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Author Affiliation:
[1]Department of Zoology, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Chowdhary Para, Rahara, Khardaha, West Bengal – 700118, India
[2]Nature Mates-Nature Club, 6/7 Bijoygarh, Kolkata – 700032, West Bengal, India
[3]Department of Environmental Science, University of Calcutta, 35, Ballygunge Circular Rd, Kolkata, West Bengal – 700019, India
[4]Department of Environmental Science, Indira Gandhi National Open University, College Rd, Ravenshaw University Campus, Cuttack, Odisha - 753003, India

*Corresponding Author
Department of Zoology, Ramakrishna Mission Vivekananda Centenary College (Autonomous), Chowdhary Para, Rahara, Khardaha, West Bengal – 700118,
India
Email: pakhibitan2019@gmail.com

ORCID List

Abhik Rong	0009-0000-1414-0408
Tarak Samanta	0000-0001-6809-0549
Souvik Mazumdar	0009-0009-0627-9456
Nivedita Sengupta	0000-0003-1085-7385
Lina Chatterjee	0000-0002-5626-5046
Arjan Basu Roy	0000-0001-9872-3562

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A Preliminary Checklist of Spiders in Ecopark Area, Near East Kolkata Wetland, West Bengal

Abhik Rong[1,2*], Arindam Das[1,2], Tarak Samanta[2,3], Souvik Mazumdar[1,2], Nivedita Sengupta[4], Lina Chatterjee[2,4], Arjan Basu Roy[2], Bulganin Mitra[1]

ABSTRACT

Examining spiders, despite their frequently unsettling reputation, is a quest that produces a plethora of valuable understandings about the intricate interconnectedness of life on our planet. For millions of years, these arachnids with eight legs, classified as Arachnida, have been deeply integrating themselves into ecosystems, demonstrating extraordinary adaptability and ecological importance. From their fascinating silk-spinning abilities to their diverse hunting strategies, spiders play a crucial role in maintaining the delicate balance of various ecosystems. As scientists delve into the world of spiders, they unearth many secrets of these enigmatic creatures, helping to gain a deeper understanding of biodiversity, evolution, and the interaction among the species in the natural world. In this exploration, researchers discover that the study of spiders goes far beyond mere arachnology; it is a key to unlocking broader mysteries in ecology, behavior, and even potential applications in fields such as medicine and materials science. This study conducted in Ecopark, an expansive urban park in Kolkata, West Bengal, aimed to document the diversity of spider species. A total of 33 spider species, belonging to nine families, were identified. The results contribute valuable baseline data for future spider research in Kolkata, shedding light on the ecological significance of urban parks in preserving diverse ecosystems. This study emphasises the importance of urban parks for ecosystem conservation while also addressing a gap in spider research in the region.

Keywords: Ecopark, Guild structure, Araneae, Spiders.

1. INTRODUCTION

Spiders, the most essential group of organisms, inhabit diverse environments ranging from aquatic settings to underground realms, deserts to snowy plains, and from towering mountain peaks to coastal shores. Their significance has grown as they are increasingly recognized as sensitive indicators of ecological health, making them valuable in assessing disturbances to their habitats (Rutkowski et al., 2018;

Stojanowska et al., 2020). Spiders exhibit a remarkable sensitivity to subtle alterations in their surroundings, such as changes in habitat structure, encompassing factors like habitat complexity, depth of litter, and microclimate characteristics (Downie et al., 1999). Spiders, which belong to the Araneae order within the Arthropoda phylum, can easily be distinguished from other arachnids due to the presence of a pedicel. This narrow stalk is a clear connection between the cephalothorax and the abdomen (Platnick, 1995).

A defining feature of spiders is the existence of a carapace on the dorsal side of their cephalothorax. Their jaws, known as chelicerae, are equipped with fangs that serve as piercing instruments for injecting venom, making them a crucial aspect of spider anatomy (Suraj and Parimala, 2020). Spiders have eight legs with some of them being venomous, while the rest are non-venomous. However, only a limited subset of venomous spiders, particularly those with neurotoxic venom, can have an impact on humans. In India, the number of spiders posing a severe threat to humans is relatively tiny (Palem et al., 2017). Spiders, as prevalent insectivorous predators in terrestrial ecosystems, consume a substantial amount of prey without causing harm to plants (Vairale and Wagh, 2021). Significant variations exist among spider families in terms of their biology, prey capture methods, silk production, web construction, and niche selection.

Spiders can play a crucial role in controlling populations of terrestrial arthropods (Coddington and Levi, 1991). Recognizing the potential of spiders as effective biocontrol agents for insect pests and valuable bioindicators, it is imperative to conduct comprehensive explorations of spider diversity promptly. This is especially crucial given that spiders closely link their distribution and presence to habitat structures and vegetation parameters (Buddle et al., 2000). Study of spiders can be beneficial for understanding biodiversity patterns (Platnick, 1999). In conservation studies spiders are often overlooked, despite having a significant role in the natural ecosystem (Chetia and Kalita, 2012). Numerous misconceptions surround the potential health impacts of spiders, contributing to a sense of mystery and anxiety. Despite research indicating that factors unrelated to spider bites cause most cases of necrotic arachnidism, a common belief persists that bites from various spider species can lead to necrotic ulceration.

The primary clinical disorders resulting from spider bites are latrodectism and loxoscelism. Latrodectism, induced by widow spider bites (*Latrodectus* spp.), manifests as local, regional, or generalized pain accompanied by nonspecific symptoms and autonomic consequences. Loxoscelism, in its cutaneous form caused by *Loxosceles* spp., presents as erythema and discomfort that may progress to a necrotic ulcer. Systemic loxoscelism is characterized by renal failure and intravascular hemolysis. The structural complexity of the surrounding environment directly influences the density and diversity of the local spider community. Enhanced litter layers boost soil-dwelling spider populations by providing additional retreats, hiding places, and protection from severe temperatures and humidity. Spiders that construct webs closely tie themselves to the vegetation's structure due to specific criteria for web attachment.

Both correlational and experimental data demonstrate a robust connection between spider density and habitat structure. The preponderance of evidence indicates that agricultural practices such as intercropping, mulching, and conservation tillage, which enhance the structural complexity of the environment, lead to heightened density and diversity within the spider community. As of 2022, the 'World Spider Catalog' reports a global presence of approximately 50,220 spider species. Within the order Araneae, there are 51,090 species distributed across 4,314 genera belonging to 132 families, ranking it sixth in species diversity after the five most significant insect orders (Coleoptera, Lepidoptera, Hymenoptera, Diptera, Hemiptera) (Singh, 2023). Despite India's abundant biodiversity and tropical climate, researchers have described only 2,344 spider species, organized into 596 genera and 65 families.

It's noteworthy that researchers may misidentify some species in India, indicating the need for further taxonomic clarification (Singh and Singh, 2021). According to listing, India is home to 1,940 spider species, distributed across 492 genera within 61 families. This is a slightly lower count than the previously mentioned figure of 2,344 species, highlighting the ongoing refinement and update of spider taxonomy in the region. In the early twentieth century, various researchers Pocock, (1900), Strand, (1909), Hirst, (1909), Gravely, (1915), Gravely, (1921), Gravely, (1924), Gravely, (1931), Gravely, (1935), Narayan, (1915), Mukerjee, (1930), Bhattacharya, (1935a), Bhattacharya, (1935b) documented a total of at least 62 spider species primarily from regions such as Birbhum, Darjeeling, Hooghly, Kalimpong, Kolkata, and North and South 24 Parganas districts in West Bengal. Afterward, for a period of about fifteen years, starting from 1951 until 1992, a large number of researchers performed thorough and comprehensive research on the spider population in West Bengal.

Their efforts led to the description and recording of hundreds of spider species from various locations within the state. In Biswas and Biswas, (1992) took the pioneering initiative of compiling available data and crafting an annotated checklist detailing the spider fauna of West Bengal. Their comprehensive work documented 213 species categorized under 70 genera within 20 families. In the subsequent years of the current century, various researchers have conducted surveys across diverse locations, including Tea Estates in north Bengal, National Parks, vegetable fields, agricultural fields, sanctuaries, and the mangroves of Sundarbans. These investigations

led to the creation of checklists that incorporated additional species from different districts in the state, notably Alipurduar, Bankura, Darjeeling, Jalpaiguri, Nadia, North 24 Parganas, Purba Medinipur, South 24 Parganas, and Uttar Dinajpur.

Over the past two decades, extensive urbanization has occurred, leading to a significant decrease in the essential green spaces necessary for maintaining the optimal balance of various parameters in metropolitan areas. The urbanization process is associated with a reduction in local plant biodiversity, disruption of natural habitats, and the exacerbation of environmental problems, ultimately contributing to the loss of biodiversity (Grimm et al., 2008). The Eco-Park adopts a comprehensive and systematic strategy for sustainability, aiming to harmonize ecological renewal, resource preservation, and the imperative to establish an urban open space for recreation.

Initially a segment of the East Calcutta wetland, as documented by Samanta et al., (2022), the Rajarhat block experienced significant urbanization from 1990 to 2016, with urban areas now covering over 44% of the transformed land. The park, recognized as a sustainability hotspot, exemplifies a methodical commitment to sustainable development. A preliminary investigation was carried out to record the variety of spiders in Ecopark, a city park in Kolkata. A total of 33 species of spiders belonging to 9 families were identified from the Ecopark. The dominant families were Salticidae, with 16 species found at Ecopark. The spiders were analyzed in terms of their guild structure, and the analysis identified five distinct feeding groups which include orb weavers, stalkers, foliage runners, space web builders, and ambushers.

2. MATERIALS AND METHODS

Study Area

The study was conducted to record the variety of spiders in Ecopark, an urban park in Kolkata, West Bengal State, Eastern India (Figure 1). The data was collected from May 2021 to June 2022. Ecopark is a 480-acre urban park that contains a variety of micro-ecosystems, including a forest, grassland, marshes, shrubs, and herbs, in addition to a 104-acre water body. The park is located in Kolkata, West Bengal, which has a hot, tropical monsoon climate with summer temperatures of 42°C, monsoon season moving average of 30°C, and winter temperatures of 10°C.

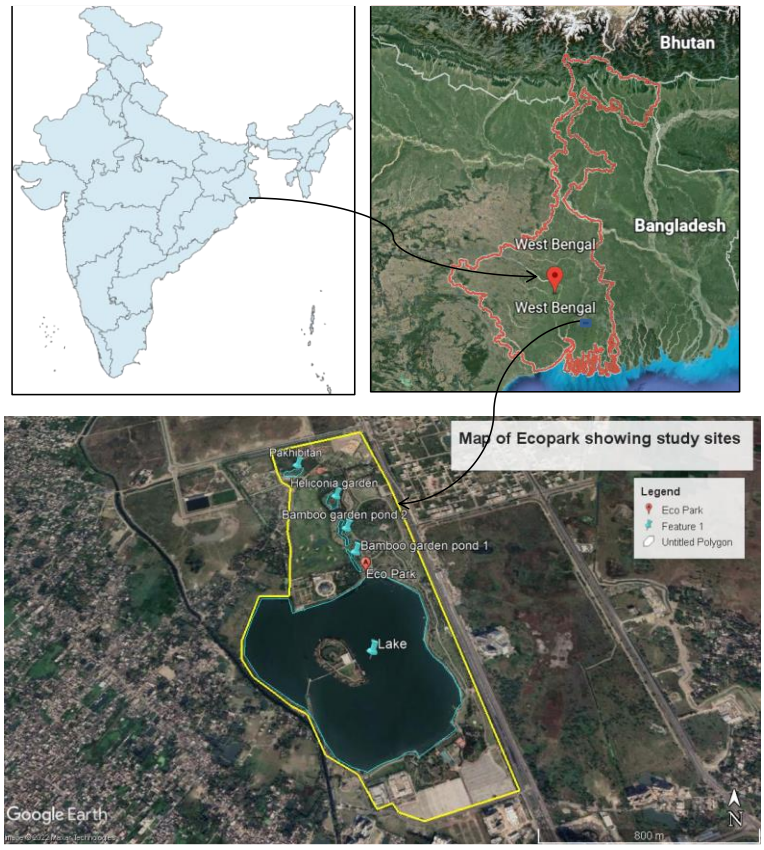

Figure 1 Map of the study area

Methods

Material Used: Falcon vials, 70% alcohol, brush, Petridis, bottle, sweep net, bag, forceps, needle, pen, pencil, datasheet, scale, glue, sticker (for spider specimens labeling), mobile phone (for taking photography of different spider species), five Container (for pitfall trap), one chopper (or digging the soil), soap solution, Leica microscope and Lawrence microscope (for a better and clear picture of the different spider species). Sampling was conducted at 15day intervals using four collections methods: Visual searching, hand picking, sweeping net and bush beating. Spiders' microhabitats, such as the ground, litter, shrubs, flowers, leaves, branches, and holes were investigated visually. The spiders were spotted by tracing their webs and web lines. Spiders were carefully collected by hand collection method using gloves on the vegetation of trees and bushes. The specimens were collected under an open, upside-down umbrella by placing it beneath a tree and shaking it six to eight times. The specimens dropped and were collected immediately for identification. The collected specimens were photographed with mobile or digital cameras and then they were identified with the help of experts, published journals, books, and citizen forums.

3. RESULTS

The study reports 33 species of spiders under nine families from Ecopark (Table 1). Photo Plate 1 presents pictures of some of the spider species mentioned in (Table 1). Spiders from the family Salticidae proved to be the most dominant species (49%) followed by Araneidae (12%), Oxyopidae (9%), Pholcidae, Sparassidae, Theridiidae, Tetragnathidae each 6% and Hersiliidae, Thomisidae each 3% (Figure 2).

Table 1 List of Spider Species with family and functional guilds of Ecopark.

Sl. No.	Family	Scientific name	Guild
1	Hersiliidae	*Tamopsis* sp.	Ambushers
2	Pholcidae	*Pholcus phalangioides* Füssli, 1775	Space web builders
3	Pholcidae	*Crossopriza lyoni* (Blackwall, 1867)	Space web builders
4	Salticidae	*Telamonia dimidiata* (Simon, 1899)	Stalkers
5	Salticidae	*Chrysilla lauta* Thorell, 1887	Stalkers
6	Salticidae	*Langona* sp.	Stalkers
7	Salticidae	*Myrmaplata plataleoides* (O. Pickard-Cambridge, 1869)	Stalkers
8	Salticidae	*Epocilla* sp.	Stalkers
9	Salticidae	*Carrhotus viduus* (C. L. Koch, 1846)	Stalkers
10	Salticidae	*Chrysilla acerosa* Wang & Zhang, 2012	Stalkers
11	Salticidae	*Bianor* sp.	Stalkers
12	Salticidae	*Myrmarachne* sp.	Stalkers
13	Salticidae	*Plexippus* sp.	Stalkers
14	Salticidae	*Hasarius adansoni* (Audouin, 1826)	Stalkers
15	Salticidae	*Phintella vittata* (C. L. Koch, 1846)	Stalkers
16	Salticidae	*Hyllus semicupreus* (Simon, 1885)	Stalkers
17	Salticidae	*Plexippus paykulli* (Audouin, 1826)	Stalkers
18	Salticidae	*Phintelloides versicolor* (CL Koch, 1846)	Stalkers
19	Salticidae	*Menemerus* sp.	Stalkers
20	Thomisidae	*Misumena* sp.	Ambushers
21	Sparassidae	*Gnathopalystes* sp.	Foliage runners
22	Sparassidae	*Heteropoda venatoria* (Linnaeus, 1767)	Foliage runners
23	Oxyopidae	*Oxyopes macilentus*L.Koch, 1878	Stalkers

24	Oxyopidae	*Peucetia viridana* (Stoliczka, 1869)	Stalkers
25	Oxyopidae	*Oxyopes* sp.	Stalkers
26	Theridiidae	*Argyrodes* sp.	Space web builders
27	Theridiidae	*Nesticodes rufipes* (Lucas, 1846)	Space web builders
28	Tetragnathidae	*Tylorida ventralis* (Thorell, 1877)	Orb weavers
29	Tetragnathidae	*Leucauge decorata* (Blackwall, 1864)	Orb weavers
30	Araneidae	*Bijoaraneus mitificus* (Simon, 1886)	Orb weavers
31	Araneidae	*Cyrtophora cicatrosa* (Stoliczka, 1869)	Orb weavers
32	Araneidae	*Argiope anasuja* Thorell, 1887	Orb weavers
33	Araneidae	*Nephila pilipes* (Fabricius, 1793)	Orb weavers

Photo Plate 1 Some Spider of study area; *4. Telamonia dimidiate, 12. Myrmarachne sp., 13. Plexippus sp., 17. Plexippus paykulli, 19. Menemerus sp., 20. Misumena sp., 22. Heteropoda venatoria, 25. Oxyopes sp., 27. Nesticodes rufipes, 30. Bijoaraneus mitificus, 31. Cyrtophora cicatrosa, 32. Argiope anasuja*

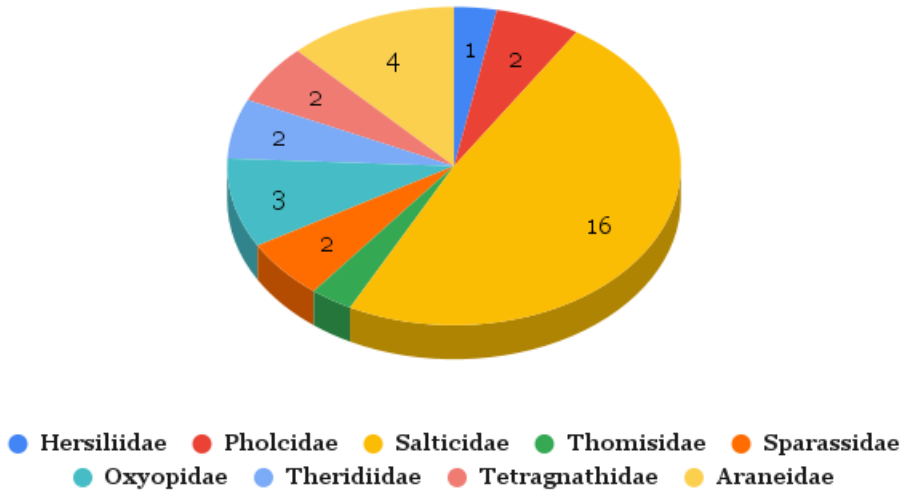

Figure 2 Pie chart representing the number of species under each family

The family Salticidae stands out with the most species, totaling 16 (Figure 2). Jumping spiders, which belong to this family, are known for their unique hunting behavior and excellent vision. Families like Hersiliidae, Thomisidae, Sparassidae, Theridiidae, and Tetragnathidae are represented by a smaller number of species, each ranging from 1 to 4 (Figure 2). This could indicate specific ecological niches or adaptations within these families. Sparassidae and Oxyopidae contribute to 2 and 3 species respectively (Figure 2). These families, commonly known as huntsman spiders and lynx spiders, often exhibit diverse hunting strategies and are distributed across various habitats. Araneidae, with four species, represents the orb-weaving spiders (Figure 2). This family is known for constructing intricate webs for prey capture, and the presence of multiple species suggests various strategies within this group. Pholcidae and Thomisidae contribute to 2 and 1 species respectively (Figure 2). Pholcidae, or cellar spiders, are known for their distinctive webs and prey capture methods. Thomisidae, or crab spiders, are adept at camouflage and ambush strategies.

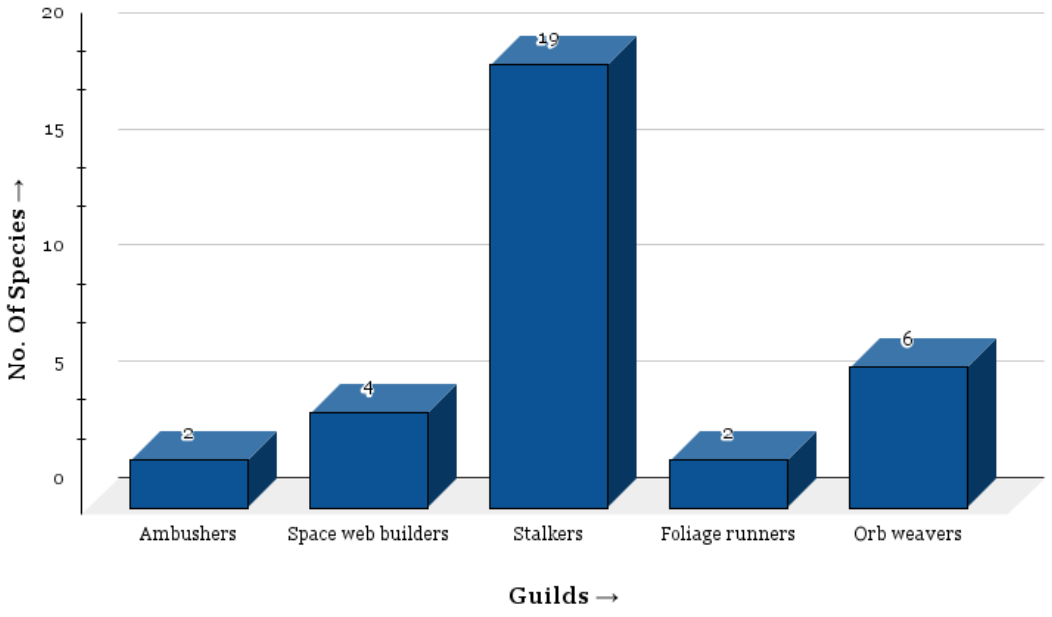

Figure 3 Graph showing the guilds observed of the identified species

Five guilds, namely orb weavers, foliage runners, stalkers, space-web builders, and ambushers were identified based on the foraging behavior (Uetz et al., 1999) (Figure 3). The diverse guilds observed within the spider species in this study shed light on the multifaceted ecological roles these arachnids play within their habitats. The predominant guild, comprising Stalkers, suggests a potential emphasis on hunting behavior or a specific predatory niche within the ecosystem. Additionally, the significant representation of Space web builders and Orb weavers indicates a substantial reliance on web construction for prey capture, highlighting the importance of web architecture strategies in their foraging success. The presence of Ambushers and Foliage runners in the small number indicates a special hunting technique or habitat preference for this spider group.

4. DISCUSSION

The results obtained from the study provide valuable insights into the diversity and ecological roles of spider species within the Ecopark habitat. Presently, the World Spider Catalog documents 48,409 confirmed spider species across 120 families, found globally. The identification of 33 spider species across nine families highlights the rich biodiversity present in the area. Among these families, Salticidae emerged as the most dominant, constituting nearly half of the total species observed. This dominance underscores the significance of jumping spiders within the ecosystem, known for their unique hunting behavior and exceptional visual acuity. Jumping spiders, categorized under the Salticidae family, are active during the day and rely on their keen vision for hunting prey. They are renowned for their intricate behaviors, which are primarily mediated through the coordinated functioning of their four sets of camera-like eyes (Cerveira et al., 2021).

Furthermore, the distribution of species among different families revealed interesting patterns. Families such as Hersiliidae, Thomisidae, Sparassidae, Theridiidae, and Tetragnathidae exhibited lower species richness, indicating potential ecological niches or adaptations within these groups. In contrast, families like Sparassidae and Oxyopidae, commonly referred to as huntsman spiders and lynx spiders respectively, demonstrated diverse hunting strategies and habitat distributions, contributing to their relatively higher representation (Mestre et al., 2020). The guild concept is widely embraced and has proven to be an effective and fruitful approach (Blondel, 2003). The observation of distinct guilds among spider species sheds light on their varied foraging behaviors and ecological roles within the ecosystem. The prevalence of Stalkers as the predominant guild suggests a potential emphasis on hunting behavior or specialization in a specific predatory niche.

Additionally, the significant representation of Space web builders and Orb weavers underscores the importance of web construction in prey capture, reflecting the intricate strategies employed by spiders to ensure foraging success. The presence of Ambushers and Foliage runners, albeit in smaller numbers, suggests specialized hunting techniques or habitat preferences within these spider groups. Overall, these findings highlight the multifaceted ecological dynamics of spiders and their significant contributions to ecosystem functioning, particularly in predator-prey interactions. This study contributes to a deeper understanding of spider ecology and underscores the importance of conserving their habitats to maintain biodiversity and ecosystem balance. Future research endeavors could delve further into the specific ecological roles of different spider guilds and their interactions with other organisms within the Ecopark ecosystem.

5. CONCLUSION

The study indicates a diverse distribution of spider species across different families. Factors such as ecological niche availability, hunting strategies, and specific adaptations may attribute to the variations in species counts among families. Further studies on the behaviors and ecological roles of these spider species could provide valuable insights into the dynamics of these arachnid communities. Due to the enormous species richness in this environment, this study not only highlighted the need of an urban park to protect the ecosystem but it also filled a gap in spider research in Kolkata. It will now supply a baseline for future studies.

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Author's Contribution

AR, SM and NS: Manuscript writing, editing and data analysis; AD: Species handling and identification; TS: Data Collection; LC: Planning, execution and photography; ABR and BM: Planning and supervision.

Conflicts of interests:

The authors declare that there are no conflicts of interests.

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Ethical approval

The Animal ethical guidelines are followed in the study for species observation & identification.

Data and materials availability

All data associated with this study are present in the paper.

REFERENCES

1. Bhattacharya GC. A new species of gregarious spider mimicking *Camponotus compressus*. Sci Cult 1935b; 1:159–160.
2. Bhattacharya GC. A new spider of Bengal, mimicking *Oecophylla smaragdina* (Fabr.). J Bombay Nat Hist Soc 1935a; 37:960–962.
3. Biswas B, Biswas K. Araneae: Spiders. State Fauna Series 3. Fauna of West Bengal 1992; 3:357–500.
4. Blondel J. Guilds or functional groups: does it matter? Oikos 2003; 100(2):223–231. doi: 10.1034/j.1600-0706.2003.12152.x
5. Buddle CM, Spence JR, Langor DW. Succession of boreal forest spider assemblages following wildfire and harvesting. Ecography 2000; 23:424-436.
6. Cerveira AM, Nelson XJ, Jackson RR. Spatial acuity-sensitivity trade-of in the principal eyes of a jumping spider: possible adaptations to a 'blended' lifestyle. J Comp Physiol A Neuroethol Sens Neural Behav Physiol 2021; 207(3):437-448. doi: 10.1007/s00359-021-01486-2
7. Chetia P, Kalita DK. Diversity and distribution of spiders from Gibbon Wildlife Sanctuary, Assam, India. Asian J Conserv Biol 2012; 1(1):5-15.
8. Coddington JA, Levi HW. Systematics and Evolution of Spiders (Araneae). Annu Rev Ecol Syst 1991; 22(1):565-592. doi: 10.1146/annurev.ecolsys.22.1.565
9. Downie IS, Wilson WL, Abernethy VJ, McCracken DI, Foster GN, Ribera I, Waterhouse A, Murphy KJ. The impact of different agricultural land-uses on epigeal spider biodiversity in Scotland. J Insect Conserv 1999; 3(4):273–286. doi: 10.1023/A:1009649222102
10. Gravely FH. Notes on Indian mygalomorph Spiders. Records of the Indian Museum, Calcutta, 1915; 11:257–287.
11. Gravely FH. Notes on Indian mygalomorphspiders. II. Records of the Indian Museum, Calcutta, 1935; 37:69–84.
12. Gravely FH. Some Indian spiders of the families Ctenidae, Sparassidae, Selenopidae and Clubionidae. Records of the Indian Museum, Calcutta, 1931; 33:211–282.
13. Gravely FH. Some Indian spiders of the family Lycosidae. Records of the Indian Museum, Calcutta, 1924; 26:587–613.
14. Gravely FH. Some Indian spiders of the subfamily Tetragnathinae. Records of the Indian Museum, Calcutta, 1921; 22:423–459.
15. Grimm NB, Foster D, Groffman P, Grove JM, Hopkinson CS, Nadelhoffer KJ, Pataki DE, Peters DPC. The changing landscape: ecosystem responses to urbanization and pollution across climatic and societal gradients. Front Ecol Environ 2008; 6(5):264–272.
16. Hirst AS. On some new or little-known mygalomorph spiders from the Oriental Region and Australasia. Records of the Indian Museum, Calcutta, 1909; 3(4:30):383–390.
17. Mestre L, Narimanov N, Menzel F, Entling MH. Non-consumptive effects between predators depend on the foraging mode of intraguild prey. J Anim Ecol 2020; 89(7):1690–1700. doi: 10.1111/1365-2656.13224
18. Mukerjee D. Description of a new ant-mimicking spider, *Synemosyna transversa* sp. nov. J Bombay Nat Hist Soc 1930; 34:200–201.

19. Narayan K. Notes on ant-like spiders of the family Attidae in the collection of the Indian Museum. Records of the Indian Museum, Calcutta, 1915; 11:393–406.
20. Palem H, Kanike S, Purushottam VRS. Diversity of spider fauna (Arachnida: Araneae) in different ecosystems, Eastern Ghats, Southern Andhra Pradesh, India. S. Asian J Life Sci 2017; 4(2):51-60. doi: 10.14737/journal.sajls/2016/4.2.51.60
21. Platnick NI. A revision of the Appalachian spider genus *Liocranoides* (Araneae: Tengellidae). Am Mus Novit 1999; 3285 :1-13.
22. Platnick NI. A revision of the spider genus Orthonops (Araneae: Caponiidae). Am Mus Novit 1995; 3150:1–18.
23. Pocock RI. The Fauna of British India including Ceylon and Burma Arachnida. Taylor and Francis London, London, 1900; 279.
24. Rutkowski R, Rybak J, Rogula–Kozłowska W. Spider webs in monitoring of air pollution. SHS Web Conf 2018; 57(02011):1–8.
25. Samanta T, Chatterjee L, Roy AB, Sinha S, Besra S. Importance of Ecopark, Kolkata in the context of sustainability, compare to Rajarhat grassland, as a habitat for Odonata (Dragonflies and Damselflies) diversity. World News Nat Sci 2022; 44:165-175.
26. Singh R, Singh G. Faunal diversity of orb-weaver spiders (Araneidae: Araneomorphae: Araneae: Arachnida) in India. IJBEI 2021; 1(2):62–133.
27. Singh R. An Updated Checklist of the Spider (Arachnida: Araneae) Fauna of West Bengal, India. Mun Ent Zool 2023; 18 (2):1448–1503.
28. Stojanowska A, Rybak J, Bożym M, Olszowski T, Bihałowicz JS. Spider webs and lichens as bioindicators of heavy metals: a comparison study in the vicinity of a Copper Smelter (Poland). Sustainability 2020; 1219(8066):1–13. doi: 10.3390/su 12198066
29. Strand E. Süd-und ostasiatischeSpinnen. II. Fam. Clubionidae. Fam. Salticidae. Abhandlungen der Naturforschenden Gesellschaft Görlitz, 1909; 26:1–128.
30. Suraj R, Parimala B. Study on Diversity of Spider fauna in University College of Science Campus, Tumakuru, Karnataka, India. Int J Innov Res Sci Eng Technol 2020; 9(5):3301–3304.
31. Uetz GW, Halaj J, Cady AB. Guild structure of spiders in major crops. J Arachnol 1999; 27:270–280.
32. Vairale AB, Wagh GA. Diversity of spiders in microhabitats of a tropical reserve forest of Amravati, Maharashtra, India. Biosc Biotech Res Comm 2021; 14(1):446–452.