1842) | | x | |

| | | | | |
|---|---|---|---|---|
| 40 | *N. vigilans* (Blackwall, 1865) | | | x |
| 41 | *Neoscona* sp. | x | | |
| 42 | *Parawixia dehaani* (Doleschall, 1859) | x | | |
| | II. Family Clubionidae Wagner, 1887 | | | |
| 43 | *Clubiona drassodes* O.P. Cambridge, 1874 | | | x |
| 44 | *Clubiona* sp. | | | x |
| | III. Family Corinnidae arsch, 1880 | | | |
| 45 | *Castianeira zetes* Simon, 1897 | | | x |
| | IV. Family Ctenidae, Keyserling, 1877 | | | |
| 46 | *Ctenus indicus* Gravely, 1931 | x | | |
| 47 | *Ctenus idukkiyensis* sp. nov. | | | x |
| | V. Family Eresidae C.L. Koch, 1851 | | | |
| 48 | *Stegodyphus sarasinorum* Karsch, 1891 | | | x |
| | VI. Family Filistatidae Ausserer, 1867 | | | |
| 49 | *Pritha* sp. | | x | |
| | VII. Family Gnaphosidae Pocock, 1898 | | | |
| 50 | *Gnaphosa* sp. | | | x |
| | VIII. Family Hersilidae Thorell, 1870 | | | |
| 51 | *Hersilia savignyi* Lucas, 1836 | x | | |
| | IX. Family Lyniphidae Blackwall, 1859 | | | |
| 52 | *Linyphia* sp. nov. | x | | |
| 53 | *L. urbasae*Tikader, 1970 | | | x |
| 54 | *Linyphia* sp. | | x | |
| 55 | *Neriene sundaica* (Simon, 1905)** | x | | |
| | X. Family Lycosidae Sundevall, 1833 | | | |
| 56 | *Hippasa agelenoides* (Simon, 1884) | | | x |
| 57 | *H. greenalliae* (Blackwall, 1867) | x | | |
| 58 | *H. holmerae* Thorell, 1895 | | x | |
| 59 | *H. lycosina* Pocock, 1900 | x | | |
| 60 | *Hippasa* sp. | | x | |
| 61 | *Lycosa poonaensis* Tikader & Malhotra, 1980 | | x | |
| 62 | *L. tista* Tikader, 1970 | | | x |
| 63 | *Lycosa* sp. | | | x |
| 64 | *Pardosa amkhasensis* Tikader & Malhotra, 1976 | | x | |
| 65 | *P. minuta* Tikader & Malhotra, 1976 | | | x |
| 66 | *P. pseudoannulata* (Bösenberg & Strand, 1906) | | | x |
| 67 | *P. sumatrana* (Thorell 1890) | | | x |
| 68 | *Pardosa* sp. | | | x |
| | XI. Family Miturgidae Simon, 1885 | | | |
| 69 | *Cheiracanthium melanostomum* (Thorell, 1895) | | | x |
| | XII. Family Nephilidae Simon, 1894 | | | |
| 70 | *Herennia multipuncta* (Doleschall, 1859) | x | | |

| | | | | |
|---|---|---|---|---|
| 71 | *Nephila kuhlii* Doleschall, 1859 | x | | |
| 72 | *N. pilipes* (Fabricius, 1793) | | | x |
| 73 | *Nephilengys malabarensis* (Walckenaer, 1842) | x | | |
| | XIII. Family Oxyopidae Thorell, 1870 | | | |
| 74 | *Oxyopes ashae* Gajbe, 1999 | | x | |
| 75 | *O. bharatae* Gajbe 1999 | | x | |
| 76 | *O. birmanicus* Thorell, 1887 | | x | |
| 77 | *O. hindostanicus* Pocock, 1901 | | | x |
| 78 | *O. javanus* Thorell, 1887 | | | x |
| 79 | *O. lineatipes* (C. L. Koch, 1847)** | x | | |
| 80 | *O. ratnae* Tikader, 1970 | | | x |
| 81 | *O. sakuntalae* Tikader, 1970 | | x | |
| 82 | *O. shweta* Tikader, 1970 | | | x |
| 83 | *O. sunandae* Tikader, 1970 | | | x |
| 84 | *Oxyopes* sp. | | | x |
| 85 | *Peceutia* sp. | x | | |
| 86 | *Peucetia viridana* (Stoliczka, 1869) | | | x |
| | XIV. Family Philodromidae Thorell, 1870 | | | |
| 87 | *Philodroumus* sp. | x | | |
| 88 | *Tibellus elongatus* Tikader, 1960 | x | | |
| | XV. Family Pholcidae C.L. Koch, 1851 | | | |
| 89 | *Artema atlanta* Walckenaer, 1837 | | X | |
| | XVI. Family Pisauridae Simon, 1890 | | | |
| 90 | *Pisaura gitae* Tikader, 1970 | | | x |
| 91 | *Pisaura* sp. | | x | |
| 92 | *Thalassius albocinctus* (Doleschall, 1859) | | | x |
| | XVII. Family Psechridae Simon, 1890 | | | |
| 93 | *Fecenia travancoria* Pocock, 1899 | x | | |
| 94 | *Psechrus torvus* (O.P.Cambridge, 1869) | x | | |
| | XVIII. Family Salticidae Blackwall, 1841 | | | |
| 95 | *Bavia* sp. | | | x |
| 96 | *Bianor incitatus* Thorell, 1890 | | | x |
| 97 | *Carrhotus viduus* (C.L. Koch, 1846) | | x | |
| 98 | *Cyrba ocellata* (Kroneberg, 1875) | | x | |
| 99 | *Epeus indicus* Proszynski, 1992 | | x | |
| 100 | *Hasarius adansoni* (Audouin, 1826) | | | x |
| 101 | *Hindumanes karnatakaensis* (Tikader & Biswas, 1978) | | x | |
| 102 | *Hyllus diardi* (Walckenaer, 1837)** | | | x |
| 103 | *H. semicupreus* (Simon, 1885) | | x | |
| 104 | *Myrmarachne orientales* Tikader, 1973 | | | x |
| 105 | *M. plataleoides* (O.P. Cambridge, 1869) | | | x |
| 106 | *Phaeacius* sp. | | | x |
| 107 | *Phintella vittata* (C.L. Koch, 1846) | | | x |

| | | | | |
|---|---|---|---|---|
| 108 | *Phintella* sp. | | x | |
| 109 | *Plexippus paykulli* (Audouin, 1826) | | | x |
| 110 | *P. petersi* (Karsch, 1878) | | | x |
| 111 | *Plexippus* sp. | | x | |
| 112 | *Portia fimbriata* (Doleschall, 1859) ** | | | x |
| 113 | *Rhene danieli* Tikader, 1973 | | x | |
| 114 | *R. flavigera* (C. L. Koch, 1846) | | | x |
| 115 | *Siler semiglaucus* Simon, 1901** | | | x |
| 116 | *Telamonia dimidiata* (Simon, 1899) | | | x |
| 117 | *Telamonia* sp. | | | x |
| 118 | *Thiania bhamoensis* Thorell,1887 | | | x |
| 119 | *Thyene* sp. | | x | |
| | XIX. Family Scytodidae Blackwall, 1864 | | | |
| 120 | *Scytodes fusca* Walckenaer, 1837 | x | | |
| | XX. Family Sparassidae Bertkau, 1872 | | | |
| 121 | *Heteropoda nilgirina* Pocock, 1901 | x | | |
| 122 | *H. venatoria* (Linnaeus, 1767) | | | x |
| 123 | *Olios milleti* (Pocock, 1901) | | | x |
| | XXI. Family Tetragnathidae Menge, 1866 | | | |
| 124 | *Dyschiriognatha dentata* Zhu & Wen, 1978** | | x | |
| 125 | *Leucauge celebesiana* (Walckenaer, 1842) | | | x |
| 126 | *L. decorata* (Blackwall 1864) | | | x |
| 127 | *L. dorsotuberculata* Tikader, 1982 | x | | |
| 128 | *L. pondae* Tikader, 1970 | | | x |
| 129 | *L. subgemmea* Bösenberg & Strand, 1906** | | x | |
| 130 | *L. tessellata* (Thorell, 1887) | | | x |
| 131 | *Leucauge* sp. | | | x |
| 132 | *Opadometa fastigata* (Simon, 1877) | | | x |
| 133 | *Orsinome* sp. | | x | |
| 134 | *Tetragnatha andamanensis* Tikader, 1977 | | x | |
| 135 | *T. ceylonica* O. P. Cambridge, 1869 | | | x |
| 136 | *T. cochinensis* Gravely, 1921 | | x | |
| 137 | *T. javana* (Thorell, 1890) | | x | |
| 138 | *T. mandibulata* Walckenaer, 1842 | | | x |
| 139 | *T. maxillosa* Thorell, 1895 | | | x |
| 140 | *Tetragnatha vermiformis* Emerton, 1884 | | | x |
| 141 | *T. viridorufa* Gravely, 1921 | | x | |
| 142 | *Tetragnatha* sp. | | | x |
| 143 | *Tylorida culta* (O. P. Cambridge, 1869) | | x | |
| | XXII. Family Theridiidae Sundevall, 1833 | | | |
| 144 | *Achaearanea* sp. nov. | | | x |
| 145 | *A. durgae* Tikader, 1970 | | x | |
| 146 | *A. mundula* (L. Koch, 1872) | x | | |
| 147 | *Achaearanea* sp. | x | | |
| 148 | *Ariamnes flagellum* (Doleschall, 1857) | | | x |

| | | | | |
|---|---|---|---|---|
| 149 | *Argyrodes flavescens* (Cambridge, 1880)** | x | | |
| 150 | *A. gazedes* Tikader, 1970 | x | | |
| 151 | *Argyrodes* sp. | | x | |
| 152 | *Chrysso argyrodiformis* (Yaginuma, 1952) | | | x |
| 153 | *Coleosoma* sp. ** | | x | |
| 154 | *Phycosoma martinae* (Roberts, 1983) | | x | |
| 155 | *Phycosoma* sp. | | x | |
| 156 | *Theridion* sp. | | | x |
| 157 | *Theridula angula* Tikader, 1970 | | | x |
| | XXIII. Family Thomisidae Sundevall, 1833 | | | |
| 158 | *Camaricus formosus* Thorell, 1887 | x | | |
| 159 | *Misumena* sp. | | x | |
| 160 | *Thomisus andamanensis* Tikader, 1980 | | | x |
| 161 | *T. lobosus* Tikader, 1965 | | | x |
| 162 | *T. projectus* Tikader, 1960 | x | | |
| 163 | *Thomisus* sp. | | x | |
| 164 | *Xysticus* sp. | x | | |
| | XXIV. Family Uloboridae Thorell, 1869 | | | |
| 165 | *Miagrammopes* sp. | x | | |
| 166 | *Uloborus danolius* Tikader, 1969 | | | x |
| 167 | *U. krishnae* Tikader, 1970 | | | x |
| 168 | *Uloborus* sp. | | x | |
| 169 | *Zosis geniculata* (Olivier, 1789) | | | x |
| Total | | 35 | 48 | 85 |

**First report of the genus from India*
*** First report of the species from India*

Table 3.

Total numbers of families, genera and species of spider recorded from the forest ecosystems in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 13 | 27 |
| 2 | Clubionidae | 1 | 2 |
| 3 | Corinnidae | 1 | 1 |
| 4 | Ctenidae | 1 | 2 |
| 5 | Eresidae | 1 | 1 |
| 6 | Gnaphosidae | 1 | 1 |
| 7 | Hersillidae | 1 | 1 |
| 8 | Lyniphidae | 2 | 3 |
| 9 | Lycosidae | 3 | 9 |
| 10 | Miturgidae | 1 | 1 |

| | | | |
|---|---|---|---|
| 11 | Nephilidae | 3 | 4 |
| 12 | Oxyopidae | 2 | 9 |
| 13 | Philodromidae | 2 | 2 |
| 14 | Pholcidae | 1 | 1 |
| 15 | Pisauridae | 2 | 2 |
| 16 | Psechridae | 2 | 2 |
| 17 | Salticidae | 13 | 16 |
| 18 | Scytodidae | 1 | 1 |
| 19 | Sparassidae | 2 | 3 |
| 20 | Tetragnathidae | 3 | 12 |
| 21 | Theridiidae | 6 | 9 |
| 22 | Thomisidae | 3 | 5 |
| 23 | Uloboridae | 3 | 4 |
| Total | | 68 | 118 |

Table 4.

Total numbers of families, genera and species of spider recorded from the rice (*Oryza sativa* L.) agroecosystem in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 12 | 29 |
| 2 | Clubionidae | 1 | 2 |
| 3 | Corinnidae | 1 | 1 |
| 4 | Ctenidae | 1 | 1 |
| 5 | Eresidae | 1 | 1 |
| 6 | Filistatidae | 1 | 1 |
| 7 | Gnaphosidae | 1 | 1 |
| 8 | Hersillidae | 1 | 1 |
| 9 | Lyniphidae | 1 | 1 |
| 10 | Lycosidae | 3 | 10 |
| 11 | Miturgidae | 1 | 1 |
| 12 | Oxyopidae | 2 | 11 |
| 13 | Pisauridae | 2 | 3 |
| 14 | Salticidae | 15 | 20 |
| 15 | Sparassidae | 1 | 1 |
| 16 | Tetragnathidae | 6 | 18 |
| 17 | Theridiidae | 7 | 9 |
| 18 | Thomisidae | 2 | 4 |
| 19 | Uloboridae | 1 | 2 |
| Total | | 60 | 117 |

Table 5.

Total numbers of families, genera and species of spider recorded from the coconut (*Cocos nucifera L.*) agroecosystem in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 5 | 8 |
| 2 | Clubionidae | 1 | 1 |
| 3 | Corinnidae | 1 | 1 |
| 4 | Gnaphosiae | 1 | 1 |
| 5 | Hersillidae | 1 | 1 |
| 6 | Lycosidae | 3 | 8 |
| 7 | Miturgidae | 1 | 1 |
| 8 | Oxyopidae | 1 | 3 |
| 9 | Pisauridae | 1 | 1 |
| 10 | Salticidae | 13 | 17 |
| 11 | Sparassidae | 2 | 2 |
| 12 | Tetragnathidae | 1 | 4 |
| 13 | Theridiidae | 5 | 5 |
| 14 | Uloboridae | 2 | 2 |
| Total | | 38 | 55 |

Table 6.

Total number of families, genera and species of spider recorded from bitter gourd (*Momordica charantia L.*) crop in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 10 | 19 |
| 2 | Clubionidae | 1 | 1 |
| 3 | Hersillidae | 1 | 1 |
| 4 | Lyniphidae | 1 | 1 |
| 5 | Lycosidae | 3 | 7 |
| 6 | Miturgidae | 1 | 1 |
| 7 | Nephilidae | 1 | 1 |
| 8 | Oxyopidae | 1 | 4 |
| 9 | Pisauridae | 1 | 1 |
| 10 | Salticidae | 8 | 9 |
| 11 | Tetragnathidae | 3 | 8 |
| 12 | Theridiidae | 6 | 8 |
| 13 | Thomisidae | 2 | 2 |
| 14 | Uloboridae | 2 | 3 |
| Total | | 41 | 66 |

Table 7.

Total numbers of families, genera and species of spider recorded from snake gourd (*Trichosanthes cucumerina L.*) crop in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 8 | 13 |
| 2 | Clubionidae | 1 | 1 |
| 3 | Lycosidae | 3 | 6 |
| 4 | Miturgidae | 1 | 1 |
| 5 | Oxyopidae | 1 | 3 |
| 6 | Pisauridae | 1 | 1 |
| 7 | Salticidae | 7 | 7 |
| 8 | Tetragnathidae | 2 | 4 |
| 9 | Theridiidae | 3 | 3 |
| 10 | Thomisidae | 1 | 1 |
| 11 | Uloboridae | 1 | 1 |
| Total | | 29 | 41 |

Table 8.

Total numbers of families, genera and species of spider recorded from ivy gourd (*Coccinia grandis L.*) Voigt) crop in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 8 | 13 |
| 2 | Lycosidae | 2 | 3 |
| 3 | Nephilidae | 1 | 1 |
| 4 | Oxyopidae | 1 | 3 |
| 5 | Salticidae | 6 | 6 |
| 6 | Sparassidae | 1 | 1 |
| 7 | Tetragnathidae | 1 | 3 |
| 8 | Theridiidae | 1 | 1 |
| 9 | Thomisidae | 1 | 1 |
| 10 | Uloboridae | 1 | 1 |
| Total | | 23 | 33 |

Table 9.

Total numbers of families, genera and species of spider recorded from cowpea (*Vigna unguiculata* L. Walp.) crop in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 8 | 13 |
| 2 | Lycosidae | 3 | 5 |
| 3 | Miturgidae | 1 | 1 |
| 4 | Oxyopidae | 1 | 3 |
| 5 | Salticidae | 5 | 5 |
| 6 | Tetragnathidae | 2 | 3 |
| 7 | Theridiidae | 2 | 2 |
| 8 | Thomisidae | 1 | 1 |
| Total | | 23 | 33 |

Table 10.

Total numbers of families, genera and species of spider recorded from cabbage (*Brassica oleracea* L. var. capitata) crop in central Kerala, India

| Sl. No. | Family | No. of Genera | No. of Species |
|---|---|---|---|
| 1 | Araneidae | 6 | 8 |
| 2 | Lycosidae | 1 | 2 |
| 3 | Oxyopidae | 1 | 2 |
| 4 | Salticidae | 4 | 4 |
| 5 | Tetragnathidae | 2 | 4 |
| 6 | Uloboridae | 1 | 1 |
| Total | | 15 | 21 |