

## **Spiders of Taleigao Plateau, Goa, India**

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### **Abstract**

Spiders have utilitarian value. The present study is the first comprehensive documentation of the spider fauna from the Taleigao plateau, Goa, India and has revealed occurrence of 74 species of spiders belonging to 17 families. The investigation was carried out for 8 months from July 2016 to February 2017. Through this research, some new families, genera and species were reported for Goa, some of which are endemic to India. The methods included active searching and visual surveys. Salticids were the most dominant and diverse group of spiders in the study, yet it is one of the least studied families in India. The spiders such as *Hersilia savignyi*, *Plexippus petersi* were the predominant species of spiders in the study area. The spiders belonged to 9 foraging guilds. The present study has emphasized the need for conservation of this ecosystem by characterizing species diversity and highlighting endemic species. It has definitely filled the lacuna of spider study in Goa to some extent and forms a basis for further investigations on the spider diversity in the areas in and around the state. Future research on the spiders of Taleigao plateau can certainly expect innumerable discoveries.

**Keywords:** Spiders; Plateau; India; Endemic; Dominant; Diverse; Guilds; Conservation

### **1. Introduction**

Class Arachnida of Phylum Arthropoda includes air breathing arthropods, with their head and thorax usually fused together, forming a cephalothorax which is provided with four pairs of legs and lack wings and antennae [1]. Today, class Arachnida comprises of 11 orders and approximately 640 families, 9000 genera and 93,000 described species

[1, 2]. Spiders (Order Araneae) are the largest order of Arachnids and rank seventh in total species diversity among all other groups of organisms. They are ancient animals with a history going back over 350 million years [3].

Spiders represent one of the most important components of global biodiversity. They are abundant and widespread in almost all ecosystems and play a significant role in ecology by being exclusively predatory thereby maintaining the ecological equilibrium. Spiders are also 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 [3]. The ubiquity, diversity and ecological role of spiders make them a promising focal group [4]. However, despite their fundamental roles in most natural ecosystem, they have largely been ignored in conservational studies.

The current world list of spiders includes 46,879 species under 4062 genera distributed over 112 families [5]. The final count in India is represented by 1686 species belonging to 438 genera of 61 families [6, 7], while from Goa 39 species contained in 28 genera from 10 families were last reported [8].

Spiders are extremely abundant throughout the country, but the knowledge of the Indian spiders is extremely fragmentary [9]. Western Ghats region is one of the regions rich in biodiversity and endemic species and has been internationally recognized as a biodiversity hotspot. Spiders being a less charismatic species and due the scarcity of biologists studying spiders, research on the spiders of India in general and Western Ghats in particular remain scant.

The present study was carried out on Taleigao plateau, Goa. Goa is a unique region characterized by the coastal belt, but also owing its uniqueness to large laterite and basaltic plateaus on the mountain crests of Western Ghats. Earlier floristic surveys revealed that the plateaus in Goa harbor the largest number of endemic plant species of the Western Ghats, especially herbs [10]. However, no work has been done on the fauna of this region except for avifaunal studies [11, 12]. All the same, most of the plateaus in the region are already ecologically dabbled, without any prior serious environmental impact assessment.

## **2. Materials and Methodology**

### **2.1 Study area**

The present study was conducted for 8 months, i.e. from July 2016 - February 2017 on Taleigao Plateau with geographical location between 15° 27'15"N and 17° 50'00"E (Figure 1). The plateau is about 8 km from Panjim, capital city of Goa. It is an east west trending lateritic table land spread over an area of approximately 296ha. Most of it is occupied by many semi / Government establishments and residential tenements. Its central zone houses the Goa University campus spanning 173ha of the total area. Vegetation mainly consisted of moist deciduous type mixed with evergreen species. Extensive patches of grasslands on the lateritic rocky outcrops are interspersed by large thickets of shrubs and trees.

Taleigao being in the tropical zone and near the Arabian sea the climate is warm and humid for most of the year, with atmospheric temperatures ranging from 21 to 37<sup>0</sup>C. The humidity ranges from 60 to 95%.



**Figure 1:** Study area.

## 2.2 Collection and preservation of sample

For the study, spiders were looked for in a variety of habitats in the plateau such as human dwellings, buildings, gardens, fallow land and around water bodies like ponds, tanks and the intertidal rocky shore. Specimens were also looked for under stones and loose bark, in leaf litter and flowers.

Methods included-visual searching for the spiders as far distinct vision is possible. Pitfall trapping was used to trap all possible spiders moving in that area. Ground search-hand collection, was done under leaf litter, fallen or dry wood whereas some spiders were hand collected. Sweep netting was done for the foliage dwelling spiders covering the herbs and shrubs in the area. Beating trap was done with a wooden stick and an inverted umbrella placed under the trees to catch the spiders which were unable to reach or seen hanging above. Vegetation beating and litter sampling were among the other methods.

When a spider was located, it was photographed in its microhabitat with Canon EOS 500D, 18-55 mm lens, with attached magnifying lenses. The spiders were captured in airtight plastic collection containers, and then were preserved in storage containers with 70% ethanol. Spiders were picked and transferred using forceps. Feather weight forceps were preferred to reduce damage (Photos 1-9).

## 2.3 Identification

The spiders were examined under a binocular microscope and identified with the help of identification keys by [13, 14], online literature and other resources. The taxonomy and nomenclature followed is as per the world spider catalogue [5].



**Photos 1: Araneidae:** *Argiope anasuja*, *Neoscona mukerjei*, *Nephila kuhlii*, *Telacantha* sp.



**Photos 2: Corinnidae:** *Castianeira zetes*, **Ctenidae:** *Ctenus* sp., **Gnaphosidae:** *Zelotes* sp., **Hersiliidae:** *Hersilia savignyi*.



**Photos 3: Lycosidae:** *Hippasa agelenoides*, *Hippasa pisaurina*.



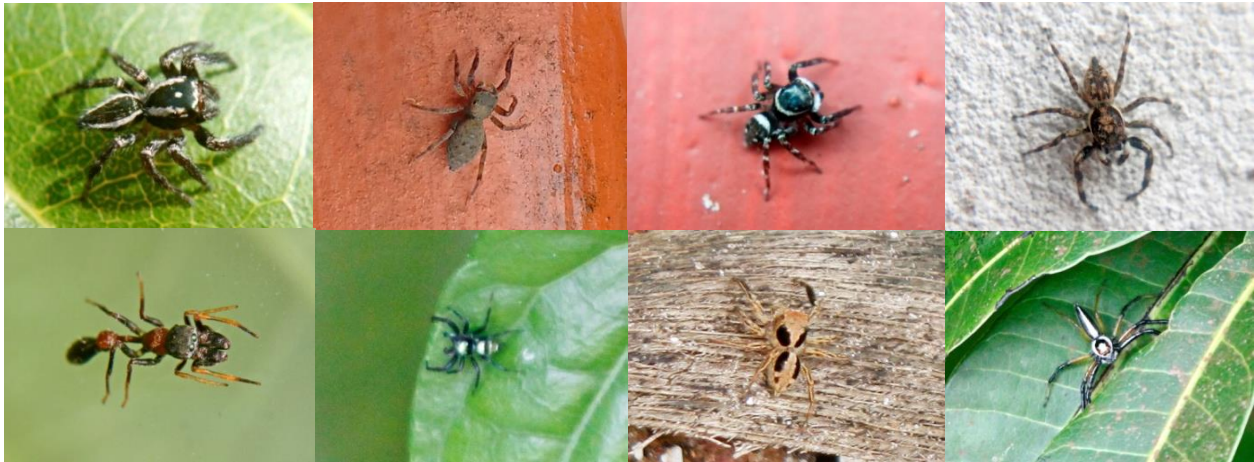
**Photos 4: Oxyopidae:** *Oxyopes birmanicus*, *Oxyopes javanus*, *Oxyops shweta*.



**Photos 5: Pholcidae:** *Artema atlanta*, *Crossopriza lyoni*.



**Photos 6:** Pisauridae: *Dendrolycosa gitae*, Psecheridae: *Psechrus* sp.



**Photos 7:** Salticidae: *Carrhotus viduus*, *Cyrbia ocellata*, *Hasarius adansoni*, *Menemerus bivittatus*, *Myrmarachne melanocephala*, *Phintella vittata*, *Plexippus petersi*, *Telamonia dimidiata*.



**Photos 8:** Sparassidae: *Heteropoda* sp., *Olios* sp., Tetragnathidae: *Leucauge decorata*, *Tetragnatha* sp.



**Photos 9:** Theraphosidae: *Poecilotheria regalis*, Theridiidae: *Achaearanea durgae*, Thomisidae: *Thomisus spectabilis*, Uloboridae: *Uloborus* sp.

### 3. Result

In this present study, a total of 74 species of spiders belonging to 44 genera distributed over 17 families were recorded (Table 1). It was surprising to find that the work covered only a small region, i.e. the Taleigao plateau with different sub-habitats, in the whole of Goa which is the smallest state of India, and has got the diversity that is 4.38% of Indian spiders.

Sr.No.	Family	Spider Fauna Genus/Species	Guild
1	Araneidae	1. <i>Araneus</i> sp.	Orb Web Weavers
		2. <i>Argiope anasuja</i> (Thorell, 1887)	Orb Web Weavers
		3. <i>Argiope pulchella</i> (Thorell, 1881)	Orb Web Weavers
		4. <i>Cyclosa spirifera</i> (Simon, 1889)	Orb Web Weavers
		5. <i>Cyclosa</i> sp.	Orb Web Weavers
		6. <i>Cyrtophora cicatrosa</i> (Stoliczka, 1869)	Orb Web Weavers
		7. <i>Eriovixia</i> sp.	Orb Web Weavers
		8. <i>Herennia multipuncta</i> (Doleschall, 1859)	Orb Web Weavers
		9. <i>Larinia</i> sp.	Orb Web Weavers
		10. <i>Neoscona bengalensis</i> (Tikader and Bal, 1981)	Orb Web Weavers
		11. <i>Neoscona muckerjei</i> (Tikader, 1980)	Orb Web Weavers
		12. <i>Neoscona theisi</i> (Walckenaer, 1906)	Orb Web Weavers
		13. <i>Neoscona</i> sp.	Orb Web Weavers
		14. <i>Nephila kuhlii</i> (Doleschall, 1859)	Orb Web Weavers
		15. <i>Nephila maculata</i> (Simon, 1901)	Orb Web Weavers
		16. <i>Thelacantha</i> sp.	Orb Web Weavers
2	Corinnidae	17. <i>Castianeira zetes</i> (Simon, 1897)	Ground runners
3	Ctenidae	18. <i>Ctenus</i> sp.	Other hunters
4	Gnaphosidae	19. <i>Zelotes</i> sp.	Ground runners
5	Hersiliidae	20. <i>Hersilia savignyi</i> (Lucas, 1836)	Foliage runners
6	Lycosidae	21. <i>Hippasa agelenoides</i> (Simon, 1884)	Ground runners
		22. <i>Hippasa greenalliae</i> (Blackwall, 1867)	Ground runners
		23. <i>Hippasa pisaurina</i> (Pocock, 1900)	Ground runners
		24. <i>Pardosa</i> sp. 1	Ground runners
		25. <i>Pardosa</i> sp. 2	Ground runners
7	Oxyopidae	26. <i>Oxyopes birmanicus</i> (Thorell, 1887)	Stalkers
		27. <i>Oxyopes javanus</i> (Thorell, 1887)	Stalkers
		28. <i>Oxyopes shweta</i> (Tikader, 1970)	Stalkers
		29. <i>Oxyopes</i> sp. 1	Stalkers

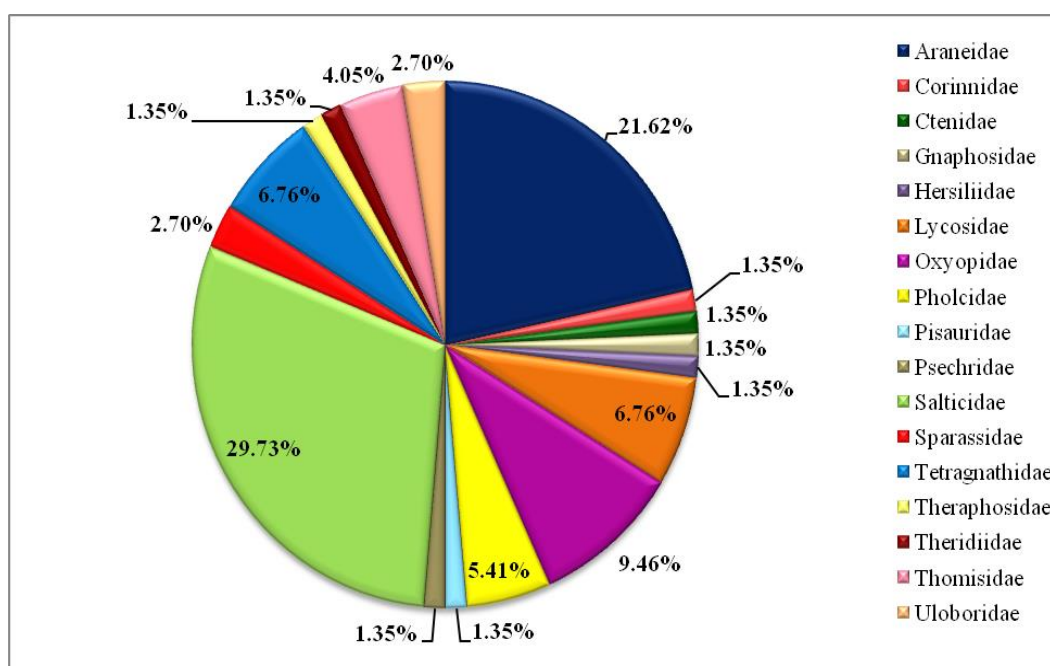
		30. <i>Oxyopes</i> sp. 2	Stalkers
		31. <i>Oxyopes</i> sp. 3	Stalkers
		32. <i>Oxyopes</i> sp. 4	Stalkers
8	Pholcidae	33. <i>Artema atlanta</i> (Walckenaer, 1837)	Space web builders
		34. <i>Crossopriza lyoni</i> (Blackwall, 1867)	Space web builders
		35. <i>Pholcus phalangioides</i> (Fuesslin, 1775)	Space web builders
		36. <i>Pholcus</i> sp.	Space web builders
9	Pisauridae	37. <i>Dendrolycosa gitae</i> (Tikader, 1970)	Ambushers
10	Psechridae	38. <i>Psechrus</i> sp.	Sheet web weavers
11	Salticidae	39. <i>Carrhotus viduus</i> (C.L. Koch, 1846)	Stalkers
		40. <i>Cyrba ocellata</i> (Kroneberg, 1875)	Stalkers
		41. <i>Cyrba</i> sp.	Stalkers
		42. <i>Hasarius adansoni</i> (Audouin, 1826)	Stalkers
		43. <i>Hyllus semicupreus</i> (Simon, 1885)	Stalkers
		44. <i>Langona</i> sp.	Stalkers
		45. <i>Menemerus bivittatus</i> (Dufour, 1831)	Stalkers
		46. <i>Menemerus</i> sp. 1	Stalkers
		47. <i>Menemerus</i> sp. 2	Stalkers
		48. <i>Menemerus</i> sp. 3	Stalkers
		49. <i>Menemerus</i> sp. 4	Stalkers
		50. <i>Menemerus</i> sp. 5	Stalkers
		51. <i>Myrmarachne melanocephala</i> (MacLeay, 1839)	Stalkers
		52. <i>Phintella vittata</i> (C.L. Koch, 1846)	Stalkers
		53. <i>Phintella</i> sp.	Stalkers
		54. <i>Plexippus paykulli</i> (Audouin, 1826)	Stalkers
		55. <i>Plexippus petersi</i> (Karsch, 1878)	Stalkers
		56. <i>Plexippus</i> sp. 1	Stalkers
		57. <i>Plexippus</i> sp. 2	Stalkers
		58. <i>Plexippus</i> sp. 3	Stalkers
		59. <i>Stenaelurillus</i> sp.	Stalkers
		60. <i>Telamonia dimidiata</i> (Simon, 1899)	Stalkers
12	Sparassidae	61. <i>Heteropoda</i> sp.	Foliage runners
		62. <i>Olios</i> sp.	Foliage runners
13	Tetragnathidae	63. <i>Leucauge decorata</i> (Blackwall, 1864)	Orb Web Weavers
		64. <i>Leucauge</i> sp.	Orb Web Weavers

		65. <i>Tetragnatha</i> sp. 1	Orb Web Weavers
		66. <i>Tetragnatha</i> sp. 2	Orb Web Weavers
		67. <i>Tylorida</i> sp.	Orb Web Weavers
14	Theraphosidae	68. <i>Poecilotheria regalis</i> (Pocock, 1899)	Sensing web weavers
15	Theridiidae	69. <i>Achaearanea durgae</i> (Tikader, 1970)	Space web builders
16	Thomisidae	70. <i>Stiphropus</i> sp.	Ambushers
		71. <i>Synema</i> sp.	Ambushers
		72. <i>Thomisus spectabilis</i> (Doleschall, 1859)	Ambushers
17	Uloboridae	73. <i>Uloborus</i> sp. 1	Orb Web Weavers
		74. <i>Uloborus</i> sp. 2	Orb Web Weavers

**Table 1:** A complete checklist of spiders obtained during the study on Taleigao Plateau.

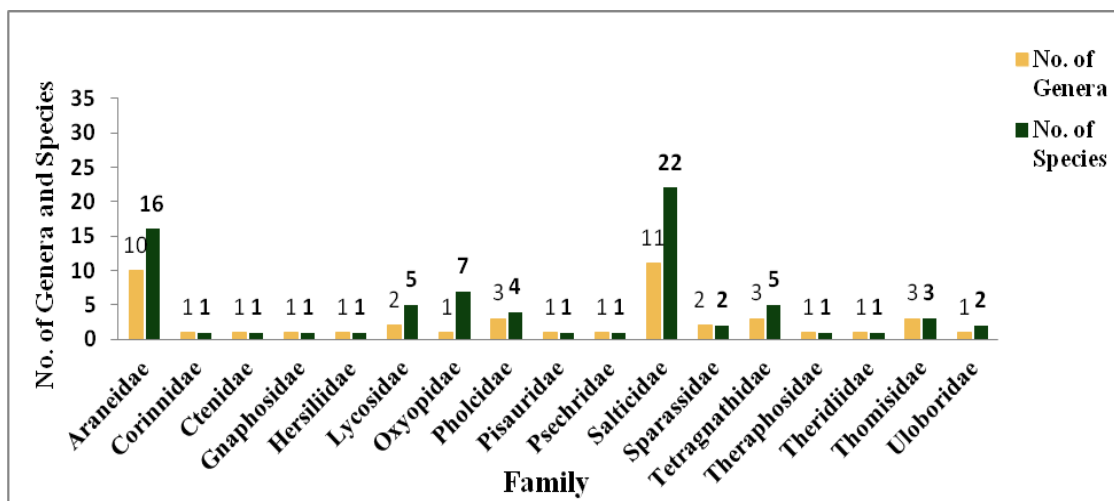
### 3.1 Family diversity

17 families were reported representing 27.9% of 61 families in India. The most dominant family recorded during the present research was Salticidae followed by Araneidae. The least number of species was recorded in families Corinnidae, Ctenidae, Hersiliidae, Pisauridae, Psechridae and Theraphosidae (Graph 1).



**Graph 1:** Percentile distribution of spider families.





**Graph 2:** Comparative distribution of generic and species diversity of spiders in different families.

### 3.2 Generic diversity

India represents 438 genera from which 44 genera were recorded during the study. This accounts for 10.04% of the genera found in India. Highest generic diversity was found in Salticidae (11), Araneidae (10), Tetragnathidae (3), Pholcidae (3), Thomisidae (3), Lycosidae (2), Sparassidae (2), and Corinnidae, Ctenidae, Hersiliidae, Gnaphosidae, Oxyopidae, Pisauridae, Psechridae, Theraphosidae, Theridiidae, Uloboridae were with 1 genera each (Graph 2). The number of genera is higher than those in, Sikkim-33 [15] and Andaman and Nicobar Island-41 [16].

### 3.3 Species diversity

Though India accounts with 1686 species of spiders, present report of 74 species recorded from the 296 ha area surveyed, accounts for 4.38% of reported Indian spider species, which is quite high (Graph 2). Maximum richness was observed with respect to species *Hersilia savignyi*, *Oxyopes javanus*, *Artema atlanta*, *Hasarius adansoni*, *Menemerus bivittatus*, *Plexippus paykulli* and *Plexippus petersi*.

### 3.4 Endemism

A total of 252 endemic species of spiders are reported from India so far [17]. Among the 74 species, on the Taleigao plateau, 5 species, *Cyclosa spirifera*, *Neoscona bengalensis*, *Neoscona mukerjei*, *Achaearanea durgae* and *Poecilotheria regalis* are endemic to India whereas *Argiope anasuja*, *Castianeira zetes*, *Hyllus semicupreus* are endemic to South Asia. *Crossopriza lyoni*, *Pholcus phalangioides*, *Hasarius adansoni*, *Plexippus paykulli* are cosmopolitan and the remaining spiders are mostly endemic to South East Asia and to the Continent Asia.

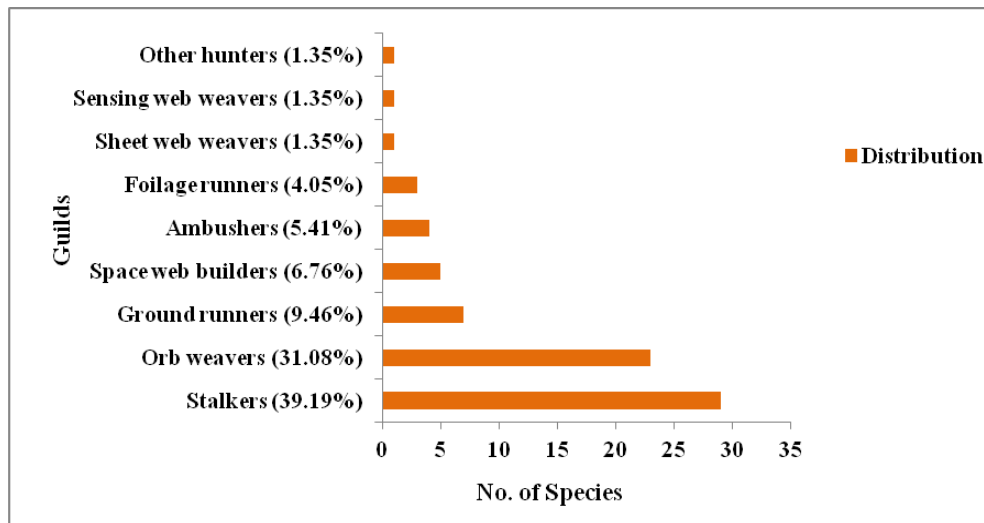
### 3.5 New record of a primitive spider for the state

So far from Goa, only one family viz., Theraphosidae under suborder Mygalomorphae has been reported [8]. But, during the present investigations another member viz., *Poecilotheria regalis*, which happens to be a new record for

the state of Goa was recorded. Earlier reports indicate that, this species was found in Kerala, Karnataka and Tamil Nadu [18].

### 3.6 Guild Classification

The spider guild classification was composed according to the families reported during the study. The spiders were classified into 9 ecological guilds based on their foraging mode (Graph 3).



**Graph 3:** Guild structure of spiders.

## 4. Discussion

In the study of spider diversity in Taleigao which lasted for just 8 months, it was attention grabbing to find various types of spiders flourishing in this small area with 27.9 % of spider families and 4.38 % spider species. Nearly 88 % of all the species recorded through this work, for the Taleigao plateau, are new additions to the checklist of the state over the earlier report [8].

The high diversity was found to be mainly due to the habitat and the environment. Taleigao plateau is endowed with different types of habitats and comprises of dense vegetation with splendid variety of flora and fauna. The diversity of spider indicates the presence of its associates especially insects. Insects are the main prey base for spiders [19]. The rich floral and faunal diversity is the key to build the microhabitat of different species of spiders [3].

Vegetation architecture also plays a major role in the species composition found within a habitat [20, 21, 22] and vegetation which is structurally more complex can sustain higher abundance and diversity of spiders [23, 22]. Hence complex vegetation and structural diversity on the plateau explain the occurrence of different guild structures. The various guilds also provide an understanding of disturbances and habitat modification on spiders.

Humidity and temperature affects the distribution of spiders as it influences the growth, development and activity [24, 25]. Since spiders normally have preferences on humidity and temperature [26, 25], these factors limit them to

areas within the range of their physiological tolerances. The high rate of transpiration by plants on the plateau area makes the atmosphere humid. Because of this complex interaction of various climatic factors like rainfall, temperature, availability of water source nearby, this area holds many smaller but diverse environmental niches.

Canopy and litter in some areas of the plateau additionally offer greater survival opportunities in the form of ecological niches. The plateau thus offers arthropods appropriate environment with favorable factors that support the rich spider diversity of the plateau. On this account, the study establishes that diversity normally increases when a greater variety of habitat types are present [27, 25] and the physical structure and species composition of vegetation define diversity of species and abundance through habitat availability [28, 25].

## 5. Conclusion

Taxonomy of spiders is an ambiguous area and consolidated data is lacking. Insufficient information in ecology and taxonomy of Indian spiders lowers the use of spiders as indicators species [29, 30]. Spiders of Goa are not studied enough with an extensive account of spider fauna being unavailable. This research has yielded new records of families, genera and species of spiders for the state of Goa. Several species of spiders are photographed for the first time in Goa and this digital data will be useful for the studies in future.

The investigation has thus proved to be invaluable as it has helped in creating a database bank, for holding information regarding distribution and diversity of these species, serving as baseline information to the ecology and the importance of spiders of this area. At the same time, the study has also shown that the Taleigao plateau habitat with its favorable vegetation and climate provides an ideal location for the growth and diversity of spiders. But the current development trend on the plateau can destroy the original lateritic mosaic. Therefore, documenting the spider diversity pattern on this plateau has provided data to justify the conservation of this ecosystem, as spiders are sensitive and are easily affected due to habitat damage resulting from anthropogenic activities.

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