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Ecological insights into spider diversity and behaviour in Chhattisgarh: A review

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Abstract
Spiders, belonging to the order Araneae, represent one of the most diverse and ecologically significant groups of arthropods, playing critical roles in maintaining ecological balance as both predators and prey. Despite their ecological importance, regional studies on spider diversity and behavior remain limited in several parts of India, including the state of Chhattisgarh. This review consolidates current knowledge on the diversity, taxonomy, behavior, and ecological functions of spiders documented in Chhattisgarh across various habitats, including forests, grasslands, agricultural fields, and urban ecosystems. The review highlights the rich taxonomic diversity of spiders in the region, comprising over 220 species across 96 genera and 23 families, with prominent families such as Araneidae, Thomisidae, Salticidae, and Gnaphosidae being well represented (Choudhury *et al.* 2024; Nichat *et al.* 2025). Behavioral observations indicate a wide range of adaptations in web-building, foraging, mating, and diurnal/nocturnal activity patterns. Field surveys conducted using techniques such as sweep netting, pitfall trapping, visual inspection, and web mapping have revealed significant seasonal and habitat-based variations in spider community composition, strongly influenced by monsoon cycles and habitat structure (Kujur & Ekka, 2016; Gajbe, 2007). Additionally, the review discusses the vital role of spiders in natural pest regulation, contributing to ecosystem stability and offering potential applications in sustainable agriculture. Threats such as habitat destruction, pesticide exposure, and climate change are also examined, along with the urgent need for spider conservation initiatives and public awareness. Future research priorities include taxonomic revisions, molecular systematics, long-term ecological monitoring, and the exploration of spiders' potential in biotechnology and pest management. By synthesizing available scientific literature and recent field reports, this review serves as a foundational resource for researchers, conservationists, and policymakers aiming to promote arachnid biodiversity research and conservation in Chhattisgarh.

Keywords: Spider diversity, Chhattisgarh, Araneae, ecological behavior, taxonomy, conservation, web-building, pest control.

1. Introduction

1.1 Importance of Spider Biodiversity

Spiders (Order: Araneae) are one of the most diverse groups of terrestrial arthropods, with over 50,000 described species globally across 130 families and an estimated actual number surpassing 120,000 species (World Spider Catalog, 2024; Foelix, 2011) [12]. This remarkable diversity plays an essential role in maintaining ecological balance. According to Nyffeler and Birkhofer (2017) [32, 33], spiders consume 400-800 million tons of insect prey annually worldwide, indicating their massive impact on controlling arthropod populations.

"Spiders represent a major predatory group of terrestrial ecosystems and are ecologically important in regulating insect populations, particularly in agricultural and forest ecosystems" (Foelix, 2011 [12]; Nyffeler & Birkhofer, 2017) [32, 33].

1.2 Role of Spiders in Ecosystems

Spiders are generalist predators, contributing significantly to biological pest control. They not only regulate herbivore populations but also serve as a food source for birds, reptiles, and mammals, maintaining the food web (Marc *et al.* 1999 [28]; Riechert & Lockley, 1984) [45]. Their behavioral traits-like web-building, foraging strategies, and habitat specificity-make them ideal candidates for use as bioindicators in environmental monitoring (Pearce & Venier, 2006) [39].

Moreover, spiders are being increasingly studied for biomimetic applications, such as silk for medical and industrial use and venom for pharmaceutical exploration (Kuhn-Nentwig *et al.* 2011) [24].

1.3 Need for Regional Studies in Chhattisgarh

Although India is home to more than 1,800 species of spiders (Siliwal *et al.* 2005) [55, 56], regions like Chhattisgarh remain poorly explored. Recent work by Choudhury *et al.* (2024) [9] compiled an updated checklist of 222 spider species across 96 genera and 23 families in the state, including 41 species recorded for the first time in Chhattisgarh. This highlights the underexplored spider diversity in the region.

Similarly, habitat-based surveys in Raigarh district by Kujur and Ekka (2024) [26, 27] revealed 121 species across various families using standardized diversity indices like Shannon-Wiener and Simpson's Index, further emphasizing the ecological richness and research potential of the area.

"There is a critical need for localized studies in biodiversity hotspots like Chhattisgarh to assess the composition, ecological roles, and conservation requirements of spider fauna" (Kujur & Ekka, 2024 [26, 27]*; Choudhury et al. 2024)* [9].

2. Methodology

This review is based on an extensive compilation and critical analysis of published scientific literature, field surveys, institutional reports, and taxonomic databases relevant to spider diversity and behavior in Chhattisgarh. Peer-reviewed articles from journals such as *Journal of Threatened Taxa*, *Indian Journal of Arachnology*, and *Asian Journal of Conservation Biology*, along with region-specific faunal surveys conducted by the Zoological Survey of India (ZSI), formed the core sources of data. Specific attention was given to studies conducted in various ecosystems of Chhattisgarh-including forests, agroecosystems, urban areas, and wetlands-to obtain a comprehensive understanding of habitat-specific spider diversity. Search engines like Google Scholar, ResearchGate, and Scopus were utilized for sourcing scientific papers, while validated field records and species checklists were also referred to from institutional theses and conference proceedings.

To evaluate spider behavior and sampling methodologies, studies involving sweep netting, pitfall traps, visual counts, hand collection, nocturnal surveys, and web mapping were reviewed. These methods were assessed in terms of their effectiveness across different habitat types and seasons. Furthermore, comparative data on species richness, relative abundance, and ecological roles were extracted, tabulated, and analyzed to determine trends in community structure and behavior. The review also considered unpublished field observations and regional biodiversity reports that specifically document spider fauna in districts such as Bilaspur, Bastar, Raipur, and Dantewada, enhancing the geographical scope of the study. This multi-source synthesis provides a robust foundation for identifying knowledge gaps and research opportunities in the spider fauna of Chhattisgarh.

3. Geographical and Ecological Profile of Chhattisgarh

3.1 Climate, Vegetation Types, and Habitats

Chhattisgarh is located in central India and encompasses a diverse ecological landscape with plains, hills, and plateau regions. The state experiences a tropical monsoon climate, with average annual rainfall of 1,292 mm, primarily during June-September. Temperatures range from as low as 5 °C in winter to over 45 °C in summer (Jhariya & Raj, 2014) [22].

Approximately 44.21% of the total area of Chhattisgarh is under forest cover, with predominant vegetation types including Tropical Moist Deciduous and Tropical Dry Deciduous Forests (Champion & Seth, 1968) [7]. These forest types provide suitable microhabitats for a variety of spider families, supporting both ground-dwelling and arboreal species.

Moist deciduous forests dominated by Sal (Shorea robusta) are found in areas with higher rainfall, whereas dry deciduous forests dominated by Teak (Tectona grandis) and mixed species occur in drier areas with open canopy structure (Sahu & Singh, 2020) [48]. These habitat types offer varying degrees of vegetation complexity, leaf litter, and humidity, which influence spider diversity and web-building behavior.

The Achanakmar-Amarkantak Biosphere Reserve, located in Bilaspur district, is a biodiversity hotspot encompassing Northern Moist Deciduous and Dry Mixed Deciduous Forests with over 1,500 plant species and diverse faunal elements, including spiders (Roy *et al.* 2018) [47].

3.2 Agroecological Zones and Forest Types Relevant to Spider Diversity

Chhattisgarh is divided into three major agroclimatic zones:

1. Chhattisgarh Plains (CPZ) - Fertile lowlands with extensive rice cultivation.
2. Northern Hills Zone (NHZ) - Undulating hills and forested zones, rich in sal and mixed deciduous forests.
3. Bastar Plateau Zone (BPZ) - Characterized by high forest density, tribal-dominated areas, and tropical deciduous forests (Jain *et al.* 2022) [21].

Each agroclimatic zone presents distinct ecosystems, which directly impact arthropod biodiversity including spiders. According to Kujur and Ekka (2024) [26, 27], spider communities in Raigarh district (Northern Hills) vary significantly between habitats due to differences in vegetation density, microclimate, and forest type.

The structural complexity of forests in these zones-such as canopy layers, understory shrubs, and litter cover-provides ideal microhabitats for various spider guilds (Salticidae, Araneidae, Lycosidae, Thomisidae), influencing their distribution, web architecture, and hunting strategies (Nichat *et al.* 2025) [31].

Table 1: Habitat Zones and Relevance to Spider Diversity

Zone	Vegetation Type	Dominant Species	Spider Habitat Characteristics
Chhattisgarh Plains	Moist Deciduous Forest	Shorea robusta, Terminalia spp.	Dense canopy, high litter, web spiders, orb-weavers
Northern Hills	Dry Deciduous & Mixed Forests	Tectona grandis, Diospyros spp.	Open canopy, shrubland, cursorial hunters (Lycosidae)
Bastar Plateau	Tropical Deciduous Forests	Madhuca indica, Butea spp.	Diverse niches, canopy dwellers, ground hunters, ambushers

4. Taxonomic Diversity of Spiders in Chhattisgarh

4.1 Families and Genera Reported

Chhattisgarh's spider fauna comprises 23 families and 96 genera, as documented by Choudhury, Nirmalkar, Singh, and Anand (2024) [9]. The most species-rich families include:

- Araneidae (49 species across multiple genera)
- Thomisidae (32 species)
- Gnaphosidae (31 species)
- Others include Salticidae, Lycosidae, Theridiidae, Uloboridae, and Theraphosidae (ResearchGate, ResearchGate).

A more focused survey in *Gomarda Wildlife Sanctuary* by Kujur and Ekka (2016) [25] recorded 120 species in 49 genera under 16 families, with Thomisidae (24 species, 9 genera) and Araneidae (22 species, 8 genera) most abundant (isca.in).

Another recent study by Nichat *et al.* (2025) [31] in northeast Gariaband forests documented 55 species in 42 genera across 11 families, highlighting Araneidae and Salticidae as dominant communities (mbimph.com).

4.2 Species Richness Across Different Habitats

In Raigarh district, Kujur and Ekka (2024) [26, 27] surveyed habitats including riverine forest, grassland, plantation, and mixed Sal forest, documenting 121 species across 49 genera and 16 families. The Araneidae dominated in both richness and abundance, while Theraphosidae represented a minor but noteworthy component. Diversity indices (Fisher's α) ranged between 20.3 and 29.2, indicating significant habitat heterogeneity and species turnover across habitat types (mbimph.com).

In contrast, Gariaband region (Nichat *et al.* 2025) [31] showed lower overall richness (55 species) but included similar dominant families-Araneidae and Salticidae-emphasizing habitat-specific assemblages in forested landscapes (mbimph.com).

4.3 Endemic and Rare Species

While Chhattisgarh lacks strictly endemic spider taxa in published records, certain species noted in central India extend into adjacent regions. For example, *Thanatus ketani* (Bhandari & Gajbe) is described as endemic to India, and recorded in Chhattisgarh contexts (Indravihar Park survey) (Docslib).

Other Indian endemics, such as *Poecilotheria miranda* (Bradley & Pocock, 1900) and *Chilobrachys fimbriatus* (Pocock, 1899) [40], occur in similar tropical deciduous forests in central India and are critically endangered; although their exact presence in Chhattisgarh remains unconfirmed, their habitats overlap with those in Bastar and the Maikal range (Wikipedia). These species highlight the potential conservation significance of tarantula-bearing habitats in the region.

Spiders such as Stegodyphus sarasinorum, a socially organized cooperative genus common to India, may inhabit Chhattisgarh's grassland and scrub ecosystems, though region-specific surveys have yet to record them explicitly (Wikipedia, inaturalist.org).

5. Sampling Techniques and Methodologies Used in Spider Studies

5.1 Sweep Netting, Pitfall Traps, Visual Counts, and Web Observations

Ecological surveys of spiders typically integrate multiple complementary sampling methods to capture the full guild diversity present in an area.

- **Pitfall Traps:** Widely used for sampling ground-active spiders, especially cursorial hunters like *Lycosidae* and *Gnaphosidae*. Traps usually consist of jars (approx. 9 cm diameter) partially filled with preservative solution and left in the field for 5-8 days (Coddington *et al.* 1996 [10]; Azevedo *et al.* 2018) [2] (PMC, PMC). They are effective at capturing species richness at ground level, though they may underrepresent arboreal taxa and yield biased density estimates (Gauging megadiversity. 2017; Privet *et al.* 2019) [41] (PMC).
- **Sweep Netting:** Targeting spiders dwelling in herbaceous and low shrub strata, typically employing ~20 vigorous sweeps per sampling unit (Southwood & Henderson, 2000; Patel, 2016) [37]. In cotton fields in Pakistan, Tahir and Butt (2008) [61] standardized 20 sweeps per session, walking in a looping pattern across the plot, yielding substantial information on web-building *Araneidae* and foliage-dwelling taxa (PMC).
- **Visual Counting & Hand-Picking:** Also known as active searching. Teams visually search vegetation, ground litter, rocks, and webs for about 30 minutes per quadrat, collecting spiders by forceps or aspirator. This method captures both ground-dwelling and arboreal species and is particularly useful for web-builders present at eye height or below (Coddington *et al.* 1996 [10]; Horsák *et al.* 2019) (PMC). In Thar Desert studies, Sørensen *et al.* (2002) [57] and Tikader (1987) [63] protocols were followed with aspirators and beat trays (Tembhurne *et al.* 2024) (SpringerOpen).
- **Beating Tray / Vegetation Beating:** Vegetation (shrubs, low branches) is struck with a stick over a tray or white cloth, dislodging spiders into the tray - especially effective for arboreal and foliage-dwelling spiders (Coddington *et al.* 1996 [10]; The Wayanad study, 2020) (PMC).
- **Litter Extraction**: Leaf litter is collected and sifted or sorted manually or using Berlese funnels to isolate cryptic, ground-dwelling taxa (Coddington *et al.* 1996 [10]; Vedel *et al.* 2017) (PMC).

Some studies also explore novel approaches, such as vibration-based collection methods, where spiders are attracted to idling engines and sampled-though this is still experimental (Merrifield *et al.* 2015) (PMC).

5.2 Seasonal and Diurnal Sampling Methods

Temporal factors-season and time of day-strongly influence spider activity and detectability:

- **Seasonality:** Several Indian studies showed peak species richness during monsoon and post-monsoon seasons, with lower diversity in winter (Patel *et al.* 2016 [37]; Biosciences Review 2017) (Juniper Publishers, biotech-asia.org). For instance, in semi-arid Gujarat, maximum abundance occurred in monsoon, while Shannon diversity index was highest in post-monsoon (2.774) and lowest during winter (1.582) (Juniper Publishers).

- **Time-of-Day Sampling:** Sampling both early morning and late evening can avoid midday biases when spiders are less active (Tahir & Butt, 2008) [61] (PMC). In biometric diversity studies, morning and evening surveys improved representative sampling of both diurnal and nocturnal guilds.
- **Nocturnal Hand Collecting (NHC):** Advocated by Azevedo *et al.* (2018) [2] and Privet *et al.* (2019) [41] as more efficient than pitfall traps in structurally complex tropical forests, since many understory species are active at night and visible under torchlight. NHC tends to lower bias and requires less setup time compared to pitfalls (Azevedo *et al.* 2018 [2]; Privet *et al.* 2019) [41] (MDPI).
- **Standardized Protocols Over Time:** Longitudinal studies (monthly/bi-monthly or seasonal) help in understanding temporal variations and community shifts (Journal of Insect Conservation, 1999) (SpringerLink).

6. Behavioral Patterns of Spiders in Chhattisgarh

6.1 Web-Building Behavior and Web Types

- Most orb-weaving spiders (Family *Araneidae*, including genera like *Argiope*, *Gasteracantha*, *Cyclosa*) in India construct vertical spiral orb webs, often rebuilding them nightly, and including a "stabilimentum" silk decoration in some species (*Argiope*), which may serve to attract prey or deter predators (Patel & Patel, 2018 [36]; "Spider Fauna of India,"2023) (isca.in, ResearchGate).
- Sheet- or dome-shaped webs are produced by certain Eresidae, while Lycosidae and other cursorial spiders do not build capture webs, instead making sheet retreats or silk-lined burrows for shelter (Patel & Patel, 2018 [36]; Agastya Foundation data) (WGBIS).
- Salticidae (jumping spiders) generally do not spin webs for prey capture, but regularly construct silk draglines and planar retreats where they rest nightly-even occasionally orb-like webs used solely as shelters (Bioscience studies on Maharashtra jumping spiders) (bbrc.in).

6.2 Foraging Strategies: Active Hunting vs. Sit-and-Wait

- Jumping spiders (Salticidae) actively stalk prey using complex hunting sequences: orientation (alert), pursuit, and capture via jump (Jackson & Forster, 2009; Maharashtra study) (bbrc.in).
- Crab spiders (Thomisidae), lynx spiders (Oxyopidae), and wolf spiders (Lycosidae) employ ambush strategies, waiting on flowers, bushes, or ground for prey to come within reach (Agastya Foundation campus observations) (WGBIS).
- In colonial orb-weavers (e.g. *Stegodyphus*), foraging may involve group web foraging, shifting between solitary or group behavior based on prey availability, demonstrating risk-sensitive foraging strategies (Pruitt *et al.* Mexico genus *Metepeira*) (SpringerLink).
- Some species like *Dictis* (spitting spiders) in India spit venom-coagulated silk to immobilize prey at distance, often running back before strike-a unique mixed strategy (Research Stash summary) (researchstash.com).

6.3 Mating and Reproductive Behavior

- In orb-weaving spiders (e.g. *Argiope*), males approach female webs using vibrational courtship ("shudder" signals); these reduce risk of pre-copulatory cannibalism by delaying female aggression (Wignall & Herberstein, 2013) [67] (PMC).
- Among Portia jumping spiders, complex courtship involves leg displays, web drumming, and in some cases mid-air mating; females can exhibit cannibalism both before and after mating (Jackson 1982 [20]; behavior in Indian Portia spp.) (Wikipedia).
- Some orb-weaver males (e.g. *Nephilengys malabarensis*) may practice remote copulation, detaching a palp that continues spermatizing the female while the male escapes; such behavior also reduces sperm competition (Animal Behaviour study reviewed in 2025) (Live Science).
- In social spiders like Stegodyphus sarasinorum, observed in India, division of labor includes maternal sacrifice (matriphagy), coordinated brood care, and prey capture; personality traits such as boldness determine individual roles (Grinsted *et al.* 2013) [16] (WIRED).

6.4 Diurnal / Nocturnal Activity

- Araneidae orb-weavers are primarily nocturnal web-builders, active in the evening and early night; they often rest inverted at the center of the web during the day (Spider Fauna of India, 2023) (ResearchGate).
- Salticidae (jumping spiders) are diurnal predators, using excellent vision for hunting during daylight hours; some species extend activity into low-light periods (Maharashtra study; Agastya data) (bbrc.in).
- Lycosidae and Oxyopidae often are day-active hunters, though certain wolf spiders may hunt near burrow mouths at dawn, dusk, or during cooler parts of the night (wolf spider overview) (Wikipedia).
- Social colonial species (*Anelosimus*, *Stegodyphus*) may remain in retreat during hot midday hours and become active in prey capture during cooler evening or rainy periods (Gonzaga *et al.* 2002 [14]; Anelosimus observations) (Wikipedia).

6.5 Implications for Chhattisgarh Spider Studies

Given the diversity of genera reported from Chhattisgarh (e.g. *Argiope*, *Cyclosa*, *Salticus*, *Stegodyphus* etc.), the behavioral patterns outlined above are highly relevant for future behavioral surveys in the region:

- Expect nighttime web rebuilding by orb-weavers and web decorations (stabilimentum) in open forest or edge zones.
- Seasonal variation in foraging-monsoon and post-monsoon periods likely show heightened activity across guilds.
- Behavioral observations should include courtship vibrations, web drumming, and possible cannibalistic or reproductive signals.
- Active daily (jumping/spider hunters) vs. nocturnal (web-builders) activity periods should guide sampling times.
- For social spiders, behavior trials (e.g. division of task, boldness assays) and observations of communal prey

capture and maternal care may reveal locally occurring Stegodyphus or Anelosimus clusters.

7. Seasonal and Habitat-wise Variation in Spider Community Composition

7.1 Influence of Monsoon, Temperature, and Humidity

Multiple Indian studies documents marked seasonal fluctuations in spider abundance and diversity:

- Patel *et al.* (2008) in North Gujarat's semi-arid zone found peak abundance during monsoon, with species richness highest in early monsoon; activity declined sharply in winter and early summer. They reported a strong positive correlation with temperature ($r = +0.85$), and moderate correlation with humidity ($r = +0.48$), attributing richness patterns mainly to prey availability driven by monsoonal vegetation growth (biotech-asia.org, IntechOpen).
- In Kerala's Pathiramanal Island, IntechOpen authors observed that ambient temperature and humidity strongly influenced spider assemblages-higher abundance and richness in October-January; both extremes of high rain and heat suppressed populations (IntechOpen).
- Deshmukh and Raut (2013) [11] reported in Salbardi forest, Maharashtra, that across monsoon, summer, and winter seasons, Salticidae and Araneidae dominated. Species richness and diversity (Shannon, Simpson) peaked in monsoon and winter, with lowest values in summer (Entomology Journal).

7.2 Comparison Across Forest, Grassland, Agricultural, and Urban Ecosystems

Habitat structure strongly drives spider community differences:

- Forest ecosystems offer structural complexity-leaf litter, multiple vegetation strata, understory microhabitats-yielding high beta diversity across seasons. Research in the Western Ghats (Wayanad region) showed webs and ambush guilds thrive in structurally complex forests; stalkers were dominant feeding guild (36%), followed by orb-weavers (24.7%) (IntechOpen, Researchers Links).
- In agricultural lands, such as rice fields, wolf spiders (*Pardosa pseudoannulata*) dominate as active hunters; they adapt best under mid-range temperature (~25 °C) and seasonal prey flushing during monsoon planting cycles. They often serve as biocontrol agents during Kharif seasons (Wikipedia).
- Grasslands and riparian zones, particularly in oil palm, shrubland, or water-margin habitats, support a mix of ground runners (Lycosidae), foliage runners (Salticidae), and orb-weavers. Muthupet mangrove studies in South India recorded six guilds; orb-weavers represented ~62%, foliage runners 15%, and ground runners just 2%-with highest density in post-monsoon and summer (ResearchGate).
- In urban or fragmented landscapes, species richness drops and guild composition shifts toward generalist taxa. Although Indian-specific data are limited, urban-forest edge gradients generally favor Salticidae and Nephilidae on vegetation, and ground hunters in disturbed patches.
- Protected reserves or biospheres (e.g. Achanakmar-Amarkantak) likely support diverse seasonal communities-but published seasonal datasets specific to Chhattisgarh are currently unavailable.

7.3 Implications for Chhattisgarh

Based on analogous biomes within India, following patterns may be expected in Chhattisgarh:

- Monsoon and post-monsoon (July-January) are expected to host highest spider abundance and species richness across all habitat types, particularly in forest patches and riparian corridors.
- Forest habitats (Moist and Dry Deciduous) would likely support dominant families like Araneidae and Salticidae, especially orb-weavers and stalkers, during monsoon and post-monsoon.
- Agricultural zones (rice paddies, agroforestry areas) likely show high activity of cursorial wolf and jumping spiders (e.g. *Pardosa*, *Salticus*) when crops are standing and insect prey plentiful.
- Grassland and scrub zones in Bastar plateau or Raigarh may support seasonal shifts-Lycosidae likely abundant ground foragers during monsoon, with orb-weaver dominance as vegetation fills in later seasons.
- Urban edges and tea/coffee plantations may show reduced diversity with dominance of polyphagous generalists.

8. Ecological Roles and Importance of Spiders

8.1 Role as Natural Pest Control Agents

Spiders are pivotal in agricultural ecosystems as natural, generalist predators, consuming diverse crop pests and reducing reliance on chemical pesticides:

- A study by Joshi & Venkateshwarlu (2023) [23] in rice fields of Dakshina Kannada (South India) documented 30 spider species across six families (Salticidae, Araneidae, Oxyopidae, Tetragnathidae, Thomisidae, Pisauridae), actively preying on pest insects and enhancing crop health (irjse.in, bbrc.in, journalcra.com).
- In Tamil Nadu, Sugumaran *et al.* (2024) [59] reviewed spider distribution and ecological efficiency, highlighting their role as eco-friendly pest controllers in rice, cotton, and sugarcane fields. Families such as Salticidae and Tetragnathidae were especially abundant and contributed to suppressing pest populations (journaljalsi.com).
- Surveys in the Cauvery Delta (Veeramani *et al.* 2023) [66] recorded multiple spider species across croplands, emphasizing spiders' abundance in cultivated areas and their role in suppressing insect pests in agro-ecosystems (dzarc.com).

Moreover, the Centre for Indian Knowledge Systems (CIKS) has pioneered ecological techniques to preserve spiders in paddy and cotton ecosystems-demonstrating that reducing pesticide use, conserving native spiders like lynx spiders (Oxyopidae), and rearing giant crab spiders can significantly improve pest regulation in traditional farming systems (Ciks).

8.2 Contribution to Ecosystem Balance and Food Webs

Beyond pest suppression, spiders have vital ecological roles that support biodiversity, trophic structure, and ecosystem resilience:

- Spiders are obligate generalist predators, consuming vast quantities of insects-including pests and disease

vectors. Science Friday estimates one spider may consume up to 2,000 insects per year, and collectively spiders kill an estimated 400-800 million tons annually (Science Friday 2016, Down To Earth).

- They occupy key positions in food webs, both as predators of herbivores and prey for larger taxa (birds, mammals, reptiles). Their significant biomass makes them indispensable energy nodes in terrestrial ecosystems (Researchers Links).
- By preying on decomposers and detritivores, spiders indirectly influence nutrient cycling and soil processes-demonstrating roles beyond visible predator-prey dynamics (Researchers Links).
- Social species such as *Stegodyphus sarasinorum* exhibit coordinated group foraging and communal prey capture, influencing localized insect dynamics and demonstrating complex interactions among spider communities and their prey (Wikipedia).

Note that salticid egg sacs are targeted by parasitic wasps (genus *Idris*), indicating spiders are also regulated by natural enemies. New studies in West Bengal (Rajmohana *et al.* 2025) [42] uncovered species that parasitize spider eggs, highlighting overlooked interactions that structure arthropod communities and maintain ecological balance (timesofindia.indiatimes.com).

8.3 Implications for Chhattisgarh Ecosystems

Applying these broader ecological insights to Chhattisgarh suggests:

- Spiders likely suppress pests in rice paddies, millet fields, agroforestry systems, and orchards across the state-especially during monsoon and post-monsoon crop cycles.
- Forest and riparian zones support rich guilds of orb-weavers, jumping spiders, and ambush predators, regulating herbivore insects and maintaining ecosystem health.
- Urban and peri-urban landscapes likely host generalist spider species that provide residual pest suppression in gardens, parks, and crop edges.
- Spiders contribute to food webs, supporting populations of local birds, reptiles, and small mammals-which are themselves economically and culturally significant.
- Recognizing spider population regulation by parasitoids (such as *Idris* wasps) underscores the complexity of spider-mediated ecological networks.

9. Conservation Status and Threats to Spider Diversity

9.1 Habitat Destruction, Pesticide Use, and Climate Change Impacts

- **Habitat Loss & Fragmentation:** Habitat degradation through deforestation, agricultural expansion, and mining in Chhattisgarh leads to reduced microhabitats essential for spider diversity, especially leaf litter and understory vegetation (Sebastian & Peter, 2009) [50].
- **Pesticide Use in Agriculture:** Intensive pesticide applications in agroecosystems like rice and vegetable fields negatively affect non-target arthropods such as spiders, which play a crucial role as biological control agents (Riechert & Lockley, 1984 [45]; Patel & Patel, 2002) [34].
- **Climate Change and Temperature Extremes:** Altered temperature and rainfall patterns due to climate change impact spider behavior and distribution, with effects on foraging and reproductive cycles observed in both arid and semi-humid zones (Rana *et al.* 2024) [43]. Wolf spider activity, for example, is highly temperature dependent and can decrease with climate extremes (Wise, 1993) [69].
- **Threats to Endemic or Rare Species:** Though specific endemic species in Chhattisgarh are still under study, similar Indian tarantula species (e.g., *Thrigmopoeus insignis*) face threats from illegal collection and habitat loss (Siliwal, Molur & Daniel, 2005) [55, 56].

9.2 Conservation Gaps and Awareness Needs

- **Lack of Species-Level Protection and Research:** Most Indian spiders are not listed under conservation frameworks like the IUCN Red List or India's Wildlife Protection Act (Siliwal *et al.* 2005) [55, 56]. Regional surveys in Chhattisgarh remain sparse (Tikader, 1987 [63]; Siliwal & Molur, 2007) [54], creating a major knowledge gap.
- **Limited Public Awareness and Arachnophobia:** Fear-based killing and negative perceptions of spiders hinder conservation, emphasizing the need for community education and inclusion of spiders in environmental awareness programs (Sebastian & Peter, 2009) [50].
- **Underutilization of Modern Methods:** Recent advancements like DNA metabarcoding allow the identification of spider parasitoids from egg sacs, offering non-destructive tools for ecological study (Gopi *et al.* 2024) [15].

Table 2: Reported Spider Species in Chhattisgarh

S. No.	Scientific Name	Common Name	Family	Habitat	Behavior
1	*Neoscona mukerjei*	Orb-weaving spider	Araneidae	Forest, agricultural field	Web-building, nocturnal
2	*Oxyopes shweta*	Lynx spider	Oxyopidae	Grasslands, crop fields	Active hunter, diurnal
3	*Pardosa birmanica*	Wolf spider	Lycosidae	Forest floor, crop fields	Ground hunter, maternal care
4	*Salticus scenicus*	Zebra jumping spider	Salticidae	Urban walls, forest edge	Active hunter, diurnal
5	*Tetragnatha mandibulata*	Long-jawed orb weaver	Tetragnathidae	Wetlands, rice fields	Orb web builder, nocturnal
6	*Thomisus onustus*	Flower crab spider	Thomisidae	Flowers, shrubs	Sit-and-wait predator
7	*Pholcus phalangioides*	Cellar spider	Pholcidae	Houses, buildings	Web builder, synanthropic
8	*Argiope pulchella*	Garden orb weaver	Araneidae	Garden, grassland edges	Web builder, diurnal
9	*Clubiona drassodes*	Sac spider	Clubionidae	Tree bark, under leaves	Nocturnal hunter
10	*Stegodyphus sarasinorum*	Social spider	Eresidae	Dry shrubs, bushes	Communal webs, social behavior

Note: This is a representative list; actual species richness may vary and needs field validation. Detailed inventories are available from the Zoological Survey of India (ZSI) and regional publications like Bastawade (2005) [3] and Patel & Vyas (2001) [35].

Table 3: Confirmed Spider Species in Chhattisgarh

Species	Family	Authority (Year Described)	Distribution in Chhattisgarh	Notes
Conothele purvaghati	Halonoproctidae	Mirza (2022) [30]	Bastar district, Kanger Valley NP	Trapdoor spider, endemic (ResearchGate, Wikipedia)
Agroeca tikaderi	Liocranidae	(Gajbe, 1992)	Narayanpur district	Endemic to Chhattisgarh (Wikipedia)
Argiope aemula	Araneidae	Gajbe (2007) [13]	Central India including Chhattisgarh	Orb-weaver common in forests (wsc.nmbe.ch)
Cyclosa confraga	Araneidae	Gajbe (2007) [13]	Central India including Chhattisgarh	Web-builder on vegetation (wsc.nmbe.ch)
Cyclosa spirifera	Araneidae	Gajbe (2007) [13]	Central India including Chhattisgarh	Described from Madhya Pradesh region (wsc.nmbe.ch)
Cithaeron indicus	Cithaeronidae	Platnick & Gajbe (1994)	Madhya Pradesh / Chhattisgarh records	Ground-dwelling spider (wsc.nmbe.ch)

In Gomarda Wildlife Sanctuary (Raigarh district), a survey documented 120 species across 49 genera within 16 families, including:

- *Thomisidae* (24 species, 9 genera)
- *Araneidae* (22 species, 8 genera)
- *Gnaphosidae* (10 genera represented) (ISCA)

A 2025 survey in Gariaband forests yielded 55 species in 42 genera across 11 families, with Araneidae and Salticidae dominating (Nichat *et al.* 2025) [31] (mbimph.com).
According to Choudhury *et al.* (2024) [9], Chhattisgarh hosts 222 spider species from 96 genera and 23 families, with:

- *Araneidae*: 49 species
- *Thomisidae*: 32 species
- *Gnaphosidae*: 31 species
  And 41 species newly reported for the state
- (ResearchGate).

Table 4: Suggested Expanded Species Table (for Field Survey Use)

No.	Species	Family	Habitat Observed	Common Behavior
1	*Conothele purvaghati*	Halonoproctidae	Bastar (trapdoors)	Sedentary trapdoor
2	*Agroeca tikaderi*	Liocranidae	Narayanpur (under bark)	Ground-active hunter
3	*Argiope aemula*	Araneidae	Forest edges, shrubs	Orb-web builder, nocturnal
4	*Cyclosa confraga*	Araneidae	Herbaceous vegetation	Stabilimentum-decorated webs
5	*Cyclosa spirifera*	Araneidae	Grassland / open vegetation	Web-builder, small prey capture
6	*Cithaeron indicus*	Cithaeronidae	Forest floor, under stones	Ground-dweller, nocturnal

Table 5: Overview of Ecological Roles of Spiders

Ecological Role	Description	Reference
Natural Pest Control	Predation on crop pests (aphids, leafhoppers, etc.)	Riechert & Lockley (1984) [45]
Food Web Contributor	Serve as both predator and prey in trophic chains	Nyffeler & Birkhofer (2017) [32, 33]
Biodiversity Indicators	Reflect ecological health and microhabitat richness	Sebastian & Peter (2009) [50]
Soil and Leaf Litter Dynamics	Some species influence decomposition and nutrient cycling	Bragança & Lima (2010) [5]

Table 6: Habitat-Wise Spider Diversity in Chhattisgarh

Habitat Type	Species Richness	Common Spider Families	Notable Observations
Forest (Sal/Teak)	High	Araneidae, Salticidae, Thomisidae	Orb-web and ambush hunters dominant
Grassland	Moderate	Lycosidae, Gnaphosidae	Ground-dwelling hunters prevalent
Agricultural Fields	Variable	Tetragnathidae, Oxyopidae, Clubionidae	Seasonal fluctuations; affected by pesticide use
Urban Ecosystems	Low-Moderate	Pholcidae, Theridiidae	Synanthropic species dominant

Table 7: Sampling Techniques Used in Spider Studies

Method	Target Spider Group	Advantages	Limitations	References
Sweep Netting	Foliage-dwelling spiders	Easy, cost-effective, large area coverage	Ineffective for ground and web spiders	Chetia & Kalita (2011) [8]
Pitfall Traps	Ground-dwelling spiders	Good for activity-density studies	Affected by weather and terrain	Patel & Vyas (2001) [35]
Visual Encounter	All types	Comprehensive if done by trained observers	Observer bias; time-consuming	Sebastian & Peter (2009) [50]
Web Observation	Web-building spiders	Behavior, structure, prey capture analysis	Doesn't capture hunting spiders	Wise (1993) [69]

Table 8: Major Threats and Conservation Gaps in Chhattisgarh

Threat	Impact on Spiders	Suggested Action	Reference
Habitat Destruction	Loss of microhabitats and rare/endemic species	Promote habitat preservation	Siliwal *et al.* (2005) [55, 56]
Pesticide Use	Mortality of non-target spiders	Integrated Pest Management (IPM) practices	Patel & Patel (2002) [34]
Climate Change	Affects reproduction, foraging, and distribution	Long-term ecological monitoring	Rana *et al.* (2024) [43]
Lack of Taxonomic Clarity	Undocumented species remain unidentified	Molecular taxonomy and barcoding	Shrivastava & Sharma (2024)
Public Misconceptions	Killing due to fear; low conservation value	Awareness and community involvement	Sebastian & Peter (2009) [50]

10. Future Prospects and Research Priorities

10.1 Need for Taxonomic Revisions and Molecular Studies

- Traditional spider taxonomy in India still relies heavily on morphology, which often fails to reveal cryptic diversity or account for sexual dimorphism and juvenile stages (Shrivastava & Sharma, 2024). Integrative approaches-blending morphology with molecular data-are essential to resolve such issues (Shrivastava & Sharma, 2024; Bond *et al.* 2023) [4] (journalarrb.com).
- The first large-scale DNA barcoding of Indian spiders (covering 101 morphospecies across 72 genera in 21 families) uncovered cryptic species and multiple molecular operational taxonomic units (MOTUs), indicating the need for taxonomic revision in widely recorded genera such as *Pardosa*, *Cyclosa*, and *Argiope* (Kuntner *et al.* published in PubMed data; e.g., cryptic in *Pardosa pusiola*, *Cyclosa spirifera*) (first Indian barcoding study, 2020s) (PubMed).
- Modern phylogenomic methods-including Ultra-Conserved Elements (UCEs)-have shown that some spider families (e.g. Ctenidae) are not monophyletic, signaling the need to re-evaluate family-level taxonomy using genomic data (Hazzi & Hormiga, 2023 [17]; Bond *et al.* 2023) [4] (ScienceDirect).
- For Chhattisgarh, implementing DNA barcoding and molecular phylogenetics alongside morphological study would not only clarify species boundaries but also guide conservation of potential endemic or regionally rare taxa.

10.2 Potential in Agriculture, Biotechnology, and Ecology

- Spiders are highly underutilized as biological control agents. A review by Sugumaran *et al.* (2024) [59] highlighted over 77 aphidophagous spider species in India, demonstrating their potential in managing crop pests such as aphids across multiple agroecosystems (Sugumaran *et al.* 2024) [59] (PubMed, journaljalsi.com).
- The CIKS initiative-focused on organic farming-has successfully developed mass-rearing techniques for lynx and giant crab spiders, using them to control cockroaches and pest complexes, thus showcasing scalable spider-based biocontrol strategies (CIKS, 2019) (Ciks).
- Spider silk and venom research opens doors in biotechnology and medicine: recombinant spider silk (even from transgenic goats) is being explored for applications such as artificial ligaments, sutures, and high-strength materials (Monks & Yan, 2016; Lepore *et al.* 2015) (Wikipedia).
- Ecological monitoring using spiders as bioindicators offers potential for habitat health assessments. DNA metabarcoding techniques are advancing rapidly: ZSI researchers recently decoded spider-parasitoid interactions from egg sacs, indicating hidden ecological complexity (Rajmohana *et al.* 2025) [42] (The Times of India).

10.3 Recommended Priorities for Future Research in Chhattisgarh

1. **Integrative Taxonomy:** Combine morphology, COI barcoding, and multi-locus phylogenomics (e.g., UCEs) to resolve species identities and detect hidden diversity.
2. **Ecological Barcode Libraries:** Establish a DNA barcode reference database for spiders from Chhattisgarh to support community monitoring and biocontrol identification.
3. **Field Trials in Agroecosystems:** Assess spider predation efficacy in rice, millets, and agroforestry systems-field trials replicating CIKS models can help quantify benefits and acceptance.
4. **Silk & Venom Characterization:** Explore local spider species (e.g. orb-weavers, salticids) for novel biomaterials or venom peptides with pharmaceutical or agricultural potential.
5. **Spatiotemporal Monitoring:** Integrate molecular markers with long-term habitat monitoring (forest, riparian, urban, agricultural zones) to document community changes under climate or land use shifts.
6. **Citizen Science & Education:** Incorporate local communities and schools in barcode collection and species mapping using platforms like iNaturalist, enhancing taxonomic awareness and conservation.

11. Conclusion

The review highlights that spiders, as one of the most diverse and ecologically significant arthropod groups, play vital roles in maintaining ecosystem balance, particularly through their predatory regulation of pest populations (Nyffeler & Birkhofer, 2017) [33]. Chhattisgarh, with its diverse forest types, agroecological zones, and climatic gradients, supports a rich spider fauna that remains underexplored in both taxonomic and ecological dimensions (Patel & Vyas, 2001 [35]; Bastawade, 2005).

The documented spider diversity across forested, agricultural, grassland, and urban landscapes reflects significant habitat-specific variation in species richness and behavior. The observed web-building strategies, hunting adaptations, and reproductive behaviors further underline the adaptive diversity of spiders in the region (Sebastian & Peter, 2009 [50]; Chetia & Kalita, 2011) [8].

Despite their ecological importance, spiders face mounting threats from habitat destruction, pesticide use, and climate variability (Bragança & Lima, 2010 [5]; Rayar, 2019) [44]. Conservation attention toward arachnofauna is minimal, and awareness among the public and policymakers is lacking. Effective conservation will require integrative taxonomic

approaches, molecular tools for species identification, long-term ecological monitoring, and incorporation of spiders into pest management frameworks (Bond *et al.* 2023 [4]; Shrivastava & Sharma, 2024).

In conclusion, Chhattisgarh offers immense potential for spider-related research with applications in agriculture, ecology, and biotechnology. Strengthening regional research capacity, documenting underexplored habitats, and promoting public engagement can collectively enhance the conservation and scientific understanding of this critical arthropod group.

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