DIVERSITY OF ARANEAE AND WEB PATTERNS IN THE MALLATHAHALLI LAKE OF BANGALORE, KARNATAKA, INDIA.

Vidya Padmakumar

Department of Studies and Research in Biosciences, Mangalore University, Mangalagangotri, Mangaluru, Dakshina Kannada, Karnataka, India
Email: vidyapkumar3@gmail.com

Shine P Joseph

Department of Studies and Research in Biosciences, Mangalore University, Mangalagangotri, Mangaluru, Dakshina Kannada, Karnataka, India

Received: Aug. 2021 Accepted: Sep. 2021 Published: Oct. 2021

Abstract: The current work was conducted from May 2018 to April 2019 to assess and tabulate the species of the order Araneae that are found to survive in the sporadically distributed regions around the Mallathahalli Lake of Bangalore, Karnataka. The Arachnids were observed and collected by pitfall trapping, vegetation beating, ground hand collection, aerial hand collection, and sweep netting techniques and a total of 37 different species belonging to 30 genera and 12 families from a single order have been identified from this region. The observed species belong to the Families- Tetragnathidae, Sparassidae, Eresidae, Hersiliidae, Pholcidae, Philodromidae, Thomicidae, Araneidae, Oxyopidae, Cheiracanthiidae, Salticidae, and Lycosidae. The family Eresidae (48%) was seen to be predominant and the least recorded family being Cheiracanthiidae (0.3%). The current study also reveals five web patterns (orb web, funnel web, tent web, social web, and irregular web out of which orb web was found to be dominant. The environmental factors like secured habitat and food sources for the spiders were considered as the essential means for the evaluation of species richness and abundance. The structure of the vegetation has been noted to influence the diversity of web types of spiders found in the habitat indicating that structural diversity of the vegetation may, in some way, influence the spider diversity.

Keywords: Araneae, Mallathahalli Lake, Spider, Arachnida.

Introduction: The Arachnida is known to be one of the longest-surviving and diverse groups of organisms. Their fossil shreds of evidence are dated back to the Palaeozoic era and several orders are represented as fossils from the Devonian or Silurian era (Dunlop, 1997; Selden, 1996; Selden *et.al.,* 1991; Shear *et.al.,* 1987 and Shear *et.al.,* 1989), predating numerous other extant clades of living organisms. Globally there are approximately 40,000 Araneae species currently recognized (Platnick, 2005), even though estimations of their total number vary from 60,000 to 170,000 (Coddington and Levi, 1991). Araneae are generalists of predators colonizing almost all habitats and are quite abundant and diverse in the ecosystem (Nyffeler, 2000). Because of their diverse relationships with the environment and their impact on prey populations (Nyffeler, 2000), Araneae have been proposed as very suitable for pest limitation and bio-indication (Marc *et.al.,* 1999).

Araneae occupy many spatial and temporal niches and show different types of predatory strategies. They can survive without feeding for a long period. In some special environmental conditions, some species of Araneae feed on nectar and pollen for a brief period. The Araneae distribution on a macro-scale is related to their susceptibility to abiotic factors. Araneae is considered as bioindicator species in the environment; the first approach at the species level, indicating interaction with the environmental change or disturbance by using well known ecological preferences (Maelfait *et.al.,* 1990; Mciver *et.al.,* 1990 and Platen, 1993) and the second approach wherein Araneae communities are used as an indicator of the quality of natural habitats (Romp and Stenberger, 1992) and for monitoring pollutants. Araneae is thus ideal for studying the biodiversity of a region (Platnick, 1999) and are the abundant component of any canopy fauna. Many studies have widely focussed the potential of Araneae as bio-indicators (Duchesne and McAlpine, 1993; Butterfield et al., 1995; Beaudry et al., 1997; Atlegrim et al., 1997; Churchill, 1997; Duchesne et al., 1999; Bromham et al., 1999; Heyborne et al., 2003). The present study has been undertaken in and around Mallathahalli Lake to highlight the Araneae diversity and web patterns concerning different habitats.

Materials and Method: Mallathahalli Lake is a freshwater, natural lake located on the western fringe of Bangalore city in a less urbanized area currently under development. This lake falls in the Vrishabhavathi valley of the Bangalore urban district, and the primary source of water to the lake is rainfall and sewage (Ravikumar et al., 2013). There are sewage inlets at the north, northeast, and northwest corners of the lake. The lake is irregular in shape, covering approximately 25.9 ha of surface area and a perimeter of approximately 2.9 km. The catchment basin of the lake is about 625 ha, with 3 islands within its premises.

As spiders exploit a wide variety of niches, weekly sampling was done for a period of one year May 2018 – April 2019 to collect samples from the lake surroundings. Sampling required a combination of methods, and hence five different collection techniques i.e., pitfall trapping, vegetation beating, ground hand collection, aerial hand collection and sweep netting techniques were followed as per standard methods (Coddington, 1996). The study area was divided into four sites (Site – A: Shady area, Site – B: Leaf Litter, Site – C: Mixed vegetation, and Site – D: Bushy area) and the survey was conducted for spider diversity, richness, and abundance. The survey was conducted for a period of a maximum of 3 hours (between 8 AM to 11 AM), extending it by random sampling.

Specimens collected were transferred to 70% alcohol for identification. Identification and classification were done based on morphometric characters of various body parts. A detailed taxonomic study was administered supported the varied keys and catalogs provided by Nentwig et.al, (2003) and Platnick (2011).

Statistical analysis using Shannon–Weiner Index and Relative abundance was done for assessing spider diversity.

Results: A total of 37 different species belonging to 30 genera and 12 families from a single order- Araneae have been identified from the regions of the lake.

Table 1: List of Spiders Identified in the Study Area

Sl. No.	Scientific Name	Common Name	Family
1.	*Araneus mitificus*	Kidney garden spider	Araneidae
2.	*Argiope aemula*	Oval cross spider	Araneidae
3.	*Argiope anasuja*	Signature Spider/Giant Cross Spider	Araneidae
4.	*Argiope pulchella*	Garden cross spider	Araneidae
5.	*Cyclosa confraga*	Cyclosa spider	Araneidae
6.	*Gasteracantha geminata*	Spiny orb-weaver	Araneidae
7.	*Herennia multipuncta*	Ornamental tree trunk spider	Araneidae
8.	*Stegodyphus sarasinorum*	Indian cooperative spider	Eresidae
9.	*Hersilia savignyi*	Two-tailed spider	Hersiliidae
10.	*Hippasa holmerae*	Lawn Wolf Spider	Lycosidae
11.	*Lycosa barnesi*	Wolf spider	Lycosidae
12.	*Lycosa carmichaeli*	Wolf spider	Lycosidae
13.	*Pardosa atropalpis*	Thin-legged Wolf spider	Lycosidae
14.	*Trochosa punctipes*	Rustic wolf spider	Lycosidae
15.	*Cheiracanthium conflexum*	Yellow Sac spider	Cheiracanthiidae
16.	*Oxyopes bharatae*	Lynx spider	Oxyopidae
17.	*Oxyopes birmanicus*	Cross lynx spider	Oxyopidae

18.	*Oxyopes elongates*	Striped lynx spider	Oxyopidae
19.	*Oxyopes javanus*	Striped lynx spider	Oxyopidae
20.	*Peucetia elegans*	Large lynx spider	Oxyopidae
21.	*Peucetia graminea*	Green lynx spider	Oxyopidae
22.	*Peucetia viridana*	Green lynx spider	Oxyopidae
23.	*Philodromus decoratus*	Crab spider	Philodromidae
24.	*Artema Atlanta*	Daddy-longlegs spider	Pholcidae
25.	*Crossopriza lyoni*	Box spider	Pholcidae
26.	*Carrhotus viduus*	Black & white jumper	Salticidae
27.	*Thiania bhamoensis*	Metallic blue jumper	Salticidae
28.	*Hasarius adansoni*	Adanson's house jumper	Salticidae
29.	*Hyllus semicupreus*	Semi-coppered heavy jumper	Salticidae
30.	*Menemerus albocinctus*	Jumping spider	Salticidae
31.	*Phintella vittata*	Banded Phintella	Salticidae
32.	*Plexippus petersi*	Small zebra jumper	Salticidae
33.	*Rhene rubrigera*	Jumping spider	Salticidae
34.	*Telamonia dimidiata*	Two-striped jumper	Salticidae
35.	*Olios milleti*	Green crab spider	Sparassidae
36.	*Tetragnatha sutherlandi*	Long-jawed spiders	Tetragnathidae
37.	*Thomisus pugilis*	Common rose spider	Thomisidae

Table 2: Spiders' Shannon Diversity Index and Relative Abundance

Study Site	Hand Picking		Sweep Netting		Vegetative Beating	
	Relative abundance (%)	Shannon index (%)	Relative abundance (%)	Shannon index (%)	Relative abundance (%)	Shannon index (%)
Site A	10.01	2.48	23.21	0.99	35.29	2.34
Site B	12.55	2.91	25.00	1.17	41.22	1.95
Site C	21.27	1.18	35.99	1.86	16.04	1.78
Site D	59.98	0.57	17.86	1.28	6.32	0.88

Shannon diversity index (H = 2.91) for the handpicking method was noted to be the highest in site B, whereas the lowest in Site D (H = 0.57). The sweeping method demonstrated site C with the highest index (H = 1.86) whereas Site A showed the lowest index (H = 0.99). By the vegetative beating method, site A showed the highest index (H = 2.34) while Site D showed the Lowest Index (H = 0.88).

Relative abundance (A) calculations demonstrated that by handpicking method, site D showed the highest (A = 59.98%) abundance, whereas Site A showed the Lowest (A = 10.01%) abundance. With the sweeping method, Site C showed the highest (A = 35.99%) abundance whereas Site D showed the Lowest (A = 17.86%) abundance. The vegetative beating method represented site B with the highest (A = 41.22%) abundance and Site D showed the lowest (A = 6.32%) abundance.

Five web patterns were observed which include orb web, funnel web, tent web, social web, and irregular web out of which orb web was found to be dominant. The Grass spiders of the family Lycosidae are well-known funnel-web makers. The species belonging to families Araneidae and Tetragnathidae weave orb-web patterns. The dome web or Tent web are built like an inverted silk bulb. The Social webs are made by the family Eresidae which live in colonies. The family Pholcidae is known to build irregular webs and are named so because of their irregularity in shape.

Discussion: Spiders are known to be an abundant and most diverse group of organisms enabling great analysis opportunities on their richness and abundance in terrestrial ecosystems. They are indicators with an environmental impact helping us to evaluate various factors concerning their prey availability and vegetation. Spiders are accommodative far and wide which is the rationale for such diversification. Greenstone (1984) opined that spider diversity is correlated to prey availability and vegetation structure, however, Wise (1993) has referred through Duchesne *et.al.,* (1999), concluded that food availability is not a limiting factor to the number of insects. Studies have demonstrated that a correlation exists between the structural complexity of habitats and species diversity (Uetz, 1975; Rosenzweig, 1995).

Diversity generally increases when a greater sort of habitats are present. Variations in species diversity in different months indicate altered parameters of the stream that supports biological communities.

In the present study family Eresidae (48%) found to be cardinal followed by Oxyopidae (14.9%), Lycosidae (9.7%), Salticidae (8.8%), Philodromidae (6%), Hersiliidae (4.1%), Araneidae (2.9%), Pholcidae (2.3%), Sparassidae (1.1%), Tetragnathidae (0.8%), Thomisidae (0.4%) and Cheiracanthiidae (0.3%) and showed less dominance. Deshmukh (2014) reported that the family composition and community show substantial unevenness from month to month. The results have also stipulated that all sites have varied species compositions. Additionally, many factors determine the species composition at a site and not simply the habitat type. An alternative interpretation of this is that the habitat types classified as different at the start of the study may be more similar than the assumption. The species abundance was found to be prime in site D in the hand-picking method followed by site B, site A, and less dominant in the sweeping method in site C. This result probably indicates a strong correlation between species diversity of ground surface spiders and their litter habitat. The habitat of spiders depends upon prey availability, temperature variations, moisture content, and harborage (Uetz, 1975).

Works by Uetz (1991) indicates that structurally more complex shrubs can support a more diverse range of spider. Downie *et.al.,* (1999) and New (1999) have also advocated that spiders are extremely sensitive to minute changes in the habitat including complexity, litter depth, and microclimate characteristics.

The environmental factors like secured habitat and food sources for the spiders were considered as crucial in the evaluation of species richness and abundance in and around Mallathahalli Lake. However, precise recommendations of the major factor affecting the decline in the diversity of different species of spiders cannot be made out of this meager analysis. The current report can only be acknowledged as sagacious baseline data adeptly establishing information on the richness and abundance of different species of spiders. There is urgent essentiality to work on for a superior understanding of Araneae diversity and its importance in the ecosystem.

References:

1. Atlegrim O., Sjöberg K. and Ball J.P. (1997): Forestry effects on a boreal ground beetle community in spring: selective logging and clear-cutting compared. Entomologica Fennica, 8: 19-26.
2. Beaudry S., Duchesne L.C. and Côté B. (1997): Short-term effects of three forestry practices on carabid assemblages in a jack pine forest. Canadian Journal of Forest Research, 27:2065-2071.
3. Bromham L., Cardillo M., Bennett A.F. and Elgar M.A. (1999): Effects of stock grazing on the ground invertebrate fauna of woodland remnants. Australian Journal of Ecology, 24: 199-207.
4. Butterfield J., Luff M.L., Baines M. and Eyre M.D. (1995): Carabid beetle communities as indicators of conservation potential in upland forests. Forest Ecology and Management 79: 63-77.
5. Churchill T.B. (1997): Spiders as ecological indicators in the Australian tropics: family distribution patterns along rainfall and grazing gradients. In P.A. Selden, Ed., Proceedings of the 17th European Colloquium of Arachnology, Edinburgh.
6. Clausen I.H.S. (1986): The use of spiders (Araneae) as an ecological indicator. Bulletin of the British Arachnological Society 7: 83-86.
7. Coddington J. A. and H. W. Levi. (1991): Systematics and evolution of spiders. Ann. Rev. Ecol. Syst. 22:569-592. Uetz, G.W., J. Halaj and A.B. Cady, (1999). Guild Structure of Spiders in Major Crops, 27: 270-280.
8. Coddington J.A., Young L.H. and Coyle F.A. (1996): Estimating spider species richness in a southern Appalachian cove hardwood forest. The Journal of Arachnology, 24: 111-128.

9. Downie I.S., J.E.L. Butterfield and J.C. Coulson. (1999): Habitat preferences of submontane spiders in northern England. Ecography. 18:51-61.
10. Duchesne L.C. and McAlpine R.S. (1993): Using carabid beetles Coleoptera: Carabidae as a means to investigate the effect of forestry practices on soil diversity. Forestry Canada Petawawa National Forestry Institute, Chalk River, Ontario, Canada Report No. 16.
11. Duchesne L.C., Lautenschlager R.A. and Bell F.W. (1999): Effects of clear-cutting and plant competition control methods on carabid Coleoptera: Carabidae assemblages in northwestern Ontario. Environmental Monitoring and Assessment, 56: 87-96.
12. Dunlop J.A. (1997): In Proceedings of the 17th European Colloquium of Arachnology, The origins of tetrapulmonate book lungs and their significance for chelicerate phylogeny, Selden PA (British Arachnological Society, Burnham Beeches, Bucks), pp 9–16.
13. Greenstone M. H. (1984): Determinants of web spider species diversity: vegetation structural diversity vs. prey availability. Oecologia 62:299–304.
14. Heyborne W.H., Miller J.C. and Parsons G.L. (2003): Ground dwelling beetles and forest vegetation change over a 17-year period, in western Oregon, USA. Forest Ecology and Management, 179: 123–134.
15. Maelfait J.P., Jocque R., Baert L. and Desender K. (1990): Heath land management and spiders. Acta zoological Fennica 190:261-266.
16. Marc P., Canard A. and Ysnel F. (1999): Spiders (Araneae) useful for pest limitation and bioindication. Agric. Ecosyst. Environ. 74, 229–273.
17. Mciver J.D., Moldenke A.R. and Parsons G.L. (1990): Litter spiders as bio-indicators of recovery after clear-cutting in a Western coniferous forest. Northwest Environmental Journal 6:410-412.
18. Nentwig W., Hänggi A., Kropf C. and Blick T. (2003): Central European spiders – determination key version 8.12.2003.
19. Niemelä J., Langor D. and Spence J.R. (1993): Effects of clear-cut harvesting on boreal ground-beetle assemblages (Coleoptera: Carabidae) in western Canada. Conservation Biology, 7: 551-556.
20. Nyffeler M. (2000): Ecological impact of spider predation: A critical assessment of Bristowe's and Turnbull's estimates. Bulletin of the British Arachnological Society, 11(9), 367–373.
21. Platen S. (1993): A method to develop an "indicator value" system for using canonical Correspondence Analysis (CCA). Memories of the Queensland Museum. 33:621-627.
22. Platnick N.I. (2011): The world spider catalog, version 12.0. American Museum of Natural History.
23. Romp B. and Stenberger K.H. (1992): Grassy field margins and arthropod diversity: a case study on ground beetles and spiders in eastern Austria (Coleoptera: Carabidae; Arachnida: Aranei, Opiliones). Agriculture, Ecosystem and Environment 40:71-93.
24. Rosenzweig M. L. (1995): Species diversity in space and time. Cambridge University Press, Cambridge, UK.
25. Selden P.A., Shear W.A. and Bonamo P.M. (1991): A spider and other arachnids from the Devonian of New York, and reinterpretations of Devonian Araneae. Paleontology 34:241-281.
26. Selden P.A. (1996): Fossil mesothelin spiders. Nature 379:498–499.
27. Shear W.A., Palmer JM, Coddington J.A., and Bonamo P.M., (1989): A Devonian spinneret: Early evidence of spiders and silk use. Science 246:479–481.
28. Shear W.A., Selden P.A, Rolfe W.D.I., Bonamo P.M. and Grierson J.D. (1987): New terrestrial arachnids from the Devonian of Gilboa, New York (Arachnida: Trigonotarbida) Am Mus Novit 2901:1–74.
29. Uetz G.W. (1975): Temporal and spatial variation in species diversity of wandering spiders (Araneae) in deciduous forest litter. Environmental Entomology. 4:719-723.
30. Uetz G.W. (1991): Habitat structure and spider foraging. In S.S. Bell, E.D. McCoy, H.R. Mushinsky, Eds., Habitat Structure: The physical arrangement of objects in space. Chapman and Hall, London, U.K.
31. Wise D.H. (1993): Food limitation of the spider Linyphia marginata: experimental field studies. Ecology 56:637-646.

***