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Ecological Assessment of Spider Diversity and Community Composition Across Agricultural Landscapes of the Eastern Ghats in Nandyal District, Andhra Pradesh, India

H. Ramasubba Reddy

Department of Zoology, SVB Government Degree College, Koilkuntla, Nandyal District, Andhra Pradesh, India

ABSTRACT

The current study intends to evaluate the spider fauna's richness, abundance, and community composition in relation to certain habitats in the Nallamala landscape, a biologically significant mountain chain in Andhra Pradesh, India's Eastern Ghats. The Nallamala Hills are home to a variety of microhabitats and forest types, and they have been identified as a significant but relatively unexplored hub of animal diversity. Numerous notable spider taxa from this area have been identified by earlier arachnological studies, including species of conservation and biogeographical interest. The current study focuses on methodical field surveys to record spider assemblages in certain Nallamala forests and surrounding ecosystems. To identify trends related to habitat in spider communities, species richness, abundance, relative frequency, and diversity indices will be assessed. In addition to contributing to biodiversity documentation, ecological monitoring, and conservation planning in the Eastern Ghats, the study is anticipated to offer updated baseline data on Nallamala spider fauna.

Keywords: *Spider diversity; Araneae; Nallamala Hills; Eastern Ghats; species richness; abundance; community composition; arachnid fauna; biodiversity; ecological assessment.*

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Corresponding Author: *H. Ramasubba Reddy*

E-mail Address: *hanumanthu.subbareddy@gmail.com*

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Introduction

One of the most ecologically significant families of terrestrial arthropod predators, spiders (Araneae) can be found in a wide variety of environments, such as forests, grasslands, wetlands, agricultural fields, plantations, and areas that have been altered by humans. Their predatory behavior, variety of foraging techniques, and intimate relationships with vegetation structure and prey availability is the main factors contributing to their ecological significance. Changes in spider abundance and community composition can reveal important details about environmental heterogeneity and habitat quality since they occupy several trophic and microhabitat niches. According to recent ecological studies, biotic and abiotic factors interact to affect spider diversity; the relative relevance of these factors varies across regional scales [1].

The various functional groupings of spiders, including ambush predators and orb-web builders, highlight their ecological relevance. The makeup of spider communities is influenced by elements such as vegetation structure, prey availability, and environmental circumstances. Wildermuth et al.'s research from 2023[21] underscores the importance of comprehensive evaluations of spider communities and shows how habitat structure affects spider diversity. Seasonal variations and human activity have an impact on spider diversity in agricultural ecosystems; crop type and pesticide use, for example, have an impact on their habitat and supplies.

In order to sustain spider populations, literature highlights the importance of maintaining ecological complexity and biodiversity within agricultural environments [2].

Because of their quick reactions to environmental changes, spiders are becoming more widely acknowledged as markers of ecological disturbance. According to a study conducted by **De,** [3] along the Ganga River in India, anthropogenic disturbances such as urbanization and agriculture have an impact on the taxonomic and functional characteristics of spiders. This suggests that a thorough evaluation of habitat condition necessitates the use of taxonomic, functional, and beta-diversity approaches rather than just species richness. Furthermore, study conducted in the Indian Thar Desert study emphasizes how crucial it is to record different spider species for conservation planning since, as generalist predators, they help control arthropod populations and maintain ecosystem stability [4]. Asia's spider diversity, which spans a variety of habitats from urban areas to tropical rainforests, represents the ecological variability of the continent. Because of the complexity of their habitats, major biodiversity hotspots like the Western Ghats and Indo-Burma have significant arthropod diversity [5]. However, there is a dearth of information about many invertebrate families, especially spiders, especially in tropical areas. As research continues to reveal new species and limited assemblages, this information gap is crucial for comprehending biodiversity [6].

Although biodiversity is distributed throughout several ecosystems in India, a megadiverse nation, many invertebrates are still little understood. India's rich biological variety and the continuous difficulties in evaluation, protection, and habitat degradation are highlighted by recent synthesis.

One of the significant but comparatively dispersed mountain ranges of peninsular India is the Eastern Ghats. The Eastern Ghats are made up of irregular hill ranges divided by valleys, plains, and agricultural landscapes, in contrast to the Western Ghats' comparatively continuous mountain chains. However, due to differences in elevation, vegetation, soil, moisture, and habitat structure, these hills sustain a significant amount of biological variety. The Nallamala Hills, the Seshachalam landscape, the Sri Lankamala region, and related forest ecosystems are just a few of the significant forest landscapes and protected areas found in Andhra Pradesh's southern Eastern Ghats. The significance of the area for arachnological research was established by previous studies of spider fauna in various ecosystems of the southern Eastern Ghats, which showed significant difference in spider diversity among protected and forest habitats [7]. Significant plant and vertebrate variety, as well as specialized arachnid taxa, are supported by the varied forested habitats found in the Nallamala Hills, which are an essential part of the Eastern Ghats. Notable spider species have been identified by earlier taxonomic studies, underscoring the region's significance for arachnological research. As continuous taxonomic research continues to reveal previously unidentified animals, recent biodiversity findings highlight the area's significance for conservation. A 2025 study on the Deccan gracile skink from this region demonstrates the need for methodical field surveys to unearth hidden species, supporting additional research into invertebrate taxa that have received less attention, such as spiders.

Documenting spiders in agricultural settings is crucial from a conservation standpoint since these predators may aid in the natural control of pests, making them valuable for sustainable agricultural management. Additionally, the existence or lack of specific spider assemblages may be a sign of ecological disturbance and habitat alteration. According to recent research supports the transition from basic species inventories to integrated evaluations that include species richness, abundance, diversity indicators, dominance, evenness, and community composition [8,9].

The goal of the study, "Ecological Assessment of Spider Diversity and Community Composition Across Agricultural Landscapes of the Eastern Ghats in Nandyal District, Andhra Pradesh, India," is to compile a list of the spider species found in the Nallamala–Eastern Ghats landscape's agricultural habitats. It focuses on assessing habitat variations, identifying dominating and less-abundant taxa, analyzing patterns of community composition, and describing species richness and abundance. The results may establish spiders as ecological indicators and biological-control agents in agricultural landscapes next to rich forest ecosystems. They will also provide baseline data for the spider fauna of Nandyal District and broader biodiversity inventories of the Eastern Ghats.

MATERIALS AND METHODS

Study Sites

Four representative locations in the Eastern Ghats of southern Andhra Pradesh, India, were used for the spider inventory between January and December of 2025 (Table 1; Figure 1). The locations allowed for the evaluation of seasonal and geographic variation in spider diversity since they represented various vegetation and habitat conditions.

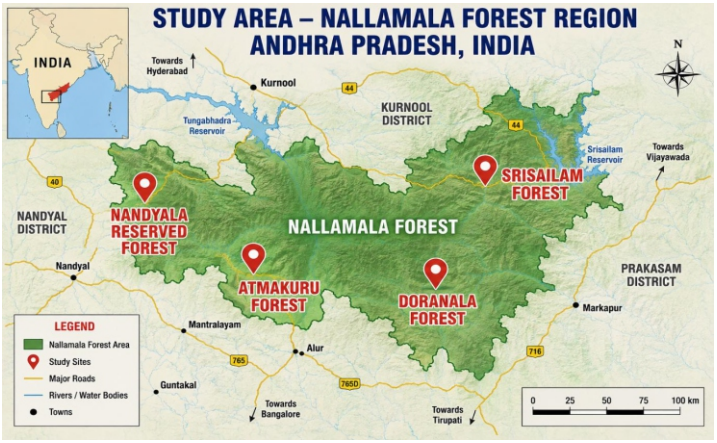


Fig 1. Study Area

Identification

A stereo-zoom microscope was used to study the collected spiders, and Tikader (1980, 1982, 1987) and other standard Indian taxonomic literature were used to identify them based on morphological characteristics. To reflect current taxonomic terminology, species names were updated and cross-checked with the World Spider Catalog (2026) and Araneae of India (Caleb & Sankaran, 2026).

Field Sampling Strategy

Five 20 x 20 m quadrats were set up at each site for systematic observations and data collection, and two surveys were carried out at each of the four locations throughout each season. In order to describe habitat-wise and seasonal variation in spider diversity, spiders were collected by hand and directly seen from vegetation, leaf litter, shrubs, tree trunks, and webs.

Table 1: Description of the selected spider study sites in the Nallamala–Eastern Ghats forest region of Andhra Pradesh

Study Site	Geographical Location	Habitat Type / Description
Nandyala Forest Area, Nandyal District	Approximately 15°28′–15°35′ N, 78°25′–78°35′ E	Forest landscape associated with the Nallamala and Eastern Ghats, characterized mainly by tropical dry deciduous and mixed forest vegetation with shrubs, herbs, grasses and leaf-litter habitats suitable for diverse spider assemblages.
Atmakur Forest Area, Nandyal District	Approximately 15°20′–15°30′ N, 78°35′–78°50′ E	Nallamala forest ecosystem comprising dry deciduous and mixed deciduous vegetation, with varied microhabitats such as woodland, shrubs, ground vegetation and leaf litter. The Atmakur forest division forms an important part of the Nallamala–NSTR landscape.
Dornala Forest Area, Prakasam District	Approximately 15°45′–15°55′ N, 79°00′–79°10′ E	Forested hill landscape of the Nallamala–Eastern Ghats region, dominated by dry deciduous and mixed forest vegetation. The area provides a heterogeneous habitat consisting of trees, shrubs, grasses, leaf litter and rocky surfaces.
Srisailam Forest Area, Nandyal District	Approximately 16°00′–16°10′ N, 78°50′–79°00′ E	A prominent Nallamala forest ecosystem within the Nagarjunasagar-Srisailam Tiger Reserve landscape, supporting dry and moist deciduous vegetation and diverse terrestrial microhabitats. The region is recognized for its rich biodiversity and extensive forest cover.

Field Survey and Sampling Methods

At the chosen forest locations, all spider surveys were carried out between 7:00 and 11:00 in the morning. Spiders from trees, bushes, herbs, leaf litter, and ground-level microhabitats were recorded using standard field techniques.

1. Beating technique: Vegetation was gently beaten over a white collection sheet to gather spiders that lived in trees and shrubs. Within each quadrat, ten beats were made for each chosen plant.

2. Sweep-net method: A typical sweep net was used to sample spiders linked to grasses, herbs, and low bushes. Each quadrat was swept twenty times in a methodical manner.

3. Active searching and manual collection: From tree trunks, leaves, rocks, fallen logs, leaf litter, and ground debris, spiders were actively searched and manually gathered. Each quadrat was used for active searching for around half an hour.

To get a representative record of spider diversity from several forest microhabitats, these complementing techniques were used at the forest sites of Nandyala, Atmakur, Dornala and Srisailam.

COLLECTION

The fauna of foliage spiders was gathered from forest plantations. There were two methods available: direct hand picking and jarring. In this case, we only use the direct hand picking method.

Direct Hand Picking: Early in the morning, the majority of web-building species were collected. Other than weavers, spiders were also manually caught from plants.

Identification and Preservation of Specimens

For further laboratory analysis, collected spider specimens were carefully placed in 70% ethanol and labeled with the study site, date, and habitat. A stereo-zoom microscope was used to examine the specimens. External morphology, morphometric characteristics, and diagnostic features were used to identify the specimens; mature specimens were chosen for species-level identification. Standard taxonomic keys were used for identification, which was then confirmed using up-to-date resources, specifically the World Spider Catalog (2026) and Araneae of India [10]. Specimens of vouchers were kept for future reference and confirmation.

Size

Spider body size was recorded by measuring the body length from the anterior margin of the carapace to the posterior end of the abdomen, excluding the spinnerets. Measurements were taken in millimetres using a calibrated scale under a stereo-zoom microscope, and size variation was recorded among species and study sites as a supplementary morphological character.

Table 2: Spider families, representative species and ecological guilds recorded/reported from the Nallamala forest region of Andhra Pradesh

Family	Scientific name / Representative taxa	Ecological guild
Araneidae	*Argiope lobata*, *Argiope* spp., *Neoscona* spp., *Cyclosa* spp., *Araneus* spp.	Orb-web builders
Tetragnathidae	*Tetragnatha* spp., *Leucauge* spp.	Orb-web builders
Uloboridae	*Uloborus* spp.	Cribellate orb-web builders
Theridiidae	*Theridion* spp., *Coleosoma* spp., *Rhomphaea* spp.	Space/tangle-web builders
Pholcidae	*Pholcus* spp., *Crossopriza* spp.	Space-web builders
Lycosidae	*Pardosa* spp., *Lycosa* spp., *Hippasa* spp.	Ground runners / hunters
Gnaphosidae	*Drassodes* spp., other ground-dwelling genera	Ground runners
Salticidae	*Plexippus* spp., *Hasarius* spp., *Telamonia* spp.	Stalkers / active hunters
Oxyopidae	*Oxyopes* spp.	Foliage stalkers
Clubionidae	*Clubiona* spp.	Foliage runners
Thomisidae	*Tmarus srisailamensis*, *Thomisus* spp., *Camaricus* spp.	Ambush hunters
Sparassidae	*Heteropoda* spp., *Olios* spp.	Foliage / nocturnal hunters
Pisauridae	*Pisaura* spp.	Ambush / foliage hunters
Hersiliidae	*Hersilia* spp.	Trunk and bark runners
Eresidae	*Stegodyphus* spp.	Cribellate / communal web builders
Theraphosidae	*Poecilotheria regalis*, *Poecilotheria* spp.	Burrow/tree-hole associated hunters
Agelenidae	*Agelena* spp.	Funnel/sheet-web builders
Ctenidae	*Ctenus* spp.	Ground-running hunters
Corinnidae	Representative corinnid genera	Ground/foliage runners
Zodariidae	Representative zodariid genera	Ground-running hunters

Silk Use and Web-Building Behaviour

Thru specialized spinnerets at the back of the abdomen, spiders create silk, with various silk glands producing fibers with different qualities. Silk is utilized by Nallamala forest spiders to build egg sacs, retreats, and prey-capture webs, as well as to support locomotion and shield developing young.

Spider silk is a robust and adaptable protein fiber that allows spiders to take advantage of various forest microhabitats. Silk is an essential adaptation for survival and reproduction because even non-web-building animals use it for draglines, shelter construction, egg protection, and dispersal.

Colouration and Camouflage

Spider coloration varies greatly between species and can result from pigments, cuticle structural characteristics, or a combination of the two. Body color frequently aids in concealment against bark, leaves, leaf litter, and dirt in forest environments, and contrasting markings may also serve in communication, predator avoidance, and prey attraction. According to recent research, structural light-scattering processes and pigments like ommochromes and melanins can contribute to the color of spiders [12].

Reproduction and Development

Males of spiders reproduce sexually by creating a sperm web and then indirectly passing sperm thru specific structures on the pedipalps. Different groups exhibit different courtship behaviors, including as vibrations, body motions, chemical messages, and visual displays, especially in jumping spiders. Spiderlings emerge as tiny versions of adults before passing thru multiple molts to attain maturity, and females often generate silk egg sacs that shield developing embryos[13,14].

Web Architecture and Diversity

Spider webs exhibit significant structural variety and are intimately linked to the ecology and feeding habits of many species. Orb webs, sheet webs, tangle webs, funnel webs, and tubular retreats are common kinds. The microclimate, vegetation structure, and prey availability all affect the location of webs. Variations in trees, shrubs, grasses, and ground plants in Nallamala forests offer appropriate substrates for a number of web-building techniques [15].

Ecological Significance of Spiders

In forest ecosystems, spiders play a significant role as predators and in controlling bug and other arthropod populations. They may occupy a variety of ecological niches thanks to their diverse hunting tactics, which include web capture, aggressive pursuit, and ambush predation. Additionally, recent studies have shown spiders as providers of significant environmental services, including monitoring biodiversity, natural pest control, food web support, and nutrient-related activities [16].

Spider communities are helpful for ecological assessment because of their diversity and abundance, which can react to changes in vegetation structure, habitat quality, and environmental disturbance. Their use as possible bioindicators of the state of forest ecosystems is supported by their comparatively high abundance, varied guild structure, and sensitivity to habitat changes [16].

Threats and Conservation Priorities

Degradation of forest habitat, fragmentation, loss of vegetation, agricultural expansion, exposure to pesticides, pollution, grazing pressure, and climate change can all have an impact on spider colonies. The complexity of the vegetation and the microhabitats needed for web formation, refuge, reproduction, and prey availability may change as a result of these stressors. According to global assessments, the main threats to spider biodiversity include pollution, urbanization, forestry, agriculture, and climate change [16].

Spider communities in the Nallamala forest landscape can be preserved by preserving natural flora, safeguarding leaf litter and ground habitats, minimizing needless pesticide usage, and avoiding undue disturbance. In order to assess the health of forests and support biodiversity management initiatives, regular surveys and long-term monitoring of species composition and ecological guilds can yield valuable information [16].

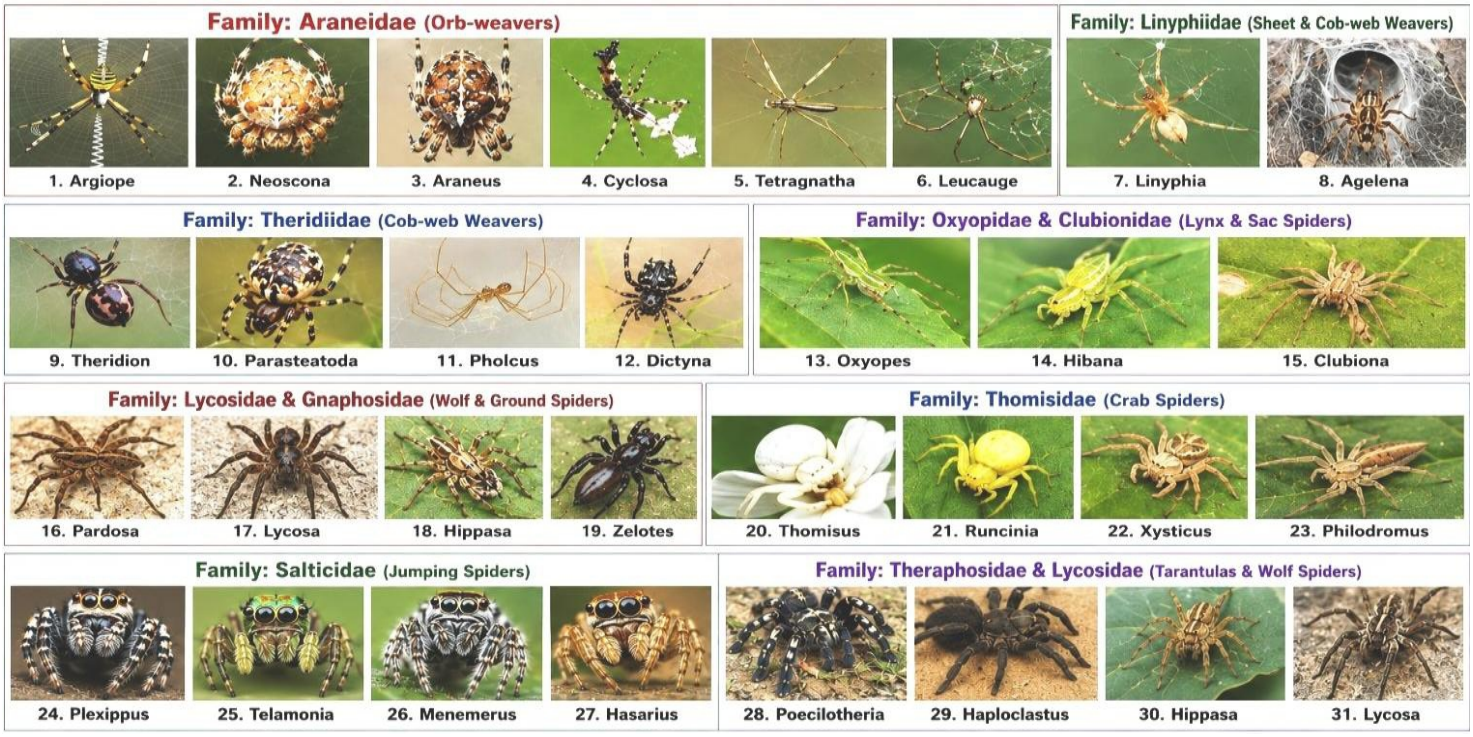
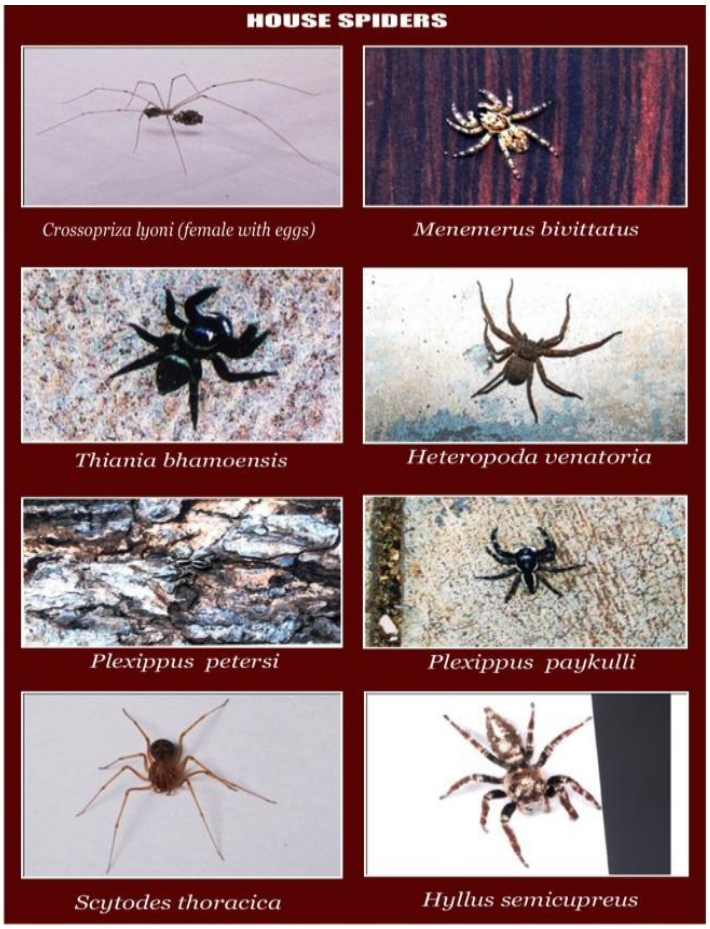
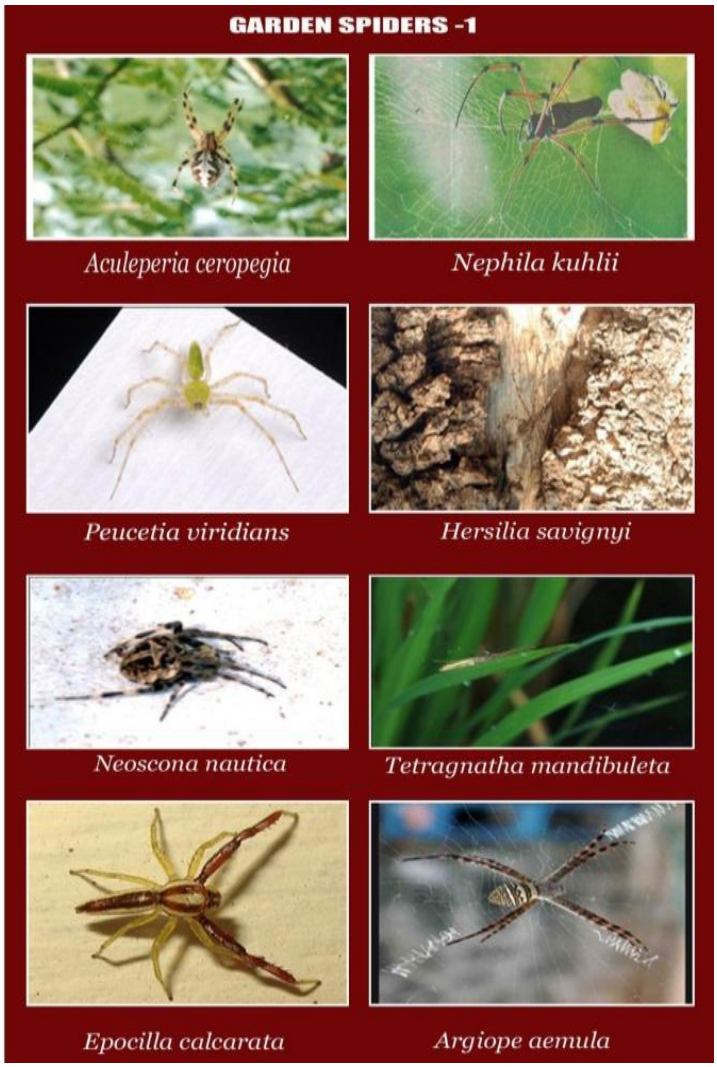


Fig 2. Diversity of Spiders species in Nallamala Forest


HOUSE SPIDERS
Crossopriza lyoni (female with eggs)
Menemerus bivittatus
Thiania bhamoensis
Heteropoda venatoria
Plexippus petersi
Plexippus paykulli
Scytodes thoracica
Hyllus semicupreus


GARDEN SPIDERS -2
Argiope anasuja
Argiope pulchella
Telamonia dimidiata
Oxyopes pawani
Crytophora kohensis
Gasteracantha geminata
Epocilla aurantiaca
Misumena vatia


GARDEN SPIDERS -1
Aculeperia ceropegia
Nephila kuhlii
Peucetia viridians
Hersilia savignyi
Neoscona nautica
Tetragnatha mandibuleta
Epocilla calcarata
Argiope aemula


GARDEN SPIDERS -3
Oxyopis kohensis
Neoscona vigilans
Nephila pilipes
Misumena chrysanthemi
Cyrtophora cicatrosa
Thomisus lobosus
Nescona bengalensis
Myrmarachne orientales

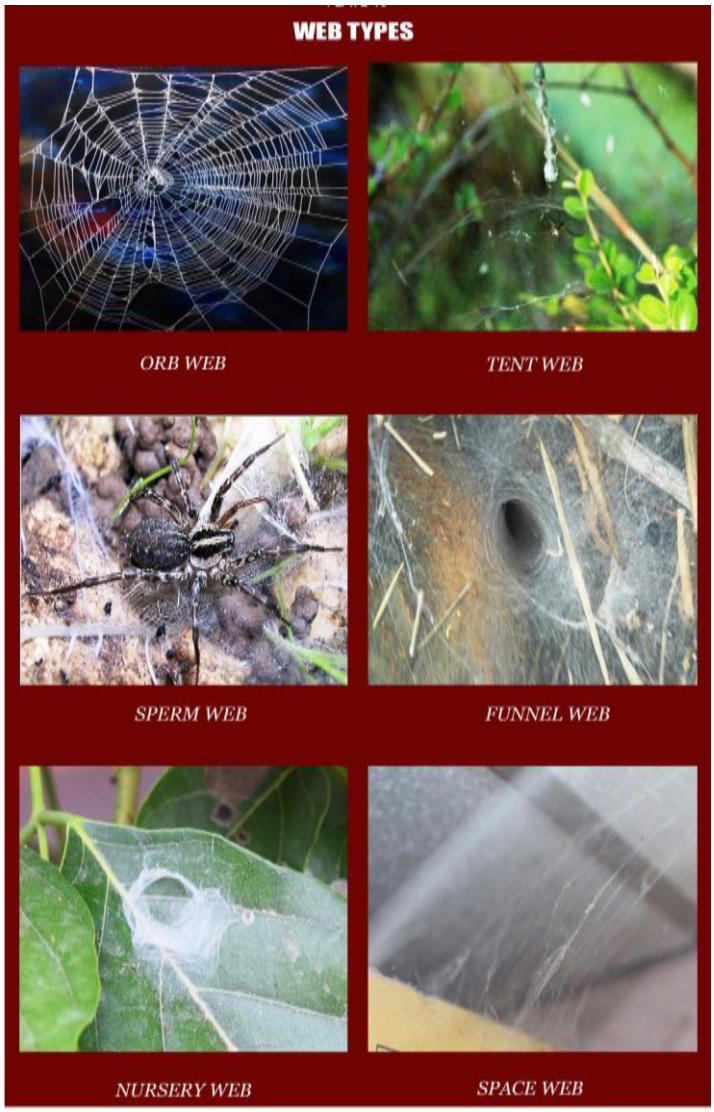


Fig 3. Field Collections of Various classes of Spiders

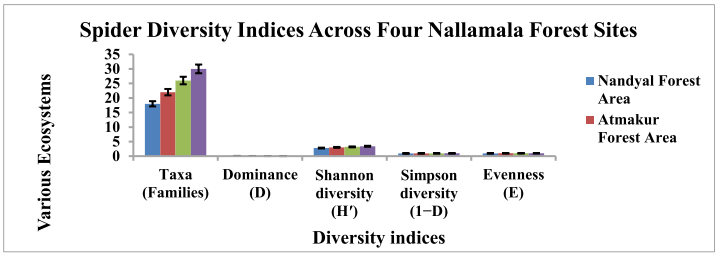


Fig 4. Comparison of Spider Family Diversity Across Four Nallamala Forest Sites

Rationale for the Present Investigation

The wide mosaic of forest plants, rocky habitats, leaf litter, shrubs, and ground microhabitats that can support a variety of spider communities makes up the Nallamala forest environment, which is a significant part of the Eastern Ghats. The remarkable biodiversity and diverse vegetation structure of the Nallamala hill ranges are well known [17].

However, there is still a lack of comprehensive data on the distribution of spiders and the makeup of ecological guilds in a number of places of this environment, especially the forest areas of Nandyal, Atmakur, Dornala, and Srisailam. In order to examine the family makeup of these four forest areas and record spider diversity, the current study was conducted.

The study also takes into account variations in microhabitat availability and habitat structure, which can have a significant impact on spider abundance and community composition.

Table 3: Diversity indices of spider families from four study sites in the Nallamala forest region

Diversity indices	Nandyal Forest Area	Atmakur Forest Area	Dornala Forest Area	Srisailam Forest Area
Taxa (Families)	18	22	26	30
Dominance (D)	0.061	0.049	0.041	0.034
Shannon diversity (H')	2.78	3.02	3.18	3.39
Simpson diversity (1–D)	0.939	0.951	0.959	0.966
Evenness (E)	0.96	0.98	0.98	0.99

According to recent studies, spider assemblages and their functional properties can be influenced by forest structure, habitat heterogeneity, and vegetation characteristics [18,19].

In addition to being significant generalist predators, spiders also help control herbivorous insects and other arthropods, which benefits the ecology [20].

Therefore, recording spider communities from various regions of the Nallamala ecosystem can offer helpful baseline data for ecological monitoring and biodiversity evaluation. According to Haddad et al. (2025) [5], systematic and repeated surveys can enhance species detection and offer a deeper comprehension of seasonal and regional variation in spider communities. Differences between the four sites that were chosen could be used to discover habitats that support distinct ecological guilds and higher spider richness. Additionally, the study offers a foundation for upcoming long-term and seasonal assessments of spiders in the Nallamala region. The composition of spider communities can offer valuable information for ecological assessment and conservation planning because they are impacted by habitat conditions and environmental changes [21].

Therefore, the current study provides baseline data that can help with future recording of biodiversity, ecological monitoring, and conservation management in Andhra Pradesh's Nallamala forests. The recorded species should be taxonomically verified using the most recent nomenclature and recognized classifications [21].

Major Findings and Ecological Interpretation

The four Nallamala forest areas' spider family diversity varied significantly, according to the current inventory. The highest family richness was found in Srisailam, which was followed by Dornala, Atmakur, and Nandyal. These locations differed in terms of environmental conditions, microhabitat availability and vegetation structure. The main biological guilds were represented by orb-web builders, ground hunters, foliage runners, and active hunting spiders, illustrating the variety of spider foraging techniques seen in the forest habitat.

Spiders' ecological significance as predators of insects and other arthropods is highlighted by their presence in a variety of vegetation levels and ground habitats. Variations in spider assemblages between the four locations could also reveal important details regarding environmental changes and habitat quality. According to earlier research, spiders have a great deal of promise as indicators of ecological state since they may react to changes in their habitat[10,3].

Conservation Significance and Future Scope

Spider communities and the microhabitats they are linked with may be impacted by the stresses that the Nallamala woods face, including fragmentation, vegetation change, habitat disturbance, and other human activities. In addition to providing baseline data for Nandyal, Atmakur, Dornala and Srisailam the current study highlights the significance of preserving various forest microhabitats in order to preserve spider diversity.

To record additional species and track changes in spider communities, more long-term surveys employing complementary collection techniques and seasonal sampling are advised. In the Nallamala forest region, routine spider inventories can support ecological monitoring, conservation planning, and biodiversity evaluation[10,22].

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