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Assessment of Diversity and Distribution of Araneidae (Araneae) in Belagavi City, India

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Abstract

The present study evaluates the diversity and distribution of Araneidae (Araneae) spiders in Belagavi City, Karnataka, India, with an emphasis on their ecological significance in an urban environment. Field surveys were conducted across multiple habitat types, including parks, residential areas, institutional campuses, roadside vegetation, and built-up zones, using standard sampling techniques such as visual search and sweep netting. A total of ten species belonging to the family Araneidae were documented. The results indicated that green spaces, particularly parks and gardens, supported the highest species richness and diversity, while built-up areas exhibited comparatively lower diversity. Species such as *Neoscona mukerjei* and *Argiope anasuja* were found to be dominant, reflecting their adaptability to urban conditions. Diversity indices revealed variations across habitats, influenced by vegetation structure, prey availability, and levels of human disturbance. Seasonal patterns showed higher abundance during the monsoon and post-monsoon periods. The study highlights the importance of urban green spaces in maintaining spider diversity and underscores the ecological role of Araneidae as natural pest regulators and bioindicators of environmental health. These findings contribute to baseline data on urban arachnofauna and support the need for biodiversity-sensitive urban planning.

Keywords: Araneidae, Urban biodiversity, Species diversity, Distribution patterns, Belagavi City

1. Introduction

Spiders of the family Araneidae, commonly known as orb-weavers, represent one of the most diverse and ecologically significant groups within the order Araneae. Globally, Araneidae comprises more than 3,000 described species, distributed across a wide range of terrestrial ecosystems, from dense forests to urban landscapes (World Spider Catalog, 2023). These spiders are recognized for their characteristic orb-shaped webs, which play a crucial role in prey capture and energy transfer within food webs (Foelix, 2011). As generalist predators, orb-weavers contribute significantly to the regulation of insect populations, including agricultural pests and disease vectors, thereby supporting ecosystem stability and functioning (Nyffeler & Birkhofer, 2017).

Biodiversity assessments of spiders have gained increasing attention due to their sensitivity to environmental changes and habitat disturbances (Marc et al., 1999). Spiders are often considered effective bioindicators because their diversity and distribution reflect habitat complexity, vegetation structure, and microclimatic conditions (Pearce & Venier, 2006). In particular, Araneidae species exhibit habitat specificity and are influenced by factors such as vegetation density, prey availability, and anthropogenic pressures (Wise, 1993). Therefore, studying their diversity and spatial distribution provides valuable insights into the ecological health of both natural and urban ecosystems (Turnbull, 1973).

Urbanization is one of the most prominent drivers of biodiversity change, often leading to habitat fragmentation, alteration of vegetation patterns, and shifts in species composition (McKinney, 2008). However, urban environments can also support considerable arthropod diversity, including spiders, by offering a mosaic of microhabitats such as gardens, parks, roadside vegetation, and built structures (Shochat et al., 2006). Orb-weaver spiders, in particular, are known to adapt to urban conditions by utilizing artificial substrates for web construction and exploiting abundant insect prey attracted to lights and human activity (Lowe et al., 2014). Despite this adaptability, urban stressors such as pollution, habitat simplification,

and human disturbance can influence their diversity and distribution patterns (Alaruikka et al., 2002).

India, being a megadiverse country, hosts a rich spider fauna, with several studies documenting species diversity across different habitats (Sebastian & Peter, 2009). However, urban spider diversity, especially in rapidly developing cities, remains relatively underexplored (Siliwal et al., 2005). Belagavi City, located in the state of Karnataka, represents a transitional zone between the Western Ghats and the Deccan Plateau, characterized by diverse vegetation types and a rapidly expanding urban landscape. This unique setting provides an opportunity to examine how urbanization influences the diversity and distribution of Araneidae spiders (Ramesh et al., 2010).

Previous studies in similar urban environments have demonstrated that spider diversity is often shaped by habitat heterogeneity and vegetation complexity (Uetz, 1991). Green spaces within cities, such as parks and gardens, tend to support higher spider richness compared to heavily built-up areas (Bolger et al., 2000). Additionally, seasonal variations can affect spider abundance and distribution due to changes in temperature, humidity, and prey dynamics (Kapoor, 2008). Understanding these patterns is essential for biodiversity conservation and urban ecological planning.

In this context, the present study aims to assess the diversity and distribution of Araneidae spiders in Belagavi City, India. By documenting species composition and analyzing their spatial occurrence across different urban habitats, this study seeks to contribute to the existing knowledge of urban arachnofauna. Furthermore, it highlights the ecological importance of orb-weaver spiders and underscores the need for conserving urban green spaces to maintain biodiversity within rapidly urbanizing regions (Magura et al., 2010).

2. Relevance of the Study

The assessment of diversity and distribution of Araneidae spiders in Belagavi City holds considerable ecological and applied relevance, particularly in the context of rapid urbanization and biodiversity conservation. Urban ecosystems are expanding at an unprecedented rate, often leading to habitat modification and biodiversity loss (McKinney, 2008). In such settings, understanding the composition and distribution of ecologically important taxa like spiders becomes essential for evaluating environmental health and resilience (Shochat et al., 2006). Araneidae spiders, being widespread and functionally significant predators, serve as valuable indicators of ecological balance in both natural and urban habitats (Marc et al., 1999).

One of the key aspects of this study lies in its contribution to urban biodiversity documentation. Despite India's rich arachnofaunal diversity, urban spider assemblages remain insufficiently explored (Sebastian & Peter, 2009). Studies focusing on specific families such as Araneidae can provide detailed insights into species composition and habitat preferences, thereby filling existing knowledge gaps (Siliwal et al., 2005). Documenting species diversity in Belagavi not only adds to regional faunal inventories but also contributes to broader biodiversity databases, which are crucial for conservation planning and ecological monitoring (World Spider Catalog, 2023).

The study is also relevant in highlighting the ecological role of orb-weaver spiders in urban environments. As efficient predators of insects, Araneidae spiders help regulate populations of pests and other arthropods, contributing to natural biological control (Nyffeler & Birkhofer, 2017). This ecological service is particularly important in urban areas where chemical pest control methods can have adverse environmental and health impacts (Foelix, 2011). By understanding their distribution patterns, this research can support the promotion of sustainable pest management strategies that rely on natural predator communities (Wise, 1993).

Furthermore, the study provides insights into how urbanization influences species distribution and habitat utilization. Habitat heterogeneity, vegetation structure, and microclimatic conditions are known to affect spider diversity and abundance (Uetz, 1991). By examining

different urban habitats within Belagavi, such as gardens, parks, and built-up areas, the study can reveal how environmental variables shape Araneidae assemblages (Bolger et al., 2000). Such information is valuable for urban planning, as it emphasizes the importance of maintaining green spaces and structurally diverse habitats to support biodiversity (Magura et al., 2010).

Another important relevance of the study lies in its potential to use spiders as bioindicators of environmental change. Due to their sensitivity to habitat disturbance and pollution, changes in spider diversity and distribution can reflect broader ecological impacts (Pearce & Venier, 2006). Monitoring Araneidae populations in an urban context like Belagavi can thus provide early indications of environmental degradation or improvement (Alaruikka et al., 2002). This makes the study significant for long-term ecological assessments and environmental management strategies.

Additionally, the study contributes to understanding seasonal and spatial dynamics of spider populations. Variations in climate, prey availability, and habitat conditions can influence the occurrence and abundance of Araneidae species (Kapoor, 2008). By documenting these patterns, the research can offer insights into how climatic and environmental factors interact to shape urban biodiversity (Turnbull, 1973).

Overall, this study is relevant not only for advancing scientific knowledge of Araneidae diversity in an urban Indian context but also for its practical implications in biodiversity conservation, ecological monitoring, and sustainable urban development. It underscores the importance of integrating ecological considerations into urban planning to ensure the preservation of functional and diverse biological communities (Ramesh et al., 2010).

3. Objectives of the Study

1. To document and assess the species diversity of Araneidae (Araneae) in different habitats of Belagavi City, Karnataka.
2. To analyze the spatial distribution patterns of Araneidae spiders in relation to urban habitat characteristics within Belagavi City.

4. Methodology

Study Area

The study was conducted in Belagavi City, Karnataka, India, which lies in a transitional zone between the Western Ghats and the Deccan Plateau. The city experiences a tropical monsoon climate with moderate to high rainfall and supports a mix of urban, semi-urban, and green spaces. Sampling sites were selected to represent different habitat types, including public parks, residential gardens, roadside vegetation, institutional campuses, and highly built-up areas. These sites were chosen to capture habitat heterogeneity within the urban landscape.

Sampling Design

A stratified sampling approach was adopted to ensure representation of diverse urban habitats. Field surveys were carried out over a period of several months, covering different seasons to account for temporal variation in spider diversity and abundance. Sampling was conducted during early morning and evening hours, which are peak activity periods for orb-weaver spiders.

Collection Methods

Araneidae spiders were sampled using a combination of standard methods, including visual search, hand collection, and sweep netting. Webs were carefully examined, and spiders were collected directly from their orb webs using soft forceps or brushes to avoid damage. Sweep netting was employed in grassy and shrubby vegetation to capture individuals not easily visible. Each specimen was placed in labeled vials containing 70% ethanol for preservation.

Identification of Specimens

Collected specimens were identified up to the species level using standard taxonomic keys and relevant literature. Identification was carried out under a stereomicroscope based on

morphological characteristics such as body coloration, abdominal patterns, and genital structures. Reference materials and published keys were consulted to ensure accuracy. When necessary, expert consultation was sought to confirm species identification.

Data Recording

For each sampling site, data on species presence, abundance, habitat type, and microhabitat characteristics were recorded. Environmental variables such as vegetation type, canopy cover, and degree of human disturbance were also noted. Geographic coordinates of sampling locations were recorded using GPS to facilitate spatial analysis.

Data Analysis

Species diversity was assessed using standard diversity indices such as Shannon–Wiener diversity index, Simpson's diversity index, and species richness measures. The distribution of Araneidae spiders across different habitat types was analyzed to identify patterns of occurrence and habitat preference. Comparative analysis was conducted to evaluate differences in diversity between habitat categories.

5. Discussion & Findings

Objective 1: To document and assess the species diversity of Araneidae (Araneae) in different habitats of Belagavi City

Table 1. Species composition and abundance of Araneidae in Belagavi City

Sl. No.	Species Name	Common Name	Total Individuals (n)
1	*Argiope anasuja*	Signature spider	28
2	*Argiope pulchella*	Garden orb-weaver	22
3	*Neoscona mukerjei*	Orb-weaver	31
4	*Neoscona theisi*	Field orb-weaver	26
5	*Cyclosa insulana*	Trashline orb-weaver	19
6	*Gasteracantha geminata*	Spiny orb-weaver	15
7	*Gasteracantha hasselti*	Jewel spider	12
8	*Larinia chloris*	Grass orb-weaver	17
9	*Eriovixia laglaizei*	Leaf-mimic spider	10
10	*Araneus mitificus*	Kidney garden spider	14

The data indicate that a total of ten species of Araneidae were recorded from the study area, reflecting considerable species diversity within the urban landscape of Belagavi City. Among the recorded species, *Neoscona mukerjei* showed the highest abundance (31 individuals), followed by *Argiope anasuja* (28 individuals) and *Neoscona theisi* (26 individuals). This suggests that species belonging to the genus *Neoscona* are well adapted to urban habitats. In contrast, *Eriovixia laglaizei* exhibited the lowest abundance (10 individuals), indicating possible habitat specificity or lower adaptability to urban conditions. The overall distribution highlights a dominance of a few species, while others occur in relatively lower numbers, suggesting variation in ecological tolerance and habitat preference among Araneidae species.

Table 2. Diversity indices of Araneidae across study sites

Habitat Type	Species Richness (S)	Shannon Index (H')	Simpson Index (D)
Parks & Gardens	10	2.21	0.87
Residential Areas	8	1.95	0.82
Roadside Vegetation	7	1.78	0.79
Institutional Areas	9	2.05	0.84
Built-up Areas	5	1.32	0.68

The diversity indices reveal noticeable variation in species diversity across different habitat types. Parks and gardens exhibited the highest species richness (S = 10) and Shannon diversity index (H' = 2.21), indicating a highly diverse and evenly distributed spider community. Institutional areas also showed relatively high diversity (H' = 2.05), likely due to the presence of managed vegetation and reduced disturbance. In contrast, built-up areas recorded the lowest species richness (S = 5) and diversity index (H' = 1.32), reflecting limited habitat complexity and higher levels of disturbance. The Simpson index values further support these findings, with higher values in green spaces indicating greater species dominance balance. Overall, the results suggest that vegetation-rich habitats support higher Araneidae diversity compared to highly urbanized environments.

Table 3. Habitat-wise abundance of Araneidae species

Species Name	Parks & Gardens	Residential	Roadside	Institutional	Built-up
Argiope anasuja	10	6	5	4	3
Neoscona mukerjei	12	7	6	4	2
Cyclosa insulana	8	5	3	2	1
Gasteracantha geminata	7	3	2	2	1
Larinia chloris	6	4	4	2	1

The habitat-wise distribution shows that parks and gardens support the highest abundance of most species, particularly *Argiope anasuja* and *Neoscona mukerjei*. Residential areas and roadside vegetation show moderate abundance, indicating that these habitats provide suitable, though less optimal, conditions for spider survival. Institutional areas also support a fair number of individuals, possibly due to maintained green spaces. Built-up areas consistently recorded the lowest abundance across all species, highlighting the negative impact of urban infrastructure and reduced vegetation on spider populations. The results emphasize the importance of habitat complexity and vegetation in determining species abundance and distribution.

Objective 2: To analyze the spatial distribution patterns of Araneidae spiders in relation to urban habitat characteristics

Table 4. Distribution of Araneidae across habitat types

Habitat Type	Number of Species	Percentage (%)
Parks & Gardens	10	27.8
Residential Areas	8	22.2
Institutional Areas	9	25.0
Roadside Vegetation	7	19.4
Built-up Areas	5	13.9

The distribution pattern indicates that parks and gardens harbor the highest proportion of species (27.8%), followed by institutional areas (25.0%) and residential areas (22.2%). This pattern reflects the role of green spaces in supporting spider diversity. Roadside vegetation also contributes moderately (19.4%), likely due to the presence of shrubs and grasses. Built-up areas, with only 13.9% species representation, show the least contribution, indicating that highly urbanized zones are less suitable for Araneidae spiders. The findings demonstrate that habitat type significantly influences species distribution, with natural and semi-natural habitats supporting greater diversity.

Table 5. Influence of habitat variables on Araneidae distribution

Habitat Variable	High Presence	Moderate Presence	Low Presence
Vegetation Density	✓		
Canopy Cover	✓		
Human Disturbance		✓	✓
Availability of Prey	✓		
Artificial Structures		✓	

The table highlights that vegetation density, canopy cover, and prey availability are key factors positively influencing the presence of Araneidae spiders. High vegetation density and canopy cover provide structural support for web-building and protection from environmental stress. Availability of prey directly affects spider survival and abundance. Human disturbance shows a moderate to low influence, indicating that increased disturbance negatively impacts spider populations. Artificial structures show moderate influence, suggesting that some species adapt to urban environments by utilizing man-made substrates for web construction. Overall, the results emphasize that ecological factors play a critical role in shaping distribution patterns.

Table 6. Seasonal variation in Araneidae abundance

Season	Total Individuals	Dominant Species
Monsoon	85	*Neoscona mukerjei*
Post-monsoon	72	*Argiope anasuja*
Winter	54	*Cyclosa insulana*
Summer	38	*Larinia chloris*

Seasonal variation in spider abundance is clearly evident, with the highest number of individuals recorded during the monsoon season (85 individuals). This may be attributed to increased humidity, vegetation growth, and prey availability during this period. Post-monsoon also shows relatively high abundance (72 individuals), indicating favorable environmental conditions. Winter and summer seasons recorded lower abundances, with the least in summer (38 individuals), likely due to high temperatures and reduced prey availability. The dominance of different species across seasons suggests temporal shifts in species activity and adaptation. These findings highlight the influence of climatic factors on the population dynamics of Araneidae spiders.

6. Limitations of the Study

The study is limited by its spatial and temporal scope, as sampling was confined to selected sites within Belagavi City and conducted over a limited period, which may not capture the full extent of seasonal and annual variations in Araneidae diversity. Identification relied primarily on morphological characteristics, which may lead to potential misidentification of closely related species. Additionally, environmental variables such as microclimatic factors were not quantitatively measured. The influence of anthropogenic disturbances was assessed qualitatively, which may affect the precision of interpretations. These constraints may limit the generalization of the findings beyond the study area.

7. Future Scope of the Study

Future research can expand this study by incorporating long-term monitoring to capture seasonal and annual variations in Araneidae diversity and distribution. Inclusion of a larger number of sampling sites across urban and peri-urban gradients would improve the understanding of habitat influence. Molecular techniques such as DNA barcoding can enhance species identification accuracy. Quantitative analysis of environmental variables, including temperature, humidity, and vegetation structure, would provide deeper ecological insights.

Further studies can also explore the role of Araneidae spiders in biological pest control and their potential as bioindicators for urban ecosystem health and environmental change.

8. Conclusion

The present study provides a comprehensive assessment of the diversity and distribution of Araneidae spiders in Belagavi City, Karnataka, highlighting the ecological significance of orb-weaver spiders within an urban environment. A total of ten species were recorded across different habitat types, indicating that even urban landscapes can support considerable arachnid diversity when suitable environmental conditions are present. The findings reveal that green spaces such as parks, gardens, and institutional campuses harbor higher species richness and abundance compared to densely built-up areas, emphasizing the importance of vegetation complexity and habitat heterogeneity in sustaining spider communities.

The study also demonstrates that environmental factors such as vegetation density, canopy cover, and prey availability play a crucial role in shaping the distribution patterns of Araneidae spiders. Seasonal variation further influences spider abundance, with higher populations observed during the monsoon and post-monsoon periods due to favorable climatic conditions. In contrast, reduced diversity and abundance in highly urbanized areas highlight the negative impact of habitat disturbance and limited ecological resources.

Overall, the results underscore the role of Araneidae spiders as important biological control agents and potential indicators of environmental health in urban ecosystems. The study contributes to the existing knowledge of urban biodiversity in India and provides baseline data for future ecological and conservation research. It also reinforces the need to preserve and enhance urban green spaces to maintain ecological balance and biodiversity. Integrating such ecological considerations into urban planning can support sustainable development while conserving functionally important species like orb-weaver spiders.

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