Bulletin of Pure and Applied Sciences
Zoology (Animal Science), Vol.42A, No.1,
January-June 2023: P.16-28

Print version ISSN 0970 0765
Online version ISSN 2320 3188
DOI: 10.48165/bpas.2023.42A.1.3

Original Research Article *Content Available online at: https://www.bpasjournals.com/zoology*

Spider Diversity in Wainganga River Basin of Balaghat, Madhya Pradesh

[1]D.M. Agase, [2]M.S. Markam, [3]S. R. Zaheen, [4]S. M. Khan, [5]P. Y. Meshram, [6]P. Sharma, [7]T.S. Kothe and [8]M.K Bisen

Author's Affiliation:
[1,2]Assistant Professor, Department of Zoology, Jata Shankar Trivedi Government P.G. College, Balaghat, Madhya Pradesh 481101, India
E-mail: sbt.durgesh@gmail.com
E-mail: mmarkam_bgt@rediffmail.com
[3,4,5]Research Student, Department of Zoology, Jata Shankar Trivedi Government P.G. College, Balaghat, Madhya Pradesh 481101, India
E-mail: shahanazaheen@gmail.com
E-mail: khan.seefa2001@gmail.com
E-mail: payalmeshram277@gmail.com
[6]Research Student, Department of Zoology, RTM Nagpur University Nagpur, Maharastra 440022, India.
E-mail: pratishthasharma82@gmail.com
[7]Assistant Professor, Department of Zoology, Govt. KNG College, Balaghat, Madhya Pradesh 481001, India.
E-mail: tanu0602@gmail.com.
[8]Assistant Professor, Department of Botany, Govt College, Lamta, Balaghat, Madhya Pradesh 481551, India.
E-mail: mukeshk.bisen@gmail.com

***Corresponding author:**
Dr. Durgesh M. Agase,
Assistant Professor, Department of Zoology, Jata Shankar Trivedi Government P.G. College, Balaghat, Madhya Pradesh 481101, India
E-mail: sbt.durgesh@gmail.com

Article Info:
Received on 23.11.2022
Revised on 29.01.2023
Approved on 09.02.2023
Accepted on 18.02.2023
Published on 16.06.2023

ABSTRACT:
Spiders have a critical role in the ecological web. They are significant ecological indicators. In central India Balaghat district of Madhya Pradesh is known for having the highest forest density, biological diversity, and ecological values. In the present study, a total of 65 spider species from 15 families and 47 genera were identified. In total, 2340 individual spiders have been observed in the Wainganga basin of Balaghat. Family Araneidae has the most species (30.76%) out of the 15 families studied. This was followed by Salticidae (21.53%), Lycosidae (10%), Theridiidae (10%), and Tetragnathidae (6.1%). Habitat heterogeneity, availability of water resources, rich vegetation, and an abundance of prey density ultimately increase the abundance and diversity of spiders in the present study site.

Keywords: Balaghat, Ecological indicators, Spider Diversity

How to cite this article: Agase D.M., Markam M.S., Zaheen S.R., Khan S.M., Meshram P.Y., Sharma P., Kothe T.S. and Bisen M.K. (2023). Spider Diversity in Wainganga River Basin of Balaghat, Madhya Pradesh. *Bulletin of Pure and Applied Sciences-Zoology*, 42A (1), 16-28.

INTRODUCTION

Spiders are ancient arthropods from the Arachnida class with a 350-million-year history (Misal et al., 2019). They are eight-legged, air-breathing insects with fangs that can inject poison and spinnerets that produce silk (Selden et al., 2008). In terrestrial habitats, spiders constitute a diverse and common type of invertebrate predator (Shabnam et al., 2021). They are known to live in almost every terrestrial ecosystem, from the tops of the greatest mountain ranges to the depths of the largest caves and potholes, from humid marsh to dry desert. They are carnivorous and feed mostly on insects and other arthropods (Uniyal, 2004). There is strong evidence demonstrating the significance of spider communities for nutrient cycling and their involvement in the stabilization of insect populations (Rypstra et al., 1986). Due to their enormous numbers and insectivorous feeding behavior, spiders are thought to be the main factor regulating insect communities in agricultural areas (Shabnam et al., 2021). Despite recent studies on the faunistic richness of spiders, India has fewer spiders than other regions of the world in terms of recorded numbers (R. Singh et al., 2022). Spiders have a crucial role in the ecological web. They are significant ecological indicators. They are used to monitor environmental danger signs early on and as biological control agents because their assemblages have the power to inhibit the population expansion of insect pests and other natural enemies. They are one of the most successful groups of natural predators in agricultural ecosystems, and as efficient predators, they can control populations of key insect pests. Spiders are categorized into 132 families and 4,275 genera, with around 49,713 known species worldwide (World Spider Catalog 2022). In India, there are 1,875 species classified into 478 genera and 61 families (Padma et al., 2021).

The Balaghat district of Madhya Pradesh is known in central India for having the highest forest density, biological diversity, and ecological values. The present study attempted to explore the distribution of spider variety in the Wainganga River Forest habitat. The main objective of the current study is to periodically gather baseline information on spider diversity.

MATERIALS AND METHODS

Study Area

The spider diversity survey was carried out in Madhya Pradesh's Balaghat District (21°30′ to 22°30′ N Latitude and 80°00′ to 81°00′ E Longitude) in the Wainganga River Basin. The river Wangangais one of Godavari's northern tributaries. The origin of Wangangais on flat terrain, emerging from a spring of Mahadev Hills of the Satpuda Range of District Seoni. Wainganga traverses a distance of 642 km through two states, Madhya Pradesh and Maharashtra, before it's confluence with Wardha River. A few kilometers from there, the Wardha-Wainganga confluence occurs, and then the river takes the name *Pranhita,* which meets the Godavari in Kaleshwaram, Telangana. The Balaghat Wainganga's basin is located between longitude 76°E and 80° 53' E and latitude 18° 48' to 22° 43' N. It is located between 900 and 1600 mm in the medium rainfall zone. During the southwest monsoon, which lasts from June to October, the majority of the rainfall occurs. The minimum temperature in the winter ranges from 7° C to 13° C. The maximum temperature ranges between 39° and 47° degrees Celsius. In the Madhya Pradesh district of Balaghat, the hottest month is May, and the coldest months are December and January (Central Water Commission 2022). The research was carried out at various points along the Wainganga River. The major types of vegetation in the current study area included grasslands, wetlands, open scrub forests, dry deciduous forests, and bamboo groves. The present study was carried out along ten transects ranging in length from 200 to 600 meters and covering an area of 2.60 square Kilometres. Transects were divided into four habitats for this study based on general landscape attributes and vegetation present.

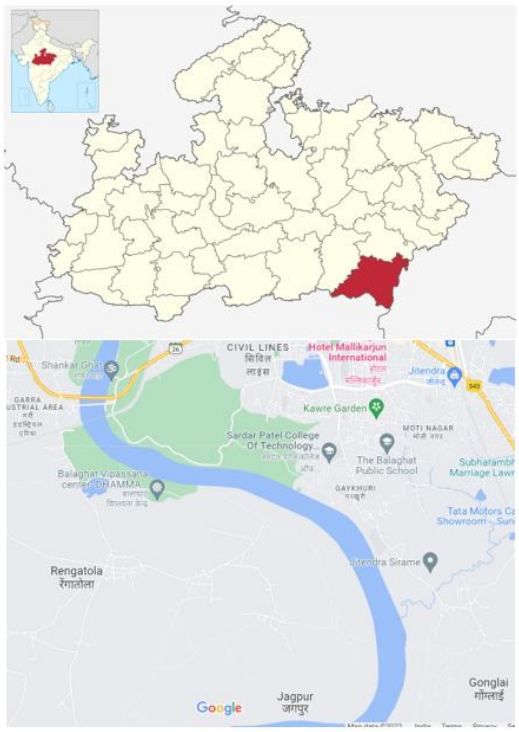

Figure 1: The geographical location of the study area (Image: google earth)

Survey and Identification of spiders

For the monitoring of spider diversity, the survey was conducted for a period of one year from October 2021 to September 2022. Spider diversity was quantified and studied using fixed radius point counts along transects. The survey was done between 6:30 am to 11:30 am (morning) and 5:00 pm to 7:00 pm (evening). For the documentation of spiders, photographs were taken in their natural habitat. During the study, no live specimens were collected. A Nikon 5700D with a 70-300 mm lens and the macro lens were utilized to take the spider photos. The study site was mapped and monitored using a DJI Mavic 3 drone camera. A visual search method was used to find spiders. The presence of spiders was visually recorded in microhabitats such as the ground, litter, foliage, flower, and tree trunk (Shabnam et al., 2021). The identification of spiders was done using field guides; Spiders of India by PA Sebastian and KV Peter.

Data analysis

The current spider study used taxonomic articles from the World Spider Catalog (2021) and a handbook on key morphological features of spiders to classify them (Tikader, 1987). During the study period, the calculation of the relative abundance (RA) of each spider species was done.

Obtained relative abundance (RA) values were examined under four categories (Rare; RA ≤ 0.5, Uncommon; RA > 0.5 to 1.5, Common; RA >1.5 to 3.5 and Very Common; RA > 3.5). The rank abundance plot was created using the log-transformed total individual counts of each spider species. The seasonal index was calculated using the following formula for comparing spider species variation: Seasonal index (SI) = number of species identified in season / total number of species. For the present study area, the diversity measures Simpson's dominance index (D), Mechanic's Index (D_{mn}), and Margoles' richness index (D_{mg}) were computed.

RESULTS

The present study sites' diverse habitats and dense vegetation sustain a high spider population. In the present study, a total of 65 spider species from 15 families and 47 genera were identified. In total, 2340 individual spiders have been observed in the Wainganga basin. Table 1 provides a checklist of spiders along with their families, relative abundance, and web type. Plates 1 to 4 show photographs of spiders found in the study area.

Family Araneidae has the most species (30.76%) out of the 15 families studied. This was followed by Salticidae (21.53%), Lycosidae (10%), Theridiidae (10%), and Tetragnathidae (6.1%). Fig. 2 depicts the family distribution of spider species. A rank abundance plot obtained from the log-transformed value of the total individual count represented in a gentle curve showing high species richness and evenness of spider species (Fig. 2).

Spider species namely *Nephila pilipes, Nephila kuhlii,Argiopepulchella,Agriopeaemula*and*Phintella vittata*were found common. On the other hand, *Stiphropus sp., Idiops sp.,* and *Scytodes sp.* spiders are very low in number. In the present study, out of 47 genera, *Argiope and Araneus* were dominated. Fig. 4 shows the seasonal index which indicates different spider species in the present study area. Table 2 shows the value of different diversity indexes calculated for spider's diversity for the present study area. The Simpson's Index of Diversity (D) was found 0.97 which indicates the richness and evenness of spider species in the Wainganga River basin. Margalef's index and Menhinik's index were 8.23 and 1.34 respectively which represents the high species richness of the present study site.

Table: 1 List of Spiders

S.N.	Common Name	Scientific Name	Family	RA	Guild
1	Northern Golden Orb Weaver	*Nephila pilipes*	Araneidae	0.07008547	Orb Weaver
2	Signature Spider	*Argiope pulchella*	Araneidae	0.0542735	Orb Weaver
3	Signature Spider	*Argiope aemula*	Araneidae	0.05213675	Orb Weaver
4	Trashline Orb Weaver	*Cyclosaconica*	Araneidae	0.03333333	Orb Weaver
5	European Garden Spider	*Araneus diadematus*	Araneidae	0.01965812	Orb Weaver
6	Spotted Orb Weaver	*Neoscona adianta*	Araneidae	0.02222222	Orb Weaver
7	Black Wood Spider	*Nephila kuhlii*	Araneidae	0.05470085	Orb Weaver
8	Green Lynx Spider	*Peucetiaviridans*	Oxyopidae	0.01923077	Stalkers
9	Striped lynx	*Oxyopessalticus*	Oxyopidae	0.02521368	Stalkers
10	Heavy-bodied Jumping spider	*Hyllus semicupreus*	Salticidae	0.02863248	Foliage runner
11	Two-striped jumping Spider	*Telamoniadimidiata*	Salticidae	0.01367521	Foliage runner
12	Black Jumping Spider	*Evarchaarcuata*	Salticidae	0.01666667	Foliage runner
13	Pantropical Jumper	*Plexippuspaykulli*	Salticidae	0.03418803	Foliage runner
14	Banded phintella	*Phintellavittata*	Salticidae	0.01837607	Foliage runner
15	Magnolia Green Jumper	*Lyssomanesviridis*	Salticidae	0.01837607	Foliage runner
16	Peppered jumper	*Pelegrinagalathea*	Salticidae	0.01153846	Foliage runner
17	Himalayan Jumping spider	*Euophrysomnisuperstes*	Salticidae	0.01196581	Foliage runner
18	Grey Wall Jumper	*Menemerusbivittatus*	Salticidae	0.00769231	Foliage runner

S.N.	Common Name	Scientific Name	Family	RA	Guild
19	Jumping Spider	*PlexippusSp.*	Salticidae	0.02564103	Foliage runner
20	Green Long jawed orbweaver	*Tetragnathaguatemalensis*	Tetragnathidae	0.01367521	Orb Weaver
21	Decorative silver orb spider	*Leucaugedecorata*	Tetragnathidae	0.01324786	Orb Weaver
22	Wolf spider	*Arctosa cinerea*	Lycosidae	0.01367521	Riparian vegetation
23	Wandering Wolf Spider	*Pardosapseudoannulata*	Lycosidae	0.01923077	Non-web-building spider
24	Common funnel web spider	*Hippasaagelenoides*	Lycosidae	0.01752137	Funnel-web
25	Trapdoor Spider	*IdiopsSpe.*	Idiopidae	0.00128205	Tubular burrows
26	Feather-legged Spider	*Uloboruskrishnae*	Uloboridae	0.00384615	Orb weavers
27	Wolf spider	*Arctosalaminata*	Lycosidae	0.00769231	Riparian vegetation
28	Funnel Web Wolf Spider	*Hippasagreenalliae*	Lycosidae	0.00683761	Funnel-web
29	Yellow Sac Spider	*Cheiracanthiummildei*	Cheiracanthiidae	0.01324786	Thorny-Stemmed plants
30	Two-tailed Spider	*Hersiliasavignyi*	Hersiliidae	0.01623932	Trunks of large trees
31	Black Widow Spider	*Latrodectus mactans*	Theridiidae	0.0017094	Tangle-web spiders
32	Dew-drop Spider	*Argyrodeselevatus*	Theridiidae	0.00512821	Tangle-web spiders
33	Cob Web Spider	*Theridion sp.*	Theridiidae	0.00384615	Tangle-web spiders
34	Crab Spiders	*Bassaniana versicolor*	Thomisidae	0.00512821	Foliage runner
35	Signature Spider	*Argiope keyserlingi*	Araneidae	0.01923077	Orb Weaver
36	Tan or familiar Jumping Spider	*Platycryptusundatus*	Salticidae	0.013675	Orb Weaver
37	Long-Jawed Orb-Weavers	*Tetragnathajavana*	Tetragnathidae	0.009402	Orb Weaver
38	Long-Jawed Orb-Weavers	*Tetragnathacochinensis*	Tetragnathidae	0.005556	Orb Weaver
39	Scaffold Web Spider	*Cryptachaeaveruculata*	Theridiidae	0.014103	Tangle-web spiders
40	Mirror Spider	*Thwaitesiaargentiopunctata*	Theridiidae	0.002564	Tangle-web spiders
41	Dark Fishing Spider	*Dolomedestenebrosus*	Pisauridae	0.007692	Tangle-web spiders
42	Daddy long-legs Spider	*Pholcusphalangioides*	Pholcidae	0.013675	Tangle-web spiders
43	Striped Fishing Spider	*Dolomedes scriptus*	Pisauridae	0.016667	Foliage runner

S.N.	Common Name	Scientific Name	Family	RA	Guild
44	Green zig zag Spider	*Agriopechloreis*	Araneidae	0.017094	Orb Weaver
45	Crab Spider	*Stiphropus Sp.*	Thomisidae	0.000855	Foliage runner
46	Garden tent-web Spider	*Cyrtophoracicatrosa*	Araneidae	0.01453	Orb Weaver
47	Spotted Orb Weaver	*Neoscona crucifera*	Araneidae	0.017094	Orb Weaver
48	Wolf Spider	*Piratapiraticus*	Lycosidae	0.01453	Riparian vegetation
49	Rubens Orbweaver	*Hypsosingarubens*	Araneidae	0.013248	Orb Weaver
50	Pantropical Huntsman Spider	*Heteropodavenatoria*	Sparassidae	0.011111	Foliage runner
51	Kidney garden spider	*Araneus mitificus*	Araneidae	0.002564	Orb Weaver
52	Spotted fishing spider	*Dolomedes triton*	Pisauridae	0.012821	Riparian vegetation
53	Jumping Spider	*Metacyrbataeniola*	Salticidae	0.023932	Foliage runner
54	Comb-footed spiders	*Achaearanealunata*	Theridiidae	0.011111	Tangle-web spiders
56	European garden like spider	*Angulatadiadematus*	Araneidae	0.003419	Orb Weaver
57	Araneus orb weaver	*Araneus ventricosus*	Araneidae	0.009402	Orb Weaver
58	Jumping Spider	*Habronattusdecorus*	Salticidae	0.013675	Foliage runner
59	Banded Orb-Web Spider	*Argiope trifasciata*	Araneidae	0.011966	Orb Weaver
60	Furrow Orb Spider	*Larinioidescornutus*	Araneidae	0.005128	Orb Weaver
61	Spitting Spiders	*Scytodes sp.*	Scytodiidae	0.001709	Foliage runner
62	Hackled Orb Weavers	*Uroboros sp.*	Uloboriidae	0.003419	Orb Weaver
63	Jewel Spider	*Gemmoides sp.*	Araneidae	0.005128	Orb Weaver
64	Brilliant Jumping Spider	*Phidippus Clarus*	Salticidae	0.009402	Foliage runner
65	Bolas Spider	*Cladomelea sp.*	Araneidae	0.010256	Orb Weaver

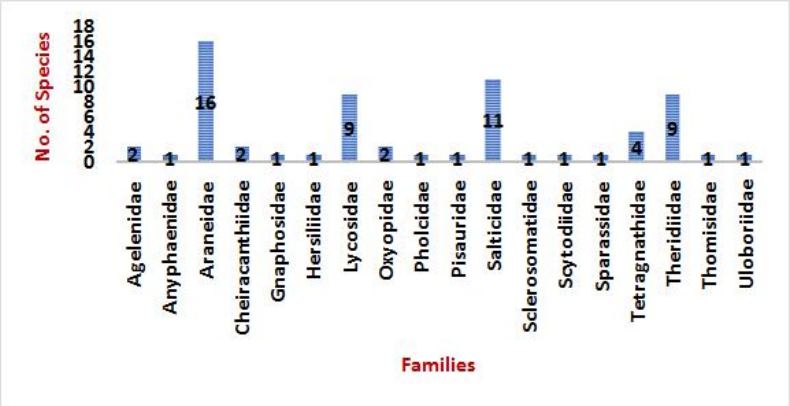

Figure 2: Abundance of Spider Families

Figure 3: Rank Abundance Curve

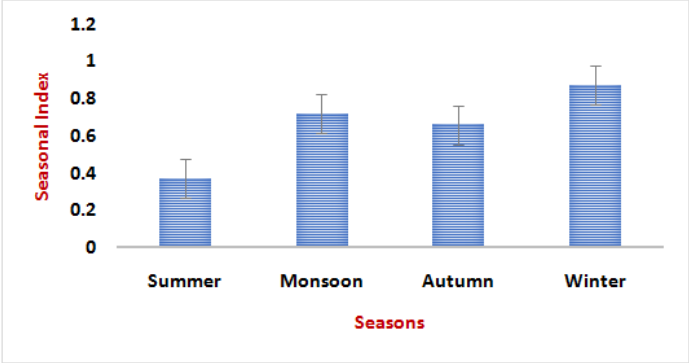

Figure 4: Seasonal Index

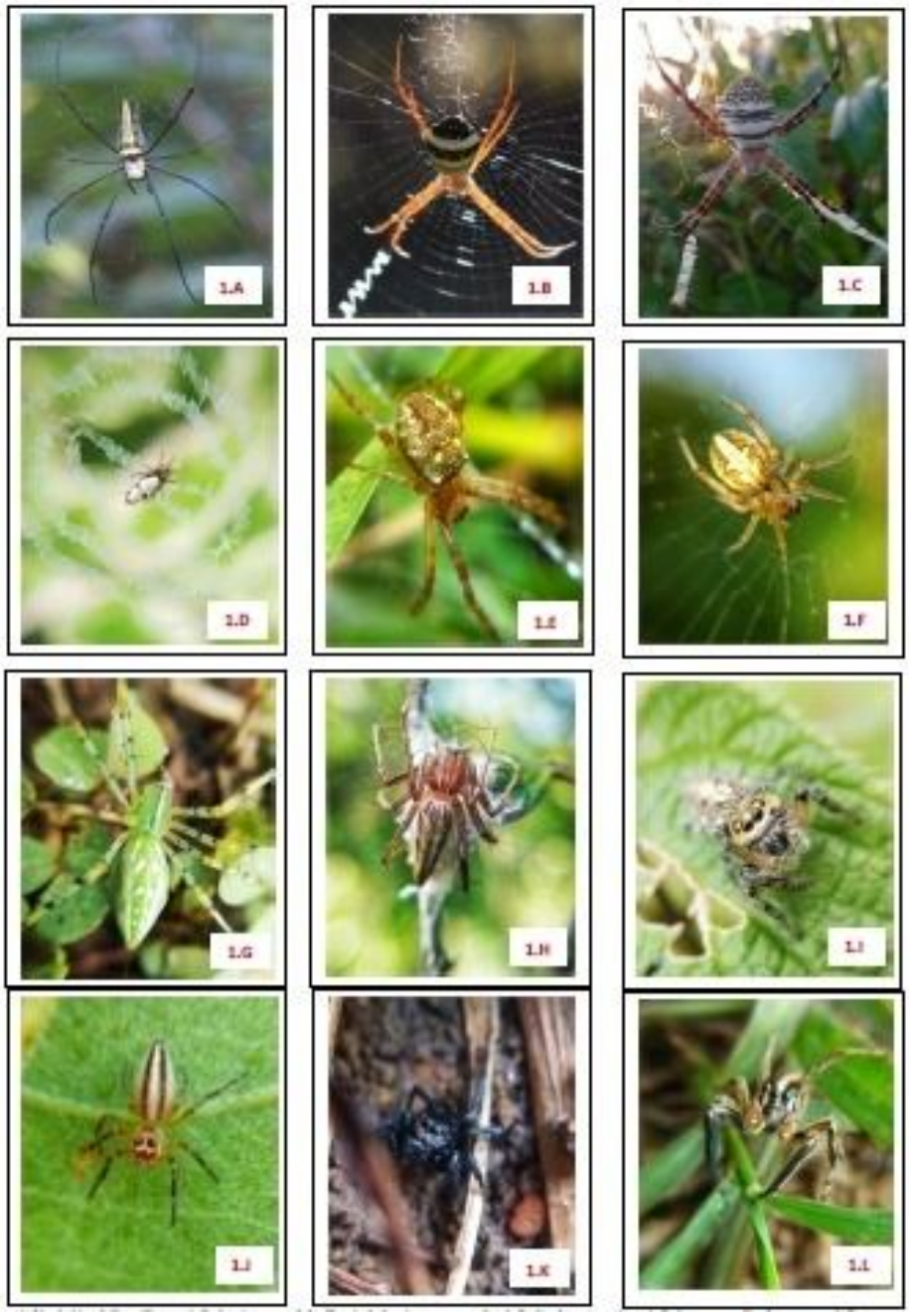

Plate 1: (1.A *Nephila pilipes,* 1.B *Argiope pulchella,* 1.C *Argiope aemula,* 1.D *Cyclosaconica,* 1.E *Araneus diadematus,* 1.F *Neoscona adianta,* 1.G *Peucetia viridans,* 1.H *Oxyopes salticus,* 1.I *Hyllus semicupreus,* 1.J *Telamonia dimidiata,* 1.K *Evarcha arcuata,* 1.L *Plexippus sp.)*

Plate 2: (2.A *Phintella vittata,* 2.B *Lyssomanes viridis,* 2.C *Pelegrina galathea,* 2.D *Euophrys omnisuperstes,* 2.E *Menemerus bivittatus*, 2.F *Plexippus paykulli*, 2.G *Tetragnatha guatemalensis*, 2.H *Tetragnatha guatemalensis,* 2.I *Leucauge decorate,* 2.J *Arctosa cinerea*, 2.K *Pardosa pseudoannulata*, 2.K *Hippasa agelenoides* 2.L *Idiops Sp.*)

Plate 3: (3.A *Uloborus krishnae,* 3.B *Arctosa laminata,* 3.C *Hippasa greenalliae,* 3.D *Cheiracanthium mildei,* 3.E *Hersilia savignyi,* 3.F *Latrodectus mactans, 3.G Argyrodes elevates* 3.H *Theridion sp.,* 3.I *Xysticus cristatus, 3.J Platycryptus undatus, 3.K Tetragnatha javana, 3.L Tetragnatha cochinensis*)

Plate 4: (4.A *Cryptachaea veruculata, 4.B Thwaitesia sp. 4.C Dolomedes tenebrosus, 4.D Dolomedes scriptus, 4.E Stiphropus Sp.,* 4.F *Cyrtophora cicatrosa*, 4.G *Pirata piraticus*, 4.H *Hypsosinga rubens,* 4.I *Heteropoda venatoria*, 5.J *Araneus mitificus*, 5.K *Metacyrba taeniola*, 5.L *Achaearanea lunata)*

DISCUSSION

The present study was preliminary and an initial attempt to understand the distribution of spider diversity in the forest and near the Wainganga River's stream habitat. The study emphasizes the importance of the Wainganga River's mosaic and variegated vegetation in supporting a diverse range of spiders. The various time periods and collection techniques may be connected to the variations in spider fauna. Because spiders are extremely sensitive to small changes in habitat structure, complexity, and microclimate characteristics, environmental factors such as vegetation type, seasonality, spatial heterogeneity, predation, prey occurrence, and so on can affect species diversity. From one geographical region to another, their distribution and abundance may differ (Padma et al., 2021). In addition to their significance as bioindicators, they are also well-known for producing spider venom, which is produced by mosquito larvae and adults that transmit malaria parasites and is essential in pharmacological extracts (Misal et al., 2019). Spiders are well known for being adaptable, cunning predators, and crucial contributors to ecosystems, helping to form both communities and food webs. They act as biological agents because they eat pests like flies, caterpillars, aphids, plant bugs, and thrips (Uniyal 2004).Spiders have been also shown to accumulate many trace metals and are known to be good indicators of ecotoxicological studies (Zmudzki, and Laskowski, 2012) A greater variety of spider species indicates a healthier and more complex community because a greater variety of species allows for more interactions and, as a result, greater system stability, which in turn indicates good environmental conditions (Shabnam et al., 2021).

The Indian spider fauna is represented by 1520 spider species under 60 families and 377 genera (Sebastian and Peter 2009). The present study represents 65 species under 15 families. In Western Ghat, Kerala total of 150 species belonging to 20 families were recorded, where the Salticidae family is dominated (Rajeevan et al., 2019). In the present work, the family Araneidae has the most species (30.76%) out of the 15 families. Similarly, the study of the spider fauna of the Kaveri River Basin, Kerala reported family Araneidae was the most dominant and constitutes 21.5% of the total spider species (Jose et al., 2018). The dominance of the family Araneidae in the near river basin may be supported by the river's stream habitat. In the present study, spiders of the family Araneidae and Tetragnathidae were found mainly on small herbs, shrubs, flowering plants, and trees and built Orb Web. On the other side, most of the members of the family Salticidae and Lycosidae did not spin webs and were found in grasslands protected by litter from trees. The most suitable season is from post-Manson to early summer for many spiders (Hsieh and Linsenmair, 2012). In our study, the highest abundance of spider numbers was found in the winter season.

The spider fauna of the Wainganga River basin has never been documented. The present study is the first report from this area. The present study emphasizes that the spider diversity of the Wainganga River basin is quantitatively rich. As an environmental indicator spider play a vital role in the ecosystem and proper documentation of spider fauna can provide valuable information about the health of the ecosystem.

CONCLUSION

Habitat heterogeneity, availability of water resources, rich vegetation, and an abundance of prey density ultimately increase the abundance and diversity of spiders in the present study site. The present study provides initial data about the spider diversity of the Wainganga River basin of the Balaghat, district. Out of 65 recorded spider species, the Araneidae family shows maximum diversity. However, the present study is the first report on the spider fauna of Balaghat, and future monitoring and research are required to observe for any change in the species composition of spider diversity. This work will be helpful for further details research on spider fauna, and their seasonal distribution. The present study will also help to recognize the potential threats to spider diversity. Thus, the present work concluded that the Wainganga River basin of Balaghat is rich in spider diversity.

REFERENCES

1. Central Water Commission (2022). CWC online at http://cwc.gov.in accessed on {08.10.2022}.
2. Hsieh, Y., L. and Linsenmair, K.E. (2012) Seasonal dynamics of arboreal spider diversityin a temperate forest, *Ecology and Evolution*, 2(4), 768–777.
3. Jose A. C, Sudhin P. P, Prasad P. M, Sreejith K. A. (2018). Spider Diversity in Kavvayi River Basin, Kerala, Southern India. *Curr World Environ*. 13(1), 100-112.
4. Misal, P. K., Bendre, N.N., Pawar P. A., and Bhoite S. H. (2019). An Updated Review on the Spiders of Order Araneae from the Districts of Western Ghats of India. *Bioscience Biotechnology Research Communications* 12 (4), 855-864.
5. Padma, S and Sundararaj, R (2021). Diversity of Spiders (Arachnida: Araneae) and the Impact of Pruning in Indian Sandalwood Plantations from Karnataka, India. *Journal of Threatened Taxa* 13 (12), 19762-19772.
6. Rajeevan, S., & Smija, M.K., and Varghese, T and Prasadan, P.K., (2019). Spider Diversity (Arachnida: Araneae) in Different Ecosystems of the Western Ghats, Wayanad Region, India. *South Asian Journal of Life Sciences*. 7 (2), 29-39.
7. Rypstra, A. L. (1986). Web Spiders in Temperate and Tropical Forests: Relative Abundance and Environmental Correlates. *American Midland Naturalist, 115(1), 42*.
8. Sebastian, P.A., and Peter, K.V. (2009). Spiders of India. Universities Press (India) Privet Limited.
9. Selden, P.A., Shear, W.A., and Sutton, M.D. (2008). Fossil evidence for the origin of spider spinnerets, and a proposed arachnid order. *Proceedings of the National Academy of Sciences* 105 (52), 20781-20785.
10. Shabnam, F.P., Rajeevan, S., Puthanpurayil, K., Prasadan, and Ambalaparambil, V.S. (2021). Spider diversity (Arachnida; Araneae) in different plantations of the Western Ghats, Wayanad region, India: spider diversity in Western Ghats, Wayanad. *European Journal of Ecology*, *7* (1), 80-94.
11. Singh, R. and Sharma A. (2022). "An Updated Checklist of Spider (Araneomorphae: Araneae: Arachnida) Diversity of Madhya Pradesh, India". *International Journal of Zoological Investigations,* 08 (01), 191-218.
12. Uniyal, V. P. (2004). Spiders as Conservation Monitoring Tools. *Proceedings of the Training Programme on Pest Management in Buildings for Pest Management Professionals.* Eds. B.S. Rawat, Central Building Research Institute (CSIR) Roorkee: 102-108.
13. World Spider Catalog (2022). World Spider Catalog. Version 23.5. Natural History Museum Bern, online at http://wsc.nmbe.ch, accessed on {23.11.2022}.
14. Tikader, B.K. (1987). *Handbook, Indian spiders*, Zoological Survey of India, Calcutta
15. Zmudzki, S., and Laskowski, R. (2012) Biodiversity and structure of spider communities along a metal pollution gradient. *Ecotoxicology.* 21(5), 1523-32.