A pioneering study on the spider fauna (Arachnida: Araneae) of Sagar District, Madhya Pradesh, India

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Abstract: The present investigations were carried out to elucidate the spider fauna of the Sagar district of Madhya Pradesh. A total of 1,505 spider specimens were documented from various sites of the study area. A total of 74 species grouped under 58 genera and 22 families are reported. The family Araneidae was the most common, accounting for 31% of the overall population followed by Salticidae, which accounted for 15% of the overall population. Spiders belonging to seven guild structures were identified which were then classified on the basis of their dietary habits. Further research is needed to analyze the behavior, biology and web patterns of these ubiquitous creatures.

Keywords: Agroforestry, Araneidae, forest habitat, guild structure, orb weavers, Salticidae, spider diversity.
INTRODUCTION

Spiders are remarkable primitive arthropods of the class Arachnida that live in every ecosystem on the planet, from Arctic islands to dry desert regions (Foelix 2011). They are members of the order Araneae, which are commonly known as spiders. Spiders can play an essential role in managing the populations of terrestrial arthropods. Because of their small body size, quick reproduction period, and great sensitivity to temperature and moisture changes, they are good biological monitors of ecosystem changes and habitat adjustments (Napiórkowska et al. 2021). Spiders are not only ecologically significant, but also commercially beneficial (Koneri & Nangoy 2017). Spider silk and venom have become essential industrial commodities, particularly in the pharmaceutical industry. They are also beneficial in decreasing the negative effects of pesticide and insecticide overdoses (Jose et al. 2018).

British explorers began studying spiders in India in the latter half of the 19th century and taxonomists from India carried on the work (Siliwal et al. 2005). Presently, about 50,040 spider species classified into 4,250 genera and 131 families are described worldwide (WSC 2022) and India has 1,904 spider species classified under 490 genera and 60 families (Caleb & Sankaran 2022). The spider fauna of Madhya Pradesh was studied by various workers beginning from Tikader (1980, 1982a,b), Tikader & Malhotra (1980), and Gajbe (1987–2003) in which they described several species from the families Thomisidae, Philodromidae, Lycosidae, Araneidae, and Gnaphosidae. Patil et al. (2013, 2016) studied spiders from Rani Veerangana Durgawati Wildlife Sanctuary and from the Nauradehi Wildlife Sanctuary, respectively. However, there is no information available so far on the spider fauna of Sagar district in Madhya Pradesh and thus the present work was carried out.

MATERIALS AND METHODS

Study area

Sagar district is located in the north central region of Madhya Pradesh and covers an area of 10,252 km². It lies between 23.16–24.45 °N & 78.06–79.35 °E (Figure 1). The major part of the district is enclosed by the Deccan trap lava flows and Vindhayan sandstones in the eastern region (Pareta & Pareta 2013). The climate is quite harsh, with maximum temperatures of 45 °C in summer and minimum temperatures of 6 °C in winter. The annual rainfall ranges 1,050–1,100 mm. It has a total forest area of 2,75,924.38 ha, with 1,91,607.32 ha of reserved forests and 84,317.06 ha of protected forests (ISFR 2019).

Sampling sites

Three different habitats were selected: forest (Malthone, Dhana 1 and Shahgarh range), agricultural (Patheriya Jat, Rajaua, Deori) and agroforestry (Rehli, Dhana 2, and Rahatgarh). The surveys were conducted during October 2017 to October 2021. A total of 42 quadrates with 20m x 20m dimensions were established in selected sites of the district.

Collection

Spider specimens were collected by active visual searching, vegetation beating, net sweeping, and hand picking following Sørensen et al. (2002). All surveys were conducted from 800 h to 1200 h, with an opportunistic night time survey conducted as well. Spiders were collected and photographed with a DSLR camera (Canon...
EOS 2000) before being put back into their natural environment. The collected specimens were preserved in 30 ml glass vials in 70% ethyl alcohol with proper labeling.

**Identification**

The preserved specimens were examined under a Quasmo SZB-47A stereomicroscope. Spiders were recognized to the family, genus, species levels using existing literatures and standard taxonomic keys provided by Pocock (1900); Gravely (1921a,b, 1924, 1931); Tikader (1977, 1980, 1982a); Tikader & Malhotra (1980); Tikader & Biswas (1981); Majumder & Tikader (1991); Gajbe (2004, 2007, 2008); Caleb (2016). The spider guild categorization was based on the dietary habits and ecological traits of the respective families (Höfer & Brescovit 2001).

**RESULTS**

The Sagar district, Madhya Pradesh is home to a variety of spider species. During the entire study period 1,505 specimens were collected from the study area belonging to 74 species under 22 families (Table 1; Images 1–69). The number of families, genera, species, number of individuals and percentage of number of individuals in particular families are enlisted in Table 2. Araneidae was the dominant family with 19 species from nine genera, followed by Salticidae with 14 species from 13 genera. The seven different guild types include orb-web builders, sheet web weavers, space builders, stalkers, foliage hunters, ambushers, and ground runners (Figure 2). Orb weavers (14 species) made up the most common feeding guild, accounting for 630 spider specimens (42%) of the overall population, followed by stalkers 373 spiders, 19 species (25%), space builders, 197 spiders, four species (13%), sheet web weavers, 132 spiders, one species (9%), foliage runners 95 spiders, six species (6%), ambushers 48 spiders, eight species (3%) and ground runners with 30 spiders, six species (2%) (Figure 2). During the survey, more spiders were seen in forest and agroforestry habitats than in agriculture habitat. Abundance of spiders was high in 2020 and 2021 (Figure 3).

**DISCUSSION**

In the present investigations 22 families have been reported from different sites of Sagar district. Gajbe (2007), Patil et al. (2013), and Patil et al. (2016) in their studies reported 24, 7, and 12 families respectively from Jabalpur and nearby places. Gajbe & Gajbe (2004) reported that most spiders which live on the ground or in plants have some form of camouflage. Some of the noteworthy examples of mimics seen in the present study are the ant-mimicking spiders of genus *Myrmaplata*, spiders of genus *Cyclosa* resembling trash, *Tetragnatha* species resembling twigs or reed tips, while *Hersilia* camouflage themselves perfectly with the surroundings. Analyzing the spider diversity patterns in Sagar district environment provides valuable information which can be used to validate the ecosystem’s balance. The present study was undertaken with the objective to document the spider fauna of Sagar district and prepare the first
### Table 1. Checklist of spiders from Sagar district, Madhya Pradesh, India.

| Scientific name | Guild          |
|------------------|----------------|
| **Clubionidae**  |                |
| 1. *Argiope aemula* (Walckenaer, 1841) | Orb weavers |
| 2. *Argiope anasuja* Thorell, 1887 | Orb weavers |
| 3. *Bijoaraneus mitificus* (Simon, 1886) | Orb weavers |
| 4. *Cyclosa bifida* (Doleshall, 1859) | Orb weavers |
| 5. *Cyclosa heuruberculata* Tikader, 1982 | Orb weavers |
| 6. *Cyclosa insulana* (Costa, 1834) | Orb weavers |
| 7. *Cyrtophora cicatrosa* (Stoliczka, 1869) | Orb weavers |
| 8. *Eriovixia excelsa* (Simon, 1889) | Orb weavers |
| 9. *Gasteracantha kuhli* C. L. Koch, 1837 | Orb weavers |
| 10. *Gasteracantha sp.* | Orb weavers |
| 11. *Neoscona mulkerjii* Tikader, 1980 | Orb weavers |
| 12. *Neoscona nautica* (L. Koch, 1875) | Orb weavers |
| 13. *Neoscona sp.* 1 | Orb weavers |
| 14. *Neoscona sp.* 2 | Orb weavers |
| 15. *Neoscona theisi* (Walckenaer, 1841) | Orb weavers |
| 16. *Neoscona vigilans* (Blackwall, 1865) | Orb weavers |
| 17. *Nephiliphila pilipes* (Fabricius, 1793) | Orb weavers |
| 18. *Nephiliphila sp.* | Orb weavers |
| 19. *Parawixia defaahii* (Doleshall, 1859) | Orb weavers |
| **Cheiracanthiidae** |                |
| 20. *Cheiracanthium melanostomum* (Thorell, 1895) | Foliage runners |
| 21. *Clubiona drassodes* O. Pickard-Cambridge, 1874 | Foliage runners |
| **Corinnidae** |                |
| 22. *Castianeira sp.* | Foliage runners |
| 23. *Castianeira zetes* Simon, 1897 | Foliage runners |
| **Dictynidae** |                |
| 24. *Nigma sp.* | Stalkers |
| **Eresidae** |                |
| 25. *Stegodyphus sarasinorum* Karsch, 1892 | Sheet weavers |
| **Gnaphosidae** |                |
| 26. *Drassodes carinivulvus* Caporiacco, 1934 | Ground runners |
| 27. *Pocilochroa sp.* | Ground runners |
| **Hersiliidae** |                |
| 28. *Hersilia savignyi* Lucas, 1836 | Ambushers |
| **Lycosidae** |                |
| 29. *Hipposa fabreae* Gaije & Gaije, 1999 | Ground runners |
| 30. *Lycosa shaktoe* Bhandari & Gaije, 2001 | Ground runners |
| 31. *Pardosa sp.* | Ground runners |
| **Oecobiidae** |                |
| 32. *Oecobius putus* O. Pickard-Cambridge, 1876 | Space builders |
| **Oxyopidae** |                |
| 33. *Hamataelfa sp.* | Stalkers |
| 34. *Oxyopes bimanicus* Thorell, 1887 | Stalkers |
| 35. *Oxyopes javanus* Thorell, 1887 | Stalkers |
| 36. *Oxyopes shweta* Tikader, 1970 | Stalkers |
| 37. *Pescetto viridans* (Stoliczka, 1869) | Stalkers |
| 38. *Perezinella venusta* L. Koch, 1878 | Ambushers |
| 39. *Tibellus elongatus* Tikader, 1960 | Ambushers |
| 40. *Artema atlanta* Walckenaer, 1837 | Space builders |
| 41. *Crosophriza longiana* (Blackwall, 1867) | Space builders |
| 42. *Pholcus phalangioides* (Fuesslin, 1775) | Space builders |
| **Prodidomidae** |                |
| 43. *Zimiris doriae* Simon, 1882 | Ground runners |
| **Salticidae** |                |
| 44. *Carrhotus sp.* | Stalkers |
| 45. *Epocilla sp.* | Stalkers |
| 46. *Harmochirus sp.* | Stalkers |
| 47. *Hasarius adansoni* (Audouin, 1826) | Stalkers |
| 48. *Memenerus bivittatus* (Dufour, 1831) | Stalkers |
| 49. *Myrmactalopa plateloides* O. Pickard-Cambridge, 1869 | Stalkers |
| 50. *Plexippus paykullii* (Audouin, 1826) | Stalkers |
| 51. *Plexippus petersi* (Karsch, 1878) | Stalkers |
| 52. *Portia sp.* | Stalkers |
| 53. *Rhene flavicorns* Simon, 1902 | Stalkers |
| 54. *Siler semiglaucus* (Simon, 1901) | Stalkers |
| 55. *Steneolarius sp.* | Stalkers |
| 56. *Telamonia dimidiatula* (Simon, 1899) | Stalkers |
| 57. *Thyene sp.* | Stalkers |
| **Scytodidae** |                |
| 58. *Scytodes pallida* Doleshall, 1859 | Stalkers |
| **Sparassidae** |                |
| 59. *Gnathopalystes kochi* (Simon, 1880) | Foliage runners |
| 60. *Heteropoda venatoria* (Linnaeus, 1767) | Foliage runners |
| 61. *Olios millet* (Pocock, 1901) | Foliage runners |
| **Tetragnathidae** |                |
| 62. *Guzygella indica* (Tikader & Bal, 1980) | Orb weavers |
| 63. *Leucage decorata* (Blackwall, 1864) | Orb weavers |
| 64. *Tetragnatha mandibulata* Walckenaer, 1841 | Orb weavers |
| 65. *Tetragnatha sp.* | Orb weavers |
| **Theridiidae** |                |
| 66. *Nestesocodes nupes* (Lucas, 1846) | Space builders |
| **Thomisidae** |                |
| 67. *Camaricus formosus* Thorell, 1887 | Ambushers |
| 68. *Henriksenia sp.* | Ambushers |
| 69. *Indoxysticus minutus* (Tikader, 1960) | Ambushers |
| 70. *Runcinia insecta* (L. Koch, 1875) | Ambushers |
| 71. *Thomisus lobosus* Tikader, 1965 | Ambushers |
| **Uloboridae** |                |
| 72. *Uloborus sp.* 1 | Orb weavers |
| 73. *Uloborus sp.* 2 | Orb weavers |
| 74. *Zosis geniculata* (Olivier, 1789) | Orb weavers |
Table 2. Diversity and abundance of spiders in Sagar district, Madhya Pradesh, India.

| Family         | Number of genera | Number of species | No. of Individuals | Percentile distribution of families of spiders of Sagar district, Madhya Pradesh. |
|----------------|------------------|-------------------|--------------------|----------------------------------------------------------------------------------|
| 1 Araneidae    | 9                | 19                | 472                | 31                                                                               |
| 2 Cheirancanthisiidae | 1            | 1                 | 14                 | 1                                                                                |
| 3 Clubionidae  | 1                | 1                 | 15                 | 1                                                                                |
| 4 Corinnidae   | 1                | 2                 | 11                 | 1                                                                                |
| 5 Dictynidae   | 1                | 1                 | 11                 | 1                                                                                |
| 6 Eresidae     | 1                | 1                 | 132                | 9                                                                                |
| 7 Gnaphosidae  | 2                | 2                 | 9                  | 1                                                                                |
| 8 Hersiliidae  | 1                | 1                 | 9                  | 1                                                                                |
| 9 Lycosidae    | 3                | 3                 | 13                 | 1                                                                                |
| 10 Oecobiidae  | 1                | 1                 | 55                 | 4                                                                                |
| 11 Oxyopidae   | 3                | 5                 | 129                | 9                                                                                |
| 12 Pisauridae  | 1                | 1                 | 8                  | 1                                                                                |
| 13 Philodromidae | 1              | 1                 | 9                  | 1                                                                                |
| 14 Philidae    | 3                | 3                 | 106                | 7                                                                                |
| 15 Prodidomidae| 1                | 1                 | 8                  | 1                                                                                |
| 16 Salticidae  | 13               | 14                | 220                | 15                                                                               |
| 17 Scytodidae  | 1                | 1                 | 13                 | 1                                                                                |
| 18 Sparassidae | 3                | 3                 | 55                 | 4                                                                                |
| 19 Tetragnathidae | 3             | 4                 | 97                 | 6                                                                                |
| 20 Theridiidae | 1                | 1                 | 36                 | 2                                                                                |
| 21 Thomisidae  | 5                | 5                 | 22                 | 1                                                                                |
| 22 Uloboridae  | 2                | 3                 | 61                 | 4                                                                                |

Figure 3. Abundance distribution of spiders from 2017 to 2021 of Sagar district, Madhya Pradesh.
Image 1–12. Spiders of Sagar district, Madhya Pradesh: 1—Bijoaraneus mitificus | 2—Argiope aemula | 3—Argiope anasuja | 4—Cyclosa bifida | 5—Cyclosa hexatuberculata | 6—Cyclosa insulana | 7—Cyrtophora cicatrosa | 8—Eriovixia excelsa | 9—Gasteracantha kuhli | 10—Neoscona mukerjei | 11—Neoscona nautica | 12—Neoscona sp. © Tanmaya Rani Sethy.
Image 13–24. Spiders of Sagar district, Madhya Pradesh: 13—Neoscona sp. | 14—Neoscona theisi | 15—Neoscona vigilans | 16—Nephila pilipes | 17—Parawixia dehaani | 18—Cheiracanthium melanostomum | 19—Clubiona drassodes | 20—Castianeira sp. | 21—Castianeira zetes | 22—Nigma sp. | 23—Stegodyphus sarasinorum | 24—Drassodes carinivulus. © Tanmaya Rani Sethy.
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Image 25–36. Spiders of Sagar district, Madhya Pradesh: 25—Poecilochroa sp. | 26—Zimiris doriae | 27—Hersilia savignyi | 28—Hippasa fabreae | 29—Lycosa shoktoe | 30—Pardosa sp. | 31—Oecobius putus | 32—Hamataliwa sp. | 33—Oxyopes birmanicus | 34—Oxyopes javanus | 35—Oxyopes shweta | 36—Peucetia viridana. © Tanmaya Rani Sethy.
Image 37–48. Spiders of Sagar district, Madhya Pradesh: 37—Tibellus elongatus | 38—Artema atlanta | 39—Crossopriza lyoni | 40—Pholcus phalangioides | 41—Carrhotus sp. | 42—Epocilla sp. | 43—Harmochirus sp. | 44—Hasarius adansoni | 45—Thyene sp. | 46—Menemerus bivittatus | 47—Myrmaplata plataleoides | 48—Plexippus paykulli. © Tanmaya Rani Sethy.
Image 49–60. Spiders of Sagar district, Madhya Pradesh: 49—Plexippus petersi | 50—Rhene flavicomans | 51—Siler semiglaucus | 52—Stenaelurillus sp. | 53—Telamonia dimidiata | 54—Scytodes pallida | 55—Gnathopalystes kochi | 56—Heteropoda venatoria | 57—Leucauge decorata | 58—Tetragnatha mandibulata | 59—Tetragnatha sp. | 60—Guizygella indica. © Tanmaya Rani Sethy.
spider checklist of this area thus, providing a baseline data of spiders that live in the forest, agricultural and agroforest habitats. Spiders however, face risks such as habitat loss due to laterite mining, pollution, and changes in land use practices. Further research needs to be carried out to ensure efficient conservation of spiders.

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