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Studies on diversity of spider fauna in rice agro-ecosystem in mid-hills of Meghalaya

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Abstract
The present study was conducted to document spider diversity in the rice field in the mid-hills of Meghalaya. The study was conducted from July to October 2018. A total of 731 numbers of individuals falling under 41 species belonging to 23 genera from 10 families were identified from the rice field during the study period. Araneidae was the most dominant family represented by 6 genera with 16 species, followed by the family Lycosidae represented by 2 genera with 4 species. The third largest family was Oxyopidae which was represented by a single genus with 3 species. A guild structure analysis of the spiders revealed six feeding guilds such as orb web weavers, stalkers, ground runners, space web builders, ambushers and foliage runners. The dominant guild was orb web weavers.

Keywords: guild structure, ambushers, araneidae, orb web weavers

Introduction
Spiders belong to the phylum Arthropoda, animal with hard exoskeleton and jointed appendages. They belong to the class Arachnida and order, Aranaeae. Spiders are one of the most diverse groups of arthropods. Next to mites, they are the second most diverse arachnids [1]. Spiders are the most omnipresent and numerous predators both in natural and agro-ecosystem [2]. In the rice ecosystem, spider is playing an important role as a predator as they are efficient in reducing the population of plant hoppers and leaf hoppers. Biological control through spiders is one of the best methods to reduce the use of harmful chemical pesticides as well as insect-pests population [3]. In addition to killing pests, these chemicals are also taking a heavy toll on useful insects. Preservation of spiders necessitates abandoning of these pesticides, or spot treatment and rational use of the same. Once pesticides are kept away from the fields, spiders invariably take shelter in the fields, feed on the pests and add to the productivity. Spiders have always been known to be effective predators, though their potential as bio-control agents has not been exploited to its fullest, at least in India. In recent years, the utilization of spiders in biological control is getting more importance as the spiders have much character which suits them to be a successful predator [4]. Having a detailed idea of spiders is valuable to know their effects on herbivorous pests [5] and also to understand their colonization to environmental changes [6]. Spiders study in rice field is highly valuable because it helps to observe the effect of these predators on herbivores pest and to understand how profound changes on the environment affect spider diversity. No specific extensive studies on spider fauna diversity in this region was done and published. It is the first approach in this region, to study the spider fauna. Therefore, a study was conducted on the diversity of spiders to provide base line information for future studies as an important biological control agent in the integrated pest management.

Materials and Methods
The investigation was carried out at the Experimental farm of the College of Post- Graduate Studies in Agricultural Sciences (CPGS-AS), CAU (Imphal), Umiam, Ri-Bhoi district. The experimental site is situated at 25°40.886' N latitude and 91°54.72' E longitude and an altitude of 1010 m above the mean sea level (MSL). The investigation was carried out for a period of four months starting from July and continued up to October 2018.

Sampling methods

To develop a package of methods of quantitative sampling of spiders, collections were made using different methods *viz*., visual search through hand picking and use of sweep nets, trapping using pitfall traps, rubbish traps and using aspirator. The plot was divided into 100 quadrats measuring 10 m × 10m. Five such quadrats were chosen each at four corners and one in the middle. In each of the quadrats five pitfall traps were installed and the entire plot was covered during the sampling period.

Collecting devices

Active searching

Active searching was done in the early morning or evening hours. Each quadrat was selected at random and the ground, shrubs, and leaf litters were thoroughly searched for spiders. Possible webs were thoroughly examined on different parts of the plant from bottom to top. Spiders were collected either using the hand or jar technique.

Sweeping

Standard sweeping method was done using a sweep net of dimension, 0.6m in diameter with a handle of 1.2m long. Sweep netting was done by sweeping through aerial plant parts and grasses. Each sweep covered an arc of 1.5 m approximately through the vegetation on every alternate step. Each transect was chosen from the centre and the path that allowed uninterrupted sweeping was chosen. The contents of these sweep nets were transferred to a collection bottle containing a little amount of 70% ethyl alcohol and the contents were sorted on the same day. Spiders and other arthropods were separated from vegetation.

Pitfall trapping

This method was adopted mainly for collection of ground dwelling arthropods like spiders, insects etc. Pitfall traps were set out using a plastic container (15 cm height and 10cm width) dug into the soil to a depth of 20 cm. Five pitfall traps were placed in four corners and one in the centre of chosen 10m×10 m quadrats. The traps were set up between early morning and evening hours and specimens were collected the next morning. Soap solution were kept in the traps as trapping fluid and changed after every week.

Rubbish traps

These traps were made by using chicken wire mesh, stuffed with leaf litter. Five rubbish traps were placed in each of the randomly chosen 10×10 m quadrats. The traps were placed in the field allowing a week for arthropods to take up residence. Once in seven days, these traps were removed and brought to the laboratory and arthropods found inside were collected.

Preservation and Identification of spiders: Preservation was done using 70 percent ethyl alcohol (70 parts of 100 percent alcohol + 30 parts of distilled water) in glass vials. For spiderlings, preservation was done using Oudeman's fluid (85 parts of 70% alcohol+ 5 parts glycerine+ 8 parts GAA+ 2 parts distilled water). Preserved specimens were examined under a stereo zoom microscope in the laboratory. Spiders were identified with the help of Dr. Manju Siliwal, Arachnologist at Wildlife Institute of India, Dehradun.

Results and Discussions

A total of 731 individuals belonging to 41 species, 23 genera and 10 families were collected during the study period. Checklist of spiders recorded is shown in Table 1. Under this order, Araneidae was the most dominant family (31.5%), followed by Lycosidae (24.5%) and oxyopidae (14.6%) as shown in Fig.1. Araneidae was the most species dominant family represented by 6 genera with 16 species, of which *Argiope* was the most dominant genus with the maximum number of individual belonging to *Argiope pulchella* (Table 3). A study was conducted on spider abundance in Kuttanad rice agroecosystem, Kerala, who reported that Araneidae was the most dominant family with 17 numbers of species [7]. Another study in Jambughoda Wildlife Sanctuary, Panchmahal District, Gujarat, India recorded 138 spider species belonging to 90 genera and 29 families of which, the most dominant family was Araneidae (26 species) [8]. Araneidae is a large cosmopolitan family commonly known as orb weavers. The family exhibits a wide variation in size, colour, shape and behaviour. Genus *Argiope* is characterised by the presence of stabilimenta. Their web contains a large white zigzag structure in its centre called the stabilimentum and it reflects UV light. They have been shown to play a role in attracting prey to the web, and possibly to prevent its destruction by large animals [9]. Abundance of *Argiope* species was found in the later stages of the crop growth as they are true orb weavers that require sufficient growth of the plant to build the web for catching prey. Another study of spider diversity from Vadnagar taluka, Gujarat reported 75 species belonging to 51 genera spread over 19 families and Araneidae was the most dominant family [10]. Family Lycosidae was represented by two genera namely *Lycosa* and *Pardosa* (Table 1) and *Lycosa sp.* (72) was most abundantly found species and these species are found to be more prevalent in nursery stage. The strong dominance of Lycosidae on the ground may partly be attributed to the extensive use of pitfalls as a sampling method. It has been found that pitfalls overestimate the relative abundance of this family, particularly in spring and summer [11]. Oxyopidae was third dominant family and represented by single genus with three species and *Oxyopes sp*. was most occurring species with 53 individuals (Table 3). Family Tetragnathidae was represented by three genera *viz*., Tetragnatha (38) and *Guizygiella* (15) and Tylorida (8) as shown in Table 3. Salticidae was represented by 4 genera and *Phintella sp*. was the most dominant species. Salticidae, are active hunting spiders capable of jumping over a distance. They are diurnal in activities. They move by walking, running, jumping or leaping and use all these movements in prey capture. They hunt the prey by stalking, chasing and leaping over it. Prey includes mainly insects. Aggressive mimicry has also been shown by some salticids and do not use web for prey capture [12]. Thomisidae was represented by three genera, of which *Oxytate sp*. was the most abundant species with 14 numbers of individuals. Four families *viz*., Uloboridae, Theridiidae, Clubionidae and Mimetidae were recorded with a single genus each (Table1). Ursani and Soomro also studied and updated the checklist of the spider fauna in Sindh province, Pakistan and reported 132 species belonging to 24 families and 73 genera and families Uloboridae and Clubionidae were represented by only a single species [13]. Another study was conducted on the diversity of spiders in Kavvayi river basin and recorded 112 species belonging to 81 genera and 21 families [14]. Similarly, More reported the first record of diversity of spiders from Zolambi region of Chandoli National Park in Western Ghats. A total of 90 species belonging to 55

genera and 19 families were recorded from the study area during 2011- 2013 with a dominance of Araneid, Salticid and Lycosid spiders [15]. Likewise, Araneidae was reported as dominant family followed by Lycosidae, Linyphiidae, Pholcidae, Salticidae [16]. Similarly a study was conducted on Diversity and distribution of spider fauna in arid and semi-arid region of Rajasthan and concluded that Araneidae, Oxyopidae and Salticidae were found most abundant families (41.44, 15.78 and 9.86% abundance, respectively) [17]. Another study on the spider fauna conducted in rice ecosystem in Kumarakom reported 17 species belonging to 6 families of which Tetragnathidae and Salticidae was species dominant families [18]. Similar to the present findings, study on diversity of spiders in agroecosystem from Vidarbha and Maharashtra and resulted in 50 species from 39 genera and 15 families [19]. Another work was done on diversity of predatory spider and their species composition in rice ecosystem in kolasib district of Mizoram and recorded total of 10 families, 20 genera and 31 species and Lycosidae was the most dominant family [20]. A total of 24 species of spider belonging to 10 families were found during the survey period in Jowai area of Meghalaya. However, 2 species among them were not identified. Family Araenidae was represented by the highest number (5 species) of spider followed by Tetragnathidae and Thomisidae (3 species each) [21].

Table 1: Checklist of spider recorded in the study

S. No.	Family	Genus	Scientific name
1	Araneidae	Argiope	*Argiope pulchella* (Thorell, 1881)
2	Araneidae	Argiope	*Argiope* sp.
3	Araneidae	Araneus	*Araneus mitificus* (Simon, 1886)
4	Araneidae	Araneus	*Araneus* sp.1
5	Araneidae	Araneus	*Araneus* sp 2
6	Araneidae	Neoscona	*Neoscona mukerjei* (Tikader, 1980)
7	Araneidae	Neoscona	*Neoscona* sp.1
8	Araneidae	Neoscona	*Neoscona* sp.2
9	Araneidae	Neoscona	*Neoscona bengalensis* (Tikader & Bal, 1981)
10	Araneidae	Neoscona	*Neoscona theisi* (Walckenaer, 1841)
11	Araneidae	Cyclosa	*Cyclosa hexatuberculata* (Tikader, 1982)
12	Araneidae	Cyclosa	*Cyclosa insulana* (Costa, 1834)
13	Araneidae	Cyclosa	*Cyclosa confraga* (Thorell, 1892)
14	Araneidae	Cyclosa	*Cyclosa* sp.
15	Araneidae	Larinia	*Larinia* sp.
16	Araneidae	Neogea	*Neogea nocticolor* (Thorell, 1887)
17	Lycosidae	Lycosa	*Lycosa* sp
18	Lycosidae	Lycosa	*Lycosa mackenziei* (Gravely, 1924)
19	Lycosidae	Pardosa	*Pardosa sumatrana* (Thorell, 1890)
20	Lycosidae	Pardosa	*Pardosa birmanica* (Simon, 1884)
21	Salticidae	Plexippus	*Plexippus paykulli* (Audouin, 1826)
22	Salticidae	Plexippus	*Plexippus* sp.
23	Salticidae	Phintella	*Phintella* sp.
24	Salticidae	Thiania	*Thiania* sp
25	Salticidae	Hasarius	*Hasarius adansoni* (Audouin, 1826)
26	Mimetidae	Mimetus	*Mimetus* sp.1
27	Mimetidae	Mimetus	*Mimetus* sp.2
28	Clubionidae	Clubiona	*Clubiona* sp.
29	Oxyopidae	Oxyopes	*Oxyopes bharatae* (Gajbe, 1999)
30	Oxyopidae	Oxyopes	*Oxyopes bimanicus* (Thorell, 1887)
31	Oxyopidae	Oxyopes	*Oxyopes* sp.
32	Tetragnathidae	Oxyopes	*Tetragnatha* sp.
33	Tetragnathidae	Guizygiella	*Guizygiella* sp. 1
34	Tetragnathidae	Guizygiella	*Guizygiella* sp. 2
35	Tetragnathidae	Tylorida	*Tylorida* sp.
36	Uloboridae	Uloborus	*Uloborus* sp.
37	Thomisidae	Diaea	*Diaea* sp.
38	Thomisidae	Oxytate	*Oxytate* sp.
39	Thomisidae	unidentified	unidentified
40	Theridiidae	Ruborridion	*Ruborridion* sp. 1
41	Theridiidae	Ruborridion	*Ruborridion* sp. 2

Table 2: Family wise distribution of spiders in the study area

S. No.	Family	No. of individuals
1	Araneidae	230
2	Lycosidae	179
3	Salticidae	55
4	Mimetidae	16
5	Clubionidae	14
6	Oxyopidae	107

7	Tetragnathidae	61
8	Uloboridae	8
9	Thomisidae	29
10	Theridiidae	32
	Total	731

Table 3: Arachnida at species level in rice ecosystem

Family	Species	Total
Araneidae	*Argiope pulchella* (Thorell, 1881)	32
	Argiope sp.	24
	Araneus mitificus (Simon, 1886)	7
	Araneus sp.1	7
	Araneus sp 2	18
	Neoscona mukerjei (Tikader, 1980)	17
	Neoscona sp.*1*	8
	Neoscona sp.2	8
	Neoscona bengalensis (Tikader & Bal, 1981)	31
	Neoscona theisi (Walckenaer, 1841)	12
	Cyclosa hexatuberculata (Tikader, 1982)	15
	Cyclosa insulana (Costa, 1834)	16
	Cyclosa confraga (Thorell, 1892)	8
	Cyclosa sp.	6
	Larinia sp.	10
	Neogea nocticolor (Thorell, 1887)	11
Lycosidae	*Lycosa* sp	72
	Lycosa mackenziei (Gravely, 1924)	48
	Pardosa sumatrana (Thorell, 1890)	32
	Pardosa birmanica (Simon, 1884)	27
Salticidae	*Plexippus paykulli* (Audouin, 1826)	14
	Plexippus sp.	8
	Phintella sp.	17
	Thiania sp	8
	Hasarius adansoni (Audouin, 1826)	8
Mimetidae	*Mimetus* sp.1	9
	Mimetus sp.2	7
Clubionidae	*Clubiona* sp.	14
Oxyopidae	*Oxyopes bharatae* (Gajbe, 1999)	35
	Oxyopes bimanicus (Thorell, 1887)	19
	Oxyopes sp.	53
Tetragnathadae	*Tetragnatha* sp.	38
	Guizygiella sp. 1	8
	Guizygiella sp. 2	7
	Tylorida sp.	8
Uloboridae	*Uloborus* sp.	8
Thomisidae	*Diaea* sp.	9
	Oxytate sp.	14
	unidentified	6
Theridiidae	*Ruborridion* sp. 1	10
	Ruborridion sp. 2	22

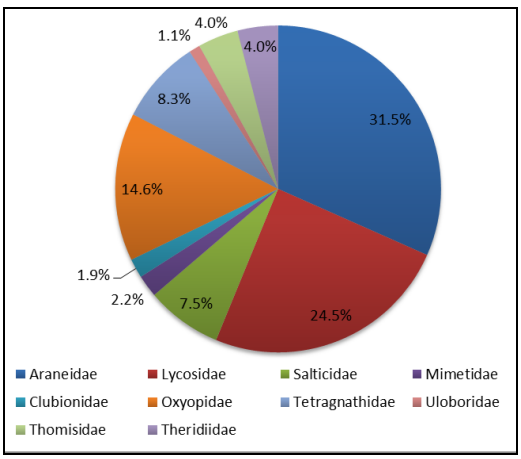

Fig 1: Comparative density (%) of spiders recorded during the study period.

Composition of guild structure

During this study, spiders collected were classified into six feeding guilds [22] namely orb weavers, stalkers, ground runners, ambushers, space web builders, foliage runners. Of these, the most dominant guild was orb weavers constituting 41.80% of the total sample collected, followed by ground runners (25%), stalkers (22.6%) as shown in Fig 2. Orb weavers were represented by nine species of the families Araneidae and Tetragnathidae. These spiders construct perfect orb webs for prey capture. Because of bright colouration and large orb webs, these spiders were easily recognized. Spiders belonging to the family Lycosidae constitute the ground runner guild which was represented by two species. The present findings are in accordance with the findings of Sharma and Singh who reported orb web weavers as the most dominant guild (44.34%) followed by ground runners (28.8), stalkers (16.5%) [23]. The abundance of orb weavers may be due to the dense canopy of rice field which makes them congenial for the formation of webs in the profuse vegetation. Grasslands and small shrubs provided good habitats for the lycosids. In addition, abundance of spiders is also related with the time of collection and sampling methods. Environmental factors spatial heterogeneity seasonality, habitat type, environmental stability, predation can also affect the diversity of species [24]. The most common explanation for the observed pattern of the spider guild structure includes its microenvironment and structural diversity. Complex habitat promotes diverse spider assemblage which results in increase diversity and abundance of food promoting rapid population increase and thus leading to elevated spider densities [25]. Studies have demonstrated that the spider habitat selection is affected by a variety of biotic and abiotic factors together with the architectural attributes of the habitat. Architectural attributes include size, shape and spatial arrangement of substrate used by spiders [26]. In general, spiders have preferences for humidity and temperature and these factors limit them to areas within the range of their physiological tolerances [27].

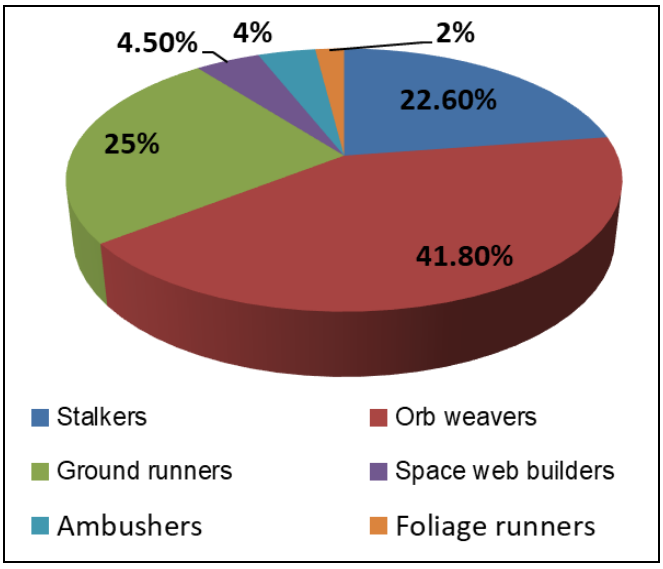

Fig 2: Composition of guild structure recorded during the study period

Conclusion

From the study, it can be concluded that the rice ecosystem has a diverse spider community, recording at a total of 731 individuals in 41 species belonging to 23 genera from 10 families. Araneidae was found to be the most dominant family contributing 31.55% of all the spiders collected. Four families *viz*., Uloboridae, Theridiidae, Clubionidae and Mimetidae were recorded with a single genus each. Spiders like *Pardosa* and *Tetragnatha* which are efficient natural enemies of rice pests were also recorded in the study. Indiscriminate uses of pesticides have resulted in pest resurgence and secondary outbreaks of insect pests therefore generalist natural enemies should be encouraged to increase the population build-up in agricultural ecosystems. Thus, the study on diversity of spiders put effort into the challenges in developing spiders as successful bio-control agents which is environmentally sound, economically viable and socially accepted pest management for future generations.,

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References

1. Francke OF. Biodiversidad de Arthropoda (Chelicerata: Arachnida exAcari) en México. Revista Mexicana de Biodiversidad. 2014;85:408-418.
2. Sudhikumar AV, Mathew MJ, Sunish E, Sebastian PA. Seasonal variation in spider abundance in Kuttanad rice agroecosystem, Kerala, India (Araneae). European Arachnology 2005;1:181-190.
3. Ghafoor A, Mohmood A. Population dynamics of the araneid fauna from district Gujranwala, Pakistan. Journal of Animal and Plant Sciences 2011;21(4):812-816.
4. Rajeswaran J, Duraimurugan P, Shanmugam PS. Role of spiders in agriculture and horticulture ecosystem. Journal of Food Agriculture and Environment 2005;3(3/4):147.
5. Maloney D, Drummond FA, Alord R. Spider predation in Agroecosystems: Can spiders effectively control pest population. MAFES Technical Bulletin 2003;190:1-32.
6. Oberg S. Diversity of spiders after spring sowing – influence of farming system and habitat type. Journal of Applied Entomology 2007;131(8):524-531.
7. Sudhikumar AV, Mathew MJ, Sunish E, Murugesan S, Sebastian PA. Preliminary studies on the spider fauna in Mannavan shola forest, Kerala, India (Araneae). European Arachnology Supplement 2005;1:319-327.
8. Solanki R, Siliwal M, Kumar D. A preliminary checklist of spiders (Araneae: Arachnida) in Jambughoda Wildlife Sanctuary, Panchmahal District, Gujarat, India. Journal of Threatened Taxa 2020;12(11):16576-16596.
9. Blackwell J. Descriptions of several species of East Indian spiders, apparently to be new or little known to arachnologists. Annuals and Magazine of Natural History 1867;19:387-394.
10. Parmar BM, Patel KB. Study of spider diversity from Vadnagar Taluka, Mahesana. Gujarat. Life Sciences Leaflets 2015;64:94-101.
11. Lang A. The pitfalls of pitfalls: a comparison of pitfall trap catches and absolute density estimates of epigeal invertebrate predators in arable land. Journal of pest science 2000;73(4):99-106.
12. Everton NL, Milton DS. Spider diversity in a rice agroecosystem and adjacent areas in Southern Brazil. Revista Colombiana de Entomologia 2009;35(1):1-5.
13. Ursani TJ, Soomro NM. Checklist of spider fauna of

Sindh Province, Pakistan. Pakistan Journal of Entomology 2010;32(1):61-73.
14. Jose AC, Sudhin PP, Prasad PM, Sreejith KA. Spider Diversity in Kavvayi River Basin, Kerala, Southern India. Current World Environment 2018;13(1):100.
15. More S. Diversity of spiders from Zolambi region of Chandoli national park. IOSR Journal of Pharmacy and biological sciences 2015;10(2):30-33.
16. Lone MA, Dar IY, Bhat GA. A study on ecological distribution and community diversity of spiders in Gulmarg wildlife sanctuary of Kashmir Himalaya. Journal of Ecology and the Natural Environment 2015;7(3):81-86.
17. Kumari V, Saini KC, Singh NP. Diversity and distribution of spider fauna in arid and semi-arid region of Rajasthan. Journal of Biopesticides 2017;10(1):17-24.
18. John RM, Tom H. A preliminary study on the spider diversity of a rice ecosystem in Kumarakom. Journal of Entomology and Zoology Studies 2018;6(5):827-829.
19. Keswani S. Ganesh V. Diversity, population and habitat used by spiders in banana agro-ecosystems. Indian Journal of Arachnology 2014;3(1):35-40.
20. Chowdhury S, Boopathi T, Chakraborty A, Sontakke PP, Paul T, Bhattacharjee D *et al*. Diversity of predatory spider and their species composition in rice ecosystem in Kolasib district of Mizoram. Innovative Farming 2017;2(1):12-18.
21. Anindita B, Mahadev C, Prabal S. Spider diversity in different habitats at Jaintia Hills of Meghalaya. International Journal of Life Sciences 217;5(4):613-619.
22. Uetz GW, Halaj J, Cady AB. Guild structure of spiders in major crops. Journal of Arachnology 1999;27:270-280.
23. Sharma A, Singh R. Biodiversity and guild structure of spiders in Northeastern Uttar Pradesh. Research Journal of Life Sciences, Bioinformatics, Pharmaceutical and Chemical Science 2018;4:525-541.
24. Rosenzweig ML. Species Diversity in Space and Time. Cambridge University Press Cambridge, UK, 1995, 458.
25. Schmidt MH, Tscharntke T. The role of perennial habitats for Central European farmland spiders. Agriculture Ecosystem and Environment 2005;105:235-242.
26. Hawksworth DL, Kalin-Arroyo MT. Magnitude and distribution of biodiversity. –In: Heywood, V.H. (ed) Global Biodiversity Assessment. United Nations Environment Programme. London: Cambridge University Press 1995,
27. Pandit R, Pai IK. Spiders of Taleigao Plateau, Goa, India 2017. https://doi.org/10.26502/jesph.96120022