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Diversity and distribution of spiders from Gibbon Wildlife Sanctuary, Assam, India

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ABSTRACT

The study describes the identification of the spider assemblages with respect to their diversity and distribution in the semi evergreen forest, Gibbon Wildlife Sanctuary, Assam, India. The paper aims to introduce this neglected Order- *Araneae* which is primarily unknown to Science particularly in Northeast India. A total of 95 species of spiders belonging to 56 genera and 18 families were recorded during the study from June-August and October-December, 2011. The species were identified using keys for Indian spiders from (Tikader, 1987; Platnick , 2011). Methodology included active searching at all layers from ground level to tree canopy layer accessible easily for hand collecting and visual surveys. This is the first attempt to report the spider assemblages and their microhabitat preferences from Assam, India. Such surveys are vital for conservation of these creatures and building a biodiversity database of this mega diverse group from a fragmented semi-evergreen forest ecosystem in Assam, India. This study is focused on the neglected diversity of spider fauna representing this semi evergreen forest.

Key words: Gibbon Wildlife Sanctuary, *Araneae*, Morphospecies, Conservation.

INTRODUCTION

The Northeastern region of India lies at the conjugation of Indo-Himalayan Biodiversity hotspot. In Northeast, Assam with the political boundary of 78,438 sq. km. is the home of a large and diverse assemblage of intermediate predator species of the order *Araneae*, or the spiders (Coddington & Levi 1991; Wise, 1993). The origin of spiders could be traced back nearly 400 million years to the Devonian period. The abundance and resemblance of the spiders to their modern descendents can be dated back to the early Tertiary period (almost 70 million years ago). Spiders have become a successful group due to the many and varied ways in their capability to use silk (Masterman G.F. 1888; Paul Hilliard, 1994; Mark Carwardine, 1995; Rainer Foelix, 1996) . The state Assam and its natural heritage in some protected area like Gibbon Wildlife Sanctuary is currently experiencing slow but steady urbanization, industrialization and expansion of agriculture. Ecosystem of some species in this region is under high peril of complete annihilation owing to unsustainable human activities (A. K. Gupta, Narayan Sharma, Sabyasachi Dasgupta, D. Chakraborty& R. Hazarika; Debojyoti Chakraborty & A. K. Gupta; Reneema Hazarika & A. K. Gupta). In this regards, it is very vital to improve upon the knowledge on biodiversity of these regions in order to develop proper conservation strategies and bio-monitoring systems. A major action strategy implemented for environmental conservation involves surveys for called biological monitoring systems. Such surveys usually identify environmental disturbances in a given ecosystem using selected group of organisms called bioindicators (Garg and Hippargi 2007). Many Amphibians, Reptiles, Aves, Mammals, & Spiders are good indicators of environmental health. They play important roles in the dynamics of a specific habitat and are sensitive to habitat loss, climatic change and environmental upheavals (Wyman, 1990; Daniel, 2002). In this study emphasis was laid on to specify the diversity of spiders and their potential as bioindicators of this region. In general, taxonomic studies on spiders and invertebrates of Gibbon Wildlife Sanctuary, Assam, India are comparatively few and limited. No specific extensive studies on spider faunal diversity in this region were done and published. This study focuses on the spiders (Arachnida: Araneae) as a representative invertebrate fauna from this ecosystem. Data thus collected may facilitate future initiatives of biodiversity database of these species in the region.

MATERIALS AND METHODS

Study area

Gibbon Wildlife Sanctuary is a semi-evergreen forest and is among the highest protected tracts in the sub-Himalayan belt otherwise called as the "Biodiversity Hotspot". Spiders were actively searched in the different fragments of forest surrounded by small villages and tea-estates. A railway tract dissects the forest into different compartments. Gibbon wildlife Sanctuary is situated in the Jorhat district of Assam, Northeast India. The Sanctuary covers an area of 19.49 sq.km. and is an important wet evergreen forest of Assam. Formerly it was called "Hollongapar Reserve Forest"; that was declared as a wildlife sanctuary in 1997.The sanctuary is located at an altitude of 100-120m above and the land is well drained with some few depression left after monsoon. The habitat has been classified as "Assam valley Tropical wet Evergreen Forest" (Champion And Seth 1968). The floristic of the habitat has been discussed by (Champion and Seth 1968). The weather in the area may

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be classified as subtropical hot, wet monsoon periods (May-August) and cool dry winter (September to April). Winter rains are also not uncommon. The average rainfall is around 249 cm (Ghosh, 2007), and the average temperature varies from 5°C (min) - 38°C (max). There is extensive work on primate species in Gibbon Wildlife Sanctuary (Chetry *et al.,* 2001, 2005, 2006; Bhattacharjee *et al*., 2004). The forest holds the important populations of Hoolock Gibbon (*Hoolock hoolock*), Capped Langur (*Trachypithecus pileatus*), Rhesus Macaque (*Macaca mulatta*), Assamese Macaque (*Macaca assamensis*), Pig tailed Macaque (*Macaca leonina*), Slow loris (*Nyctecebus bengalensis*) and Stump-tailed macaque (*Macaca arctoides*). Insect and arachnid fauna of Gibbon forest provide protein biomass to the arboreal animals particularly to the arboreal primates (Chetry & Bhattacharjee 2006; Tilson, 1979, Gittins and Tilson 1984). Beside Primates, the rich diversity is reported with 489 species of plant and more than 300 species of birds and large population of

Table 1. Geographical location of the study area

Survey area	Longitude	Latitude
Compartment No. 1	26°40′30.10″N	094°21′11.50″E
Compartment No. 2	26°41′05.30″N	094°20′39.15″E
Compartment No. 3	26°41′50.05″N	094°20′30.05″E
Compartment No. 4	26°41′47.05″N	094°20′43.35″E
Compartment No. 5	26°41′03.35″N	094°21′13.05″E

Sampling

Line transects were used to search the spiders in different compartments. Transects were chosen in random with semi-quantitative sampling methods to record the spiders. Spiders were searched for maximum two hours (0900-1100 hrs) in each compartment, extending the search with different compartment sizes. The sampling was carried for two months each from June-August 2011 and October-December 2011. The sampling methods includes-visual searching for the spiders as far distinct vision is possible. Ground search were done under leaf litter, fallen or dry wood. Sweep netting was done for the foliage dwelling spiders covering the herbs and shrubs. Beating trap was done with a wooden stick and an umbrella placed under the trees to catch the spiders which were unable to reach or seen hanging above. Web pattern, habitat type were recorded with every encounter. The caught spiders were placed separately on vials with 70% ethyl alcohol. The collection date, compartment name and habitat were recorded on each vial. Spiders were identified up to the species level using the identification keys by (Tikader, 1987; Pocock, 1900; Richard Dewing *et al*., 1998; Rod & Ken Preston -Mafham, 1983; K. Vijayalakhmi & Preston Ahimaz 1993). Immature spiders together with insufficient knowledge and identification keys were classified up to

Figure 1. Map of Assam

Figure 2. Map of Gibbon Wildlife Sanctuary, Assam (Forest Division, Jorhat, Assam)

the morphospecies level (Oliver & Beattie 1996; Krell, 2004). A general list of spiders recorded in study area during the survey period is enlisted in (Table 2). (Tikader, 1987 and Platnick, 2011) was followed for the taxonomic classification of the spiders.

OBSERVATION

During the study, species were recorded, belonging to 18 families (Table 2) that represent 30 % of the total families reported from India. Most species of spiders found belonged to family Salticidae and Araenidae. *Argiope pulchella* was found to be the most abundant species in this region followed by *Nephila plipes, Plexippus paykulli, Oxyopes javanus, Herennia multipunctata* etc. Out of total spider species recorded, about 38 % were found to be web builders, 62 % were ground wanderers (Table 2). The unidentified species were properly labeled as morphospecies (1,2,3..etc,.) and photographed for identification. The pattern of web building, egg laying, egg sac, feeding, and reproduction were noticed for different species and properly recorded.

Table 2. Spider species recorded during the study. Accounts of Species

Sl. No.	Family	Species	Natural history
1.	Araneidae (Simon,1895)	*Araneus mitificus* (Simon 1886)	Orb web spider
		Argiope aemulla (Walckenaer, 1842)	Orb web spider
		Argiope pulchella (Thorell, 1881)	Orb web spider
		Cyclosa insulana (Costa, 1834)	Orb web spider
		Cyclosa sp.	Orb web spider
		Cyrtarachne sp.	Orb web spider
		Cyrtophora citricola (Forskål, 1775)	Orb web spider
		Cyrtophora feai (Thorell, 1887)	Orb web spider
		Cyrtophora moluccensis (Doleschall, 1857)	Orb web spider
		Eriophora sp.	Orb web spider
		Gasteracantha dalyi (Pocock, 1900)	Orb web spider
		Gasteracantha diadesmia (Thorell, 1887)	Orb web spider
		Gasteracantha kuhli (Koch, 1837)	Orb web spider
		Neoscona bengelensis (Tikader & Bal)	Orb web spider
		Neoscona biswasi (Bhandari & Gajbe)	Orb web spider
		Neoscona mukerjei (Tikader, 1980)	Orb web spider
		Neoscona nautical (Koch,1875)	Orb web spider
		Ordagarius sp.	Orb web spider
		Parawixia dehaani (Doleschall, 1859)	Orb web spider
		Total Araenidae:19	
2.	Corinnidae (Karsch, 1880)	*Castianiera* sp.	
		Total Corinnidae:01	
3.	Ctenizidae (Thorell, 1887)	*Morphospecies* sp.*1*	Tube dweller
		Total Ctenizidae:01	
4.	Hersiliidae (Thorell, 1870)	*Hersilia savignyi* (Lucas, 1836)	Bark Spider
		Total Hersilidae:01	
5.	Linyphiidae(Blackwall, 1859)	*Linyphia* sp.*1*	Sheet Web Spider
		Linyphia sp.*2*	Sheet Web Spider
		Total Linyphiidae:02	
6.	Lycosidae (Sundevall, 1833)	*Geolycosa urbana* (Cambrige, 1876)	Ground Dweller
		Hippasa sp.	Ground Dweller
		Lycosa mackenziei (Gravely, 1924)	Ground Dweller
		Lycosa sp.1	Ground Dweller
		Total Lycosidae:04	

7.	Nephilidae	*Herennia multipuncta* (Doleschall, 1859)	Orb Web Spider
		Nephila kuhlii (Doleschall, 1859)	Orb Web Spider
		Nephila pilipes (Fabricius,1793) IXc.1.	Orb Web Spider
		Total Nephilidae:03	
8.	Oxyopidae (Thorell, 1870)	*Oxyopes assamensis* (Tikader, 1969)	Plant Dwelling Spider
		Oxyopes birmanicus (Thorell, 1847)	Plant Dwelling Spider
		Oxyopes javanus (Thorell, 1887)	Plant Dwelling Spider
		Oxyopes lineatips (C L Koch, 1847)	Plant Dwelling Spider
		Oxyopes pankaji (Gajbe & Gajbe, 2000)	Plant Dwelling Spider
		Oxyopes rufisternum Thorell	Plant Dwelling Spider
		Oxyopes shweta (Tikader, 1970)	Plant Dwelling Spider
		Oxyopes sp.	Plant Dwelling Spider
		Total Oxyopidae:08	
9.	Pholcidae (C.L. Koch, 1851)	*Artema Atlanta* (Walckanaer, 1837)	Zunk web Spider
		Crossopriza lyoni (Blackwell, 1867)	Zunk web Spider
		Total Pholcidae:02	
10.	Pisauridae (Simon, 1890)	*Pisaura gitae* (Tikader, 1970)	Foliage Dweller
		Pisaura putiana (Barrion & Litsinger, 1995)	Foliage Dweller
		Pisaura sp. *1*	Foliage Dweller
		Thalassius albocinctus (Doleschall, 1859)	Foliage Dweller
		Total Pisauridae:04	
11.	Salticidae (Blackwell, 1841)	*Acemonea tenuipes*	Jumping spider
		Bavia sp.	Jumping spider
		*Brettus albolimbatus (*Simon, 1900)	Jumping spider
		Carrhotus viduus (Koch, 1846)	Jumping spider
		Cosmophasis umbrotica ♂ (Simon, 1903)	Jumping spider
		Cosmophasis umbrotica ♀ (Simon, 1903)	Jumping spider
		Epius indicus (Proszynski, 1992)	Jumping spider
		Hasarius adansoni (Savigny &Audwin, 1825)	Jumping spider
		Menemerus bivittatus (Dufour, 1831)	Jumping spider
		Myrmarachne mathewei (Mathew MJ, 2007)	Jumping spider
		Myrmarachne orientalis (Tikader, 1973)	Jumping spider
		Myrmarachne plataleoides (O.P.-Cambridge, 1869)	Jumping spider
		Phintella vittata (Koch, 1846)	Jumping spider
		Plexippus paykulli ♂(Audouin, 1826)	Jumping spider

		Plexippus paykulli ♀ (Audouin, 1826)	Jumping spider
		Portia assamensis (Wanless, 1978)	Jumping spider
		Rhene rubrigera (Thorell 1887)	Jumping spider
		Telamonia dimidiata ♂ (Simon, 1899)	Jumping spider
		Telamonia dimidiata ♀ (Simon, 1899)	Jumping spider
		Thiania bhamoensis (Thorell 1887)	Jumping spider
		Thiania sp.	Jumping spider
		Total Salticidae:18	
12.	Scytodidae (Blackwall, 1864)	*Scytodes thoracica* (Latreille 1802)	Ground Dweller
		Total Scytodidae:01	
13.	Sparassidae (Bertkau, 1872)	*Heteropoda venatoria* (Linnaeus 1767)	Wandering spiders
		Heteropoda nilgirina (Pocock 1901)	Wandering spiders
		Heteropoda sp.*1*	Wandering spiders
		Heteropoda sp. *2*	Wandering spiders
		Neosparassus milleti	Wandering spiders
		Neosparassus sp.	Wandering spiders
		Olios milleti (Pocock, 1901)	Wandering spiders
		Total Sparassidae:07	
14.	Tetragnathidae (Menge, 1866)	*Leucauge decorate* (Blackwall, 1864)	Orb Web Spider
		Leucauge pondae (Tikader 1970)	Orb Web Spider
		Leucauge tessellate (Thorell, 1887)	Orb Web Spider
		Leucauge venusta (Walckenaer 1842)	Orb Web Spider
		Opadometa fastigata (Simon 1877)	Orb Web Spider
		Tetragnatha mandibulata (Walckenaer 1842)	Orb Web Spider
		Tetragnatha viridorufa (Gravely 1921)	Orb Web Spider
		Tylorida striata ,P Sebestian	Orb Web Spider
		Total Tetragnathidae:08	
15.	Theraphosidae (Thorell, 1870)	*Morphospecies* sp.*1*	Tube dweller
		Morphospecies sp.*2*	Tube dweller
		Morphospecies sp.*3*	Tube dweller
		Total Theraposidae:03	
16.	Theridiidae (Sundevall, 1833)	*Chrysso nigra* (Cambridge,1880)	Leaf Dweller
		Chrysso pulcherrimus (Mello-Leitas 1917)	Leaf Dweller
		Steatoda sp.	Leaf Dweller
		Total Theridiidae:03	
17.	Thomisidae (Sundevall, 1833)	*Amyciaea forticeps* (Cambridge, 1873)	Foliage Dweller

		Camaricus formosus (Thorell 1887)	Foliage Dweller
		Misumena vatia	Foliage Dweller
		Oxytate sp.	Foliage Dweller
		Oxytate virens (Thorell 1891)	Foliage Dweller
		Thomisus lobosus (Tikader, 1965	Foliage Dweller
		Thomisus projectus (Tikader 1960)	Foliage Dweller
		Xysticus minutes (Tikader 1960)	Foliage Dweller
		Total Thomisidae:08	
18.	Uloboridae (Thorell, 1869)	*Uloborus danolius* (Tikader 1960)	Orb web spider
		Zosis sp. *1*	Orb web spider
		Total Uloboridae:02	
	Total Families: 18	*Total Genera:* 56 *Total Species:* 95	

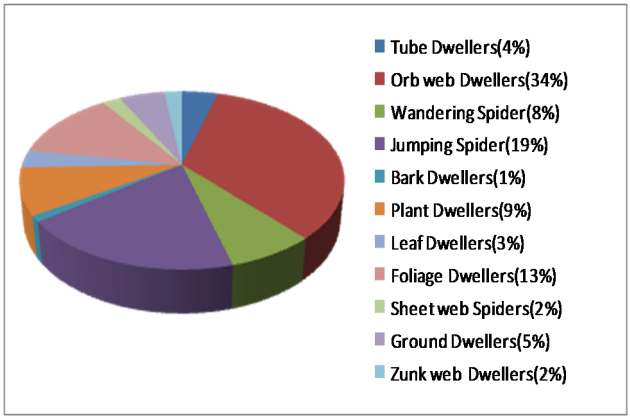

Figure 3. Comparative density (percentage) of spiders recorded during the study.

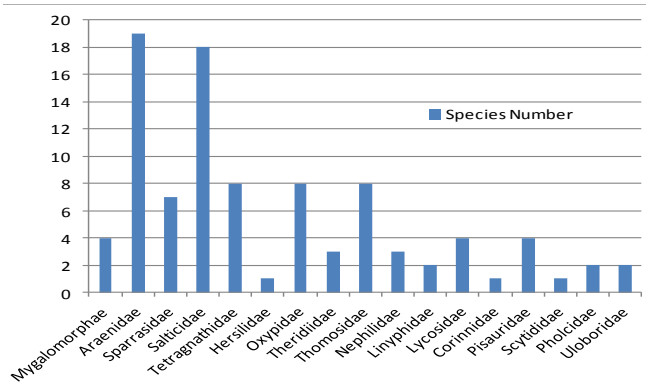

Figure 4. Graph of spiders and their numbers recorded during the study.

RESULTS

The spider fauna of India is represented by 1520 spider species belonging to 377 genera and 60 families (Sebastian and Peter 2009). The study represents 18 families, 56 genera and 95 species arranged on their foraging behavior in the field (Uetz *et al.,* 1999). The distribution of some families was found to be continuous (Araenidae, Salticidae, Tetragnathidae etc), while some had very discontinuous distribution.Coloration in spiders varies extensively among the species due to different environmental effects which also is due to different behavioral pattern observed on them (Oxford & Gillespie 1998; Craig & Ebert 1994; Hauber, 2002; Tso *et al.,* 2004, 2006,2007; Hoese *et al.,* 2006; Vaclav & Prokop 2006).

Family diversity: Araenidae (19 species) and Salticidae (18 species) occupy maximum number of species where Tetragnathidae (8 species), Oxypidae (8 species), Thomisidae (8 species), Sparrasidae (7 species) covers the middle order of species diversity. Mygalomorphae (4 species), Lycosidae (4 species), Pisauridae (4 species), Theridiidae (3 species), Nephilidae (3 species), Linyphidae (2 species), Pholcidae (2 Species), Uloboridae (2 species) with Hersilidae (1 species), Corinnidae (1 species) and Scytodidae (1 species) counts with only few species during the study.

Generic diversity

India represents 377 genera (Sebastian and Peter 2009) from which 56 genera were recorded in Gibbon Wildlife Sanctuary during the study. Highest generic diversity is found in Salticidae (15), Araenidae (10), Thomisidae (6) and Tetragnathidae (4). The number of genera is higher than those in Andaman & Nicobar Islands - 33 (Tikader, 1970), Sikkim - 41 (Tikader, 1977) and Calcutta - 47 (Tikader, 1981). All the genera were cited from different parts of India (Tikader, 1970, 1977, 1981, 1982, 1987; Biswas, 1981) but no proper distribution was recorded from Assam. So, all the genera are the first records from Assam, India.

Species richness

India accounts with 1520 spider species and 95 species were recorded from Gibbon Wildlife Sanctuary in 19.49 sq.km. area during the study. This record is high compared with other records like Andaman and Nicobar islands (65 species), Sikkim (55 species) and Calcutta (99 species), (Tikader, 1970, 1977 ; Tikader & Biswas,1981).

Endemism

Among the 95 species recorded *Gasteracantha dalyi, Myrmarachne orientalis, Olios milleti* are endemic to South Asia. *Neoscona bengalensis, Neoscona biswasi, Neoscona mukherjei, Oxyopes assamensis, Oxyopes*

Plate 1: Some of the Spider species observed during the study

Figure 5. Spiders of the family Theraposidae (unidentified)

Figure 6. Aranidae (From left- *Ordagarius* sp., *Gasteracantha kuhlii, Cyrtarachne* sp., *Cyrtophora moluccensis, Gasteracantha dalyi, Eriphora* sp.)

Figure 7. Sparassidae: (From left- *Heteropoda venatoria, Heteropoda* sp.1 & 2)

Plate 2: Some of the Spider species observed during the study

Figure 8. Spiders of the family Salticidae (From left- *Myrmachne orientalis, Phintella vitatta, Epius indicus* and *Thiania bhamoensis*)

Figure 9. Hersilidae (*Hersilia savignyi*); Nephilidae (*Nephila plipes, Herennia multipuncta*, *Nephila kuhli*)

Figure 10. From left- Thomisidae (*Amyciaea forticeps, Oxytate* sp., *Misumena vatia*), Theridiidae (*Steatoda* sp.),Tetragnathidae (*Leucauge* sp., *Leucauge decorata*).

pankaji, Pisaura gitae, Epeus indicus, Heteropoda nilgirina, Leucauge pondae, Tetragnatha viridorufa, Misumena vatia, Thomisus lobosus, Thomisus projectus, Xysticus minutes and Uloborus denolius are endemic to India.

Affinities

The spiders recorded from Gibbon wildlife sanctuary show affinities with pantropical, paleotropical, holarctic, palearctic and cosmotropical regions.The species having affinities with paleotropical region is *Leucauge decorata* (Tetragnathidae), pantropical *Heteropoda venatoria* (Sparassidae), *Menemerus bivittatus* (Salticidae), *Artema atlanta* (Pholcidae), holarctic *Scytodes thoracica* (Scytodidae), palearctic *Oxyopes lineatus* (Oxyopidae) and cosmotropical *Neoscona nautica* (Araenidae). *Gasteracantha geminata* (Araenidae), *Asemonea tenuipes, Myrmarachne plataleoides (*Salticidae*)* and *Olios milleti (*Sprassidae*)* shows affinities with the species of Sri Lanka.

CONCLUSION

Study on spiders is completely untouched in Assam, Northeast India. Checklist or records to these spiders are not yet prepared. Thus the study is the baseline information over the ecology, importance and the threats faced by the spider species. The rich floral and faunal diversity in the Sanctuary is the key to build the microhabitats of different species. Structurally more complex herbs and shrubs can support a more diverse spider community (Uetz, 1991). The study will also help to work for the conservation of the species and specify the hidden benefits in them. Thomisids, Oxyopids, Salticides, Uloborids, Tetragnathids etc., are some of the expert silent predators in the tea and paddy ecosystems that are seen feeding on small insects like moths, butterflies, beetles, aphids, hoppers etc. (Ford, 1977, Rypstra and Carter 1995). They are maintaining ecological equilibrium by suppressing insect pest (Hazarika, L.K. and Chakraborti, S.K. 1998). Thus efforts can be laid to rear spiders and use them as biocontrolling media upon necessary. The pesticides used in the tea plantation are seen to be a death factor of the spiders that resides in or around the tea plantations. Highly fragmented territory of the spiders acts as a barrier for dispersal form one compartment to the other around the sanctuary (Bonte *et al*., 2004). It is also seen that adaptation to the various environment has facilitated them to survive in broad functional groups.

While lack of information in ecology and taxonomy of Indian Spiders however lowers the use of spiders as indicators species (Kapoor, 2008; Noss, 1990). Certain factors like distribution and relationship of them to the various habitats, and its responses to the different disturbance made difficult, using them as indicator species. The study shows information related to the species distribution in a particular habitat with response to environment, disturbance, and availability of food.

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